date: 12 Jan 1982

from: S. M. Walters

INTRODUCTION TO THE UNIX OPERATING SYSTEM

This manual contains the entire set of documents describing the uNIX operating system. This particular version is the fourth in a series of UNIX look-alike systems built during the last five years. It is intended for a single user and does not support any multi-tasking or multi-user features. It is simple to mount and use on Z-80 systems having 64 Kbytes of RAM and an 8086 version will be available shortly. The operating system can access different types of storage without modification.

It supports a hierarchial file system complete with pathnames and subdirectories. Files are placed in the filesystem using dynamic allocation, can be protected and can reach a maximal length of 8 Mbytes. Files can be declared to be physical device drivers allowing uniform treatment of both disk files and real devices such as printers and modems. The operating system supplies several subroutines for reading and writing bytes or blocks of bytes to or from files. In doing so, no constraints are made on the data allowing arbitrary binary patterns on all 8 bits. It allows simultaneous read and write access of the same file and permits up to eight files to be open simultaneously. Entry points for moving the file pointers are provided for allowing random access of any byte within any file. Volumes of the filesystem can be mounted and removed at will allowing the user to access volumes as subdirectories.

There is a shell programming language which allows the passing of arguments to commands as well as re-direction of the standard I/O channel. Pseudo pipes are provided to pass I/O between commands without user intervention. The shell allows multiple commands on a single line and is easily made to read files containing command lines. Such files can be declared executable which will cause the operating system to interpret their content as commands whenever the file name is entered as a command. This allows the user to quickly make new commands which themselves are built from other commands.

The operating system also includes entry points for printing and reading numbers or strings. It allows tab stops to be set and provides a string reading routine which recognizes character and line delete. It also includes a string comparator which matches two text lines.

There are numerous commands mounted under the operating system for

creating, manipulating and removing files or directories. Also mounted are code generation systems for both the Z-80 and 8086 processors. These each include a C compiler, an assembler producing relocatable code and a link editor for combining modules which were generated separately. A screen oriented text editor as well as a text processor are included for building programs and doing word processing.

Thus, the uNIX operating system provides all necessary tools for generating quality software. It has been subjected to intense use on several machines for nearly two years. Several applications have been developed using it including a bit-slice machine programmed entirely in microcode designed on this system. The 8086 software generation system mentioned earlier was developed in its entirety using this operating system on a Z-80.

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MOUNTING THE UNIX OPERATING SYSTEM

This note describes a procedure for mounting the uNIX operating system on your computer hardware. It is expected that the system consists of a Z-80 processor and 64 Kbytes of RAM. While it is possible to run the system with less RAM, it is not recommended. To determine whether your available RAM is adequate, a memory map is attached which shows the purposes for which various blocks of memory is used.

It is necessary for you to develop disk driver routines which are compatible with an 8 inch disk using single density sectors having 256 bytes per sector and 15 sectors per track. This is usually a simple modification of routines which already exist within your system. Generally, the only modification required is the number of bytes read from the disk controller chip, usually a 1771 or 1791.

Once this is done, you should load the uNIX module from the system disk. The module is located on 64 consecutive sectors starting with track 0, sector 4. This amounts to exactly 16 Kbytes. To check your loading procedure, a hexadecimal dump of the first of these sectors is attached.

Next, you should construct the "bios" (Basic I/O Software) for your hardware. To assist you in this task, a sample bios is also attached. Notice that only five routines are required. Two of these are the console input and output routines. It is recommended that the general structure of the conin and conout routines in the sample bios be preserved. Simple modifications of these will enable you to use different ports or to call subroutines for the console I/O such as would be required for a video RAM. Notice that there are sections which check for certain control characters (cntl-q, cntl-s, cntl-x) for restarting the operating system. It is important that these sections remain as they are.

The remaining routines are for interfacing the disks in your system. There are three such routines which read sectors, write sectors and format the disk. Two parameters are passed to the disk drivers by the operating system. The first of these is the memory address where the

256 byte memory block is located which is to be read or written. The second is an integer between 0 and 32767 which is referred to as an inode. The address is passed to the routines in the HL register. The inode is the second value on the stack, the first being the return address which must be preserved. This inode integer must be decomposed into the disk, track and sector which you wish it to reference. Normally, the value is decomposed as shown below:

```
disk id = high_byte(inode/15);
track id = low_byte(inode/15);
sector id = 1+remainder(inode/15);
```

Before you panic and begin writing a divide and remainder program, let me inform you that the operating system includes one! The sample bios shows a simple program which unravels the stack to get the address and inode and goes on to convert it into disk/track/sector. If the disk system you are using supports something other than 15 sectors per track, it is only necessary to modify the parameter "15" before calling the divide/remainder routine.

The third disk driver is a formatter which should re-write the disk drive named in the L register on entry. To obtain the greatest performance speed from the operating system, the sequence of sector numbers given in the sample bios should normally be used. If an intelligent disk controller is used, the sequence given may need to be modified. The scheme here is to interleave the sectors on the disk so that the "read" subroutine (see the subroutine manual) wastes the least amount of time possible between sector transfers. This is determined by experimently loading a large file into memory and timing the load interval. Then, change the interleave sequence and repeat the experiment. Continue until the load time appears optimized. In any event, the formatter is not needed when the system is first brought up and in no event is the sequence given a requirement to make the system operational. Any interleave sequence can be used initially and optimization should wait until the operating system is functional.

One final note on the disk driver routines. Each routine should detect errors in accessing the disk drives and should make several attempts to accomplish the transfer. If the routine fails to make the required transfer, do not simply return to the operating system. Instead, print the command, disk drive, track, sector and memory address and jump to the warm start entry point (0C003H). This will allow the operating system to recover gracefully. If desired, the programs could simply "hang" in an infinite loop after an error. Then, the operator could remove the disk and reset the system manually. Either is acceptable.

After the five routines are built for location 0C057H and the 64 sectors of the operating system have been sucessfully loaded, you should simply merge the two by first loading the operating system at

location 0C000H and then overlaying the new bios at location 0C057H. Note that the new bios cannot extend beyond location 0C51AH. Next, simply place the operating system disk in drive 0 and jump to location 0C000H. After a few disk accesses, the system will type its cold start message and you are ready to go! A later section of this manual will describe a few commands useful for getting started. After you are sure the bios is working properly, you should re-write the 64 sectors starting at track 0, sector 4 with the modified copy of the operating system. After this is done, you can simply load the block at memory location 0C000H and jump to the beginning of the system.

```
;*****************************************************
;*                                                   *
;*       A SKELETAL BIOS FOR uNIX                    *
;*                                                   *
;*****************************************************

;
;
;    THE FOLLOWING EQUATES ARE FOR AN 8251 AT I/O
;    PORT 0. THE MASK WORDS ARE USED TO DETERMINE
;    THE STATE OF THE UART USING THE STATUS PORT.
;
DATA    EQU 0    ; I/O PORT FOR UART DATA
STATUS  EQU 1    ; I/O PORT FOR UART STATUS
IMASK   EQU 02H ; DATA AVAILABLE MASK FOR INPUT
OMASK   EQU 01H ; BUFFER EMPTY MASK FOR OUTPUT
;
;    THE JUMP TABLE WHICH FOLLOWS MUST BE PLACED
;    AT LOCATION 0C057H IN THE OPERATING SYSTEM.
;    THE ENTIRE BIOS PACKAGE MUST FIT IN THE BLOCK
;    OF MEMORY FROM 0C057H TO 0C51AH. THESE FIVE
;    ROUTINES ARE ALL THAT IS REQUIRED FOR THE USER
;    TO INTERFACE THE OPERATING SYSTEM.
;
    ORG 0C057H
;
    JMP CONIN
    JMP CONOUT
    JMP LOAD
    JMP SAVE
    JMP FORMAT
;
;    CONSOLE INPUTING ROUTINE
;
;    USED TO READ CHARACTERS FROM THE CONSOLE
;    DEVICE AND RETURN THEM TO THE OPERATING SYSTEM.
;    IT CHECKS FOR SEVERAL SPECIAL CHARACTERS WHICH
;    CAN BE TYPED BY THE USER FOR RESTARTING THE
;    OPERATING SYSTEM. THESE ARE:
;
;    CNTL-X (18H)     COLD START (0C000H)
;    CNTL-Q (11H)     WARM START (0C003H)
    NULL (00H)  END OF FILE, TRANSLATE TO 8000H
    CNTL-S (13H)     IGNORE
;   LINEFEED (0AH)   TRANSLATE TO CARRIAGE RETURN (0DH)
;
CONIN:  IN  STATUS  ; CHECK FOR DATA AVAILABLE
    ANI IMASK   ; USING THE MASK
    JZ  CONIN   ; WAIT UNTIL A CHARACTER ARRIVES
    IN  DATA    ; GET IT
    ANI 7FH ; MASK PARITY
    MOV L,A ; PUT IT IN THE L REGISTER
    MVI H,0 ; CLEAR THE H REGISTER
    CPI 0AH ; TEST FOR LINEFEED
    JZ  NLINE   ; IF SO, TRANSLATE TO CAR. RET.
    CPI 00H ; TEST FOR END OF FILE
    JZ  EOFILE  ; IF SO, TRANSLATE TO 8000H
    CPI 13H ; TEST FOR CNTL-S
    JZ  CONIN   ; IF SO, IGNORE
```

```
     CPI 11H ; TEST FOR CNTL-Q
     JZ  0C003H  ; IF SO, WARM START
     CPI 18H ; TEST FOR CNTL-X
     JZ  0C000H  ; IF SO, COLD START
     RET      ; NOTHING SPECIAL, QUIT
  INE:  MVI L,0DH   ; FORCE VALUE TO CAR. RET.
     RET      ; QUIT
EOFILE: MVI H,80H   ; FORCE VALUE TO 8000H (EOF)
     RET      ; QUIT

;    CONSOLE OUTPUTING ROUTINE
;
;    THIS ROUTINE TRANSMITS A CHARACTER TO THE CONSOLE
;    WHEN CALLED BY THE OPERATING SYSTEM. IT IS REQUIRED
;    TO TRANSLATE CARRIAGE RETURN (0DH) INTO BOTH CARRIAGE
;    RETURN AND LINEFEED (0AH). IF A CARRIAGE RETURN IS
;    TO BE SENT, IT CHECKS TO SEE IF ANY SPECIAL CHARACTERS
;    HAVE BEEN SENT BY CALLING THE CHKIO PROGRAM.

CONOUT: MOV A,L ; CHAR TO TYPE IN L ON ENTRY
     CPI 0DH ; TEST FOR CAR. RET.
     JNZ CONX    ; IF NOT, JUST SEND THE CHAR
     CALL    CHKIO   ; TEST FOR RESTARTS OF THE OP. SYS.
     MVI L,0AH   ; SET UP FOR LINE FEED
     CALL    CONX    ; SEND IT
     MVI L,0DH   ; SET UP FOR CAR. RET. AND SEND IT
;
CONX:   IN  STATUS  ; TEST THE UART FOR
     ANI 0MASK   ; TRANSMIT BUFFER EMPTY
     JZ  CONX    ; WAIT UNTIL NOT BUSY
     MOV A,L ; GET THE CHAR TO SEND FROM L
     OUT DATA    ; SEND IT
     RET      ; QUIT
;
;    CHKIO TESTS THE RESTART STATUS OF THE OP. SYS.
;
;    THERE IS A VARIABLE AT LOCATION 9FD6H WHICH
;    DETERMINES IF RESTARTS ARE ALLOWED OR NOT.
;    IF THE VARIABLE IS 0, THEY SHOULD BE ALLOWED.
;    THIS ROUTINE CHECKS TO SEE IF THE VARIABLE
;    IS IN A STATE ALLOWING COLD OR WARM STARTS TO
;    BE MADE. IF ENABLED, IT THEN TESTS TO SEE IF
;    THE CONSOLE HAS TYPED A CNTL-X (COLD START),
;    OR A CNTL-Q (WARM START). IT ALSO CHECKS FOR
;    CNTL-S WHICH IS USED TO TEMPORARILY STOP OUTPUT
;    AT THE CONSOLE.
;
CHKIO:  LDA 9FD6H   ; THIS VARIABLE SHOULD BE TESTED
     ORA A   ; FOR ANY NON-ZERO VALUE
     RNZ      ; IF NON-ZERO, QUIT
     IN  STATUS  ; OTHERWISE, CHECK FOR DATA AVAILABLE
     ANI IMASK   ; IN THE UART INPUT SIDE
     RZ       ; IF NONE, QUIT
     IN  DATA    ; ELSE, READ THE DATA
     ANI 7FH ; MASK PARITY
     CPI 11H ; TEST FOR CNTL-Q
     JZ  0C003H  ; IF SO, WARM START
     CPI 18H ; TEST FOR CNTL-X
     JZ  0C000H  ; IF SO, COLD START
     CPI 13H ; TEST FOR CNTL-S
```

```
    JZ  HOLD    ; IF SO, HOLD ALL OUTPUT
    RET     ; NOTHING, SO QUIT
HOLD:   IN  STATUS  ; TEST FOR A CHARACTER
    ANI IMASK   ; IN THE UART
    JZ  HOLD    ; WAIT UNTIL IT ARRIVES
    RET     ; QUIT WITHOUT READING IT
;
;   LOAD ROUTINE TRANSFERS FROM DISK TO MEMORY
;
;   THIS ROUTINE IS PASSED AN INODE VALUE WHICH
;   IT DECOMPOSES INTO DISK/TRACK/SECTOR. IT IS
;   ALSO PASSED THE ADDRESS WHERE IT IS TO PLACE
;   THE SPECIFIED SECTOR. IF DIFFERENT DRIVES
;   ARE TO BE MOUNTED, THIS ROUTINE MUST BE
;   MODIFIED TO INTERFACE THEM.
;
LOAD:   XCHG        ; LOAD ADDRESS INTO DE
    POP H   ; GET THE RETURN ADDR
    XTHL        ; RESTORE IT, GET THE INODE
    PUSH    D   ; SAVE ADDRESS ON STACK
    LXI D,15    ; SET DE TO SCTRS PER TRACK (15)
    CALL    0C012H  ; DIVIDE,REMAINDER FUNCTION
    INR E   ; NOW, E IS THE SECTOR TO LOAD
    MOV D,L ; NOW, D IS THE TRACK TO LOAD
    MOV C,H ; NOW, C IS THE DISK TO ACCESS
    POP H   ; NOW, HL IS THE ADDRESS TO LOAD
;
;   PLACE YOUR DISK DEPENDENT PROGRAMS HERE. IT
;   SHOULD TRANSFER THE DISK/TRACK/SECTOR SPECIFIED
;   BY THE ABOVE REGISTERS TO THE MEMORY POINTED TO
;   BY THE HL REGISTER. IT SHOULD MAKE SEVERAL TRIES
;   TO LOAD THE SECTOR WHICH IS 256 BYTES IN LENGTH.
;   IF IT IS NOT SUCCESSFUL, IT SHOULD REPORT THE ERROR
;   AND THEN JUMP TO THE WARM START ENTRY POINT (0C003H).
;   IF NO ERRORS WERE MADE, IT SHOULD JUMP TO THE
;   CHKIO ROUTINE TO ALLOW SYSTEM RESTARTS TO BE MADE.
;
    JMP CHKIO   ; CHECK FOR RESTARTS
;
;
;
;
;
;   SAVE ROUTINE TRANSFERS FROM MEMORY TO DISK
;
;   THIS ROUTINE IS PASSED AN INODE VALUE WHICH
;   IT DECOMPOSES INTO DISK/TRACK/SECTOR. IT IS
;   ALSO PASSED THE ADDRESS WHERE IT IS TO FIND
;   THE SPECIFIED SECTOR. IF DIFFERENT DRIVES
;   ARE TO BE MOUNTED, THIS ROUTINE MUST BE
;   MODIFIED TO INTERFACE THEM.
;
'E:   XCHG        ; LOAD ADDRESS INTO DE
    POP H   ; GET THE RETURN ADDR
    XTHL        ; RESTORE IT, GET THE INODE
    PUSH    D   ; SAVE ADDRESS ON STACK
    LXI D,15    ; SET DE TO SCTRS PER TRACK (15)
    CALL    0C012H  ; DIVIDE,REMAINDER FUNCTION
    INR E   ; NOW, E IS THE SECTOR TO LOAD
    MOV D,L ; NOW, D IS THE TRACK TO LOAD
```

```
      MOV C,H ; NOW, C IS THE DISK TO ACCESS
      POP H   ; NOW, HL IS THE ADDRESS TO LOAD
;
;     PLACE YOUR DISK DEPENDENT PROGRAMS HERE. IT
;     SHOULD WRITE THE DISK/TRACK/SECTOR SPECIFIED
      BY THE ABOVE REGISTERS WITH THE MEMORY POINTED TO
;     BY THE HL REGISTER. IT SHOULD MAKE SEVERAL TRIES
;     TO WRITE THE SECTOR WHICH IS 256 BYTES IN LENGTH.
;     IF IT IS NOT SUCCESSFUL, IT SHOULD REPORT THE ERROR
      AND THEN JUMP TO THE WARM START ENTRY POINT (0C003H).
;     IF NO ERRORS WERE MADE, IT SHOULD JUMP TO THE
;     CHKIO ROUTINE TO ALLOW SYSTEM RESTARTS TO BE MADE.
;
      JMP CHKIO   ; CHECK FOR RESTARTS
;
;
;
;     FORMAT ROUTINE FORMATS AN ENTIRE DISK
;     FOR 256 BYTE SECTORS, SINGLE DENSITY
;
FORMAT: MOV A,L ; GET THE DISK ID INTO A
;
;     PLACE YOUR DISK FORMATTER PROGRAM HERE. THE
;     DISK TO FORMAT IS IN THE L AND A REGISTERS.
;     ALL TRACKS SHOULD BE FORMATTED. WHILE ANY
;     INTERLEAVE OF SECTORS IS ALLOWED, THE SYSTEM
;     WILL PERFORM FASTEST IF THE FOLLOWING INTERLEAVE
;     IS USED.
;
      EVEN TRACKS: 1 9 2 10 3 11 4 12 5 13 6 14 7 15 8
;     ODD  TRACKS: 5 13 6 14 7 15 8 1 9 2 10 3 11 4 12
;
;     THIS SELECTION MAY REQUIRE MODIFICATION IF AN
;     INTELLIGENT DISK CONTROLLER SUBSYSTEM IS USED.
```

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A GUIDE TO THE uNIX OPERATING SYSTEM

These notes are intended to help the user understand the operation of uNIX. It attempts to explain how the system operates and what capabilities it has. Detailed information for each command is contained in the Command Set section.

THE FILE SYSTEM

The uNIX file system is, perhaps, its most attractive feature. It supports a hiearchial file system under which directories can have subdirectories which can have subdirectories ad infinitum. When the system is booted, it begins in the "root" directory. This is the highest level in the directory tree. Within the root directory, there can be any number of subdirectories. To find out if there are any subdirectories in the root, type "ls -al". In the output, the leftmost columns contain the mode of each file. Those having a "d" at the end of their mode are directories. You will see that "bin" and "lib" are directories. To move inside a directory, type "cd bin". Now, type "ls -al" and you will see a different set of files entirely. To get back to the root, type "cd". As you can see, the cd command allows you to move about in the directory tree. Whatever directory you are in at any given time is referred to as the "current" directory. It can be referenced in names as ".". The directory which contains the current directory as a subdirectory is referred to as the "parent" directory. It can be referenced in names as "..". A "grandparent" directory can be referenced using "../..". Any command which references a file will look for the filename in the current directory unless you specify otherwise. Using the characters "/" and "..", it is possible to reference files in other parts of the filesystem. For example, the file names "hello", "/hello" and "../hello" can reference three different files of the same name (hello). The first of these would be found in the current directory. The second would be in the root directory and the third would be found in the parent. It is possible to reference files in subdirectories below the current directory by names such as "dirx/hello". Other possibilities such as "../../dirx/temp/hello" exist. This notion of referencing files in other than the current directory is referred to as "pathname". A pathname is the path to a file such as "/dir1/dir2/file" in which case the path begins in the root (due to the leading slash) or "../dirx/file" in which case the path begins in the current directory (due to no leading slash). These two referencing techniques are

referred to as "absolute" path (/bin/temp) and "relative" path (../dirx/hello).

It is possible to make new directories (see mkdir), remove them (see rmdir) and move them about (see mvdir). There is no limit on the number of subdirectories that can exist within any single directory or the total number of them within the system. Directory names (and ordinary files as well) can be made to disappear in listings of the directory in which they appear (see chmod).

Ordinary files can assume any length up to 8 Mbytes which is the maximum addressing range of the filesystem. Filenames can consist of any alphabetical character, upper or lower case, any number and the characters "." and "_". Names are restricted to 13 characters. Files can be protected from reading or writing and they can be made to not list when the directory content is listed. Files can be moved about (see mv), copied (see cp), removed (see rm) or transfered to other disks (see uucp, dup). Unlike other filesystems, there is no filetype for determining the use of the file and for that reason, there is no restriction as to the way in which files are used. Naming conventions are generally used to differentiate between files that are C programs (name.c), assembly language programs (name.s), link modules (name.o) and executable routines (name). However, these are simply conventions and are not required for the proper operation of the filesystem or the operating system. There is no constraint on the content of the files and any 8 bit pattern can be passed to or from them. End-of-file (EOF) is denoted by the value 8000H (0x8000 in C) which cannot be confused with any 8 bit data pattern. Operating system entry points are provided for reading (getc, getchar, read) and writing (putc, putchar, write) files. Another entry point, seek, allows the user to move the file pointers allowing random access of any byte within a file. Like directories, there is no constraint on the number of files in the filesystem.

RUNNING PROGRAMS

After uNIX is booted, it checks to see if there is a file named "profile" in the root directory. If there is, it will execute it as a set of system commands. This is the source of the login message. If you wish to set parameters or run programs you have developed each time the system is booted, you can simply place the appropriate command line in the "profile" and the system will execute it each time it is booted. The profile is list and write protected. To list it, use "ls -a" and to see its content, use "cat profile" or "vi profile". To modify it, you must force the file mode bits to 0 using "chmod".

To run a program, simply type its name. The operating system will search a set of directories specified by the "path" variable for the name. If found, it will load the program and execute it. The path variable can be displayed and modified using the stty command. Further details on it can be found in the system subroutine. The default value of the path variable will cause the system to first search in the "/bin" directory and then in the current directory. The bin directory holds all operating system commands. When entering commands, multiple

commands can be entered on a single line from the console if they are separated by semicolons (;).

STANDARD I/O

When any program runs, any output it sends using putchar and any input it reads using getchar can be directed to or from a file (instead of the terminal) when the command is entered. For instance, the command "ls" sends its output to the standard output (virtually every command does). If it is desired to save the listing in a file, simply type "ls>filename" instead. If you wish to add more output to the end of a file, an append operator is provided. For example, "ls -l>>filename" will place the listing at the end of "filename" without otherwise modifying the file. Input to commands can be redirected as well. For example, "cmnd<filename" will cause "cmnd" to read from "filename" instead of the console. If it is desired to pass the output of one program to the input of another, a "pipe" for doing this is provided. For instance "cmnd1|cmnd2" will cause the output of cmnd1 to be used as input to cmnd2. These pipes can be used any number of times within a command line. For example, "c1|c2|c3|c4".

PHYSICAL DEVICE DRIVERS

The file system allows uniform treatment of both disk files and physical devices such as line printers, terminals and modems. To use this feature, simply write a program which reads a character from the device into the L register (if it reads) or outputs the content of the L register to the device (if it writes). On input, the value 0 (null) should be converted into 8000H (end-of-file) in the HL register pair. On output, the value 0DH (carriage return) should cause both 0DH and 0AH (line feed) to be sent to the device. If a device is write only (such as a line printer), it can be read protected (see chmod). If a device is read only (such as a keyboard) it can be write protected. If it can be read or written (such as a terminal) no protection bits are necessary but the routine must be informed whether it is to read or write the device. The operating system manages this by passing the value 80H in the H register if it is to read and 00H if it is to write. Thus, a simple check of the H register can be made at the beginning of the driver to decide which action it should take. Once the routine is written and an object module has been generated, check its length with "ls -l". Modules to be used in the capacity must be 256 bytes or less in length. This is plenty for most devices. Now, change the mode of the file to a physical device (see chmod) with the appropriate read/write protection. Once this is done, if output is directed to this filename or inputs are requested from it, the operating system will not return the actual content of the file. Instead, it will cause the program in the file to be loaded and run to provide the requested I/O. This is a very powerful capability of the operating system.

SHELL PROGRAMMING

Frequently, in developing programs or using the system, a user will wish to execute several lengthy commands each time an experiment is

performed. Rather than type the commands over and over again, the user can place them in a file and cause them to be executed by typing a simpler command. For instance, the command "sh<file" causes the operating shell to read from "file". This will cause the commands in "file" to be executed. In doing this, the commands themselves will be echoed to the terminal as if the user were typing them. If this is not desired, try "sh file". This will eliminate the command echo. In fact, several files can be executed in this manner if desired as in "sh file1 file2 file3". If the user wishes, the file can be declared to be an executable file (see chmod) in which case, the operating system will automatically interpret the file content as commands. Once this is done, typing "file" will execute the set of commands in the file.

ARGUMENT PASSING

When a command line is entered, the first name is the program to run and any other names are called arguments to that program. The operating system buffers these arguments and they can be accessed by any program running (see arg). Each program run is directly passed the number of arguments on the command line. Tokens which redirect I/O activity are not counted as arguments and will not be passed to the program. Thus, the program does not have to check its parameters to be sure they are really arguments and not I/O redirection.

Shell programs can be passed arguments as well. This is discussed in detail in the system call section (see system). If a command line inside a file which is declared executable and the user wishes to refer to arguments on the command line which invoked the file, the user can do so using dollar sign ($) followed by a number where the number refers to the argument order with 0 being the first argument on the line (the command name). Dollar sign followed by no number will stop and read an argument from the console and dollar sign follwed immediately (no spaces or tabs) by a string in double quotes will print the string at the console before reading the argument. This allows the user to prompt for arguments.

Assembly language programs as well can receive arguments from the user through the operating system. This is done in an identical manner as any command. Assembly programs can call the arg routine to receive arguments just as well as C programs. For complete detail on passing arguments and other operating system entry points, see the system call section of this manual.

CONSOLE OPTIONS

The console represents the primary I/O device through which a user communicates with the operating system. The actual routines for reading and writing the console are placed in the bios section of the operating system (see mounting instructions). There is a file in the root directory named "con" which jumps to these routines so if any programs wish to do I/O directly to the console, they can open the "/con" file and then use getchar, getc, putchar or putc to read or write it. Several options can be controlled which relate to the console. In particular, the character delete (backspace), the line

delete and tabstops can all be set up to be any value desired (see stty). Even the prompt string which the system uses to alert the user for more input can be set using stty. The visual editor (vi) has a file for deriving the sequences it sends to the terminal for moving the cursor, etc. (see vi). This allows the system to be set up for almost any smart terminal. Finally, the console terminal should have a keyboard and display capable of displaying the full ASCII character set. This is primarily needed for C programming where various brackets and braces are used. However, the operating system does distinguish between upper and lower case itself.

SYSTEM OPERATION

This section gives a brief introduction to the internal operation of the system. This knowledge is in no way required for its use and is given only as a matter of information.

The filesystem of the operating system is simply a collection of blocks called i-nodes. Physically, these are 256 byte sectors on disks. The system refers to these with an integer between 0 and 32767. In doing this, the system becomes completely independent of the disk subsystem and is easily transported to other disk systems. The routines in the bios section are responsible for decomposing the i-node passed to them into disk/track/sector identities. This is made easy by the inclusion of a routine for producing quotient and remainder of a divide operation. I-nodes in the filesystem are used to store both file content and a forward linked list for determining what i-nodes are in use for files and what the next i-node in the file is. The linked list is distributed on the disk and can be found on every 128th i-node starting with i-node 0. Since an i-node which is used for the linked list also stores 256 bytes, it can be thought of as 128 integers (16 bit). Each integer represents the state of its corresponding i-node within that block on the filesystem, the first such integer being its own state (busy). The integer can be interpreted as four different states. If it is 0, then the corresponding i-node is idle and can be allocated for a file to utilize. If it is positive, the i-node is busy and the integer represents the next i-node in the file being accessed. If its value is -1 (OFFFFH, 0xffff), the i-node does not exist in the disk system. This can be used to prevent the operating system from accessing i-node which do not exist in the "tail" of the disk and could potentially be used to prevent access of defective media. If the integer is negative but not equal to -1, then the corresponding i-node is the last sector in the file being accessed and if lower byte of the integer is the actual number of bytes used by the file on the i-node. This linked list is initialized by the fmt command such that all i-nodes except those in the linked list itself are idle. The root directory is also set up when the media is formatted. It is empty except for the name "." (its own reference value), and the root directory always begins in i-node 1.

Beyond this, nothing in the filesystem is structured. I-nodes are allocated sequentially from the linked list and will be used in blocks if possible. This prevents slow access due to file fragmentation.

I-nodes can be used for files and directories alike. When a new directory is created, the system simply opens a new file, places "." and ".." in it (along with the starting i-nodes for each) and places the name and its starting i-node in the parent directory. This simple structure allows the creation of very sophisticated filesystem trees.

MEMORY MAP

00000H - 08BFFH	uNIX commands load at location 0. This allows 35 K bytes for commands.
08C00H - 090FFH	uNIX stack area (1 K byte).
09100H - 0A0FFH	uNIX variable area and disk buffers (4 K bytes).
0A100H - 0BFFFH	This area is not used by uNIX. Users can place video RAMs or other software here and rely on it not being altered by the operating system.
0C000H - 0FFFFH	The μNIX system kernel (16 K bytes).

To begin with, only a small amount of memory is needed at location 0, say 4 K bytes, but all other segments must be fully supplied.

uNIX COMMAND SET

The following is a list of commands provided in the /bin/ directory on your system disk. They are briefly described here and the pages that follow contain a more complete description of each. Any command can be executed by simply typing its name.

as - Z-80 assembler
asm - 8086 assembler
cat - concatenate files
cc - Z-80 C compiler
ccc - 8086 C compiler
cd - change directories
chmod - change file mode
cmp - compare files
cp - copy files
cpr - print C programs
demount - remove a mounted volume
du - summarize disk usage
dup - duplicate a disk
echo - type arguments
fmt - format a new disk
inode - examine inodes
ld - Z-80 link editor
ldr - 8086 link editor
ls - list directory contents
mk - prepare a C file for execution
mkdir - make a new directory
mount - access a volume
mv - move or rename files
mvdir - move or rename directories
pr - format files for printing
pwd - print working directory
reloc - relocate to absolute
rm - remove files
rmdir - remove directories
script - the text processor
sh - the command processor
stty - change crt parameters
uucp - unix to unix copy
vi - visual screen editor
xas - executable Z-80 assembler
xcc - executable C compiler
xd - dump a file in hexadecimal
xld - executable link editor
xsh - executable command processor

NAME arg - get the pointer to an argument

SYNOPSIS arg(number)

DESCRIPTION ARG expects only one argument which it uses as the command argument number which is being requested. It returns a pointer to the desired argument if it exists. If not, it returns a pointer to a null. The argument being requested is found on the command line which invoked the function that called arg. Argument 0 on this line is the command name itself. I/O redirection tokens are not counted as arguments and cannot be found using arg. As an example,

cmnd abc def <temp xyz>looper

will have as arguments:

0 - "cmnd" 1 - "abc" 2 - "def" 3 - "xyz"

and arg will return pointers to each as requested.

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO system.

NAME close - cease accessing a file

SYNOPSIS close(mode)

DESCRIPTION This routine closes the file currently being used for the standard input and/or the standard output. The argument passed to it indicates the mode of the file to be closed as indicated below.

0 Close the file being used as the standard input, resume reading the previous standard input file.

1 Close the file being used as the standard output, resume writing the previous standard output file.

2 Do both 0 and 1.

As indicated, the file previously in use as the standard input, standard output or both resumes its former status. Closing a file using mode 1 truncates all characters beyond the current write pointer. Closing with mode 2 does not. This is important when using the seek subroutine. Close returns no values.

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO open, seek, getchar, putchar.

NAME compare - compare two strings in memory

SYNOPSIS compare(&s1,&s2)

DESCRIPTION COMPARE is passed two arguments which are assumed to be addresses of two strings in memory which are terminated by NULL characters (0x00). The routine compares the two and returns a value of 0 (not equal) or 1 (equal). Either string or both may contain the wild card (*). Remember that the C compiler treats quoted strings as an address. This allows the user to program:

```
if(compare(&string1,"hello"))
        goto do_hello;
```

for testing input text to desired responses.

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO None.

NAME fprintf - print a value into a file

SYNOPSIS fprintf(id,format,value)

DESCRIPTION FPRINTF allows the user to print values inside of strings in many different fashions. The results can be directed to any file open for writing in the system. It requires exactly three arguments. The first is the fileid returned by open when the desired file was last opened for writing. The second argument is the address of a format string which controls the output. The third argument is the value to print. FPRINTF will read the format string and will simply type any characters not preceeded by the percent (%) symbol directly into the file identified by id. If a percent symbol is found, subsequent characters control the printing as follow.

%Nd	Print value as a signed decimal using N character positions.
%Nu	Print value as an unsigned decimal using N character positions.
%Nx	Print value as a hexadecimal number using N character positions.
%No	Print value as an octal number using N character positions.
%Nb	Print value as a binary number using N character positions.
%c	Print value as a single character.
%s	Print the null terminated string at the address value. ie. use value as a pointer.

Use of a length field (N) is optional. If the number cannot be printed in N positions, it will be printed anyway using as many as required. If N has a leading zero (0), the value will be printed with leading zeroes. Tabs are expanded as specified by the tabstops set by stty.

WARNINGS Never write to an invalid fileid.

BUGS None known.

FILES None.

SEE ALSO printf, scanf, stty.

NAME getc - read a single character from a file

SYNOPSIS getc(id)

DESCRIPTION GETC requires a single argument which it uses as a fileid previously opened for reading. It will return the next character in the file. Since it returns an integer, binary data can be passed through files. When end of file is encountered, getc will return the value 32768 (0x8000) for any subsequent call. Note that this cannot be confused with real data since characters are between -256 and +255.

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO getchar, open, close.

NAME getchar - read the standard input

SYNOPSIS getchar()

DESCRIPTION GETCHAR operates exactly like getc but does not require an argument to determine what file to read since it always reads the file last opened for reading. Like getc, it returns the value read with 32768 (0x8000) meaning end of file.

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO getc, open, close.

NAME open - access files

SYNOPSIS open(&filename,mode)

DESCRIPTION This routine opens a file as the standard input, the standard output, or both. It expects two arguments. The first is the address of a null terminated file name. The second is the mode of file access desired. Three values of mode are permitted. They are:

0 - open the file for reading only 1 - open the file for writing only
2 - open the file for reading and writing

Once open, the file becomes the standard input or output or both. The previously accessed file remains open and can be accessed using getc or putc. It will become the standard input (or output) once again when the current file is closed. It is possible to access the old standard input by using the fileid of the current file - 1 and the old standard output using the fileid of the current file + 1. This allows the user to perform I/O relative to the current fileid. When opening a file for writing, the file is assigned zero length. If a file already exists, it will be truncated to zero length. This action is not taken in mode 2. If a file cannot be accessed, open returns the value -1 which is not a valid fileid. Modes 0 and 1 return the value of the fileid which can be used with getc, putc, and fprintf respectively for accessing the file. Mode 2 returns a composite id equal to 16 * input_id + output_id. Directory names must end in "/" to be opened.

WARNINGS Users should not modify directories.

BUGS None known.

FILES None.

SEE ALSO close.

NAME printf - print a value at the standard output

SYNOPSIS printf(format,value)

DESCRIPTION PRINTF is identical to fprintf except that it does not accept a fileid argument. In lieu of this, it always directs its output to the file currently open as the standard output.

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO fprintf.

NAME putc - write a character to a file

SYNOPSIS putc(id,byte)

DESCRIPTION PUTC expects two arguments. The first is the fileid of a previously opened file to write. The second is the character to be placed in the file. There are no constraints on the byte being written. This allows transfers of binary data to files.

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO open, close, putchar.

NAME putchar - write a character to a file

SYNOPSIS putchar(byte)

DESCRIPTION PUTCHAR sends the byte passed it as an argument to the file currently open as the standard output. No constraints are made on the byte being passed. This allows binary data to be transferred.

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO open, close, putc.

NAME read - transfer a block from a file to memory

SYNOPSIS read(id,address,nbytes)

DESCRIPTION READ requires three arguments. The first is the fileid to be used for the transfer. The second is the address in memory where the block is to be placed. The third is the number of bytes to transfer. When finished, read will return the actual number of characters transferred. This routine can be alternated with getc or getchar on the same file and each will read sequentially. Read is most efficient when used to transfer large blocks of data but any length is permissible. The third argument, nbytes, is treated as an unsigned value. This permits moves of up to 65535 characters in a single block. If the file does not contain as many characters as requested, read will transfer all that remain and return that number.

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO open, close, getc, getchar, write.

NAME scanf - text and number reading routine

SYNOPSIS scanf(&bptr,&format,&variable)

DESCRIPTION SCANF expects three arguments. The first is the address of a pointer which CONTAINS the address of the string to process. The pointer would normally be a character pointer previously initialized to the address of a buffer loaded with ASCII text. The second argument is the address of a format string which will control scanf in matching text and reading values. The third argument should be a character, an integer or a character pointer depending upon the intended value to be transferred. Scanf will compare the text string to the format string. If at any time they do not match, scanf will terminate and return the value 0 and they buffer pointer variable will not be moved. If they match to the end of the format string (a null terminates it), scanf will return the value 1 and the buffer pointer will be moved so that it points to the next character in the buffer. While matching, scanf recognizes special sequences in the format string. These are given below.

*	Matches any number of blanks or tabs in the text string.
%d	Matches a decimal number. The value of the number will be placed in the variable.
%x	Matches a hexadecimal number. The variable will be set equal to the number.
%o	Matches an octal number. The variable is set to its value.
%n	Matches a number specifying its own base. Such numbers are 4096 (decimal), 0x1000 (hexadecimal), 01234 (octal) and 0b0101 (binary). This is probably the most convenient format.
%c	Reads a single character from the text and places it in the variable. In this case, the variable should be declared as a character.
%s	Reads a string from the text into the memory pointed to by the variable. In this case, the variable should be a character pointer and must have been initialized with a buffer address.

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO compare.

NAME seek - move file pointers

SYNOPSIS seek(page,byte,mode)

DESCRIPTION SEEK expects three arguments. The first is the page on which the file pointer is to be positioned where a page is interpreted as 256 bytes. The second is the specific byte within the page to which the file pointer is to point. The combination of these is used to move the file pointer where the final position is taken to be 256 * page + byte. It is not necessary for byte to be in the range 0 to 255. For example, page=0,byte=1024 is equivalent to page=4,byte=0. The third argument determines which file pointer to move. Mode is decoded as:

0 - read pointer 1 - write pointer 2 - both read and write pointers

Notice that no fileid is passed since seek always moves the standard input and/or the standard output pointers. After seek is completed, getchar, getc, putchar, putc, as well as read and write will begin accessing the file beginning at the new pointer values.

WARNINGS If the files open are physical devices, seek merely returns. It is not possible to backup a physical device.

BUGS None known.

FILES None.

SEE ALSO open, close.

NAME string - read a string into memory

SYNOPSIS string(&buffer)

DESCRIPTION STRING expects a single argument which it uses as the address of a buffer in which it loads a string. Characters making up the string are read from the standard input until a newline is found. When this occurs, string returns the number of characters read from the input. The routine also places a null after the received newline so that the string can be processed by other routines but the null does not count in the count returned by it. While reading the standard input, characters are echoed to the standard output. It recognizes the character delete, line delete and tabstops set by stty. Tabs are converted to blanks only in the echoed output and the true tab value (0x09) is stored in the buffer. After the string is read, the routine checks to see if the first character is the exclamation point (!). If it is, string calls the operating system on the remainder of the buffer and then reads another string from the standard input. This allows easy access to the operating system from new programs being built.

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO stty.

NAME system - execute a command

SYNOPSIS system(&buffer)

DESCRIPTION SYSTEM is the true command processor in the uNIX operating system. It expects a single argument which it uses as the address of a null terminated string containing commands. It breaks the tokens found in the command string into separate strings. The first token which is not an I/O redirect control is taken to be the command. The program having that name will be loaded into memory and executed as an object module. The program must be in relocatable format as generated by the link editor and will be relocated as required by the operating system. The system will search directories for the command name as specified by the path variable. The path variable can be modified using stty. Normally, it is:

"/bin/::"

which will cause the system to search first in the /bin directory and then second in the current directory. The colons denote the end of the path to which the command name is appended. In other words, /bin/:: is the path and the command xyz is typed, the following paths will be used for finding xyz.

/bin/xyz xyz

All other tokens found on the line are considered to be arguments to the command. Any argument can be referenced by the user using the arg function. When the command is actually loaded, it is passed a single argument which is the number of arguments which was present on the command line invoking the program named by the command. Tokens are seperated by spaces, tabs, or I/O redirect symbols. Redirect refers to the operating system ability to establish what files are the standard input or standard output. This is done by preceding a name with the less than symbol (<) for the standard input or the greater than symbol (>) for the standard output. Two greater than symbols (>>) specify appending to the named file as the standard output. Some examples follow:

ls>file cmnd<abc>/xyz ls /bin/ >>file

When specifying I/O redirect, the name must immediately follow the redirect symbol. Pseudo pipes are supported by system. This allows output from one command to be run as input to the next command. For example,

ls!pr>/lpr

will cause the output from ls to be placed as input to pr whose output in turn is directed to /lpr.

Multiple commands may be present in the buffer provided they are separated by semicolons (;).

The arguments of the calling function can be used within the current function. Dollar sign ($) specifies this action if it is followed immediately by the argument number desired. For example, a shell program xyz contains the statement:

```
pr $1>$2
```

When invoked by the statement xyz abc temp, the example will become,

```
pr abc>temp
```

If dollar sign is not followed by a number, system will read a string to use as the argument from /con. If dollar sign is immediately followed by a string in double quotes, the string will be printed at /con and then the argument will be read from /con. It is possible to concatenate arguments together by simply not placing spaces between them. For instance,

```
$1.c $1$2 $"Enter name".s
```

are all proper values. The name of the calling command can be accessed using $0.

System does not break up strings in double quotes but it does translate backslash sequences within them. For instance,

"hello there!*n*"

will be kept intact with only the newline (\n) being translated.

When system is finished processing the entire command string, it will return the same value returned to it by the last command executed.

WARNINGS None.

BUGS Double quoted strings cannot be used as I/O redirect token names (ls > "Hello there").

FILES None.

SEE ALSO arg, stty.

NAME write - transfer a block from memory to a file

SYNOPSIS write(id,address,nbytes)

DESCRIPTION WRITE requires three arguments. The first is the fileid to be used for the transfer. The second is the address in memory where the block is to be found. The third is the number of bytes to transfer. When finished, write will return the actual number of characters transferred. This routine can be alternated with putc or putchar on the same file and each will write sequentially. Write is most efficient when used to transfer large blocks of data but any length is permissible. The third argument, nbytes, is treated as an unsigned value. This permits moves of up to 65535 characters in a single block.

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO open, close, put, putchar, read.

NAME unix - start the operating system

SYNOPSIS unix(start)

DESCRIPTION UNIX is the beginning entry point for the entire operating system. It expects a single argument. The value of this argument determines the action taken. If the value is 1, the operating system makes a cold start. This implies:

The tabs are set to 4. The erase is set to backspace (0x08). The prompt is set to "% ". The path is set to "/bin::". Any file I/O is terminated, no files are open. The argument pointer is reset. The current directory is set to the root (1). If a file named profile exists in the root, it will be executed as shell commands. The shell is executed using /con for I/O.

If the value is 0, the operating system makes a warm start. This implies:

Any files open will be closed gracefully. The argument pointer is reset. The shell is executed using /con for I/O.

If the value is 2, the operating system initializes the file system and returns to the caller. This allows the user to use the file system for transferring files from other operating systems.

WARNINGS If sh or /con are missing, the system cannot boot.

BUGS None known.

FILES None.

SEE ALSO None.

NAME xas - the real Z-80 assembler

SYNOPSIS xas [-l] [-oname] [-p#] [-x] file_name

DESCRIPTION XAS accepts a number of argument flags. These are specified below.

-l	Generate a listing
-oname	Place the output in the "name" file
-p#	Page size (for listings) is # lines. (the default is 66).
-x	Do not generate relocatable code.

The final argument is the filename to assemble. The input language to the assembler must be in upper case and is a derivative of the Technical Design Labs (TDL) modifications of the 8080 programming language to include Z-80 extensions.

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO as, cc, ld.

NAME xcc - executable C compiler

SYNOPSIS cc source destination

DESCRIPTION XCC is the real C compiler. It accepts two arguments. The first is assummed to be a C program to compile and the second is used as the destination file name for the resulting assembly language program. For example,

xcc file.c result.s

will place an assembly language program in the file result.s. This compiler accepts standard C program text with some exceptions. It does not allow for multiple dimensional arrays (one-dimensional only), it does not support structures in any way, and it does not allow initialized variables. It also does not support the #define statement. It does support all other standard features of the C language.

WARNINGS Unlike cc, xcc does not append the ".c" and ".s" suffixes so remember to enter them if they are required.

BUGS None known.

FILES None.

SEE ALSO cc.

NAME xd - hexadecimal dump of a file.

SYNOPSIS xd file

DESCRIPTION XD prints the named file (if found) in hexadecimal notation. The address, beginning with 0, is printed next to each line of 16 bytes. XD can only be terminated by cntl-Q.

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO None.

NAME xld - the real link editor

SYNOPSIS xld [-l] [-oname] [-e] [-r] [-p#] [files]

DESCRIPTION XLD accepts several arguments which are described below.

-l	Produce a listing at the console
-lname	Produce a listing at "name"
-oname	Send the resulting module to "name"
-r#	Offset the relocatable code by #
-p#	Page size (for listings) is # lines
-e	Retain any ENTRY definitions in the files (ie. place them in the output)

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO ld, as, cc.

NAME xsh - executable shell

SYNOPSIS Never invoke this command

DESCRIPTION XSH is used by the operating system for executing files which are deemed shell programs. This is determined by the mode byte of the file and is checked by the operating system when a command is invoked.

WARNINGS Users should not invoke XSH or in any manner modify it. It is included here only for completeness.

BUGS None known.

FILES None.

SEE ALSO None.

NAME vi - visual editor

SYNOPSIS vi file_name

DESCRIPTION This manual describes the commands and capabilities of the VI screen oriented text editor. For the duration of this manual, the character ^ should be interpreted as the word "control". For instance, ^F means control-F. The symbol <cr> means carriage return, the symbol <sp> means the space character, the symbol <bs> means the backspace character, and <num> means an optional number. All other characters should be interpreted exactly as depicted and be sure to observe their case (upper or lower) as it is significant.

VISUAL MODE COMMANDS

I. Vertical Motion Group

<num>-	Move up num lines in the file, or to top.
<num><cr>	Move down num lines in the file, or to end.
<num>g or G	Go to line number num in the file, or to end if num is greater than total number of lines in file.
h or H	Go to top line currently displayed on screen.
l or L	Go to bottom line currently displayed on screen.
^F	Scroll down 1 screen size in the file.
^B	Scroll back 1 screen size in the file.
^D	Scroll down 1/2 screen size in the file.
^U	Scroll back 1/2 screen size in the file.

II. Display Control Group

z<cr>	Redraw screen, with cursor on top line.
z.	Redraw screen, with cursor on center line.

z- Redraw screen, with cursor on bottom line.

^L Redraw screen.

III. Locate Group

/string<cr> Go to next occurence of character string "string" in the file, searching in the forward direction. If end of file is hit, search will abort.

?string<cr> Go to next occurence of "string" in the file, searching backwards. If top of file is hit, search will abort.

n Go to next occurence of the last locate string entered. Search in same direction as before.

N Go to next occurence of the last locate string entered. Reverse direction of search.

% When the cursor is currently pointing to a brace, bracket, or parenthesis, this command will locate the matching brace, bracket, or parenthesis. If not found, terminal will "beep".

IV. Horizontal Motion Group

<num><sp> Space forward num characters on current line, or to end of line.

<num><bs> Back up num characters on current line, or to start of line.

~ Go to first character in current line.

^ Go to first non-blank character in current line.

$ Go to end of current line.

<num>w Move forward to start of numth following alpha-numeric word on current line, or to end of line.

<num>e Move forward to end of numth following alpha-numeric word.

<num>b Move back to start of numth previous alpha-numeric word.

<num>W Move forward to start of numth following blank delimited word on current line, or to end of line.

<num>E Move forward to end of numth following blank delimited word.

<num>B Move back to start of numth previous blank delimited word.

V. Delete Group

<num>dd Delete num lines, starting with the current line, or delete to end of file.

<num>d<sp> Delete the next num characters on the current line, starting with the current character, or to end of line.

<num>x Same as <num>d<sp>, only shorter.

d$ Delete from cursor to end of current line.

<num>dw Delete from cursor to start of numth following alpha-numeric word on current line.

<num>de Delete from cursor to end of numth following alpha-numeric word on current line.

<num>dW Delete from cursor to start of numth following space delimited word on current line.

<num>dE Delete from cursor to end of numth following space delimited word on current line.

VI. Yank Group

<num>yy Yank num lines, starting with the current line, or yank to end of file.

<num>y<sp> Yank the next num characters on the current line, starting with the current character, or to end of line.

y$ Yank from cursor to end of current line.

<num>yw Yank from cursor to start of numth following alpha-numeric word on current line.

<num>ye Yank from cursor to end of numth following alpha-numeric word on current line.

<num>yW Yank from cursor to start of numth following space

delimited word on current line.

<num>yE Yank from cursor to end of numth following space delimited word on current line.

VII. Change Group

<num>cc Change num lines, starting with the current line.

<num>c<sp> Change the next num characters on the current line, starting with the current character, or to end of line.

c$ Change from cursor to end of current line.

<num>cw Change from cursor to start of numth following alpha-numeric word on current line.

<num>ce Change from cursor to end of numth following alpha-numeric word on current line.

<num>cW Change from cursor to start of numth following space delimited word on current line.

<num>cE Change from cursor to end of numth following space delimited word on current line.

VIII. Input Group

i Insert new text between current character and previous character.

a Append new text between current character and next character.

(ESCape) Stop inputing characters into the file.

r Replace the current character with the next character typed in. New line characters cannot be changed with this command.

o Open a new line below the current line, and start inputting on this line.

O Open a new line above the current line, and start inputting on this line.

p Put the contents of the yank buffer between the current character and the next character (or between the current

line and the next line, if the yank buffer contains lines).

P — Put the contents of the yank buffer between the current character and the previous character (or between the current line and the previous line, if the yank buffer contains lines).

IX. Macro Group

Macros are allowed to call each other, or themselves. Any command can be used in a macro. Any error which causes a "beep" terminates a macro.

<num>m — Execute the current definition of macro num (1 to 4).

<num>M — Display the current definition of macro num on the command line.

<num>s or S — Enter a new definition for macro num on the command line.

X. Miscellaneous Commands

^G — Print file statistics on command line.

<num>t — Set tabstops to every numth character.

D — Display the current contents of the yank buffer.

J — Join the current line and the line below it into one line, deleting the newline between them.

C — Toggle the caps lock option (converts all letters to capitals while in input mode).

COMMAND MODE COMMANDS

I. File Manipulation Group

:w<cr> — Write file to current file name displayed with ^G command.

:w fname<cr> — Write file to file name fname.

:W<cr> — Same effect and options available as for :w<cr> above,

except that a :q<cr> will be executed after the write.

:r<cr> Restore current file to version currently saved on disk.

:e fname<cr> Discard current file being edited, and edit a new file named fname, if the current edited version of the file matches the version saved on disk.

:E fname<cr> Discard current file being edited, and edit a new file named fname, regardless of the state of the version of the file saved on disk.

:y fname<cr> Place the contents of file fname into the yank buffer.

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:q<cr> Quit the edit session, if the current edited version of the file matches the version saved on disk.

:Q<cr> Quit the edit session, regardless of the state of the version of the file saved on disk.

:!string<cr> Execute the character string "string" as a shell command.

USING DIFFERENT TERMINALS

Each time VI begins running, it reads a terminal profile from the file /bin/vi.crt which contains the various sequences which cause the terminal to perform operations on its display. The file contents are described below.

Lines This is a binary character which is the number of lines available for display on the terminal screen.

Home clear<cr>This string must contain the sequence which homes and clears the terminal screen.

Clear to end<cr>This string must contain the sequence which causes the terminal to clear the screen from the current cursor location to the end of line.

Insert line<cr>This string must contain the sequence which causes the terminal to insert an empty line at the cursor location.

Delete line<cr>This string must contain the sequence which causes the

terminal to delete the line at the cursor location.

Enter insert mode<cr>This string must contain the sequence which causes the terminal to begin insertion of characters received at the cursor location.

Exit insert mode<cr>This string must contain the sequence which causes the terminal to cease insertion of characters received at the cursor location.

Delete character<cr>This string must contain the sequence which causes the terminal erase the character at the cursor location.

row offset+16 This is a binary character which will specifies how much offset to add to the row addresses passed to the terminal. Normally, this value is made to be 16 which results in no offset.

move row<cr> This is the first part of the string which will cause the terminal to move its cursor to a new row and column. This portion specifies the row address as well as any characters to send before it is sent. The row address will be send when the specification %d or %c is found. If %d is used, the value is sent in ASCII decimal. If the format is %c, it will be sent as a binary character.

col offset+16 This is a binary character which will specifies how much offset to add to the column addresses passed to the terminal. Normally, this value is made to be 16 which results in no offset.

move col<cr> This is the second part of the string which will cause the terminal to move its cursor to a new row and column. This portion specifies the column address as well as any characters to send before or after it is sent. Like the row address, the value will be inserted whenever %d or %c is found.

Fortunately, this file can be created very simply using the "echo" command of the operating system. First, write down the sequences and values to send. Then, determine what ASCII characters have these values and write them down. In doing this, control characters should be preceeded by a backslash (\) and remember that carriage return can be coded as \n. For instance, the sequence ESC & cntl-x can be written as "\E&\X". Once these sequences are written down, they can be placed into a file by typing:

```
echo "the entire sequence">filename
```

An example sequence, which will condition VI for a Hewlett-Packard HP2621 is shown below. Notice that the sequence has been broken in two parts for convenience.

```
echo   "\X\E[H\E[J\n\E[K\n\E[L\n\E[M\n\E[Q\n\E[R\n\E[P\n">hp.crt
echo "\P\E[&a%dR\n\P%dC\n">>hp.crt
```

Note also that the second piece of the string is appended using the I/O redirect append operator (>>) supported by the operating system.

The content of the file can be viewed using the "xd" command to be sure it is correctly built. Then, move the file into the "bin" directory by typing:

```
mv filename /bin/vi.crt
```

Now, VI should be compatible with your terminal.

WARNINGS None.

BUGS None known.

FILES /bin/vi.crt

SEE ALSO None.

NAME script - text processor

SYNOPSIS script file_name

DESCRIPTION This manual describes a text formatter program entitled "MICROSCRIPT". MICROSCRIPT accepts a single argument which is the text file which is to be processed. It accepts no other arguments or flags.

The MICROSCRIPT program has been modelled roughly after the "SCRIPT" text formatter program marketed by the University of Waterloo. Extensive simplifications to the features have been made, however, to allow efficient implementation on a small microcomputer such as the Z-80. Specifically, any sort of commands which would require extensive amounts of internal buffering have been eliminated. The primary losses thus incurred are as follows:

1. Multiple column output is not supported in any way. All output must be in the form of one column per page.

2. No specific support of footnotes is provided.

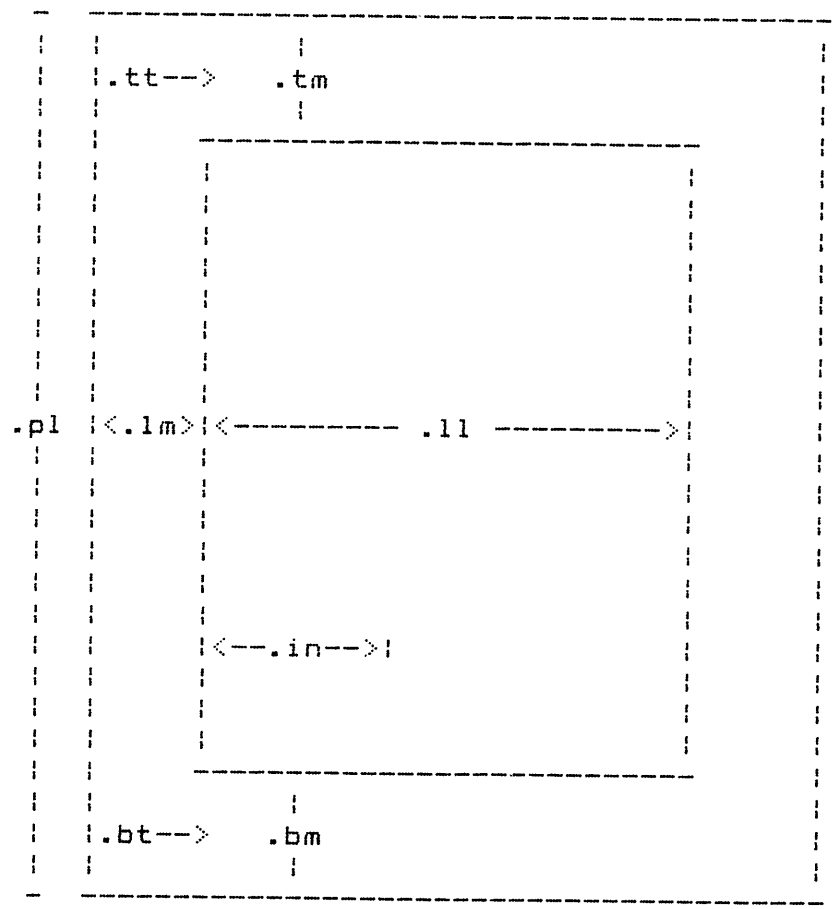
3. No command is supported which requires that text be formatted first, and then printed later. For example, no support of "conditional paging" to force a block of text to all appear on the same page is provided.

4. In addition, several little used commands have been eliminated and/or changed to allow greater generality of use at the cost of a certain amount of convenience.

Despite these limitations, MICROSCRIPT is quite capable of supporting a wide range of document styles. Most of the unsupported features can be accomplished by perfoming a trial format of the document, and then making a few minor changes to the definition to allow for exact page placement. Only multiple column output remains impossible.

PAGE FORMAT:

All documents prepared with MICROSCRIPT are, of course, printed on pages. Every aspect of page size and characteristics are user definable within the framework of MICROSCRIPT. Each page produced by MICROSCRIPT has the following basic format:



.pl = page length
.tm = top margin
.bm = bottom margin
.lm = left margin
.ll = line length
.in = indent amount within .ll
.tt = top title line
.bt = bottom title line

ENTRY OF COMMANDS AND ARGUMENTS:

All commands to MICROSCRIPT are of the form .xx, with the '.' beginning in column 1 of an input record, and "xx" being a 1 or 2 letter command. Command names have been picked as much as possible to reflect their function. Arguments are optional, depending on the command, and come in two forms: numerical values, and strings. A numerical argument may be specified in any one of four ways:

n	The numerical value n is assigned to the appropriate parameter.
+n	The parameter is incremented by the value of n.
-n	The parameter is decremented by the value of n.
no arg.	If the argument is left off entirely, the parameter returns to it's default vaule.

A string argument is any sequence of printable characters surrounded by two "delimiter" characters. The delimiter character can be any printable character other than space, tab, or '$'. Examples of strings are as follows:

```
/this is a string/
"\so is this"
```

In some commands, more than one string must be specified at once, with consecutive delimiters between each. For example:

```
/string1/string2/string3/
```

You can put more than one command on one line, if desired, by following the first command with a ';', and then putting the leading '.' of the next command immediately after the ';'. It is also possible to follow a command with a ';' and then normal text to format all on one line. For example, if you wish to center just one line, it is allowable to type:

```
 .ce 1;Line to center
```

Finally, if some command .xx is not recognized, MICROSCRIPT will search on disk for a file with the name xx. (Note that the leading '.' is not part of the file name.) If the file exists, MICROSCRIPT will process any commands and input lines in the specified file until it is exausted, and will then return to the original file being processed. In this way, "macro" commands can be written for often used sequences. Nesting of macros *is* allowed, and is limited only by the number of buffers in the operating system.

THE FORMATTING PROCESS:

The MICROSCRIPT text formatter program operates in one of three basic modes, selected by the user. A description of the functional characteristics of each follows:

mode 1: The simplest mode of operation is "unformatted" mode, specified by the ".nf" or "no-fill" command. In this mode, lines of text from the input file are copied to the output file exactly as they appear in the input file. All system parameters listed in the PAGE FORMAT section of this document are obeyed while in this mode, *except for line length* (.ll). In this case, lines will be whatever length you make them in the input file. This mode is primarily useful for entering tables, diagrams, and other things where the exact placement of all characters must be undisturbed. For example, the "picture" of a typical page which appears earlier in this manual was formatted using this mode.

mode 2: Both other modes operate in what is known as "fill" mode, specified by the ".fi" command. When in fill mode, words of text are copied from the input file to a separate output buffer within MICROSCRIPT, one at a time, with one space between each word. Any extra blanks between words in the input file are deleted, and line boundaries within the input file have no real significance (except for delimiting command lines). Whenever the output reaches a point where no more words can be included without exceeding the line length (.ll) parameter, the buffer is printed, emptied, and the process starts over again.

mode 3: The last mode available is "fill and adjust" mode, obtained by specifying both the ".fi" and ".ad" commands. Adjust mode can be turned off by specifying ".na". If ".nf" is specified, the state of adjust mode is unimportant. Fill and adjust mode operates in exactly the same fashion as fill mode alone, except that one additional processing step takes place. Whenever it has been determined that no more words will fit into the output buffer, extra spaces are inserted between words already in the buffer until the length of the line to print is *exactly* equal to the line length. This document was prepared using this mode. Also, this mode is the default condition when MICROSCRIPT is first called.

As long as at least two full words can fit on any one line (of length .ll), MICROSCRIPT will never hyphenate. If this condition is not met, MICROSCRIPT will, if necessary, hyphenate words to make them fit within the specified line length. Since MICROSCRIPT is not overly intelligent about it's placement of hyphens, it is best to avoid letting the line length get this small.

Whenever (in fill mode) it becomes necessary to print the output buffer and start filling it over again, this condition is referred to as a "break". The most common reason for a break to occur is that the output buffer is full. However, there are several other conditions which may occur which will cause a break even if the buffer is not full. For example, if a new paragraph is started, the last line of the old paragraph must be printed before the new paragraph can begin, even if it is not full. Also, many other commands such as ".sp" (skip spaces) and ".bp" (begin new page) will cause a break. Whenever a break does occur, the last line printed will *not* be adjusted before printing, even if ".ad" is specified. This is necessary, since the output buffer is not really full.

UNDERSCORING:

In order to underscore text within MICROSCRIPT, it is only necessary to surround the text to underscore with '\' characters. For example, if the following line is entered:

\Every good boy does fine\.

The following will be the result:

Every good boy does fine.

If in no-fill mode, *everything* between the '\' characters will be underscored, including any blanks. If in fill mode, only non-blank characters can be underscored.

If it is really desired to enter a '\' into the text stream, you can type '\\'. Also, if some line contains only one '\', everything from the '\' to the end of the line will be underscored.

LIST OF AVAILABLE COMMANDS:

The remainder of this manual consists of a list of all currently available commands within MICROSCRIPT, and a short description of the function of each. Whenever an underscored quantity appears in a list of argument options, this quantity is the "default" value, obtained if the argument is omitted entirely. Also, if a '*' appears before the command name, this indicates that the command causes a break.

.ad — Turn on "adjust" mode. Note that this command will do nothing if ".fi" is not specified.

.bm <0|n|+n|-n> — Set bottom of page margin to <argument> lines.

* .bp <pn=1|n|+n|-n> — Terminate current page, and begin a new page with page number <argument>. Default is the next page number. +n and -n argument values are relative off of the current page number (not the next page number).

* .br — Initiate a "break". (Refer to section on the formatting process for a definition of break.)

.bt <n|+n|-n> /string1/string2/string3/ — Bottom title line definition (see section on page format for placement on page). The bottom title line will be printed as the nth line of the bottom margin (n = <argument>). The line will consist of string1 left adjusted, string2 centered, and string3 right adjusted within the line length parameter. If the sequence "$$" appears in any string, it will be replaced by the current page number printed as 2 decimal digits. Similarly, the sequence "$$$" will print the current page number as 3 digits. Note that these translations only apply to title line definitions. MICROSCRIPT defaults to " .bt 0 ////". If the value of <argument> does not fall within the range of the bottom margin, the title line is not printed.

* .ce <until .ec|n> — Center the next <argument> lines in the input file. If no argument is given, all further lines will be centered until a ".ec" command is encountered.

.ds — From the next line printed until some other command overrides, start double spacing between all printed lines of text.

.ec — Terminate line centering mode. If the mode was already off, this command will do nothing.

.fi — Turn on "fill" mode.

* .in <0|n|+n|-n> — Indent all following printed lines by <argument> spaces, until some other command overrides. If in fill mode, the "effective" available line length will be decreased by the indent amount, so that the overall line length will remain the same.

* .le — Terminate a list item. This is accomplished by setting the indent amount to 0, and then executing a ".sp 1". (See the ".li" command below for the definition of a list item.)

* .li <n|+n|-n> /string/ — Start a list item. A list item consists of a string (the /string/ argument), and a block of text which is associated with that string. The .li command will execute a ".sp 1", and then set the indent amount to <argument>. Note that the same variable is affected here as in the ".in" command. All lines printed after the .li command will be indented by <argument> spaces. *In addition*, the *first* line printed after the .li command is issued will have the contents of /string/ printed on that line, located at the very beginning of the line (without any indent). For example, the command list that you are now reading was formatted with .li commands, with <argument> = 21, and with each /string/ = to the name and argument list for the command. If /string/ is too big to fit within the alloted space provided by the indent, the "effective" line length will be decreased accordingly *for that first line only*. After the first line is printed, the indent will revert to the value specified in the .li command. Note that the .li command description that you are now reading is an example of this situation.

* .ll <60|n|+n|-n> — Set current line length to <argument> characters. This value is only used in fill mode. Note that .in, .li, and .p may all cause the "effective" value of this variable to decreased.

.lm <0|n|+n|-n> — Set left margin on page to <argument> characters. Note that this variable does not affect the defined line length.

.na — Turn off "adjust" mode.

* .nf — Turn off "fill" mode.

* .p — Begin a new paragraph. This command executes a ".sp 1", and then increments the indent amount by <pi> characters. This extra indent amount applies only to the *first* line printed after the .p command. After the first line, the indent amount reverts to it's previous value. The value of <pi> can be set with the ".pi" command.

* .pi <3|n|+n|-n> — Set paragraph indent amount to <argument>.

.pl <66|n|+n|-n> Set current page length to <argument> lines per page.

* .sp <1|n> Skip <argument> lines in the output file. Note that if ".ds" is specified, 2*<argument> lines will actually be skipped.

.ss From the next line printed until some other command overrides, start single spacing all printed lines of text.

.tm <6|n|+n|-n> Set top of page margin to <argument> lines.

.tt <n|+n|-n> /string1/string2/string3/ Top title line definition. See the .bt (Bottom title line) description for details. This command operates in the same way as .bt, except that it is associated with the *top* margin.

* <tab> If a line of text begins with a tab character, MICROSCRIPT will perform the same actions incurred by issuing a ".p" command, except that it does not print the blank line between paragraphs. When in the unformatted mode, no action at all is taken.

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO None.

NAME asm - the 8086 assembler

SYNOPSIS asm [-ls] filename [filename] ....

DESCRIPTION ASM is the 8086 assembler. It accepts one or more arguments which it treats as the path to a file to assemble. Filenames given in the arguments to asm are appended with ".s" prior to searching. The wild card character (*) is permitted and asm will assemble all files ending in ".s" which match the name. Asm accepts two flags, if desired, which can produce a listing and/or a symbol table.

-l Produce a listing

-s Produce a symbol table

In both cases, the output will appear at the console unless the standard output has been redirected to a file. An example of this follows.

```
asm -l /temp/* >temp.listing
```

The assembler accepts lower case files containing standard Intel mnemonics for the 8086.

When the assembler is finished, there will be a ".o" file for each ".s" file which it was asked to assemble. These files are ready for link editing.

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO ccc, ldr.

NAME ccc - the 8086 C compiler

SYNOPSIS ccc filename [filename] ....

DESCRIPTION CCC is the 8086 C compiler. It accepts any number of arguments greater than one and treats each as a pathname to a ".c" file to be compiled. The wild card character (*) is permitted and the compiler will compile all ".c" files which match the specified name. For example,

```
ccc xyzzy /temp/ab*
```

will compile "xyzzy.c" and all files in the directory "temp" whose names begin with "ab" and end in ".c".

When the compiler is finished, there will be a ".s" file for each ".c" file which was compiled. These files are standard 8086 assembly language programs and are ready to be assembled by the 8086 assembler.

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO asm, ldr.

NAME ldr - the 8086 link editor

SYNOPSIS ldr [-ls] filename [filename] ....

DESCRIPTION LDR is the 8086 link editor. It accepts any number of arguments greater than one which it treats as a path to a ".o" file to be link edited. The wild card character (*) can be used in which case the link editor will link all matching files ending in ".o". It accepts two flags.

-l Produce a listing of the symbol table. The listing will appear at the standard output and can be re-directed to a file or printer.

-s Place a copy of the symbol table in the output. This is useful for debuggers.

When the link editor has finished, there will be a single file created which will have the name of the first argument but without the ".o". This file is the executable module.

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO ccc, asm..

NAME cpr - print C programs

SYNOPSIS cpr [-f] [-i#] [-p#] filename

DESCRIPTION CPR is a useful utility for printing C source programs. It provides pagination, titles, statement numbering, as well as level and bracket nesting. It accepts a single argument which is the filename to print. It also accepts a set of flags for setting options.

-f	Skip to a new page at the end of each C function.
-i#	Set page indent amount to # (default is 0).
-p#	Set page length to # (default is 66).
-fi#p#	If all options are requested.

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO None.

NAME as - Z-80 assembler

SYNOPSIS as as_pgm

DESCRIPTION AS accepts a single argument which it treats as the name of a ".s" file. On completion, a new file named as_pgm.o will exist in the current directory. This file is a load module program ready to be link edited. For example,

as myfile

will cause "myfile.s" to be assembled producing "myfile.o". Note that the user should not enter the ".s" suffix. The source file will not be modified in any manner. For more details on the Z-80 assembly language, see the xas manual. Listings cannot be produced using this command. If a listing is desired, use xas.

WARNINGS This routine is simply a shell program which calls the real assembler, xas.

BUGS None known.

FILES None.

SEE ALSO mk, cc, xas, ld.

NAME cat - concatenate files

SYNOPSIS cat [file_name] .....

DESCRIPTION The cat command permits the user to type those files named at the standard output. It accepts any number of arguments including none. If none are given, it simply echos the standard input to the standard output until the end of file is reached. If arguments are passed, all files named are typed. The wild card (*) is permitted and cat will type all files with matching names. Some examples are given below.

```
cat *.c bios.s
cat ../tempfile
cat /user/help/* manual/x*
```

This command requires no flags. Tabs are always translated as specified by the stty setting. (See also STTY)

WARNINGS Binary files (non-ASCII) cannot be viewed by cat. Attempts to do so may cause system buffers to be overflowed.

BUGS None known.

FILES None.

SEE ALSO stty.

NAME cc - C compiler

SYNOPSIS cc c_pgm

DESCRIPTION CC accepts a single argument which it treats as the name of a ".c" file. On completion, a new file named c_pgm.s will exist in the current directory. This file is an assembly language program ready to be assembled. For example,

cc myfile

will cause "myfile.c" to be compiled producing "myfile.s". Not that the user should not enter the ".c" suffix. The source file will not be modified in any manner. For more details on the C programming language, see the xcc manual.

WARNINGS This routine is simply a shell program which calls the real compiler, xcc.

BUGS None known.

FILES None.

SEE ALSO mk, as, xcc, ld.

CD

NAME cd - change directories

SYNOPSIS cd [path_name]

DESCRIPTION The cd command permits motion within the file hiearchy. It accepts either no arguments or a single argument. If no arguments are given, it moves to the root directory. If an argument is passed, it moves to that directory. The argument may begin with a slash in which case the search begins at the root. If there is no leading slash, it begins with the current directory. In either case, the argument should be a path to a valid directory. If any fault is found with the path, an explanatory message is printed. Some examples follow.

cd cd ../temp/abc cd /user/bin

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO mkdir, rmdir, mvdir

NAME chmod - change mode of files

SYNOPSIS chmod newmode filename [filenames]

DESCRIPTION The chmod command allows the user to modify the mode word associated with a file. It accepts as arguments a new mode value and a list of filenames. The filename list can use the wild card (*) and can be paths to other directories. The new mode value is given in symbolic form using combinations of the letters shown below.

l	No list. The filename will not be listed by the ls command unless the -a option (of ls) is used.
x	Shell executable. The file will be interpreted as shell commands when entered as a command rather than be loaded and executed directly.
p	Physical device driver. If input or output is directed to such a file, the file will be used as a program for doing I/O. The length of such a file must be less than 256 bytes.
w	Write protected. Files protected in this manner can not be written. This applies to physical device drivers as well.
r	Read protected. Files protected in this manner can not be read. This is useful for physical device drivers which are write only. (ie. line printers).
0	No modes. This removes all protection and/or mode bits so the file can be manipulated normally.

Any unspecified option is disabled in the resulting mode. When specifying more than one flag, the flags must be ordered as listed (lxpwr). Directories can only be modified by the no list option and ordinary files cannot be made into directories by chmod. Some examples follow.

chmod lpw modem /dev/* chmod l /bin/

Note that when directories are named, the name must end in a forward slash.

Be careful with the use of the wild card (*) and this command. If the modes of physical device drivers are made wrong, the file will be

destroyed if written and must be remade. If the console driver (/con) is damaged in this manner, the disk becomes useable.

BUGS None known.

FILES None.

SEE ALSO ls

NAME cmp - compare two files

SYNOPSIS cmp file1 file2

DESCRIPTION CMP does file comparison on a character by character basis. It accepts two arguments which are taken to be filenames. If either cannot be found, a message is printed. Otherwise, the two are compared. If equal, CMP merely returns. If not, the line, char position and byte number are reported. CMP can be run on any file.

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO None.

NAME cp - copy files

SYNOPSIS cp file1 file2 cp file [files] directory/

DESCRIPTION COPY routine allows users to copy files from one place to another. It requires two or more arguments. The last argument is the destination file (or directory) and all others are source files. Like the 'mv' command, it accepts source arguments with wild cards and copys all matching files into the destination argument which should be a directory. For example:

cp abc* xyz/

will copy all files whose names begin with abc into the directory named xyz. This is quite useful for backing up large groups of files. When copyed, the name of the files will be unchanged in the new destination directory. Copy will overwrite any existing file by the same name unless it is r/w protected, a directory or a physical device driver.

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO mv.

NAME demount - demount a disk volume

SYNOPSIS demount volume name

DESCRIPTION DEMOUNT allows the user to remove a previously mounted removable volume from the filesystem. It requires two arguments. The first is the numeric id of the volume and the second is the directory name by which it is known. The removable volume will become linked to the root directory and the directory name will be removed (provided that it can be found). For example,

demount 1 user

will unlink the disk which has be mounted on drive 1 and remove the directory named "user".

WARNINGS The system must be reset if this command is executed from the volume being demounted.

BUGS None known.

FILES None.

SEE ALSO mount

NAME rmdir - remove directory lists

SYNOPSIS rmdir dir [dirs] ....

DESCRIPTION RMDIR permits directories to be removed. It accepts any number of arguments greater than or equal to one. Arguments may be pathnames and may include wild cards. If the argument is found, and is a directory containing only "." and "..", then it will be removed and will have its sectors deallocated. If the directory is not empty, it will not be removed.

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO mkdir, mvdir, cd.

NAME du - summarize disk utilization

SYNOPSIS du [volume]

DESCRIPTION DU command summarizes disk usage. It counts the number of files on the disk and the number of sectors in use. The number of files includes directories, hidden files and all others. In other words, it really counts ALL files. The number of sectors in use includes those associated with the linked list used for file management. It can be called with up to one argument which is the volume number to summarize. If no argument is given, it will summarize the root volume. An example summary is given below.

```
130 files
busy:  915, 229K,  79%
idle:  240,  59K,  21%
```

For the busy and idle reports, the first value is disk sectors, the second value is in Kbytes stored on the disk, and the final value represents the percent busy or idle of the total volume capacity.

WARNINGS Unmounted volumes cannot be examined. Attempts to do so will require system reset.

BUGS None known.

FILES None.

SEE ALSO None.

NAME dup - duplicate a disk

SYNOPSIS dup

DESCRIPTION DUP allows the user to duplicate the disk currently mounted in the drive. It is intended for single disk systems only. Those with multiple drives can use the copy routine instead. It examines the disk i-map sectors and only loads those sectors which are actually in use. These sectors are buffered in memory until 32K of store is used. It then prompts the user to mount the slave disk, copies the store onto the disk and then prompts the user to mount the master disk. Using this scheme, at most 10 exchanges must be made. When completed, the slave disk will exactly match the master except for those sectors which were not in use. The content of these should not matter.

WARNINGS If any disk errors occur while writing the slave, dup cannot continue. Reset the system and repeat the operation. Be careful not to exchange the disks incorrectly.

BUGS None known.

FILES None.

SEE ALSO None.

NAME echo - type arguments as strings

SYNOPSIS echo [text]

DESCRIPTION ECHO simply sends all its arguments to the standard output as character strings. No character is placed between the strings when sent. Character translations such as \n are performed by the system when strings in double quotes are passed as arguments. If no arguments are given, ECHO simply types (exactly) the standard input to the standard output. Some examples follow.

```
echo "Hello world\n"
echo abc def "Now is the time"
```

ECHO is most useful when its output is redirected.

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO None.

NAME fmt - format a disk volume

SYNOPSIS fmt [volume] [drive]

DESCRIPTION FMT allows users to format uNIX disks. If no argument is given or if the argument is 0, FMT will create a root disk. If a single argument is passed, it denotes the volume number by which the newly created disk will be refered. If a second argument is given, it is the drive on which the volume will be mounted for formatting. It will request the insertion of the disk on the drive requested by the user. After the new disk is inserted and a return is typed, FMT will initialize the disk and place a fresh linked list having the directory "." as well as the "con" driver in the directory if the disk is a root disk. If the disk is not a root volume, it will contain "." and ".." where ".." is linked to the root. After formatting, the user will be asked to remount the system disk if drive 0 was used. Note that volume and drive are independent. This allows the user to create any volume using any drive.

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO None.

NAME inode - display inodes on a disk

SYNOPSIS inode [number]

DESCRIPTION INODE ROUTINE allows the user to read and modify disk inodes. To read an inode, simply type the inode number to display in decimal (10) or hex (0x10). To modify an inode, simply type the inode number, the element to modify in brackets, an equals sign, and the value to subsitute. For example,

21[15]=0x44

Any value can be specified in decimal or hexadecimal. Inode accepts at most one argument which is used as the first one to dump. It will then prompt for subsequent inode values. To exit the routine, type end-of-file (NULL).

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO None.

NAME ld - link edit load modules

SYNOPSIS ld ld_module [ld_modules] ....

DESCRIPTION LD is the system link editor. It accepts any number of arguments which are assumed to be names of ".o" files. The first of these is made the entry point of the resulting module so order counts. It automatically includes the file /lib/sys.o which links the operating system entry points (see LIB). For example,

ld abc xyz /def/temp

will link edit abc.o, xyz.o, /def/temp.o, and /lib/sys.o into a single executable file named abc. If no errors occur, the result can be executed by simply typing its name. The resulting module is relocatable.

WARNINGS This routine is simply a shell program which calls the real link editor, xld.

BUGS None known.

FILES /lib/sys.o

SEE ALSO mk, cc, as, xld, reloc, LIB.

NAME ls - list files in directories

SYNOPSIS ls [-ailmst] [file_names] [directory_paths] ....

DESCRIPTION The LS command allows the user to examine the contents of directories. It accepts as arguments either filenames to match or paths to directories. Any number of arguments of either type can be given. The command recognizes the wild card character (*) within filenames. Some examples follow.

```
ls
ls *.c
ls temp tempx
ls /bin/a*.c user/help
```

If a name ends in forward slash (/), ls will treat it as a directory and will list all files within it. Several flags are available to influence the command. These are described next.

-a	List ALL files, even those marked as unlisted
-i	List the starting inode and the name
-l	Use the long listing. Gives the filemode byte, the starting inode (in decimal), the length (in hex) and the file name
-m	List the filemode byte and name
-s	List the file size (in hex) and name.
-t	Trace and print all inode numbers (in decimal) used in the file(s).

Several flags can be given at once but they must be in alphabetical order. For instance,

```
ls -al
ls -t *.c
ls -at /user/help *.c ../bozo
```

Whenever the filemode byte is displayed, it is printed as the following symbols.

```
l - No list option (overide with ls -a)
x - Shell executable
```

p - Physical device driver
r - Read protected
w - Write protected
d - Directory

If the option is not enabled, an underline (_) is printed in the letter's place.

WARNINGS None.

BUGS None known.

FILES The names . and .. indicate the current and previous directory respectively.

SEE ALSO chmod.

NAME mk - make a C program

SYNOPSIS mk c_pgm [ld_files]

DESCRIPTION MK accepts a variable number of arguments. The first is expected to be the name of a C program, c_pgm.c, and any other arguments are expected to be load modules, ld_file.o. MK will run the C compiler and the assembler on the first argument. It will then run the link editor on all arguments. It automatically includes /lib/sys.o which is the system library. For example,

mk xyz /lib/split ../findex

will compile xyz.c (which generates xyz.s), and assemble xyz.s (which generates xyz.o). Finally, it will load the files xyz.o /lib/split.o ../findex.o /lib/sys.o.

WARNINGS Remember to omit the ".c" and ".o" suffixes.

BUGS None known.

FILES None.

SEE ALSO cc,as,ld,xcc,xas,xld.

NAME mkdir - make new directories

SYNOPSIS mkdir name [name] .....

DESCRIPTION MKDIR routine permits the user to create new directories anywhere in the directory tree. Each argument should consist of a new directory name to place the in the parent directory. If the name is already taken or cannot be created for some reason, a message will be printed. Otherwise, the directory will be added and will contain links to itself and its parent directory. These two links will be marked as directorys themselves and will have the 'list' option off. The new directory name in the parent directory will be marked as a directory but will have the 'list' option on. Any number of arguments may be given.

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO rmdir, cd

NAME mount - mount a removable volume

SYNOPSIS mount volume name

DESCRIPTION MOUNT allows the user to access a demountable volume. It requires two arguments. The first is the volume id to access and the second is the directory name which it is to be called. MOUNT then links the two disks so that the specified volume id appears as a subdirectory by the given name. MOUNT can be executed at any location in the filesystem. This allows a demountable volume to become a leaf in the root directory tree. If the given name already exists, the command will not mount the volume.

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO demount

NAME mv - move files within the filesystem

SYNOPSIS mv file1 file2 mv file1 [files] directory/

DESCRIPTION MV command allows files (not directories) to be renamed or moved about in the directory hiearchy. The command requires at least two arguments. If more than two arguments are given, the last should be a path name to a directory. For example,

mv abc xyz def ../dirx/ mv abc ../dirx/

Wildcard (*) is also permitted. For example,

mv abc* xyz temp ../

The more simple (and usual) use is to rename a file. For example,

mv abc xyz mv temp oldfile

WARNINGS If several files are moved and the last argument is NOT a directory, all files but the last of them will be lost and the last will assume the new name. For example,

mv abc abcde abcdefg xyzzy mv abc* xyzzy

both result in lost files. A single file will remain named xyzzy which is the last one found when searching the directory. This command cannot be used to rename or relocate directories, files which are physical device drivers or protected files. To move such files, use chmod to clear the protection bits.

BUGS None known.

FILES None.

SEE ALSO cp, rm

NAME mvdir - move directories within the filesystem

SYNOPSIS mvdir old_dir new_dir mvdir dir [dir_list] directory/

DESCRIPTION MVDIR command allows directories (not files) to be renamed or moved about in the directory hiearchy. The command requires at least two arguments. If more than two arguments are given, the last should be a path name to a directory. For example,

mvdir abc xyz def ../dirx/ mvdir abc ../dirx/

Wildcard (*) is also permitted. For example,

mvdir abc* xyz temp ../

The more simple (and usual) use is to rename a directory. For example,

mvdir abc xyz mvdir temp oldfile

WARNINGS Never move a directory to itself (mvdir abc abc/), or to a subdirectory beneath it (mvdir abc xyz/), or operate on the names "." or "..". Either of these can scramble a disk beyond any hope of recovery.

BUGS None known.

FILES None.

SEE ALSO mkdir, rmdir, cd.

NAME pr - print a list of files

SYNOPSIS pr [-h] [filenames]

DESCRIPTION PR does printing and reformatting of files. It accepts any number of arguments including none and treats each as the pathname to a file. Wild cards in the pathname are permitted. If used, PR will print all files which are found that match the pathname. It accepts a single flag, -h, which will suppress printing of the header on each page. If no matching files are found, an appropriate message is printed. Otherwise, the files will be printed at the standard output. If no arguments are given, PR will read the standard input for the information to print until it is exhausted. Tabs will be expanded as specified by the stty setting. The output of PR should be re-directed to the printer driver routine as shown below.

```
pr manual >/lpr
```

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO stty.

PWD

NAME pwd - print working directory

SYNOPSIS pwd

DESCRIPTION PWD prints the working directory. This is done by moving up the file system from the current directory and seeking directory names that have the inode of the current directory. The names are concatenated and printed when no ".." directory is found. This denotes the top of the tree.

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO cd, mkdir, rmdir, mvdir.

RELOC

NAME reloc - relocate modules to an absolute address.

SYNOPSIS reloc file address

DESCRIPTION RELOC accepts two arguments. The first is the name of a module which has been link edited. The second is the address at which the module will be placed when it runs. The address can be specified in decimal (4096) or hexadecimal (0x1000). Upon completion, a file named core will exist in the current directory which contains the absolute image. For example,

reloc bozo 0xc000

will generate a core file which is bozo loaded at 0xc000. This command is most useful for generating ROM images.

WARNINGS Files generated for absolute loads will NOT execute under the operating system. The operating system memory management requires relocatable images which it converts to absolute images when the file is executed.

BUGS None known.

FILES core.

SEE ALSO None.

NAME rm - remove lists of files

SYNOPSIS rm file [files] .....

DESCRIPTION RM permits files to be removed. It accepts any number of arguments greater than or equal to one.They may be pathnames and may include wildcards. The pathnames are split into directory and file. If the directory is found, any name in it matching the file will be removed and have its inodes marked idle. If no matching file is found in the directory, the filename is printed along with a message. If the directory is not found, the directory name is printed. Files which are read protected, write protected, physical device drivers, or directories cannot be removed. To remove such files, force their mode bits to 0 using chmod. Some examples follow.

rm abc rm abc* /bin/temp rm ../xyzzy*.c

WARNINGS No second chance is given. Be careful with wild cards.

BUGS None known.

FILES None.

SEE ALSO chmod.

RMDIR

NAME rmdir - remove directory lists

SYNOPSIS rmdir dir [dirs] ....

DESCRIPTION RMDIR permits directories to be removed. It accepts any number of arguments greater than or equal to one. Arguments may be pathnames and may include wild cards. If the argument is found, and is a directory containing only "." and "..", then it will be removed and will have its sectors deallocated. If the directory is not empty, it will not be removed.

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO mkdir, mvdir, cd.

NAME sh - shell program

SYNOPSIS sh [files]

DESCRIPTION SH provides the basic system operation. It reads strings from the standard input which it passes to the SYSTEM routine for execution. It is the first procedure invoked by uNIX. It can be called with no arguments in which case it will read the standard input. If arguments are given, it will open each of them as standard input and execute them as SYSTEM commands until the file is exhausted. SH accepts no flags. SH is responsible for prompting for new commands. The prompt string can be changed using the stty command.

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO xsh, system, stty.

NAME stty - set teletype options

SYNOPSIS stty [option [value]]

DESCRIPTION STTY allows the user to setup various system options. The current options are:

stty erase value (system character delete) stty kill value (system line delete) stty tabs value (system tab stops) stty path string (system command search) stty prompt string (system prompt string)

If no arguments are passed, STTY will print the value of all options. If a single argument is passed, it will print the value of the selected option. When the system is reset, the initial values of the options are:

erase = 0x08 kill = 0x7f tabs = 0x04 path = "/bin/::" prompt = "% "

If tabs are set to 0, the system will print the true value of the tab (0x09). If it is other than 0, the system will replace the tab with an appropriate number of blanks for that group of tabstops. For further discussion of the path variable, see the "system" subroutine description.

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO system.

NAME uucp - unix to unix copy

SYNOPSIS uucp [files] ....

DESCRIPTION UUCP permits transfer of blocks of files from one disk to another using memory as a buffer. It accepts any number of arguments (including none) and treats each as the pathname to a file. Wild cards in the pathname are permitted. If used, UUCP will load and buffer all files found that match the pathname. It requires no flags and if no matching files are found, an appropriate message is printed. After all files are found and loaded, a message will be printed requesting the user to exchange disks. When this is done, the buffered files will be written onto the new disk under their old names but they will be placed at the root directory. The system will re-start using the new disk.

WARNINGS No check is made for overflowing memory. Do not try to uucp more than 32K of files at a time.

BUGS None known.

FILES None.

SEE ALSO dup

NAME rmdir - remove directory lists

SYNOPSIS rmdir dir [dirs] ....

DESCRIPTION RMDIR permits directories to be removed. It accepts any number of arguments greater than or equal to one. Arguments may be pathnames and may include wild cards. If the argument is found, and is a directory containing only "." and "..", then it will be removed and will have its sectors deallocated. If the directory is not empty, it will not be removed.

WARNINGS None.

BUGS None known.

FILES None.

SEE ALSO mkdir, mvdir, cd.

Bootstrap

```
;                       BOOTSTRAP PROGRAM
;
;                   FOR Z-80 MICROPROCESSOR
;                           by
;
;                        L. A. TOMKO
;
;
;
;
;   equates:
;
a_  equ 061h            ; ascii 'a'
b_  equ 062h            ; 'b'
c_  equ 063h            ; 'c'
d_  equ 064h            ; 'd'
e_  equ 065h            ; 'e'
f_  equ 066h            ; 'f'
g_  equ 067h            ; 'g'
h_  equ 068h            ; 'h'
i_  equ 069h            ; 'i'
j_  equ 06ah            ; 'j'
k_  equ 06bh            ; 'k'
l_  equ 06ch            ; 'l'
m_  equ 06dh            ; 'm'
n_  equ 06eh            ; 'n'
o_  equ 06fh            ; 'o'
p_  equ 070h            ; 'p'
q_  equ 071h            ; 'q'
r_  equ 072h            ; 'r'
s_  equ 073h            ; 's'
t_  equ 074h            ; 't'
u_  equ 075h            ; 'u'
v_  equ 076h            ; 'v'
w_  equ 077h            ; 'w'
x_  equ 078h            ; 'x'
y_  equ 079h            ; 'y'
z_  equ 07ah            ; 'z'
sp_ equ 020h            ; 'space'
nl_ equ 0dh             ; 'newline'
A_  equ 041h            ; 'A'
B_  equ 042h            ; 'B'
C_  equ 043h            ; 'C'
D_  equ 044h            ; 'D'
E_  equ 045h            ; 'E'
F_  equ 046h            ; 'F'
G_  equ 047h            ; 'G'
H_  equ 048h            ; 'H'
I_  equ 049h            ; 'I'
J_  equ 04ah            ; 'J'
K_  equ 04bh            ; 'K'
L_  equ 04ch            ; 'L'
M_  equ 04dh            ; 'M'
N_  equ 04eh            ; 'N'
O_  equ 04fh            ; 'O'
P_  equ 050h            ; 'P'
Q_  equ 051h            ; 'Q'
R_  equ 052h            ; 'R'
S_  equ 053h            ; 'S'
T_  equ 054h            ; 'T'
U_  equ 055h            ; 'U'
V_  equ 056h            ; 'V'
W_  equ 057h            ; 'W'
X_  equ 058h            ; 'X'
Y_  equ 059h            ; 'Y'
```

ALL of These were unnecessary — I DIDN'T HAVE documentation on the CROSS-Assembler, and didn't know How to specify ASCII characters.

```
Z_ equ 05ah              ; 'Z'
amp_ equ 040h            ; ampersand (&)
qm_ equ 03fh             ; question mark (?)
ESC equ 01bh             ; ESC character
ESCMOD equ 1             ; CRT ESCAPE mode
INSMOD equ 8             ; CRT INSERT mode
ROWMOD equ 3             ; CRT ROW mode
COLMOD equ 4             ; CRT COLUMN mode
spbase equ 0afffh        ; where to start the stack
tau equ 0fah             ; cursor blinker time constant, in ms (fa = 250)
crtwrds equ 0800h        ; number of 2-byte words in CRT RAM
crtram equ 0b000h        ; beginning of CRT RAM
endcrt equ crtram + (2 * crtwrds) - 1   ; last of CRT memory
botln equ crtram + 0d00h  ;  the line below the bottom line on the CRT
hibot equ botln/0100h    ; high byte of bottom line
botlft equ crtram + 0c80h ;  lower left of screen
uplft equ crtram + 080h ; Upper left of visible screen
scdline equ crtram + 0100h ; Second line of the crt
botlf1 equ botlft + 1    ; next space after bottom left of crt
kbfsze equ 31            ; keyboard buffer size (32) -must be power of 2 - 1.
keyprt equ 0d6h          ; I/O control port for keyboard PIO
kbvctr equ 0h            ; keyboard interrupt vector
pmod0 equ 0fh            ; sets a PIO to mode 0 (output)
pmod1 equ 04fh           ; sets a PIO to mode 1 (input)
enable equ 083h          ; enables PIO interrupts
disable equ 3            ; disables PIO interrupts .
lgosze equ 11            ; The logo gets printed at the beginning
dskdta equ 0d3h          ; Disk data register (IO port)
dsksct equ 0d2h          ; disk sector register (IO port)
dsktrk equ 0d1h          ; Disk track register (IO port)
dskcmd equ 0d0h          ; Disk command or status (IO port)
SEEK equ 01fh            ; track seek command for disk
DSKRST equ 0d0h          ; reset disk controller command
DMA equ 0c0h             ; DMA controller
WRSCTR equ 0a8h          ; Write sector command
RDSCTR equ 084h          ; Read sector command
keybrd equ 0d4h          ; keyboard data port
mscntl equ 0d7h          ; misc. PIO control port
mscio equ 0d5h           ; misc PIO data port
RAM equ 0f2h             ; RAM turnon port
ROM equ 0f3h             ; ROM turnon port
t2 equ 0f6h              ; timer 2
FMTBLK equ 06000h        ; start of block data for format routine
;
;
;
org 00h                  ; starts at the reset location
        di
        out (ROM),a      ; make sure executing from ROM (cold start)
        im 2             ; interupt mode for z-80 peripherals
        ld hl,crtwrds    ; number of 2-byte words in the CRT RAM
        ld sp,endcrt     ; last location of the CRT RAM
        ld de,02020h     ; two ASCII 'blank's, one in each byte
clear:  push de          ; writes two 'blanks' to consecutive CRT locations
        dec hl           ; looking for hl=0 to stop clearing CRT RAM
        ld a,h           ; test upper byte first
        or a             ; to make the flags appear
        jp nz,clear      ; certainly not through if upper byte is > 0
        ld a,l           ; now look at the lower byte
        or a
        jp nz,clear      ; if both are zero, we are done with clearing CRT
;
        ld a,DSKRST      ; Reset the disk controller, to abort SEEK command
        out (dskcmd),a   ; which is ineffective because the head is
;                          unloaded during the automatic Reset SEEK.
;
```

TURNS ON ROM (SO does RESET)

note: interrupt driven

my CRT is memory mapped

```
;                       Now for a little egocentricity, we'll print a logo
;
        ld hl,crtram    ; the beginning of the crt ram, for reference
        ld de,0121h     ; a good relative position to start logo
        add hl,de
        ex de,hl        ; want the crt ram address in de
        ld bc,lgosze    ; length of the logo (it's short)
        ld hl,logo      ; the address of the logo string, tucked away in rom
        ldir            ; one of those wonderful z-80 block transfers
;
;
;               Enable the pio chip and the interupts
;
        ld a, pmod1     ; pmod1 = 4f, sets the pio to mode 1 (input)
        out (keyprt),a  ; keyport is the control port for keyboard pio
        ld a,kbvctr     ; the interrupt vector for the keyboard (=0h)
        out (keyprt),a  ;
        ld a,enable     ; enable = 083h, enables port interrupt
        out (keyprt),a  ;
        in a,(keybrd)   ; do one read to set 'ready' output.
;
;
;               initialize 1 ms timer.  (used for cursor BLINKER)
;
        ld a,07h        ; sets timer mode, non-interrupting, prescale/16
        out (0f4h),a    ; f4 is ctc channel 0.
        ld a,0fah       ; time constant of 250 counts = 1 ms total
        out (0f4h),a    ;
        ld a,08h        ; ctc vector(s) 8 + counter #
        out (0f4h),a    ;
;
;
;
;
        out (0cfh),a    ; Set single density for floppy controller
;
        xor a           ; a =0
        ld (dskrdy),a   ; clear 'disk ready' flag
;
; Initialize PIOB, Port B for miscellaneous interrupts, including disk
;
        ld a, 0cfh      ; Mode 3 - bit I/O
        out (mscntl),a  ; PIOB, Port B control
        ld a,1          ; D0 only is input - all else = outputs
        out (mscntl),a  ;
        ld a,037h       ; disable interrupt, active high, mask follows
        out (mscntl),a  ; (This initialization is repeated in disk routines)
        ld a,0feh       ; Mask all but D0.
        out (mscntl),a  ;
        ld a,010h       ; vector
        out (mscntl),a  ;
        in a,(mscio)    ; do a read to set 'ready' output.
;
;
;
;                       misc. initialization
;
        xor a           ;
        ld (keyflg),a   ; initialize keyboard flag = off
        ld (kbwptr),a   ; keyboard write pointer
        ld (kbfptr),a   ; keyboard read pointer
        ld (cstat),a    ; start with cursor status = off.
        ld (dskid),a    ; default disk ID is 00
        ld (crtmod),a   ; set CRT mode to normal
```

```
        ld hl,crtram    ; beginning of CRT RAM
        ld bc,0200h     ; offset for the initial cursor position
        add hl,bc       ;
        ld (curse), hl  ;
        call curson     ; start the cursor blinking
        ld hl,vectab    ; the vector transfer table address is vectab (I hope)
        ld a,h          ; need upper byte in a to load reg. I.
        ld i,a          ; load the high byte of vector table
;
;
;                       Load RAM from ROM and change to RAM
        ld hl,0         ;
        ld de,0         ;
        ld bc,04000h    ;
        ldir            ;
        out (RAM),a     ; turns RAM on
;
        ld sp,spbase    ; load stack pointer so we can call subroutines
        ei              ; enable interrupts so disk will work
        call restor     ; set disk to track zero
;
;
;                       now we ask the almighty z to monitor the keyboard.
;
;
monitor:
        ld sp,spbase    ; reload the stack pointer
        call dskdly     ; wait for controller to clear
        ld a,DSKRST     ; Reset controller, abort any commands
        out (dskcmd),a  ;
        ld a,0dh        ; first print a 'cr' and a '$' on the crt
        call putcrt     ; \n
        ld a,024h       ;
        call putcrt     ; $
;
        ei              ; enable the system interrupts.
        ld hl,mon1      ; This next little operation clears peripheral devices
        push hl         ; that may have pending interrupts acknowledged but
        reti            ; not cleared with a "reti" command. Each iteration
mon1:   ld hl,mon2      ; clears only one device, so we will do three just
        push hl         ; to be sure!
        reti            ;
mon2:   ld hl,mon3      ;
        push hl         ;
        reti            ;
mon3:
;
        call kbdchr     ; that's 'keyboard character' - which returns a
;                         character when a key is depressed.
        and 07fh        ; masks the parity bit (maybe not necessary)
        cp 072h         ; is it an'r'?
        jp z,readkw     ; if so, it may be a read command
        cp 077h         ; is it a 'w'?
        jp z,writkw     ; maybe a write command
        cp 065h         ; how about an 'e'?
        jp z,execute    ; probably an execute command
        cp b_           ; 'b' points to boot command
        jp z,uboot      ;
        ld a,qm_        ; if anything else, we load a '?' into A,
        call putcrt     ; and dump it to the crt at the cursor position
        jp monitor      ; then try again
;
;
;                       we seem to have a 'read' command, but let's
;                       look at the second character to find out which kind
readkw: call kbdchr     ;
```

Here's the RAM/ROM transfer. Writes to low order (0-4000 Hex) are always allowed, 'Reads' start next instruction after turn-on.

much of what follows is utilities to read or write memory locations or execute laboriously machine-language programs.

Boot ('bt') boots CP/M

```
        and 07fh
        cp 06bh         ; is it a 'k'?
        jp z,rdkbd      ; 'rk' means read hex from keyboard to memory
        cp 074h         ; is it a 't'?
        jp z,rdtape     ; then load memory from tape
        cp 064h         ; if it's a 'd',
        jp z,rddsk      ; then load memory from disk
        cp 06dh         ; 'm' is for memory examination
        jp z,rdmem      ;
        ld a,03fh       ; otherwise, '?' and back to monitor
        call putcrt
        jp monitor
;
;
rdmem:  call getaddr    ; start address to examine
        push hl         ; save it
        call getaddr    ; how many to read
        push hl         ;
        pop bc          ; keep the count in BC
        pop hl          ; use hl for address to read
rdm1:   ld a,(hl)       ; read the location
        call pthxch     ; puts out two characters for the byte in A
        ld a,sp_        ; 'blank'
        call putcrt     ; gives a nice space between bytes
        inc hl          ; next location
        dec bc          ; decrement the counter
        ld a,b
        or c            ; are we done yet?
        jp z,monitor    ; if so, go home
        jp rdm1         ; else do it again.
;
;
;                       rdkbd is a routine to allow input of hex data
;                       into consecutive memory locations beginning with
;                       the address specified after the keyword 'rk',
;                       followed by a space. the hex bytes are separated
;                       by blanks, may appear as many per line as desired
;                       (and fit). a prompt consisting of the next address
;                       appears after each newline. the sequence is
;                       terminated by an 'eof' character.
;
rdkbd:  call getaddr    ; getaddr gets the starting address of the command,
;                       and writes it into a location 'addr'
rkbstrt:
        call kbdchr     ; next character after address, or after a byte
        and 07fh        ; should be a blank, newline or eof
        cp 020h         ; if a blank,
        jp z,nxbyte     ; expect two hex characters to follow.
        cp 0dh          ; a newline should prompt a prompt.
        jp z,prompt     ;
        cp 04h          ; an eof ends the process.
        jp z,monitor    ; go home.
abrt:   ld a,03fh       ; else we have garbage, so print '?' and wait for blank
        call putcrt     ;
        jp rkbstrt      ;
;
;                       nxbyte looks for two hex characters. if successful,
;                       it will write the equivalent byte in the current
;                       location in 'addr'. if garbage is received, '?'s will
;                       be displayed until a 'blank', newline or eof - i.e.,
;                       the particular byte is aborted.
;
nxbyte: call kbdchr     ;
        call chkhex     ; this returns a hex value in a, or ff if not hex.
        cp 0ffh         ; if not hex,
        jp z,abrt       ; print a '?' and look for a blank, eof or newline
```

```
        ld b,a          ; tuck the hex digit away for a microsecond
        call kbdchr     ; get the next digit
        call chkhex     ; same song second verse
        cp 0ffh         ;
        jp z,abrt       ;
        ld hl,(addr)    ; that's where we want to store this byte
        rrd             ; loads the lower nibble into upper nibble of (addr)
        ld a,b          ; recall, that's the upper nibble
        rrd             ; presto! the lower nibble shifts to its proper place,
;               and the upper nibble slips in behind it. deos ex machina!
        inc hl          ; get the next address location
        ld (addr),hl    ; and store that in addr
        jp rkbstrt      ; look for blanks, etc.
;
;
writkw:                 ; Write command - tape or disk? or mistake?
        call kbdchr     ; Get the next character from keyboard
        and 07fh        ; mask parity bit
        cp 074h         ; 't' for tape
        jp z,wrtape     ;
        cp 064h         ; 'd' for disk
        jp z,wdsk       ;
        cp 06dh         ; 'm' for memory (block move)
        jp z,blkmv      ;
        ld a,03fh       ; '?' if we don't know what else to do
        call putcrt     ;
        jp monitor      ; abort if unrecognizable character sequence
;
;
;
;       Block Move routine moves from source address to destination
;       address as many bytes as you please.
;
blkmv:  call getaddr    ; next word will be the "from" address
        push hl         ; save it
        call getaddr    ; next word will be "to" address
        push hl         ;
        call getaddr    ; finally, how many bytes to transfer?
        push hl         ;
        pop bc          ; BC is the counter for the LDIR command
        pop de          ; DE is the destination pointer
        pop hl          ; and HL is the source.
        ldir            ; GO!
        jp monitor      ; done. go home.
;
;
wrtape:                 ; Write memory to tape. First find out from where
        call gtprms     ; to read, where to stop, and where to write.
        call wtape      ; Big tape writing routine. May be a dummy at first.
        jp monitor      ; Back to monitor when finished
;
;
wdsk:                   ; Write block to disk.
        ld c,1          ; 'Write' flag to common disk I/O routine
        call dskio      ;
        jp monitor      ;
;
;
rddsk:                  ; Read block from disk
        ld c,0          ; Set 'Read' flag to common disk I/O routine
        call dskio      ;
        jp monitor      ;
;
execute:                ; Jumps to address specified after 'ex' keyword
        call kbdchr     ; Get character after the 'e'
        cp 078h         ; Should be an 'x'
```

```
        jp nz,abrt      ; Don't know what else to do.
        ld bc,monitor   ; Want returns to go to monitor
        push bc         ; so load that to the stack.
        call getaddr    ; Gets the next 4 hex characters, assembles them
        jp (hl)         ; into address in HL, to which we journey now. bye!
;
;
;
uboot:                  ; check for 'bt' command; boot uNIX if found.
        call kbdchr     ;
        cp t_           ; Already got 'b'; look for 't'.
        jp z,uboot1     ; If 'bt', Boot.
        ld a,qm_        ; Else, '?' and return to monitor.
        call putcrt     ;
        jp monitor      ;
;
uboot1:                 ; Boot uNIX.
        ld bc,0f00h     ; Number of bytes to move.
        ld de,0a100h    ; Destination
        ld hl,01000h    ; EPROM source
        ldir            ; Block move
;
        ld hl,0c000h    ; Start of uNIX kernel
        ld (strtlc),hl  ;
        ld hl,040h      ; Number of sectors to read
        ld (endloc),hl  ;
        ld hl,3         ; First Inode
        ld (tnode),hl   ;
        ld a,0          ; 'Read' flag
        ld (rwflg),a    ;
        call dskio1     ;
;
        ld bc,0fh       ; Overlay jump table
        ld de,0c057h    ; uNIX location of jump table
        ld hl,0a920h    ; BIOS location of jump table
        ldir            ;
;
        jp 0a100h       ; Go To uNIX!
;
;
;
                        end monitor
;*****************************************************************************
;
timer:                  ; Goofs off for 'a' milliseconds
        push af
        push bc         ; CTC 2 is driven by CTC 0
        ld b,a          ; Tuck away the input parameter
        ld a,0c7h       ; setup CTC 2 as counter, with interrupt enabled
        out (t2),a      ; t2 = 0f6h = timer 2
        xor a           ; A = 0
        ld (timflg),a   ; zero timer flag
        ld a,b          ; recall input parameter
        out (t2),a      ; The count (1-255)
timlp:                  ; now loop till timer flag is turned on again
        ld a,(timflg)   ;
        or a            ;
        jp z,timlp      ;
        pop bc          ; Clean up and return when flag is set (by the
        pop af          ; 'timein' interrupt handler routine
        ret             ;
;
timein:                 ; Here it is: handles the CTC-2 interrupts for timer
        push af         ;
        ld a,041h       ; Disables counter interrupt and resets it
        out (t2), a     ;
```

Here's BOOT.

2nd 2732 is located at 1000h - of course, its contents are read from RAM, since RAM was turned on initially. We are just moving it to location a100h.

} THIS is the jump table referred to in SMW's 'Mounting the Unit OS". It is in my 'BIOS' package, which we just RELOCATED ABOVE

```
        ld a,1              ; Set timer flag, so timer routine will trigger
        ld (timflg),a       ;
        pop af
        ei                  ; re-enable interrupts
        reti                ;
;
;
;                           end timein
;************************************************************
;
;
ltimer:                     ; Times for 'a' x 250 milliseconds
        push bc             ;
        ld b,a              ; Uses 'timer' a times
        ld a,250            ; 250 ms timer
ltlp:   call timer          ;
        dec b               ;
        jp nz,ltlp          ;
        pop bc              ;
        ret
;
;
;                           end ltimer
;***********************************************
;
;
;
hexchr:                     ; Returns 2 ASCII characters in h and l,
        push af             ; representing the hex byte in 'a'
        push bc             ;
        ld b,a              ; save byte
        and 0fh             ; look at lower nibble
        cp 10               ; if < 10, must be 0 - 9
        jp m, digit         ;
        sub 10              ; must be > 10, so subtract 10, and add A
        add a,061h          ; 'a'
        ld l,a              ; that's the lower character
        jp thigh            ;
digit:  add a,030h          ; '0' ASCII
        ld l,a              ;
thigh:  ld a,b              ; the saved byte
        rrc a               ; rotate upper nibble to lower position
        rrc a               ;
        rrc a               ;
        rrc a               ;
        and 0fh             ; same song second verse
        cp 10               ;
        jp m, dig2          ;
        sub 10              ;
        add a,061h          ;
        ld h,a              ; upper character
        jp thru             ;
dig2:   add a,030h          ;
        ld h,a              ;
thru:   pop bc              ;
        pop af              ;
        ret                 ;
;
;
;                           end hexchr
;*****************************************
;
;
;               kbdchr returns a character when and if a key is depressed.
;
kbdchr:                     ; save environment, stash all garbage!
```

```
        push bc         ;
        push hl         ;
keyloop:                ;
        ld a,(keyflg)   ; this flag is set by keyboard interrupt routine
        or a            ;
        jp z,keyloop    ; if not set, there's nothing in the buffer
;
        ld a,(kbfptr)   ; kbfptr is the offset of the last character read.
        inc a           ; this now points to the next character to be read.
        and kbfsze      ; kbufsze = 2**n - 1 for buffer size of 2**n.
        ld (kbfptr),a   ; reload the new pointer
        ld c,a          ; going to construct the address of the next character.
        ld b,0h         ;
        ld hl,kbdbuf    ; buffer starting address
        add hl,bc       ; now hl has the address of next character. first, however
        ld a,(kbwptr)   ; check to see if write pointer = read pointer.
        cp c            ; if they are the same, this "read" will empty the buffer
        jp nz,rdout     ; so, we will clear the flag. otherwise, just return.
        xor a           ; clear accumulator
        ld (keyflg),a   ; and thus clear the keyboard flag.
;
rdout:  ld a,(hl)       ; actually reads the character from the buffer into a
        pop hl          ;
        pop bc          ; restore the fragile environment
        ret             ;
;
;
;                       End kbdchr
;*****************************************************************************
;
;               getaddr is a routine to get 4 hex characters and
;               assemble them into an address in HL and 'addr'. Aborts
;               to monitor if it doesn't understand anything.
getaddr:        ;
        push af         ;
        call kbdchr     ; get a character
        and 07fh        ;
        cp 020h         ; should be a blank.
        jp nz,qmk       ; qmk is the abort for this routine
;
        call kbdchr     ; this should be the beginning of the hex number.
        call chkhex     ; returns hex value in a, or ff if invalid.
        cp 0ffh         ; look for invalid case
        jp z,qmk        ; is the
        ld hl,addr      ; addr is the place where we will store the result.
        inc hl          ; since this is the high byte, store in next loc.
        rld             ; shifts digit into addr (4 bits).
;
        call kbdchr     ; get second character
        call chkhex     ;
        cp 0ffh         ;
        jp z,qmk        ;
        ld hl,addr      ;
        inc hl          ;
        rld             ;
;
        call kbdchr     ; 3rd digit
        call chkhex     ;
        cp 0ffh         ;
        jp z,qmk        ;
        ld hl,addr
        rld
;
        call kbdchr     ; 4th digit
        call chkhex     ;
        cp 0ffh         ;
```

```
        jp z,qmk        ;
        ld hl,addr      ;
        rld             ;
;
;
        ld hl,(addr)    ; return number in hl as well as (addr)
        pop af          ;
        ret             ; bye!
;
qmk:    ld a,03fh       ; load a '?'
        call putcrt     ; write it to crt.
        jp monitor      ; abort and return to the monitor.
;
;                       End getaddr
;*****************************************************
;
;
prompt:                 ; Write next address at left of screen
        ld a,0dh        ; 'cr' and newline
        call putcrt     ;
        ld de,(addr)    ; next address to be entered
        ld a,d          ;
        call pthxch     ; Writes hex number (one digit) on CRT
        ld a,e          ;
        call pthxch     ;
        ld a,03ah       ; ':'
        call putcrt     ;
        ld a,020h       ; 'space'
        call putcrt     ;
        jp nxbyte       ;
;                       This is part of monitor: prompt
;*************************************************************************;
;
gtprms:                 ; gets start, end locations and tnode for
        call getaddr    ; tape/disk read/write. Getaddr returns
        ld (strtlc),hl  ; next parameter in hl, as well as in (addr).
        call getaddr    ;
        ld (endloc),hl  ;
        call getaddr    ;
        ld (tnode),hl   ;
        ret             ;
;
;************************************************
;
;
ascii:                  ; Two ASCII chars in hl are combined into a
        push de         ; byte in A
        ex de,hl        ; need hl later
        ld hl,temp1     ; a nice utility storage location
        ld a,d          ; look at the high byte
        call chkhex     ;
        cp 0ffh         ; look for non-hex flag
        jp z,hexerr     ;
        rld             ; Rotate digit into temp1
        ld a,e          ; Do it again for the lower byte
        call chkhex     ;
        cp 0ffh         ;
        jp z,hexerr     ;
        rld             ;
        ld a,(temp1)    ; Return the byte in A
        jp donasc       ;
;
hexerr: ld hl,msg3      ; msg3 = 'invalid hex char '
        call pstrng     ; puts the string to CRT
        ld a,d          ; NOW PRINT THE input data
        call putcrt     ;
```

```
        ld a,e          ;
        call putcrt     ;
        xor a           ; return with 0 in A
;
donasc: pop de          ;
        ret             ;
;
;
msg3:   db 049h,06eh,076h,061h,06ch,069h,064h,020h,068h,065h
        db      078h,020h,063h,068h,061h,072h,020h,0
;
;                       End ASCII
;****************************************
;
;
chkhex:                 ; If ASCII character inA is 0-9 or a-f, returns
                        ; hex value in  A. Else returns ff.
        cp 030h         ; < '0' ?
        jp m,erhx       ;
        cp 03ah         ; < '9' + 1 ?
        jp m,numhx      ;
        cp 061h         ; < 'a' ?
        jp m,erhx       ;
        cp 067h         ; < 'f' + 1 ?  (i.e., 'g')
        jp m,alphx      ;
;
erhx:   ld a,0ffh       ; ff -> A
        ret             ;
;
numhx:  sub 030h        ; A - '0' --> A
        ret             ;
;
alphx:  sub 057h        ; (A - 'a') + 10 --> A
        ret
;
;                       End chkhex
;*******************************************
;
;
;
;
;               putcrt writes a character (found in a) to the crt
;               much like a serial terminal.
;
putcrt: push af
        push bc
        push de
        push hl
        call cursoff    ; Turn the cursor off, which replaces the character
                        ; at the cursor location and prevents interrupts.
        cp ESC          ; First look for the ESC character
        jp z,setesc     ; If found, set escape mode
        ld c,a          ; save the character in C for a while
        ld a,(crtmod)   ; Find state of CRT
        and 7           ; look at all but INSERT mode bit
        cp ESCMOD       ; escape mode?
        jp z,escape     ;
        cp ROWMOD       ; Row mode?
        jp z,row        ;
        cp COLMOD       ; column mode?
        jp z,column     ;
        ld a,(crtmod)   ; reload crt mode to look at INSERT bit
        cp INSMOD       ;
        jp z,insert     ;  insert mode.
        or a            ;
```

```
        call nz,audcrt1 ; Any other modes are illegal
        ld a,c          ; restore character to A
        cp 020h         ; check for special chars (< 20h)
        jp m,special    ; handle those separately
        cp 080h         ; currently not allowing bit 7 = 1
        jp p,special    ;
        jp z,special    ;
;
        ld hl,(curse)   ; pointer to cursor
        ld (hl),a       ; that's where we will write.
;                       now, fiddle with the cursor.
        ld a,l          ; lower byte of cursor address
        cp 04fh         ; that's eol for even rows
        jp z,eoln       ; return and scroll
        cp 0cfh         ; eol for odd lines
        jp z,eoln       ;
        inc a           ; if not eol, just increment cursor address
        ld l,a          ; don't worry about carry - never occurs in line.
        ld (curse),hl   ; update the cursor position
nullo:  call curson     ; Now turn the cursor back on before departing
        pop hl
        pop de
        pop bc
        pop af
        ret             ; bye!
;
eoln:   ld de,031h      ; just wrote last char on line. move cursor to
        add hl,de       ; beginning of next line. (by adding 31h)
        ld (curse),hl   ; update the cursor position
        ld de,botln     ; if cursor >= xdxx, we must scroll
        ld a,d          ; just look at the upper byte
        cp h            ;
        jp nz,nullo     ; otherwise, we'll just return
        ld hl,botlft    ; scroll needed - first set cursor to bottom left
        ld (curse),hl   ;
        call scroll     ; scroll moves everything up one, but leaves cursor.
        jp nullo        ;
;
;
special:                ; handles special characters, like tabs, spaces, etc.
        cp 080h
        jp p,nullo      ; initially, if bit7 = 1 we will just ignore it.
        jp z,nullo      ;
;
        cp 08h          ; backspace?
        jp z,backsp     ;
;
        cp 09h          ; tab?
        jp z,tab        ;
;
        cp 0ah          ; linefeed?
        jp z,lf         ;
;
        cp 0ch          ; formfeed (clear screen)?
        jp z,clr        ;
;
        cp 0dh          ; carraige return?
        jp z,cr         ;
        jp nullo        ; don't know what it is, so just ignore it.
;
;
backsp: ld hl,(curse)   ; backspace moves cursor back, does not erase.
        ld a,l          ; stops backspacing at beginning of line.
        cp 0h           ;
        jp z,nullo      ;
        cp 040h         ;
```

```
        jp z,nullo      ;
;
        dec a           ; not at beginning of line, so decrement.
        ld l,a          ;
        ld (curse),hl   ;
        jp nullo        ;
;
;
tab:    ld a,020h       ; put out spaces until cursor is left at even '8' mult.
        call putcrt     ;
        ld hl,(curse)   ;
        ld a,l
        and 07h         ; look at last 3 bits
        jp z,nullo      ; done.
        jp tab          ; do it again
;
;
lf:     ld hl,(curse)   ; leaves cursor in same relative position.
        ld de,080h      ; adding 80h to cursor position puts it strt. down
        add hl,de       ;
        ld a,h          ; however, if cursor >= 0300h, must scroll
        cp hibot        ; compare bottom of screen (high byte)
        jp nz,nxtline   ; If not below screen, reload cursor
        call scroll     ; scroll won't change curse, so we just leave it alone
        jp nullo        ; gracefully return.
nxtline:
        ld (curse),hl   ; reload the cursor with the new value
        jp nullo        ;
;
;
clr:    ld a,26         ; going to do 26 scrolls to clear the screen
movup:  call scroll     ;
        dec a           ;
        jp nz,movup     ;
        ld hl,uplft     ; going to put cursor at top left
        ld (curse),hl   ;
        jp nullo        ; graceful exit.
;
;
cr:     ld hl,(curse)   ; return to start of line and do line feed
        ld a,l          ; look at the lower byte
        cp 07fh         ; if greater than 7fh, we were on an odd line
        jp p,oddln      ;
        ld l,0h         ; even line: return to 0.(l)
        ld (curse),hl   ; moves the cursor back to start of current line
        jp lf           ; now do a line feed. note: routine returns 'cr'
oddln:  ld l,080h       ; odd line: return cursor to xx80h.
        ld (curse),hl   ;
        jp lf           ;
;
;
;
;
;
escape:                 ; previous character was and ESC
        ld a,(crtmod)   ;
        and INSMOD      ; clear all but INSERT mode bit
        ld (crtmod),a   ;
        ld a,c          ; look at the new character
        cp E_           ;
        jp z,clr        ; Home/Clear routine
        cp K_           ;
        jp z,clrlne     ; Clear to end of line
        cp L_           ;
        jp z, insln     ; insert new line at cursor row
        cp M_           ;
```

```
        jp z,delne      ; delete a line
        cp amp_         ;
        jp z,insmde     ; enter insert mode
        cp O_           ; (capital O)
        jp z,exmod      ; exit insert mode.
        cp N_           ;
        jp z,delchr     ; Delete character at cursor
        cp Y_
        jp z, mvrow     ; cursor row set
        jp nullo        ; ignore anything we don't understand
;
;
;
clrlne:                 ; Clears from cursor to end of line
        ld hl,(curse)   ; Get cursor position
cln1:                   ;
        ld a,1          ;
        cp 04fh         ; EOL for even rows
        jp z,nullo      ; done
        cp 0cfh         ; EOL for odd rows
        jp z,nullo      ; Also done
        ld a,sp_        ; Not done, so write a blank
        ld (hl),a       ; at (hl)
        inc l           ; Next...
        jp cln1         ; do it again
;
;
;
inslne:                 ; Inserts blank line at current cursor
                        ; line, moving lines below it down.
        call crsbol     ; cursor to begining of line, --> HL
ins0:                   ;
        ld de,botlft    ;
        scf             ; clear the carry for 16 bit subtract
        ccf             ;
        sbc hl,de       ; Is cursor at bottom row?
        jp z,clrlne     ; If so, just clear the line
        ld hl,botlft-080h       ; Next row up
ins1:                   ;
        ld bc,80        ; 80 columns
        ldir            ; moves 'em down
        scf             ;
        ccf             ; clear carry flag
        ld bc,0d0h      ; enough to get to start of next line up
        ex de,hl        ; first do DE
        sbc hl,bc       ; subtract
        ex de,hl        ;
        sbc hl,bc       ;
        ld bc,(curse)   ;
        ld a,e          ; Going to see if the activity is at (curse)
        cp c            ; yet.
        jp nz,ins1      ; If not, do some more
        ld a,d          ;
        cp b            ;
        jp nz,ins1      ;
        jp clrlne       ; blank the row if at cursor
;
;
;
delne:                  ; Deletes line of cursor; moves lines below
                        ; one up; blank line at bottom; cursor
                        ; at beginning of deleted line.
        call crsbol     ; cursor to beginning of current line
        ld d,h          ; HL now has starting cursor position
        ld e,l          ;
```

```
        ld bc,080h      ;
        add hl,bc       ; Next line below
        ld bc,80        ; 80 columns
        call repeat     ; part of scroll: routine.
        jp nullo        ;
;
;
;
crsbol:                 ; Puts cursor at start of current line,
                        ; returns position in HL
        push af         ;
        ld hl,(curse)   ;
        ld a,l          ;
        cp 07fh         ;
        jp p,crsb1      ; if > 7f, oddline
        ld l,0          ; BOL for even line
        ld (curse),hl   ; reload it
        pop af          ;
        ret             ;
crsb1:                  ;
        ld l,080h       ; BOL for odd line = xx80
        ld (curse),hl   ;
        pop af          ;
        ret             ;
;
;
;
insmde:                 ; Enter the insert mode
        ld a,INSMOD     ;
        ld (crtmod),a   ;
        jp nullo        ;
;
;
mvrow:                  ; enter row address mode
        ld a,(crtmod)   ;
        or ROWMOD       ; put rowmode bits in without changing insert mode
        ld (crtmod),a   ;
        jp nullo        ;
;
;
;
setesc:                 ; An ESC character has been received; set esc mode
        ld a,(crtmod)   ;
        or ESCMOD       ;
        ld (crtmod),a   ;
        jp nullo                ;
;
;
exmod:                  ; Exit insert mode - clear everything
        xor a           ;
        ld (crtmod),a   ;
        jp nullo        ;
;
;
;
delchr:                 ; Delete character at cursor position.
        ld hl,(curse)   ; Move text right of cursor left one slot.
delc1:                  ;
        ld a,l          ;
        cp 04fh         ;
        jp z,delc2      ; end of line. even row
        cp 0cfh         ;
        jp z,delc2      ; end of line, odd row
        inc hl          ;
```

```
        ld a,(hl)       ; get char. to right
        dec hl          ;
        ld (hl),a       ; put it one left
        inc hl          ;
        jp delc1        ;
delc2:                  ;
        ld a,sp_        ; Blank last character in row
        ld (hl),a       ;
        jp nullo        ;
;
;
;
row:                    ; load row register
        ld a,c          ; restore the character to A
        cp 25           ; Only 25 rows
        jp m,row1       ; OK if less than 25
        ld a,24         ; else set to max = 24
row1:                   ;
        ld (rowno),a    ; save it for next time
        ld a,(crtmod)   ;
        and INSMOD      ; clear all but Insert Mode bit
        or COLMOD       ; concatenate Column mode bits
        ld (crtmod),a   ;
        jp nullo        ;
;
;
;
;
;
column:                 ; expect column address
        ld a,(crtmod)   ; Clear all but the Insert mode
        and INSMOD      ;
        ld (crtmod),a   ;
        ld a,c          ;
        cp 80           ; only 80 columns
        jp m,col1       ; if less, OK
        ld c,79         ; else change C to 79
col1:                   ;
        ld de,080h      ; Distance between rows
        ld hl,uplft     ; upper left of screen
        ld a,(rowno)    ; Row number from previous read
        or a            ;
        jp z,col3       ; skip multiply if rowno = 0
col2:                   ;
        add hl,de       ; crude multiplication
        dec a           ;
        jp nz,col2      ; add A times!
;
col3:                   ;
        ld a,c          ; column offset
        add a,l         ; add it to the hl (don't worry about carry)
        ld l,a          ;
        ld (curse),hl   ;
        jp nullo        ;
;
;
;
;
insert:                 ; Inserts a character at cursor position
        ld de,(curse)   ; Won't advance beyond EOL
        ld h,d          ;
        ld a,e          ;
        cp 80           ;
        jp p,insrt1     ; > 80 --> odd line
        ld l,04fh       ; EOL for even line
```

```
        jp insrt2       ;
insrt1:                 ;
        ld l,0cfh       ; EOL for odd line
insrt2:                 ;
        ld a,e          ;
        cp l            ; Are we back to cursor positiomn yet?
        jp z,insrt3     ;
        dec l           ;
        ld a,(hl)       ; get character to left
        inc l           ;
        ld (hl),a       ; move it one right
        dec l           ;
        jp insrt2       ;
insrt3:                 ;
        ld (hl),c       ; load the incoming character there
        ld a,l          ; Now make sure we are not at the EOL
        cp 04fh         ;
        jp z,insrt4     ;
        cp 0cfh         ;
        jp z,insrt4     ;
        inc hl          ; If not, increment cursor
insrt4:                 ;
        ld (curse),hl   ; load cursor
        jp nullo        ;
;
;
;
;                       End of putcrt
;*****************************************************
;
;
;
audcrt1:                ; "crtmod" had illegal value
        push af         ;
        push hl         ;
        ld hl,crtm1     ; load message address
        call pstrng     ; prints the message
        ld a,(crtmod)   ;
        ld l,a          ; temporarily store the mode
        xor a           ;
        ld (crtmod),a   ; clear the CRT mode
        ld a,l          ; recall the illegal mode
        call putcrt     ; print it
        pop hl          ;
        pop af          ;
        ret             ;
;
crtm1:  db      I_,l_,l_,e_,g_,a_,l_,sp_,C_,R_,T_,sp_,m_,o_,d_,e_,nl_
        db      0
;
;
;
;*********************************************************
;
curses:                 ; cursor blinker. handles 250 ms interrupt.
        push af         ;
        push bc         ;
        push hl         ;
        ld a,(cstat)    ; cstat-0 > cursor 'off', character at cursor pos.
;                         cstat = 1 > 'on'; character saved in cchar
        or a            ;
        jp z,turnon     ; if off, turn on
turnoff:                ;
        ld a,(cchar)    ; if on, get character from storage
        ld hl,(curse)   ; find out where the cursor is
```

```
        ld (hl),a       ; and write the character there
        xor a           ; a = 0
        ld (cstat),a    ; clear cursor status.
        jp home         ; return
;
turnon:
        ld hl,(curse)   ; find the cursor
        ld a,(hl)       ; get the character there
        ld bc,cchar     ; character storage address
        ld (bc),a       ; store the character there
        ld a,05fh       ; an underscore (the cursor)
        ld (hl),a       ; put it on the crt
        ld a,01h        ; a = 1
        ld (cstat),a    ; set cursor status = 'on' (1)
;
home:   pop hl          ;
        pop bc          ;
        pop af          ;
        ei              ; Turn those interrupts back on!
        reti            ;
;
;                       End curses
;***************************************
;
cursoff:                ; turns cursor off by stopping counter, making sure
        push af         ; that screen displays character in the cursor
        push hl         ; position.
        ld a,043h       ; ctc command to stop counting
        out (0f7h),a    ; f7 is ctc port 3 (cursor counter)
        ld a, (cstat)   ; find out what state the cursor was in
        or a            ;
        jp z,donoff     ; cursor already off, so just quit
        ld a,(cchar)    ; cursor was on, so get character from storage
        ld hl,(curse)   ; find the cursor
        ld (hl),a       ; put 'er there!
        xor a           ; now clear the cursor status bit
        ld (cstat),a    ;
;
donoff: pop hl          ;
        pop af          ;
        ret             ; bye!
;
;                       End cursoff
;***************************************
;
curson: push af         ; turns the cursor on.
        ld a,(cstat)    ; was it on already?
        or a            ;
        jp nz,donon     ; if so, quit.
        ld a,0c7h       ; if not, set ctc to go
        out (0f7h),a    ;
        ld a,tau        ; tau = time constant in ms (0fah = 250 ms)
        out (0f7h),a    ;
;
donon:  pop af
        ei              ; Just to make sure, enable interrupts
        ret
;
;                       End curson
;***************************************
;
scroll: push af         ; scroll moves everything up one notch on crt,
        push bc         ; without bothering the cursor position.
        push de         ; in fact, it turns the cursor off, so user must
        push hl         ; be sure to turn it back on sometime.
        call cursoff    ;
```

```
        ld bc,050h      ; 80 columns per row
        ld de,uplft     ; upper left corner of visible screen area
        ld hl,scdlne    ; next position down
        call repeat     ; moves everything below DE up one line
        pop hl          ;
        pop de          ;
        pop bc          ;
        pop af          ;
        ret             ;
;
;
;*********************************************
;
;
repeat: ldir            ; (de) < (hl), hl++, de++, bc-- till bc=0. nifty!
        ld bc,030h      ; enough to get to start of next line.
        add hl,bc       ;
        push hl         ; tuck it away
        ex de,hl        ; now lets do it to de
        add hl,bc       ; did it!
        ex de,hl        ; back to de
        pop hl          ; retreived.
        ld bc, 050h     ; 80 columns, as before.
        ld a,h          ; going to see if we are done yet
        cp hibot        ; 3dxx is beyond the last row
        jp nz,repeat    ; if not there, do some more.
        ld hl,botlft    ; left of bottom line
        ld de,botlf1    ; next position
        ld (hl),020h    ; put a blank in the left position
        ldir            ; propagate it across the row.
        ret             ;
;                       End repeat
;*************************************************
;
;
;
keyinr:                 ; Handles interrupts by the keyboard
        push af         ;
        push bc         ;
        push hl         ;
        in a,(keybrd)   ; Reads keyboard port
        cp 04           ; if EOF,
        jp z,keysoft    ; soft restart (monitor)
        cp 018h         ; if CAN,
        jp z,keyhard    ; cold restart (loc 00)
        call putcrt     ; Try to write it to the CRT
        ld c,a          ; Tuck it away
        ld a,(kbwptr)   ; Keyboard 'write' pointer offset
        inc a           ; next position is where to write
        and kbfsze      ; modulo kbfsze (size of keyboard buffer)
        ld(kbwptr),a    ;
        ld hl,kbdbuf    ; start position of buffer (3d00)
        add a,l         ; add offset
        ld l,a          ;
        ld (hl),c       ; put character in buffer
        ld a,1          ; keyboard ready flag - there's something in
        ld (keyflg),a   ; the buffer.
        pop hl
        pop bc
        pop af
        ei              ; enable the interrupts
        reti
keysoft:
        ld hl,monitor   ;
```

```
        push hl         ;
        reti            ;
keyhard:
        ld hl,0         ;
        push hl         ;
        reti            ;
;
;
;                       End keyinr
;***********************************************

;
;
pstrng:                 ; Put ASCII string found in location HL
        push af         ; to CRT until '0' byte encountered
;
strglp: ld a,(hl)       ; look at each character
        cp 0            ; The null character
        jp z,strgrt     ; quit when zero encountered
        call putcrt     ; Else write it to CRT
        inc hl          ; next one
        jp strglp       ;
;
strgrt: pop af          ;
        ret             ;
;
;                       End pstrng
;*********************************************
;
;
pthxch:                 ; Puts hex number to CRT as two ASCII characters
        push hl         ;
        call hexchr     ; returns two ASCII chars in H,L
        ld a,h          ; High one
        call putcrt     ;
        ld a,l          ;
        call putcrt     ;
        pop hl          ;
        ret             ;
;
;                       End pthxch
;*****************************************
;
;
;
;
ldsv:                   ; Preparation for disk read or write
        ex de,hl        ; Save address in DE (stolen from SMW)
        pop hl          ; That's the subroutine return address
        ex (sp),hl      ; pops Tnode from stack and pushes return address
        push de         ; Also save the from/to address on stack
        ld de, 15       ; Number of sectors per track
        ex de,hl        ; our divide routine divides de/hl
        call ccdiv      ; From Z-80 library
        inc e           ; 1 + remainder = sector
        ld d,l          ; now track = d
        ld c,h          ; c = disk number (use 0 as default)
        pop hl,         ; now HL contains the address
        ld a,(dskid)    ; The current disk id, possibly loaded by hand
        cp c            ;
        jp nz,ermsg4    ; If not right disk, abort w message
        ld a,d          ; The desired track
        out (dskdta),a  ; Load to disk data register
        ld a,SEEK       ; SEEK = 01fh, the seek command
        out (dskcmd),a  ; send it to controller
        call waitdk     ; Waits for disk controller to interrupt
```

```
        in a,(dskcmd)   ; get status
        and 018h        ; look at CRC or seek errors
        jp nz,ermsg5    ;
        ret             ;
;
;
ermsg5: ld hl,msg5      ; "Seek error "
        call pstrng     ;
erdata: ld a,d          ; track
        call pthxch     ;
        ld a,e          ; sector
        call pthxch     ;
        jp monitor      ;
;
msg5: db 053h, 065h, 065h, 06bh, 020h, 065h, 072h, 072h, 06fh, 020h, 0
;
;
;                       End ldsv
;*****************************************
save:                   ; Writes one block to disk
                        ; given address in HL, and Tnode second on
                        ; stack.
        pop bc          ; Return address
        pop de          ; Tnode
        push bc         ; Save the return address
        push de         ; Give next routine Tnode in stack
        call ldsv       ; Common disk IO program unravels Tnode and gets
                        ; to right track on right disk (or aborts)
        call cursoff    ; Don't want interrupts during write.
        call keyoff     ; Same reason.
        ld a,0b7h       ; enable PIO int; 'or' logic; active high; mask follows
        out (mscntl),a  ;
        ld a,0feh       ; Mask all but D0.
        out (mscntl),a  ;
        ld a,014h       ; Vector --> dskout interrupt handler.
        out (mscntl),a  ;
        in a,(mscio)    ; clears PIO ready signal.
        ld a,e          ; E should contain sector number
        out (dsksct),a  ; put that in disk sector register
        ld b, 0ffh      ; Prevents B from decrementing to zero in 'dskin'
        ld c,0d3h       ; set C to controller data port
        ld a,WRSCTR     ; write sector command (0a8h)
        out (dskcmd),a  ; to the command register
        call waitdk     ; Now just sit back and wait for disk to finish
        call curson     ; Let 'er blink again
        call keyon      ; and listen to the keyboard.
        in a,(dskcmd)   ; get controller status
        and 07ch        ; mask the write-pertinent bits
        jp nz,ermsg7    ; Print write-error message if any bad bits
        ret             ; otherwise, return
;
ermsg7: ld hl,msg7      ; msg7 = "disk write error"
        call pstrng     ;
        ld a,d          ; should contain Tnode
        call pthxch     ; write it to CRT
        ld a,e          ; lower byte
        call pthxch     ;
        jp monitor
;
;
msg7: db 044h, 069h, 073h, 06bh, 020h, 077h,072h, 069h, 074h, 065h
      db 020h, 065h, 072h, 072h, 06fh, 072h, 020h, 0
;
;
;                       End save
```

```
;*************************************************************
;
;
keyon:                  ; Turns on the keyboard
        push af         ;
        ld a,enable     ;
        out (keyprt),a  ;
        pop af          ;
        ret             ;
;
keyoff:                 ; Turns off keyboard
        push af         ;
        ld a,disable    ;
        out (keyprt),a  ;
        pop af          ;
        ret             ;
;
;
;*************************************************************
;
;
dskout:                 ; Disk output interrupt handler.
                        ; NOTE: this has to be FAST!
                        ; INPUTS: HL contains the address to be written
                        ; from. C contains the disk controller data port.
                        ; B should be written to a high value to prevent
                        ; it from decrementing to zero, which would
                        ; set the "z" flag and screw up the dkwait
                        ; routine.
        outi            ; (HL) > (C); inc HL; dec B
        in a,(mscntl)   ; clears the PIO interrupt.
        ei              ;
        reti            ;
;
;                       end dskin
;*************************************************************
                        ;
load:                   ; Reads a sector to memory specified in HL
                        ; from disk at Tnode, contained in stack
        pop bc          ;
        pop de          ; First exhange the first two stack positions
        push bc         ;
        push de         ;
        call ldsv       ; Finds the right track and disk, and unravels Tnode
        call cursoff    ; We don't want interrupts during disk read.
        call keyoff     ; Don't want keyboard interrupts, either.
        ld c,0d3h       ; Setup C for the "diskin" interrupt handler.
        ld a,0b7h       ; enable int, 'or' logic, active high, mask follows
        out (mscntl),a  ;
        ld a,0feh       ; Mask all but D0.
        out (mscntl),a  ;
        ld a,012h       ; vector to "diskin"
        out (mscntl),a  ;
        in a,(mscio)    ; Do a read to set ready flag.
        ld a,e          ; E should contain the sector number
        out (dsksct),a  ; load it in controller sector register
        ld b,0ffh       ; B will decrement and  affect flags at 0.
        ld a,RDSCTR     ; command to read a sector (= 084h)
        out (dskcmd),a  ; to command port
        call waitdk     ; wait for execution
        call curson     ; restart cursor - interrupts OK now.
        call keyon      ;
        in a,(dskcmd)   ; get status
        and 01ch        ; Mask CRC and lost data bits
        call nz,erprnt  ; print disk read-error message if bad bits
        jp nz,ermsg6    ;
```

```
        ret             ; else done - return
;
ermsg6: ld hl,msg6      ; "disk read error "
        call pstrng     ;
        ld a,d          ; Track
        call pthxch     ;
        ld a,e          ; sector
        call pthxch     ;
        jp monitor      ;
;
msg6: db d_,i_,s_,k_,sp_,r_,e_,a_,d_,sp_,e_,r_,r_,o_,r_,nl_
        db t_,r_,a_,c_,k_,sp_,s_,e_,c_,t_,o_,r_,sp_,0
;
;
;                       end load
;*****************************************************
;
dskin:                  ; Interrupt handler for disk reads.
                        ;
                        ; NOTE: this routine must go FAST!
                        ; INPUTS: HL contains the start address to be
                        ; loaded to. It will be incremented each call.
                        ; C contains the input port address.
                        ; B will be decremented each time, so
                        ; Flag register will be affected when
                        ; B becomes 0. This may interact with calling
                        ; program. Set B to 'FF' before starting to
                        ; minimize this.
        ini             ; input (C) and inc HL. (16 cycles)
        nop             ; (4 cycles) This is needed temporarily to
                        ; prevent bad memory read of 'ff'.
        ei              ; (4 cycles)
        reti            ; (14 cycles) resets PIO without reading it.
;
;                       end diskin
;*****************************************************
;
;
;
                          ENTRY: dskio1 for uboot operation,else dskio
dskio:  ld a,c          ; INPUT: C contains read/write flag (0=read).
        ld (rwflg),a    ; Common routine to read/write 'endloc' blocks
        call gtprms     ; from/to disk to/from memory beginning at
dskio1: ld hl,(endloc)  ; 'strtlc'. The disk sectors are sequential,
        ld a,l          ; beginning at remainder of tnode/15 +1
        or a            ; on track tnode/15 low byte.
        jp nz,wdsk1     ; If endloc = 0 or 1, a single block is written
        ld l,1          ;
        ld (endloc),hl  ; just set endloc = 1 if it was zero on input
wdsk1:  ld hl,(tnode)   ;
        push hl         ; 'save' and 'load' expect tnode in stack
        ld hl,(strtlc)  ; and starting address in HL.
        ld a,(rwflg)    ; C contains a write/read flag ( 0 = read)
        or a
        jp z,rd
        call save       ; Writes a block to disk
        jp mop          ;
rd:     call load       ; Reads a block from disk
mop:    ld hl,(endloc)  ; mopup: see if we are through
        dec l           ; reduce number of blocks left to go by one
        ret z           ; go home if done
        ld (endloc),hl  ; resave endloc if not done.
        ld de,0100h     ; add 256 to the start location
        ld hl,(strtlc)
        add hl,de
        ld (strtlc),hl
```

```
        ld hl,tnode     ; prepare to increment tnode (for next
;                       sequential block)
        inc (hl)
        jp wdsk1        ; then do it again
;
;                       End dskio
;*****************************************************
;
waitdk:                 ; waits till disk is through with whatever.
        push af         ;
        ld a,7          ; setup 49 microsecond wait, so controller
                        ; status will be valid after command.
waitdk1:                ;
        dec a           ; This loop kills 7 microseconds per pass
        jp nz,waitdk1   ;
waitdk2:                ;
        ld b,0ffh       ; B is decremented (but not tested) in disk
                        ; interrupt routines (diskin, siskout). We
                        ; write B to ff to prevent a 'z' condition
                        ; in the flag register in case the interrupt
                        ; occurs during the "and" operation. We may
                        ; therefore miss the resetting of the 'busy'
                        ; status bit for one loop, but no matter.
                        ;
        in a,(dskcmd)   ; now start looking at controller status register
        and 1           ; LSB is the busy bit
        jp nz,waitdk2   ; loop if still busy
        pop af          ;
        ret             ;
;
;                       End waitdk
;*****************************************
;
ccdiv:                   ; Divides DE by HL, returns quotient in HL
        ld b,h          ; with remainder in DE. (signed divide)
        ld c,l          ; from "runtime Library for Small C Compiler
        ld a,d          ;by Ron Cain
        xor b
        push af
        ld a,d
        or a
        call m,ccdeneg
        ld a,b
        or a
        call m,ccbcneg
        ld a,16
        push af
        ex de,hl
        ld de,0
ccdiv1: add hl,hl
        call ccrdel
        jp z,ccdiv2
        call ccmpbcde
        jp m,ccdiv2
        ld a,l
        or 1
        ld l,a
        ld a,e
        sub c
        ld e,a
        ld a,d
        sbc a,b
        ld d,a
ccdiv2: pop af
        dec a
        jp z,ccdiv3
```

```
        push af
        jp ccdiv1
;
ccdiv3: pop af
        ret p
        call ccdeneg
        ex de,hl
        call ccdeneg
        ex de,hl
        ret
;
ccdeneg: ld a,d          ; negates the integer in DE
        cpl
        ld d,a
        ld a,e
        cpl
        ld e,a
        inc de
        ret
;
ccbcneg: ld a,b          ; negates the integer in BC
        cpl
        ld b,a
        ld a,c
        cpl
        ld c,a
        inc bc
        ret
;
ccrdel: ld a,e           ; Rotate DE left one bit
        rla
        ld e,a
        ld a,d
        rla
        ld d,a
        or e
        ret
;
ccmpbcde: ld a,e         ; compare bc to de
        sub c
        ld a,d
        sbc a,b
        ret
;
;
;
wtape:  ret      ; dummy tape write program
rdtape: ret      ; Dummy tape read program
;
;
logo:   db       04ch, 041h, 054h, 027h, 073h, 020h
        db       046h, 06fh, 06ch, 06ch, 079h, 0h
;
;
        org 0900h        ; origin of vector table for interrupts
vectab: dw keyinr        ; 00 > keyboard interrupt
        dw vcterr        ; 02 > tape output - not implemented yet
        dw vcterr        ; 04 DMA controller - not supposed to interrupt
        dw vcterr        ; 06 > tape input - not implemented yet.
        dw vcterr        ; 08 > CTC channel 0 - shouldn't interrupt.
        dw vcterr        ; 0a > CTC channel 1 - not defined yet.
        dw timein        ; 0c > timer channel.
        dw curses        ; 0e > cursor interrupt.
        dw vcterr        ; 10 > PIO interrupt - formerly DISK controller.
        dw dskin         ; 12 > PIO for disk input operations.
        dw dskout        ; 14 > Same PIO for disk output operations
```

```
;
;
vcterr:                 ; routine to handle strange vectors from interrupts.
        push hl         ;
        ld hl,msg8      ; "\nunknown interrupt vector\n"
        call pstrng     ;
        pop hl          ;
        ei              ; enable interrupts
        reti            ;
;
msg8:   db nl_,u_,n_,k_,n_,o_,w_,n_,sp_,i_,n_,t_,e_,r_,r_,u_,p_,t_,sp_
        db v_,e_,c_,t_,o_,r_,nl_,0
;
;                       end vectab
;*****************************************************
;
;
;
;               ERROR MESSAGES
;
ermsg4: ld hl,msg4      ; 'Wanted disk/Found disk: '
        call pstrng     ;
        call pthxch     ; desired disk was in A
        ld a,c          ; Loaded disk in C
        call pthxch     ;
        jp monitor      ;
msg4:   db 057h, 061h, 06eh, 074h, 065h, 064h, 020h, 064h, 069h, 073h, 06bh
        db 02fh, 046h, 06fh, 075h, 06eh, 020h, 064h, 069h, 073h, 06bh
        db 03ah, 020h, 0
;       format: A disk formatting program for 8"
;       single density single side disk.
;
;*****************************************************************
;
format:                 ;
        call restor     ; sets disk to track 0
        ld d,0          ; D will contain the track No.
nxtrk:  call trkfmt     ; generates track format info in memory
                        ; beginning at FMTBLK
        call cursoff    ; eliminate cursor interrupts while writing.
        call keyoff     ; and keyboard interrupts, too.
        ld a,0b7h       ; enable PIO int; 'or'; act. high; mask follows.
        out (mscntl),a  ;
        ld a,0feh       ;
        out (mscntl),a  ; Disable all but D0.
        ld a,014h       ; vector to "dskout"
        out (mscntl),a  ;
        in a,(mscio)    ; one read to clear ready flag
        ld c,0d3h       ; set C to controller data port
        ld hl,FMTBLK    ; start of data block for Format routine
        ld a,0f4h       ; f4 = write track (format)
        out (dskcmd),a  ;
        call waitdk     ; waits for controller to be done.
        call curson     ;
        call keyon      ; OK to get interrupts now
        in a,(dskcmd)   ; get status
        and 044h        ; mask lost data or write protect
        call nz,erprnt  ; if error, print registers
        inc d           ; next track
        ld a,77         ; last track = 76
        cp d            ;
        ret z           ; done
        ld a,05bh       ; Step in, update register, no verify,  load
        out (dskcmd),a  ;
        call waitdk     ;
        in a,(dskcmd)   ; get status
```

```
        and 010h        ; look for "seek error" bit
        call nz, erprnt ; print registers if error
        jp nxtrk        ; do another track
;
;*****************************************
;
;
;       trkfmt formats 1 track of disk according to IBM 3740 format
;       with 256 bytes/sector.
;       INPUT: register d contains track No.
;
trkfmt:
        ld hl,FMTBLK    ; Beginning of block storage to keep track info
        ld b,40         ; 40 (decimal) bytes to be loaded
        ld a,0ffh       ; A = what to load (ff)
        call bload      ; writes 'B' bytes of (A), incrementing hl
        ld b,6,         ;
        ld a,0          ;
        call bload      ; 6 '0's
        ld (hl),0fch    ; fch = index mark
        inc hl          ; point to next location
        ld b,26         ;
        ld a,0ffh       ;
        call bload      ; 26 'ff's
        ld c,15         ; want to write 15 sectors/track
        call sect       ; writes (C) sectors
        ld b,0ffh       ;
        ld a,0ffh       ;
        call bload      ; write a bunch of ff's till timeout
        ret
;
;       end of trkfmt
;*****************************************
;
;
;       sect writes (C) sectors worth of info into memory
;       INPUT: C is no. of sectors to write (destroyed)
;              D is track No. (kept)
;
sect:
        ld b,6          ;
        ld a,0          ;
        call bload      ; bload writes (B) bytes of (A), incs hl
        ld (hl),0feh    ; ID address mark
        inc hl          ;
        ld (hl),d       ; track no.
        inc hl          ;
        ld (hl),0       ; side no. (always 0)
        inc hl          ;
        call secno      ; returns a sector no. in A, given C and D
        ld (hl),a       ; load sector no.
        inc hl          ;
        ld (hl),1       ; sector length (1 -> 256 bytes)
        inc hl          ;
        ld (hl),0f7h    ; f7 writes 2 CRC's
        inc hl          ;
        ld b,11         ;
        ld a,0ffh       ;
        call bload      ; 11 ff's
        ld b,6          ;
        ld a,0          ;
        call bload      ; 6 0's
        ld (hl),0fbh    ; data address mark
        inc hl          ;
        ld b,0          ; setup for 256 bytes of e5
        ld a,0e5h       ;
```

```
        call bload      ; actual data field loaded w/ e5
        ld (hl),0f7h    ; 2 CRC's
        inc hl          ;
        ld b,27         ;
        ld a,0ffh       ;
        call bload      ; 27 ff's
        dec c           ; next sector
        jp nz,sect      ; do it again
        ret             ; else done, return.
;
;                       end of sect
;*********************************************************
;
;
;
;       secno returns a sector No. in A, given a sequence no. in C
;       and a track no. in D.
;       INPUT: reverse sequence No. in C (kept)
;              track No. in D (kept)
;
secno:
        push hl         ;
        ld a,d          ; track No.
        and 1           ; look at lowest bit
        jp z,even       ; odd or even?
        ld b,0          ; if odd, look at oddlist
        ld hl,oddlst    ; sequence for odd tracks
        add hl,bc       ; offset by sequence No.
        ld a,(hl)       ; get that value
        pop hl          ; restore
        ret             ; done
even:
        ld b,0          ; even track No.
        ld hl,evnlst    ; SO USE even list
        add hl,bc       ; add offset of seq. No.
        ld a,(hl)       ; get it.
        pop hl          ;
        ret             ;
;
oddlst: db      0ffh,14,13,12,11,10,9,8,7,6,5,4,3,2,1,15
evnlst: db      0ffh,14,13,12,11,10,9,8,7,6,5,4,3,2,1,15
;
;
;       end of secno
;**********************************
;
;
;       bload loads (B) locations with(A) in memory beginning
;       with (hl), incrementing hl as it goes. b!=0
bload:
        ld (hl),a       ;
        inc hl          ;
        dec b           ;
        jr nz,bload     ;
        ret             ;
;
;       end of bload
;**********************************
;
;
restor:         ; sets disk to track 0
        push af         ;
        ld a,0bh        ; restore, slowest stepping speed, loads head
        out (dskcmd),a  ; write to command register
```

```
        call waitdk     ; wait for controller to interrupt
        in a,(dskcmd)   ;
        and 010h        ; look for "seek error" bit
        call nz,erprnt  ; print error if found
        ld a,0d0h       ; Controller reset (force interrupt)
        out (dskcmd),a  ;
        pop af          ;
        ret             ;
;
;
;**********************************
;
;
erprnt:                 ; prints registers and return address
        push af         ; preserve a register
        call pthxch     ; prints contents of A register
        ld a,h          ;
        call pthxch     ;
        ld a,l          ;  print H and L registers
        call pthxch     ;
        ld a,b          ;
        call pthxch     ; print B register
        ld a,c          ;
        call pthxch     ; print C register
        ld a, d         ;
        call pthxch     ; print D register
        ld a,e          ;
        call pthxch     ; print E register
        inc sp          ;
        inc sp          ; look at return address
        ex (sp),hl      ; put it in hl and save hl in stack
        ld a,h          ;
        call pthxch     ; print high byte of return address
        ld a,l          ;
        call pthxch     ; and low byte
        ex (sp),hl      ; restore the return and hl
        dec sp          ;
        dec sp          ; restore the sTACK POINTER
        pop af          ;
        ret             ;
;*****************************************************
;
;       Dskdly delays for 7 x YY microseconds at 2 mhz,
;       or 3.5 x YY at 4 mhz.
;
dskdly:                 ;
        push af         ;
        ld a,16         ; This is "YY"
dly1:   dec a           ;
        jp nz,dly1      ;
        pop af          ;
        ret             ;
;
;**********************************
;
;       RAM Definitions
;
dataorg 04000h
addr:   dw      0h      ; place to store the address from keyboard
keyflg: db      0h      ; flag set when keyboard is depressed
kbfptr: db      0h      ; offset for reads from keyboard buffer
kbwptr: db      0h      ; keyboard entry pointer
curse:  dw      0h      ; address of cursor
cstat:  db      0h      ; status of cursor (on = 1, off = 0)
cchar:  db      0h      ; storage for character under cursor
dskrdy: db      0h      ; disk ready flag
```

```
timflg: db      0h      ; timer flag
strtlc: dw      0h      ; starting memory location for transfers to IO
endloc: dw      0h      ; end memory location, or number of blocks fo IO
tnode:  dw      0h      ; INODE for disk or tape
temp1:  db      0h      ; just a utility spot
dskid:  db      0h      ; the loaded disk id
trflg:  db      0h      ; tape read flag
;
tpbuf:  db      0h      ; single byte tape buffer
stpflg: db      0h      ; danged if I know what that is!
;
kbdbuf: ds      64      ; keyboard buffer (64 bytes)
rwflg:  db      0       ; disk read/write flag.
crtmod: db      0       ; Mode of CRT
rowno:  db      0       ; row address variable, for direct cursor add.
```

BIOS

```
;                       BIOS PROGRAM
;
;                   FOR Z-80 MICROPROCESSOR
;                         by
;
;                       L. A. TOMKO
;
;
;
;   equates:
;
sp_ equ 020h            ; 'space'
nl_ equ 0dh             ; 'newline'
amp_ equ 040h           ; ampersand (@)
ESC equ 01bh            ; ESC character
ESCMOD equ 1            ; CRT ESCAPE mode
INSMOD equ 8            ; CRT INSERT mode
ROWMOD equ 3            ; CRT ROW mode
COLMOD equ 4            ; CRT COLUMN mode
spbase equ 0afffh       ; where to start the stack
tau equ 0fah            ; cursor blinker time constant, in ms (fa = 250)
crtwrds equ 0800h       ; number of 2-byte words in CRT RAM
crtram equ 0b000h       ; beginning of CRT RAM
endcrt equ crtram + (2 * crtwrds) - 1   ; last of CRT memory
botln equ crtram + 0d00h  ;  the line below the bottom line on the CRT
hibot equ botln/0100h   ; high byte of bottom line
botlft equ crtram + 0c80h ;  lower left of screen
uplft equ crtram + 080h ; Upper left of visible screen
scdlne equ crtram + 0100h ; Second line of the crt
botlf1 equ botlft + 1   ; next space after bottom left of crt
kbfsze equ 31           ; keyboard buffer size (32) -must be power of 2 - 1.
keyprt equ 0d6h         ; I/O control port for keyboard PIO
kbvctr equ 0h           ; keyboard interrupt vector
pmod0 equ 0fh           ; sets a PIO to mode 0 (output)
pmod1 equ 04fh          ; sets a PIO to mode 1 (input)
enable equ 083h         ; enables PIO interrupts
disable equ 3           ; disables PIO interrupts
dskdta equ 0d3h         ; Disk data register (IO port)
dsksct equ 0d2h         ; disk sector register (IO port)
dsktrk equ 0d1h         ; Disk track register (IO port)
dskcmd equ 0d0h         ; Disk command or status (IO port)
DSKRST equ 0d0h         ; Reset Disk Controller Command
SEEK equ 01eh           ; track seek command for disk, with verify
UNLOAD equ 012h         ; SEEK without head load or verify (no step!)
RESTORE equ 0ah         ; Restore command for disk, 10 ms step.
WTRK equ 0f4h           ; Write Track Command for disk
DMA equ 0c0h            ; DMA controller
WRSCTR equ 0a8h         ; Write sector command
RDSCTR equ 080h         ; Read sector command, no 15ms delay.
keybrd equ 0d4h         ; keyboard data port
mscntl equ 0d7h         ; misc. PIO control port
mscio equ 0d5h          ; misc PIO data port
RAM equ 0f2h            ; RAM turnon port
ROM equ 0f3h            ; ROM turnon port
t2 equ 0f6h             ; timer 2
FMTBLK equ 06000h       ; start of block data for format routine
COLDST equ 0c000h       ; Cold Start location for uNIX.
;
;
;
org 0a100h              ; starts at A100, which is supposedly safe
reboot: di              ;
        im 2            ; interupt mode for z-80 peripherals
        ld hl,crtwrds   ; number of 2-byte words in the CRT RAM
```

```
        ld sp,endcrt    ; last location of the CRT RAM
        ld de,0202Oh    ; two ASCII 'blank's, one in each byte
clear:  push de         ; writes two 'blanks' to consecutive CRT locations
        dec hl          ; looking for hl=0 to stop clearing CRT RAM
        ld a,h          ; test upper byte first
        or a            ; to make the flags appear
        jp nz,clear     ; certainly not through if upper byte is > 0
        ld a,l          ; now look at the lower byte
        or a
        jp nz,clear     ; if both are zero, we are done with clearing CRT
;
;
;               Enable the pio chip and the interupts
;
        ld a, pmod1     ; pmod1 = 4f, sets the pio to mode 1 (input)
        out (keyprt),a  ; keyport is the control port for keyboard pio
        ld a,kbvctr     ; the interrupt vector for the keyboard (=0h)
        out (keyprt),a  ;
        ld a,enable     ; enable = 083h, enables port interrupt
        out (keyprt),a  ;
        in a,(keybrd)   ; do one read to set 'ready' output.
;
;
;               initialize 1 ms timer.
;
        ld a,07h        ; sets timer mode, non-interrupting, prescale/16
        out (0f4h),a    ; f4 is ctc channel 0.
        ld a,0fah       ; time constant of 250 counts = 1 ms total
        out (0f4h),a    ;
        ld a,08h        ; ctc vector(s) 8 + counter #
        out (0f4h),a    ;
;
;
;
;
        out (0cfh),a    ; Set single density for floppy controller
;
;
; Initialize PIOB, Port B for miscellaneous interrupts, including disk
;
        ld a, 0cfh      ; Mode 3 - bit I/O
        out (mscntl),a  ; PIOB, Port B control
        ld a,1          ; D0 only is input - all else = outputs
        out (mscntl),a  ;
        ld a,037h       ; disable interrupt, active high, mask follows
        out (mscntl),a  ; (This initialization is repeated in disk routines)
        ld a,0feh       ; Mask all but D0.
        out (mscntl),a  ;
        ld a,010h       ; vector
        out (mscntl),a  ;
        in a,(mscio)    ; do a read to set 'ready' output.
;
;
;
;                       misc. initialization
;
        xor a           ;
        ld (keyflg),a   ; initialize keyboard flag = off
        ld (kbwptr),a   ; keyboard write pointer
        ld (kbfptr),a   ; keyboard read pointer
        ld (cstat),a    ; start with cursor status = off.
        ld (dskid),a    ; default disk ID is 00
        ld (crtmod),a   ; CRT mode = normal
        ld hl,crtram    ; beginning of CRT RAM
```

```
        ld bc,0200h     ; offset for the initial cursor position
        add hl,bc       ;
        ld (curse), hl  ;
        call curson     ; start the cursor blinking
        ld hl,vectab    ; the vector transfer table address is vectab (I hope)
        ld a,h          ; need upper byte in a to load reg. I.
        ld i,a          ; load the high byte of vector table
;
;
;
;
;
        ld bc,0fh       ; Load the BIOS jump table.
        ld de,0c057h    ; That's where it goes.
        ld hl,xfrtbl.   ; That's where it comes from.
        ldir            ;
;
;
monitor:
        ld sp,spbase    ; reload the stack pointer.
        call dskdly     ; wait a few u-seconds for controller clear
        ld a,DSKRST     ; Reset controller, abort any commands.
        out (dskcmd),a  ;
        ld a,nl_        ; print a 'cr' on the crt
        call putcrt     ; \n
        ei              ; enable the system interrupts.
        ld hl,mon1      ; This next little operation clears peripheral devices
        push hl         ; that may have pending interrupts acknowledged but
        reti            ; not cleared with a "reti" command. Each iteration
mon1:   ld hl,mon2      ; clears only one device, so we will do three just
        push hl         ; to be sure!
        reti            ;
mon2:   ld hl,mon3      ;
        push hl         ;
        reti            ;
mon3:   nop             ;
;
;******* should jump to operating system from here.*****
        jp COLDST       ; operating system entry (cold start).
;
;
;
;               putcrt writes a character (found in a) to the crt
;               much like a serial terminal.
;
putcrt: push af
        push bc
        push de
        push hl
        call cursoff    ; Turn the cursor off, which replaces the character
                        ; at the cursor location and prevents interrupts.
        ld c,a          ; save the character in C for a while
        ld a,(crtmod)   ; Find state of CRT
        and 7           ; look at all but INSERT mode bit
        cp ESCMOD       ; escape mode?
        jp z,escape     ;
        cp ROWMOD       ; Row mode?
        jp z,row        ;
        cp COLMOD       ; column mode?
        jp z,column     ;
        ld a,c          ; Now check for ESC character
        cp ESC          ; since not in ESCMOD, ROWMOD, or COLMOD.
        jp z,setesc     ; If Char = ESC, set ESCMOD.
        ld a,(crtmod)   ; reload crt mode to look at INSERT bit
```

```
        cp INSMOD       ;
        jp z,insert     ;  insert mode.
        or a            ; Any other mode is an
        call nz,audcrti ; illegal CRT mode
        ld a,c          ; restore character to A
        and 07fh        ; mask off reverse video bit
        cp 020h         ; check for special chars (< 20h)
        jp m,special    ; handle those separately
        ld a,c          ; restore again
        ld hl,(curse)   ; pointer to cursor
        ld (hl),a       ; that's where we will write.
;                       now, fiddle with the cursor.
        ld a,l          ; lower byte of cursor address
        cp 04fh         ; that's eol for even rows
        jp z,eoln       ; return and scroll
        cp 0cfh         ; eol for odd lines
        jp z,eoln       ;
        inc a           ; if not eol, just increment cursor address
        ld l,a          ; don't worry about carry - never occurs in line.
        ld (curse),hl   ; update the cursor position
nullo:  call curson     ; Now turn the cursor back on before departing
        pop hl
        pop de
        pop bc
        pop af
        ret             ; bye!
;
eoln:   ld de,031h      ; just wrote last char on line. move cursor to
        add hl,de       ; beginning of next line. (by adding 31h)
        ld (curse),hl   ; update the cursor position
        ld de,botln     ; if cursor >= xdxx, we must scroll
        ld a,d          ; just look at the upper byte
        cp h            ;
        jp nz,nullo     ; otherwise, we'll just return
        ld hl,botlft    ; scroll needed - first set cursor to bottom left
        ld (curse),hl   ;
        call scroll     ; scroll moves everything up one, but leaves cursor.
        jp nullo        ;
;
;
special:                ; handles special characters, like tabs, spaces, etc.
        cp 080h
        jp p,nullo      ; initially, if bit7 = 1 we will just ignore it.
        jp z,nullo      ;
;
        cp 08h          ; backspace?
        jp z,backsp     ;
;
        cp 09h          ; tab?
        jp z,tab        ;
;
        cp 0ah          ; linefeed?
        jp z,lf         ;
;
        cp 0ch          ; formfeed (clear screen)?
        jp z,clr        ;
;
        cp 0dh          ; carraige return?
        jp z,cr         ;
        jp nullo        ; don't know what it is, so just ignore it.
;
;
backsp: ld hl,(curse)   ; backspace moves cursor back, does not erase.
        ld a,l          ; stops backspacing at beginning of line.
        cp 0h           ;
        jp z,nullo      ;
```

```
        cp 040h         ;
        jp z,nullo      ;
;
        dec a           ; not at beginning of line, so decrement.
        ld l,a          ;
        ld (curse),hl   ;
        jp nullo        ;
;
;
tab:    ld a,020h       ; put out spaces until cursor is left at even '8' mult.
        call putcrt     ;
        ld hl,(curse)   ;
        ld a,l          ;
        and 07h         ; look at last 3 bits
        jp z,nullo      ; done.
        jp tab          ; do it again
;
;
lf:     ld hl,(curse)   ; leaves cursor in same relative position.
        ld de,080h      ; adding 80h to cursor position puts it strt. down
        add hl,de       ;
        ld a,h          ; however, if cursor >= 0300h, must scroll
        cp hibot        ; compare bottom of screen (high byte)
        jp nz,nxtline   ; If not below screen, reload cursor
        call scroll     ; scroll won't change curse, so we just leave it alone
        jp nullo        ; gracefully return.
nxtline:
        ld (curse),hl   ; reload the cursor with the new value
        jp nullo        ;
;
;
clr:    ld a,26         ; going to do 26 scrolls to clear the screen
movup:  call scroll     ;
        dec a           ;
        jp nz,movup     ;
        ld hl,uplft     ; going to put cursor at top left
        ld (curse),hl   ;
        jp nullo        ; graceful exit.
;
;
cr:     ld hl,(curse)   ; return to start of line and do line feed
        ld a,l          ; look at the lower byte
        cp 07fh         ; if greater than 7fh, we were on an odd line
        jp p,oddln      ;
        ld l,0h         ; even line: return to 0.(l)
        ld (curse),hl   ; moves the cursor back to start of current line
        jp lf           ; now do a line feed. note: routine returns 'cr'
oddln:  ld l,080h       ; odd line: return cursor to xx80h.
        ld (curse),hl   ;
        jp lf           ;
;
;
;
;
escape:                 ; previous character was and ESC
        ld a,(crtmod)   ;
        and INSMOD      ; clear all but INSERT mode bit
        ld (crtmod),a   ;
        ld a,c          ; look at the new character
        cp 'E'          ;
        jp z,clr        ; Home/Clear routine
        cp 'K'          ;
        jp z,clrlne     ; Clear to end of line
        cp 'L'          ;
        jp z, insline   ; insert new line at cursor row
```

There sequences are modelled after Heath/Zenith terminals.

```
        cp 'M'          ;
        jp z,delne      ; delete a line
        cp amp_         ;
        jp z,insmde     ; enter insert mode
        cp 'O'          ; (capital O)
        jp z, exmod     ; exit insert mode.
        cp 'N'          ;
        jp z,delchr     ; Delete character at cursor
        cp 'Y'
        jp z, mvrow     ; cursor row set
        jp nullo        ; ignore anything we don't understand
;
;
;
clrlne:                 ; Clears from cursor to end of line
        ld hl,(curse)   ; Get cursor position
clnl:                   ;
        ld a,l          ;
        cp 04fh         ; EOL for even rows
        jp z,nullo      ; done
        cp 0cfh         ; EOL for odd rows
        jp z,nullo      ; Also done
        ld a,sp_        ; Not done, so write a blank
        ld (hl),a       ; at (hl)
        inc l           ; Next...
        jp clnl         ; do it again
;
;
;
inslne:                 ; Inserts blank line at current cursor
                        ; line, moving lines below it down.
        call crsbol     ; cursor to begining of line, --> HL
ins0:                   ;
        ld de,botlft    ;
        scf             ; clear carry for 16-bit subtract
        ccf             ;
        sbc hl,de       ; Cursor at Bottom row?
        jp z,clrlne     ; If so, just clear the line.
        ld hl,botlft-080h       ; Next row up
ins1:                   ;
        ld bc,80        ; 80 columns
        ldir            ; moves 'em down
        scf             ;
        ccf             ; clear carry flag
        ld bc,0d0h      ; enough to get to start of next line up
        ex de,hl        ; first do DE
        sbc hl,bc       ; subtract
        ex de,hl        ;
        sbc hl,bc       ;
        ld bc,(curse)   ;
        ld a,e          ; Going to see if the activity is at (curse)
        cp c            ; yet.
        jp nz,ins1      ; If not, do some more
        ld a,d          ;
        cp b            ;
        jp nz,ins1      ;
        jp clrlne       ; blank the row if at cursor
;
;
;
delne:                  ; Deletes line of cursor; moves lines below
                        ; one up; blank line at bottom; cursor
                        ; at beginning of deleted line.
        call crsbol     ; cursor to beginning of current line
        ld d,h          ; HL now has starting cursor position
```

```
        ld e,l          ;
        ld bc,080h      ;
        add hl,bc       ; Next line below
        ld bc,80        ; 80 columns
        call repeat     ; part of scroll: routine.
        jp nullo        ;
;
;
;
crsbol:                 ; Puts cursor at start of current line,
                        ; returns position in HL
        push af         ;
        ld hl,(curse)   ;
        ld a,l          ;
        cp 07fh         ;
        jp p,crsb1      ; if > 7f, oddline
        ld l,0          ; BOL for even line
        ld (curse),hl   ; reload it
        pop af          ;
        ret             ;
crsb1:                  ;
        ld l,080h       ; BOL for odd line = xx80
        ld (curse),hl   ;
        pop af          ;
        ret             ;
;
;
;
insmde:                 ; Enter the inseert mode
        ld a,INSMOD     ;
        ld (crtmod),a   ;
        jp nullo        ;
;
;
mvrow:                  ; enter row address mode
        ld a,(crtmod)   ;
        or ROWMOD       ; put rowmode bits in without changing insert mode
        ld (crtmod),a   ;
        jp nullo        ;
;
;
;
setesc:                 ; An ESC character has been received; set esc mode
        ld a,(crtmod)   ;
        or ESCMOD       ;
        ld (crtmod),a   ;
        jp nullo                ;
;
;
exmod:                  ; Exit insert mode - clear everything
        xor a           ;
        ld (crtmod),a   ;
        jp nullo        ;
;
;
;
delchr:                 ; Delete character at cursor position.
        ld hl,(curse)   ; Move text right of cursor left one slot.
delc1:                  ;
        ld a,l          ;
        cp 04fh         ;
        jp z,delc2      ; end of line, even row
        cp 0cfh         ;
        jp z,delc2      ; end of line, odd row
```

```
        inc hl          ;
        ld a,(hl)       ; get char. to right
        dec hl          ;
        ld (hl),a       ; put it one left
        inc hl          ;
        jp delc1        ;
delc2:                  ;
        ld a,sp_        ; Blank last character in row
        ld (hl),a       ;
        jp nullo        ;
;
;
;
row:                    ; load row register
        ld a,c          ; restore the character to A
        cp 25           ; Only 25 rows
        jp m,row1       ; OK if less than 25
        ld a,24         ; else set to max = 24
row1:                   ;
        ld (rowno),a    ; save it for next time
        ld a,(crtmod)   ;
        and INSMOD      ; clear all but Insert mode bit
        or COLMOD       ; concatenate Column mode bits
        ld (crtmod),a   ;
        jp nullo        ;
;
;
;
;
;
column:                 ; expect column address
        ld a,(crtmod)   ; clear all but Insert mode
        and INSMOD      ;
        ld (crtmod),a   ;
        ld a,c          ;
        cp 80           ; only 80 columns
        jp m,col1       ; if less, OK
        ld c,79         ; else change C to 79
col1:                   ;
        ld de,080h      ; Distance between rows
        ld hl,uplft     ; upper left of screen
        ld a,(rowno)    ; Row number from previous read
        or a            ;
        jp z,col3       ; skip multiply if rowno = 0
col2:                   ;
        add hl,de       ; crude multiplication
        dec a           ;
        jp nz,col2      ; add A times!
;
col3:                   ;
        ld a,c          ; column offset
        add a,l         ; add it to the hl (don't worry about carry)
        ld l,a          ;
        ld (curse),hl   ;
        jp nullo        ;
;
;
;
;
insert:                 ; Inserts a character at cursor position
        ld de,(curse)   ; Won't DVANCE BEYOND EOL
        ld h,d          ;
        ld a,e          ;
        cp 80           ;
        jp p,insrt1     ; > 80 --> odd line
```

```
        ld l,04fh       ; EOL for even line
        jp insrt2       ;
insrt1:                 ;
        ld l,0cfh       ; EOL for odd line
insrt2:                 ;
        ld a,e          ;
        cp l            ; Are we back to cursor positiomn yet?
        jp z,insrt3     ;
        dec l           ;
        ld a,(hl)       ; get character to left
        inc l           ;
        ld (hl),a       ; move it one right
        dec l           ;
        jp insrt2       ;
insrt3:                 ;
        ld (hl),c       ; load the incoming character there
        ld a,l          ; Now make sure we are not at the EOL
        cp 04fh         ;
        jp z,insrt4     ;
        cp 0cfh         ;
        jp z,insrt4     ;
        inc hl          ; If not, increment cursor
insrt4:                 ;
        ld (curse),hl   ; load cursor
        jp nullo        ;
;
;
;
;
;                       End of putcrt
;*************************************************
;
;
audcrt1:                ; illegal CRT mode
        push af         ;
        push hl         ;
        ld hl,crtm1     ; load message address
        call pstrng     ; print it
        ld a,(crtmod)   ; save the crt mode
        ld l,a          ;
        xor a           ;
        ld (crtmod),a   ; clear the crt mode to normal
        ld a,l          ;
        call putcrt     ; print the offending mode
        pop hl          ;
        pop af          ;
        ret             ;
;
crtm1: db 'Illegal CRT mode',0
;
;
;
;
hexchr:                 ; Returns 2 ASCII characters in h and l,
        push af         ; representing the hex byte in 'a'
        push bc         ;
        ld b,a          ; save byte
        and 0fh         ; look at lower nibble
        cp 10           ; if < 10, must be 0 - 9
        jp m, digit     ;
        sub 10          ; must be > 10, so subtract 10, and add A
        add a,061h      ; 'a'
        ld l,a          ; that's the lower character
        jp thigh        ;
digit:  add a,030h      ; '0' ASCII
```

```
        ld l,a          ;
thigh:  ld a,b          ; the saved byte
        rrc a           ; rotate upper nibble to lower position
        rrc a           ;
        rrc a           ;
        rrc a           ;
        and 0fh         ; same song second verse
        cp 10           ;
        jp m, dig2      ;
        sub 10          ;
        add a,061h      ;
        ld h,a          ; upper character
        jp thru         ;
dig2:   add a,030h      ;
        ld h,a          ;
thru:   pop bc          ;
        pop af          ;
        ret             ;
;
;
;
;************************************************
;
curses:                 ; cursor blinker. handles 250 ms interrupt.
        push af         ;
        push bc         ;
        push hl         ;
        ld hl,(curse)   ; Get the cursor position.
        ld a,(hl)       ; Get the character there.
        xor 080h        ; Reverse-video that character.
        ld (hl),a       ; and Write it back.
        ld a,(cstat)    ; cstat-0 > cursor 'off', character at cursor pos.
;                       ; cstat = 1 > 'on'; character saved in cchar
        or a            ;
        jp z,turnon     ; if off, turn on
turnoff:                ;
        xor a           ; a = 0
        ld (cstat),a    ; clear cursor status.
        jp home         ; return
;
turnon:
        ld a,01h        ; a = 1
        ld (cstat),a    ; set cursor status = 'on' (1)
;
home:   pop hl          ;
        pop bc          ;
        pop af          ;
        ei              ; Turn those interrupts back on!
        reti            ;
;
;                       End curses
;****************************************
;
cursoff:                ; turns cursor off, making sure
        push af         ; that screen displays character in the cursor
        push hl         ; position.
        ld a, (cstat)   ; find out what state the cursor was in
        or a            ;
        jp z,blnkck     ; cursor already off, so check blink status
        ld hl,(curse)   ; find the cursor
        ld a,(hl)       ; Look at the character in the cursor position.
        xor 080h        ; Toggle the reverse-video bit.
        ld (hl),a       ; put 'er there!
        xor a           ; now clear the cursor status bit
        ld (cstat),a    ;
blnkck: ld a,(blink)    ; Is the Blinker activated?
```

```
        or a            ;
        jp z, donoff    ; If not, return happily.
        ld a,043h       ; else Kill the Cursor Counter!
        out (0f7h),a    ;
        xor a           ;
        ld (blink), a   ; and Zero the Blinker status.
;
donoff: pop hl          ;
        pop af          ;
        ret             ; bye!
;
;                       End cursoff
;**************************************
;
curson: push af         ; turns the cursor on.
        push hl         ;
        ld a,(cstat)    ; was it on already?
        or a            ;
        jp nz,ckblnk    ; if so, check for blinker status.
        ld hl,(curse)   ; Get cursor position.
        ld a,(hl)       ; Get character at Cursor position.
        xor 080h        ; Toggle the reverse video bit.
        ld (hl),a       ; Put the toggled character back.
        ld a,1          ;
        ld (cstat),a    ; Set the cursor status = ON.
ckblnk: ld a,(blink)    ; Check whether blinker is activated.
        or a            ;
        jp nz,donon     ; if so, just return happy.
        ld a,0c7h       ; else set CTC to start blinking.
        out (0f7h),a    ; CTC address = f7.
        ld a,tau        ; 250 ms time constant (500 ms at 2 mhz)
        out (0f7h),a    ; The CTC is expecting this output.
        ld a,1          ;
        ld (blink), a   ; Set blinker staus.
;
donon:  pop hl
        pop af
        ret
;
;                       End curson
;**************************************
;
;
scroll: push af         ; scroll moves everything up one notch on crt,
        push bc         ; without bothering the cursor position.
        push de         ; in fact, it turns the cursor off, so user must
        push hl         ; be sure to turn it back on sometime.
        call cursoff    ;
        ld bc,050h      ; 80 columns per row
        ld de,uplft     ; upper left corner of visible screen area
        ld hl,scdlne    ; next position down
        call repeat     ; moves everything below DE up one line
        pop hl          ;
        pop de          ;
        pop bc          ;
        pop af          ;
        ret             ;
;
;
;
;*******************************************
;
;
repeat: ldir            ; (de) < (hl), hl++, de++, bc-- till bc=0. nifty!
        ld bc,030h      ; enough to get to start of next line.
        add hl,bc       ;
```

```
        push hl         ; tuck it away
        ex de,hl        ; now lets do it to de
        add hl,bc       ; did it!
        ex de,hl        ; back to de
        pop hl          ; retreived.
        ld bc, 050h     ; 80 columns, as before.
        ld a,h          ; going to see if we are done yet
        cp hibot        ; 3dxx is beyond the last row
        jp nz,repeat    ; if not there, do some more.
        ld hl,botlft    ; left of bottom line
        ld de,botlf1    ; next position
        ld (hl),020h    ; put a blank in the left position
        ldir            ; propagate it across the row.
        ret             ;
;
;                       End repeat
;************************************************
;
;
;
keyinr:                 ; Handles interrupts by the keyboard
        push af         ;
        push bc         ;
        push hl         ;
        in a,(keybrd)   ; Reads keyboard port
        ld c,a          ; Tuck it away
        ld a,(kbwptr)   ; Keyboard 'write' pointer offset
        inc a           ; next position is where to write
        and kbfsze      ; modulo kbfsze (size of keyboard buffer)
        ld(kbwptr),a    ;
        ld hl,kbdbuf    ; start position of buffer (3d00)
        add a,l         ; add offset
        ld l,a          ;
        ld (hl),c       ; put character in buffer
        ld a,1          ; keyboard ready flag - there's something in
        ld (keyflg),a   ; the buffer.
        pop hl
        pop bc
        pop af
        ei              ; enable the interrupts
        reti
;
;
;                       End keyinr
;************************************************

;
;
pstrng:                 ; Put ASCII string found in location HL
        push af         ; to CRT until '0' byte encountered
;
strglp: ld a,(hl)       ; look at each character
        cp 0            ; The null character
        jp z,strgrt     ; quit when zero encountered
        call putcrt     ; Else write it to CRT
        inc hl          ; next one
        jp strglp       ;
;
strgrt: pop af          ;
        ret             ;
;
;                       End pstrng
;************************************************
;
;
pthxch:                 ; Puts hex number to CRT as two ASCII characters
```

```
        push hl         ;
        call hexchr     ; returns two ASCII chars in H,L
        ld a,h          ; High one
        call putcrt     ;
        ld a,l          ;
        call putcrt     ;
        pop hl          ;
        ret             ;
;
;                       End pthxch
;****************************************
;
;
;
ldsv:                   ; Preparation for disk read or write
        ld a,5          ; Setup for 5 tries to seek track
        ld (dsktry),a   ;
        ex de,hl        ; Save address in DE (stolen from SMW)
        pop hl          ; That's the subroutine return address
        ex (sp),hl      ; pops Tnode from stack and pushes return address
        push de         ; Also save the from/to address on stack
        ld de, 15       ; Number of sectors per track
        ex de,hl        ; our divide routine divides de/hl
        call ccdiv      ; From Z-80 library
        inc e           ; 1 + remainder = sector
        ld d,1          ; now track = d
        ld c,h          ; c = disk number (use 0 as default)
        ld a,(dskid)    ; The current disk id, possibly loaded by hand
        cp c            ;
        jp nz,ermsg4    ; If not right disk, abort w message
        in a,(dsktrk)   ; Find out where the head is.
        cp d            ; compare with the desired track.
        jp nz,ldsv1     ; SEEK if not on the right track.
        ld a,0d0h       ; RESET controller to force Type I status
        out (dskcmd),a  ;
        call dskdly     ; Let controller clear
        in a,(dskcmd)   ; Look at status
        and 020h        ; look at Head Load bit.
        jp nz,ldsvq     ; Head loaded; Right track: so quit, already.
ldsv1:  ld a,d          ; else load the desired track
        cp 77           ; Make sure track is in range
        jp p,ermsg9     ; Abort with message if not.
        out (dskdta),a  ; Load to disk data register
        call dskdly     ; Wait a few microseconds
        ld a,SEEK       ; SEEK = 01fh, the seek command
        out (dskcmd),a  ; send it to controller
        call waitdk     ; Waits for disk controller to interrupt
        in a,(dskcmd)   ; get status
        call dskdly     ; Wait a few microseconds
        and 018h        ; look at CRC or seek errors
        jp nz,ldstry    ;
ldsvq:  pop hl          ; return with r/w address in hl
        ret             ;
;
;
ermsg5: ld hl,msg5      ; "Seek error "
        call pstrng     ;
erdata: ld a,d          ; track
        call pthxch     ;
        ld a,e          ; sector
        call pthxch     ;
        jp reboot       ;
                        ;
msg5:   db      'Seek Error',0
                        ;
```

```
ermsg9: ld hl,msg9      ; "Track out of range"
        call pstrng     ;
        jp erdata       ; Also print track and sector.
;
msg9: db 'Track out of range ',0
;
ldstry:                 ; try (dsktry) times to seek track
        ld a,(dsktry)   ;
        dec a           ;
        jp z,ermsg5     ; Give up after (dsktry) tries.
        ld (dsktry),a   ;
        call restor     ; backup to track 00
        jp ldsv1        ;
;
;
;                       End ldsv
;***********************************************
save:                   ; Writes one block to disk
                        ; given address in HL, and Tnode second on
                        ; stack.
        pop bc          ; Return address
        pop de          ; Tnode
        push bc         ; Save the return address
        push de         ; Give next routine Tnode in stack
        call ldsv       ; Common disk IO program unravels Tnode and gets
                        ; to right track on right disk (or aborts)
        ld a,5          ; 5 tries to write
        ld (dsktry),a   ;
        push hl         ; save start address in case of abort
save1:                  ;
        call cursoff    ; Don't want interrupts during write.
        call keyoff     ; don't allow keyboard to interrupt
        ld a,0b7h       ; enable PIO int; 'or' logic; active high; mask follows
        out (mscntl),a  ;
        ld a,0feh       ; Mask all but D0.
        out (mscntl),a  ;
        ld a,014h       ; Vector --> dskout interrupt handler.
        out (mscntl),a  ;
        in a,(mscio)    ; clears PIO ready signal.
        ld a,e          ; E should contain sector number
        out (dsksct),a  ; put that in disk sector register
        call dskdly     ; Wait a few microseconds
        ld b, 0ffh      ; Prevents B from decrementing to zero in 'dskin'
        ld c,0d3h       ; set C to controller data port
        ld a,WRSCTR     ; write sector command (0a8h)
        out (dskcmd),a  ; to the command register
        call waitdk     ; Now just sit back and wait for disk to finish
        call curson     ; Let 'er blink again
        call keyon      ; and let the keyboard interrupt
        in a,(dskcmd)   ; get controller status
        call dskdly     ; Wait a few microseconds
        and 07ch        ; mask the write-pertinent bits
        jp nz,savtry    ; Print write-error message if any bad bits
        pop hl          ; restore stack
        ret             ; otherwise, return
;
ermsg7: ld hl,msg7      ; msg7 = "disk write error"
        call pstrng     ;
        ld a,d          ; should contain Tnode
        call pthxch     ; write it to CRT
        ld a,e          ; lower byte
        call pthxch     ;
        jp monitor
;
;
msg7: db 'Disk write error',0
```

```
;
savtry:                 ; try (dsktry) times
        ld a,(dsktry)   ;
        dec a           ;
        jp z,ermsg7     ; Give up
        ld (dsktry),a   ;
        pop hl          ; recall the start address
        push hl         ; save it again, in case another retry
        jp save1        ;
;
;
;                       End save
;*************************************************************
;
;
keyon:                  ; Turns on the keyboard
        push af         ;
        ld a,enable     ;
        out (keyprt),a  ;
        pop af          ;
        ret             ;
;
keyoff.:                ; Turns off keyboard
        push af         ;
        ld a,disable    ;
        out (keyprt),a  ;
        pop af          ;
        ret             ;
;
;
;                       End keyon/keyoff
;*********************************************************
;
;
dskout:                 ; Disk output interrupt handler.
                        ; NOTE: this has to be FAST!
                        ; INPUTS: HL contains the address to be written
                        ; from. C contains the disk controller data port.
                        ; B should be written to a high value to prevent
                        ; it from decrementing to zero, which would
                        ; set the "z" flag and screw up the dkwait
                        ; routine.
        outi            ; (HL) > (C); inc HL; dec B
        in a,(mscntl)   ; clears the PIO interrupt.
        ei              ;
        reti            ;
;
;                       end dskin
;*************************************************************
                        ;
load:                   ; Reads a sector to memory specified in HL
                        ; from disk at Tnode, contained in stack
        pop bc          ;
        pop de          ; First exhange the first two stack positions
        push bc         ;
        push de         ;
        call ldsv       ; Finds the right track and disk, and unravels Tnode
        ld a,5          ; 5 tries
        ld (dsktry),a   ;
        push hl         ; Save start address in case of abort
load1:                  ;
        call cursoff    ; We don't want interrupts during disk read.
        call keyoff     ; turn off keyboard, too
        ld c,0d3h       ; Setup C for the "diskin" interrupt handler.
```

```
        ld a,0b7h       ; enable int, 'or' logic, active high, mask follows
        out (mscntl),a  ;
        ld a,0feh       ; Mask all but D0.
        out (mscntl),a  ;
        ld a,012h       ; vector to "diskin"
        out (mscntl),a  ;
        in a,(mscio)    ; Do a read to set ready flag.
        ld a,e          ; E should contain the sector number
        out (dsksct),a  ; load it in controller sector register
        call dskdly     ; Wait a few microseconds
        ld b,0ffh       ; B will decrement and  affect flags at 0.
        ld a,RDSCTR     ; command to read a sector (= 084h)
        out (dskcmd),a  ; to command port
        call waitdk     ; wait for execution
        call cursor     ; restart cursor - interrupts OK now.
        call keyon      ;
        in a,(dskcmd)   ; get status
        call dskdly     ; Wait a few microseconds
        and 01ch        ; Mask CRC and lost data bits
        jp nz,ldtry     ;
        pop hl          ; restore stack
        ret             ; else done - return
;
ermsg6:
        call erprnt     ;
        ld hl,msg6      ; "disk read error "
        call pstrng     ;
        ld a,d          ; Track
        call pthxch     ;
        ld a,e          ; sector
        call pthxch     ;
        jp reboot       ;
;
msg6: db 'Disk read error. Track/sector = ',0

;
ldtry:                  ; Try (dsktry) times
        ld a,(dsktry)   ;
        dec a           ;
        jp z,ermsg6     ;
        ld (dsktry),a   ;
        call restor     ; Unload, goto track 0, reload, verify
        ld a,d          ; D should still be the track No.
        out (dskdta),a  ; load track to controller
        call dskdly     ; wait for it to settle down
        ld a,SEEK       ; Now get back on the right track
        out (dskcmd),a  ;
        call waitdk     ; wait for controller interrupt
        in a,(dskcmd)   ; check status
        and 018h        ; CRC or SEEK errors
        jp nz,ldtry     ; try again if it fails (5 times max)
        pop hl          ; recall start address if successful
        push hl         ; save it for another retry
        jp load1        ;
;
;                       end load
;*****************************************************
;
dskin:                  ; Interrupt handler for disk reads.
                        ;
                        ; NOTE: this routine must go FAST!
                        ; INPUTS: HL contains the start address to be
                        ; loaded to. It will be incremented each call.
                        ; C contains the input port address.
                        ; B will be decremented each time, so
                        ; Flag register will be affected when
```

```
                        ; B becomes 0. This may interact with calling
                        ; program. Set B to 'FF' before starting to
                        ; minimize this.
        ini             ; input (C) and inc HL. (16 cycles)
        nop             ; (4 cycles) This is needed temporarily to
                        ; prevent bad memory read of 'ff'.
        ei              ; (4 cycles)
        reti            ; (14 cycles) resets PIO without reading it.
;
;                       end diskin
;*****************************************************
;
waitdk:                 ; waits till disk is through with whatever.
        push af         ;
        ld a,16         ; setup 49 microsecond wait, so controller
                        ; status will be valid after command.
waitdk1:                ;
        dec a           ; This loop kills 7 microseconds per pass
        jp nz,waitdk1   ; at 2 mhz, 3.5 at 4 mhz system clock.
waitdk2:                ;
        ld b,0ffh       ; B is decremented (but not tested) in disk
                        ; interrupt routines (diskin, siskout). We
                        ; write B to ff to prevent a 'z' condition
                        ; in the flag register in case the interrupt
                        ; occurs during the "and" operation. We may
                        ; therefore miss the resetting of the 'busy'
                        ; status bit for one loop, but no matter.
                        ;
        in a,(dskcmd)   ; now start looking at controller status register
        and 1           ; LSB is the busy bit
        jp nz,waitdk2   ; loop if still busy
        pop af          ;
        ret             ;
;
;                       End waitdk
;*****************************************
;
ccdiv:                   ; Divides DE by HL, returns quotient in HL
        ld b,h          ; with remainder in DE. (signed divide)
        ld c,l          ; from "runtime Library for Small C Compiler
        ld a,d          ;by Ron Cain
        xor b
        push af
        ld a,d
        or a
        call m,ccdeneg
        ld a,b
        or a
        call m,ccbcneg
        ld a,16
        push af
        ex de,hl
        ld de,0
ccdiv1: add hl,hl
        call ccrdel
        jp z,ccdiv2
        call ccmpbcde
        jp m,ccdiv2
        ld a,l
        or 1
        ld l,a
        ld a,e
        sub c
        ld e,a
        ld a,d
        sbc a,b
```

```
        ld d,a
ccdiv2: pop af
        dec a
        jp z,ccdiv3
        push af
        jp ccdiv1
;
ccdiv3: pop af
        ret p
        call ccdeneg
        ex de,hl
        call ccdeneg
        ex de,hl
        ret
;
ccdeneg: ld a,d          ; negates the integer in DE
        cpl
        ld d,a
        ld a,e
        cpl
        ld e,a
        inc de
        ret
;
ccbcneg: ld a,b          ; negates the integer in BC
        cpl
        ld b,a
        ld a,c
        cpl
        ld c,a
        inc bc
        ret
;
ccrdel: ld a,e           ; Rotate DE left one bit
        rla
        ld e,a
        ld a,d
        rla
        ld d,a
        or e
        ret
;
ccmpbcde: ld a,e         ; compare bc to de
        sub c
        ld a,d
        sbc a,b
        ret
;
;
;
;
;
;
        org 0a800h       ; origin of vector table for interrupts
vectab: dw keyinr        ; 00 > keyboard interrupt
        dw vcterr        ; 02 > tape output - not implemented yet
        dw vcterr        ; 04 DMA controller - not supposed to interrupt
        dw vcterr        ; 06 > tape input - not implemented yet.
        dw vcterr        ; 08 > CTC channel 0 - shouldn't interrupt.
        dw vcterr        ; 0a > CTC channel 1 - not defined yet.
        dw vcterr        ; 0c > timer channel.
        dw curses        ; 0e > cursor interrupt.
        dw vcterr        ; 10 > PIO interrupt - formerly DISK controller.
        dw dskin         ; 12 > PIO for disk input operations.
        dw dskout        ; 14 > Same PIO for disk output operations
```

(interrupt Vector Table)

```
;
;
vcterr:                 ; routine to handle strange vectors from interrupts.
        push hl         ;
        ld hl,msg8      ; "\nunknown interrupt vector\n"
        call pstrng     ;
        pop hl          ;
        ei              ; enable interrupts
        reti            ;
;
msg8:   db 'Unknown interrupt vector',nl_,0
;
;                       end vectab
;*****************************************************
;
;
;               ERROR MESSAGES
;
ermsg4: ld hl,msg4      ; 'Wanted disk/Found disk: '
        call pstrng     ;
        call pthxch     ; desired disk was in A
        ld a,c          ; Loaded disk in C
        call pthxch     ;
        jp monitor      ;
msg4:   db 'Wanted disk/Found disk:',0
;*****************************************************************
;
;       format: A disk formatting program for 8"
;       single density single side disk.
;
;
;
format:                 ;
        call restor     ; sets disk to track 0
        ld d,0          ; D will contain the track No.
nxtrk:  call trkfmt     ; generates track format info in memory
                        ; beginning at FMTBLK
        call cursoff    ; eliminate cursor interrupts while writing.
        ld a,0b7h       ; enable PIO int; 'or'; act. high; mask follows.
        out (mscntl),a  ;
        ld a,0feh       ;
        out (mscntl),a  ; Disable all but D0.
        ld a,014h       ; vector to "dskout"
        out (mscntl),a  ;
        in a,(mscio)    ; one read to clear ready flag
        ld c,0d3h       ; set C to controller data port
        ld hl,FMTBLK    ; start of data block for Format routine
        ld a,0f4h       ; f4 = write track (format)
        out (dskcmd),a  ;
        call waitdk     ; waits for controller to be done.
        call curson     ;
        in a,(dskcmd)   ; get status
        call dskdly     ; wait a few microseconds
        and 044h        ; mask lost data or write protect
        call nz,erprnt  ; if error, print registers
        inc d           ; next track
        ld a,77         ; last track = 76
        cp d            ;
        ret z           ; done
        ld a,05bh       ; Step in, update register, no verify,  load
        out (dskcmd),a  ;
        call waitdk     ;
        in a,(dskcmd)   ; get status
        call dskdly     ; wait a little while
        and 010h        ; look for "seek error" bit
```

```
        ld (hl),0f7h    ; 2 CRC's
        inc hl          ;
        ld b,27         ;
        ld a,0ffh       ;
        call bload      ; 27 ff's
        dec c           ; next sector
        jp nz,sect      ; do it again
        ret             ; else done, return.
;
;                       end of sect
;*************************************************************
;
;
;
;       secno returns a sector No. in A, given a sequence no. in C
;       and a track no. in D.
;       INPUT: reverse sequence No. in C (kept)
;              track No. in D (kept)
;
secno:
        push hl         ;
        ld a,d          ; track No.
        and 1           ; look at lowest bit
        jp z,even       ; odd or even?
        ld b,0          ; if odd, look at oddlist
        ld hl,oddlst    ; sequence for odd tracks
        add hl,bc       ; offset by sequence No.
        ld a,(hl)       ; get that value
        pop hl          ; restore
        ret             ; done
even:
        ld b,0          ; even track No.
        ld hl,evnlst    ; SO USE even list
        add hl,bc       ; add offset of seq. No.
        ld a,(hl)       ; get it.
        pop hl          ;
        ret             ;
;
oddlst: db      0ffh,8,15,7,14,6,13,5,12,4,11,3,10,2,9,1
evnlst: db      0ffh,11,3,10,2,9,1,8,15,7,14,6,13,5,12,4
;
;
;       end of secno
;*********************************
;
;
;       bload loads (B) locations with(A) in memory beginning
;       with (hl), incrementing hl as it goes. bl=0
bload:
        ld (hl),a       ;
        inc hl          ;
        dec b           ;
        jr nz,bload     ;
        ret             ;
;
;       end of bload
;***********************************
;       <<NOTE: Would prefer to unload head first to clear dust,
;               etc, but to do so would turn off drive as it is
;               now configured. This is a good area for future
;               modification. 'UNLOAD' has been defined as a
;               'SEEK' without head load or verify. This can
;               be used to unload head in place, by simply
;               loading the data register with the contents
```

```
        call nz, erprnt ; print registers if error
        jp nxtrk        ; do another track
;
;*****************************************
;
;
;       trkfmt formats 1 track of disk according to IBM 3740 format
;       with 256 bytes/sector.
;     . INPUT: register d contains track No.
;
trkfmt:
        ld hl,FMTBLK    ; Beginning of block storage to keep track info
        ld b,40         ; 40 (decimal) bytes to be loaded
        ld a,0ffh       ; A = what to load (ff)
        call bload      ; writes 'B' bytes of (A), incrementing hl
        ld b,6          ;
        ld a,0          ;
        call bload      ; 6 '0's
        ld (hl),0fch    ; fch = index mark
        inc hl          ; point to next location
        ld b,26         ;
        ld a,0ffh       ;
        call bload      ; 26 'ff's
        ld c,15         ; want to write 15 sectors/track
        call sect       ; writes (C) sectors
        ld b,0ffh       ;
        ld a,0ffh       ;
        call bload      ; write a bunch of ff's till timeout
        ret
;
;       end of trkfmt
;*****************************************
;
;
;       sect writes (C) sectors worth of info into memory
;       INPUT: C is no. of sectors to write (destroyed)
;              D is track No. (kept)
;
sect:
        ld b,6          ;
        ld a,0          ;
        call bload      ; bload writes (B) bytes of (A), incs hl
        ld (hl),0feh    ; ID address mark
        inc hl          ;
        ld (hl),d       ; track no.
        inc hl          ;
        ld (hl),0       ; side no. (always 0)
        inc hl          ;
        call secno      ; returns a sector no. in A, given C and D
        ld (hl),a       ; load sector no.
        inc hl          ;
        ld (hl),1       ; sector length (1 -> 256 bytes)
        inc hl          ;
        ld (hl),0f7h    ; f7 writes 2 CRC's
        inc hl          ;
        ld b,11         ;
        ld a,0ffh       ;
        call bload      ; 11 ff's
        ld b,6          ;
        ld a,0          ;
        call bload      ; 6 0's
        ld (hl),0fbh    ; data address mark
        inc hl          ;
        ld b,0          ; setup for 256 bytes of e5
        ld a,0e5h       ;
        call bload      ; actual data field loaded w/ e5
```

```
;               of the track register before issuing. >>
;
restor:                         ; sets disk to track 0
        push af                 ;
        ld a,DSKRST             ; reset the controller
        out (dskcmd),a          ;
        call dskdly             ; wait for that to take effect
        ld a,RESTORE            ; restore, load head, verify
        out (dskcmd),a          ; write to command register
        call waitdk             ; wait for controller to interrupt
        in a,(dskcmd)           ;
        call dskdly             ; wait a few microseconds
        and 010h                ; look for "seek error" bit
        call nz,erprnt          ; print error if found
        jp nz,reboot            ; Give up after printing.
        ld a,0d0h               ; reset controller
        out (dskcmd),a          ;
        call dskdly             ; wait a few microseconds
        pop af                  ;
        ret                     ;
;
;
;*****************************************
;
;       Dskdly delays for 7 x YY microseconds at 2 mhz,
;       or 3.5 x YY at 4 mhz.
dskdly:                         ;
        push af                 ;
        ld a,16                 ; this is "YY"
dly1:   dec a                   ;
        jp nz,dly1              ;
        pop af                  ;
        ret
;
;***********************************
;
;
erprnt:                         ; prints registers and return address
        push af                 ; preserve a register
        call pthxch             ; prints contents of A register
        ld a,h                  ;
        call pthxch             ;
        ld a,l                  ;  print H and L registers
        call pthxch             ;
        ld a,b                  ;
        call pthxch             ; print B register
        ld a,c                  ;
        call pthxch             ; print C register
        ld a, d                 ;
        call pthxch             ; print D register
        ld a,e                  ;
        call pthxch             ; print E register
        inc sp
        inc sp                  ; look at return address
        ex (sp),hl              ; put it in hl and save hl in stack
        ld a,h                  ;
        call pthxch             ; print high byte of return address
        ld a,l                  ;
        call pthxch             ; and low byte
        ex (sp),hl              ; restore the return and hl
        dec sp                  ;
        dec sp                  ; restore the sTACK POINTER
        pop af                  ;
        ret                     ;
;
;
```

```
;***********************************
;
;
conin:                  ; Reads characters from the keyboard,
                        ; checks for special characters,
                        ; returns these to the operating system.
                        ; INPUTS: none.
                        ; OUTPUTS: character in HL
                        ;
        ld a,(keyflg)   ; This flag is set by keyinr
        or a            ;
        jr z,conin      ; Loop until something shows up
        ld a,(kbfptr)   ; Pointer to the last character read
        inc a           ;
        and kbfsze      ; increment modulo kbfsze
        ld (kbfptr),a   ; reload the pointer
        ld c,a          ;
        ld b,0          ;
        ld hl,kbdbuf    ; keyboard buffer starting address
        add hl,bc       ; now HL --> next character in buffer
        ld a,(kbwptr)   ; see if write ptr = read ptr.
        cp c            ; if so, this is the only character there.
        jr nz,conin1    ;
        xor a           ; last character, so clear keyboard flag.
        ld (keyflg),a   ;
conin1:                 ;
        ld a,(hl)       ; read character from buffer
        and 07fh        ; mask parity
        ld l,a          ; normal return has character in HL
        ld h,0          ;
        cp nl_          ; look for line feed
        jr z,nline      ;
        cp 0            ; NULL?
        jr z,eofile     ; end of file.
        cp 013h         ; control-s?
        jr z,conin      ; ignore it.
        cp 011h         ; control-q?
        jp z,0c003h     ; warm start
        cp 018h         ; control-x?
        jp z,0c000h     ; cold start
        ret             ; else just return
nline:                  ;
        ld l,0dh        ; translate to carriage return
        ret             ;
eofile:                 ;
        ld h,080h       ; translate to 8000h
        ret             ;
;
;                       end of conin
;***************************************************************
;
;
conout:                 ; transmits a character to the crt.
                        ; Actually, it interfaces with
                        ; putcrt, which is a software package
                        ; of considerable size that does the
                        ; work.
                        ; INPUTS: character in L
                        ; OUTPUTS: none.
                        ;
        ld a,l          ; gets character into A.
        cp nl_          ; if newline, check for restarts.
        jp z,conout1    ;
        call putcrt     ; writes character in A to CRT.
        ret             ;
conout1:                ;
```

```
        call chkio      ;
        ld a,nl_        ; reload newline (destroyed by chkio)
        call putcrt     ;
        ret             ;
;
;
;                       end conout
;*****************************************************
;
;
chkio:                  ; Tests for system restarts.
        ld a,(09fd6h)   ; This variable allows restarts if zero.
        or a            ;
        ret nz          ; Just return if not allowed to restart.
        ld a,(keyflg)   ; Keyboard flag, set by keyinr.
        or a            ;
        ret z           ; Nothing there? just return.
        ld a,(kbfptr)   ; offset to last character read
        inc a           ;
        and kbfsze      ; increment modulo kbfsze
        ld c,a          ;
        ld b,0          ;
        ld hl,kbdbuf    ; buffer starting address
        add hl,bc       ; points to new character
        ld a,(hl)       ; get the character
        and 07fh        ; mask parity
        cp 011h         ; warm start
        jp z,0c003h     ;
        cp 018h         ; cold start
        jp z,0c000h     ;
        cp 013h         ; control-s?
        jr z,hold       ; stop output
        ret             ; else just return. Note that keyflg is
                        ; still on, so conin will pick up the
                        ; character. kbfptr has also not been
                        ; updated. This may result in multiple
                        ; cold/warm starts.
hold:                   ;
        xor a           ;
        ld (keyflg),a   ; Clear the keyboard flag.
        ld a,c          ; the incremented buffer pointer
        ld (kbfptr),a   ; update kbfptr
holdi:                  ;
        ld a,(keyflg)   ; look for another keystroke
        or a            ;
        jr z,holdi      ; Loop till you see one
        ret             ; then return without reading character,
                        ; or incrementing buffer pointer.
;
;
;                      end chkio
;*****************************************************
;
;
;       BIOS jump table. The following block is relocatable, and
;       should be loaded at 0c057h.
;
xfrtbl: jp conin
        jp conout
        jp load
        jp save
        jp format
;
;
;*****************************************************
;
```

```
;       RAM Definitions
;
addr:   dw      0h      ; place to store the address from keyboard
keyflg: db      0h      ; flag set when keyboard is depressed
kbfptr: db      0h      ; offset for reads from keyboard buffer
kbwptr: db      0h      ; keyboard entry pointer
curse:  dw      0h      ; address of cursor
blink:  db      0h      ; Blinker status (on = 1, off = 0)
cstat:  db      0h      ; status of cursor (on = 1, off = 0)
dskrdy: db      0h      ; disk ready flag
timflg: db      0h      ; timer flag
strtlc: dw      0h      ; starting memory location for transfers to IO
endloc: dw      0h      ; end memory location, or number of blocks fo IO
tnode:  dw      0h      ; INODE for disk or tape
temp1:  db      0h      ; just a utility spot
dskid:  db      0h      ; the loaded disk id
trflg:  db      0h      ; tape read flag
;
tpbuf:  db      0h      ; single byte tape buffer
stpflg: db      0h      ; danged if I know what that is!
;
kbdbuf: ds      64      ; keyboard buffer (64 bytes)
rwflg:  db      0       ; disk read/write flag.
crtmod: db      0       ; Mode of CRT
rowno:  db      0       ; Row address variable, for direct cursor address
dsktry: db      0       ; Number of tries to read/write disk (usually 5)
```