A MICROPROCESSOR DEVELOPMENT SYSTEM FOR THE ALTOS SERIES MICROCOMPUTERS

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THESIS

A Microprocessor Development System
for the ALTOS Series Microcomputers

by

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An ALTOS series microcomputer is being used as the host computer in a microprocessor development system (MDS). The MDS hardware, consisting of the PRO-LOG STD bus, a Z8Ø cpu card, 2K bytes EPROM and 36K bytes random access memory, is controlled by the host via a single serial I/O port. The system provides the capability to develop and test both software and hardware in the combined CP/M (MP/M) and MDS environments.

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A Microprocessor Development System for the ALTOS Series Microcomputers

by

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Submitted in partial fulfillment of the requirements for the degree of

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ABSTRACT

An ALTOS series microcomputer is being used as the host computer in a microprocessor development system (MDS). The MDS hardware, consisting of the PRO-LOG STD bus, a Z80 cpu card, 2K bytes EPROM and 36K bytes random access memory, is controlled by the host via a single serial I/O port. The system provides the capability to develop and test both software and hardware in the combined CP/M (MP/M) and MDS environments.

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I. INTRODUCTION

The Naval Postgraduate School Electrical Engineering Department's microcomputer/microprocessor development laboratory, presently being used for microprocessor application courses at the beginning and intermediate levels, offers two methods of applications development. One method uses the Tektronix 8002 development system. While this system is very capable for hardware applications development, it is limited in available software, provides for use by only a single user at a time, and takes a considerable amount of time to learn to use properly. Also, because of the high cost of additional in-circuit emulation modules for different processors, the system has been slow to expand. On the other end of the spectrum, the ALTOS series single and multi-user microcomputer systems provide extremely good support for software development due to the vast variety of CP/M based software currently available. These systems have a much lower per-user cost and provide a work environment more enhancing to individual productiveness. The primary disadvantage, however, is the lack of support for hardware development, without having to get inside the computers and building some type of kludged interface whose reliability is often haphazard at best.

The design and implementation of a relatively low cost, low complexity, highly flexible microprocessor development system, combining many of the good features of each of these methods is the topic of further discussion in this thesis.

II. THE MICROPROCESSOR DEVELOPMENT SYSTEM

The bounding needs of this microprocessor development system (MDS) are grouped into the four areas listed below:

The overall system cost should be relatively low in contrast to large development systems such as the Tektronix 8002.

The MDS should be of low complexity in both software and hardware requirements.

The system should utilize existing software and hardware to the best extent possible.

The system should be expandable and easily customized or reconfigured to operate with numerous other microcomputer systems.

The determination of these needs made the selection of final requirements almost automatic. The primary decisions were what capabilities should be included in the MDS within the constraints of the needs given and the time available. Typical development system components include software support for editing, assembling and debugging applications programs and hardware support for testing both the software and hardware in an in-circuit emulation (ICE) environment.

Because of the low complexity constraint and the limited time available for this project, it was decided that the ICE component would be the area where most of the compromises would be made during the system design. To further meet the

stated needs, the decision was made to design the system for operation as a task in the CP/M and MP/M operating systems environment.

A. HARDWARE CONSIDERATIONS

Initial ideas for meeting the hardware needs of the MDS included utilizing an ALTOS microcomputer as the control computer for a separate hardware development system. The minimum hardware development system would consist of a dedicated microprocessor, EPROMs for an onboard monitor, sufficient random access memory (RAM) for storage and execution of fairly complex programs and a serial RS-232C port for interface to the ALTOS.

The ALTOS computer and the hardware development system together would form the complete microprocessor development system. For clarity, the ALTOS computer will henceforth be referred to as the 'HOST', the hardware development system as the 'MDS' and the overall system as the 'AMDS', for ALTOS Microprocessor Development System.

The MDS hardware was the subject of primary consideration during the initial stages of system design. Consideration was first given to wire-wrapping circuits to meet the stated minimum hardware requirements, but this approach was soon recognized as being prohibitive due to the considerable time requirements involved for this type of work.

This approach would also contribute to a less reliable and less flexible system for long term use and future expansion.

Thus, the decision was made to use a standardized bus system which has achieved industry acceptance in both proven applications and in manufacturer support and which would offer a reasonable initial system cost (under $1500.00). While several manufacturers offer such a system, the PRO-LOG Corporation STD bus was chosen over others primarily due to its immediate availability and local manufacturer support.

The final MDS hardware configuration consists of the following PRO-LOG components:

A 16 slot STD bus and card cage with provisions for wire-wrapped cards.

A 2MHz Z80 processor card with onboard provisions for up to 4K bytes of RAM and up to 8K bytes of 2716 EPROM.

Two 16K byte static memory cards.

A dual USART card consisting of two fully independent, asynchronous RS-232C serial ports with provision for one of these to be configured as a 20mA loop for TTY applications.

Several blank utility cards for wire-wrapped applications.

A DC power supply providing +5V/10A and ±12V/1A.

The only hardware modification necessary to get this system operable was the addition of a manual reset switch which is only a momentary ground to the push-button reset

pin (48) on the STD bus. The STD bus pin definitions are given in Figure 1.

PIN	MNEMONIC	DESCRIPTION
1	+5VDC	Logic Power
2	+5VDC	Logic Power
3	GND	Logic Ground
4	GND	Logic Ground
5	VBB#1	Logic Bias #1 (-5V)
6	VBB#2	Logic Bias #2 (-5V)
7	D3	Data Bit 3
8	D7	Data Bit 7
9	D2	Data Bit 2
10	D6	Data Bit 6
11	D1	Data Bit 1
12	D5	Data Bit 5
13	DO	Data Bit O
14	D4	Data Bit 4
15	A7	Address Line 7
16	A15	Address Line 15
17	A6	Address Line 6
18	A14	Address Line 14
19	A5	Address Line 5
20	A13	Address Line 13
21	A4	Address Line 4
22	A12	Address Line 12
23	A3	Address Line 3
24	A11	Address Line 11
25	A2	Address Line 2
26	A10	Address Line 10
27	A1	Address Line 1
28	A9	Address Line 9
29	AO	Address Line O
30	A8	Address Line 8
31	WR*	Write to Memory or I/O
32	RD*	Read Memory or I/O
33	IORQ*	I/O Address Select
34	MEMRQ*	Memory Address Select
35	IOEXP	I/O Expansion
36	MEMEX	Memory Expansion
37	REFRESH*	Refresh Timing
38	MCSYNC*	CPU Machine Cycle Sync.
39	STATUS 1*	CPU Status
40	STATUS O*	CPU Status

Figure 1 - PRO-LOG STD Bus Pin Definitions

PIN	MNEMONIC	DESCRIPTION
41	BUSAK*	Bus Acknowledge
42	BUSRQ*	Bus Request
43	INTAK*	Interrupt Acknowledge
44	INTRQ*	Interrupt Request
45	WAITRQ*	Wait Request
46	NMIRQ*	Nonmaskable Interrupt
47	SYSRESET*	System Reset
48	PBRESET*	Push-Button Reset
49	CLOCK*	Clock from Processor
50	CNTRL*	AUX Timing
51	PCO	Priority Chain Out
52	PCI	Priority Chain In
53	AUX GND	AUX Ground
54	AUX GND	AUX Ground
55	AUX +V	AUX Positive (+12VDC)
56	AUX -V	AUX Negative (-12VDC)

*Low-level active indicator

Figure 1 (cont'd)

B. SOFTWARE CONSIDERATIONS

The editing, assembling and debugging software needs for the AMDS were easily fullfilled by deciding to utilize CP/M based software. The basic CP/M and MP/M operating systems provide software for each of these needs, therefore simplifying the overall system design considerably. Additionally, the existence of a vast selection of CP/M based software products on the commercial market greatly enhances the growth prospects for software applications development with this system. An added feature of the decision to use CP/M based software is the ability to develop and test software on any microcomputer using the CP/M operating system. This feature alone is one of the most advantageous aspects of the AMDS.

With these capabilities accounted for, the remaining software considerations were those of determining the software requirements for the HOST to control the MDS and deciding upon those capabilities which should be included in the control software package.

C. THE SYSTEM CONTROL SOFTWARE

The system control software needs were divided into two areas: 1) the control program resident in the HOST, to be used in exercising overall control of both the ALTOS and the MDS and; 2) the MDS onboard monitor program, to be used for communications with the HOST and for interpreting and executing HOST commands.

1. <u>The HOST Control Software</u>

The primary functions of the AMDS control program resident in the HOST are to communicate with the system user and to exercise positive control of the MDS. It is intended to be the workhorse of the system, providing numerous routines to simplify the work required of the MDS.

A study of the monitor and control programs for typical development systems helped in identifying the following software needs as the most essential user requirements for implementation into the HOST control program:

A routine to download data from disk to MDS memory.

A routine to upload data from MDS memory and store it on disk.

A routine for examining and modifying MDS memory contents.

A routine for filling specified blocks of MDS memory with a specific byte of data for memory initialization.

A routine to locate a specific data sequence in MDS memory.

A routine to dump the contents of MDS memory to a CRT or printer in a format conducive to user interpretation.

A routine to initiate the execution of a program previously placed into MDS memory.

Each of these routines are implemented in the HOST control program. Additional routines provide: 1) the ability to perform additions and subtractions of two hexadecimal

numbers and display the results, 2) a routine for continuous modification of MDS memory without an intermediate examination of each location, and 3) routines for online user self-help and system use instructions.

The primary consideration in the design of the HOST control program was in making it user oriented. Thus, considerable effort was made to make the system easy to learn and to provide positive user feedback in all modes of operation. Examples of this include the implementation of a menu displaying all user options, detailed instructions for required input formats (available at any time), and fully explanatory error displays. Operation of the system is designed so that the user should never be in doubt as to what is going or what is required of him.

The control program flow is straightforward. Program parameters are first initialized followed by displaying the menu of options on the user's console and prompting him for input of the desired option. The input is then interpreted and a branch is made to the routine chosen, whereupon the user is again prompted for additional input unique to that option. Upon completion of the option, at the command of the user or after a trap to certain errors, the program returns control to the menu routine to await further user commands. This flow is easier visualized, as shown in Figure 2.

The flow of the individual option subroutines is equally simple. Upon entering each routine, again various

parameters are initialized and the user is prompted for initial input. When the proper input is received, the routine takes the necessary actions to perform the task, including communications with the MDS, if applicable, and prompting the user for additional inputs as required. On completion of the option, control returns to the menu routine.

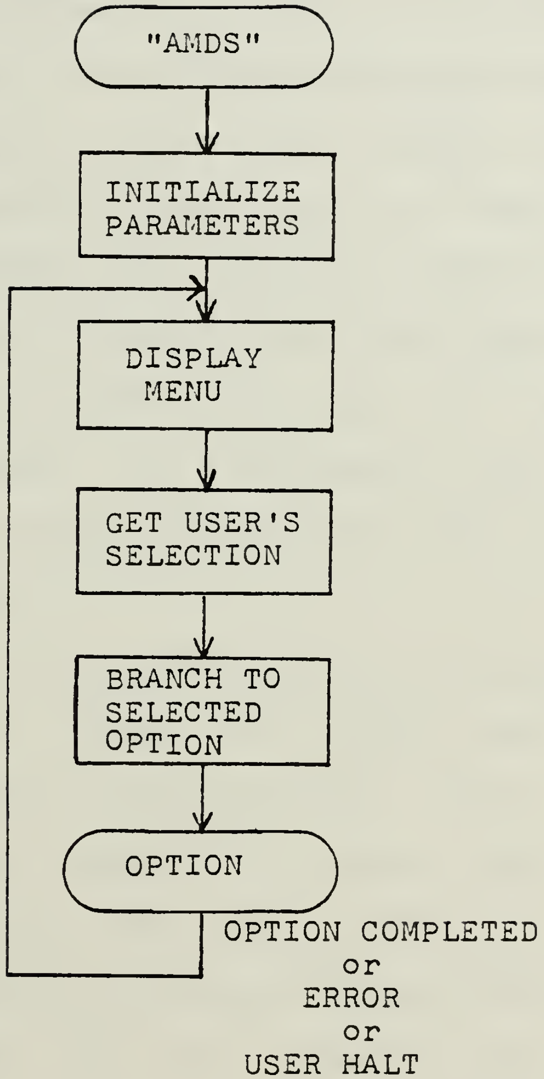


Figure 2 - HOST Control Program Flowchart

All user input is checked for validity including proper syntax, correct number and placement of parameter delimiters and for valid hexadecimal digits where applicable. Additionally, the input is checked for user requests for help or to terminate the option and return to the menu. Data input and output formats were kept as compatible as possible with those in the CP/M dynamic debugging tool (DDT). All input is terminated with a carriage return or a line feed and input line editing functions conform to the rules set forth in the CP/M and MP/M users manuals. By maintaining this degree of compatibility the learning cycle of the AMDS user should be lessened considerably.

System errors are divided into two categories; those due to faulty user inputs and those due to disk I/O operations. Depending on the particular error, errors may take one of three courses of action. They may return directly to the menu, they may restart the option in progress when the error occurred or they may simply return to the point where the error occurred and await user provided corrective measures. More details are provided in the AMDS user's guide.

The final area of the HOST control program requiring discussion is that of the routines and associated protocols used for intercommunication between the HOST and the MDS. Because the MDS may not always utilize a fast processor such

as the Z80 and since the MDS is provided with the ability to execute user programs in real time, it was conceivable that the MDS response time to the HOST could be considerably slow in some instances. This also brings up the possibility of lost data if the HOST is transmitting faster than the MDS can service its serial I/O port. A final problem in such an asynchronous setup is what the data sent is intended for, be it a command or some type of processable data.

In order to alleviate the lost data problem and to lessen the response time to the HOST, several assumptions were made in the communications software design. The primary assumption is that the HOST has communications priority at all times. From this assumption the following protocols were established and implemented. A type of software handshaking between HOST and MDS is provided for each character sent by either device. Some experimentation was done with the use of packets of characters greater than one, but some data loss was experienced when either the HOST or MDS was busy with other tasks besides I/O. Though time prohibited further experimentation in this area, it is felt that some type of hardware initiated control signals would be necessary to increase transmission/reception reliability in a packet communications mode for this system.

The protocol thus implemented follows several rules. For each piece of data to be transmitted two bytes of data are actually required. The first byte indicates the type of

data to follow. Types include command data, pure data, and status data. Each type is assigned a hexadecimal equivalent as follows:

Ø55H indicates that the next byte to be transmitted will be a command

ØFFH indicates that the next byte to be transmitted will be pure data

ØØH indicates that the next byte to be transmitted will be status data (the only currently implemented status data is ØØH, meaning the sender is at some point in the execution of its program where it awaiting input from the other device in order to proceed)

As an example, when the user wants to examine an MDS memory location the HOST first sends the data sequence:

Ø55H , Ø58H (Ø58H is the ASCII hexadecimal code for 'X', the Examine Command)

After receipt and display of the data in MDS memory, the user wants to change it to say, Ø3FH, thus the HOST would send the sequence: ØFFH , Ø3FH .

In addition to this rule, recall that a software handshake is provided for every character sent. As each character is received, the receiving system returns an acknowledgement byte of Ø11H, the ASCII hexadecimal code for XON, meaning the character has been received and further transmissions may proceed. At the same time, the sender is awaiting this acknowledgement before proceeding with further transmissions or continuing on to other tasks. This handshaking overhead seems unrealistically high at first glance, but it is negligible to the user for most types of

applications envisioned for this system and it provides a high degree of confidence in the communications setup. Perhaps the only time the communications throughput would be degraded, in the user's eyes, would be when an application program might require nearly continuous data transmissions for a lengthy period of time. A way around this particular situation is discussed in the section on system implementation.

To improve MDS response to HOST transmissions, the MDS checks for receipt of a HOST transmission prior to every output to the HOST. If the HOST has sent information, typically a new command, the MDS halts whatever it was doing and processes the new data.

Further details concerning the HOST control program are discussed in the system user's guide and all routines are well documented in the source code listings and flow diagrams in the appendices.

2. The MDS Onboard Monitor

Because the HOST control program was designed to do most of the the work required of the AMDS, the MDS monitor software was much easier to develop.

The monitor software essentially consists of a command/data interpreter, a set of complementary routines for each of the HOST initiated MDS options, and a similar set of I/O routines for communications with the HOST. The

program flow is basically the same as described for the HOST control program, with the exception that there is no direct input from the user. The MDS monitor does not have any error routines since all system error detection is built into the HOST control program. If for any reason the monitor does not understand the HOST transmissions it simply waits until something is sent that it does recognize and then proceeds. Though it is unlikely that the system will get hung up in a loop during normal HOST to MDS communications, if it should occur, either an ESCape sequence from the HOST or a manual reset of the MDS will terminate the loop. The only foreseeable circumstances in which this might occur are when a user program, executing in MDS memory, attempts to obtain information from the HOST when the HOST is not expecting such a request.

The monitor is written for automatic startup after either a system power-on reset or a manual reset. All MDS serial I/O ports are initialized to communicate at 9600 baud. Routines for user program I/O with the HOST console and for return to the MDS monitor are also provided via simple user calls, as explained in the user's guide.

Again, more detailed information may be best gleened from the AMDS user's guide, the flow diagrams and accompanying source code listings in the appendices.

III. SYSTEM IMPLEMENTATION AND CUSTOMIZATION

The AMDS is a modular system with respect to both software and hardware. Though this thesis is concerned primarily with implementation of the system as already stated, with an ALTOS microcomputer and the PRO-LOG STD hardware, the design is intended to be usable on any other CP/M or MP/M based system with only a few software changes and minor additional hardware interface requirements (beyond the MDS hardware needs, naturally).

A. PUTTING IT ALL TOGETHER

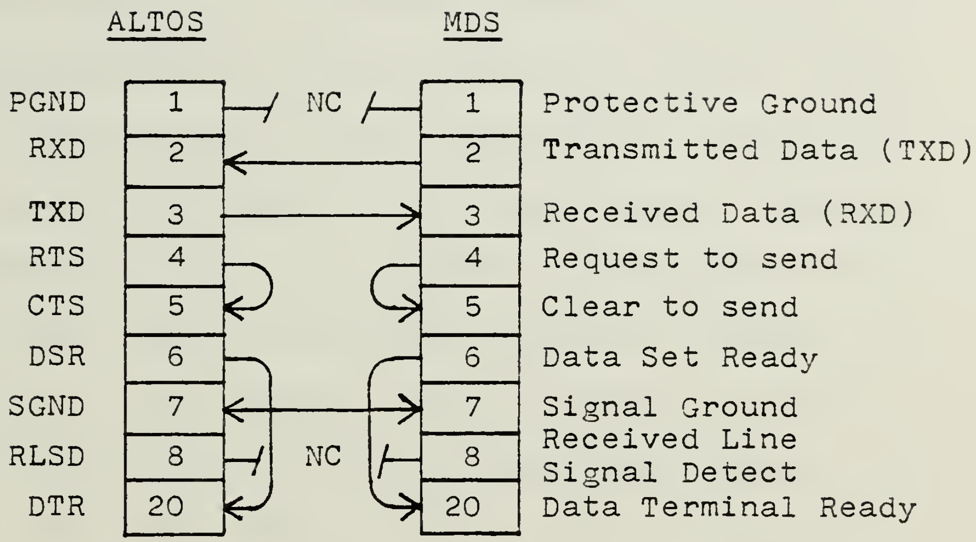
Implementation of the HOST control program is simply a matter of loading and executing the program via the normal CP/M method of typing in the name of the object file, in this case 'AMDS', followed by a carriage return or line feed.

Implementing the MDS system, while not especially taxing, does require the use of a PROM programmer to load the monitor software into EPROM. Once this is accomplished, and the EPROMs are installed, the system implementation is nearly complete. All that remains is connecting the systems together, turning on the power and the reset is automatic.

This particular development system is coupled together via a standard RS-232C connector cable set with a 25-pin,

DB-25P, male 'D' connector on the HOST end and a 26-pin female Amphenol connector on the MDS end. Only the signal ground, transmit and receive signals are necessary and other RS-232C signals are ignored in this implementation. (The standard RS-232C pin definitions are shown in Figure 3.) The HOST end of the connector is plugged into the auxiliary serial port on the ALTOS multi-user system and the MDS end is connected to the 'A' channel socket on the dual USART card. Additionally, it should be ensured that the 'A' channel is jumpered for DTE (Data Terminal Equipment) operation, as explained in the dual USART card documentation listed in the bibliography.

These procedures are all that is necessary to implement and use the basic system.



* NC - No Connection

Figure 3 - RS-232C Pin Definitions and
System I/O Setup

B. CUSTOMIZATION

The primary areas of customization of the AMDS are those concerning the use of different processors in the MDS and the use of different serial interfaces.

At present the PRO-LOG Corporation STD bus supports the 8080, 8085, Z80, Z80A and the 6800 series microprocessors. The current implementation uses the Z80 with onboard EPROM and RAM. The ROM and RAM address areas may be jumpered to either the lower (as done here) or the upper 16K of address space. In order to use the monitor in the upper 16K of address space would require a hardware addition capable of taking control of the address lines, at power-on reset or manual reset, and forcing the next execution address to coincide with the first address of the monitor. Otherwise, the Z80 (and 8080/8085) processors normally execute location 0000H after a reset sequence. If no monitor program is located at this location the processor executes garbage until a HALT instruction is encountered. An implementation of the monitor in high memory, however, is an idea to be well considered for future versions of the AMDS, as it would provide better compatibility with the page zero I/O mapping scheme used by the 6800 microprocessor. As an additional benefit, it would lessen some of the software limitations currently imposed by the current configuration. These limitations are discussed in a separate section of this paper.

As to the use of different serial I/O interfaces, several hardware additions may be necessary on the ALTOS computers. If the system is used with the single-user ALTOS computers, the options are to use the serial port currently used by the printer or to build an additional serial port into the computer via the use of its internal bus connector. If using the multi-user system, two AMDS systems could be supported simultaneously by simply using two of the serial ports currently used for consoles. To support four complete AMDS systems would require the addition of three more serial ports in a manner similar to that discussed for the single user system.

The changes in serial port usage would require a few minor changes in the HOST control program. If ZILOG SIO devices are used, as presently installed in the ALTOS series computers, the software modification reduces to simply changing the status (MSTATPT) and data (MDATAPT) port designations in the 'equates' (EQU statements) section at the beginning of the HOST control software source code and then reassembling the code for the new serial ports. If serial communication chips other than the SIO are used, the HOST control routines MDSTAT, MDSIN, and MDSOUT would have to be modified to operate with the particular chip chosen.

On the MDS side of the system, the customization process for software changes of serial ports is very similar to that of the HOST. Using additional INTEL 8251 USARTs would

necessitate only changes to serial port equates for CHASTAT and CHADATA in the MDS monitor source code, followed by reassembly and reprogramming of the EPROMs. Use of serial devices other than the 8251, would require appropriate changes to the MDS routines HOSTAT, HOSTIN, and HOSTOUT.

Beyond these hardware oriented customization procedures, provisions have been included for the addition of more user options and error processes in the HOST control software. Each of these areas use 'jump' tables to vector to the option or error routine selected. To add an option to the menu, the new option routines would be added to the body of the current source code, a JMP xxxx (xxxx is the option label) instruction would be added to the menu jump table and the menu display would be modified appropriately in the message storage section of the source code. The insertion of additional error codes is identical, except that the jump instructions are inserted in the error jump table.

One further comment on the addition of user options concerns the method of decoding the option selected. Menu options are identified by an assigned alphabetic character from A through Z (current options go only through the letter N). The ASCII code for each option is modified for use with the jump table in the following manner. The ASCII code is first 'anded' with the data 01FH. This removes all ASCII biasing and leaves only the hexadecimal equivalents of the numbers 1 through 26, corresponding to the letters A to Z.

These numbers are then used to find the appropriate vector from the jump table, as further explained in the source documentation. Thus the provision for twelve more options, O through Z, is included in the current version of the HOST control software. If these options are added, simple changes are also required to the equates for MAXCHCE, the highest option letter in use, and for NHSTCMD, the current number of 'host only' commands.

A consideration to keep in mind when editing the HOST software is the fact that it is currently a 62K byte file and thus larger than the index table capacity of the TED text editor used widely at the Naval Postgraduate School. For this reason, the source code is broken into two files: AMDSP1.ASM containing the primary option routines, and AMDSP2.ASM containing the utility and support routines and message and data storage definition areas. Prior to assembly, the files are concatenated via the use of the CP/M Peripheral Interchange Program (PIP) as follows:

```
PIP AMDS.ASM=AMDSP1.ASM,AMDSP2.ASM
```

The file AMDS.ASM is then assembled using whatever assembler is desired.

MDS monitor software customization is at least as simple, if not easier than that for the HOST. Commands are decoded via the simple mechanism of comparing the command to a set of known commands and then jumping to the option

routines selected. The only additional source code changes which might be applicable to the MDS would be a change of the assembly origin (ORG statements) addresses if the monitor is to be moved into upper memory as mentioned previously.

C. SYSTEM LIMITATIONS

This system, as with many other well designed systems, also has its limitations. Some of these have already been alluded to in previous sections and will now be discussed in more depth.

The current MDS configuration, with the lower 16K address space reserved for the monitor ROM and RAM, imposes several notable limitations on the use of the AMDS. Besides the page zero I/O mapping incompatibility between the 6800 and Z80, which has already been pointed out, the inability to use this address space for user program execution places a restriction on the types of CP/M based software which may be downloaded and executed in the MDS memory.

CP/M's executable object files, designated as '.COM' files, are created with the implied intent of loading and initiating the execution of these files from location 0100H. Since this location is within the reserved area in the MDS, such '.COM' files cannot be downloaded and executed in MDS memory. Unfortunately, most CP/M software on the commercial market is distributed in this format.

The restriction thus imposed is that only disk files in the INTEL Hex Format (see Figure 4) or in a page relocatable format may be downloaded and executed in MDS memory. This is because these formats are not dependent upon any address restrictions and are executable in whatever address space for which they are assembled.

RH	RL	LA	RT	DATA	CK

RH - RECORD HEADER: AN ASCII COLON (3A HEX) SIGNALS THE START OF EACH RECORD.

RL - RECORD LENGTH: TWO ASCII HEX CHARACTERS GIVE THE RECORD LENGTH (THE NUMBER OF 8-BIT DATA BYTES IN THE RECORD). END OF FILE IS INDICATED BY A ZERO RECORD LENGTH. (10 HEX IS MAX. RL)

LA - LOAD ADDRESS: FOUR ASCII HEX CHARACTERS GIVE THE ADDRESS WHERE THE FIRST DATA BYTE OF THE RECORD IS LOCATED.

RT - RECORD TYPE: THE RECORD TYPE IS ALWAYS 00 EXCEPT FOR THE LAST RECORD OF AUTOSTART FILES, WHERE IT IS 01.

DATA - TWO ASCII HEX CHARACTERS REPRESENT EACH 8-BIT DATA BYTE.

CK - CHECKSUM: TWO ASCII HEX CHARACTERS GIVE THE NEGATIVE SUM OF ALL PREVIOUS BYTES IN THE RECORD, EXCEPT FOR THE COLON. THE SUM OF ALL THESE BYTES PLUS THE CHECKSUM EQUALS ZERO.

Figure 4 - INTEL HEX File Record Format

The free address space of the present MDS, 4000H to 0BFFFH, is therefore sufficient for the needs of these file types. As mentioned, most distributed software does not come in these formats. For use of the MDS in beginner and intermediate level course work, however, this restriction should not be a dominant disadvantage in applications development and in gaining an insight into the use of microprocessors.

Because of the time constraints imposed, as well as this student's lack of familiarity with page relocatable file formats, only the use of type '.HEX' files are supported for upload and download operations in the current version of the AMDS.

Other limitations of the system are: the lack of breakpoint setting and cpu register examination facilities in the MDS; the lack of a facility for moving blocks of MDS memory; the inability to operate the MDS in a true in-circuit emulation mode; the current limitation of having only a single processor and the inability to operate multiple processors on the MDS bus; and the limitations already discussed concerning communications protocols.

Most of these limitations are only temporary, with the possible exception of obtaining true in-circuit emulation. The high communications overhead of the HOST to MDS interface can be avoided by user programs in the MDS memory

simply by utilizing a separate console and the additional MDS serial port when the need for high speed data transfer arises.

IV. CONCLUSIONS AND RECOMMENDATIONS

The original needs stated for the microprocessor development system have been met, with the exceptions noted as limiting factors. Even with these limitations imposed on the current design, however, it is felt that a significant tool has been added to the small, but growing Electrical Engineering microcomputer laboratory. The final design of the system has left considerable room for future expansion and improvement in both areas of software and hardware and is thus a good vehicle for additional thesis study.

A. FUTURE HARDWARE

There are numerous changes and enhancements to be made to the system in the hardware area. Some of these enhancements are described below.

Implementation of hardware initiated communication control signals to increase system response and throughput.

The addition of a Master/Slave cpu capability to operate and evaluate different microprocessor types on the same bus; this capability would have to be implemented via the use of interrupts and the bus request control lines plus appropriate software.

The addition of analog to digital and digital to analog (A/D and D/A) capability will significantly increase the usefullness of the system in hardware development applications.

Another worthwhile improvement would be the addition of a PROM programmer with the capability to change its personality under software control in order to program different types of PROMs.

..... and the list goes on.

B. FUTURE SOFTWARE

Many of the immediate enhancements to the system will probably be an outgrowth of the limitations pointed out previously. These include making changes for the use of CP/M '.COM' files and adding support for page relocatable files. These two additions alone, would tremendously improve the potential uses of the AMDS.

Other near future additions should include facilities for moving blocks of MDS memory and for the use of breakpoint, single-stepping and program trace routines. Such routines would probably be best implemented as individual files downloaded to the MDS memory. The routines could then operate as an extension of the onboard monitor. This would also provide the flexibility to execute routines for different processors under control of a dedicated monitor.

The addition of software for cross assembly of source code between various processors is another recommendation worth careful consideration. One idea, which was considered for inclusion in this thesis but was axed for lack of time, is the use of macro assemblers for cross 'translation' of source code. The idea would be to develop source code using

the standard mnemonics of a particular processor and then translate the source code to the mnemonics understood by whatever processor is actually available. Once this is accomplished, testing and debugging of the software can be done with available hardware. The code can then be translated or cross assembled back to code for the original processor and put to use in its intended application, all without the use of a true development system for that processor.

Finally, an area of great promise is that of systems networking. The new CPNET and MPNET loose-coupled network facilities, by DIGITAL RESEARCH Corporation, provide numerous avenues for further study into allowing the AMDS to share its resources with other computer systems.

All of these improvements are feasible and cost effective. These additions will also allow much of the burden to be taken off the beginning program and hardware designers. Much of the less interesting trivia normally associated with applications development can be skipped over and the solution to the problem can be approached in a more efficient and structured manner.

APPENDIX A

AMDS USERS GUIDE

TABLE OF CONTENTS

AMDS USERS GUIDE

1. INTRODUCTION

The ALTOS Microprocessor Development System (AMDS) is designed to be used as an aid to students in beginning and intermediate levels of software and hardware applications development. The system consists of an ALTOS microcomputer, running under the CP/M or MP/M operating systems, and a hardware development and testing system built around the PRO-LOG STD bus. Included in the current (June 1981) hardware development system are a 2MHz Z80 cpu card with onboard monitor in EPROM and 4K bytes of static RAM, two 16K byte static RAM cards and a dual USART asynchronous RS-232C serial I/O card. The ALTOS and the hardware development system are linked together via a serial I/O channel.

The ALTOS computer, hence referred to as the 'HOST', exercises control over the hardware development system (designated as the 'MDS') via the execution of the HOST control program named AMDS.COM . The onboard monitor in the MDS contains routines which complement those in the HOST control program, though on a less complex scale. A more detailed treatment of the inner workings of the AMDS system is available in the student thesis by LT. Stephen M. Hughes, USN, titled "A Microprocessor Development System for the ALTOS Series Microcomputers".

2. HOW TO USE THE AMDS

The AMDS' primary use is in the design and testing of both software and hardware applications in a real time environment. The typical steps for effective use of the system would be as follows:

a) Using standard CP/M or MP/M software development tools, such DDT, TED, ED, ASM and MAC, the user would develop, test and debug (to the extent possible) software to be used in a hardware/microprocessor oriented application.

b) Simultaneously to step a), the user, or other members of a project team, would be designing, wire wrapping and performing initial tests on the hardware, using available test equipment such as oscilloscopes, digital voltmeters, etc.

c) At such time as the hardware and software are ready to be tested together, the AMDS would come into use. At this point the wire wrapped circuitry would be inserted into a slot in the development bus, the software would be downloaded to the MDS memory and, via the use of the AMDS user options, the software and hardware would be tested as a single unit.

d) Refinements and correction to both hardware and software could then be made as in steps a) and b) and step c) then repeated until the application operates as intended.

The intent of this procedure, though it might appear cumbersome, is to allow the software programmers to concentrate on their work using proven and tested development aids while simultaneously allowing the hardware designer/builders to forge ahead in their respective areas. The lesson to be learned is the ′real world′ concept that communications between such distinct but collectively important segments of a team effort are what is necessary for successful fullfillment of the project goals. These intergroup communications require that each team carefully plan the project in its initial stages of development and that the division of responsibilities and the methods of implementation of the project are thoroughly understood by all members of the team. With this type of planning and communication of ideas, the AMDS concept is thus seen as less cumbersome than initially thought and actually allows for a very flexible working environment. The use of the AMDS also relieves the hardware designers of much of the burden previously placed on students to design and wire wrap their own cpu and memory cards.

3. GETTING STARTED

This section is intended as a quick review for those already familiar with the use of the AMDS. Others should carefully review the remainder of this guide prior to attempting to use the system.

With software developed and tested as best possible (naturally those software routines fully dependent upon the hardware have not been completely tested) and with the hardware prototype in hand, the stage is set for utilization of the AMDS.

With the MDS power OFF (!) the prototype card is inserted snugly into one of the wide slots of the card cage which are specially designed to accept wire wrapped cards. After insuring the card is properly in place, the power is then switched on and the MDS reset switch is pressed. The MDS is now ready for use.

Next, the AMDS HOST control software is initiated from the ALTOS system console by typing 'AMDS', followed by a carriage return. The HOST control program then loads into memory and begins execution by displaying a menu of user options and prompts the user for a reply. At this point the user(s) may proceed with testing using the options described in subsequent sections of this guide.

4. SYSTEM FUNCTIONS (USER OPTIONS)

The AMDS control program is designed as a menu-driven program. This means that after each primary task is completed, the user is shown a menu of options from which he may chose his next move. Each of these options is discussed in the remainder of this section of the guide.

A. SUPPRESS PRINTING MENU -

Selection of option 'A' allows the experienced AMDS user to automatically suppress the display of the menu at the end of each option. When this is done the system status (whether the HOST or MDS is in control) and reminders of which option suppresses and which does not suppress the menu are printed, followed by the prompt to input a menu option.

B. DO NOT SUPPRESS PRINTING MENU -

Opposite of option 'A', option 'B' allows the user to regain full menu display if he cannot remember the option code he wishes to select.

C. BASIC INSTRUCTIONS -

Option 'C' displays a set of basic instructions for use of the AMDS. These instructions should normally answer the questions of most first time users without the need to resort to this guide.

D. HEXADECIMAL ADD and SUBTRACT -

Option 'D' allows the user to quickly obtain the 16 bit hexadecimal sum and difference of two numbers. When this option is selected, a message verifying the option actually entered will be displayed, followed by a prompt for input.

The input expected is two hexadecimal numbers, of up to four digits each, separated by either a comma or a space as the following example shows:

>Ø1AF F3AB or >Ø1AF,F3AB

The sum and difference of these two numbers are then displayed as:

SUM = F55A DIFF = ØEØ4

The user is then returned to the menu for selection of another option.

(** This option has the same input format as the 'H' command in DDT **)

E. RETURN SYSTEM CONTROL TO HOST -

Selection of option 'E' is necessary only when the system control has been passed to the MDS via a previous command for it to execute a program in its own memory. This option then allows the user to request the MDS to

terminate its present action and return control to the HOST in preparation for subsequent commands.

** Note that this option may not be effective if the program being executed in MDS memory runs astray or never checks for or attempts to perform I/O with the HOST. The only remedy in this situation is to manually reset the MDS.

F. RETURN TO CP/M -

Selection of option 'F' will terminate use of the AMDS and return the user to the CP/M (or MP/M) operating environment. (The input of a control C as the first entry after any prompt will also accomplish the same thing.)

G. DOWNLOAD HEX FILE - DISK TO MDS -

Option 'G' allows the user to download an INTEL Hex format file from disk to MDS memory. Hex files are normally generated in the course of the assembly process.

** Note that only 'HEX' file types are supported in this version and the system will not accept requests for any other types.

When this option is selected, an option verification message is displayed and the user is prompted to input the filename. The entry of the filetype 'HEX' is

optional but acceptable. Rules for acceptable filenames follow those set forth in CP/M documentation with the exception that ambiguous filenames (those containing ?'s) are not accepted. Additionally, only the currently logged in disk drive will be used for disk I/O and if the drive select code is entered with the filename it will be ignored if it fails to match that which is currently logged in.

After the Hex file is successfully downloaded, a message to that effect will be displayed and the user will be returned to the menu.

H. UPLOAD MDS MEMORY TO HEX DISK FILE -

Option 'H' is just the reverse of option 'G'. Filename input is the same. After the filename is input, the user is prompted for the starting and ending addresses in MDS memory from which the contents are to be saved on disk in a 'HEX' type file. Acceptable inputs are two hexadecimal numbers, the first being less than the second, input in the same manner as in option 'D':

>403C 659F

When the upload is completed, the user will be so informed and returned to the menu.

I. EXAMINE/SET MDS MEMORY LOCATION(S) -

Option 'I' allows the user to examine and modify (set) the contents of MDS memory. The first prompt is for the initial MDS address to be examined such as: >ØBC3 . The system then fetches the data from that location and displays it as:

ØBC3 3A

and waits for more input after the '3A'. If the user desires to change the data in that memory location, he may then enter the new data. The system stores the new data and automatically advances, examines and displays the next sequential location in MDS memory. This process continues until a period is the only data input.

If no modification of a memory location is desired, a carriage return will cause an advance to the next memory location without modifying the MDS memory.

(** This option has the same I/O format as the 'S' command in DDT **)

J. CONTINUOUS SET OF MDS MEMORY -

Option 'J' is similar to the examine/set option ('I') except that it does not examine the MDS memory, it only modifies it with sequential input data. The first input requested is the starting MDS address for modifications, i.e. >13DA . The second and subsequent prompts are for

data to be entered into MDS memory, sequentially starting at the address specified. Input data may be up to 255 characters long (including spaces and commas) for a single line of input. If more than 255 characters are input, the system merely issues another prompt for a continuation line. Each byte of data is separated by a space or a comma. When input is completed, a period entered after the prompt will terminate the option.

K. FILL MDS MEMORY WITH SPECIFIED BYTE -

Option 'K' enables the user to fill any portion of MDS memory with a specified byte of data. The advantage of this is to allow the user better knowledge of the current contents of MDS memory and to help in identifying needed data during memory dumps to the CRT. The input expected after the prompt are the start and ending MDS addresses followed by the data to be placed in those locations. For example:

>Ø395,7FDØ,2A	will fill MDS memory between, and including, locations Ø395H and 7FDØH with data 2A, the ASCII code for '*'

(** This option has the same input format as the 'F' command in DDT **)

L. LOCATE BYTE SEQUENCE IN MDS MEMORY -

Option 'L' allows the user to search MDS memory for a sequential data sequence up to 16 bytes long. The first input prompted for is the search start address followed by an optional end address as shown:

>0023 579A or >0023

If no end address is given it will default to 0FFFFH. The next prompt is for the byte sequence as:

>00 03 45,9A,CC ..... up to 16 bytes

If the sequence is found, the starting address of the sequence in MDS memory is displayed. If not found, an appropriate message is also displayed.

M. DUMP MDS MEMORY LOCATION(S) TO CONSOLE -

Option 'M' provides for a hexadecimal and ASCII MDS memory dump to the CRT. The only inputs required are the start and optional end addresses for the dump in the same format as option 'L'. If no end address is specified it defaults to the start address + 256.

(** The dump I/O format is the same as that for the 'D' command in DDT **)

If the user wishes to continue the dump after the initial dump completes, he may type in the letter 'D' to

dump the next 256 byte block. Any other input will return the user to the menu.

** Note that unlike the DDT dump command, the only way to abort a memory dump is by pressing the ESCape key.

N. EXECUTE MDS MEMORY FROM A SPECIFIED LOCATION - Option 'N' allows the user to pass system control to the MDS and let it execute a program in its memory. User input required is the MDS start address of the program to be executed. After the address is input, the user is asked whether or not the program to be executed in MDS memory will be sending data to the HOST console for display. If the answer is no, then the user is returned to the menu. IF the answer is yes, then the HOST system loops waiting for data to display, until one of the conditions mentioned below is met.

** Note that when this option is selected, the options F through N are disabled until the MDS returns control to the HOST; when the 'E' option is selected; or when the MDS system is manually reset.

** For further discussion on the proper use of this option, see the section on 'TIPS FOR MDS PROGRAMMING'.

5. INFORMATION OF GENERAL INTEREST

a) The prompt for all user input is '>' .

b) All inputs may be in either upper or lower case alphabetics.

c) All input is terminated with either a carriage return or a line feed.

d) All address and data inputs are expected to be in hexadecimal notation. Address inputs contain from 1 to 4 hex digits and data inputs contain 1 or 2 hex digits.

e) When inputting addresses and data, mistakes may be corrected in two ways: 1) by using the RUBOUT key or backspace keys to delete input or 2) by simply continuing to input the hex characters until the correct ones are input. For addresses, the program always takes the last four or less hex digits input and for data, the last two or less digits entered. At least one digit must be entered for every required input parameter.

f) A question mark '?' entered during input will cause the required input formats for each option to be displayed. When the display is completed, the currently selected option is restarted.

g) If the ESCape key is entered as input, the option is immediately terminated and the user is returned to the menu.

h) The MDS is automatically reset at power-on but it is generally a good idea to manually reset it anyway.

i) The MDS to HOST serial I/O port and the additional I/O port in the MDS are both initialized at every reset to operate at a 9600 baud rate.

6. TIPS FOR PROGRAMMING THE MDS

a) If a program requires considerable communications with the user, the best terminal response will be gained by using a separate CRT attached to the spare serial I/O port in the MDS. This port may be reprogrammed for a different baud rate if necessary (see the PRO-LOG dual UART documentation for detailed steps for programming channel B).

b) If the user does not wish to fool with programming the MDS channel B USART, but still has the need for console I/O, his program may use the routines built into the monitor specifically for this purpose. In a manner similar to the BDOS calls used by CP/M, the user program may call location 0005H in the monitor for console I/O using the HOST console. The conventions for these calls is as follows:

- for input from the HOST console the user program should call MDS address 0005H with the function code 01H in register C; the character from the console will be returned in the Accumulator

- for output to the console, a call is made to MDS address 0005H with the function code 02H in register C, and the character for output in the Accumulator

- to merely check to see if input has been received from the HOST, address 0005H is called with function code 03H in register C ; if no character is waiting the accumulator will be returned = 00H, otherwise A = 0FFH meaning input has been received

- if a call is made to MDS address 0005H with a function code in register C other then 01H, 02H or 03H, no I/O will take place and the C register will be returned with 0FFH

** Two points should be remembered when using the HOST console for I/O:

1) the data returned from the I/O port is a full eight bits as received with no stripping of the high order bit for ASCII data

2) when the console is to be used for user program I/O, be sure to answer yes to the query about console I/O when option 'N' is selected

c) if no I/O with the host console is necessary, as in a) above, the user program should at least periodically check the HOST port status to see if it wants to terminate the execution of the user program. If data is waiting a call should be made as explained above to fetch the data so that the monitor can interpret it

d) the user always returns control to the HOST via a jump to location 0038H in MDS memory; a RST 7 instruction will also accomplish the same thing

e) do not forget that MDS user memory starts at location 4000H and all HEX files should be assembled for addresses above that location

7. SYSTEM ERROR MESSAGES

System error messages are the result of either user data input errors or disk I/O errors. A list with brief explanations follows:

A. USER INPUT ERRORS -

INVALID MENU SELECTION - this message is displayed when an option is input which is not one of the selections from the menu. (* this error returns the user to the menu *)

TOO MANY OR TOO FEW DELIMITERS IN INPUT - used to indicate that too many or too few parameters were input than expected. Acceptable delimiters are a space or a comma. (* this error restarts the current option *)

PERIOD ONLY PLEASE ! - given when a period is input to terminate input and the period is preceded or followed by other input data. Only a period may be input. (* this error restarts the current option *)

INVALID HEX DIGIT - an input of a non-Hex digit (not in the range Ø-9, A-F) was attempted. (* this error restarts the current option *)

CAN'T HAVE A DELIMITER AT START OR END OF INPUT - either a space or a comma was input as the first or last character in an input line. (* this errorestarts the current option *)

TWO OR MORE DELIMITERS SEQUENTIALLY - too many delimiters were inserted between input parameters. (* this error restarts the current option *)

AMBIGUOUS FILENAMES NOT ALLOWED - the filename which was input contained a '?' . (* this error reprompts for new input *)

COLON (:) NOT PROPERLY PLACED IN FILENAME - the only colon allowed in the filename is after the drive code and before the first letter of the filename. (* this error reprompts for new input *)

FILENAME TOO LONG OR TOO SHORT - maximum filename length is 8 characters; minimum is 1. (* this error reprompts for new input *)

HEX FILETYPES ONLY ! - only files of type '.HEX' are implemented in this version. (* this error reprompts for new input *)

NO SPACES ALLOWED IN FILENAME - filename characters must be sequential with no spaces. (* this error reprompts for new input *)

NON-PRINTABLE CHARACTERS NOT ALLOWED IN FILENAME - only printable characters are allowed in filename. (* this error reprompts for new input *)

START ADDRESS CANNOT BE GREATER THAN FINISH ADDRESS - when in the UPLOAD option, the user must specify MDS memory address boundaries for upload with the start address lower than the end address. (* this error restarts the upload option *)

WARNING - ONLY CURRENTLY SELECTED DISK WILL BE USED, INPUT IGNORED ! - this version of AMDS does not allow disk drive specification unless it is the same as the disk currently logged in to the user. Other drive specifications are ignored and the option defaults to the currently logged disk.

B. DISK I/O ERRORS -

FILE NOT FOUND - the file specified cannot be found in the directory for download to the MDS. (* this error restarts the download option *)

HEX CHECKSUM ERROR - a data error was detected while trying to download a HEX file. (* this error returns the user to the menu *)

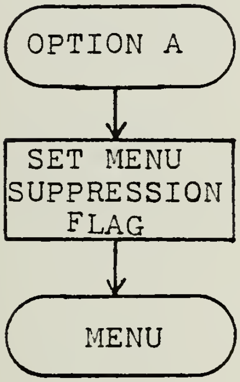
DISK READ ERROR - an attempt was made to read a disk file but was unsuccessful; check diskette media then the disk drive. (* this error returns the user to the menu *)

OUT OF DIRECTORY SPACE - disk directory is full; delete files or use another diskette. (* this error returns the user to the menu *)

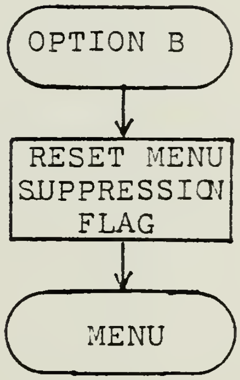
OUT OF DIRECTORY OR DISK STORAGE SPACE - ran out of space in one of these areas while attempting to write data to a disk; *** when this occurs, the data already written is deleted, i.e. NO PARTIAL files are saved ***. (* this error returns the user to the menu *)

APPENDIX B

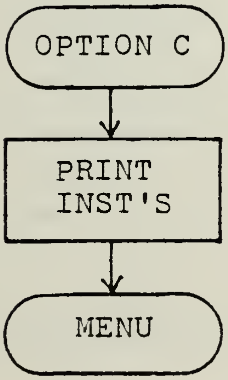
FLOWCHARTS FOR HOST AND MDS USER OPTIONS



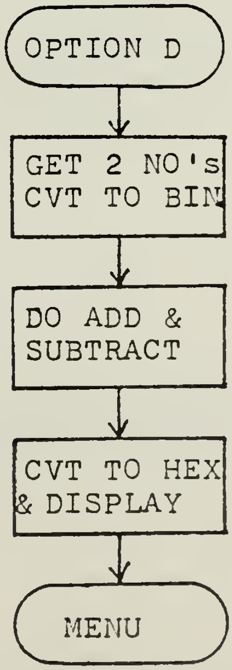
MENU SUPPRESSION



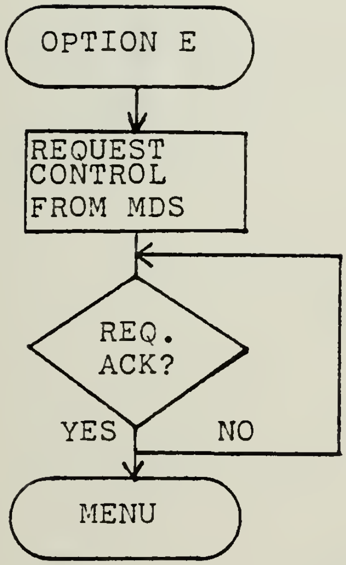
NO MENU SUPPRESSION



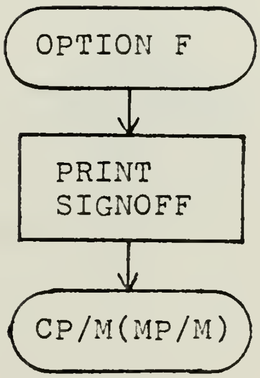
BASIC INSTRUCTIONS



HEX ADD/SUBTRACT

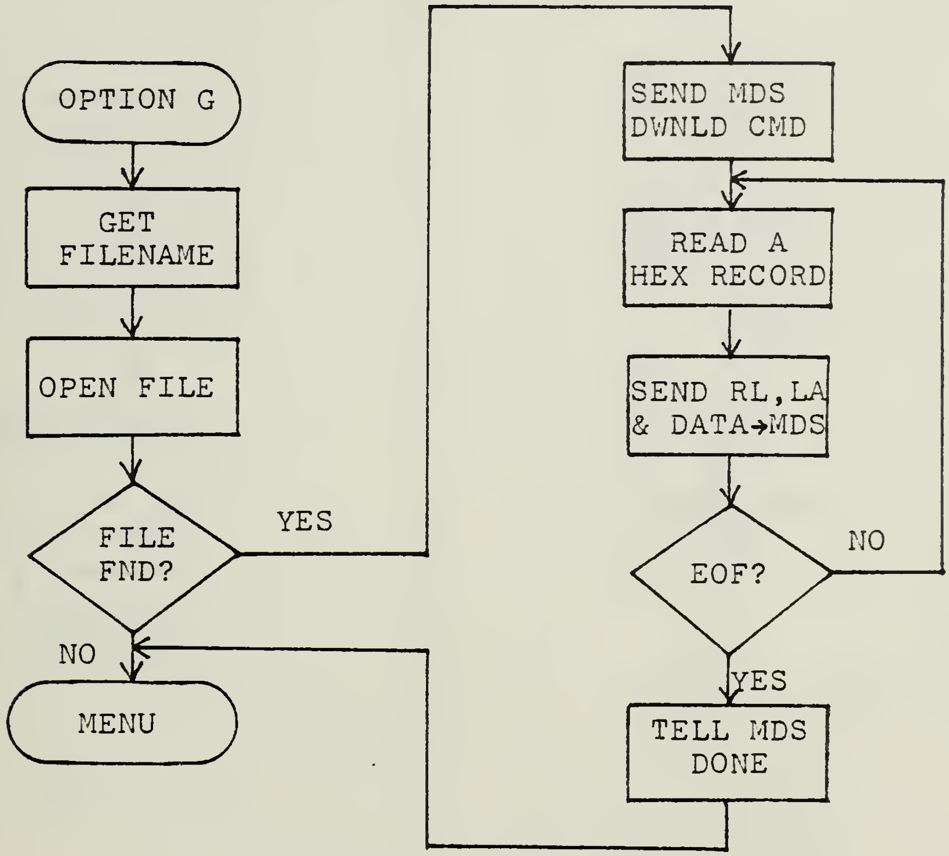


RETURN CONTROL TO HOST

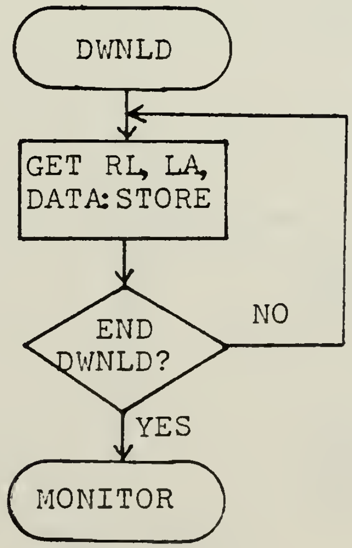


RETURN TO CP/M

DOWNLOAD HEX FILE TO MDS MEMORY

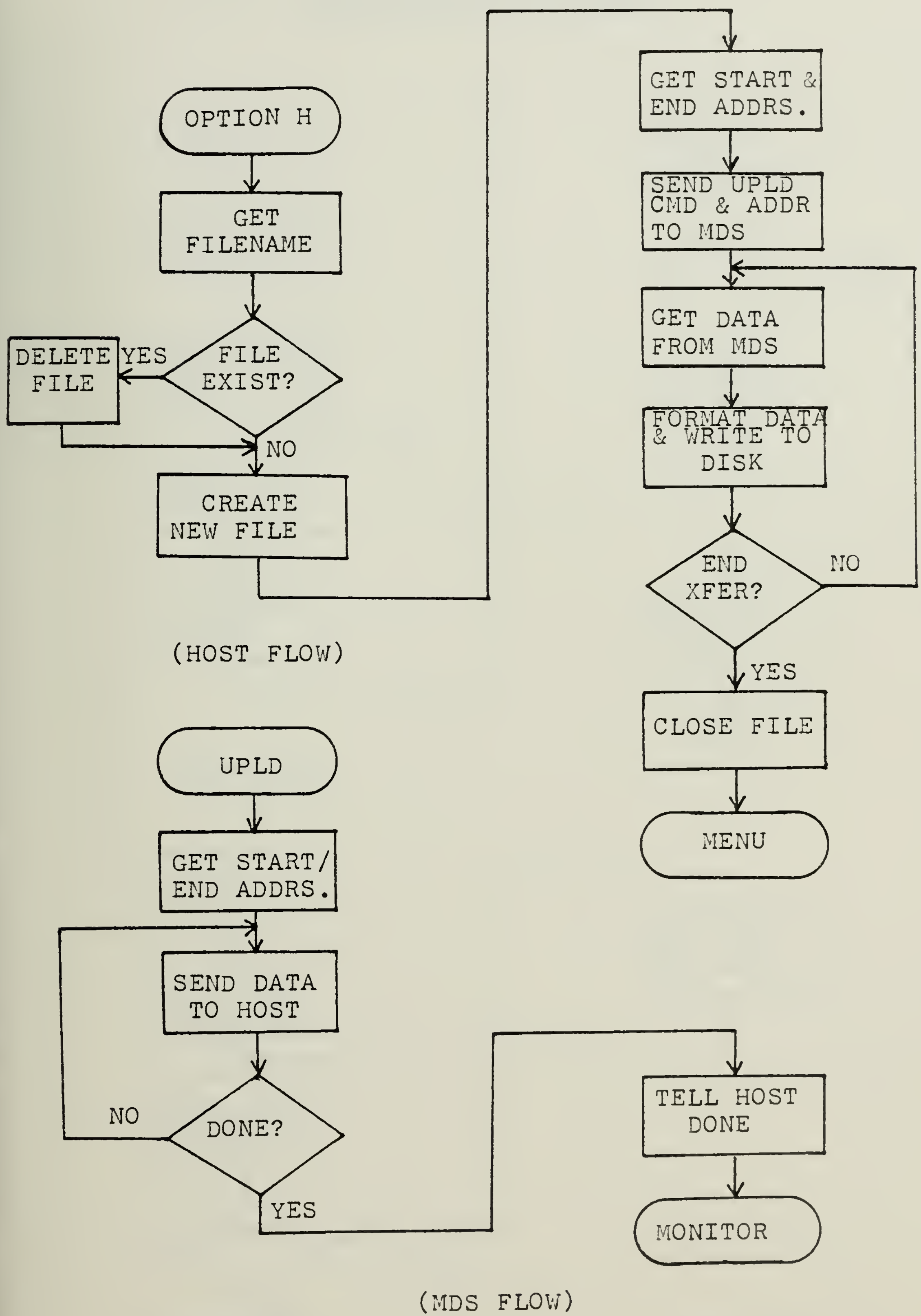


(HOST FLOW)

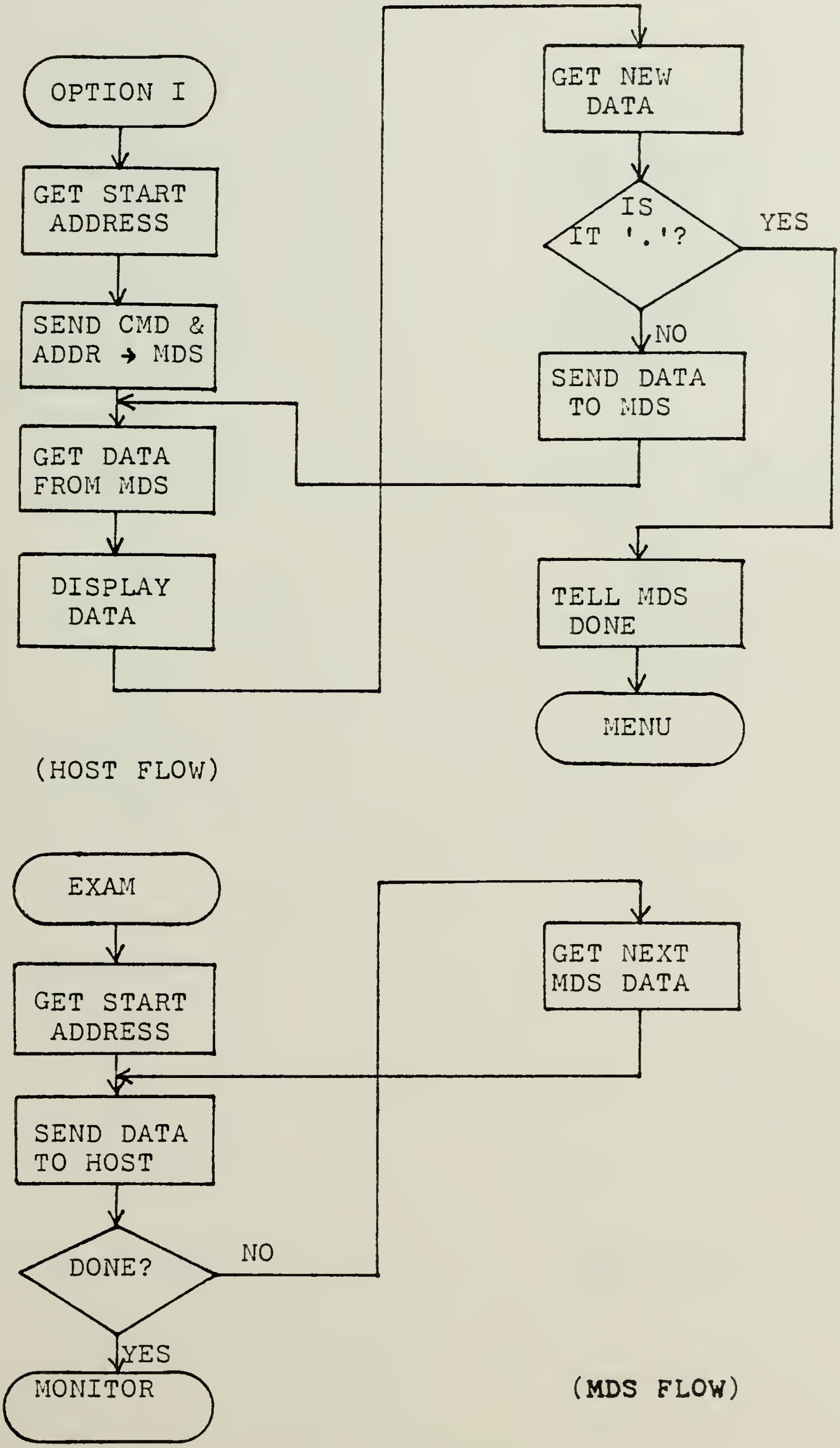


(MDS FLOW)

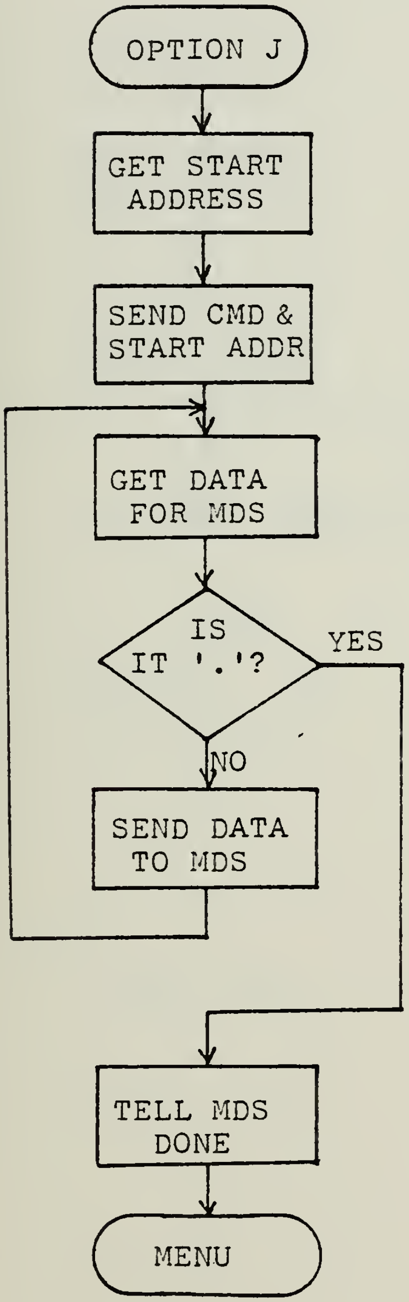
UPLOAD FROM MDS MEMORY TO HEX DISK FILE



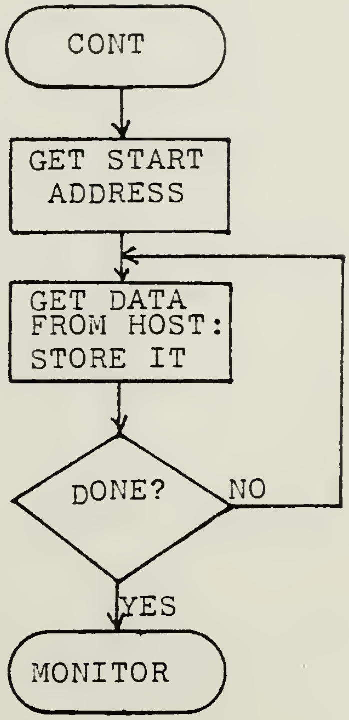
EXAMINE/SET MDS MEMORY



CONTINUOUS MDS MEMORY SET

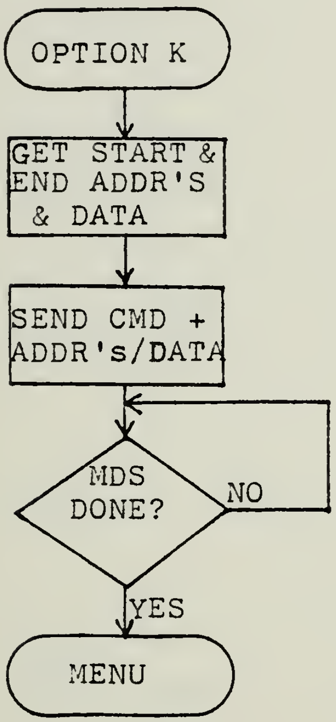


(HOST FLOW)

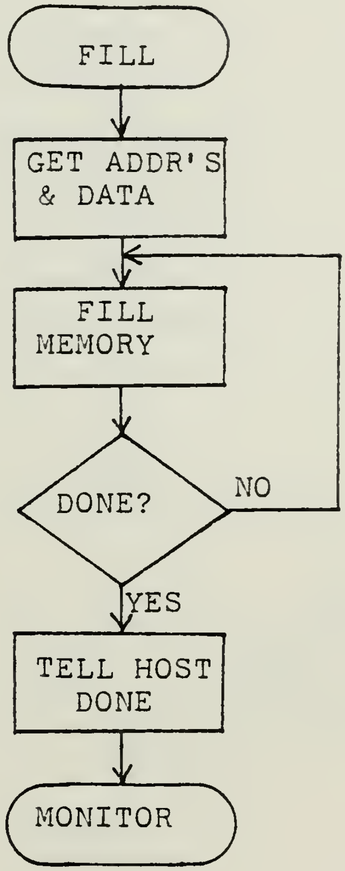


(MDS FLOW)

FILL MDS MEMORY WITH SPECIFIED BYTE

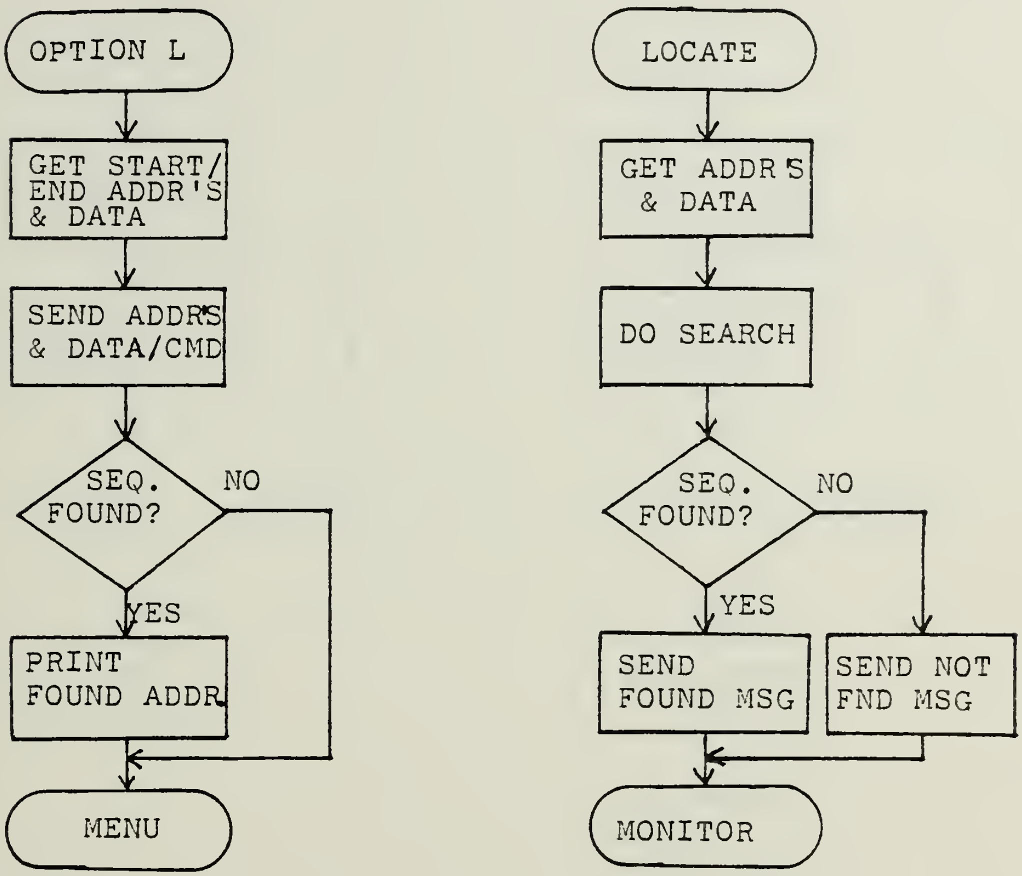


(HOST FLOW)



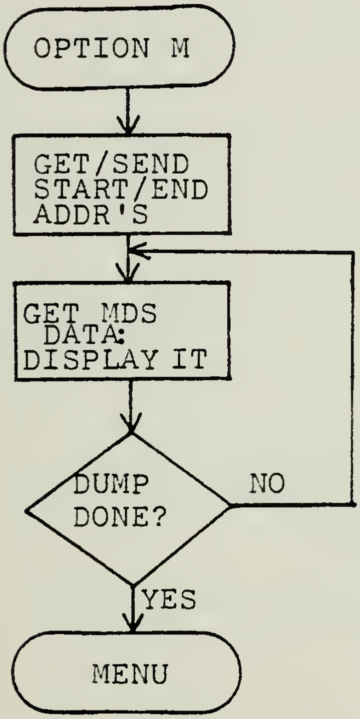
(MDS FLOW)

LOCATE BYTE SEQUENCE IN MDS MEMORY

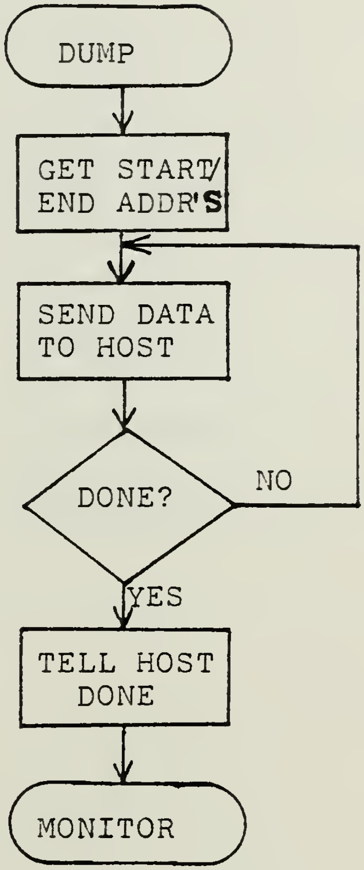


(HOST FLOW) (MDS FLOW)

DUMP MDS MEMORY TO THE HOST CONSOLE

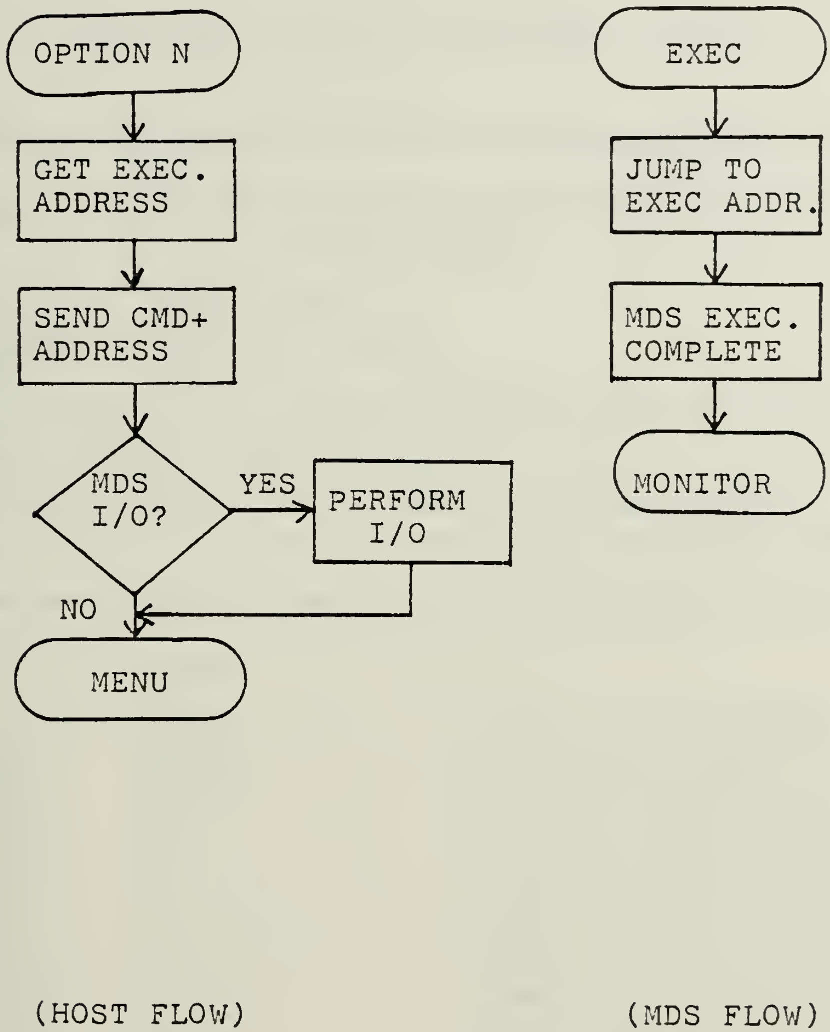


(HOST FLOW)



(MDS FLOW)

EXECUTE USER PROGRAM IN MDS MEMORY



APPENDIX C

AMDS HOST CONTROL SOFTWARE LISTING

```
****************************************************************
*                                                              *
*     AMDS - ALTOS MICROCOMPUTER DEVELOPMENT SYSTEM            *
*                      (HOST CODE)                             *
*                                                              *
* VERSION 1.5,  28 MAY 1981                                    *
* LT. STEPHEN M. HUGEES - author                               *
*                                                              *
*    This is the HOST (ALTOS) control code for the AMDS.       *
* Separate code for the MDS onboard monitor is listed          *
* under the filename AMDS1.ASM .                               *
*    The AMDS user's manual should be consulted for            *
* specifics not given in the documentation which follows.      *
*                                                              *
****************************************************************

        org     100h

CPM     EQU     0000H               ;WARM BOOT RE-ENTRY TO CP/M
BDOS    EQU     0005H               ;DOS ENTRY POINT
MSTATPT EQU     29H                 ;MDS SIO STATUS PORT
MDATAPT EQU     28H                 ;MDS SIO DATA PORT
CONIN   EQU     1                   ;CONSOLE INPUT FUNCTION
CONOUT  EQU     2                   ;CONSOLE OUTPUT FUNCTION
PRTSTRG EQU     9                   ;PRINT STRING TO CONSOLE
READCON EQU     10                  ;READ CONSOLE BUFFER
CONST   EQU     11                  ;CONSOLE STATUS FUNCTION
OPENF   EQU     15                  ;OPEN FILE FUNCTION
CLOSEF  EQU     16                  ;CLOSE FILE FUNCTION
DELF    EQU     19                  ;DELETE FILE FUNCTION
READF   EQU     20                  ;READ SEQUENTIAL FUNCTION
WRITEF  EQU     21                  ;WRITE SEQUENTIAL FUNCTION
MAKEF   EQU     22                  ;MAKE FILE FUNCTION
CURRNTD EQU     25                  ;GET CURRENT DISK FUNCTION
SETDMA  EQU     26                  ;SET DMA ADDRESS FUNCTION
CR      EQU     0DH                 ;ASCII CARRIAGE RETURN
LF      EQU     0AH                 ;ASCII LINE FEED
ESC     EQU     1BH                 ;ASCII ESCAPE CODE
COMMA   EQU     ','                 ;ASCII COMMA
PERIOD  EQU     '.'                 ;ASCII PERIOD
SPACE   EQU     ' '                 ;ASCII SPACE
BKSPCE  EQU     08H                 ;ASCII BACK-SPACE
XON     EQU     011H                ;CONTROL Q
```

```
MINCHCE EQU     'A' AND 1FH      ;MINIMUM MENU CHOICE
MAXCHCE EQU     'N'+1 AND 1FH    ;MAXIMUM MENU CHOICE
EOF     EQU     1AH              ;CONTROL Z - END OF FILE or
                                 ; BUFFER INDICATOR
NHSTCMD EQU     6                ;CURRENT NUMBER OF HOST CMDS
STACK   EQU     $                ;64 LEVEL STACK AVAILABLE


STARTER XRA     A                ;INITIALIZE HOST IN CONTROL.
        STA     SYSSTAT
        STA     MENUSUPF         ;MENU NOT SUPPRESSED
        LXI     D,SIGNON         ;PRINT SIGNON AND BASIC
                                 ; INSTRUCTIONS
        CALL    PRINT
MENU    XRA     A                ;INIT. MDSRDYF EVERY TIME
        STA     MDSRDYF
        INR     A                ;DEFAULT TO NO MENU
        STA     MENUFLG          ; SUPPRESSION ON MENU ERRORS
                                 ; OTHER THAN INVALID CHOICE
        MVI     A,48             ;INIT. CONSOLE READ BUFFER
        STA     CONBUFF          ; TO 48 CHARACTERS MAX
        LXI     SP,STACK         ;SET STACK POINTER
        LDA     MENUSUPF         ;PRINT MENU?
        ORA     A
        JNZ     MENU01           ;NO
        LXI     D,MENUMSG        ;YES
        CALL    PRINT
MENU01  CALL    STATSYS          ;DISPLAY SYSTEM STATUS
        CALL    BUFFRD           ;GET MENU CHOICE
        XRA     A                ;NO DELIMITERS ALLOWED
        CALL    SCAN             ;CHECK INPUT FOR DELIMITERS
        JNC     MENU011          ; SCAN OK
        LXI     D,MFDELERR       ;INPUT ERROR (SYNTAX LIKELY)
        CALL    PRINT
        CALL    DELAY            ;DELAY TO READ ERROR MSG
        JMP     MENU             ;BACK TO MENU
MENU011 INX     D                ;ALL INPUT OK, POINT TO IT
        DCR     B                ; AT END OF BUFFER YET?
        JNZ     MENU011          ; NO, TRY AGAIN
        LDAX    D                ; GET OPTION
        ANI     1FH              ;DELETE ASCII BIAS
        CPI     MINCHCE          ;IS CHOICE < 'A'?
        JC      MENU012          ; YES, ILLEGAL CHOICE
        CPI     MAXCHCE          ;IS CHOICE VALID?
        JC      MENU013          ; APPEARS TO BE
MENU012 MVI     A,1              ; NO - PRINT ERROR MSG #1
        JMP     ERROR
MENU013 PUSH    PSW              ;SAVE OPTION
        CPI     NHSTCMD          ;IF HOST CMD, MDS CONTROL
        JC      MENU014          ; HAS NO EFFECT (EXCEPT
                                 ; EXIT CMD)
```

```
        LDA     SYSSTAT             ;GET SYSTEM STATUS
        ORA     A
        JZ      MENU014             ;HOST IN CONTROL
        LXI     D,CNTRLMSG          ;MDS IN CONTROL
        CALL    PRINT
        JMP     MENU                ;ONLY ESCAPE WILL GET
                                    ; CONTROL BACK
MENU014 POP     PSW                 ;RETRIEVE OPTION
MENU1   STA     MENUFLG             ;SAVE CHOICE FOR USE IN
                                    ; HELPING USER LATER
        CALL    MENUCH              ;BRANCH TO APPROPRIATE
                                    ; CHOICE

MENUCH  MOV     C,A                 ;COMPUTE MENU CHOICE VECTOR
        MVI     B,0
        LXI     H,CHOICE-3
        DAD     B
        DAD     B
        DAD     B
        PCHL                        ;CHOICE VECTOR IS IN PC
        NOP
        NOP

* THIS JUMP TABLE MAY BE ADDED TO FOR FUTURE EXPANSION UP *
*  TO 26 MENU CHOICES  *

CHOICE  JMP     MENSUP              ;SUPPRESS MENU
        JMP     NOMENSUP            ;DO NOT SUPPRESS MENU
        JMP     INST                ;INSTRUCTIONS
        JMP     HEXARITH            ;HEX SUM & DIFF.
        JMP     RCNT2HST            ;RETURN CONTROL TO HOST
        JMP     CPM                 ;RETURN TO CPM

* MDS COMMAND JUMP TABLE *

        JMP     DWNLD               ;DOWNLOAD HEX FILE
        JMP     UPLD                ;UPLOAD HEX FILE
        JMP     EXAM                ;EXAMINE/SET MDS MEMORY
        JMP     CSET                ;CONTINOUS SET W/O EXAMINE
        JMP     FILL                ;FILL MDS MEMORY
        JMP     LOCATE              ;LOCATE BYTE SEQUENCE IN
                                    ; MDS MEMORY
        JMP     DUMP                ;DUMP MDS MEMORY
        JMP     EXEC                ;EXECUTE MDS MEMORY


*** HOST COMMANDS ONLY - MDS DOESN'T CARE WHAT IS  ***
***  HAPPENING  ***

* MENU SUPPRESSION *
```

```
MENSUP  MVI     A,1             ;SET MENU SUPPRESSION FLAG
        STA     MENUSUPF
        JMP     MENU

* NO MENU SUPPRESSION (DEFAULT) *

NOMENSUP XRA    A               ;RESET MENU SUPPRESSION FLAG
         STA    MENUSUPF
         CALL   CRLF
         JMP    MENU

* INST - INSTRUCTIONS *

INST    LXI     D,INSTRUC       ;PRINT INSTRUCTIONS
        CALL    PRINT
INST1   CALL    CONSTAT         ;WAIT FOR RESPONSE
        RRC
        JNC     INST1           ;LOOP
        CALL    CONSIN          ;GET CHARACTER
        JMP     MENU

* HEXARITH - ADDITION/SUBTRACTION OF TWO HEXADECIMAL *
*  NUMBERS *

HEXARITH LXI    D,HEXMSG        ;PRINT VERIFICATION MESSAGE
        CALL    PRINT
        CALL    BUFFRD          ;GET INPUT
        MVI     A,1             ;ONE DELIMITER REQUIRED
        CALL    SCAN            ; CHECK FOR IT
        JNC     HEX1            ; ALL DELIMITERS OK
        MVI     A,2             ;DELIMITER ERROR
        JMP     ERROR
HEX1    CALL    GET4BIN         ;GET FIRST NUMBER
        SHLD    FIRST           ; SAVE IT
        CALL    GET4BIN         ;GET SECOND NUMBER
        SHLD    SECOND          ; SAVE IT
        MOV     B,H             ;BC = SECOND NUMBER
        MOV     C,L
        LHLD    FIRST           ;HL = FIRST NUMBER
        DAD     B               ;HL = HL + BC
        SHLD    SUM             ;SAVE SUM
        LHLD    FIRST           ;HL = FIRST NUMBER
        ORA     A               ;CLEAR CARRY
        MOV     A,L             ;HL = HL - BC - CARRY
        SUB     C
        MOV     L,A
        MOV     A,H
        SBB     B
        MOV     H,A
        PUSH    H
```

```
        POP     B               ;BC = DIFFERENCE
        LXI     H,HEXMSG2+7     ;CONVERT FOR PRINTING
        CALL    CNVT16
        LHLD    SUM             ;NOW PREPARE SUM FOR
        PUSH    H               ; PRINTING
        POP     B               ;BC = SUM
        LXI     H,HEXMSG1+6
        CALL    CNVT16
        LXI     D,HEXMSG1       ;PRINT SUM & DIFFERENCE
        CALL    PRINT
        CALL    CRLF
        JMP     MENU            ;RETURN TO MENU


*** MDS COMMANDS - INITIATED BY HOST IN ALL CASES ***

* DWNLD - HEX FILE DOWNLOAD FROM DISK TO MDS MEMORY *

DWNLD   LXI     D,DWNLDMSG      ;PRINT VERIFICATION MESSAGE
        CALL    PRINT
        CALL    GETFILEN        ;GET & CHECK FILENAME
        LXI     D,FCB           ;OPEN FILE
        CALL    OPENFILE
        CPI     255             ;FILE FOUND?
        JNZ     OPENOK          ; YES
        MVI     A,13            ; NO, ERROR
        JMP     ERROR
OPENOK  MVI     A,'W'           ;SEND DOWNLOAD CMD TO MDS
        CALL    MDSCMD
        XRA     A               ;RESET CONTINUATION &
        STA     CONTFLG         ; FIRST THROUGH LOOP FLAGS
        STA     FIRSTIME
RDFILE  LXI     H,DSKBUFF       ;POINTER TO DISK BUFFER
        CALL    READSK          ;READ IN AS MUCH AS POSSIBLE
        LXI     H,DSKBUFF       ;NOW CONVERT IT TO BINARY &
                                ; SEND IT TO MDS
RECHD   MOV     A,M             ;FIND ':' AS RECORD START
        CPI     ':'
        JZ      RECLEN          ;FOUND IT
        INX     H
        CALL    EOFCK           ;END OF FILE/BUFFER?
        JMP     RECHD           ; NO, TRY AGAIN
RECLEN  MVI     B,Ø             ;INIT. CHECKSUM
        CALL    HEXBIN          ;GET RECORD LENGTH
        ORA     A               ;IF RECLEN=Ø, THEN DONE
        JZ      DWNLDNE         ; DONE
        STA     BUFFCNT         ;SAVE THE RECLEN
        MOV     C,A             ; NOT DONE - SAVE RECLEN
        CALL    MDATAOUT        ;SEND IT TO MDS
        CALL    GETSADR         ;GET START ADDRESS
```

```
        LDA     FIRSTIME        ;IF FIRST TIME THROUGH LOOP
        RRC                     ; THEN SAVE ADDR FOR LATER
        JC      RECLEN1         ;NOT FIRST TIME
        DCR     A               ;SET THE FLAG
        STA     FIRSTIME
        SHLD    START           ; AND SAVE THE ADDRESS
RECLEN1 SHLD    FINISH          ;SAVE OTHER LOAD ADDRS
        CALL    ADDROUT         ;SEND ADDRESS TO MDS
        XCHG                    ;GET BUFFER POINTER BACK
        CALL    HEXBIN          ;IGNORE RECORD TYPE
HEXDATA CALL    HEXBIN          ;GET DATA BYTE
        CALL    MDATAOUT        ;SEND DATA TO MDS
        DCR     C               ;DECREMENT RECORD LENGTH
        JNZ     HEXDATA         ; MORE TO GET
        CALL    CHECKIT         ;SEE IF CKSUM IS OK
        INX     H               ;GET NEXT RECORD
        JMP     RECHD
DWNLDNE LHLD    START           ;GET STARTING LOAD ADDR
        PUSH    H
        POP     B               ;PREPARE IT FOR PRINTING
        LXI     H,DWNDONE1+20
        CALL    CNVT16
        LHLD    FINISH          ;NOW READY THE FINISH ADDR
        LDA     BUFFCNT         ;GET RECLEN
        ADD     L
        MOV     L,A
        MOV     A,H
        ACI     0
        MOV     H,A
        PUSH    H
        POP     B
        LXI     H,DWNDONE1+43
        CALL    CNVT16
        LXI     D,DWNDONE       ;PRINT COMPLETION MESSAGE
        CALL    PRINT
        CALL    DELAY
        CALL    HOSTDONE        ;TELL MDS DONE
        JMP     MENU

GETSADR CALL    HEXBIN          ;GET STARTING LOAD ADDRESS
        MOV     D,A             ; FOR RECORD
        CALL    HEXBIN
        MOV     E,A
        XCHG                    ;HL = LOAD ADDRESS
                                ;DE = BUFFER POINTER
        RET

CHECKIT CALL    HEXBIN          ;CHECK FOR CORRECT CHECKSUM
        XRA     A
        ADD     B               ;SHOULD BE ZERO
        RZ                      ; OK
```

```
        MVI     A,14            ;CHECKSUM ERROR
        JMP     ERROR

* UPLD - HEX FILE UPLOAD (SAVE) OF MDS MEMORY TO DISK *

UPLD    MVI     A,128           ;INIT. BUFFER COUNT
        STA     BUFFCNT
        LXI     D,UPLDMSG       ;PRINT VERIFICATION MESSAGE
        CALL    PRINT
        CALL    GETFILEN        ;GET FILENAME & CHECK IT
        LXI     D,FCB
        CALL    DELETE          ;DELETE ANY EXISTING FILE
        CALL    CREATE          ;CREATE A NEW FILE
        CPI     255             ; CREATE OK?
        JNZ     UPLD01          ; YES
        MVI     A,16            ; NO, OUT OF DIRECTORY SPACE
        JMP     ERROR
UPLD01  CALL    BUFFRD          ;GET ADDRESS INPUTS
        MVI     A,1             ;ONE DELIMITER ALLOWED
        CALL    SCAN
        JNC     UPLD1           ;SCAN OK
        MVI     A,2             ;ERROR
        JMP     ERROR
UPLD1   CALL    GET4BIN         ;GET MDS START & FINISH
        SHLD    START           ; ADDRESSES FOR UPLOAD
        CALL    GET4BIN
        SHLD    FINISH
        XCHG                    ;DE = FINISH ADDRESS
        LHLD    START           ;CHECK FOR START > FINISH
        MOV     A,E
        SUB     L
        MOV     A,D
        SBB     H
        JNC     UPLD2           ; OK
        MVI     A,17            ;ERROR - START > FINISH
        JMP     ERROR
UPLD2   MVI     A,'U'           ;SEND UPLOAD CMD TO MDS
        CALL    MDSCMD
        LHLD    START           ;SEND START & END ADDRESSES
        CALL    ADDROUT
        LHLD    FINISH
        CALL    ADDROUT
        LXI     H,DSKBUFF
UPLD3   MVI     A,':'           ;STORE RECORD HEADER
        CALL    BUFFCK
        CALL    WRITLEN         ;STORE RECORD LENGTH
        CALL    WRITADDR        ;STORE STARTING LOAD ADDR
                                ; & RECORD TYPE
        CALL    WRITDATA        ;GET AND STORE DATA
        CALL    WRITCKS         ;STORE CHECKSUM & CR,LF
```

```
        JMP     UPLD3           ;DO ANOTHER HEX RECORD
WRITLN01 XRA    A               ;WRITE LENGTH, ALTERNATE
        JMP     WRITLEN1        ; ENTRY FOR ZERO RECLEN
WRITLEN MVI     A,16            ;ALL RECORDS HAVE RECLEN=16
                                ; EXCEPT THE LAST
WRITLEN1 MVI    B,0             ;INIT. CHECKSUM
        CALL    BINHEX          ;CNVRT TO HEX ASCII & STORE
        RET
WRITADDR LDA    START+1         ;STORE RECORD START ADDR
        CALL    BINHEX
        LDA     START
        CALL    BINHEX
        PUSH    H               ;SAVE BUFFER POINTER
        LHLD    START
        LXI     D,16            ;BUMP START ADDR FOR NEXT
        DAD     D               ; TIME
        SHLD    START
        POP     H               ;RESTORE BUFFER POINTER
        XRA     A               ;STORE RECORD TYPE
        CALL    BINHEX
        RET
WRITDATA MVI    C,16            ;DATA COUNTER
WRITDTA1 CALL   MDSIN           ;GET DATA FROM MDS
        LDA     MDSRDYF         ;MORE DATA OR MDS DONE?
        RRC
        JC      WRITDNE         ; MDS DONE
        CALL    BINHEX          ;MORE DATA
        DCR     C               ;16 BYTES YET?
        RZ                      ; YES
        JMP     WRITDTA1        ; NO, CONTINUE
WRITDNE XRA     A
        DCR     C               ;FILL REMAINDER OF RECORD
        JZ      WRTDN001        ; WITH ZEROS
        CALL    BINHEX
        JMP     WRITDNE
WRTDN001 CALL   WRITCKS         ;STORE CHECKSUM
        CALL    WRITEND         ;STORE LAST RECORD
        LDA     BUFFCNT         ;IS BUFFER FULL?
        MOV     B,A
        CPI     128
        JZ      WRITDNE1        ; YES
WRITDN01 MVI    M,EOF           ; NO, FILL REMAINDER WITH
        INX     H               ;  EOF's
        DCR     B               ;DONE WITH FILL?
        JNZ     WRITDN01        ; NO, CONTINUE
        CALL    WRITEDSK        ; YES, WRITE RECORD TO DISK
WRITDNE1 CALL   CLOSFILE        ;CLOSE THE FILE
        LXI     D,UPLDONE       ;PRINT COMPLETION MESSAGE
        CALL    PRINT
        CALL    DELAY
        JMP     MENU
```

```
WRITCKS MOV     A,B             ;STORE CHECKSUM
        CMA                     ;GET NEGATIVE OF SUM
        INR     A               ; ADD ONE
        CALL    BINHEX
        MVI     A,CR            ;STORE CR,LF SEQUENCE AT
        CALL    BUFFCK          ; HEX RECORD END
        MVI     A,LF
        CALL    BUFFCK
        RET
WRITEND MVI     A,':'           ;STORE LAST HEX RECORD
        CALL    BUFFCK
        CALL    WRITLN01        ;STORE 00 RECORD LENGTH
        XCHG                    ;DE = BUFFER POINTER
        LXI     H,0000H         ;STORE 0000 LOAD ADDR &
        SHLD    START           ; RECORD TYPE
        XCHG                    ;HL = BUFFER POINTER
        CALL    WRITADDR
        CALL    WRITCKS         ;STORE CHECKSUM
        RET
BUFFCK  MOV     M,A             ;STORE DATA
        INX     H
        LDA     BUFFCNT         ;IS BUFFER FULL?
        DCR     A
        JZ      WRITEIT         ; YES, SAVE IT ON DISK
        STA     BUFFCNT         ; NO, SAVE COUNT
        RET
WRITEIT CALL    WRITEDSK        ;WRITE 128 BYTE RECORD TO
                                ; DISK
        LXI     H,DSKBUFF       ;REINIT. BUFFER AREA
        MVI     A,128           ; AND BUFFER COUNT
        STA     BUFFCNT
        RET

* EXAM - EXAMINE/SET MDS MEMORY LOCATION(S) *

EXAM    LXI     D,EXAMSG        ;PRINT VERIFICATION MESSAGE
        CALL    PRINT
        CALL    BUFFRD          ;GET ADDRESS INPUT
        XRA     A               ;NO DELIMITERS ALLOWED
        CALL    SCAN            ;DELIMITER CHECK
        JNC     EXAM01          ; SCAN OK
        MVI     A,2             ;INPUT ERROR (SYNTAX OR HEX)
        JMP     ERROR
EXAM01  CALL    GET4BIN         ;GET START ADDRESS
        SHLD    START
        MVI     A,'X'           ;SEND EXAM/SET CMD TO MDS
        CALL    MDSCMD
        LHLD    START
        CALL    ADDROUT         ;SEND START ADDRESS TO MDS
EXAM1   CALL    MDSIN           ;GET DATA IN MDS MEMORY
        STA     MDSDATA         ; SAVE IT
```

```
         PUSH    H               ;SAVE ADDR. BEING EXAMINED
         MOV     C,A             ;C = MDSDATA
         LXI     H,EXAMSG2+1     ;CONVERT DATA FOR PRINTING
         CALL    CNVT8
         POP     B               ;GET ADDR. BACK,
         PUSH    B               ; BUT SAVE IT
         LXI     H,EXAMSG1       ;CONVERT ADDR. FOR PRINTING
         CALL    CNVT16
         XCHG                    ;DE = EXAMSG1
         CALL    PRINT           ;PRINT MDS ADDR. & DATA
         CALL    BUFFRD1         ;GET REPLACEMENT DATA
         ORA     A               ; IF NO INPUT, THEN PUT OLD
         JZ      NOSET           ;  DATA BACK
         XRA     A               ;NO DELIMITERS ALLOWED
         CALL    SCAN
         JNC     EXAM02          ; SCAN OK
EXAM020  MVI     A,2             ;INPUT ERROR
         JMP     ERROR           ;START OPTION OVER
EXAM02   CALL    CKPERIOD        ;IF INPUT WAS A PERIOD,
         ORA     A               ; THEN DONE
         JZ      EXAM2           ; NO PERIOD, GET DATA
         RAR                     ;PERIOD ONLY?
         JC      EXDONE          ; YES - ALL DONE
         MVI     A,3
         JMP     ERROR           ; NO - PERIOD + DATA IS
                                 ;  ILLEGAL, START OVER
EXAM2    CALL    GET2BIN
         MOV     A,L             ;SEND NEW DATA
         JMP     SET1
NOSET    LDA     MDSDATA         ;GET OLD DATA
SET1     CALL    MDATAOUT
         POP     H               ;BUMP ADDRESS FOR EXAM/SET
         INX     H
         JMP     EXAM1           ;GET MORE DATA FROM MDS
EXDONE   CALL    HOSTDONE        ;SIGNAL MDS DONE
         JMP     MENU            ;BACK TO MENU


* FILL - FILL MDS MEMORY LOCATION(S) WITH SPECIFIED DATA *

FILL     LXI     D,FILLMSG       ;PRINT VERIFICATION MESSAGE
         CALL    PRINT
         CALL    BUFFRD          ;GET INPUT ADDRESSES + FILL
                                 ; DATA
         MVI     A,2             ;TWO DELIMITERS REQUIRED
         CALL    SCAN            ; CHECK FOR THEM
         JNC     FILL1           ; SCAN OK
         MVI     A,2             ;JMP ERROR
         JMP     ERROR           ; START OPTION OVER
FILL1    CALL    GET4BIN         ;GET START ADDRESS
         SHLD    START           ; SAVE IT
```

```
        CALL    GET4BIN         ;GET FINISH ADDRESS
        SHLD    FINISH          ; SAVE IT TOO
        CALL    GET2BIN         ;GET FILL DATA
        MOV     A,L             ;A = DATA
        STA     CONSDATA        ; SAVE IT
        MVI     A,'F'           ;SEND FILL CMD TO MDS
        CALL    MDSCMD
        LHLD    START           ;SEND START ADDR. TO MDS
        CALL    ADDROUT
        LHLD    FINISH          ;SEND FINISH ADDR. TO MDS
        CALL    ADDROUT
        LDA     CONSDATA        ;SEND FILL DATA TO MDS
        CALL    MDATAOUT
        MVI     A,1             ;MDS IN CONTROL
        STA     SYSSTAT
FILL2   CALL    MDSIN           ;MDS DONE FILLING?
        XRA     A               ; YES - CLEAR FLAGS
        STA     SYSSTAT
        STA     MDSRDYF
        JMP     MENU            ;RETURN TO MENU

* SEND 16 BIT ADDRESS TO MDS - CALL WITH HL = ADDRESS *

ADDROUT MOV     A,H             ;MSB FIRST
        CALL    MDATAOUT
        MOV     A,L             ; THEN LSB
        CALL    MDATAOUT
        RET                     ;BACK TO CALLER

* CSET - CONTINUOUS SET MDS MEMORY WITHOUT EXAMINE *

CSET    LXI     D,CSETMSG       ;PRINT VERIFICATION MESSAGE
        CALL    PRINT
        MVI     A,ØFFH          ;INIT. CONSOLE READ BUFFER
        STA     CONBUFF         ; TO 255 CHARACTERS MAX
        CALL    BUFFRD          ;GET START ADDRESS
        XRA     A               ;NO DELIMITERS ALLOWED
        CALL    SCAN
        JNC     CSETØ1          ; SCAN OK
        MVI     A,2             ;INPUT ERROR
        JMP     ERROR           ;START OPTION OVER
CSETØ1  CALL    GET4BIN
        SHLD    START
        MVI     A,'C'           ;SEND CSET CMD TO MDS
        CALL    MDSCMD
        LHLD    START           ;SEND START ADDRESS TO MDS
        CALL    ADDROUT
        JMP     CSET11
CSET1   CALL    CRLF
CSET11  CALL    BUFFRD          ;GET REPLACEMENT DATA TILL
                                ; BUFFER FULL OR <CR>
```

```
        CALL    SCAN                    ;LOOK FOR ESCAPE
        CALL    CKPERIOD                ;CHECK FOR PERIOD IN INPUT
        ORA     A
        JZ      CSET2                   ; NO PERIOD, GET DATA
        RAR
        JC      CSET3                   ; PERIOD ONLY - ALL DONE
        MVI     A,3                     ;INPUT ERROR,
        JMP     ERROR                   ; START OPTION OVER
CSET2   CALL    STAR                    ;PRINT A LEADING STAR
                                        ; PRIOR TO VALIDATION DATA
CSET21  CALL    GET2BIN                 ;GET DATA
        MOV     A,L
        CALL    MDATAOUT                ;SEND IT TO MDS
        MOV     C,A
        LXI     H,DATAMSG+1             ;SEND IT TO CONSOLE FOR
        CALL    CNVT8                   ; VERIFICATION
        XCHG                            ;DE = ADDR. OF DATAMSG
        CALL    PRINT
        XCHG                            ;DE = CURRENT CONBUFF PTR
        MOV     A,B                     ;AT END OF BUFFER?
        CPI     ØFFH
        JZ      CSET1                   ; YES, START OVER
        CPI     ØØ
        JZ      CSET1                   ; YES, START OVER
        JMP     CSET21                  ;NO, GET MORE DATA
CSET3   CALL    HOSTDONE                ;NO DATA TO SEND, SIGNAL
                                        ; MDS DONE
        JMP     MENU                    ;RETURN TO MENU

* EXEC - EXECUTE MDS MEMORY FROM A SPECIFIED ADDRESS *

EXEC    LXI     D,EXECMSG               ;PRINT VERIFICATION MESSAGE
        CALL    PRINT
        CALL    BUFFRD                  ;GET START ADDRESS
        XRA     A                       ;NO DELIMITERS ALLOWED
        CALL    SCAN
        JNC     EXEC1                   ; SCAN OK
        MVI     A,2                     ;ERROR
        JMP     ERROR                   ;START OPTION OVER
EXEC1   CALL    GET4BIN                 ;GET START ADDRESS
        SHLD    START                   ; SAVE IT
        LXI     D,EXMSG                 ;SEE IF DATA FROM MDS TO
        CALL    PRINT                   ; CONSOLE OR NOT
EXEC11  CALL    CONSTAT                 ;WAIT FOR RESPONSE
        RRC
        JNC     EXEC11                  ; LOOP
        CALL    CONSIN                  ;GET RESPONSE
        ORI     20H                     ;FORCE TO LOWER CASE
        CPI     'y'                     ;CONSOLE INPUT FROM MDS?
        JNZ     EXEC2                   ; NO, SEND CMD & RETURN TO
                                        ; TO MENU
```

```
        LXI     D,EXMSG2          ;GIVE ESCAPE METHODS
        CALL    PRINT
        MVI     A,'E'             ; YES, SEND CMD TO MDS &
        CALL    MDSCMD            ; LOOP WAITING FOR DATA
        LHLD    START             ; OR DONE FROM MDS OR ESC
                                  ; FROM CONSOLE
        CALL    ADDROUT
EXEC020 CALL    MDSIN             ;LOOP AT MDSIN TILL ESC
                                  ; OR 'Q' OR DATA
        MOV     E,A               ;SAVE DATA FROM MDS
        LDA     MDSRDYF           ;SEE IF MDS WANTS INPUT
        ORA     A
        JNZ     GETINP            ; YES
        CALL    CONSOUT           ; NO, SEND IT TO CONSOLE
        JMP     EXEC020           ; WAIT FOR MORE
GETINP  CALL    CONSTAT           ;GET INPUT FROM KEYBOARD
        RRC
        JNC     GETINP
        CALL    CONSIN
        CALL    MDATAOUT          ;SEND IT TO MDS
        XRA     A                 ;RESET MDSRDY FLAG
        STA     MDSRDYF
        JMP     EXEC020           ;LOOP AGAIN
EXEC2   MVI     A,'E'             ;SEND MDS EXEC CMD
        CALL    MDSCMD
        LHLD    START             ;SEND START ADDRESS TO MDS
        CALL    ADDROUT
        MVI     A,1               ;SET MDS CONTROL FLAG
        STA     SYSSTAT
        JMP     MENU              ;BACK TO MENU

* LOCATE - LOCATE A SPECIFIED BYTE SEQUENCE IN MDS MEMORY *

LOCATE  CALL    CLRBUFF           ;CLEAR READ BUFFER
        LXI     D,LOCMSG          ;PRINT VERIFICATION MESSAGE
        CALL    PRINT
        MVI     A,0FFH            ;INIT. CONSOLE READ BUFFER
        STA     CONBUFF           ; TO 255 CHARACTERS MAX
        CALL    BUFFRD            ;GET ADDRESS(ES)
        XRA     A                 ;ANY DELIMITERS ?
        CALL    SCAN
        JNC     LOCATE1           ; NO, USE DEFAULT FINISH
                                  ;  ADDRESS
        MVI     A,1               ;MORE THAN ONE DELIMITER?
        CALL    SCAN
        JNC     LOC01             ; NO, GET OPTIONAL FINISH
                                  ;  ADDRESS
        MVI     A,2               ;MORE THAN 2 DELIMITERS
        JMP     ERROR             ; ERROR, START OPTION OVER
LOCATE1 CALL    GET4BIN           ;GET START ADDRESS
        SHLD    START
```

```
        JMP     LOC1            ; NO COMMA, FINISH ADDRESS
                                ;  DEFAULTS TO ØFFFFH -
                                ;  GET DATA
LOCØ1   CALL    GET4BIN         ;GET START ADDRESS
        SHLD    START
        CALL    GET4BIN         ; COMMA, GET FINISH ADDRESS
        SHLD    FINISH
        JMP     LOCDATA
LOC1    LXI     H,ØFFFFH        ;SAVE DEFAULT FINISH ADDRESS
        SHLD    FINISH
LOCDATA MVI     A,'L'           ;SEND LOCATE CMD TO MDS
        CALL    MDSCMD
        LHLD    START           ;SEND START ADDRESS TO MDS
        CALL    ADDROUT
        LHLD    FINISH          ;SEND FINISH ADDRESS TO MDS
        CALL    ADDROUT
        MVI     A,16            :16 BYTES MAX
        PUSH    PSW             ; SAVE BYTE COUNT
LOCDATA1 CALL   BUFFRD          ;GET SEARCH SEQUENCE
        CALL    SCAN            ;LOOK FOR ESCAPE
        CALL    STAR            ;PRINT A STAR
LOCDATA2 CALL   GET2BIN         ;GET A BYTE
        MOV     A,L
        CALL    MDATAOUT        ;SEND IT TO MDS
        MOV     C,A
        LXI     H,DATAMSG+1     ; & TO CONSOLE FOR
        CALL    CNVT8           ; VERIFICATION
        XCHG
        CALL    PRINT
        XCHG
        MOV     A,B             ;AT END OF BUFFER?
        CPI     ØFFH
        JZ      LOC5            ; YES, WAIT FOR SEARCH
                                ;  RESULTS
        CPI     ØØ
        JZ      LOC5            ; YES, WAIT FOR SEARCH
                                ;  RESULTS
        POP     PSW             ; NO, GET BYTE COUNT
        DCR     A               ;16 BYTES YET?
        PUSH    PSW             ;SAVE BYTE COUNT
        JZ      LOC5            ; YES, WAIT FOR SEARCH
                                ;  RESULTS
        JMP     LOCDATA2        ; NOT AT END OR 16 BYTES
LOC5    CALL    HOSTRDY         ;TELL MDS TO SEARCH
        CALL    MDSIN           ;GET MDS RESPONSE
        ORI     8ØH             ;LOOKING FOR ASCII
        CPI     'F'             ;BYTE SEQ. FOUND?
        JZ      FOUND           ; YES
        LXI     D,NOTFOUND      ;PRINT NOT FOUND MESSAGE
        JMP     ERROUT          ; BACK TO MENU
FOUND   LXI     D,FOUNDMSG      ;PRINT FOUND MESSAGE
```

```
         CALL    PRINT
         CALL    MDSIN          ;GET FOUND ADDRESS MSB
         MOV     B,A
         CALL    MDSIN          ;GET LSB OF ADDR
         MOV     C,A
         LXI     H,FOUNDMS1     ;CONVERT ADDR. FOR PRINTING
         XCHG
         CALL    PRINT          ;PRINT ADDRESS
         JMP     MENU           ;BACK TO MENU

* DUMP - DUMP MDS MEMORY LOCATION(S) *

DUMP     CALL    CLRBUFF        ;CLEAR READ BUFFER
         LXI     D,DUMPMSG      ;PRINT VERIFICATION MESSAGE
         CALL    PRINT
         CALL    BUFFRD         ;GET ADDRESS(ES)
         XRA     A              ;ANY DELIMITERS?
         CALL    SCAN
         JNC     DUMP01         ; NO
         MVI     A,1            ;MORE THEN ONE DELIMITER?
         CALL    SCAN
         JNC     DUMP010        ; NO, GET OPTIONAL FINISH
                                ;  ADDRESS
         MVI     A,2            ;MORE THAN ONE DELIMITER
         JMP     ERROR          ; ERROR, START OPTION OVER
DUMP01   CALL    GET4BIN        ;GET START ADDRESS
         SHLD    START
         JMP     DUMP1          ; NO COMMA
DUMP010  CALL    GET4BIN        ;GET START ADDRESS
         SHLD    START
         CALL    GET4BIN        ;GET OPTIONAL FINISH ADDR
         SHLD    FINISH
         JMP     DUMP2
DUMP1    LHLD    START          ;MAKE FINISH ADDRESS =
         LXI     B,0100H        ; START + 256
         DAD     B
         SHLD    FINISH
DUMP2    MVI     A,'D'          ;SEND DUMP CMD TO MDS
         CALL    MDSCMD
         LHLD    START          ;SEND START ADDRESS TO MDS
         CALL    ADDROUT
         LHLD    FINISH         ;SEND FINISH ADDRESS TO MDS
         CALL    ADDROUT
DUMP3    LXI     D,DUMPMSG3     ;ASCII DATA STORAGE
         PUSH    D
         CALL    MSG3INIT       ;INIT. ASCII STORAGE
         CALL    MDSIN          ;GET BYTE
         MOV     C,A
         LDA     MDSRDYF        ;MDS DONE TRANSMITING DATA?
         ORA     A
         JNZ     DUMPDONE       ; YES
```

```
        MOV      A,C
        STA      MDSDATA            ; NO - SAVE DATA
        LHLD     START              ;BC = START ADDRESS
        MOV      B,H
        MOV      C,L
        LXI      H,DUMPMSG1
        CALL     CNVT16
        XCHG
        CALL     PRINT
        MVI      B,16               ;SIXTEEN BYTES PER LINE
DUMPDATA POP     D                  ;RECALL ASCII DATA STORAGE
                                    ; LOCATION
        LDA      MDSDATA            ;GET DATA
        MOV      C,A                ;IS DATA ASCII PRINTABLE?
        CPI      20H
        JNC      DMPDTA1            ; YES
        CALL     SPERIOD            ; NO - STORE A PERIOD
        JMP      DMPDTA2
DMPDTA1 CPI      80H                ;GREATER THEN ASCII
        CNC      SPERIOD            ; YES, STORE A PERIOD
DMPDTA2 STAX     D                  ; STORE DATA AS IS
        MOV      A,C                ;RESTORE ORIGINAL DATA
        INX      D                  ;BUMP STORAGE ADDRESS
        PUSH     D                  ; AND SAVE IT
        LXI      H,DUMPMSG2+1       ;NOW CONVERT DATA TO HEX
                                    ; AND PRINT IT
        PUSH     B                  ;SAVE COUNT
        CALL     CNVT8
        XCHG
        CALL     PRINT
        POP      B                  ;GET COUNT BACK
        DCR      B                  ;16 BYTES YET?
        JZ       NXTLINE            ; YES
        CALL     MDSIN              ; NO - GET NEXT BYTE
        STA      MDSDATA            ;SAVE NEW DATA
        MOV      C,A                ;MDS DONE TRANSMITING DATA?
        LDA      MDSRDYF
        ORA      A
        JNZ      NXTLINE            ; YES
        JMP      DUMPDATA           ; NO - GET NEXT LINE OF DATA
SPERIOD MVI      A,'.'              ;STORE A PERIOD IF NOT A
        RET                         ; PRINTABLE ASCII CHAR.
NXTLINE LXI      D,DUMPMSG3         ;PRINT ASCII CHARACTERS
        CALL     PRINT
        LXI      B,0010H            ;GO TO NEXT LINE
        LHLD     START              ;BUMP NEW LINE START ADDRESS
        DAD      B                  ; BY SIXTEEN BYTES
        SHLD     START              ; SAVE IT
        POP      D                  ;GET GARBAGE OFF STACK
        LDA      MDSRDYF            ;DONE?
        ORA      A
```

```
        JNZ      DUMPDONE          ; YES
        CALL     CRLF              ;START NEW LINE
        JMP      DUMP3             ;DUMP TILL DONE
DUMPDONE XRA     A                 ;CLEAR MDS DONE XMITTING FLG
        STA      MDSRDYF
        CALL     CRLF              ;START NEW LINE
        CALL     BUFFRD            ;ANOTHER DUMP?
        XRA      A                 ;NO DELIMITERS ALLOWED
        CALL     SCAN
        JNC      DMPDONE1          ; SCAN OK
        MVI      A,2               ;ERROR
        JMP      ERROR             ; START OPTION OVER
DMPDONE1 INX     D                 ;POINT TO END OF BUFFER
        DCR      B                 ; THERE YET?
        JNZ      DMPDONE1          ; NO, LOOP
        LDAX     D
        ORI      20H               ;CONVERT TO LOWER CASE
        CPI      'd'
        JZ       DUMPMORE          ; YES - DUMP AGAIN FROM
                                   ;  PREVIOUS FINISH ADDR.
        JMP      MENU              ; NO - RETURN TO MENU
DUMPMORE LHLD    FINISH            ;MAKE FINISH+1 = NEW START
        INX      H                 ; ADDRESS
        SHLD     START
        JMP      DUMP1             ;DUMP 256 MORE BYTES
MSG3INIT MVI     B,17              ;INIT. ASCII DATA STORAGE
        LXI      D,DUMPMSG3        ; AREA TO ALL $'S
        MVI      A,'$'
MSG31   STAX     D
        DCR      B
        RZ                         ;INIT. DONE
        INX      D
        JMP      MSG31
CLRBUFF MVI      B,255             ;CLEAR CONSOLE READ BUFFER
        LXI      D,CONBUFF+1
        MVI      A,00              ;PUT IN ALL ZEROS
        JMP      MSG31

* RCNT2HST - RETURN CONTROL TO HOST *

RCNT2HST LDA     SYSSTAT           ;GET SYSTEM STATUS
        ORA      A
        JZ       MENU              ; HOST ALREADY IN CONTROL
        MVI      A,'Q'             ;SEND ESCAPE TO MDS
        CALL     MDSCMD
        XRA      A                 ;RESET SYSTEM STATUS FLAG
        STA      SYSSTAT
        LXI      D,ABORTEDM        ;PRINT MDS ABORTED VERIFI-
        CALL     PRINT             ; CATION
        CALL     DELAY
        JMP      MENU
```

```
*** UTILITY SUBROUTINES ***

* PRINT A STRING TO THE CONSOLE
* CALL WITH DE = STARTING ADDRESS OF STRING *

PRINT   PUSH    PSW                 ;SAVE EVERYTHING
        PUSH    B
        PUSH    D
        PUSH    H
        MVI     C,PRTSTRG           ;OUTPUT STRING TO CONSOLE
        CALL    BDOS
        POP     H                   ;RESTORE ALL REGISTERS
        POP     D
        POP     B
        POP     PSW
        RET                         ;BACK TO CALLER

* STATSYS - DISPLAY SYSTEM STATUS *

STATSYS CALL    CRLF
        CALL    CRLF
        LDA     SYSSTAT             ;GET SYSTEM STATUS FLAG
        ORA     A
        LXI     D,SYSMSG+15
        JZ      SYS1                ;HOST IN CONTROL
        LXI     H,MDSMSG            ;MDS IN CONTROL
        JMP     SYS1+3              ;PUT 'MDS' IN MESSAGE
SYS1    LXI     H,HOSTMSG           ;PUT 'HOST' IN MESSAGE
        CALL    MOVESTR
        LDA     MENUSUPF            ;GET MENU SUPPRESSION FLAG
        ORA     A
        LXI     D,SYSMSG+33
        JZ      SYS3                ;NO SUPPRESSION
        LXI     H,YESMENMG          ;SUPPRESSION
        JMP     SYS3+3
SYS3    LXI     H,NOMENMSG
        CALL    MOVESTR
        LXI     D,SYSMSG            ;PRINT SYSTEM STATUS
        CALL    PRINT
        CALL    MENPMPT             ;PRINT MENU PROMPT
        RET                         ;RETURN TO CALLER
MOVESTR MOV     A,M                 ;HL = STRING TO MOVE
        CPI     '$'                 ;DE = DESTINATION ADDRESS
        RZ                          ;RETURN IF MOVE DONE
        STAX    D                   ; NOT DONE
        INX     D
        INX     H
        JMP     MOVESTR             ;MOVE NEXT CHARACTER

* MENPMPT - PRINT MENU PROMPT *
```

```
MENPMPT LDA     MENUSUPF          ;SUPPRESS MENU?
        ORA     A
        JZ      MENPMT1           ; NO
        LXI     D,MENUPRO1        ; YES - PRINT SUPPRESED
        CALL    PRINT             ;  MENU PROMPT
        RET
MENPMT1 LXI     D,MENUPROM        ;PRINT UNSUPPRESSED MENU
        CALL    PRINT             ; PROMPT
        RET

** ROUTINES TO GET AND CHECK FILENAMES FOR VALIDITY **
**  ONLY INTEL 'HEX' FILES ARE SUPPORTED BY THIS VERSION **

* GETFILEN - INITIATE CALLS FOR INPUTTING FILENAME AND
*              MAKING APPROPIATE CHECKS *

GETFILEN CALL   CLRBUFF           ;CLEAR CONSOLE INPUT BUFFER
        LXI     D,FILENAME        ;PROMPT FOR FILENAME
        CALL    PRINT
        CALL    BUFFRD            ;GET FILENAME
        CALL    FILENCK           ;DO CHECKS ON FILENAME
        ORA     A                 ;SEE IF ANY ERRORS
        JZ      GETFN1            ; NO ERRORS
        CALL    ERROR             ; ERRORS
        JMP     GETFILEN          ;START OVER
GETFN1  CALL    MOVFN             ;MOVE FILENAME TO FCB
        CALL    UCASE             ;CONVERT ALL FILENAME
        RET                       ; ALPHABETICS TO UPPER CASE

* FILENCK - INITIATE ALL FILENAME CHECKS
* RETURN  A = 00 IF NO ERRORS
*           = ERROR NUMBER IF ERRORS IN FILENAME *

FILENCK CALL    SCANQ             ;SCAN FILENAME FOR '?'
        RRC
        JNC     FNCK1             ;NONE FOUND
        MVI     A,7               ;ERROR - NO AMBIGUOUS
        RET                       ; FILENAMES
FNCK1   CALL    SCANCOL           ;CHECK FOR ':' AND PROPER
        RRC                       ; DRIVE SELECTION
        JNC     FNCK2             ;SCAN OK
        MVI     A,8               ;TOO MANY COLONS
        RET
FNCK2   CALL    SCANUM            ;CHECK FOR TOO MANY OR TOO
        RRC                       ; FEW CHARACTERS IN FILENAME
        JNC     FNCK3             ;NO ERROR
        MVI     A,9               ;ERROR
        RET
FNCK3   CALL    CKPERIOD          ;CHECK FILENAME INPUT FOR
        ORA     A                 ; A PERIOD
        JZ      FNCK4             ;NONE FOUND
```

```
        CALL    SCANHEX             ;ONE PERIOD, CHECK FOR
        RRC                         ; 'HEX' FILETYPE
        JNC     FNCK4               ;FILETYPE OK
        MVI     A,10                ;ONLY 'HEX' FILETYPES ARE
        RET                         ; SUPPORTED
FNCK4   XRA     A                   ;CHECK FOR ESCAPE AND
        CALL    SCAN                ; OTHER DELIMITER ERRORS
        JNC     FNCK5               ;NONE FOUND
        MVI     A,11                ;NO SPACES ALLOWED IN
        RET                         ; FILENAME
FNCK5   CALL    SCANINV             ;CHECK FOR NON-PRINTABLE
        RRC                         ; CHARACTERS IN FILENAME
        JNC     FNCK6               ;NONE FOUND
        MVI     A,12                ;ERROR
        RET
FNCK6   XRA     A                   ;NO ERRORS DETECTED
        RET                         ; FILENAME OK

* SCANQ - SCAN FILENAME FOR QUESTION MARKS INDICATING AN
*         AMBIGUOUS FILENAME
* RETURN  A = 00 IF NONE FOUND
*           = 0FFH IF FOUND *

SCANQ   PUSH    B
        PUSH    D
        PUSH    H
        XCHG                        ;HL = BUFFER + 1
        MOV     C,M                 ;GET BUFFR COUNT
SCANQ01 INX     H
        MOV     A,M                 ;LOOK FOR '?'
        CPI     '?'
        JZ      SCANQ1              ;FOUND ONE
        DCR     C                   ;KEEP LOOKING?
        JNZ     SCANQ01             ;SCAN NOT DONE
        XRA     A                   ;SCAN DONE - NO ERRORS
        JMP     SCANQ1+2
SCANQ1  MVI     A,0FFH              ;AT LEAST ONE '?' FOUND
        POP     H
        POP     D
        POP     B
        RET

* SCANCOL - SCAN FILENAME FOR A ':' THEN LOOK FOR PROPER
*           DRIVE SELECT CODE (ONLY CURRENT DRIVE IN USE
*           IS SUPPORTED, OTHERS ARE IGNORED)
*         - A ':' IN ANY OTHER POSITION IN THE FILENAME IS
*           NOT LEGAL
* RETURN  A = 00 IF NO ERROR
*           = 0FFH IF AN ILLEGAL ':' IS FOUND *

SCANCOL PUSH    B
```

```
        PUSH    D
        PUSH    H
        CALL    CURDSK          ;GET CURRENT DISK
        ORI     40H             ;CONVERT IT TO A CHARACTER
        INR     A
        STA     CURRENT         ;SAVE IT
        XCHG                    ;GET BUFFER COUNT
        MOV     C,M
        INX     H
        INX     H               ;THE ONLY ':' WOULD BE HERE
        DCR     C
        MOV     A,M
        CPI     ':'
        JNZ     SCANCOL1        ;NONE HERE
        DCX     H               ;FOUND IT, CHECK FOR
        INR     C               ; CORRECT DRIVE
        MOV     A,M
        ANI     0DFH            ;FORCE TO UPPER CASE
        MOV     B,A
        LDA     CURRENT
        CMP     B               ;SAME?
        JZ      SCNCOL11        ; YES, OK
        LXI     D,DRIVERR       ; NO, PRINT WARNING &
        CALL    PRINT           ;  IGNORE IT
        CALL    DELAY
        INX     H
        DCR     C
        JMP     SCANCOL2        ;CONTINUE SCAN
SCANCOL1 DCX    H               ;CHECK IF 1st CHAR IS ':'
        INR     C
SCNCOL11 MOV    A,M
        CPI     ':'
        JZ      SCANCOL3        ; YES, ERROR
        DCR     C               ; NO
        JZ      SCNCOLDN        ;SCAN DONE
        INX     H               ;SCAN NOT DONE
        DCR     C
SCANCOL2 INX    H
        MOV     A,M             ;SEE IF ANY MORE ':'
        CPI     ':'
        JZ      SCANCOL3        ; YES, ERROR
        DCR     C               ; NO
        JNZ     SCANCOL2        ;CONTINUE SCAN
SCNCOLDN XRA    A               ;DONE, NO ERRORS DETECTED
        JMP     SCANCOL3+2
SCANCOL3 MVI    A,0FFH          ;TOO MANY ':'
        POP     H
        POP     D
        POP     B
        RET
```

```
* SCANHEX - SCAN FILETYPE FOR 'HEX'
* RETURN  A = ØØ IF FOUND
*           = ØFFH IF NOT FOUND *

SCANHEX PUSH    B
        PUSH    D
        PUSH    H
        XCHG                    ;GET BUFFER COUNT
        MOV     C,M
SCANHX1 INX     H               ;GO TO PERIOD
        MOV     A,M
        CPI     PERIOD
        JZ      COMPARE         ;FOUND IT
        DCR     C
        JNZ     SCANHX1         ;KEEP LOOKING
        JMP     SCNHXER         ;ERROR, NO PERIOD
COMPARE INX     H
        MOV     A,M
        ANI     ØDFH            ;FORCE TO UPPER CASE
        CPI     'H'
        JNZ     SCNHXER         ;ERROR
        INX     H
        MOV     A,M
        ANI     ØDFH
        CPI     'E'
        JNZ     SCNHXER
        INX     H
        MOV     A,M
        ANI     ØDFH
        CPI     'X'
        JNZ     SCNHXER
        XRA     A               ;NO ERROR
        JMP     SCNHXER+2
SCNHXER MVI     A,ØFFH          ;ERROR
        POP     H
        POP     D
        POP     B
        RET

* SCANUM - SCAN FILENAME FOR TOO MANY OR TOO FEW CHARACTERS
*          FILENAME IS CHECKED ONLY (8 CHARACTERS MAX,
*           1 CHARACTER MINIMUM)
* RETURN  A = ØØ IF NO ERROR
*           = ØFFH IF ERROR *

SCANUM  PUSH    B
        PUSH    D
        PUSH    H
        XCHG                    ;GET BUFFER COUNT
        MOV     C,M
        MVI     B,Ø             ;B = # OF CHARACTERS IN FN
```

```
SCANUM1 INX     H
        MOV     A,M
        CPI     ':'                 ;START COUNT AT ':'?
        JNZ     SCANUM2             ; YES
        DCR     B                   ; NO, START AT BEGINNING
        DCR     C                   ;DONE YET?
        JZ      SCANUM4             ; YES
        JMP     SCANUM1             ; NO
SCANUM2 CPI     PERIOD              ;GO TO PERIOD OR BUFFER END
        JZ      SCANUM4             ; PERIOD, DONE
        INR     B                   ;KEEP COUNTING
        DCR     C
        JZ      SCANUM4             ;DONE
        JMP     SCANUM1             ;LOOP
SCANUM4 XRA     A                   ; < 1 CHARACTER?
        CMP     B
        JZ      SCANUM5             ; YES, ERROR
        MVI     A,8                 ; > 8 CHARACTERS?
        CMP     B
        JC      SCANUM5             ; YES, ERROR
        XRA     A                   ; NO ERRORS
        JMP     SCANUM5+2
SCANUM5 MVI     A,ØFFH              ;ERROR
        POP     H
        POP     D
        POP     B
        RET

* SCANINV - SCAN FILENAME FOR NON-PRINTABLE CHARACTERS
* RETURN  A = ØØ IF NONE FOUND
*           = ØFFH IF ANY FOUND *

SCANINV PUSH    B
        PUSH    D
        PUSH    H
        XCHG                        ;GET BUFFER COUNT
        MOV     C,M
SCANIN1 INX     H
        MOV     A,M
        CPI     2ØH                 ; < SPACE?
        JC      SCANIN2             ; YES, ERROR
        DCR     C                   ;DONE WITH SCAN?
        JNZ     SCANIN1             ; NO
        XRA     A                   ; YES, NO ERRORS
        JMP     SCANIN2+2
SCANIN2 MVI     A,ØFFH              ;ERROR
        POP     H
        POP     D
        POP     B
        RET
```

```
* MOVFN - MOVE FILENAME FROM CONSOLE BUFFER TO FCB *

MOVFN   CALL    PURGFCB         ;PURGE AND SET UP FCB
        LXI     H,CONBUFF+1     ;GET BUFFER COUNT
        MOV     C,M
        XCHG                    ;DE = CONBUFF POINTER
        INX     D
        INX     D               ;SEE IF IT'S A COLON
        DCR     C
        LDAX    D
        CPI     ':'
        JZ      MOVIT01         ; YES
        DCX     D               ; NO
        INR     C
        JMP     MOVIT           ;START AT BUFFER START
MOVIT01 INX     D               ;START FROM COLON
        DCR     C
MOVIT   LXI     H,FCB+1
MOVIT1  LDAX    D               ;MOVE THE FILENAME
        CPI     PERIOD          ; UNTIL PERIOD OR END
                                ; OF BUFFER
        RZ                      ;DONE
        MOV     M,A             ;STORE CHAR. IN FCB
        INX     H
        INX     D
        DCR     C               ;AT END OF BUFFER?
        RZ                      ; YES, MOVE DONE
        JMP     MOVIT1          ; NO, LOOP

* PURGFCB - PURGE FILE CONTROL BLOCK (FCB) AND SET IT UP
*           FOR ACCEPTING A FILENAME OF TYPE HEX *

PURGFCB LXI     H,FCB
        LXI     D,FCBMSG
        MVI     C,16            ;SET UP FIRST 16 BYTES
PURG01  LDAX    D
        MOV     M,A
        DCR     C               ;16 BYTES DONE YET?
        JZ      PURG1           ; YES
        INX     H
        INX     D
        JMP     PURG01          ; NO, LOOP
PURG1   LXI     D,FCB+32        ;INITIALIZE CURRENT RECORD
        XRA     A               ; BYTE IN FCB
        STAX    D
        RET

* UCASE - CONVERT ALL FILENAME ALPHABETICS TO UPPER CASE *

UCASE   MVI     C,8             ;8 CHARACTERS MAX
        LXI     H,FCB+1
```

```
UCASE01 MOV     A,M
        CPI     7BH                 ;IS IT > LOWERCASE z?
        JNC     UCASE1              ; YES, OK
        CPI     'a'                 ; NO, IS IT < LOWERCASE a?
        JC      UCASE1              ; YES, OK
        ANI     0DFH                ;MUST BE LOWER CASE
        MOV     M,A                 ; CONVERT IT TO UPPER CASE
UCASE1  INX     H
        DCR     C                   ;DONE?
        RZ                          ; YES
        JMP     UCASE01             ; NO, LOOP

* HEXBIN - CONVERT TWO HEX ASCII CHARACTERS TO ONE EIGHT
*          BIT BINARY NUMBER
*        - ALSO ADD IT TO CURRENT CHECKSUM IN B
* CALL WITH HL POINTING TO FIRST CHARACTER
* RETURN BINARY NUMBER IN A *

HEXBIN  INX     H
        MOV     A,M                 ;GET FIRST DIGIT
        CALL    EOFCK               ;END OF BUFFER/FILE?
        CALL    ASCHEX              ;CONVERT TO PURE HEX
        RLC                         ;MAKE IT 4 MSB'S
        RLC
        RLC
        RLC
        MOV     E,A                 ;SAVE IT
        INX     H                   ;GET SECOND DIGIT
        MOV     A,M
        CALL    EOFCK
        CALL    ASCHEX              ;CONVERT IT
        ADD     E                   ;COMBINE THEM
        MOV     E,A                 ; SAVE IT
        ADD     B                   ;ADD TO CHECKSUM
        MOV     B,A                 ; SAVE IT
        MOV     A,E                 ;GET BINARY NUMBER
        RET

* ASCHEX - CONVERT HEX ASCII DIGIT TO PURE HEX DIGIT *

ASCHEX  SUI     '0'                 ;SUBTRACT OFF ASCII BIAS
        CPI     10
        RC                          ;NUMBER IS 0-9
        SUI     7                   ;NUMBER IS A-F
        RET

* EOFCK - CHECK FOR END OF BUFFER/FILE
*       - IF END OF FILE THEN DOWNLOAD IS DONE
*       - IF END OF BUFFER, READ MORE DISK & RETURN WITH
*         THE FIRST CHARACTER IN A
*       - OTHERWISE, RETURN WITH NO ACTION *
```

```
EOFCK   CPI     EOF
        RNZ                             ;NOT END OF FILE/BUFFER
        LDA     CONTFLG                 ;SEE IF END OF FILE
        RRC
        JNC     DWNLDNE                 ; YES
        LXI     H,DSKBUFF               ; NO, READ MORE
        CALL    READSK
        LXI     H,DSKBUFF
        MOV     A,M
        RET

* BINHEX - CONVERT AN EIGHT BIT BINARY NUMBER TO TWO HEX
*          ASCII CHARACTERS
*        - STORE THE CHARACTERS IN MEMORY POINTED TO BY HL
*        - ADD BINARY NUMBER TO RUNNING CHECKSUM IN D
* CALL WITH BINARY NUMBER IN A AND HL AS ABOVE *

BINHEX  PUSH    PSW                     ;SAVE DATA
        ADD     B                       ;ADD TO CHECKSUM
        MOV     B,A                     ; SAVE IT
        POP     PSW                     ;GET DATA
        MOV     E,A                     ; SAVE IT IN E
        ANI     0F0H                    ;PUT 4 MSB'S INTO LSB'S
        RRC
        RRC
        RRC
        RRC
        CALL    HEXASC                  ;CONVERT TO HEX ASCII
        CALL    BUFFCK                  ;STORE IT
        MOV     A,E                     ;GET DATA
        ANI     0FH                     ;NOW CONVERT LSB'S
        CALL    HEXASC
        CALL    BUFFCK                  ;STORE IT
        RET

* HEXASC - CONVERT A BINARY NUMBER TO A HEX ASCII CHAR. *

HEXASC  CPI     0AH
        JC      NUMBER                  ;IT IS 0-9
        ADI     7                       ;IT IS A-F
NUMBER  ADI     30H                     ;ADD ASCII BIAS
        RET


** DISK I/O ROUTINES **
** ALL ERROR CODES RETURNED ARE IN ACCORDANCE WITH CP/M
*   AND MP/M CONVENTIONS **

* READSK - READ THIRTY-TWO (32) 128 BYTE RECORDS FROM DISK
*          SET FLAG TO INDICATE IF ONLY A PARTIAL READ *
```

```
READSK  PUSH    B                       ;SAVE B
        MVI     B,32                    ;READ 32 RECORDS MAX
READSK1 CALL    DMASET                  ;SET DMA ADDRESS
        CALL    READREC                 ;READ A SINGLE RECORD
        CPI     0                       ;GOOD READ?
        JZ      READMORE                ; YES, DO IT AGAIN
        CPI     1                       ;EOF?
        JZ      READNE                  ; YES, DONE
        MVI     A,15                    ; NO, READ ERROR
READMORE DCR    B                       ;4K WORTH YET?
        JNZ     READSK1                 ; NO, READ MORE
        MVI     M,EOF                   ; YES, STORE END OF BUFFER
                                        ; INDICATOR
        MVI     A,0FFH                  ;SET CONTINUATION FLAG
        STA     CONTFLG
        POP     B                       ;RESTORE B
        RET
READNE  XRA     A                       ;RESET CONTINUATION FLAG
        STA     CONTFLG
        PUSH    B
        LXI     B,-128                  ;POINT TO END OF LAST RECORD
        DAD     B
        POP     B
        MVI     M,EOF                   ;ENSURE EOF MARKER IN BUFFER
        POP     B                       ;RESTORE ORIGINAL B
        RET

* WRITEDSK - WRITE A SINGLE 128 BYTE RECORD TO DISK *

WRITEDSK LXI    H,DSKBUFF               ;POINT TO DISK BUFFER
        CALL    DMASET                  ;SET DMA ADDRESS
        CALL    WRITEREC                ;WRITE RECORD TO DISK
        CPI     0                       ;GOOD WRITE?
        RZ                              ; YES, DONE
        MVI     A,18                    ; NO, OUT OF DISK SPACE
        CALL    ERROR
        CALL    CLOSFILE                ;CLOSE THE FILE BUT
        CALL    DELETE                  ; DON'T SAVE A PARTIAL FILE
        JMP     MENU

* READREC - READ A SINGLE RECORD FROM DISK *

READREC PUSH    B
        PUSH    D
        PUSH    H
        LXI     D,FCB
        MVI     C,READF
        CALL    BDOS
        POP     H
        POP     D
```

```
        POP     B
        RET

* WRITEREC - WRITE A SINGLE RECORD TO DISK *

WRITEREC PUSH   B
        PUSH    D
        PUSH    H
        LXI     D,FCB
        MVI     C,WRITEF
        CALL    BDOS
        POP     H
        POP     D
        POP     B
        RET

* DMASET - SET DMA ADDRESS
* CALL WITH ADDRESS IN HL
* RETURN WITH HL = HL + 128 *

DMASET  PUSH    PSW
        PUSH    B
        PUSH    D
        PUSH    H
        XCHG                    ;DE = DMA ADDRESS
        MVI     C,SETDMA
        CALL    BDOS
        POP     H
        LXI     B,128           ;READY DMA ADDRESS FOR NEXT
        DAD     B               ; TIME
        POP     D
        POP     B
        POP     PSW
        RET

* OPENFILE - OPEN A FILE CURRENTLY ON DOSK *

OPENFILE PUSH   B
        PUSH    D
        PUSH    H
        LXI     D,FCB
        MVI     C,OPENF
        CALL    BDOS
        POP     H
        POP     D
        POP     B
        RET

* CLOSFILE - CLOSE A FILE CURRENTLY ON DISK *

CLOSFILE PUSH   B
```

```
        PUSH    D
        PUSH    H
        LXI     D,FCB
        MVI     C,CLOSEF
        CALL    BDOS
        POP     H
        POP     D
        POP     B
        RET

* CREATE - CREATE A NEW FILE ON DISK *

CREATE  PUSH    B
        PUSH    D
        PUSH    H
        LXI     D,FCB
        MVI     C,MAKEF
        CALL    BDOS
        POP     H
        POP     D
        POP     B
        RET

* DELETE - DELETE A FILE CURRENTLY ON DISK *

DELETE  PUSH    B
        PUSH    D
        PUSH    H
        LXI     D,FCB
        MVI     C,DELF
        CALL    BDOS
        POP     H
        POP     D
        POP     B
        RET

* CURDSK - GET CURRENTLY LOGGED DISK *

CURDSK  PUSH    B
        PUSH    D
        PUSH    H
        LXI     D,FCB
        MVI     C,CURRNTD
        CALL    BDOS
        POP     H
        POP     D
        POP     B
        RET

* ERROR - ERROR HANDLING ROUTINE
* CALL WITH ACC = ERROR NUMBER *
```

```
ERROR   MOV     C,A             ;GET ERROR NUMBER
        MVI     B,0             ;COMPUTE ERROR VECTOR
        LXI     H,ERRJMP-3
        DAD     B
        DAD     B
        DAD     B
        PCHL                    ;ERROR VECTOR IS IN PC
        NOP
        NOP

ERRJMP  JMP     ERROR1          ;MENU SELECTION ERROR
        JMP     ERROR2          ;TOO MANY/FEW DELIMITERS
        JMP     ERROR3          ;PERIOD+DATA ERROR
        JMP     ERROR4          ;INVALID HEX DIGIT ERROR
        JMP     ERROR5          ;DELIMITER AT START/END
        JMP     ERROR6          ;2 OR MORE DEL. SEQUENTIALLY
        JMP     ERROR7          ;NO AMBIGUOUS FILES
        JMP     ERROR8          ;COLONS NOT PROPERLY PLACED
                                ; IN FILENAME
        JMP     ERROR9          ;TOO MANY/FEW CHAR. IN FN
        JMP     ERROR10         ;HEX FILETYPE ONLY
        JMP     ERROR11         ;NO SPACES IN FILENAME
        JMP     ERROR12         ;NO NON-PRINTABLE CHAR IN FN
        JMP     ERROR13         ;FILE NOT FOUND
        JMP     ERROR14         ;HEX CHECKSUM ERROR
        JMP     ERROR15         ;DISK READ ERROR
        JMP     ERROR16         ;OUT OF DIRECTORY SPACE
        JMP     ERROR17         ;START > FINISH ADDRESS
        JMP     ERROR18         ;OUT OF DIR/DISK SPACE
                                ; PARTIAL FILE NOT SAVED

ERROR1  LXI     D,MENERRMG      ;PRINT MENU ERROR MESSAGE
        JMP     ERROUT

ERROR2  LXI     D,MFDELERR      ;PRINT ERROR MESSAGE
        JMP     ERROUT1

ERROR3  LXI     D,PERONLYM
        JMP     ERROUT1

ERROR4  LXI     D,INVHEXER
        JMP     ERROUT1

ERROR5  LXI     D,SEDELERR
        JMP     ERROUT1

ERROR6  LXI     D,SEQDELER
        JMP     ERROUT1

ERROR7  LXI     D,AMBIGERR
```

```
        JMP     ERROUT2

ERROR8  LXI     D,COLONERR
        JMP     ERROUT2

ERROR9  LXI     D,FNCHARER
        JMP     ERROUT2

ERROR10 LXI     D,HEXFTERR
        JMP     ERROUT2

ERROR11 LXI     D,SPFNERR
        JMP     ERROUT2

ERROR12 LXI     D,NPRTERR
        JMP     ERROUT2

ERROR13 LXI     D,FNFNDERR
        JMP     ERROUT1

ERROR14 LXI     D,CKSUMERR
        JMP     ERROUT3

ERROR15 LXI     D,DSKRDERR
        JMP     ERROUT3

ERROR16 LXI     D,DIRSPERR
        JMP     ERROUT

ERROR17 LXI     D,SGFAERR
        JMP     ERROUT1

ERROR18 LXI     D,DDSPCERR
        JMP     ERROUT3

ERROUT  CALL    PRINT           ;PRINT ERROR
        CALL    DELAY           ;LET USER READ ERROR
        JMP     MENU            ;START OVER

ERROUT1 LXI     SP,STACK        ;RE-INIT. STACK
              CALL    PRINT             ;PRINT ERROR
        CALL    DELAY
        LDA     MENUFLG         ;RECALL MENU CHOICE
        JMP     MENU1           ;RESTART CURRENT OPTION

ERROUT2 CALL    PRINT           ;PRINT ERROR
        CALL    DELAY
        RET                     ;BACK TO CALLER

ERROUT3 CALL    PRINT           ;PRINT ERROR
        CALL    DELAY
```

```
        CALL    HOSTDONE           ;TELL MDS DONE
        JMP     MENU

* DELAY - APPROX. 1-2 SECOND DELAY FOR USER TO SEE ERROR
*  MESSAGE BEFORE MENU IS REPRINTED *

DELAY   PUSH    PSW
        PUSH    B
        PUSH    D
        PUSH    H
        MVI     B,15               ;OUTER LOOP INITIALIZATION
        LXI     D,-1               ;DECREMENT BY SUBTRACTION
DELAYIN LXI     H,39E0H            ;INNER LOOP INITIALIZATION
DELAYOUT DAD    D                  ;HL = HL - 1
        JC      DELAYOUT
        DCR     B
        JNZ     DELAYIN
        POP     H
        POP     D
        POP     B
        POP     PSW
        RET                        ;DELAY DONE, BACK TO CALLER

* CRLF - CARRIAGE RETURN & LINE FEED UTILITY *

CRLF    MVI     E,CR               ;PRINT CARRIAGE RETURN
        CALL    CONSOUT
        MVI     E,LF               ; THEN A LINE FEED
        CALL    CONSOUT
        RET


* ENTER - GET A HEX INTEGER FROM THE CONSOLE BUFFER
*  & RETURN WITH HL = 16 BIT BINARY DATA
* CALL WITH  C = MAX NUMBER OF CHARACTERS TO INPUT
*           DE = CONSOLE BUFFER POINTER FOR START OF
*                CONVERSION PROCESS *

ENTER   PUSH    PSW                ;SAVE A, BC, DE
        PUSH    B
        PUSH    D
        LXI     H,0000H            ;INIT. DATA AREA
ENTER1  LDAX    D                  ;GET DATA FOR CONVERSION
        CPI     'A'                ;IS IT 0-9?
        JC      ENTER15            ; YES
        ANI     0DFH               ; NO - FORCE TO UPPER CASE
ENTER15 DAD     H                  ;SHIFT PREVIOUS DATA LEFT
        DAD     H                  ; 4 BITS
        DAD     H
        DAD     H
        JC      ENTER3             ;IF OVERFLOW, PRINT ERROR
```

```
        CPI     '0'             ;IS IT 0-F?
        JC      ENTER3          ; NO - ILLEGAL CHARACTER
        CPI     'F'+1           ;IS IT > F?
        JNC     ENTER3          ; YES - ILLEGAL CHARACTER
        CPI     'A'             ;LEGAL - IS IT A-F?
        JC      ENTER2          ; NO - IT'S 0-9
        ADI     9               ;ADD CONVERSION FACTOR
ENTER2  ANI     0FH             ;ISOLATE 4 BITS
        ORA     L               ;MERGE WITH PREVIOUS DATA
        MOV     L,A
        DCR     C               ;COUNT CHARACTERS ENTERED
        JZ      ENTER4          ;EXIT IF C = 0
        INX     D               ;BUMP BUFFER ADDRESS
        JMP     ENTER1          ;GET ANOTHER HEX INTEGER
ENTER3  MVI     A,4             ;PRINT ILLEGAL CHARACTER
                                ; ERROR
        JMP     ERROR           ;START OVER
ENTER4  POP     D               ;RESTORE REGISTERS
        POP     B
        POP     PSW
        RET

* CONSIN - CONSOLE INPUT ROUTINE
*  DOESN'T RETURN UNTIL INPUT IS RECEIVED *

CONSIN  PUSH    B               ;SAVE REGISTERS
        PUSH    D
        PUSH    H
        MVI     C,CONIN         ;GET CHARACTER
        CALL    BDOS
        POP     H               ;RESTORE REGISTERS
        POP     D
        POP     B
        RET                     ;RETURN TO CALLER WITH
                                ; CHARACTER IN A

* CONSOUT - CONSOLE OUTPUT ROUTINE
*  ENTER WITH CHARACTER IN E *

CONSOUT PUSH    PSW             ;SAVE REGISTERS
        PUSH    B
        PUSH    D
        PUSH    H
        MVI     C,CONOUT        ;OUTPUT CHARACTER
        CALL    BDOS
        POP     H               ;RESTORE ALL REGISTERS
        POP     D
        POP     B
        POP     PSW
        RET                     ;BACK TO CALLER
```

```
* CONSTAT - GET CONSOLE INPUT STATUS
*  RETURNS WITH A = 00H IF NO CHARACTER WAITING
*                  = 0FFH IF CHARACTER IS WAITING *

CONSTAT PUSH    B                   ;SAVE REGISTERS
        PUSH    D
        PUSH    H
        MVI     C,CONST             ;GET STATUS
        CALL    BDOS
        POP     H                   ;RESTORE REGISTERS
        POP     D
        POP     B
        RET

* BUFFRD - READ CONSOLE INPUT INTO BUFFER POINTED TO BY DE
*  RETURN WITH DE = BUFFER START ADDRESS + 1
*               B = COUNT OF CHARACTERS INPUT
*               ALL OTHER REGISTERS (A, HL) UNCHANGED *

BUFFRD  PUSH    PSW                 ;SAVE A, HL
        PUSH    H
BUFF1   LXI     D,PROMPT            ;SEND PROMPT TO CONSOLE
        CALL    PRINT
        LXI     D,CONBUFF           ;POINT TO CONSOLE BUFFER
        PUSH    D                   ; SAVE IT
        MVI     C,READCON           ;READ CONSOLE INPUT
        CALL    BDOS
        CALL    CRLF
        POP     D                   ;POINT TO CHAR. COUNT
        INX     D
        LDAX    D                   ;GET COUNT
        ORA     A                   ;IS COUNT = 0?
        JNZ     READONE             ; NO, RETURN TO CALLER
        JMP     BUFF1               ; YES, TRY AGAIN
READONE MOV     B,A                 ;RETURN WITH B = COUNT
        POP     H                   ;RESTORE A, HL
        POP     PSW
        RET

* BUFFRD1 - READ CONSOLE INPUT INTO BUFFER POINTED TO BY DE
*  RETURN WITH DE = BUFFER START ADDRESS + 1
*               B = COUNT OF CHARACTERS INPUT
*               A = 00  IF COUNT = 0
*                 = 0FFH IF COUNT > 0
*               HL UNCHANGED *

BUFFRD1 PUSH    H                   ;SAVE HL
        LXI     D,CONBUFF           ;POINT TO CONSOLE BUFFER
        PUSH    D                   ; SAVE IT
        MVI     C,READCON           ;READ CONSOLE INPUT
        CALL    BDOS
```

```
        CALL    CRLF
        POP     D                       ;POINT TO CHAR. COUNT
        INX     D
        LDAX    D                       ;GET COUNT
        ORA     A                       ;IS COUNT = Ø?
        JZ      READONE1                ; YES, RETURN TO CALLER
        MOV     B,A                     ;SAVE CHAR COUNT
        MVI     A,ØFFH                  ;COUNT > Ø
        JMP     READONE1+1
READONE1 MOV    B,A                     ;RETURN WITH B = COUNT
        POP     H                       ;RESTORE A, HL
        RET

* SCAN - DELIMITER SCAN OF CONSOLE INPUT BUFFER
*        (SPACES AND COMMAS ARE LEGAL DELIMITERS)
*        ALSO CHECKS FOR ESCAPE AND '?' KEYS
*  CALL WITH   DE = CONBUFF + 1
*               A = NUMBER OF DELIMITERS TO LOOK FOR
*  RETURN WITH CARRY SET IF MORE OR LESS DELIMITERS
*                        THAN SPECIFIED
*              A = GARBAGE
*              OTHER REGISTERS UNCHANGED *

SCAN    PUSH    B                       ;SAVE REGISTERS
        PUSH    D
        PUSH    H
        MOV     B,A                     ;GET DELIMITER COUNT
        XCHG                            ;HL = CONBUFF + 1
        MOV     C,M                     ;GET CHARACTER COUNT
        CALL    SCNENDEL                ;SCAN FOR DELIMITERS AT
                                        ; START AND END OF INPUT
        CALL    SCANDDEL                ;SCAN FOR SEQUENTIAL DELS.
SCAN1   INX     H                       ;GET CHARACTER
        MOV     A,M
        CPI     SPACE                   ;IS IT A SPACE?
        JZ      CNTDEL                  ; YES, DEC DELIMITER COUNT
        CPI     COMMA                   ;IS IT A COMMA?
        JZ      CNTDEL                  ; YES
        CPI     ESC                     ;IS IT AN ESCAPE CHARACTER?
        JZ      SCANESC                 ; YES, ESCAPE FROM OPTION
        CPI     '?'                     ;IS IT A QUEST FOR HELP?
        JZ      QUESTION                ; YES, PRINT DATA FORMATS
SCAN2   DCR     C                       ;NONE OF THESE, CHECK NEXT
                                        ; CHARACTER
        JZ      SCANDONE                ;NO MORE CHARACTERS TO CHECK
        JMP     SCAN1
CNTDEL  DCR     B                       ;DECREMENT DELIMITER COUNT
        JMP     SCAN2                   ;LOOK FOR ANOTHER DELIMITER
SCANDONE XRA    A                       ;SEE IF B = Ø
        CMP     B
SCAND1  POP     H                       ;RESTORE REGISTERS
```

```
        POP     D
        POP     B
        RET
SCANESC LDA     MENUFLG             ;IF HOST COMMAND THEN
        CPI     NHSTCMD             ; NO ESCAPE TO MDS
        JC      MENU
        LDA     SYSSTAT             :SEE IF HOST IN CONTROL
        ORA     A
        JZ      SCNESC1             ;HOST IN CONTROL
        CALL    CNTRLCK             ;MDS ID IN CONTROL
        RRC
        JNC     MENU                ; NO ABORT
SCNESC1 MVI     A,'Q'               ; ABORT
        CALL    MDSCMD
        XRA     A                   ;CLEAR SYSSTAT FLAG, HOST
        STA     SYSSTAT             ; NOW IN CONTROL
        JMP     MENU                ;RETURN TO MENU

QUESTION LXI    D,FORMTMSG          ;PRINT DATA FORMATS AND
        CALL    PRINT               ; RETURN TO CURRENT OPTION
QUEST1  CALL    CONSTAT             ;WAIT FOR RESPONSE TO
        RRC                         ; CONTINUE
        JNC     QUEST1
        CALL    CONSIN
        LXI     D,FMTMSG1           ;CONTINUE FORMAT MESSAGE
        CALL    PRINT
QUEST2  CALL    CONSTAT
        RRC
        JNC     QUEST2
        CALL    CONSIN
        LDA     MENUFLG
        JMP     MENU1               ;BACK TO OPTION

CNTRLCK LXI     D,ABORTMSG          ; MDS IS - PRINT ABORT QUERY
        CALL    PRINT
CNTRL1  CALL    CONSTAT             ;WAIT FOR RESPONSE
        RRC
        JNC     CNTRL1
        CALL    CONSIN              ;GET RESPONSE
        ORI     20H                 ;FORCE IT TO LOWER CASE
        CPI     'y'                 ;ABORT MDS CONTROL?
        JZ      CNTRL2              ; YES
        XRA     A                   ; NO, CLEAR A
        RET
CNTRL2  MVI     A,0FFH              ; SET A
        RET

* SCNENDEL - CHECK FOR DELIMITERS AT FIRST & LAST CHARACTER
*            POSITIONS IN CONSOLE INPUT BUFFER
*  CALL WITH BUFFER COUNT IN C *
```

```
SCNENDEL PUSH    B                    ;SAVE BUFFER COUNT
         INX     H                    ;GET FIRST CHARACTER
         MOV     A,M
         CPI     SPACE                ;IS IT A SPACE?
         JZ      SCNSPC1              ; YES, ERROR
         CPI     COMMA                ;IS IT A COMMA?
         JNZ     SCNSPC2              ; NO, CONTINUE TO END
SCNSPC1  MVI     A,5                  ;ERROR
         JMP     ERROR
SCNSPC2  DCR     C                    ;AT BUFFER END YET?
         JZ      SCNSPC3              ; YES
         INX     H                    ; NO
         JMP     SCNSPC2              ; LOOP
SCNSPC3  MOV     A,M                  ;GET LAST CHARACTER
         CPI     SPACE                ;A SPACE?
         JZ      SCNSPC1              ; YES, ERROR
         CPI     COMMA                ;A COMMA?
         JZ      SCNSPC1              ; YES, ERROR
         POP     B                    ;RESTORE BUFFER COUNT
         LXI     H,CONBUFF+1          ; AND POINTER TO IT
         RET

* SCANDDEL - SCAN CONSOLE BUFFER FOR 2 OR MORE SEQUENTIAL
*            DELIMITERS *

SCANDDEL PUSH    B                    ;SAVE BUFFER COUNT
         XRA     A                    ;INIT. FIRST DELIMITER FLAG
         STA     FRSTDEL
SDEL1    INX     H                    ;GET CHARACTER
         MOV     A,M
         CPI     SPACE                ;SPACE?
         JZ      DELCK                ; YES, FIRST DELIMITER?
         CPI     COMMA                ;COMMA?
         JZ      DELCK                ; YES, FIRST DELIMITER?
         DCR     C                    ;IF C = Ø THEN DONE
         JZ      SDELDNE
         XRA     A                    ;RESET FLAG
         STA     FRSTDEL
         JMP     SDEL1                ;LOOP
DELCK    LDA     FRSTDEL              ;FIRST DELIMITER?
         ORA     A
         JNZ     DELCK1               ; NO, A=1 - ERROR
         INR     A                    ; YES, SET FRSTDEL FLAG
         STA     FRSTDEL
         DCR     C                    ;SEE IF DONE
         JZ      SDELDNE
         JMP     SDEL1                ; NO, LOOP
DELCK1   XRA     A
         STA     FRSTDEL
         MVI     A,6
         JMP     ERROR                ;PRINT ERROR
```

```
SDELDNE POP     B                   ;RESTORE BUFFER COUNT
        LXI     H,CONBUFF+1         ; AND POINTER TO IT
        RET


* CKPERIOD - CHECK FOR A PERIOD ANYWHERE IN INPUT
*  CALL WITH   DE = CONBUFF + 1
*  RETURN WITH  A = ØØ IF NO PERIOD FOUND
*                 = ØFFH IF A PERIOD ONLY
*                 = ØFØH IF A PERIOD + DATA
*               OTHER REGISTERS UNCHANGED *

CKPERIOD PUSH   B                   ;SAVE REGISTERS
        PUSH    D
        PUSH    H
        XCHG                        ;HL = CONBUFF + 1
        MOV     C,M                 ;C = CHARACTER COUNT
        MOV     D,M                 ;D = CHAR. COUNT ALSO
CKPER1  INX     H                   ;GET CHARACTER
        MOV     A,M
        CPI     PERIOD              ;IS IT A PERIOD?
        JZ      PERFND              ; YES
        DCR     C                   ; NO, ANY MORE CHARACTERS?
        JZ      CKDONE              ; NO, CHECK DONE
        JMP     CKPER1              ; YES, TRY AGAIN
PERFND  MOV     A,D                 ;RECALL ORIG. CHAR. COUNT
        CPI     1                   ;ONLY A PERIOD?
        JZ      NOERR               ; YES, NO ERROR
        MVI     A,ØFØH              ; PERIOD + DATA IS ILLEGAL
        JMP     CKDONE+1
NOERR   MVI     A,ØFFH              ;PERIOD ONLY INDICATION
        JMP     CKDONE+1
CKDONE  XRA     A                   ;CLEAR ACC., NOT FOUND
        POP     H                   ;RESTORE REGISTERS
        POP     D
        POP     B
        RET

* GET4BIN - GET 4 OR LESS HEX INTEGERS FROM THE CONSOLE
*           BUFFER AND CONVERT THEM INTO 16 BIT BINARY DATA
*           (GO INTO BUFFER, GO TO DELIMITER IF ONE EXISTS
*            OR TO BUFFER END, WHICHEVER OCCURS FIRST;
*            BACK UP NUMBER OF CHARACTERS SPECIFIED BY
*            CALLER OR TO DELIMITER OR BUFFER+1, CONVERT
*            TO BINARY AND RETURN)
*  CALL WITH  DE = START OF CONVERSION POINTER (AT A
*                  DELIMITER OR THE BUFFER COUNT)
*  RETURN WITH B = NUMBER OF CHARACTERS LEFT IN BUFFER
*              C = NUMBER OF CHARACTERS CONVERTED
*             DE = END OF BUFFER OR DELIMITER
*             HL = 16 BIT BINARY DATA *
```

```
GET4BIN MVI      C,4              ;GET 4 CHARACTERS MAX
        MOV      A,C              ;BE SURE BACKUP1 INST IS
        STA      BACKUP1+1        ; MVI A,4
GET41   XCHG                      ;HL = START OF SEARCH
GET4LOOP INX     H                ;GET CHARACTER
        MOV      A,M
        CPI      SPACE            ;IS IT A SPACE?
        JZ       BACKUP           ; YES
        CPI      COMMA            ;IS IT A COMMA?
        JZ       BACKUP           ; YES
        DCR      B                ;MORE CHARACTERS IN BUFFER?
        JZ       BACKUPØ          ; NO
        JMP      GET4LOOP         ;NONE OF THESE, TRY AGAIN
BACKUPØ INX      H                ;POINT TO BUFFER END + 1
BACKUP  PUSH     H                ;SAVE DELIMITER ADDRESS
        DCX      H                ;BACK UP 1
        CALL     BUFFTST          ;AT BEGINNING OF BUFFER?
        JZ       BACKUPØ1         ; NO
        MOV      A,M
        CPI      SPACE            ;ARE WE AT A SPACE?
        JZ       BACKUPØ1         ; YES
        CPI      COMMA            ;ARE WE AT A COMMA?
        JZ       BACKUPØ1         ; YES
        DCR      C                ;DECREMENT CHARACTER COUNT
        JNZ      BACKUP+1         ;BACK UP 1 AGAIN
        JMP      BACKUP1          ;C = Ø FINALLY
BACKUPØ1 INX     H                ;POINT TO FIRST CHARACTER
BACKUP1 MVI      A,4              ;FINALLY GOT THERE
        SUB      C                ;COMPUTE NUMBER OF BACKUPS
        MOV      C,A
        XCHG                      ;DE = CONVERSION START ADDR
        CALL     ENTER            ;DO CONVERSION
        POP      D                ;DE = DELIMITER ADDRESS
        DCR      B                ;DECREMENT CHAR. COUNT
        RET
BUFFTST PUSH     H
        PUSH     D
        LXI      D,CONBUFF+1
        MOV      A,L              ;AT BUFFER+1 YET?
        CMP      E                ;IF Z = 1 THEN AT BUFFER+1
        POP      D
        POP      H
        RET                       ; ELSE Z = Ø

* GET2BIN - SAME AS GET4BIN BUT LIMITED TO TWO CHARACTERS
*           MAX
*  SAME ENTRY PARAMETERS
*  RETURNS WITH L = 8 BIT BINARY DATA
*               OTHER REGISTERS AS IN GET4BIN *
```

```
GET2BIN MVI     C,2
        MOV     A,C                     ;TWO BACK-UP'S ONLY
        STA     BACKUP1+1               ; MODIFY GET4BIN CODE
        CALL    GET41
        MVI     A,4                     ;RESTORE GET4BIN CODE
        STA     BACKUP1+1
        RET

* MDSOUT - HOST OUTPUT TO MDS
*  CALL WITH CHARACTER IN A *

MDSOUT  PUSH    B                       ;SAVE REGISTERS
        PUSH    D
        PUSH    H
        MOV     C,A                     ;SAVE CHARACTER
MDSOUT1 MVI     A,10H                   ;RESET SIO INT BIT
        OUT     MSTATPT
        IN      MSTATPT                 ;GET SIO STATUS
        ANI     0CH                     ;CHECK FOR BOTH DTR & TXE
        CPI     0CH                     ; MUST HAVE BOTH
        JNZ     MDSOUT1                 ;LOOP TILL READY
        MOV     A,C
        OUT     MDATAPT                 ;SEND CHARACTER
        CPI     XON                     ;IF XON, DON'T WAIT FOR
        JZ      XONDN                   ; CONFIRMATION
XONCK   CALL    MDSTAT                  ;NOW WAIT FOR CONFIRMATION
        RRC
        JNC     XONCK                   ; FROM MDS
        IN      MDATAPT                 ;GET IT TO RESET SIO FLAGS
XONDN   POP     H                       ;RESTORE REGISTERS
        POP     D
        POP     B
        RET

* MDSCMD - SEND COMMAND TO MDS
*  CALL WITH A = COMMAND *

MDSCMD  PUSH    PSW                     ;SAVE COMMAND
        MVI     A,055H                  ;NEXT CHAR. WILL BE CMD
        CALL    MDSOUT
        POP     PSW                     ;SEND COMMAND
        CALL    MDSOUT
        RET

* MDATAOUT - SEND USABLE DATA TO MDS
*  CALL WITH A = DATA *

MDATAOUT PUSH   PSW                     ;SAVE DATA
        MVI     A,0FFH                  ;NEXT CHAR. WILL BE DATA
        CALL    MDSOUT
        POP     PSW                     ;SEND DATA
```

```
        PUSH     PSW                    ; SAVE IT
        CALL     MDSOUT
        POP      PSW                    ;RESTORE DATA
        RET

* HOSTRDY - HOST READY TO RECEIVE RETURN DATA FOR CURRENT
*           OPTION *

HOSTRDY MVI      A,00H                  ;NEXT CHAR. IS RDY FLAG
        CALL     MDSOUT
        MVI      A,00H                  ;SEND READY FLAG
        CALL     MDSOUT
        RET

* HOSTDONE - HOST DONE WITH ITS PART IN CURRENT OPTION,
*            IS RETURNING TO MONITOR *

HOSTDONE MVI     A,'Q'                  ;NEXT CHAR. IS DONE CMND
        CALL     MDSCMD
        RET

* MDSIN - HOST INPUT FROM MDS
*  RETURNS WITH CHARACTER IN A, OTHER REGISTERS RESTORED *

MDSIN   PUSH     B                      ;SAVE REGISTERS
        PUSH     D
        PUSH     H
        CALL     MDSINRDY               ;ANY INPUT WAITING FROM MDS?
        IN       MDATAPT                ; YES, GET DATA TYPE
        CPI      0FFH                   ;IS IT DATA?
        JZ       MDSIN2                 ; YES, GET IT
        CPI      055H                   ;QUIT CMD?
        JZ       MDSQUIT                ; YES
        JMP      MDSINDNE               ; NO, MDS MUST HAVE
                                        ;  SIGNALLED IT'S READY
                                        ;  FOR INPUT
MDSQUIT MVI      A,XON                  ;CONFIRM RECEIPT
        CALL     MDSOUT
        CALL     MDSINRDY
        IN       MDATAPT
        XRA      A                      ;RESET FLAGS
        STA      SYSSTAT
        STA      MDSRDYF
        MVI      A,XON                  ;CONFIRM RECEIPT OF 'Q'
        CALL     MDSOUT
        JMP      MENU                   ;NOW BACK TO MENU
MDSIN2  MVI      A,XON                  ;SEND CONFIRMATION
        CALL     MDSOUT
        CALL     MDSINRDY               ;WAIT FOR DATA
        IN       MDATAPT                ; THEN GET IT
        PUSH     PSW                    ; SAVE IT
```

```
        MVI     A,XON               ; CONFIRM AGAIN
        CALL    MDSOUT
        POP     PSW                 ;RESTORE DATA & REGISTERS
        POP     H
        POP     D
        POP     B
        RET

* MDSINRDY - CHECK FOR INPUT FROM MDS, LOOP TILL THERE IS *

MDSINRDY CALL   ESCK                ;CHECK FOR ESCAPE
        CALL    MDSTAT              ;GET STATUS
        RRC
        JNC     MDSINRDY            ;NO CHARACTER WAITING, LOOP
        RET                         ;CHARACTER WAITING

* MDSINDNE - SET MDS READY FOR INPUT FLAG *

MDSINDNE MVI    A,XON               ;CONFIRM IT
        CALL    MDSOUT
        CALL    MDSINRDY
        IN      MDATAPT
        MVI     A,ØFFH              ;SET MDS READY FLAG
        STA     MDSRDYF
        MVI     A,XON               ;CONFIRM RECEIPT OF DATA
        CALL    MDSOUT
        POP     H                   ;RESTORE REGISTERS
        POP     D
        POP     B
        RET                         ;BACK TO MDSIN CALLER

* ESCK - CHECK FOR ESCAPE COMMAND FROM KEYBOARD
*        IGNORE ALL OTHER INPUT *

ESCK    CALL    CONSTAT             ;CHECK FOR INPUT
        RRC
        RNC                         ; NONE
        CALL    CONSIN              ;IS IT ESCAPE?
        CPI     ESC                 ;IS IT ESCAPE?
        JZ      ESCKØ1              ; NO
        MVI     E,BKSPCE            ;DON'T PRINT CHARACTER
        CALL    CONSOUT
        RET
ESCKØ1  LDA     SYSSTAT             ;GET SYSTEM STATUS
        ORA     A
        JZ      ESCK1               ;HOST IN CONTROL
        CALL    CNTRLCK             ;SEE WHO IS IN CONTROL
        RRC
        JNC     MENU                ; NO ABORT
ESCK1   MVI     A,'Q'               ; YES, SEND ESCAPE CMD
        CALL    MDSCMD              ;  TO MDS
```

```
        XRA     A                   ;HOST NOW IN CONTROL
        STA     SYSSTAT
        JMP     MENU                ;NOW BACK TO MENU

* MDSTAT - GET STATUS OF MDS SIO
*   RETURNS WITH A = 00 AND Z = 1 IF NO CHARACTER WAITING
*                  = 0FFH AND Z = 0 IF CHARACTER WAITING *

MDSTAT  XRA     A                   ;CHECK SIO STATUS
        OUT     MSTATPT
        IN      MSTATPT
        ANI     1                   ;CHARACTER WAITING?
        RZ                          ; NO, RETURN WITH A = 0
        MVI     A,0FFH              ; YES, RETURN WITH A = 0FFH
        RET


* CNVT16 - CONVERT 16 BITS BINARY DATA TO HEX ASCII
*   CALL WITH  HL = ADDRESS FOR 4 CHARACTER ASCII OUTPUT
*                    STRING
*              BC = 16 BIT BINARY DATA
*   RETURNS    REGISTER PAIRS UNCHANGED
*              A = GARBAGE *

CNVT16  PUSH    H                   ;SAVE REGISTERS
        PUSH    D
        PUSH    B
        INX     H
        INX     H
        INX     H
        MVI     D,4                 ;CHARACTER COUNTER
CNVT161 MOV     A,C                 ;NEXT 4 BITS
        ANI     0FH
        CPI     0AH                 ;IS IT A-F?
        JC      CNVT1615            ; NO
        ADI     7                   ; YES
CNVT1615 ADI    '0'                 ;FORM ASCII
        MOV     M,A                 ;STORE THIS CHARACTER
        DCX     H                   ;BACK UP THROUGH OUTPUT AREA
        MVI     E,4                 ;DOUBLE RIGHT
        ORA     A                   ;SHIFT RIGHT 4 BITS
CNVT162 MOV     A,B
        RAR
        MOV     B,A
        MOV     A,C
        RAR
        MOV     C,A
        DCR     E                   ;DECREMENT SHIFT COUNTER
        JNZ     CNVT162             ;STILL SHIFTING
        DCR     D                   ;DECREMENT CHARACTER COUNTER
        JNZ     CNVT161             ;STILL CONVERTING
```

```
        POP     B                       ;RESTORE REGISTERS
        POP     D
        POP     H
        RET

* CNVT8 - CONVERT 8 BITS BINARY DATA TO HEX ASCII
*  CALL WITH  HL = ADDRESS FOR 2 CHARACTER ASCII OUTPUT
*                  STRING
*              C = 8 BIT BINARY DATA
*  RETURNS    REGISTER PAIRS UNCHANGED
*             A = GARBAGE *

CNVT8   PUSH    H                       ;SAVE REGISTERS
        PUSH    D
        PUSH    B
        INX     H
        MVI     D,2
        JMP     CNVT161                 ;DO CONVERSION

* STAR - PRINT A STAR *

STAR    PUSH    D
        LXI     D,STARMSG               ;PRINT IT
        CALL    PRINT
        POP     D
        RET                             ;BACK TO CALLER


*** MISCELLANEOUS MESSAGE AND DATA STORAGE AREAS ***

SIGNON    DB    CR,LF,'ALTOS MDS CONTROL PROGRAM'
          DB    ' - VERSION 1.5',CR,LF,LF,'$'
INSTRUC   DB    CR,LF,'BASIC AMDS INSTRUCTIONS:',CR,LF,LF
          DB    ' A. THE PROMPT FOR INPUT OF DATA IS'
          DB    ' ">".',CR,LF
          DB    '  B. ALL INPUTS MAY BE IN UPPER OR lower'
          DB    ' CASE.',CR,LF
          DB    '  C. ADDRESS AND DATA INPUTS ARE EXPECTED'
          DB    ' TO BE IN HEX NOTATION.',CR,LF
          DB    '  D. TERMINATE INPUTS WITH A CARRIAGE '
          DB    'RETURN OR LINE FEED.',CR,LF
          DB    '  E. NORMAL LINE EDITING ON INPUT IS AS '
          DB    'IN CP/M AND MP/M.',CR,LF
          DB    '  F. FOR ADDRESS INPUTS, THE PROGRAM '
          DB    'WILL ALWAYS TAKE THE LAST FOUR OR LESS '
          DB    CR,LF,'     HEX CHARACTERS ENTERED;  FOR '
          DB    'DATA INPUTS, THE LAST TWO OR LESS.',CR,LF
          DB    '  G. SOURCES OF COMMON ERROR ARE INVALID'
          DB    ' HEX DIGITS, TOO MANY OR TOO FEW',CR,LF
          DB    '     DELIMITERS, AND ILLEGAL SYNTAX.',CR,LF
```

```
        DB      '  H. IN GENERAL, THE SAME DATA I/O FORMAT'
        DB      ' AS USED IN DIGITAL RESEARCH''S',CR,LF
        DB      '     DDT IS USED HERE.  FOR EXCEPTIONS,'
        DB      ' CONSULT THE USER''S MANUAL.',CR,LF
        DB      '  I. A QUESTION MARK ENTERED AFTER THE '
        DB      'PROMPT WILL CAUSE THE INPUT FORMATS TO'
        DB      CR,LF
        DB      '     BE DISPLAYED.',CR,LF
        DB      '  J. IF THE ESCAPE KEY IS ENTERED DURING '
        DB      'INPUT THEN THE USER IS RETURNED',CR,LF
        DB      '     TO THE MENU.',CR,LF
        DB      '  K. FOR FURTHER DETAILS, CONSULT THE '
        DB      'USER''S MANUAL',CR,LF,LF
        DB      'PRESS ANY KEY TO CONTINUE >$'

MENUMSG DB      CR,LF,'                                        '
        DB      '    MENU',CR,LF
        DB      '          HOST COMMANDS                   '
        DB      '               MDS COMMANDS',CR,LF,LF
        DB      'A. SUPPRESS PRINTING MENU                 '
        DB      'G. DOWNLOAD HEX FILE - DISK TO MDS '
        DB      'MEMORY',CR,LF
        DB      'B. DO NOT SUPPRESS PRINTING MENU          '
        DB      'H. UPLOAD MDS MEMORY TO HEX DISK FILE'
        DB      CR,LF
        DB      'C. BASIC INSTRUCTIONS                     '
        DB      'I. EXAMINE/SET MDS MEMORY LOCATION(S)'
        DB      CR,LF
        DB      'D. HEXADECIMAL ADD & SUBTRACT             '
        DB      'J. CONTINUOUS SET OF MDS MEMORY',CR,LF
        DB      'E. RETURN SYSTEM CONTROL TO HOST          '
        DB      'K. FILL MDS MEMORY WITH SPECIFIED BYTE'
        DB      CR,LF
        DB      'F. RETURN TO CP/M                         '
        DB      'L. LOCATE BYTE SEQUENCE IN MDS MEMORY'
        DB      CR,LF
        DB      '                                          '
        DB      'M. DUMP MDS MEMORY LOCATION(S) TO CONSOLE'
        DB      CR,LF
        DB      '                                          '
        DB      'N. EXECUTE MDS MEMORY FROM SPECIFIED',CR,LF
        DB      '                                          '
        DB      '   LOCATION',CR,LF,'$'
SYSMSG  DB      'SYSTEM STATUS: $$$$ IN CONTROL;'
        DB      '  $$ MENU SUPPRESSION',CR,LF,'$'
MDSMSG  DB      'MDS $'
HOSTMSG DB      'HOST$'
NOMENMSG DB     'NO$'
YESMENMG DB     '   $'
MENERRMG DB     CR,LF,'INVALID MENU SELECTION',CR,LF,'$'
MFDELERR DB     CR,LF,'TOO MANY OR TOO FEW DELIMITERS IN'
```

```
         DB      ' INPUT',CR,LF,'$'
PERONLYM DB      CR,LF,'PERIOD ONLY PLEASE !',CR,LF,'$'
INVHEXER DB      CR,LF,'INVALID HEX DIGIT',CR,LF,'$'
SEDELERR DB      CR,LF,'CAN''T HAVE A DELIMITER AT START OR'
         DB      ' END OF INPUT',CR,LF,'$'
SEQDELER DB      CR,LF,'TWO OR MORE DELIMITERS SEQUENTIALLY'
         DB      CR,LF,'$'
AMBIGERR DB      CR,LF,'AMBIGUOUS FILENAMES NOT ALLOWED'
         DB      CR,LF,'$'
COLONERR DB      CR,LF,'COLON (:) NOT PROPERLY PLACED IN '
         DB      'FILENAME ',CR,LF,'$'
FNCHARER DB      CR,LF,'FILENAME TOO LONG OR TOO SHORT'
         DB      CR,LF,'(8 CHARS MAX, 1 CHAR MIN)',CR,LF,'$'
HEXFTERR DB      CR,LF,'HEX FILETYPES ONLY !',CR,LF,'$'
SPFNERR  DB      CR,LF,'NO SPACES ALLOWED IN FILENAME'
         DB      CR,LF,'$'
NPRTERR  DB      CR,LF,'NON-PRINTABLE CHARACTERS NOT '
         DB      'ALLOWED IN FILENAME',CR,LF,'$'
FNFNDERR DB      CR,LF,'FILE NOT FOUND',CR,LF,'$'
CKSUMERR DB      CR,LF,'HEX CHECKSUM ERROR',CR,LF,'$'
DSKRDERR DB      CR,LF,'DISK READ ERROR',CR,LF,'$'
DIRSPERR DB      CR,LF,'OUT OF DIRECTORY SPACE',CR,LF,'$'
SGFAERR  DB      CR,LF,'START ADDRESS CANNOT BE GREATER '
         DB      'THAN FINISH ADDRESS',CR,LF,'$'
DDSPCERR DB      CR,LF,'OUT OF DIRECTORY OR DISK STORAGE '
         DB      'SPACE',CR,LF,'PARTIAL FILE WAS NOT '
         DB      'SAVED !',CR,LF,'$'
DRIVERR  DB      CR,LF,'WARNING - ONLY CURRENTLY SELECTED '
         DB      'DISK WILL BE USED, INPUT IGNORED !'
         DB      CR,LF,'$'
CNTRLMSG DB      CR,LF,'MDS IS IN CONTROL, CAN''T CONTINUE'
         DB      ' UNTIL OPTION ''E'' IS SELECTED',CR,LF,'$'
ABORTMSG DB      CR,LF,'ABORT MDS CONTROL (Y/N)? $'
ABORTEDM DB      CR,LF,'MDS CONTROL ABORTED, HOST IN '
         DB      'CONTROL.',CR,LF,'$'
EXMSG    DB      CR,LF,'WILL CONSOLE BE RECEIVING DATA '
         DB      'FOR DISPLAY FROM THE MDS (Y/N)?$'
EXMSG2   DB      CR,LF,LF
         DB      ' MDS IS IN CONTROL, HOST MAY REGAIN '
         DB      'CONTROL ONLY BY TYPING THE ESCAPE KEY !'
         DB      CR,LF,LF,'$'
FORMTMSG DB      CR,LF,' INPUT PARAMETER FORMATS ARE AS '
         DB      ' FOLLOWS :',CR,LF
         DB      '    MENU         >X                 '
         DB      '   X IS OPTION SELECTION (A-N)',CR,LF
         DB      '    HEXARITH     >XXXX YYYY         '
         DB      '   XXXX & YYYY ARE HEX INTEGERS',CR,LF
         DB      '    DWNLOAD      >FILENAME(.HEX)    '
         DB      '   (.HEX) IS OPTIONAL',CR,LF
         DB      '    UPLOAD       >FILENAME(.HEX)',CR,LF
         DB      '                 >XXXX YYYY         '
```

```
         DB      '  XXXX & YYYY ARE MDS HEX START AND',CR,LF
         DB      '                                      '
         DB      '  END ADDRESSES FOR UPLOAD',CR,LF
         DB      '   EXAMINE MDS >XXXX                  '
         DB      '  XXXX IS FIRST MDS HEX ADDRESS TO'
         DB      CR,LF,'                                    '
         DB      '  EXAMINE AND SET',CR,LF
         DB      '                   >XXXX YY ZZ        '
         DB      '  XXXX IS HEX ADDRESS, YY IS HEX DATA'
         DB      CR,LF,'                                    '
         DB      '  AT THAT ADDRESS, ZZ IS CARRIAGE RETURN'
         DB      CR,LF,'                                    '
         DB      '                   or ZZ IS NEW HEX DATA'
         DB      CR,LF,'                                    '
         DB      '                   or ZZ IS ''.''',CR,LF
         DB      '   CONTINUOUS  >XXXX                  '
         DB      '  XXXX IS MDS HEX START ADDRESS FOR'
         DB      CR,LF,'                                    '
         DB      '  FIRST CHANGE',CR,LF
         DB      '                   >AA BB CC ....     '
         DB      '  ARE HEX DATA FOR ENTRY INTO MDS MEMORY'
         DB      CR,LF,'                                    '
         DB      '  (255 ENTRIES MAX, INCLUDING DELIMITERS)'
         DB      CR,LF
         DB      '                                      '
         DB      '  IF ONLY A ''.'' IS TYPED AFTER THE'
         DB      CR,LF,'                                    '
         DB      '  PROMPT, THE OPTION IS ENDED',CR,LF
         DB      '   FILL        >XXXX YYYY ZZ          '
         DB      '  XXXX & YYYY ARE MDS HEX START AND'
         DB      CR,LF,'                                    '
         DB      '  END ADDRESSES TO FILL BETWEEN;',CR,LF
         DB      '                                      '
         DB      '  ZZ IS HEX DATA TO USE FOR FILL',CR,LF
         DB      CR,LF,'PRESS ANY KEY TO CONTINUE >$'
FMTMSG1  DB      CR,LF,LF
         DB      '   LOCATE SEQ. >XXXX( YYYY)           '
         DB      '  XXXX & YYYY ARE MDS HEX START AND',CR,LF
         DB      '                                      '
         DB      '  OPTIONAL END ADDRESSES TO SEARCH BETWEEN'
         DB      CR,LF
         DB      '                   >AA BB ... PP      '
         DB      '  ARE UP TO A 16 BYTE HEX SEQUENCE',CR,LF
         DB      '                                      '
         DB      '  TO SEARCH FOR IN MDS MEMORY',CR,LF
         DB      '   DUMP             >XXXX( YYYY)      '
         DB      '  XXXX & YYYY ARE MDS HEX START AND'
         DB      CR,LF,'                                    '
         DB      '  OPTIONAL END ADDRESSES TO DUMP BETWEEN'
         DB      CR,LF
         DB      '   EXECUTE      >XXXX                 '
```

```
         DB        '  XXXX IS MDS HEX ADDRESS WHERE EXECUTION'
         DB        CR,LF
         DB        '                                         '
         DB        '  IS TO BEGIN',CR,LF,LF
         DB        'PRESS ANY KEY TO CONTINUE >$'
HEXMSG   DB        CR,LF,'HEX ADD/SUB',CR,LF,'$'
HEXMSG1  DB        'SUM = $$$$      '
HEXMSG2  DB        'DIFF = $$$$',CR,LF,'$'
EXAMSG   DB        CR,LF,'EXAMINE/SET MDS MEMORY',CR,LF,'$'
EXAMSG1  DB        '$$$$'
EXAMSG2  DB        ' $$ $'
FILLMSG  DB        CR,LF,'FILL MDS MEMORY LOCATION(S)',CR,LF
         DB        '$'
CSETMSG  DB        CR,LF,'CONTINUOUS SET MDS MEMORY W/O '
         DB        'EXAMINE',CR,LF,'$'
EXECMSG  DB        CR,LF,'EXECUTE MDS MEMORY FROM SPECIFIED '
         DB        'ADDRESS',CR,LF,'$'
LOCMSG   DB        CR,LF,'LOCATE BYTE SEQUENCE IN MDS MEMORY'
         DB        CR,LF,'$'
NOTFOUND DB        CR,LF,'BYTE SEQUENCE NOT FOUND !',CR,LF,'$'
FOUNDMSG DB        CR,LF,'FOUND STARTING AT MDS ADDRESS '
FOUNDMS1 DB        '$$$$',CR,LF,'$'
DUMPMSG  DB        CR,LF,'DUMP MDS MEMORY',CR,LF,'$'
DUMPMSG1 DB        '$$$$ $'
DUMPMSG2 DB        ' $$ $'
DUMPMSG3 DB        '$$$$$$$$$$$$$$$$$'
MENUPRO1 DB        CR,LF,'OPTION A = MENU SUPPRESSION, B = '
         DB        'NO MENU SUPPRESSION'
MENUPROM DB        CR,LF,'INPUT MENU OPTION $'
PROMPT   DB        '>$'
FILENAME DB        'FILENAME $'
DWNLDMSG DB        CR,LF,'DOWNLOAD HEX FILE FROM DISK TO MDS'
         DB        ' MEMORY',CR,LF,'$'
DWNDONE  DB        CR,LF,'DOWNLOAD COMPLETED',CR,LF
DWNDONE1 DB        'MDS START ADDRESS = $$$$H , LAST ADDRESS '
         DB        '= $$$$H',CR,LF,'$'
UPLDMSG  DB        CR,LF,'UPLOAD (SAVE) MDS MEMORY TO DISK '
         DB        'HEX FILE',CR,LF,'$'
UPLDONE  DB        CR,LF,'UPLOAD TO DISK SUCCESSFULLY '
         DB        'COMPLETED',CR,LF,'$'
DATAMSG  DB        ' $$ $'
STARMSG  DB        '*$'
FCBMSG   DB        0,20H,20H,20H,20H,20H,20H,20H,20H
         DB        'HEX',0,0,0,0


SYSSTAT  DS        1                  ;SYSTEM STATUS FLAG
                                      ; HOST IN CONTROL = 0
                                      ; MDS IN CONTROL = 1
MENUSUPF DS        1                  ;MENU SUPPRESSION FLAG
                                      ; 0 = NO SUPPRESSION
```

```
                                        ; 1 = SUPPRESSION
MENUFLG  DS      1                      ;STORAGE FOR MENU CHOICE
FRSTDEL  DB      0                      ;FIRST DELIMITER FLAG
FIRST    DW      0                      ;FIRST NUMBER TO ADD/SUB
SECOND   DW      0                      ;SECOND NUMBER TO ADD/SUB
SUM      DW      0                      ;SUM OF HEX NUMBERS
START    DW      0                      ;STARTING ADDRESS FOR
                                        ; COMMAND USE
FINISH   DW      0                      ;FINISH ADDRESS FOR
                                        ; COMMAND USE
MDSDATA  DS      1                      ;TEMP. STORAGE FOR DATA
                                        ; FROM MDS
CONSDATA DS      1                      ;TEMP. STORAGE FOR DATA
                                        ; FROM CONSOLE TO MDS
MDSRDYF  DS      1                      ;MDS READY FLAG
                                        ; 0FFH = DONE, 0 = NOT DONE
FIRSTIME DS      1                      ;FIRST TIME THROUGH READ
BUFFCNT  DS      1                      ;BUFFER COUNT SPACE
CURRENT  DS      1                      ;CURRENT DISK DRIVE
CONTFLG  DS      1                      ;CONTINUATION FLAG FOR DISK
                                        ; READ OPERATIONS
                                        ; 00 = NO CONTINUE
                                        ; 0FFH = CONTINUE
FCB      DS      36                     ;SPACE FOR FILE CONTROL
                                        ; BLOCK
CONBUFF  DB      48                     ;DEFAULT TO 48 CHARACTERS
                                        ; MAX FOR CONSOLE BUFFER
         DS      256                    ;PROVIDE FOR 255 CHARACTERS
DSKBUFF  EQU     $                      ;START OF DISK BUFFER

         END     STARTER
```

APPENDIX D

MDS MONITOR SOFTWARE LISTING

```
**************************************************************
*                                                            *
*       AMDS1 - ALTOS MICROCOMPUTER DEVELOPMENT SYSTEM       *
*                       (MDS CODE)                           *
*                                                            *
* VERSION 1.3,  28 MAY 1981                                  *
* LT. STEPHEN M. HUGHES - AUTHOR                             *
*                                                            *
*    THIS IS THE MDS MONITOR CODE FOR THE AMDS.  THE AMDS    *
* USER'S MANUAL SHOULD BE CONSULTED FOR SPECIFICS NOT        *
* GIVEN IN THE DOCUMENTATION WHICH FOLLOWS.                  *
*                                                            *
**************************************************************

RAM     EQU     2000H           ;START OF ONBOARD RAM
CHASTAT EQU     0E4H            ;CHANNEL A STATUS AND
                                ; COMMAND/CONTROL PORT
CHADATA EQU     0E3H            ;CHANNEL A DATA PORT
CHBSTAT EQU     0E2H            ;CHANNEL B STATUS AND
                                ; COMMAND/CONTROL PORT
CHBDATA EQU     0E1H            ;CHANNEL B DATA PORT
                                ; (NOT USED IN THIS CODE)
BAUDREG EQU     0E0H            ;PORT FOR SETTING BAUD RATE
                                ; OF SERIAL PORTS
XON     EQU     011H            ;CONTROL Q


        ORG     0000H           ;START OF PROM
        JMP     PORTSET         ;SET UP SERIAL PORT ON RESET
        NOP
        NOP
USERIO  JMP     USRIO           ;USER CALL FOR CONSOLE I/O


        ORG     0038H           ;RST 7 LOCATION
        JMP     EXECDNE         ;USER RST 7 COMES HERE FOR
                                ; RETURN OF CONTROL TO HOST
                                ; AND ONBOARD MONITOR


        ORG     0040H           ;RST 7 + 8
MONITOR LXI     SP,STACK        ;SET STACK EVERY TIME
```

```
        XRA       A
        STA       OPTION              ;RESET OPTION FLAG
        CALL      HOSTIN              ;GET COMMAND FROM HOST
MONITOR1 ANI      7FH                 ;COMMAND WILL BE ASCII
        CPI       'W'                 ;DOWNLOAD COMMAND?
        JZ        DWNLD
        CPI       'U'                 ;UPLOAD COMMAND?
        JZ        UPLD
        CPI       'X'                 ;EXAMINE/SET MEMORY CMD?
        JZ        EXAM
        CPI       'C'                 ;CONTINUOUS MEMORY SET CMD?
        JZ        CSET
        CPI       'F'                 ;FILL COMMAND?
        JZ        FILL
        CPI       'L'                 ;LOCATE SEQ. COMMAND?
        JZ        LOCATE
        CPI       'D'                 ;DUMP MEMORY COMMAND?
        JZ        DUMP
        CPI       'E'                 ;EXECUTE MEMORY CMD?
        JZ        EXEC
        JMP       MONITOR             ;ANYTHING ELSE IS IGNORED

* DWNLD - DOWNLOAD HEX DISK FILE TO MDS MEMORY ROUTINE
*         ROUTINE LOOPS UNTIL A HOSTDONE COMMAND IS
*         DETECTED BY THE INPUT ROUTINE *

DWNLD   CALL      HOSTIN              ;GET NUMBER OF BYTES TO
                                      ; EXPECT
        MOV       C,A                 ;C = BYTE COUNTER
        CALL      GETADDR             ;GET STARTING ADDRESS
DWNLD1  CALL      HOSTIN              ;GET A BYTE
        MOV       M,A                 ;STORE IT
        INX       H
        DCR       C
        JNZ       DWNLD1              ;MORE BYTES TO GET
        JMP       DWNLD               ;GET NEW ADDRESS FIRST

* UPLD - UPLOAD MDS MEMORY TO DISK HEX FILE *

UPLD    CALL      GETADDR             ;GET STARTING ADDRESS
        SHLD      START
        CALL      GETADDR             ;GET FINISH ADDRESS
        SHLD      FINISH
        LHLD      START
        XCHG                          ;DE = START ADDRESS
UPLD1   LDAX      D                   ;GET DATA
        CALL      HDATAOUT            ;SEND IT
        INX       D
        CALL      BUFFCMP             ;DONE YET?
        RRC
        JNC       UPLD1               ; NO
```

```
        CALL    MDSRDY              ; YES
        JMP     MONITOR

* EXAM - EXAMINE/SET MEMORY
*        LOOPS TILL INPUT DETECTS HOSTDONE COMMAND *

EXAM    CALL    GETADDR             ;GET STARTING ADDRESS
EXAM1   MOV     A,M                 ;SEND DATA AT HL ADDRESS
                                    ; TO HOST
        CALL    HDATAOUT
        CALL    HOSTIN              ;GET NEW DATA
        MOV     M,A                 ; DEPOSIT IT
        INX     H
        JMP     EXAM1               ;LOOP TILL HOSTDONE

* CSET - CONTINUOUS SET OF MDS MEMORY
*        LOOPS TILL HOSTDONE DETECTED *

CSET    CALL    GETADDR             ;GET STARTING ADDRESS
CSET1   CALL    HOSTIN              ;GET DATA
        MOV     M,A                 ; DEPOSIT IT
        JMP     CSET1               ;LOOP

* FILL - FILL DESIGNATED MEMORY LOCATIONS WITH SPECIFIED
*        DATA *

FILL    CALL    GETADDR             ;GET FIRST ADDRESS
        SHLD    START
        CALL    GETADDR             ;GET LAST ADDRESS
        SHLD    FINISH
        CALL    HOSTIN              ;GET DATA TO FILL WITH
        MOV     C,A                 ; SAVE IT
        LHLD    START
        XCHG                        ;DE = START ADDRESS
FILL1   MOV     A,C                 ;GET FILL DATA
        STAX    D                   ; DEPOSIT IT
        INX     D
        CALL    BUFFCMP             ;DONE YET?
        RRC
        JNC     FILL1               ; NO, KEEP FILLING
        CALL    MDSDONE             ; YES
        JMP     MONITOR

* LOCATE - LOCATE BYTE SEQUENCE IN MDS MEMORY
*          SENDS 'F' TO HOST IF FOUND
*          SENDS 'N' TO HOST IF NOT FOUND *

LOCATE  CALL    GETADDR             ;GET START ADDRESS
        SHLD    START
        CALL    GETADDR             ;GET FINISH ADDRESS
        SHLD    FINISH
```

```
         LXI     H,DATABUFF          ;STORE SEQUENCE HERE
         MVI     C,Ø                 ;DATA COUNTER
LOCIN    CALL    HOSTIN              ;GET SEQUENCE
         PUSH    PSW
         LDA     HSTRDYFL            ;IF SET THEN NO MORE DATA
         RRC
         JC      SEARCH              ; START SEARCH
         POP     PSW                 ;MORE DATA
         MOV     M,A                 ;STORE IT
         INX     H
         INR     C                   ;BUMP COUNTER
         JMP     LOCIN
SEARCH   MOV     A,C                 ;GET SEQUENCE COUNT
         STA     LOCOUNT             ;SAVE IT
         LHLD    START
         XCHG                        ;DE = START ADDRESS
         LXI     H,DATABUFF          ;HL = START OF SEQUENCE
SRCH1    LDAX    D                   ;GET MDS DATA
         CMP     M                   ; IS THERE A MATCH?
         JZ      MATCH               ; YES
         INX     D
         CALL    BUFFCMP             ; NO, SEE IF DONE
         RRC
         JC      NOTFND              ;YES, SEQ. NOT FOUND
         JMP     SRCH1               ;NO, TRY AGAIN
MATCH    XCHG                        ;HL = FIRST MATCH ADDRESS
         SHLD    MATCHADR            ; SAVE IT
         XCHG                        ;RESTORE DE & HL
MATCH1   DCR     C                   ;ALL MATCHES YET?
         JZ      FOUND               ; YES, FOUND SEQUENCE
         INX     D
         CALL    BUFFCMP             ;DONE YET?
         RRC
         JC      NOTFND              ; YES, SEQ. NOT FOUND
         INX     H                   ; NO, LOOK FOR NEXT MATCH
         LDAX    D
         CMP     M                   ;ANOTHER MATCH?
         JZ      MATCH1              ; YES
         LHLD    DATABUFF            ; NO, START ALL OVER
         INX     D
         LDA     LOCOUNT             ;RE-INIT. SEQ. COUNT
         MOV     C,A
         JMP     SRCH1               ;KEEP TRYING
FOUND    MVI     A,'F'               ;SEND FOUND TO HOST
         CALL    HDATAOUT
         LHLD    MATCHADR            ;GET FIRST ADDR. OF MATCH
         MOV     A,H                 ; SEND IT TO HOST, MSB FIRST
         CALL    HDATAOUT
         MOV     A,L                 ; THEN LSB
         CALL    HDATAOUT
         JMP     MONITOR             ;ALL DONE
```

```
NOTFND  MVI     A,'N'           ;SEND NOT FOUND TO HOST
        CALL    HDATAOUT
        JMP     MONITOR

* DUMP - DUMP MDS MEMORY TO HOST CONSOLE *

DUMP    CALL    GETADDR         ;GET START ADDRESS
        SHLD    START
        CALL    GETADDR         ;GET FINISH ADDRESS
        SHLD    FINISH
        LHLD    START
        XCHG                    ;DE = START ADDRESS
DUMP1   LDAX    D               ;GET MDS MEMORY DATA
        CALL    HDATAOUT
        INX     D
        CALL    BUFFCMP         ;DONE YET?
        RRC
        JNC     DUMP1           ; NO
        CALL    MDSRDY          ; YES
        JMP     MONITOR

* EXEC - EXECUTE MDS MEMORY
*        PROGRAM TO BE EXECUTED MAY RETURN MONITOR VIA
*         A 'RST 7' INSTRUCTION OR A JUMP TO LOCATION
*         0000H
*        HOST CONSOLE I/O IS AVAILABLE AS EXPLAINED IN
*         THE USRIO ROUTINE *

EXEC    STA     OPTION          ;SAVE OPTION
        CALL    GETADDR         ;GET EXECUTION ADDRESS
        PCHL                    ; GO TO IT


*** UTILITY SUBROUTINES ***

* BUFFCMP - COMPARE DE TO FINISH ADDRESS + 1
*           IF EQUAL, RETURN A = 0FFH
*           IF UNEQUAL, RETURN A = 00 *

BUFFCMP PUSH    H
        PUSH    D               ;DE=CURRENT ADDR TO COMPARE
        LHLD    FINISH          ;HL = FINISH ADDRESS + 1
        INX     H
        MOV     A,H             ;H = D?
        CMP     D
        JNZ     NOCMP           ; NO
        MOV     A,L             ; YES, L = E?
        CMP     E
        JNZ     NOCMP           ; NO
        MVI     A,0FFH          ; YES, ADDRESSES ARE EQUAL
        POP     D
```

```
        POP     H
        RET
NOCMP   XRA     A                   ;ADDRESSES NOT EQUAL
        POP     D
        POP     H
        RET

* GETADDR - GET ADDRESS FROM HOST *

GETADDR CALL    HOSTIN              ;GET MSB FIRST
        MOV     H,A
        CALL    HOSTIN              ; THEN LSB
        MOV     L,A
        RET

* PORTSET - SET UP SERIAL I/O PORTS ON EVERY RESET OR
*           CALL TO 0000H *

PORTSET MVI     A,77H               ;SET RATE TO 9600 BAUD
        OUT     BAUDREG
        MVI     A,01001110B         ;SEND CONTROL BYTE
                                    ; 1 STOP BIT
        OUT     CHASTAT             ; NO PARITY, 8 BITS/CHAR
        OUT     CHBSTAT             ; 16x RATE FACTOR
        MVI     A,00110111B         ;SEND COMMAND BYTE
        OUT     CHASTAT
        OUT     CHBSTAT
        JMP     MONITOR

* USRIO - USER TO/FROM HOST CONSOLE I/O ROUTINE
*         USER EXECUTED PROGRAMS IN MDS MEMORY MAY
*          COMMUNICATE WITH THE HOST CONSOLE VIA A CALL
*          TO LOCATION 0005H
*       - FOR INPUT FROM THE HOST CONSOLE, CALL WITH
*          REG. C = 1   -  CHARACTER WILL BE RETURNED IN A
*       - FOR OUTPUT TO HOST CONSOLE, CALL WITH THE
*          CHARACTER IN A AND REG. C = 2
*       - TO CHECK THE FOR HOST INPUT, CALL WITH
*          REG. C = 3 - RETURNS A = 00 IF NO INPUT HAS BEEN
*          RECEIVED FROM THE HOST; A = 0FFH IF INPUT IS
*          WAITING
*       - IF C <> 1, 2 or 3 THEN ROUTINE RETURNS WITH C = 0FFH

USRIO   PUSH    PSW
        MOV     A,C                 ;SEE IF INPUT OR OUTPUT
        CPI     1
        JZ      USRIN
        CPI     2
        JZ      USROUT
        CPI     3                   ;WANT STATUS ?
        CZ      HOSTAT              ; YES, GET IT
```

```
        MVI     C,ØFFH              ;ILLEGAL CODE
        RET
USRIN   CALL    MDSRDY              ;TELL HOST TO SEND INPUT
        POP     PSW
        CALL    HOSTIN              ;GET INPUT
        RET                         ; RETURN WITH IT IN A
USROUT  POP     PSW
        CALL    HDATAOUT            ;SEND CHARACTER TO HOST
        RET

* EXECDNE - THIS RETURNS USER PROGRAM TO MONITOR AND
*         RETURNS CONTROL TO HOST IF A RST 7 IS EXECUTED *

EXECDNE LDA     OPTION              ;SEE IF THE EXECUTE OPTION
        CPI     'E'                 ; WAS IN EFFECT WHEN CONTROL
                                    ; WAS TRANSFERRED HERE
        JNZ     MONITOR             ; NO, HOST IN CONTROL
        CALL    MDSDONE             ; YES, GIVE HOST CONTROL
        JMP     MONITOR

* HOSTIN - GET INPUT FROM HOST & INTERPRET TYPE OF INPUT *

HOSTIN  CALL    GETCHAR             ;GET INPUT
HOSTIN1 CPI     55H                 ;IS IT A COMMAND?
        JZ      HOSTCMD
        CPI     ØFFH                ;IS IT DATA?
        JZ      HOSTDTA
        JMP     HOSTRDY             ;MUST BE HOST READY FLAG
HOSTCMD CALL    GETCHAR             ;GET ACTUAL COMMAND
        JMP     MONITOR1                    ; GO TO MONITOR FOR DECODE
HOSTDTA CALL    GETCHAR             ;GET DATA
        RET                         ; RETURN TO CALLER WITH IT
HOSTRDY CALL    GETCHAR             ;GET READY FLAG
        MVI     A,ØFFH              ; SET FLAG IN MDS
        STA     HSTRDYFL
        RET                         ;RETURN TO CALLER

GETCHAR CALL    HOSTAT              ;LOOP TILL CHAR. IS WAITING
        RRC
        JNC     GETCHAR
GETCHAR1 IN     CHADATA             ;GET DATA
        PUSH    PSW
        MVI     A,XON
        CALL    HOSTOUT             ;CONFIRM IT
        POP     PSW
        RET

* HOSTOUT - SEND DATA TO HOST *

HOSTOUT PUSH    PSW
        CALL    HOSTAT              ;ANYTHING FROM HOST? (HOST
```

```
        RRC                            ; HAS PRIORITY)
        JNC     HOSTOUT1               ; NO
        CALL    GETCHAR1               ; YES, GET IT
        CALL    HOSTIN1                ;IF COMMAND, BACK TO MONITOR
                                       ; ELSE IGNORE IT
HOSTOUT1 IN     CHASTAT                ;GET PORT STATUS
        ANI     1
        JZ      HOSTOUT1               ; LOOP TILL READY TO SEND
        POP     PSW                    ;SEND CHARACTER
        OUT     CHADATA
        CPI     XON                    ;DON'T WAIT FOR XON
        RZ                             ; CONFIRMATION
XONCK   CALL    HOSTAT                 ;WAIT FOR CONFIRMATION
        RRC
        JNC     XONCK
        IN      CHADATA                ;GET IT
        RET

* HOSTAT - HOST INPUT STATUS *

HOSTAT  IN      CHASTAT
        ANI     2
        RZ                             ;NO CHAR. WAITING, RET A=0
        MVI     A,0FFH                 ;CHAR. WAITING, RET A=0FFH
        RET

* HDATAOUT - SEND DATA TO HOST IN PROPER FORMAT *

HDATAOUT PUSH   PSW                    ;SAVE DATA
        MVI     A,0FFH                 ;NEXT CHARACTER IS DATA
        CALL    HOSTOUT
        POP     PSW
        PUSH    PSW
        CALL    HOSTOUT                ;SEND DATA
        POP     PSW                    ;RESTORE DATA
        RET

* MDSDONE - SEND MDS DONE COMMAND *

MDSDONE MVI     A,55H                  ;NEXT CHARACTER IS COMMAND
        CALL    HOSTOUT
        MVI     A,'Q'                  ; QUIT COMMAND
        CALL    HOSTOUT
        RET

* MDSRDY - MDS IS READY FOR INPUT OR OTHER ACTION BY HOST *

MDSRDY  MVI     A,00H                  ;NEXT CHAR. IS READY FLAG
        CALL    HOSTOUT
        MVI     A,00H
        CALL    HOSTOUT
```

```
        RET


*** DATA STORAGE AREAS - IN ONBOARD RAM ***

        ORG     RAM
HSTRDYFL DS     1                       ;HOST READY FLAG
                                        ; 00 = NOT READY
                                        ; OFFH  = READY
MATCHADR DW     0                       ;STORAGE FOR FIRST ADDRESS
                                        ; OF MATCH
LOCOUNT  DS     1                       ;STORAGE FOR BYTE COUNT
START    DW     0                       ;STORAGE FOR START &
FINISH   DW     0                       ; FINISH ADDRESSES
OPTION   DS     1                       ;STORAGE FOR OPTION SELECTED
         DS     63                      ;ALLOW FOR A 32 LEVEL STACK
STACK    DS     1
DATABUFF DS     25                      ;STORAGE FOR LOCATE SEQUENCE
```

APPENDIX E

MDS MEMORY TEST PROGRAM LISTING

```
**********************************************************************
*                                                                    *
*                     MDS MEMORY DIAGNOSTIC                          *
*                                                                    *
* VERSION 2.5  11 MAY 1981                                           *
*                                                                    *
*    THIS PROGRAM IS A REVISION OF THE Z-80 MEMORY TEST              *
* PROGRAM PUBLISHED IN THE FEBRUARY 1981 ISSUE OF                    *
* "DR. DOBB'S JOURNAL OF COMPUTER CALISTHENICS & ORTHODONTIA"        *
* THE PROGRAM HAS BEEN TRANSLATED TO 8080 ASSEMBLY CODE AND          *
* MODIFIED TO OPERATE ON THE ALTOS AND MDS SYSTEMS.                  *
*                                                                    *
* REVISIONS MADE BY LT. STEPHEN M. HUGHES FOR USE IN THESIS          *
*                                                                    *
*    AS STATED IN THE ORIGINAL TEXT, "FURTHER RESALE OF THIS         *
* PROGRAM IS PROHIBITED", UNLESS INCLUDED IN THE BODY OF THE         *
* REVISIONIST'S THESIS.                                              *
*                                                                    *
**********************************************************************


        ORG     4000H

USRIO   EQU     0005H           ;USER I/O CALL
BKSPACE EQU     08H             ;ASCII BACKSPACE
ESC     EQU     1BH             ;ASCII ESCAPE CODE
CR      EQU     0DH             ;ASCII CARRIAGE RETURN
LF      EQU     0AH             ;ASCII LINE FEED

RCNT    EQU     3               ;SEQUENTIAL READS
WCNT    EQU     3               ;SEQUENTIAL WRITES

MEM     DI                      ;DISABLE INTERRUPTS
        LXI     SP,STACK        ;INITIALIZE STACK
        LXI     B,TEND          ;FORMAT ADDRESS OF END OF TEST
        LXI     H,MEMT1
        CALL    CHA

* TEST STARTS HERE *

MEM01   CALL    CRLF            ;MAKE OUTPUT PRETTY
        LXI     H,0000H         ;INITIALIZE PAS COUNT,
                                ; CUMULATIVE ERROR COUNT
```

```
                                    ; AND ADDRESS 'OR' PRODUCT
        SHLD    MEMF
        SHLD    MEMX
        SHLD    MEML
        LXI     H,-1                ;INIT. ADDRESS 'AND'
        SHLD    MEMK
        LXI     H,MEMA              ;PRINT PROGRAM TITLE
        CALL    DSPLY

* GET TEST MODE *

MEM03   MVI     A,1                 ;SET DEFAULT = ITEMIZE
        STA     MEMP
        LXI     H,MEMN
        CALL    DSPLY               ;PRINT SELECT I,T OR E
        CALL    CRLF
        MVI     A,'>'               ;PROVIDE A CUE MARK
        CALL    USROUT
        CALL    USRIN               ;WAIT FOR INPUT
        ORI     20H                 ;MAKE LOWER CASE
        CPI     'e'                 ;IF E, EXIT
        JZ      MEM55
        CPI     'i'                 ;IF I, ITEMIZE ERRORS
        JZ      MEM04
        CPI     't'                 ;IF T, PRINT TOTAL ERRORS
                                    ; ONLY
        JNZ     MEM03               ;IF NONE, TRY AGAIN
        XRA     A                   ;SET TOTAL ONLY FLAG
        STA     MEMP

* GET MEMORY TEST LIMITS *

MEM04   LXI     H,MEMB              ;PRINT ENTER FBA
        CALL    DSPLY
        CALL    ENTR                ;GET 16 BIT ADDRESS
        MOV     A,H                 ;IF UPPER BYTE OF FBA IS
        ORA     A                   ; NEGATIVE, OK TO USE
        JM      MEM05               ; SO JUMP
        LXI     D,TEND              ; OTHERWISE, MAKE SURE FBA
        PUSH    H                   ; IS NOT WITHIN TEST PROGRAM
                                    ; AREA
        MOV     A,L                 ; (HL = HL - DE - C)
        SUB     E
        MOV     L,A
        MOV     A,H
        SBB     D
        MOV     H,A
        POP     H
        JP      MEM05               ;FBA IS OK, JUMP
MEM045  LXI     H,MEMT              ;IF FBA IS WITHIN TEST PROGRAM
        CALL    DSPLY               ; AREA, SET IT TO END OF
```

```
        LXI     H,TEND          ; PROGRAM & PRINT A WARNING
MEM05   SHLD    MEMI            ;SAVE FIRST BYTE ADDRESS (FBA)
        LXI     H,MEMC          ;PRINT ENTER LAST BYTE ADDRESS
                                ; (LBA)
        CALL    DSPLY
        CALL    ENTR            ;...ACCEPT ADDRESS
        PUSH    H               ;SAVE LBA
        PUSH    H
        ORA     A               ;CLEAR CARRY FLAG
        PUSH    H               ; (DE = CONTENTS OF MEMI
                                ;       AND MEMI + 1)
        LHLD    MEMI
        MOV     D,H
        MOV     E,L
        POP     H
        MOV     A,L             ;MAKE SURE FBA < LBA
        SUB     E               ; (HL = HL - DE - C)
        MOV     L,A
        MOV     A,H
        SBB     D
        MOV     H,A
        JNC     MEM06           ;IT'S OK, JUMP
        POP     H               ;RESTORE STACK
        POP     H
        LXI     H,MEMU          ;FBA IS >= LBA SO PRINT
        CALL    DSPLY           ; ERROR MESSAGE
        JMP     MEM04           ; AND ACCEPT ADDRESSES AGAIN

* ALL ADDRESSES OK NOW *

MEM06   POP     B               ;BC = LBA
        LXI     H,MEMG+5        ;CONVERT IT FOR PRINTING
        CALL    CHA
        PUSH    H               ;CONVERT FBA FOR PRINTING
        LHLD    MEMI            ; (BC = CONTENTS OF MEMI
                                ;       AND MEMI + 1)
        MOV     B,H
        MOV     C,L
        POP     H
        LXI     H,MEMG
        CALL    CHA
        POP     H               ;HL = LBA
        PUSH    H
MEM08   LXI     H,MEMV          ;PRINT ABORT INSTRUCTION
        CALL    DSPLY
        POP     D               ;DE = LBA
        INX     D               ;LBA = LBA + 1

* MAIN LOOP OF MEMORY TEST BEGINS HERE *
* BEGIN A PASS *
```

```
MEM1    MVI     C,1             ;INITIALIZE PATTERN NO.
        LXI     H,0000H         ;INITIALIZE ERROR COUNT
        SHLD    MEME

* TEST ALL OF DESIGNATED MEMORY FOR CURRENT PATTERN *
*
*
* WRITE PATTERN INTO MEMORY *

MEM15   MVI     B,WCNT          ;INIT. WRITES COUNTER
MEM2    LHLD    MEMI            ;GET FIRST BYTE ADDRESS TO TEST
        CALL    USRSTAT         ;CHECK KEYBOARD
        RRC
        CC      MEM5            ;IF CHARACTER WAITING,
                                ; INTERRUPT TEST
        PUSH    B               ;SAVE PATTERN AND WRITES
                                ; COUNTER
MEM21   CALL    PATTN           ;COMPUTE PATTERN FOR THIS
                                ; MEMORY ADDRESS
        MOV     M,A             ; ...WRITE IT
        INX     H               ;ADVANCE MEMORY ADDRESS
        MOV     A,L             ;CHECK IF END OF AREA TO BE
        CMP     E               ; TESTED
        JNZ     MEM21           ;LOOP, NOT YET
        MOV     A,H
        CMP     D
        JNZ     MEM21           ;LOOP, NOT DONE YET
        POP     B               ;GET WRITES COUNTER
        DCR     B               ;WRITE PATTERN OVER AND OVER
        JNZ     MEM2
        MVI     B,RCNT          ;INIT. READS COUNTER

* NOW READ PATTERN BACK FROM MEMORY AND COMPARE TO COMPUTED
*  PATTERN. IF DIFFERENCE IS FOUND ON FIRST READ, ASSUME A
*  POSSIBLE WRITE ERROR. IF FIRST READ MATCHES, COMPARE 16
*  MORE TIMES LOOKING FOR SOFT READ ERRORS. *

MEM3    LHLD    MEMI            ;GET FBA OF MEMORY TO TEST
        CALL    USRSTAT         ;CHECK KEYBOARD
        ORA     A               ;IF CHARACTER WAITING,
        CNZ     MEM5            ; INTERRUPT TEST
        PUSH    B               ;SAVE PATTERN AND READS
                                ; COUNTER
MEM31   CALL    PATTN           ;COMPUTE PATTERN FOR THIS
                                ; MEMORY ADDRESS
        MOV     B,A             ;...SAVE IT
        MOV     A,M             ;READ MEMORY
        CMP     B               ;IS DATA CORRECT?
        JZ      MEM32           ; YES, JUMP
        MOV     M,B             ;WRITE THE CORRECT DATA
```

```
        CALL    ERR1            ;DATA DOESN'T MATCH,
                                ; PRINT POSSIBLE WRITE
                                ; ERROR AUDIT
        JMP     MEM35           ;TEST NEXT ADDRESS
                                ; DATA MATCHED ON FIRST TRY
                                ; TRY FOR A SOFT READ ERROR
MEM32   SUB     M               ; BY HITTING THIS ADDRESS A
        ADD     M               ; SOLID 16 TIMES
        SUB     M
        ADD     M
        SUB     M
        ADD     M
        SUB     M
        ADD     M
        SUB     M
        ADD     M
        SUB     M
        ADD     M
        SUB     M
        ADD     M
        SUB     M
        ADD     M
        CMP     B               ;DOES DATA STILL MATCH?
        CNZ     ERR2            ; NO, PRINT POSSIBLE READ
                                ; ERROR AUDIT
MEM35   INX     H               ;ADVANCE MEMORY ADDRESS
        MOV     A,L             ;CHECK IF REACHED END OF MEMORY
        CMP     E               ; AREA TO BE TESTED
        JNZ     MEM31           ;NOT DONE YET, LOOP
        MOV     A,H
        CMP     D
        JNZ     MEM31           ;NOT DONE YET, LOOP
        POP     B               ;RESTORE PATTERN AND READ
                                ; COUNTER
        DCR     B               ;READ PATTERN OVER AND OVER
        JNZ     MEM3

* DONE WITH ONE PATTERN, ADVANCE TO NEXT AND CHECK FOR END
*  OF PASS *

        INR     C               ;INCREMENT PATTERN
        MOV     A,C
        CPI     11              ;DONE YET?
        JNZ     MEM15           ; NO, LOOP
        JMP     MEM6            ;AUDIT THIS PASS

* CHARACTER WAITING ON KEYBOARD, INTERRUPT TEST AND CHECK
*  FOR EXIT REQUEST *
```

```
MEM5    CALL    USRIN               ;GET INPUT
        CPI     04H                 ;^D - FREEZE ACTION
        JZ      DISPSTP
        ORI     20H                 ;FOLD TO LOWER CASE
        CPI     'i'                 ;DYNAMIC SET ITEMIZE
        JZ      MAKEI
        CPI     't'                 ;DYNAMIC SET TOTAL ONLY
        JZ      MAKET
        CPI     'e'
        JNZ     STACKIT             ;RESTART TEST IF NOT E
MEM55   LXI     H,MEMM              ;EXIT FROM TEST, PRINT GOODBYE
        CALL    DSPLY

DISPSTP CALL    USRIN               ;WAIT FOR ANY KEY TO RESUME
                                    ; ACTION
        CALL    BSOUT               ;DON'T PRINT IT
        RET

STACKIT LXI     SP,STACK            ;RESET STACK
        JMP     MEM01               ;RESTART TEST

MAKEI   MVI     A,1                 ;MAKE ITEMIZE
        STA     MEMP
        CALL    BSOUT
        RET
MAKET   MVI     A,0                 ;MAKE TOTAL ONLY
        STA     MEMP
        CALL    BSOUT
        RET


* DONE WITH PASS THROUGH MEMORY *
*
* PRINT CONSOLE AUDIT IN THE FORM:
*
*  PASS: xxxx  ERRORS: xxxx  CUM. ERRORS: xxxx
*   (IF CUMULATIVE ERRORS > ZERO THEN ALSO PRINT)
*     AND: xxxx  OR: xxxx  *

MEM6    PUSH    D                   ;SAVE LBA+1
        PUSH    H                   ; (BC = CONTENTS OF MEMF
                                    ;       AND MEMF + 1)
        LHLD    MEMF
        MOV     B,H
        MOV     C,L
        POP     H
        INX     B                   ;COUNT PASSES
        PUSH    H                   ; (MOV BC TO MEMF)
        MOV     H,B
        MOV     L,C
```

```
        SHLD    MEMF
        POP     H
        LXI     H,MEMG1         ;CONVERT PASS COUNT
        CALL    CHA
        PUSH    H               ; (BC = CONTENTS OF MEME
                                ;       AND MEME + 1)
        LHLD    MEME
        MOV     B,H
        MOV     C,L
        POP     H
        LXI     H,MEMG2         ;CONVERT ERROR COUNT
        CALL    CHA
        PUSH    H               ; (BC = CONTENTS OF MEMX
                                ;       AND MEMX + 1)
        LHLD    MEMX
        MOV     B,H
        MOV     C,L
        POP     H
        LHLD    MEME
        DAD     B               ;ACCUMULATE ERRORS FOR
                                ; ALL PASSES
        SHLD    MEMX
        PUSH    H               ;FORMAT CUMULATIVE ERRORS
        POP     B
        LXI     H,MEMG23
        CALL    CHA
        MVI     A,CR            ;SET UP OUTPUT TO SKIP 'AND'
                                ; & 'OR' OF FAILING MEMORY
                                ; ADDRESSES IF NO ERRORS HAVE
                                ; BEEN FOUND
        STA     MEMG25
        LHLD    MEMX
        MOV     A,H             ;MAKE SURE NO ERRORS
        ORA     L
        JZ      MEM67           ;NONE YET, JUMP
        MVI     A,' '           ;REMOVE THE CARRIAGE RETURN
                                ; FROM THE OUTPUT STRING
        STA     MEMG25
        PUSH    H               ; (BC = CONTENTS OF MEMK
                                ;       AND MEMK + 1)
        LHLD    MEMK
        MOV     B,H
        MOV     C,L
        POP     H
        LXI     H,MEMG3         ;CONVERT LOGICAL 'AND' OF
                                ; FAILING ADDRESSES
        CALL    CHA
        PUSH    H               ; (BC = CONTENTS OF MEML
                                ;       AMD MEML + 1)
        LHLD    MEML
        MOV     B,H
```

```
        MOV     C,L
        POP     H
        LXI     H,MEMG4               ;CONVERT LOGICAL 'OR' OF
                                      ; FAILING ADDRESSES
        CALL    CHA
MEM67   LXI     H,MEMG                ;PRINT PASS AUDIT
        CALL    DSPLY
        LDA     MEMJ                  ;ROTATE BIT CROSSTALK SO THAT
        RLC                           ; OVER EIGHT PASSES ALL BIT
        STA     MEMJ                  ; PATTERNS WILL BE USED
        POP     D                     ;RESTORE LBA+1
        JMP     MEM1                  ;START ANOTHER PASS


* ERROR AUDITING ROUTINE *
* CONSOLE OUTPUT OF THE FORM:
*
*  A=xxxx  P=xx  C=xx  XOR=xx  ERROR-TYPE
*
*  A = FAILING ADDRESS
*  P = CALCULATED PATTERN
*  C = ACTUAL CONTENTS OF ADDRESS
*  XOR = EXCLUSIVE OR OF PATTERN AND CONTENTS
*        (ISOLATES FAILING BIT(S))
*  ERROR-TYPE = RD PRESUMED READ (SOFT) ERROR
*               WT PRESUMED WRITE (HARD) ERROR *

ERR1    PUSH    PSW                   ;POSSIBLE WRITE ERROR
        MVI     A,'W'
        STA     MEMD5
        MVI     A,'T'
        STA     MEMD5+1
        POP     PSW
        JMP     ERROR

ERR2    PUSH    PSW                   ;POSSIBLE READ ERROR
        MVI     A,'R'
        STA     MEMD5
        MVI     A,'D'
        STA     MEMD5+1
        POP     PSW

ERROR   PUSH    B                     ;SAVE ALL REGISTERS DURING
                                      ; ERROR AUDIT
        PUSH    D
        PUSH    H
        PUSH    PSW
        XRA     B                     ;LOGICAL EXCLUSIVE 'OR' OF
                                      ; CALCULATED PATTERN AND
                                      ; ACTUAL MEMORY CONTENTS
        MOV     C,A
```

```
        LXI     H,MEMD4             ;CONVERT 'OR' FOR OUTPUT
        CALL    CHAB
        POP     PSW                 ;GET MEMORY CONTENTS AND
                                    ; CONVERT IT FOR OUTPUT
        MOV     C,A
        LXI     H,MEMD3
        CALL    CHAB
        MOV     C,B                 ;CONVERT PATTERN
        LXI     H,MEMD2
        CALL    CHAB
        POP     B                   ;CONVERT CURRENT MEMORY ADDRESS
        PUSH    B
        LXI     H,MEMD1
        CALL    CHA
        LHLD    MEME
        INX     H                   ;COUNT ERRORS THIS PASS
        SHLD    MEME
        POP     D                   ;GET CURRENT MEMORY ADDRESS
        PUSH    D
        LHLD    MEMK
        MOV     A,D                 ;SAVE LOGICAL 'AND' OF
                                    ; FAILING ADDRESSES
        ANA     H
        MOV     H,A
        MOV     A,E
        ANA     L
        MOV     L,A
        SHLD    MEMK
        LHLD    MEML
        MOV     A,D                 ;SAVE LOGICAL 'OR' OF
                                    ; FAILING ADDRESSES
        ORA     H
        MOV     H,A
        MOV     A,E
        ORA     L
        MOV     L,A
        SHLD    MEML
        LDA     MEMP                ;CHECK ITEMIZE ERRORS FLAG
        ORA     A
        JZ      ERR9                ;SKIP PRINT IF FLAG = Ø
        LXI     H,MEMD              ;PRINT ERROR AUDIT
        CALL    DSPLY
ERR9    POP     H                   ;RESTORE REGISTERS AND
        POP     D                   ; RETURN TO MAIN TEST
        POP     B
        RET

* COMPUTE TEST DATA PATTERN FOR GIVEN MEMORY ADDRESS *
*
* CALL WITH  HL = MEMORY ADDRESS
```

```
*               C = PATTERN COUNTER
*
* RETURN        A = DATA PATTERN   *

PATTN   PUSH    H                   ;PATTERN COMPUTATION
        MVI     B,Ø                 ;BRANCH ON PATTERN
        LXI     H,PATTØ-3
        DAD     B
        DAD     B
        DAD     B
        XTHL                        ;(RESTORE MEM ADDR)
        NOP
        RET                         ;(BRANCH)
PATTØ   JMP     PAT1                ;1 CAMBRIDGE PATTERN
        JMP     PAT2                ;2 ADDRESS
        JMP     PAT3                ;3 ALTERNATE 1'S AND Ø'S
        JMP     PAT4                ;4 ADDRESS INVERSE
        JMP     PAT5                ;5 ALTERNATES Ø'S AND 1'S
        JMP     PAT6                ;6 ALL ONES
        JMP     PAT7                ;7 CAMBRIDGE INVERSE
        JMP     PAT8                ;8 ALL ZEROS
        JMP     PAT9                ;9 BIT CROSSTALK
        JMP     PAT1Ø               ;1Ø BIT CROSSTALK INVERSE

PAT1    MOV     A,L                 ;CAMBRIDGE PATTERN
        RRC
        RRC
        RRC
        XRA     H
        ANI     1
        JZ      ONES
ZEROS   XRA     A
        RET
ONES    MVI     A,ØFFH
        RET

PAT2    MOV     A,L                 ;ADDRESS
        RET

PAT3    MVI     A,ØAAH              ;ALTERNATE 1'S AND Ø'S
        RET

PAT4    MOV     A,L                 ;ADDRESS INVERSE
        CMA
        RET

PAT5    MVI     A,55H               ;ALTERNATE Ø'S AND 1'S
        RET

PAT6    EQU     ONES                ;ALL BITS = ONE
```

```
PAT7    MOV     A,L             ;CAMBRIDGE INVERSE
        RRC
        RRC
        RRC
        XRA     H
        ANI     1
        JZ      ZEROS
        JMP     ONES

PAT8    EQU     ZEROS           ;ALL BITS = ZERO

PAT9    MOV     A,L             ;BIT CROSSTALK
        RAR
        JC      PAT91
        LDA     MEMJ
        RET
PAT91   LDA     MEMJ
        CMA
        RET

PAT10   MOV     A,L             ;BIT CROSSTALK INVERSE
        RAR
        JNC     PAT91
        LDA     MEMJ
        RET


* BINARY TO HEX ASCII CONVERSION, 16 BITS *
*
* CALL    HL = ADDRESS FOR 4 CHAR ASCII OUTPUT STRING
*         BC = 16 BIT BINARY DATA
*
* RETURNS  HL,DE,BC UNCHANGED
*           A = GARBAGE  *

CHA     PUSH    H               ;SAVE REGISTERS
        PUSH    D
        PUSH    B
        INX     H
        INX     H
        INX     H
        MVI     D,4             ;CHAR COUNTER
CHA1    MOV     A,C             ;NEXT 4 BITS
        ANI     0FH
        CPI     0AH             ;IS IT A-F?
        JC      CHA15           ;NO
        ADI     7               ;YES
CHA15   ADI     '0'             ;FORM ASCII
        MOV     M,A             ;STORE THIS CHARACTER
        DCX     H               ;BACK UP THROUGH OUTPUT AREA
        MVI     E,4             ;DOUBLE RIGHT
```

```
        ORA     A               ;SHIFT 4 BITS
CHA2    MOV     A,B
        RAR
        MOV     B,A
        MOV     A,C
        RAR
        MOV     C,A
        DCR     E               ;DECREMENT SHIFT COUNTER
        JNZ     CHA2            ;STILL SHIFTING
        DCR     D               ;DECREMENT CHARACTER COUNTER
        JNZ     CHA1            ;STILL CONVERTING
        POP     B               ;RESTORE REGISTERS
        POP     D               ; AND EXIT
        POP     H
        RET

* BINARY TO HEX ASCII CONVERSION, 8 BITS *
*
*  CALL       HL = ADDRESS FOR 2 CHARACTER OUTPUT STRING
*              C = 8 BIT BINARY DATA
*
*  RETURN     HL,DE,BC UNCHANGED
*             A DESTROYED  *

CHAB    PUSH    H               ;SAVE REGISTERS
        PUSH    D
        PUSH    B
        INX     H
        MVI     D,2
        JMP     CHA1

* PRINT CHARACTER STRING *
*
*  CALL      HL = FIRST BYTE ADDRESS OF OUTPUT STRING
*                 (MUST END WITH ASCII CARRIAGE RETURN)  *

DSPLY   CALL    CRLF
DSPLY1  MOV     A,M
        CALL    USROUT          ;OUTPUT THIS CHARACTER
        CPI     CR              ;END OF STRING?
        RZ                      ; YES, EXIT
        INX     H               ; NO, BUMP STRING POINTER
        JMP     DSPLY1

* GET KEYBOARD ENTRY OF HEX INTEGER *
*
*  RETURN  HL = 16 BIT BINARY DATA  *
```

```
ENTR    LXI     H,0000H         ;INITIALIZE DATA
        CALL    CRLF            ;SEND CARRIAGE RETURN &
                                ; LINE FEED
        MVI     A,'>'           ;SEND A CUE MARK
        CALL    USROUT
        MVI     C,4             ;CHAR. COUNTER
ENTR1   CALL    USRIN           ;GET 1 CHARACTER
        CPI     CR              ;CARRIAGE RETURN?
        RZ                      ;YES, EXIT
        CPI     LF              ;LINE FEED?
        RZ                      ;YES, EXIT
        CPI     'A'             ;IS IT 0-9?
        JC      ENTR15          ;YES
        ANI     0DFH            ;NO, FORCE LOWER CASE
ENTR15  DAD     H               ;SHIFT PREVIOUS DATA LEFT
        DAD     H               ; 4 BITS
        DAD     H
        DAD     H
        JC      ENTR3           ;IF OVERFLOW, PRINT '?'
        CPI     '0'             ;IS IT 0-F?
        JC      ENTR3           ;ILLEGAL CHARACTER
        CPI     'F'+1
        JNC     ENTR3           ;ILLEGAL CHARACTER
        CPI     'A'             ;IS IT A-F?
        JC      ENTR2           ;NO, IT'S 0-9
        ADI     9               ;ADD FUDGE FACTOR
ENTR2   ANI     0FH             ;ISOLATE 4 BITS
        ORA     L               ;MERGE WITH PREVIOUS DATA
        MOV     L,A
        DCR     C               ;COUNT CHARACTERS
        RZ                      ;EXIT IF 4 RECEIVED
        JMP     ENTR1           ;GET ANOTHER CHARACTER
ENTR3   MVI     A,'?'           ;PRINT QUESTION MARK
        CALL    USROUT
        JMP     ENTR            ; AND RESTART ENTRY

* PRINT CARRIAGE RETURN AND LINE FEED *

CRLF    MVI     A,CR
        CALL    USROUT
        MVI     A,LF
        CALL    USROUT
        RET

* MISCELLANEOUS MESSAGES AND DATA AREA *

MEMA    DB      '8080 MEMORY TEST - VERSION 2.5',LF,CR
MEMB    DB      'ENTER ADDRESS OF FIRST MEMORY BYTE'
        DB      ' TO TEST:',CR
```

```
MEMC    DB      'ENTER ADDRESS OF LAST MEMORY BYTE'
        DB      ' TO TEST:',CR
MEMD    DB      'ADDRESS='
MEMD1   DB      '$$$$  PATTERN='
MEMD2   DB      '$$  CONTENTS='
MEMD3   DB      '$$  XOR='
MEMD4   DB      '$$  TYPE='
MEMD5   DB      '    ',CR
MEME    DW      0                   ;ERRORS THIS PASS
MEMF    DW      0                   ;PASS COUNT
MEMG    DB      '$$$$-$$$$  PASS: '
MEMG1   DB      '$$$$  ERRORS: '
MEMG2   DB      '$$$$  CUM. ERRORS: '
MEMG23  DB      '$$$$ '
MEMG25  DB      CR,'AND: '
MEMG3   DB      '$$$$  OR: '
MEMG4   DB      '$$$$',CR
MEMI    DW      0                   ;FIRST BYTE ADDRESS TO TEST
MEMJ    DB      0FEH                ;BIT CROSSTALK PATTERN
MEMK    DW      -1                  ;LOGICAL 'AND' OF FAILING
                                    ; ADDRESSES
MEML    DW      0                   ;LOGICAL 'OR' OF FAILING
                                    ; ADDRESSES
MEMM    DB      LF,'GOODBYE',CR
MEMN    DB      'I=ITEMIZE ERRORS, '
        DB      'T=PRINT ERROR TOTAL ONLY, '
        DB      'E=EXIT TEST',CR
MEMP    DB      0                   ;FLAG 1=ITEMIZE, 0=TOTAL
MEMT    DB      'END OF PROGRAM USED AS FIRST '
        DB      'ADDRESS TO TEST = '
MEMT1   DB      '$$$$',CR
MEMU    DB      'ERROR: LAST BYTE ADDRESS LESS '
        DB      'THAN FIRST BYTE ADDRESS.',CR
MEMV    DB      LF
        DB      'TO ABORT TEST PUSH ANY KEY'
        DB      CR
MEMX    DW      0                   ;CUMULATIVE ERROR COUNT


USRIN   PUSH    B                   ;GET INPUT FROM HOST CONSOLE
        PUSH    D
        PUSH    H
        MVI     C,1
        CALL    USRIO
        POP     H
        POP     D
        POP     B
        RET

USROUT  PUSH    B                   ;SEND CHARACTER TO HOST
        PUSH    D                   ; CONSOLE
```

```
         PUSH     H
         MVI      C,2
         CALL     USRIO
         POP      H
         POP      D
         POP      B
         RET

USRSTAT  PUSH     B                    ;SEE IF CHARACTER IS WAITING
         PUSH     D
         PUSH     H
         MVI      C,3
         CALL     USRIO
         POP      H
         POP      D
         POP      B
         RET

BSOUT    MVI      A,BKSPACE            ;PRINT A BACKSPACE
         CALL     USROUT
         RET


STACK    DS       64                   ;SET UP FOR 32 LEVELS
TEND     EQU      $+2
         END      100H
```

APPENDIX F

SAMPLE MENU LISTING

```
                              MENU
        HOST COMMANDS                          MDS COMMANDS

A. SUPPRESS PRINTING MENU            G. DOWNLOAD HEX FILE - DISK TO MDS MEMORY
B. DO NOT SUPPRESS PRINTING MENU     H. UPLOAD MDS MEMORY TO HEX DISK FILE
C. BASIC INSTRUCTIONS                I. EXAMINE/SET MDS MEMORY LOCATION(S)
D. HEXADECIMAL ADD & SUBTRACT        J. CONTINUOUS SET OF MDS MEMORY
E. RETURN SYSTEM CONTROL TO HOST     K. FILL MDS MEMORY WITH SPECIFIED BYTE
F. RETURN TO CP/M                    L. LOCATE BYTE SEQUENCE IN MDS MEMORY
                                     M. DUMP MDS MEMORY LOCATION(S) TO CONSOLE
                                     N. EXECUTE MDS MEMORY FROM SPECIFIED
                                        LOCATION

SYSTEM STATUS: HOST IN CONTROL;  NO MENU SUPPRESSION

INPUT MENU OPTION >
```

APPENDIX G

SAMPLE BASIC INSTRUCTION LISTING

```
BASIC AMDS INSTRUCTIONS:

  A. THE PROMPT FOR INPUT OF DATA IS ">".
  B. ALL INPUTS MAY BE IN UPPER OR lower CASE.
  C. ADDRESS AND DATA INPUTS ARE EXPECTED TO BE IN HEX NOTATION.
  D. TERMINATE INPUTS WITH A CARRIAGE RETURN OR LINE FEED.
  E. NORMAL LINE EDITING ON INPUT IS AS IN CP/M AND MP/M.
  F. FOR ADDRESS INPUTS, THE PROGRAM WILL ALWAYS TAKE THE LAST FOUR OR LESS
     HEX CHARACTERS ENTERED;  FOR DATA INPUTS, THE LAST TWO OR LESS.
  G. SOURCES OF COMMON ERROR ARE INVALID HEX DIGITS, TOO MANY OR TOO FEW
     DELIMITERS, AND ILLEGAL SYNTAX.
  H. IN GENERAL, THE SAME DATA I/O FORMAT AS USED IN DIGITAL RESEARCH'S
     DDT IS USED HERE.  FOR EXCEPTIONS, CONSULT THE USER'S MANUAL.
  I. A QUESTION MARK ENTERED AFTER THE PROMPT WILL CAUSE THE INPUT FORMATS TO
     BE DISPLAYED.
  J. IF THE ESCAPE KEY IS ENTERED DURING INPUT THEN THE USER IS RETURNED
     TO THE MENU.
  K. FOR FURTHER DETAILS, CONSULT THE USER'S MANUAL

PRESS ANY KEY TO CONTINUE >
```

APPENDIX H

SAMPLE INPUT PARAMETER FORMAT LISTING

```
INPUT PARAMETER FORMATS ARE AS  FOLLOWS :
  MENU          >X                X IS OPTION SELECTION (A-N)
  HEXARITH      >XXXX YYYY        XXXX & YYYY ARE HEX INTEGERS
  DWNLOAD       >FILENAME(.HEX)   (.HEX) IS OPTIONAL
  UPLOAD        >FILENAME(.HEX)
                >XXXX YYYY        XXXX & YYYY ARE MDS HEX START AND
                                  END ADDRESSES FOR UPLOAD
  EXAMINE MDS   >XXXX             XXXX IS FIRST MDS HEX ADDRESS TO
                                  EXAMINE AND SET
                >XXXX YY ZZ       XXXX IS HEX ADDRESS, YY IS HEX DATA
                                  AT THAT ADDRESS, ZZ IS CARRIAGE RETURN
                                                 or ZZ IS NEW HEX DATA
                                                 or ZZ IS '.'
  CONTINUOUS    >XXXX             XXXX IS MDS HEX START ADDRESS FOR
                                  FIRST CHANGE
                >AA BB CC ....    ARE HEX DATA FOR ENTRY INTO MDS MEMORY
                                  (255 ENTRIES MAX, INCLUDING DELIMITERS)
                                  IF ONLY A '.' IS TYPED AFTER THE
                                  PROMPT, THE OPTION IS ENDED
  FILL          >XXXX YYYY ZZ     XXXX & YYYY ARE MDS HEX START AND
                                  END ADDRESSES TO FILL BETWEEN;
                                  ZZ IS HEX DATA TO USE FOR FILL

PRESS ANY KEY TO CONTINUE >
```

```
LOCATE SEQ.   >XXXX( YYYY)      XXXX & YYYY ARE MDS HEX START AND
                                OPTIONAL END ADDRESSES TO SEARCH BETWEEN
              >AA BB ... PP     ARE UP TO A 16 BYTE HEX SEQUENCE
                                TO SEARCH FOR IN MDS MEMORY
DUMP          >XXXX( YYYY)      XXXX & YYYY ARE MDS HEX START AND
                                OPTIONAL END ADDRESSES TO DUMP BETWEEN
EXECUTE       >XXXX             XXXX IS MDS HEX ADDRESS WHERE EXECUTION
                                IS TO BEGIN

PRESS ANY KEY TO CONTINUE >
```

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