CP/M Plus™
(CP/M Version 3.0)
Operating System

System Guide

Foreworci

CP/M(R) 3, also marketed as CP/M Plus(R) , is a single-console operating system for 8-bit machines that use an Intel(R) 8080, 8085, or Zilog(R) Z80(R) CPU. CP/M 3 is upward-compatible with its predecessor, CP/M 2, and offers more features and higher performance than CP/M 2. This manual describes the steps necessary to create or modify a CP/M 3 Basic Input Output System (BIOS) tailored for a specific hardware environment.

The CP/M Plus (CP/M Version 3) Operating System System Guide (hereafter cited as CP/M Plus System Guide) assumes you are familiar with systems programming in 8080 assembly language and that you have access to a CP/M 2 system.   It also assumes you understand the target hardware and that you have functioning disk I/O drivers. You should be familiar with the accompanying CP/M Plus (CP/M Version 3) Operating System User's Guide (hereafter cited as CP/M Plus User's Guide) describing the operating system utilities. You should also be familiar with the CP/M Plus (CP/M Version 3) Operating system Programmer's Guide (hereafter cited as CP/M Plus Programmer's Guide), which describes the system calls use by the applications programmer to interface with the operating system. The Programmer' s Utilities Guide for the CP/M Family of Operating Systems (hereafter cited as Programmer's Utilities Guide) documents the assembling and debugging utilities.

Section 1 of this manual is an overview of the component modules of the CP/M 3 operating system.   Section 2 provides an overview of the functions and data structures necessary to write an interface module between CP/M 3 and specific hardware. Section 3 contains a detailed description of these functions and data structures, followed by instructions to assemble and link the distributed modules with your customized modules. Section 4 describes the modular organization of the sample CP/M 3 BIOS on your distribution diskette.   Section 5 documents the procedure to generate and boot your CP/M 3 system.   Section 6 is a sample debugging session.

The appendixes contain tables, and sample BIOS modules you can use, or study and modify.   Appendix A discusses removable media drives. Appendix B discusses automatic density support. Appendix C describes how CP/M 3 differs from CP/M 2.   Appendix D shows the format of the CPM3.SYS file.

Appendixes E through H are listings of the assembled source code for the four hardware-independent modules of the sample BIOS. Appendix E is the kernel module to use when creating a modular BIOS in the form of the distributed sample. Appendix F shows the System Control Block.   Appendix G is a table of equates for the baud rate and mode byte for character I/O. Appendix H contains the macro definitions you can use to generate some of the CP/M 3 disk data structures. Appendix I lists the assembled source code for the six BIOS modules that depend on the Altos@ 8000-15 Computer System hardware. It also contains a sample Submit file to build a BIOS.

Appendixes J and K are tabular summaries of the public entry points and data items in the modules of the sample BIOS. Finally, Appendix L is a tabular summary of the thirty-three functions of the CP/M 3 BIOS, complete with entry parameters and returned values.

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Section 1

CP/M 3 Operating System Overview

This section is an overview of the CP/M 3 operating system, with a description of the system components and how they relate to each other. The section includes a discussion of memory configurations and supported hardware. The last portion summarizes the creation of a customized version of the CP/M 3 Basic Input Output System (BIOS).

1.1 Introduction to CP/M 3

CP/M 3 provides an environment for program development and execution on computer systems that use the Intel 8080, 8085, -or ZBO microprocessor chip. CP/M 3 provides rapid access to data and programs through a file structure that supports dynamic allocation of space for sequential and random access files.

CP/M 3 supports a maximum of sixteen logical floppy or hard disks with a storage capacity of up to 512 megabytes each. The maximum file size supported is 32 megabytes. You can configure the number of directory entries and block size to satisfy various user needs.

CP/M 3 is supplied in two versions. One version supports nonbank-switched memory; the second version supports hardware with bank-switched memory capabilities. CP/M 3 supplies additional facilities for the bank-switched system, including extended command line editing, password protection of files, and extended error messages.

The nonbanked system requires 8.5 kilobytes of memory, plus space for your customized BIOS. It can execute in a minimum of 32 kilobytes of memory.

The bank-switched system requires a minimum of two memory banks with 11 kilobytes of memory in Bank 0 and 1.5 kilobytes in common memory, plus space for your customized BIOS. The bank-switched system provides more user memory for application programs.

CP/M 3 resides in the file CPM3.SYS, which is loaded into memory by a system loader during system initialization. The system loader resides on the first two tracks of the system disk. CPM3.SYS contains the distributed BDOS and the customized BIOS.

The CP/M 3 operating system is distributed on two single- density, single-sided, eight-inch floppy disks. Digital Research supplies a sample BIOS that is configured for an Altos 8000-15 microcomputer system with bank-switched memory and two single- density, single-sided, eight-inch floppy disk drives.

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1.2 CP/M 3 System Components

The CP/M 3 operating system consists of the following three modules: the Console Command Processor (CCP), the Basic Disk Operating System (BDOS), and the Basic Input Output System (BIOS).

The CCP is a program that provides the basic user interface to the facilities of the operating system. The CCP supplies six built- in commands: DTR, DIRS, ERASE, RENAME, TYPE, and USER. The CCP executes in the Transient Program Area (TPA), the region of memory where all application programs execute.   The CCP contains the Program Loader Module, which loads transient (applications) programs from disk into the TPA for execution.

The BDOS is the logical nucleus and file system of CP/M 3. The BDOS provides the interface between the application program and the physical input/output routines of the BIOS.

The BIOS is a hardware-dependent module that interfaces the BDOS to a particular hardware environment. The BIOS performs all physical I/O in the system.   The BIOS consists of a number of routines that you must configure to support the specific hardware of the target computer system.

The BDOS and the BIOS modules cooperate to provide the CCP and other transient programs with hardware-independent access to CP/M 3 facilities. Because the BIOS is configured for different hardware environments and the BDOS remains constant, you can transfer programs that run under CP/M 3 unchanged to systems with different hardware configurations.

1.3 Communication Between Modules

The BIOS loads the CCP into the TPA at system cold and warm start. The CCP moves the Program Loader Module to the top of the TPA and uses the Program Loader Module to load transient programs.

The BDOS contains a set of functions that the CCP and applications programs call to perform disk and character input and output operations.

The BIOS contains a Jump Table with a set of 33 entry points that the BDOS calls to perform hardware-dependent primitive functions, such as peripheral device I/O. For example, CONIN is an entry point of the BIOS called by the BDOS to read the next console input character.

Similarities exist between the BDOS functions and the BIOS functions, particularly for simple device I/O. For example, when a transient program makes a console output function call to the BDOS, the BDOS makes a console output call to the BIOS. In the case of disk I/O, however, this relationship is more complex.   The BDOS might make many BIOS function calls to perform a single BDOS file I/O function.   BDOS disk I/O is in terms of 128-byte logical records. BIOS disk I/O is in terms of physical sectors and tracks.

The System Control Block (SCB) is a 100-byte, decimal, CP/M 3 data structure that resides in the BDOS system component. The BDOS and the BIOS communicate through fields in the SCB. The SCB contains BDOS flags and data, CCP flags and data, and other system information, such as console characteristics and the current date and time. You can access some of the System Control Block fields from the BIOS.

Note that the SCB contains critical system parameters which reflect the current state of the operating system. If a program modif i es these parameters, the operating system can crash. See Section 3 of this manual, and the description of BDOS Function 49 in the CP/M Plus Proqrammer's Guide for more information on the System Control Block.

Page Zero is a region of memory that acts as an interface between transient programs and the operating system. Page Zero contains critical system parameters, including the entry to the BDOS and the entry to the BIOS Warm BOOT routine. At system start-up, the BIOS initializes these two entry points in Page Zero.   All linkage between transient programs and the BDOS   is restricted to the indirect linkage through Page Zero. Figure 1-1 illustrates the general memory organization of CP/M 3.

```
High memory:        ┌─────────────────────────────────────────┐
                    │                                         │
                    │         BIOS: Basic I/O System          │
                    │                                         │
BIOS_base:          ├─────────────────────────────────────────┤
                    │                                         │
                    │      BDOS: Basic Disk Operating System  │
                    │                                         │
BDOS_base:          ├─────────────────────────────────────────┤
                    │                                         │
                    │      LOADER:  Program Loader Module     │
                    │              Component of CCP           │
LOADER_base:        ├─────────────────────────────────────────┤
                    │                                         │
          TPA       │      TPA: Transient Program Area        │
                    │                                         │
                    ├─────────────────────────────────────────┤
                    │                                         │
                    │   CCP: Console Command Processor        │
                    │                                         │
0100H:              ├─────────────────────────────────────────┤
                    │                                         │
                    │           PAGE ZERO                     │
                    │                                         │
0000H:              └─────────────────────────────────────────┘
```
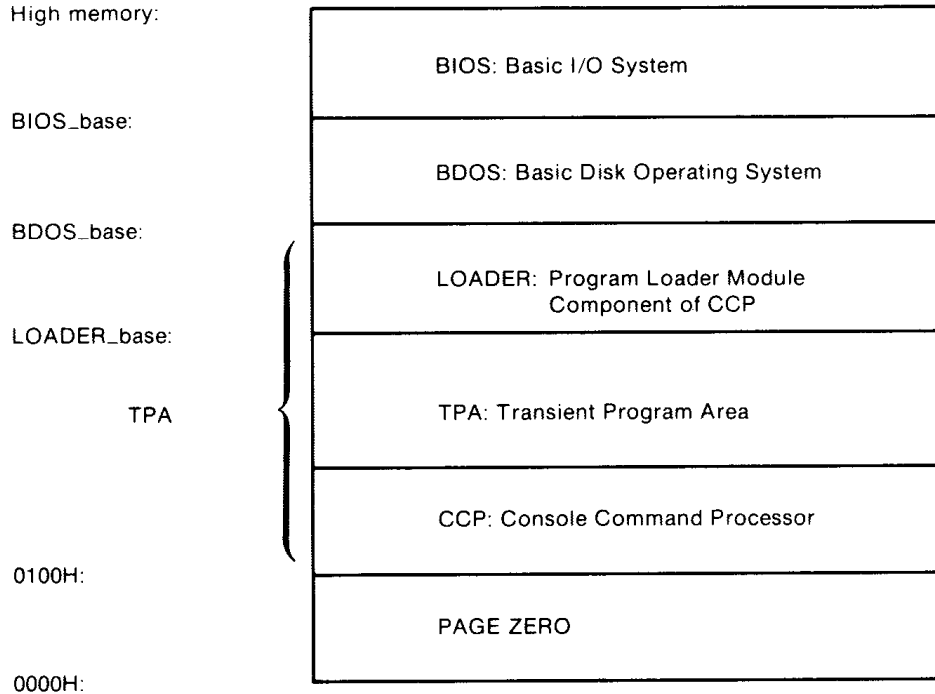
Figure 1-1. General Memory Organization of CP/M 3

Note that all memory regions in CP/M 3 are page aligned, which means that they must begin on a page boundary. Because a page is defined as 256 (100H) bytes, a page boundary always begins at a hexadecimal address where the low-order byte of the hex address is zero.

1.4 Banked and Nonbanked Systems

CP/M 3 is supplied in two versions: one for hardware that supports banked memory, and the other for hardware with a minimum of 32 kilobytes of memory. The systems are called banked and nonbanked.

Digital Research supplies System Page Relocatable (. SPR) files for both a banked BDOS and a nonbanked BDOS. A sample banked BIOS is supplied for you to use as an example when creating a customized BIOS for your set of hardware components.

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The following figure shows the memory organization for a banked system. Bank 0 and common memory are for the operating system. Bank 1 is the Transient Program Area, which contains the Page Zero region of memory. You can use additional banks to enhance operating system performance.

In banked CP/M 3 systems, CPMLDR, the system loader, loads part of the BDOS into common memory and part of the BDOS into Bank 0. CPMLDR loads the BIOS in the same manner.

Figure 1-2 shows the memory organization for the banked version of CP/M 3.

Figure 1-2. Memory organization for Banked CP/M 3 System
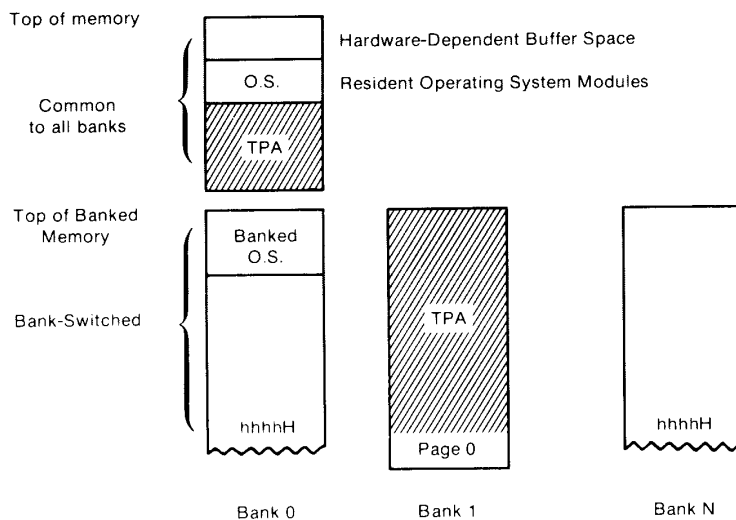
In this figure, the top region of memory is called common memory. Common memory is always enabled and addressable. The operating system is divided into two modules: the resident portion, which resides in common memory, and the banked portion, which resides just below common memory in Bank 0.

The shaded areas in Figure 1-2 represent the memory available to transient programs. The clear areas are used by the operating system for disk record buffers and directory hash tables. The clear area in the common region above the operating system represents

space that can be allocated for data buffers by GENCPM, the CP/M 3 system generation utility. The size of the buffer area is determined by the specific hardware requirements of the host microcomputer system.

Bank 0, the system bank, is the bank that is enabled when CP/M 3 is cold started. Bank 1 is the transient program bank.

The transient program bank must be contiguous from location zero to the top of banked memory. Common memory must also be contiguous. The other banks need not begin at location zero or have contiguous memory.

Figure 1-3 shows the CP/M 3 memory organization when the TPA bank, Bank 1, is enabled in a bank-switched system.
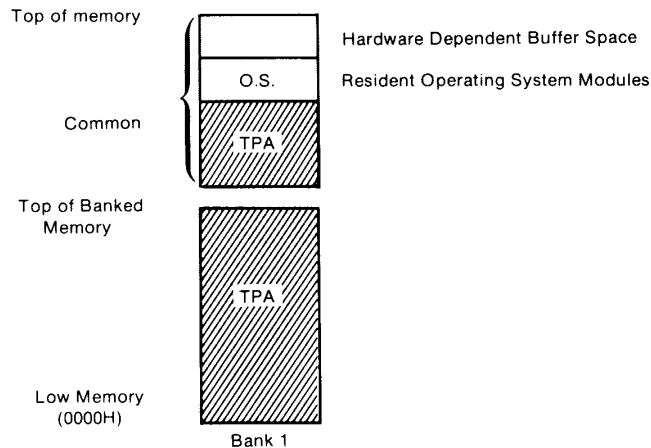
Figure 1-3. Memory Organization with Bank I Enabled
               in Banked System

The operating system switches to Bank 0 or other banks when performing operating system functions. In general, any bank switching performed by the operating system is transparent to the calling program.

The memory organization for the nonbanked version of CP/M 3 is much simpler, as shown in Figure 1-4:
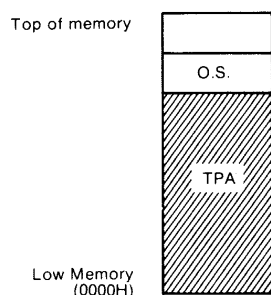
Figure 1-4. Memory Organization in Nonbanked CP/M 3 System

In the nonbanked version of CP/M 3, memory consists of a single contiguous region addressable from OOOOH up to a maximum of OFFFFH, or 64K-1.   The clear area above the operating system represents space that can be allocated for data buffers and directory hash tables by the CP/M 3 system generation utility, GENCPM, or directly allocated by the BIOS. The minimum size of the buffer area is determined by the specific hardware requirements of the host microcomputer system. Again, the shaded region represents the space available for transient programs.

1.5 Memory Requirements

Table 1-1 shows typical sizes of the CP/M 3 operating system components.

Table 1-1. CP/M 3 Operating System Memory Requirements

CP/M 3 Version	Nonbanked	Banked	
		Common	Bank 0
BDOS	8.5K	1.5K	11K
BIOS (values vary)			
floppy system	1.5K	.75K	2K
hard system	2.5K	1.5K	3K

The CP/M 3 banked system requires a minimum of two banks (Bank 0 and Bank 1) and can support up to 16 banks of memory. The size of the common region is often 16K, but can be as small as 4K. Common memory must be large enough to contain the required buffers and the resident (common) portion of the operating system, which means a 1.5K BDOS and the common part of your customized BIOS.

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In a banked environment, CP/M 3 maintains a cache of deblocking buffers and directory records using a Least Recently Used (LRU) buffering scheme. The LRU buffer is the first to be reused when the system runs out of buffer space. The BDOS maintains separate buffer pools for directory and data record caching.

The RSX modules shown in Figure 1-5 are Resident System Extensions (RSX) that are loaded directly below the operating system when included in an application or utility program. The Program Loader places the RSX in memory and chains BDOS calls through the RSX entry point in the RSX.

Figure 1-5 shows the memory organization in a typical bank- switched CP/M 3 system.
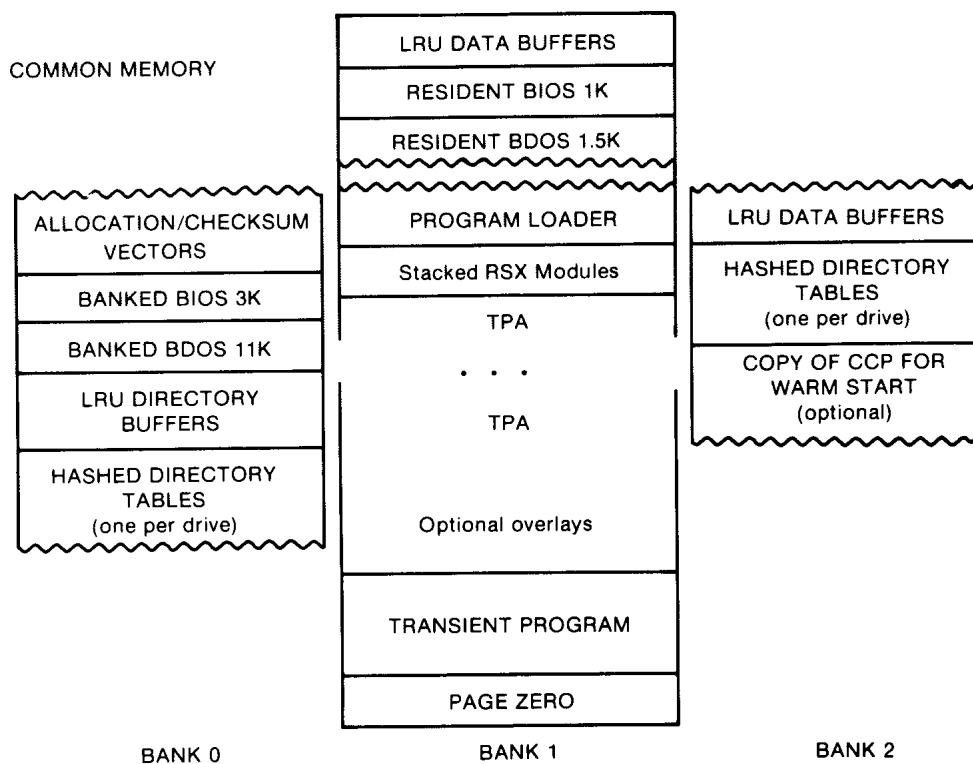
Figure 1-5. Memory Organization in Banked CP/M 3

The banked system supports a TPA of 60K or more. The banked portion of the operating system in Bank 0 requires at least 16K of memory.

In the banked system, the BDOS and the BIOS are separated into two parts: a resident portion, and a banked portion. The resident BDOS and BIOS are located in common memory. The banked BDOS and BIOS are located in the operating system bank, referred to as Bank 0 in this manual.

The TPA extends from 100H in Bank 1 up to the bottom of the resident BDOS in common memory. The banked BIOS and BDOS reside in Bank 0 with the directory buffers. Typically, all data buffers reside in common. Data buffers can reside in an alternate bank if the system has a DMA controller   capable of transferring arbitrary blocks of data from one bank to another. Hashed directory tables (one per drive) can be placed   in any bank except Bank 1 (TPA). Hashed directory tables require   4 bytes per directory entry.

Figure 1-6 shows a typical nonbanked system configuration.

```
+-----------------------------------+
|  Buffers and Hash Tables          |
|-----------------------------------|
|  BIOS                             |
|-----------------------------------|
|  BDOS                             |
|-----------------------------------|
|  PROGRAM LOADER                   |
+-----------------------------------+
                 .
                 .
                 .
+-----------------------------------+
|  Optional overlays                |
|-----------------------------------|
|  TRANSIENT PROGRAM                |
|-----------------------------------|
|  BASE PAGE 0h-100h                |
+-----------------------------------+
```
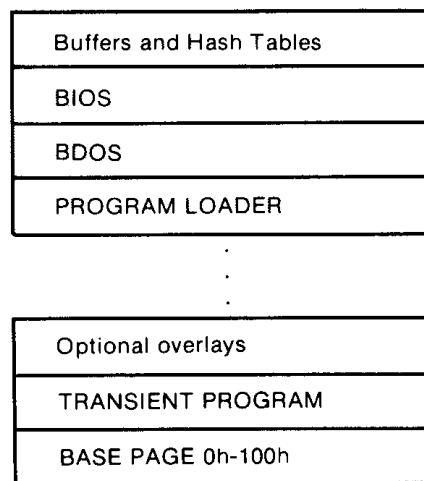
Figure 1-6. Memory organization in Nonbanked CP/M 3

The nonbanked CP/M 3 system requires 8.5K of memory plus space for the BIOS, buffers, and hash tables, allowing a TPA size of up to 52K to 54K, depending on the size of the BIOS and the number of hash tables and buffers you are using.

1.6 Disk Organization

Figure 1-7 illustrates the organization of a CP/M 3 system disk.
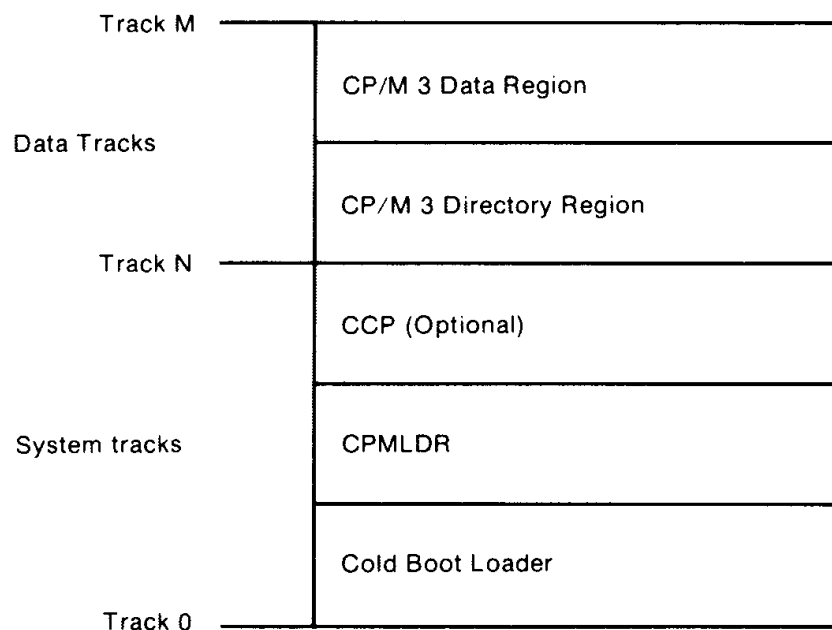
Figure 1-7. CP/M 3 System Disk Organization

In Figure 1-7, the first N tracks are the system tracks; the remaining tracks, the data tracks, are used by CP/M 3 for file storage. Note that the system tracks are used by CP/M 3 only during system cold start and warm start. All other CP/M 3 disk access is directed to the data tracks of the disk. To maintain compatibility with Digital Research products, you should use an eight-inch, single-density, IBM' 3740 formatted disk with two system tracks.

1.7 Hardware Supported

You can customize the BIOS to match any hardware environment with the following general characteristics.

1.7.1 Hardware Supported by CP/M 3 Banked System

o Intel 8080, Intel 8085, or zilog Z80 CPU or equivalent.

o A minimum of two and up to sixteen banks of memory with the top
  4K-32K in common memory. Bank 1 must have contiguous memory
  from address 0000H to the base of common memory. A reasonable
  configuration consists of two banks of 48K RAM each, with the
  top 16K in common memory.
o one to sixteen disk drives of up to 512 megabytes capacity
  each.
o Some form of ASCII console device, usually a CRT.
o One to twelve additional character input and or output devices,
   such as printers, communications hardware, and plotters.

1.7.2 Hardware Supported by CP/M 3 Nonbanked System

o Intel 8080, Intel 8085, or Zilog Z80 CPU or equivalent.
o A minimum of 32K and up to 64K contiguous memory addressable
  from location zero.
o One to sixteen disk drives of up to 512 megabytes capacity
  each.
o Some form of ASCII console device, usually a CRT.
o One to twelve additional input and or output devices, usually
  including a printer.

Because most CP/M-compatible software is distributed on eight- inch, soft-sectored, single-density floppy disks, it is recommended that a CP/M 3 hardware configuration include a minimum of two disk drives, at least one of which is a single-density floppy disk drive.

1.8 Customizing CP/M 3

Digital Research supplies the BDOS files for a banked and a nonbanked version of CP/M 3. A system generation utility, GENCPM, is provided with CP/M 3 to create a version of the operating system tailored to your hardware. GENCPM combines the BDOS and your customized BIOS files to create a CPM3.SYS file, which is loaded into memory at system start-up. The CPM3.SYS file contains the BDOS and BIOS system components and information indicating where these modules reside in memory.

Digital Research supplies a CP/M 3 loader file, CPMLDR, which you can link with your customized loader BIOS and use to load the CPM3.SYS file into memory. CPMLDR is a small, self-contained version of CP/M 3 that supports only console output and sequential file input. Consistent with CP/M 3 organization, it contains two modules: an invariant CPMLDR BDOS, and a variant CPMLDR-BIOS, which is adapted to match the host microcomputer hardware environment. The CPMLDR BIOS module can perform cold start initialization of I/O ports and similar functions. CPMLDR can display a memory map of the CP/M 3 system at start-up. This is a GENCPM option.

The following steps tell you how to create a new version of CP/M 3 tailored to your specific hardware.

1)   Write and assemble a customized BIOS following the specif ications described in Section 3. This software module must correspond to the exact physical characteristics of the target system, including memory and port addresses, peripheral types, and drive characteristics.

2)   Use the system generation utility, GENCPM, to create the CPM3.SYS file containing the CP/M 3 distributed BDOS and your customized BIOS, as described in Section 5.

3)   Write a customized loader BIOS (LDRBIOS) to reside on the system tracks as of CPMLDR. CPMLDR loads the CPM3.SYS file into memory from disk. Section 5 gives the instructions for customizing the LDRBIOS and generating CPMLDR.   Link your customized LDRBIOS file with the supplied CPMLDR file.

4)   Use the COPYSYS utility to put CPMLDR on the system tracks of a disk.

5)   Test and debug your customized version of CP/M 3.

If you have banked memory, Digital Research recommends that you first use your customized BIOS to create a nonbanked version of the CP/M 3 operating system. You can leave your entire BIOS in common memory until you have a working system. Test all your routines in a nonbanked version of CP/M 3 before you create a banked version.

1.9 Initial Load (Cold Boot) of CP/M 3

CP/M 3 is loaded into memory as follows. Execution is initiated by a four-stage procedure. The first stage consists of loading into memory a small program, called the Cold Boot Loader, from the system tracks of the Boot disk. This load operation is typically handled by a hardware feature associated with system reset. The Cold Boot Loader is usually 128 or 256 bytes in length.

In the second   stage, the Cold Boot Loader loads the   memory image of the CP/M 3 system loader program, CPMLDR, from the   system tracks of a disk into memory and passes control to it. For a   banked system, the Cold Boot Loader loads CPMLDR into Bank 0.   A PROM loader can perform stages one and two.

In the third stage, CPMLDR reads the CPM3.SYS f ile, which contains the BDOS and customized BIOS, from the the data area   of the disk into the memory addresses assigned by GENCPM.   In a banked system, CPMLDR reads the common part of the BDOS and BIOS into the common part of memory, and reads the banked part of the BDOS and BIOS into the area of memory below common base in Bank 0. CPMLDR then transfers control to the Cold BOCT system initialization routine in the BIOS.

For the f inal stage, the BIOS Cold BOOT routine, BIOS Function 0, performs any remaining necessary hardware initialization, displays the sign-on message, and reads the CCP from the system tracks or from a CCP.COM file on disk into location IOOH of the TPA. The Cold BOOT routine transfers control to the CCP, which then displays the system prompt.

Section 2 provides an overview of the organization of the System Control Block and the data structures and functions in the CP/M 3 BIOS.

End of Section 1

Section 2

CP/M 3 BIOS Overview

This section describes the organization of the CP/M 3 BIOS and the BDOS jump vector. It provides an overview of the System Control Block, followed by a discussion of system initialization procedures, character I/O, clock support, disk I/O, and memory selects and moves.

2.1 Organization of the BIOS

The BIOS is the CP/M 3 module that contains all hardware- dependent input and output routines. To configure CP/M 3 for a particular hardware environment, use the sample BIOS supplied with this document and adapt it to the specific hardware of the target system.

Alternatively, you can modify an existing CP/M 2.2 BIOS to install CP/M 3 on your target machine. Note that an unmodified CP/M 2.2 BIOS does not work with the CP/M 3 operating system. See Appendix C for a description of the modifications necessary to convert a CP/M 2.2 BIOS to a CP/M 3 BIOS.

The BIOS is a set of routines that performs system initialization, character-oriented I/O to the console and printer devices, and physical sector I/O to the disk devices. The BIOS also contains routines that manage block moves and memory selects for systems with bank-switched memory. The BIOS supplies tables that define the layout of the disk devices and allocate buffer space which the BDOS uses to perform record blocking and deblocking. The BIOS can maintain the system time and date in the System Control Block.

Table 2-1 describes the entry points into the BIOS from the Cold Start Loader and the BDOS. Entry to the BIOS is through a jump vector. The jump vector is a set of 33 jump instructions that pass program control to the individual BIOS subroutines.

You must include all of the entry points in the BIOS jump vector in your BIOS. However, if your system does not support some of the functions provided for in the BIOS, you can use empty subroutines for those functions. For example, if your system does not support a printer, JMP LIST can reference a subroutine consisting of only a RET instruction. Table 2-1 shows the elements of the jump vector.

Table 2-1. CP/M 3 BIOS Jump Vector

No.	Instruction	Description
0	JMP BOOT	Perform cold start initialization
1	JMP WBOOT	Perform warm start initialization
2	JMP CONST	Check for console input character ready
3	JMP CONIN	Read Console Character in
4	JMP CONOUT	Write Console Character out
5	JMP LIST	Write List Character out
6	JMP AUXOUT	Write Auxiliary Output Character
7	JMP AUXIN	Read Auxiliary Input Character
8	JMP HOME	Move to Track 00 on Selected Disk
9	JMP SELDSK	Select Disk Drive
10	JMP SETTRK	Set Track Number
11	JMP SETSEC	Set Sector Number
12	JMP SETDMA	Set DMA Address
13	JMP READ	Read Specified Sector
14	JMP WRITE	Write Specified Sector
15	JMP LISTST	Return List Status
16	JMP SECTRN	Translate Logical to Physical Sector
17	JMP CONOST	Return Output Status of Console
18	JMP AUXIST	Return Input Status of Aux. Port
19	JMP AUXOST	Return Output Status of Aux. Port
20	JMP DEVTBL	Return Address of Char. I/O Table
21	JMP DEVINI	Initialize Char. I/O Devices
22	JMP DRVTBL	Return Address of Disk Drive Table
23	JMP MULTIO	Set Number of Logically Consecutive sectors to be read or written
24	JMP FLUSH	Force Physical Buffer Flushing for user-supported deblocking
25	JMP MOVE	Memory to Memory Move
26	JMP TIME	Time Set/Get signal
27	JMP SELMEM	Select Bank of memory
28	JMP SETBNK	Specify Bank for DMA Operation
29	JMP XMOVE	Set Bank When a Buffer is in a Bank other than 0 or 1
30	JMP USERF	Reserved for System Implementor
31	JMP RESERV1	Reserved for Future Use
32	JMP RESERV2	Reserved for Future Use

Each jump address in Table 2-1 corresponds to a particular subroutine that performs a specific system operation. Note that two entry points are reserved for future versions of CP/M, and one entry point is provided for OEM subroutines, accessed only by direct BIOS calls using BDOS Function 50. Table 2-2 shows the five categories of system operations and the function calls that accomplish these operations.

Table 2-2. CP/M 3 BIOS Functions

Operation   Function

System Initialization
          BOOT, WBOOT, DEVTBL, DEVINI, DRVTBL

Character I/O
          CONST, CONIN, CONOUT, LIST, AUXOUT, AUXIN,
          LISTST, CONOST, AUXIST, AUXOST

Disk I/O
          HOME, SELDSK, SETTRK, SETSEC, SETDMA,
          READ, WRITE, SECTRN, MULTIO, FLUSH

Memory Selects and Moves
          MOVE, SELMEM, SETBNK, XMOVE

Clock Support
          TIME

You do not need to implement every function in the BIOS jump vector. However, to operate, the BDOS needs the BOOT, WBOOT, CONST, CONIN, CONOUT, HOME, SELDSK, SETTRK, SETSEC, SETDMA, READ, WRITE, SECTRN, MULTIO, and FLUSH subroutines. Implement SELMEM and SETBNK only in a banked environment. You can implement MULTIO, FLUSH, and TIME as returns with a zero in register A. DEVICE and some other utilities use the remaining entry points, but it is not necessary to fully implement them in order to debug and develop the system.

Note: include all routines but make the nonimplemented routines a RET instruction.

2.2 System Control Block

The System Control Block (SCB) is a data structure located in the BDOS. The SCB is a communications area referenced by the BDOS, the CCP, the BIOS, and other system components. The SCB contains system parameters and variables, some of which the BIOS can reference.   The fields of the SCB are named, and definitions of these names are supplied as public variable and subroutine names in the SCB.ASM file contained on the distribution disk. See Section 3.1 for a discussion of the System Control Block.

2.3 System Initialization

When the BOOT and WBOOT routines of the BIOS get control, they
must initialize two system parameters in Page Zero of memory, as
shown in Table 2-3.

Table 2-3. Initialization of Page Zero

Location	Description
0,1,2	Set to JMP WBOOT (0000H: JMP BIOS+3). Location 1 and 2 must contain the address of WBOOT in the jump vector.
5,6,7	Set to JMP BDOS, the primary entry point to CP/M 3 for transient programs. The current address of the BDOS is maintained in the variable @MXTPA in the System Control Block. (See Section 3.1, "System Control Block," and BIOS Function 1: WBOOT on page 52.)

The BOOT and WBOOT routine must load the CCP into the TPA in Bank I at location
0100H. The CCP can be loaded in two ways. If there is sufficient space on the system tracks,
the CCP can be stored on the system tracks and loaded from there. If you prefer, or if there is not
sufficient space on the system tracks, the BIOS Cold BOOT routine can read the CCP into
memory from the file CCP.COM on disk.

If the CCP is in a COM file, use the BOOT and WBOOT routines to perform any necessary
system initialization, then use the BDOS functions to OPEN and READ the CCP.COM file into
the TPA. In bank- switched systems, the CCP must be read into the TPA in Bank 1.

In bank-switched systems, your Cold BOOT routine can place a copy of the CCP into a
reserved area of an alternate bank after loading the CCP into the TPA in Bank 1. Then the Warm
BOOT routine can copy the CCP into the TPA in Bank 1 from the alternate bank, rather than
reloading the CCP from disk, thus avoiding all disk accesses during warm starts.

There is a 128-byte buffer in the resident portion of the BDOS in a banked system that can
be used by BOOT and WBOOT. The address of this buffer is stored in the SCB variable
@BNKBF. BOOT and WBOOT can use this buffer when copying the CCP to and from the
alternate bank.

The system tracks for CP/M 3 are usually partitioned as shown in the following figure;

| Cold Start Ldr	CPMLDR	CCP (optional)
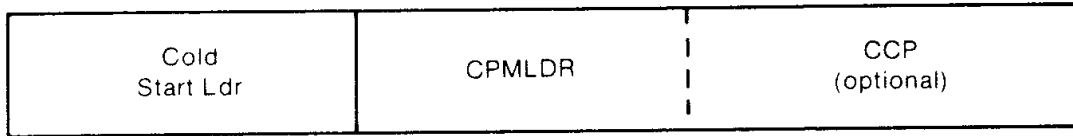
Figure 2-1. CP/M 3 System Tracks

The cold start procedure is designed so you need to initialize the system tracks only once. This is possible because the system tracks contain the system loader and need not change when you change the CP/M 3 operating system. The Cold Start Loader loads CPMLDR into a constant memory location that is chosen when the system is configured. However, CPMLDR loads the BDOS and BIOS system components into memory as specified in the CPM3.SYS file generated by GENCPM, the system generation utility. Thus, CP/M 3 allows the user to configure a new system with GENCPM and then run it without having to update the system tracks of the system disk.

2.4 Character I/O

CP/M 3 assumes that all simple character I/O operations are performed in 8-bit ASCII, upper- and lowercase, with no parity. An ASCII CRTL-Z (lAH) denotes an end-of-file condition for an input device.

Table 2-4 lists the characteristics of the logical devices.

Table 2-4. CP/M 3 Logical Device Characteristics

Device	Characteristics
CONIN, CONOUT	T h e interactive console that communicates with the operator, accessed by CONST, CONIN, CONOUT, and CONOUTST. Typically, the CONSOLE is a device such as a CRT or teletype, interfaced serially, but it can also be a memory-mapped video display and keyboard. The console is an input device and an output device.
LIST	The system printer, if it exists on your system. LIST is usually a hard- copy device such as a printer or teletypewriter.
AUXOUT	The auxiliary character output device, such as a modem.
AUXIN	The auxiliary character input device, such as a modem.

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Note that you can define a single peripheral as the LIST, AUXOUT, and AUXIN device simultaneously.   If you assign no peripheral device as the LIST, AUXOUT, or AUXIN device, the AUXOUT and LIST routines can just return, and the AUXIN routine can return with a 1AH (CTRL-Z) in register A to indicate an immediate end-of-file.

CP/M 3 supports character device I/O redirection. This means that you can direct a logical device, such as CONIN or AUXOUT, to one or more physical devices. The DEVICE utility allows you to reassign devices and display, and to change the current device configurations, as described in the CP/M Plus User's Guide. The I/O redirection facility is optional. You should not implement it until the rest of your BIOS is fully functional.

2.5 Disk I/O

The BDOS accomplishes disk I/O by making a sequence of calls to the various disk access subroutines in the BIOS. The subroutines set up the disk number to access, the track and sector on a particular disk, and the Direct Memory Access (DMA) address and bank involved in the I/O operation. After these parameters are established, the BDOS calls the READ or WRITE function to perform the actual I/O operation.

Note that the BDOS can make a single call to SELDSK to select a disk drive, follow it with a number of read or write operations to the selected disk, and then select another drive for subsequent operations.

CP/M 3 supports multiple sector read or write operations to optimize rotational latency on block disk transfers. You can implement the multiple sector I/O facility in the BIOS by using the multisector count passed to the MULTIO entry point. The BDOS calls MULTIO to read or write up to 128 sectors. For every sector number 1 to n, the BDOS calls SETDMA then calls READ or WRITE.

Table 2-5 shows the sequence of BIOS calls that the BDOS makes to read or write a physical disk sector in a nonbanked and a banked system. Table 2-6 shows the sequence of calls the BDOS makes to the BIOS to read or write multiple contiguous physical sectors in a nonbanked and banked system.

Table 2-5. BDOS Calls to BIOS in Nonbanked and Banked Systems

Nonbanked BDOS

Call	Explanation
SELDSK	Called only when disk is initially selected or reselected.
SETTRK	Called for every read or write of a physical sector.
SETSEC	Called for every read or write of a physical sector.
SETDMA	Called for every read or write of a physical sector.
READ, WRITE	Called for every read or write of a physical sector.

Banked BDOS

Call	Explanation
SELDSK	Called only when disk is initially selected or reselected.
SETTRK	Called for every read or write of a physical sector.
SETSEC	Called for every read or write of a physical sector.
SETDMA	Called for every read or write of a physical sector.
SETBNK	Called for every read or write of a physical sector.
READ, WRITE	Called for every read or write of a physical sector.

Table 2-6. Multiple Sector I/O in Nonbanked and Banked Systems

Nonbanked BDOS

Call	Explanation
SELDSK	Called only when disk is initially selected or reselected.
MULTIO	Called to inform the BIOS that the next n calls to disk READ or disk WRITE require a transfer of n contiguous physical sectors to contiguous memory.
SETTRK	Called for every read or write of a physical sector.
SETSEC	Called for every read or write of a physical sector.
SETDMA	Called for every read or write of a physical sector.
READ, WRITE	Called for every read or write of a physical sector.

Banked BDOS

Call	Explanation
SELDSK	Called only when disk is initially selected or reselected.
MULTIO	Called to inform the BIOS that the next n calls to disk READ or disk WRITE require a transfer of n contiguous physical sectors to contiguous memory.
SETTRK	Called for every read or write of a physical sector.
SETSEC	Called for every read or write of a physical sector.
SETDMA	Called for every read or write of a physical sector.
SETBNK	Called for every read or write of a physical sector.
READ, WRITE	Called for every read or write of a physical sector.

Table 2-7 shows the sequence of BDOS calls to read two contiguous physical sectors in a banked system.

Table 2-7. Reading Two Contiguous Sectors in Banked System

Call	Explanation
SELDSK	Called to initially select disk
MULTIO	With a value of 2
SETTRK	For first sector
SETSEC	For first sector
SETDMA	For first sector
SETBNK	
READ	
SETTRK	For second sector
SETSEC	For second sector
SETDMA	For second sector
SETBNK	
READ	

The CP/M 3 BDOS performs its own blocking and deblocking of logical 128-byte records. Unlike earlier versions of CP/M, the BIOS READ and WRITE routines always transfer physical sectors as specified in the Disk Parameter Block to or from the DMA buffer. The Disk Parameter Header defines one or more physical sector buffers which the BDOS uses for logical record blocking and deblocking.

In a banked environment, CP/M 3 maintains a cache of deblocking buffers and directory records using a Least Recently Used (LRU) buffering scheme. The LRU buffer is the first to be reused when the system runs out of buffer space. The BDOS maintains separate buffer pools for directory and data record caching.

The BIOS contains the data structures to control the data and directory buffers and the hash tables. You can either assign these buffers and tables yourself in the BIOS, or allow the GENCPM utility to generate them automatically.

Hash tables greatly speed directory searching. The BDOS can use hash tables to determine the location of directory entries and therefore reduce the number of disk accesses required to read a directory entry. The hash table allows the BDOS to directly access the sector of the directory containing the desired directory entry without having to read the directory sequentially. By eliminating a sequential read of the directory records, hashing also increases the percentage of time that the desired directory record is in a buffer, eliminating the need for any physical disk accesses in these cases. Hash tables and directory caches eliminate many of the directory accesses required when accessing large files. However, in a nonbanked system, hash tables increase the size of the operating system.

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When the BIOS finds an error condition, the READ and WRITE routines should perform several retries before reporting the error condition to the BDOS. Ten retries are typical. If the BIOS returns an error condition to the BDOS, the BDOS reports the error to the user in the following form:

CP/M Error on d: Disk I/O

The d: represents the drive specification of the relevant drive.

To provide better diagnostic capabilities for the user, it is often desirable to print a more explicit error message from the BIOS READ or WRITE routines before the BIOS returns an error code to the BDOS. The BIOS should interrogate the SCB Error Mode Variable to determine if it is appropriate to print a message on the console.

2.6 Memory Selects and Moves

Four BIOS functions are provided to perform memory management. The functions are MOVE, XMOVE, SELMEM, and SETBNK. The XMOVE, SELMEM, and SETBNK memory management routines are applicable to the BIOS of banked systems.

The BDOS uses the BIOS MOVE routine to perform memory-to-memory block transfers. In a banked system, the BDOS calls XMOVE to specify the source and destination banks to be used by the MOVE routine. If you use memory that is not in the common area for data record buffers, you must implement the XMOVE routine.

The BDOS uses SELMEM when the operating system needs to execute code or access data in other than the currently selected bank.

The BDOS calls the SETBNK routine prior to calling disk READ or disk WRITE functions. The SETBNK routine must save its specified bank as the DMA bank. When the BDOS invokes a disk I/O routine, the I/O routine should save the current bank number and select the DMA bank prior to the disk READ or WRITE. After completion of the disk READ or WRITE, the disk I/O routine must reselect the current bank. Note that when the BDOS calls the disk I/O routines, Bank 0 is in context (selected).

2.7 Clock Support

If the system has a real-time clock or is capable of keeping time, possibly by counting interrupts from a counter/timer chip, then the BIOS can maintain the time of day in the System Control Block and update the time on clock interrupts. BIOS Function 26 is provided for those systems where the clock is unable to generate an interrupt.

The time of day is kept as four fields. @DATE is a binary word containing the number of days since 31 December 1977. The bytes @HOUR, @MIN, and @SEC in the System Control Block contain the hour, minute, and second in Binary Coded Decimal (BCD) format.

End of Section 2

Section 3

CP/M 3 BIOS Functional Specifications

This section contains a detailed description of the CP/M 3 BIOS   The section first discusses the BIOS data structures and their relationships, including the System Control Block, the drive table, the Disk Parameter Header, the Disk Parameter Block, the Buffer Control Blocks, and the character I/O table. The overview of the data structures is followed by a summary of the functions in the BIOS jump vector. A detailed description of the entry values and returned values for each jump instruction in the BIOS jump vector follows the summary. The last part of this section discusses the steps to follow when assembling and linking your customized BIOS.

3.1 The System Control Block

The System Control Block (SCB) is a data structure located in the BDOS.   The SCB contains flags and data used by the CCP, the BDOS, the BIOS, and other system components. The BIOS can access specif ic data   in the System Control Block through the public variables defined in the SCB.ASM file, which is supplied on the distribution disk.

Declare the variable names you want to reference in the SCB as externals in your BIOS.ASM source file. Then link your BIOS with the SCB.REL module.

In the SCB.ASM file, the high-order byte of the various SCB addresses is defined as 0FEH. The linker marks absolute external equates as page relocatable when generating a System Page Relocatable (SPR) format file. GENCPM recognizes page relocatable addresses of 0FExxH as references to the System Control Block in the BDOS. GENCPM changes these addresses to point to the actual SCB in the BDOS when it is relocating the system.

Do not perform assembly-time arithmetic on any references to the external labels of the SCB. The result of the arithmetic could alter the page value to something other than 0FEH.

Listing 3-1 shows the SCB.ASM file. The listing shows the f ield names of the System Control Block. A @ before a name indicates that it is a data item. A ? preceding a name indicates that it is the label of an instruction.   In the listing, r/w means Read-Write, and r/o means Read-Only. The BIOS can modify a Read- Write variable, but must not modify a Read-Only variable. Table 3-1 describes each item in the System Control Block in detail.

```
        title 'System Control Block Definition for CP/M3 BIOS'

        public @civec, @covec, @aivec, @aovec, @lovec, @bnkbf
        public @crdma, @crdsk, @vinfo, @resel, @fx, @usrcd
        public @mltio, @ermde, @erdsk, @media, @bflgs
        public @date, @hour, @min, @sec, ?erjmp, @mxtpa


scb$base    equ     0FE00H                  ; Base of the SCB


@CIVEC   equ    scb$base+22h        ; Console Input Redirection Vector (word, r/w)
@COVEC   equ    scb$base+24h        ; Console Output Redirection Vector (word, r/w)
@AIVEC   equ    scb$base+26h        ; Auxiliary Input Redirection Vector (word, r/w)
@AOVEC   equ    scb$base+28h        ; Auxiliary Output Redirection Vector (word, r/w)
@LOVEC   equ    scb$base+2Ah        ; List Output Redirection Vector (word, r/w)
@BNKBF   equ    scb$base+35h        ; Address of 128 Byte Buffer for Banked BIOS
                                    ; (word, r/o)
@CRDMA   equ    scb$base+3Ch        ; Current DMA Address (word, r/o)
@CRDSK   equ    scb$base+3Eh        ; Current Disk (byte, r/o)
@VINFO   equ    scb$base+3Fh        ; BDOS Variable "INFO" (word, r/o)
@RESEL   equ    scb$base+41h        ; FCB Flag (byte, r/o)
@FX      equ    scb$base+43h        ; BDOS Function for Error Messages (byte, r/o)
@USRCD   equ    scb$base+44h        ; Current User Code (byte, r/o)
@MLTIO   equ    scb$base+4Ah        ; Current Multisector Count (byte,r/w)
@ERMDE   equ    scb$base+4Bh        ; BDOS Error Mode (byte, r/o)
@ERDSK   equ    scb$base+51h        ; BDOS Error Disk (byte, r/o)
@MEDIA   equ    scb$base+54h        ; Set by BIOS to indicate open door (byte,r/w)
@BFLGS   equ    scb$base+57h        ; BDOS Message Size Flag (byte,r/o)
@DATE    equ    scb$base+58h        ; Date in Days Since 1 Jan 78 (word, r/w)
@HOUR    equ    scb$base+5Ah        ;  Hour in BCD (byte, r/w)
@MIN     equ    scb$base+5Bh        ; Minute in BCD (byte, r/w)
@SEC     equ    scb$base+5Ch        ; Second in BCD (byte, r/w)
?ERJMP   equ    scb$base+5Fh        ; BDOS Error Message Jump (3 bytes, r/w)
@MXTPA   equ    scb$base+62h        ; Top of User TPA ; (address at 6,7)(word, r/o)
                end
```

Listing 3-1. SCB.ASM File

The following table describes in detail each of the fields of
the System Control Block.

Table 3-1. System Control Block Fields

Field   Meaning

@CIVEC, @COVEC, @AIVEC, @AOVEC, @LOVEC (Read-Write
Variable)

These fields are the 16 bit I/O redirection vectors for the five logical devices:
console input, console output, auxiliary input, auxiliary output, and the list
device. (See Section 3.4.2, "Character I/O Functions.")

@BNKBF (Read-Only Variable)

@BNKBF contains the address of a 128 byte buffer in the resident portion of the
BDOS in a banked system. This buffer is available for use during BOOT and
WBOOT only. You can use it to transfer a copy of the CCP from an image in an
alternate bank if the system does not support interbank moves.

@CRDMA, @FX, @USRCD, @ERDSK (Read-Only Variable)

These variables contain the current DMA address, the BDOS function number,
the current user code, and the disk code of the drive on which the last error
occurred.   They can be displayed when a BDOS error is intercepted by the
BIOS. See ?ERJMP.

@CRDSK (Read-Only Variable)

@CRDSK is the current default drive, set by BDOS Function 14.

@VINFO, @RESEL (Read-Only Variable)

If @RESEL is equal to OFFH then @VINFO contains the address of a valid
FCB. If @RESEL is not equal to OFFH, then @VINFO is undefined. You can
use @VINFO to display the filespec when the BIOS intercepts a BDOS error.

Table 3-1. (continued)

Field   Meaning

@MLTIO   (Read-Write Variable)

>@MLTIO contains the current multisector count. The BIOS can change the
>multisector count directly, or through BDOS Function 44. The value of the
>multisector count can range from 1 to 128.

@ERMDE (Read-Only Variable)

>@ERMDE contains the current BDOS error mode. 0FFH indicates the BDOS is
>returning error codes to the application program without displaying any error
>messages. 0FEH indicates the BDOS is both displaying and returning errors.
>Any other value indicates the BDOS is displaying errors without notifying the
>application program.

@MEDIA (Read-Write Variable)

>@MEDIA is global system flag indicating that a drive door has been opened.
>The BIOS routine that detects the open drive door sets this flag to 0FFH. The
>BIOS routine also sets the MEDIA byte in the Disk Parameter Header
>associated with the open-door drive to 0FFH.

@BFLGS (Read-Only Variable)

>The BDOS in CP/M 3 produces two kinds of error messages: short error
>messages and extended error messages. Short error messages display
>one or two lines of text. Long error messages display a third line of text
>containing the filename, filetype, and BDOS Function Number involved in the
>error.

In banked systems, GENCPM sets this flag in the System Control Block to
indicate whether the BIOS displays short or extended error messages. Your error
message handler should check this byte in the System Control Block. If the high-
order bit, bit 7, is set to 0, the BDOS displays short error messages. if the high-
order bit is set to 1, the BDOS displays the extended three-line error messages.

Table 3-1. (continued)

Field   Meaning

@BFLGS (continued)

For example, the BDOS displays the following error message if the BIOS returns an error from READ and the BDOS is displaying long error messages.

CP/M Error on d: Disk I/O
BDOS Function = nn   File = filename.typ

In the above error message, Function nn and filename.typ represent BDOS function number and file specification involved, respectively.

@DATE (Read-Write Variable)

The number of days since 31 December 1977, expressed as a 16-bit unsigned integer, low byte first.   A real-time clock interrupt can update the @DATE field to indicate the current date.

@HOUR, @MIN, @SEC (Read-Write Variable)

These 2-digit Binary Coded Decimal (BCD) fields indicate the current hour, minute, and second if updated by a real-time clock interrupt.

?ERJMP (Read-Write Code Label)

The BDOS calls the error message subroutine through this jump instruction. Register C contains an error code as follows:

1   Permanent Error
2   Read Only Disk
3   Read Only File
4   Select Error
7   Password Error
8   File Exists
9   ? in Filename

Error code 1 above results in the BDOS message Disk I/O.

Table 3-1. (continued)

Field   Meaning

?ERJMP (continued)

      The ?ERJMP vector allows the BIOS to intercept the BDOS error messages so you can display them in a foreign language. Note that this vector is not branched to if the application program is expecting return codes on physical errors. Refer to the CP/M Plus Programmer's Guide for more information.

      ?ERJMP is set to point to the default (English) error message routine contained in the BDOS. The BOOT routine can modify the address at ?ERJMP+L to point to an alternate message routine. Your error message handler can refer to @FX, @VINFO (if @RESEL is equal to OFFH), @CRDMA, @CRDSK, and @USRCD to print additional error information. Your error handler should return to the BDOS with a RET instruction after printing the appropriate message.

@MXTPA (Read-Only Variable)

      @MXTPA contains the address of the current BDOS entry point. This is also the address of the top of the TPA. The BOOT and WBOOT routines of the BIOS must use this address to initialize the BDOS entry JMP instruction at location 005H, during system initialization. Each time a RSX is loaded, @MXTPA is adjusted by the system to reflect the change in the available User Memory (TPA).

3.2 Character I/O Data Structures

      TheBIOS data structure CHRTBL is a character table describing the physical I/O devices. CHRTBL contains 6-byte physical device names and the characteristics of each physical device. These characteristics include a mode byte, and the current baud rate, if any, of the device. The DEVICE utility references the physical devices through the names and attributes contained in your CHRTBL. DEVICE can also display the physical names and characteristics in your CHRTBL.

      The mode byte specifies whether the device is an input or output device, whether it has a selectable baud rate, whether it is a serial device, and if XON/XOFF protocol is enabled.

Listing 3-2 shows a sample character device table that the DEVICE utility uses to set and display I/O direction.

```
        ; sample character device table

chrtbl  db 'CRT   '            ; console VDT
        db mb$in$out+mb$serial+mb$soft$baud
        db baud$9600

        db 'LPT   '            ; system serial printer
        db mb$output+mb$serial+mb$soft$baud+mb$xon
        db baud$9600

        db 'TI810 '            ; alternate printer
        db mb$output+mb$serial+mb$soft$baud
        db baud$9600

        db 'MODEM '            ; 300 baud modem port
        db mb$in$out+mb$serial+mb$soft$baud
        db baud$300

        db 'VAX   '            ; interface to VAX 11/780
        db mb$in$out+mb$serial+mb$soft$baud
        db baud$9600

        db 'DIABLO'            Diablo 630 daisy wheel printer
        db mb$output+mb$serial+mb$soft$baud+mb$xon$xoff
        db baud$1200

        db 'CEN   '            ; Centronics type parallel printer
        db mb$output
        db baud$none

        db 0                   ; table terminator
```

Listing 3-2. Sample Character Device Table

Listing 3-3 shows the equates for the fields contained in the sample character device table. Many systems do not support all of these baud rates.

; equates for mode byte fields

```
mb$input           equ  0000$000lb        ; device may do input
mb$output          equ  0000$0010b        ; device may do output
mb$in$out          equ  mb$input+mb$output ; dev may do both
mb$soft$baud       equ  0000$0100b        ; software selectable baud rates
mb$serial          equ  0000$1000b        ; device may use protocol
mb$xon$xoff        equ  0001$0000b        ; XON/XOFF protocol
    ;    equates for baud rate byte
baud$none          equ  0                 ; no baud rate
                                          ; associated with device
baud$50            equ  1                 ; 50 baud
baud$75            equ  2                 ; 75 baud
baud$110           equ  3                 ; 110 baud
baud$134           equ  4                 ; 134.5 baud
baud$150           equ  5                 ; 150 baud
baud$300           equ  6                 ; 300 baud
baud$600           equ  7                 ; 600 baud
baud$1200          equ  8                 ; 1200 baud
baud$1800          equ  9                 ; 1800 baud
baud$2400          equ  10                ; 2400 baud
baud$3600          equ  11                ; 3600 baud
baud$4800          equ  12                ; 4800 baud
baud$7200          equ  13                ; 7200 baud
baud$9600          equ  14                ; 9600 baud
baud$19200         equ  15                ; 19.2k baud
```

Listing 3-3. Equates for Mode Byte Bit Fields

3.3 BIOS Disk Data Structures

The BIOS includes tables that describe the particular characteristics of the disk subsystem used with CP/M 3. This section describes the elements of these tables.

In general, each disk drive has an associated Disk Parameter Header (DPH) that contains information about the disk drive and provides a scratche>ad area for certain BDOS operations. One of the elements of this Disk Parameter Header is a pointer to the Disk Parameter Block (DPB), which contains the actual disk description.

In the banked system, only the Disk Parameter Block must reside in common memory. The DPHS, checksum vectors, allocation vectors, Buffer Control Blocks, and Directory Buffers can reside in common memory or Bank 0. The hash tables can reside in common memory or any bank except Bank 1. The data buffers can reside in banked memory if you implement the XMOVE function.

Figure 3-1 shows the relationships between the drive table, the Disk Parameter Header, and the Data and Directory Buffer Control Block fields and their respective data structures and buffers.
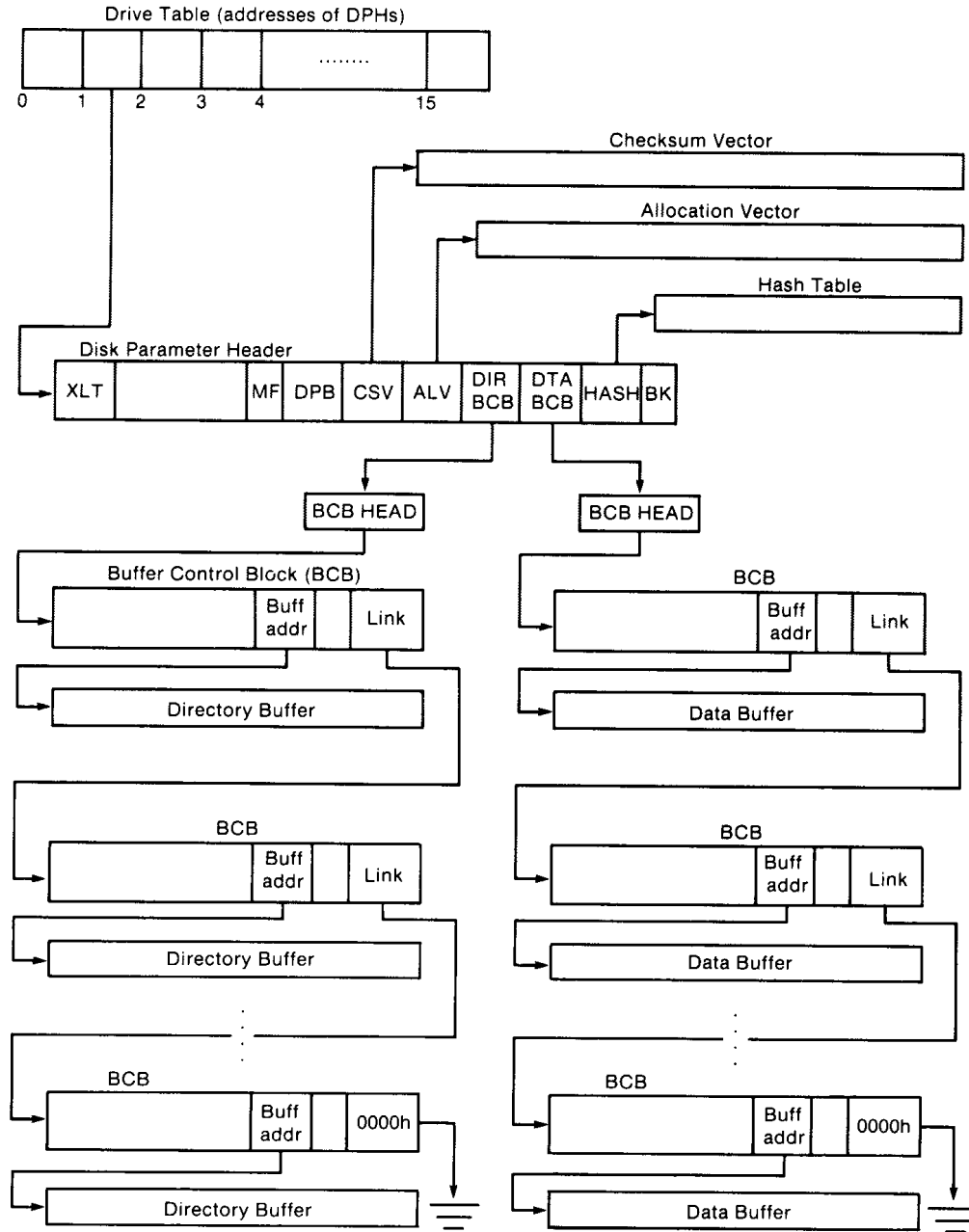
Figure 3-1. Disk Data Structures in a   Banked System

3.3.1 Drive Table

The drive table consists of 16 words containing the addresses of the Disk Parameter Headers for each logical drive name, A through P, and takes the general form:

```
drivetable    dw    dpho
              dw    dphl
              dw    dph2
                .
                .
                .
              dw    dphf
```

If a logical drive does not exist in your system, the corresponding entry in the drive table must be zero.

The GENCPM utility accesses the drive table to locate the various disk parameter data structures, so that it can determine which system configuration to use, and optionally allocate the various buffers itself. You must supply a drive table if you want GENCPM to do this allocation. If certain addresses in the Disk Parameter Headers referenced by this drive table are set to 0FFFEH, GENCPM allocates the appropriate data structures and updates the DPH. You can supply the drive table even if you have performed your own memory allocation. See the BIOS DRVTBL function described in Section 3.4.1.

3.3.2 Disk Parameter Header

In Figure 3-2, which shows the format of the Disk Parameter Header, b refers to bits.

XLT	-0-	MF	DPB	CSV	ALV	DIRBCB	DTABCB	HASH	HBANK.
16b	72b	8b	16b	16b	16b	16b	16b	16b	8b

Figure 3-2. Disk Parameter Header Format

Table 3-2 describes the fields of the Disk Parameter Header.

Table 3-2.   Disk Parameter Header Fields

Field   Comments

XLT   Set the XLT field to the address of the logical to hysical sector translation
                 table. If there is no sector translation and the   logical and physical sector
            numbers are the same, set XLT to 0000H. Disk drives with identical
            sector skew factors can share the same translation table.

                 XLT is the value passed to SECTRN in registers DE. Usually the
                 translation table consists of one byte per physical sector. Generally, it is
                 advisable to keep the number of physical sectors per logical track to a
                 reasonable value to prevent the translation table from becoming too large.
            In the case of disks with multiple heads, you can compute the head
       number from the track address rather than the sector address.

-0-   These 72 bits (9 bytes) of zeroes are the scratch area the BDOS uses to
                 maintain various parameters associated with the drive.

MF   MF is the Media Flag. The BDOS resets MF to zero when the drive is
                 logged in. The BIOS can set this flag and @MEDIA in the SCB to 0FFH
                 if it detects that a drive door has been opened. If the flag is set to 0FFH,
                 the BDOS checks for a media change prior to performing the next BDOS
                 file operation on that drive. If the BDOS determines that the drive
                 contains a new volume, the BDOS performs a login on that drive, and
                 resets the MF flag to 00H. Note that the BDOS checks this flag only
                 when a system call is made, and not during an operation. Usually, this flag
            is used only by systems that support door-open interrupts.

DPB   Set the DPB f ield to the address of a Disk Parameter Block that describes
                 the characteristics of the disk drive. Several Disk Parameter Headers can
                 address the same Disk Parameter Block if their drive characteristics are
                 identical. (The Disk Parameter Block is described in Section 3.3.3.)

Table 3-2. (continued)

Field   Comments

CSV   CSV is the address of a scratchpad area used to detect changed disks.
                 This address must be different for each removable media Disk Parameter
                 Header. There must be one byte for every 4 directory entries (or 128
                 bytes of directory). In other words, length(CSV) = (DRM/4)+l. (See
                 Table 3-3 for an explanation of the DRM field.) If the drive is
                 permanently mounted, set the CKS variable in the DPB to 8000H and set
                 CSV to 0000H. This way, no storage is reserved for a checksum vector.
                 The checksum vector may be located in common memory or in Bank 0.
                 Set CSV to 0FFFEH for GENCPM to set up the checksum vector.

ALV   ALV is the address of the scratchpad area called the allocation vector,
                 which the BDOS uses to keep disk storage allocation information.
                 This area must be unique for each drive.

                 The allocation vector usually requires 2 bits for each block on the drive.
                 Thus, length(ALV) = (DSM/4) + 2.   (See Table 3-3 for an explanation of
                 the DSM field.) In the nonbanked version of CP/M 3, you can optionally
                 specify that GENCPM reserve only one bit in the allocation vector per
                 block on the drive. In this case, length(ALV) = (DSM/8) +

                 The GENCPM option to use single-bit allocation vectors is provided in
                 the nonbanked version of CP/M 3 because additional memory is required
                 by the double-bit allocation vector. This option applies to all drives on
                 the system.

                 With double-bit allocation vectors, CP/M 3 automatically frees, at every
                 system warm start, all file blocks that are not permanently recorded in the
                 directory. Note that file space allocated to a f ile is not permanently
                 recorded in a directory unless the file is closed. Therefore, the allocation
                 vectors in memory can indicate that space is allocated although directory
                 records indicate that space is free for allocation. With single-bit allocation
                 vectors, CP/M 3 requires that a drive be   reset before this space   can be
                 reclaimed. Because it increases performance, CP/M 3 does not reset disks
                 at system warm start. Thus, with single-bit allocation vectors, if you do
                 not reset the disk system, DIR and SHOW can report an inaccurate
                 amount of free space. With single-bit

Table 3-2. (continued)

Field   I   Comments

ALV   allocation vectors, the user must type a CTRL-C at the system prompt to
(continued)   reset the disk system to ensure accurate reporting of free space. Set
                   ALV to 0FFFEH for GENCPM to automatically assign space for the
                   allocation vector, single- or double-bit, during system generation. In the
                   nonbanked system, GENCPM prompts for the type of allocation vector. In
        the banked system, the allocation vector is always double-bit and can
        reside in common memory or Bank 0. When GENCPM automatically
        assigns space for the allocation vector (ALV = OFFFEH) , it places the
        allocation vector in Bank 0.

DIRBCB   Set DIRBCB to the address of a single directory Buffer Control Block
              (BCB) in an unbanked system. Set DIRBCB to the address of a BCB list
              head in a banked system.

              Set DIRBCB to OFFFEH for GENCPM to set up the DIRBCB field. The
              BDOS uses directory buffers for all accesses of the disk directory.
        Several DPHs can refer to the same directory BCB or BCB list head; or,
        each DPH can reference an independent BCB or BCB list head.
   Section 3.3.4 describes the format of the Buffer Control Block.

DTABCB   Set DTABCB to the address of a single data BCB in an unbanked system.
        Set DTABCB to the address of a data BCB list head in a banked
        system.

              Set DTABCB to OFFFEH for GENCPM to set up the DTABCB   field.
              The BDOS uses data buffers to hold physical sectors so that it can block
              and deblock logical 128-byte records. If the physical record size of the
              media associated with a DPH is 128 bytes, you can set the DTABCB field
              of the DPH to 0FFFFH, because in this case, the BDOS does not use a
              data buffer.

HASH   HASH contains the address of the optional directory hashing table
            associated with a DPH. Set HASH to 0FFFFH to disable directory
        hashing.

Table 3-2. (continued)

Field   Comments

HASH   Set RASH to OFFFEH to make directory hashing on the drive a
(continued)   GENCPM option. Each DPH   using hashing must reference a unique hash
            table.   If a hash table is supplied, it must be 4*(DRM+l) bytes long,
            where DRM is one less than the length of the directory. In other words,
            the hash table   must contain four bytes for each directory entry of the
            disk.

HBANK   Set HBANK to the bank number of the hash table. HBANK is not used in
                    unbanked systems and should be set to zero. The hash tables can be
                    contained in the system bank, common memory, or any alternate bank
                    except Bank 1, because hash tables cannot be located in the Transient
                    Program Area.   GENCPM automatically sets HBANK when HASH is set
            to 0FFFEH.

3.3.3 Disk Parameter Block

Figure 3-3 shows the format of the Disk Parameter Block, where b refers to bits.

SPT	BSH	BLM	EXM	DSM	DRM	AL0	AL1	CKS	OFF	PSH	PHM
16b	8b	8b	8b	16b	16b	8b	8b	16b	16b	8b	8b

Figure 3-3. Disk Parameter Block Format

Table 3-3 describes the fields of the Disk Parameter Block.

Table 3-3. Disk Parameter Block Fields

Field   Comments

SPT   Set SPT to the total number of 128-byte logical records per track.

BSH   Data allocation block shift factor. The value of BSH is determined by the
                    data block allocation size.

BLM   Block mask. The value of BLM is determined by the data block allocation
            size.

Table 3-3. (continued)

Field	Comments
EXM	Extent mask determined by the data block allocation size and the number of disk blocks.
DSM	Determines the total storage capacity of the disk drive. DSM is one less than the total number of blocks on the drive.
DRM	Total number of directory entries minus one that can be stored on this drive. The directory requires 32 bytes per entry.
ALO, AL1	Determine reserved directory blocks. See Figure 3-4 for more information.
CKS	The size of the directory check vector, @DRM/4)+1. Set bit 15 of CKS to 1 if the drive is permanently mounted. Set CKS to 8000H to indicate that the drive is permanently mounted and directory checksumming is not required. Note: full directory checksumming is required on removable media to support the automatic login feature of CP/M 3.
OFF	The number of reserved tracks at the beginning of the logical disk. 0FF is the track on which the directory starts.
PSH	Specifies the physical record shift factor.
PHM	Specifies the physical record mask.

CP/M allocates disk space in a unit called a block. Blocks are also called allocation units, or clusters. BLS is the number of bytes in a block. The block size can be 1024, 2048, 4096, 8192, or 16384 (decimal) bytes.

A large block size decreases the size of the allocation vectors but can result in wasted disk space. A smaller block size increases the size of the allocation vectors because there are more blocks on the same size disk.

There is a restriction on the block size. If the block size is 1024, there cannot be more than 255 blocks present on a logical drive.   In other words, if the disk is larger than 256K, it is necessary to use at least 2048 byte blocks.

The value of BLS is not a field in the Disk Parameter Block; rather, it is derived from the values of BSH and BLM as given in Table 3-4.

Table   3-4. BSH and BLM Values

BLS	BSH	BLM
1,024	3	7
2,048	4	15
4,096	5	31
8,192	6	6 3
16,384	7	127

The block mask, BLM, equals one less than the number of 128- byte records in an allocation unit, (BLS/128 - 1), or (2**BSH)-l.

The value of the Block Shift Factor, BSH, is determined by the data block allocation size. The Block Shift Factor (BSH) equals the logarithm base two of the block size in 128-byte records, or LOG2 (BLS/128) , where LOG2 represents the binary logarithm function.

The value of EXM depends upon both the BLS and whether the DSM value is less than 256 or greater than 255, as shown in Table 3-5.

Table 3-5. Maximum EXK Values

BLS	EXM values	
	DSM<256	DSM>255
1,024	0	N/A
2, 048	1	0
4, 096	3	1
8,192	7	3
16, 384	15	7

The value of EXM is one less than the maximum number of 16K extents per FCB.

Set EXM to zero if you want media compatibility with an extended CP/M 1.4 system. This only applies to double-density CP/M 1.4 systems, with disk sizes greater than 256K bytes. It is preferable to copy double-density 1.4 disks to single-density, then reformat them and recreate them with the CP/M 3 system, because CP/M 3 uses directory entries more effectively than CP/M 1.4.

DSM is one less than the total number of blocks on the drive. DSM must be less than or equal to 7FFFH. If the disk uses 1024 byte blocks (BSH=3, BLM=7), DSM must be less than or equal to OOFFH. The product BLS*(DSM+l) is the total number of bytes the drive holds and must be within the capacity of the physical disk. It does not include the reserved operating system tracks.

The DRM entry is one less than the total number of 32-byte directory entries, and is a 16-bit value. DRM must be less than or equal to (BLS/32 * 16) - 1. DRM determines the values of AL0 and ALI. The two fields AL0 and ALI can together be considered a string of 16 bits, as shown in Figure 3-4.

AL 0   AL 1

| 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 |
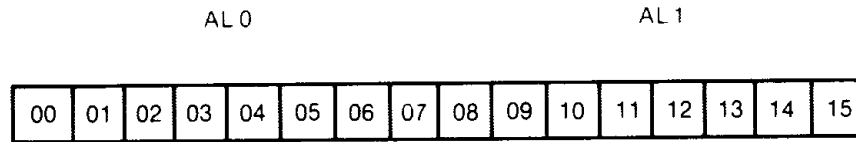
Figure 3-4. ALO and ALI

Position 00 corresponds to the high-order bit of the byte labeled AL0, and position 15 corresponds to the low-order bit of the byte labeled ALI. Each bit position reserves a data block for a number of directory entries, thus allowing a maximum of 16 data blocks to be assigned for directory entries. Bits are assigned starting at 00 and filled to the right until position 15.   AL0 and ALI overlay the first two bytes of the allocation vector for the associated drive.   Table 3-6 shows DRM maximums for the various block sizes.

Table 3-6. BLS and Number of Directory Entries

BLS	Directory Entries	Maximum DRM
1,024	32 * reserved blocks	511
2,048	64 * reserved blocks	1,023
4,096	128 * reserved blocks	2,047
8,192	256 * reserved blocks	4,095
16,384	512 * reserved blocks	8,191

If DRM = 127 (128 directory entries) , and BLS = 1024, there are 32 directory entries per block, requiring 4 reserved blocks. In this case, the 4 high-order bits of AL0 are set, resulting in the values AL0 = OF0H and AL1 = 00H. The maximum directory allocation is 16 blocks where the block size is determined by BSH and BLM.

The OFF field determines the number of tracks that are skipped at the beginning of the physical disk.   It can be used as a mechanism for skipping reserved operating system tracks, which on system disks contain the Cold Boot Loader, CPMLDR, and possibly the CCP.   It is also used to partition a large disk into smaller segmented sections.

PSH and PHM determine the physical sector size of the disk. All disk I/O is in terms of the physical sector size. Set PSH and PSM to zero if the BIOS is blocking and deblocking instead of the BDOS.

PSH specifies the physical record shift factor, ranging from 0 to 5, corresponding to physical record sizes of 128, 256, 512, 1K, 2K, or 4K bytes. It is equal to the logarithm base two of the physical record size divided by 128, or LOG2(sector-size/128). See Table 3-7 for PSH values.

PHM specifies the physical record mask, ranging from 0 to 31, corresponding to physical record sizes of 128, 256, 512, 1K, 2K, or 4K bytes. It is equal to one less than the sector size divided by 128, or, (sector-size/128)-1. See Table 3-7 for PHM values.

Table 3-7. PSH and PHN Values

Sector size	PSH	PHM
128	0	0
256	1	1
512	2	3
1,024	3	7
2,048	4	15
4,096	5	31

3.3.4 Buffer Control Block

A Buffer Control Block (BCB) locates physical record buffers for the BDOS. The BDOS uses the BCB to manage the physical record buffers during processing. More than one Disk Parameter Header can specify the same BCB. The GENCPM utility can create the Buffer Control Block.

Note that the BANK and LINK fields of the Buffer Control Block are present only in the banked system. Therefore, the Buffer Control Block is twelve bytes long in the nonbanked system, and fifteen bytes long in the banked system. Note also that only the DRV, BUFFAD, BANK, and LINK fields need to contain initial values. In Figure 3-5, which shows the form of the Buffer Control Block, b refers to bits.

DRV	REC#	WFLG	00	TRACK	SECTOR	BUFFAD	BANK	LINK
8b	24b	8b	8b	16b	16b	16b	8b	16b

Figure 3-5. Buffer Control Block Format

Table 3-8 describes the fields of each Buffer Control Block.

Table 3-8. Buffer Control Block Fields

Field	Comment
DRV	Identifies the disk drive associated with the record contained in the buffer located at address BUFFAD. If you do not use GENCPM to allocate buffers, you must set the DRV field to 0FFH.
REC#	Identifies the record position of the current contents of the buffer located at address BUFFAD. REC# consists of the absolute sector number of the record where the first record of the directory is zero.
WFLG	Set by the BDOS to OFFH to indicate that the buffer contains new data that has not yet been written to disk. When the data is written, the BDOS sets the WFLG to zero to indicate the buffer is no longer dirty.
00	Scratch byte used by BDOS.
TRACK	Contains the physical track location of the contents of the buffer.
SECTOR	Contains the physical sector location of the contents of the buffer.
BUFFAD	Specifies the address of the buffer associated with this BCB.
BANK	Contains the bank number of the buffer associated with this BCB. This field is only present in banked systems.
LINK	Contains the address of the next BCB in a linked list, or zero if this is the last BCB in the linked list. The LINK field is present only in banked systems.

The BDOS distinguishes between two kinds of buffers: data buffers referenced by DTABCB, and directory buffers referenced by DIRBCB. In a banked system, the DIRBCB and DTABCB fields of a Disk Parameter Header each contain the address of a BCB list head rather than the address of an actual BCB. A BCB list head is a word containing the address of the first BCB in a linked list. If several DPHs reference the same BCB list, they must reference the same BCB list head. Each BCB has a LINK field that contains the address of the next BCB in the list, or zero if it is the last BCB.

In banked systems, the one-byte BANK field indicates the bank in which the data buffers are located. The BANK field of directory BCBs must be zero because directory buffers must be located in Bank 0, usually below the banked BDOS module, or in common memory. The BANK field is for systems that support direct memory-to-memory transfers from one bank to another. (See the BIOS XMOVE entry point in section 3.4.4.)

The BCD data structures in a banked system must reside in Bank 0 or in common memory. The buffers of data BCBs can be located in any bank except Bank I (the Transient Program Area).

For banked systems that do not support interbank block moves through XMOVE, the BANK field must be set to 0 and the data buffers must reside in common memory. The directory buffers can be in Bank 0 even if the system does not support bank-to-bank moves.

In the nonbanked system, the DPH, DIRBCB, and DTABCB can point to the same BCB if the DPH defines a fixed media device.   For devices with removable media, the DPH DIRBCB and the DPH DTABCB must reference different BCBS. In banked systems, the DPH DIRBCB and DTABCB must point to separate list heads.

In general, you can enhance the performance of CP/M 3 by allocating more BCBS, but the enhancement reduces the amount of TPA memory in nonbanked systems.

If you set the DPH DIRBCB or the DPH DTABCB fields to 0FFFEH, the GENCPM utility creates BCBS, allocates physical record buffers, and sets these f ields to the address of the BCBS. This allows you to write device drivers without regard to buffer requirements.

3.3.5 Data Structure Macro Definitions

Several macro definitions are supplied with CP/M 3 to simplify the creation of some of the data structures in the BIOS. These macros are defined in the library file CPM3.LIB on the distribution disk.

To reference these macros in your BIOS, include the following statement:

    MACLIB   CPM3

DTBL Macro

Use the DTBL macro to generate the drive table, DRVTBL. It has one parameter, a list of the DPHs in your system. The list is enclosed in angle brackets.

The form of the DTBL macro call is
    label: DTBL   <DPHA,DPHB,...,DPHP>

where DPHA is the address of the DPH for drive A, DPHB is the address of the DPH for drive B, up to drive P. For example,

    DRVTBL: DTBL   <ACSHDO,FDSDO,FDSD1>

This example generates the drive table for a three-drive system. The DTBL macro always generates a sixteen-word table, even if you supply fewer DPH names.   The unused entries are set to zero to indicate the corresponding drives do not exist.

DPH Macro

The DPH macro routine generates a Disk Parameter Header (DPH) . It requires two parameters: the address of the skew table for this drive, and the address of the Disk Parameter Block (DPB) .   Two parameters are optional: the maximum size of the checksum vector, and the maximum size of the allocation vector. If you omit the maximum size of the checksum vector and the maximum size of the allocation vector from the DPH macro invocation, the corresponding fields of the Disk Parameter Header are set to OFFFEH so that GENCPM automatically allocates the vectors.

The form of the DPH macro call is

    label: DPH   ?trans,?dpb,[?csize],[?asizel

where:
    ?trans   is the address of the translation vector for this
                drive;
    ?dpb   is the address of the DPB for this drive;
    ?csize   is the maximum size in bytes of the checksum
                vector;
    ?asize   is the maximum size in bytes of the allocation
                vector.

The following example, which includes all four parameters, shows a typical DPH macro invocation for a standard single-density disk drive:

    FDSDO: DPH   SKEW6,DPB$SD,16,31

SKEW Macro

The SKEW macro generates a skew table and requires the following parameters: the number of physical sectors per track, the skew factor, and the first sector number on each track (usually 0 or 1).

The form of the SKEW macro call is
label: SKEW   ?secs,?skf,?fsc

where:
?secs	is the number of physical sectors per track;
?skf	is the sector skew factor;
?fsc	is the first sector number on each track.

The following   macro invocation generates the skew table for a standard single-density disk drive.

SKEW6: SKEW   26,6,1

DPB Macro

The DPB macro generates a Disk Parameter Block specifying the characteristics of a drive type. It requires six parameters: the physical sector size in bytes, the number of physical sectors per track, the total number of tracks on the drive, the size of an allocation unit in bytes, the number of directory entries desired, and the number of system tracks to reserve at the beginning of the drive. There is an optional seventh parameter that defines the CKS field in the DPB. If this parameter is missing, CKS is calculated from the directory entries parameter.

The form of the DPB macro call is
label: DPB   ?psize,?pspt,?trks,?bls,?ndirs,?off[,?ncks]

where:
?psize	is the	physical sector size in bytes;
?pspt	is the	number of physical sectors per track;
?trks	is the	number of tracks on the drive;
?bls	is the	allocation unit size in bytes;
?ndirs	is the	number of directory entries;
?off	is the	number of tracks to reserve;
?ncks	is the	number of checked directory entries.

The following example shows the parameters for a standard single-density disk drive:

DPB$SD: DPB   128,26,77,1024,64,2

The DPB macro can be used only when the disk drive is under eight megabytes. DPBs for larger disk drives must be constructed by hand.

3.4 BIOS Subroutine Entry Points

This section describes the entry parameters, returned values, and exact responsibilities of each BIOS entry point in the BIOS jump vector. The routines are arranged by function. Section 3.4.1 describes system initialization.   Section 3.4.2 presents the character I/O functions, followed by Section 3.4.3, discussing the disk I/O functions. Section 3.4.4 discusses the BIOS memory select and move functions. The last section, 3.4.5, discusses the BIOS clock support function. Table 3-9 shows the BIOS entry points the BDOS calls to perform each of the four categories of system functions.

Table 3-9. Functional Organization of BIOS Entry Points

Operation   Function

System Initialization
          BOOT, WBOOT, DEVTBL, DEVINI, DRVTBL,

Character I/O
          CONST, CONIN, CONOUT, LIST, AUXOUT, AUXIN,
          LISTST, CONOST, AUXIST, AUXOST

Disk I/O
          HOME, SELDSK, SETTRK, SETSEC, SETDMA,
          READ, WRITE, SECTRN, MULTIO, FLUSH

Memory Selects and Moves
          MOVE, XMOVE, SELMEM, SETBNK

Clock Support
          TIME

Table 3-10 is a summary showing the CP/M 3 BIOS function numbers, jump instruction names, and the entry and return parameters of each jump instruction in the table, arranged according to the BIOS function number.

Table 3-10. CP/M 3 BIOS Function Jump Table Sunmary

No.	Function	Input	Output
0	BOOT	None	None
1	WBOOT	None	None
2	CONST	None	A=0FFH if ready
			A=00H if not ready
3	CONIN	None	A=Con Char
4	CONOUT	C=Con Char	None
5	LIST	C=Char	None
6	AUXOUT	C=Char	None
7	AUXIN	None	A=Char
8	HOME	None	None
9	SELDSK	C=Drive 0-15	HL=DPH addr
		E=Init Sel Flag	HL=000H if invalid dr.
10	SETTRK	BC=Track No	None
11	SETSEC	BC=Sector No	None
12	SETDMA	BC=.DMA	None
13	READ	None	A=00H if no Err
			A=01H if Non-recov Err
			A=0FFH if media changed
14	WRITE	C=Deblk Code	A=00H if no Err
			A=01H if Phys Err
			A=02H if Dsk is R/O
			A=0FFH if media changed
15	LISTST	None	A=00H if not ready
			A=0FFH if ready
16	SECTRN	BC=Log Sect No	HL=Phys Sect No
		DE=Trans Tbl Adr	
17	CONOST	None	A=00H if not ready
			A=0FFH if ready
18	AUXIST	None	A=0H if not ready
			A=0FFH if ready
19	AUXOST	None	A=00H if not ready
			A=0FFH if ready
20	DEVTBL	None	HL=Chrtbl addr
21	DEVINI	C=Dev No 0-15	None
22	DRVTBL	None	HL=Drv Tbl addr
			HL=0FFFFH
			HL=0FFFEH
23	MULTIO	C=Mult Sec Cnt	None
24	FLUSH	None	A=000H if no err
			A=001H if phys err
			A=002H if disk R/O
25	MOVE	HL=Dest Adr	HL & DE point to next
		DE=Source Adr	bytes following MOVE
		BC=Count	
26	TIME	C=Get/Set Flag	None
27	SELMEM	A=Mem Bank	None
28	SETBNK	A=Mem Bank	None
29	XMOVE	B=Dest Bank	None
		C=Source Bank	

Table 3-10. (continued)

No. I Function   Input

30	USERF	Reserved for System Implementor
31	RESERV1	Reserved for Future Use
32	RESERV2	Reserved for Future Use

3.4.1 System Initialization Functions

This section defines the BIOS system initialization routines BOOT, WBOOT, DEVTBL, DEVINI, and DRVTBL.

BIOS Function 0: BOOT

Get Control from Cold Start Loader
  and Initialize System

Entry Parameters: None

Returned Values: None

The BOOT entry point gets control from the Cold Start Loader in Bank 0 and is responsible for basic system initialization. Any remaining hardware initialization that is not done by the boot ROMS, the Cold Boot Loader, or the LDRBIOS should be performed by the BOOT routine.

The BOOT routine must perform the system initialization outlined in Section 2.3, "System Initialization." This includes initializing Page Zero jumps and loading the CCP.   BOOT usually prints a sign-on message, but this can be omitted. Control is then transferred to the CCP in the TPA at 0100H.

To initialize Page Zero, the BOOT routine must place a jump at location 0000H to BIOS base + 3, the BIOS warm start entry point. The BOOT routine must also place a jump instruction at location 0005H to the address contained in the System Control Block variable, @MXTPA.

The BOOT routine must establish its own stack area if it calls any BDOS or BIOS routines. In a banked system, the stack is in Bank 0 when the Cold BOOT routine is entered. The stack must be placed in common memory.

BIOS Function 1:   WBOOT

Get Control When a Warm Start Occurs

Entry Parameters: None

Returned Values: None

The WBOOT entry point is entered when a warm start occurs. A warm start is performed whenever a user program branches to location 0000H or attempts to return to the CCP.   The WBOOT routine must perform the system initialization outlined in BIOS Function 0, including initializing Page zero jumps and loading the CCP.

When your WBOOT routine is complete, it must transfer control to the CCP at location 0100H in the TPA.

Note that the CCP does not reset the disk system at warm start. The CCP resets the disk system when a CTRL-C is pressed following the system prompt.

Note also that the BIOS stack must be in common memory to make BDOS function calls. Only the BOOT and WBOOT routines can perform BDOS function calls.

If the WBOOT routine is reading the CCP from a file, it must set the multisector I/O count, @MLTIO in the System Control Block, to the number of 128-byte records to be read in one operation before reading CCP.COM. You can directly set @MLTIO in the SCB, or you can call BDOS Function 44 to set the multisector count in the SCS.

If blocking/deblocking is done in the BIOS instead of in the BDOS, the WBOOT routine must discard all pending buffers.

BIOS Function 20: DEVTBL

Return Address of Character I/O Table

Entry Parameters: None

Returned Values: HL=address of Chrtbl

The DEVTBL and DEVINI entry points allow you to support device assignment with a flexible, yet completely optional system. It replaces the IOBYTE facility of CP/M 2.2. Note that the CHRTBL must be in common in banked systems.

BIOS Function 21: DEVINI

Initialize Character I/O Device

Entry Parameters: C=device number, 0-15

Returned Values: None

The DEVINI routine initializes the physical character device specif ied in register C to the baud rate contained in the appropriate entry of the CHRTBL. It need only be supplied if I/O redirection has been implemented and is referenced only by the DEVICE utility supplied with CP/M 3.

BIOS Function 22: DRVTBL

Return Address of Disk Drive Table

Entry Parameters: None

Returned Values: HL=Address of Drive Table of Disk
                            Parameter Headers (DPH); Hashing can utilized if specified by the
                   DPHs Referenced by this DRVTBL.
                            HL=0FFFFH if no Drive Table; GENCPM does not set up buffers.
                   Hashing is supported.
                            HL=0FFFEH if no Drive Table; GENCPM does not set up buffers.
                            Hashing is not supported.

The first instruction of this subroutine must be an LXI H,<address> where <address> is one of the above returned values. The GENCPM utility accesses the address in this instruction to locate the drive table and the disk parameter data structures to determine which system configuration to use.

If you plan to do your own blocking/deblocking, the first instruction of the DRVTBL routine must be the following:

lxi   h,0FFFEh

You must also set the PSH and PSM fields of the associated Disk Parameter Block to zero.

3.4.2 Character I/O Functions

This section defines the CP/M 3 character I/O routines CONST, CONIN, CONOUT, LIST, AUXOUT, AUXIN, LISTST, CONOST, AUXIST, and AUXOST.

CP/M 3 assumes all simple character I/O operations are performed in eight-bit ASCII, upper and lowercase, with no parity. ANASCII CTRL-Z (lAH) denotes an end-of-file condition for an input device.

In CP/M 3, you can direct each of the five logical character devices to any combination of up to twelve physical devices. Each of the five logical devices has a 16-bit vector in the System Control Block (SCB) . Each bit of the vector represents a physical device where bit 15 corresponds to device zero, and bit 4 is device eleven. Bits 0 through 3 are reserved for future system use.

You can use the public names defined in the supplied SCB.ASM file to reference the I/O redirection bit vectors. The names are shown in Table 3-11.

Table 3-11. I/O Redirection Bit Vectors in SCB

Name	Logical Device
@CIVEC	Console Input
@COVEC	Console Output
@AIVEC	Auxiliary Input
@AOVEC	Auxiliary Output
@LOVEC	List Output

You should send an output character to all of the devices whose corresponding bit is set. An input character should be read from the first ready device whose corresponding bit is set.

An input status routine should return true if any selected device is ready. An output status routine should return true only if all selected devices are ready.

BIOS Function 2: CONST

Sample the Status of the Console Input Device

Entry Parameters: None

Returned value: A=0FFH if a console character
                        is ready to read
                    A=00H if no console character
                        is ready to read

Read the status of the currently assigned console device and return 0FFH in register A if a character is ready to read, and 00H in register A if no console characters are ready.

BIOS Function 3:   CONIN

Read a Character from the Console

Entry Parameters: None

Returned Values: A=Console Character

Read the next console character into register A with no parity. If no console character is ready, wait until a character is available'before returning.

BIOS Function 4:   CONOUT

Output Character to Console

Entry Parameters: C=Console Character

Returned Values: None

Send the character in register C to the console output device. The character is in ASCII with no parity.

BIOS Function 5:   LIST

Output Character to List Device

Entry Parameters: C=Character

Returned Values: None

Send the character from register C to the listing device. The character is in ASCII with no parity.

BIOS Function 6:   AUXOUT

Output a Character to the Auxiliary Output Device

Entry Parameters: C=Character

Returned Values: None

Send the character from register C to the currently assigned AUXOUT device. The character is in ASCII with no parity.

BIOS Function 7:   AUXIN

Read a Character from the Auxiliary Input Device

Entry Parameters: None

Returned Values: A=Character

Read the next character from the currently assigned AUXIN device into register A with no parity.   A returned ASCII CTRL-Z (1AH) reports an end-of-file.

BIOS Function 15: LISTST

Return the Ready Status of the List Device

Entry Parameters: None

Returned Values: A=00H if list device is not
                                         ready to accept a character
                                A=0FFH if list device is
                                         ready to accept a character

The BIOS LISTST function returns the ready status of the list device.

BIOS Function 17: CONOST

Return Output Status of Console

Entry Parameters: None

Returned Values: A=0FFH if ready
                                A=00H if not ready

The CONOST routine checks the status of the console. CONOST returns an OFFH if the console is ready to display another character. This entry point allows for full polled handshaking communications support.

BIOS Function 18: AUXIST

Return Input Status of Auxiliary Port

Entry Parameters: None

Returned Values: A=0FFH if ready
                                A=00H if not ready

The AUXIST routine checks the input status of the auxiliary port. This entry point allows full polled handshaking for communications support using an auxiliary port.

BIOS Function 19:   AUXOST

Return Output Status of Auxiliary Port

Entry Parameters: None

Returned Values: A=0FFH if ready
                        A=00H if not ready

The AUXOST routine checks the output status of the auxiliary port. This routine allows full polled handshaking for communications support using an auxiliary port.

3.4.3 Disk I/O Functions

This section defines the CP/M 3 BIOS disk I/O routines HOME, SELDSK, SETTRK, SETSEC, SETDMA, READ, WRITE, SECTRN, MULTIO, and FLUSH.

BIOS Function 8:   HOME

Select Track 00 of the Specified Drive

Entry Parameters: None

Returned Values: None

Return the disk head of the currently selected disk to the track 00 position. Usually, you can translate the HOME call into a call on SETTRK with a parameter of 0.

BIOS Function 9:   SELDSK

Select the Specified Disk Drive

Entry Parameters: C=Disk Drive (0-15)
                        E=Initial Select Flag

Returned Values: HL=Address of Disk Parameter
                            Header (DPH) if drive exists
                        HL=0000H if drive does not exist

Select the disk drive specified in register C for further operations, where register C contains 0 for drive A, 1 for drive B, and so on to 15 for drive P. On each disk select, SELDSK must return in HL the base address of a 25-byte area called the Disk Parameter Header. If there is an attempt to select a nonexistent drive, SELDSK returns HL=0000H as an error indicator.

On entry to SELDSK, you can determine if it is the first time the specified disk is selected. Bit 0, the least significant bit in register E, is set to 0 if the drive has not been previously selected. This information is of interest in systems that read configuration information from the disk to set up a dynamic disk definition table.

When the BDOS calls SELDSK with bit 0 in register E set to 1, SELDSK must return the same Disk Parameter Header address as it returned on the initial call to the drive. SELDSK can only return a 00H indicating an unsuccessful select on the initial select call.

SELDSK must return the address of the Disk Parameter Header on each call. Postpone the actual physical disk select operation until a READ or WRITE is performed, unless I/O is required for automatic density sensing.

BIOS Function 10: SETTRK

Set Specified Track Number

Entry Parameters: BC=Track Number

Returned Values: None

Register BC contains the track number for a subsequent disk access on the currently selected drive. Normally, the track number is saved until the next READ or WRITE occurs.

BIOS Function 11: SETSEC

Set Specified Sector Number

Entry Parameters: BC=Sector Number

Returned Values: None

Register BC contains the sector number for the subsequent disk access on the currently selected drive. This number is the value returned by SECTRN.   Usually, you delay actual sector selection until a READ or WRITE operation occurs.

BIOS Function 12: SETDMA

Set Address for Subsequent Disk I/O

Entry Parameters: BC=Direct Memory
                                  Access Address

Returned Values: None

Register BC contains the DMA (Direct Memory Access) address for the subsequent READ or WRITE operation. For example, if B = 00H and C = 80H when the BDOS calls SETDMA, then the subsequent read operation reads its data starting at 80H, or the subsequent write operation gets its data from 80H, until the next call to SETDMA occurs.

BIOS Function 13: READ

Read a Sector from the Specified Drive

Entry Parameters: None

Returned Values: A=000H if no errors occurred
                        A=001H if nonrecoverable error
                           condition occurred
                        A=0FFH if media has changed

Assume the BDOS has selected the drive, set the track, set the sector, and specified the DMA address. The READ subroutine attempts to read one sector based upon these parameters, then returns one of the error codes in register A as described above.

If the value in register A is 0, then CP/M 3 assumes that the disk operation completed properly. If an error occurs, the BIOS should attempt several retries to see if the error is recoverable before returning the error code.

If an error occurs in a system that supports automatic density selection, the system should verify the density of the drive. If the density has changed, return a OFFH in the accumulator. This causes the BDOS to terminate the current operation and relog in the disk.

BIOS Function 14: WRITE

Write a Sector to the Specified Disk

Entry Parameters: C=Deblocking Codes

Returned Values: A=00H if no error occurred
                        A=001H if physical error occurred
                        A=002H if disk is Read-Only
                        A=0FFH if media has changed

Write the data from the currently selected DMA address   to the currently selected drive, track, and sector.   Upon each call to WRITE, the BDOS provides the following information in register C:

        0 = deferred write
        1 = nondeferred write
        2 = deferred write to the first sector of a new data block

This information is provided for those BIOS implementations that do blocking/deblocking in the BIOS instead of the BDOS.

As in READ, the BIOS should attempt several retries before reporting an error.

If an error occurs in a system that supports automatic density selection, the system should verify the density of the drive. If the density has changed, return a 0FFH in the accumulator. This causes the BDOS to terminate the current operation and relog in the disk.

BIOS Function 16: SECTRN

Translate Sector Number Given Translate Table

Entry Parameters: BC=Logical Sector Number
                      DE=Translate Table Address

Returned Values: HL=Physical Sector Number

SECTRN performs logical sequential sector address to physical sector translation to improve the overall response of CP/M 3. Digital Research ships standard CP/M disk with a skew factor of 6, where six physical sectors are skipped between each logical read operation. This skew factor allows enough time between sectors for most programs on a slow system to process their buffers without missing the next sector. In computer systems that use fast processors, memory, and disk subsystems, you can change the skew factor to improve overall response. Typically, most disk systems perform well with a skew of every other physical sector. You should maintain support of single-density, IBM 3740 compatible disks using a skew factor of 6 in your CP/M 3 system to allow information transfer to and from other CP/M users.

SECTRN receives a logical sector number in BC, and a translate table address in DE. The logical sector number is relative to zero. The translate table address is obtained from the Disk Parameter Block for the currently selected disk. The sector number is used as an index into the translate table, with the resulting physical sector number returned in HL. For standard, single-density, eight- inch disk systems, the tables and indexing code are provided in the sample BIOS and need not be changed.

Certain drive types either do not need skewing or perform the skewing externally from the system software. In this case, the skew table address in the DPH can be set to zero, and the SECTRN routine can check for the zero in DE and return with the physical sector set to the logical sector.

BIOS Function 23:   MULTIO

Set Count of Consecutive Sectors for READ or WRITE

Entry Parameters: C=Multisector Count

Returned Values: None

To transfer logically consecutive disk sectors to or from contiguous memory locations, the BDOS issues a MULTIO call, followed by a series of READ or WRITE calls. This allows the BIOS to transfer multiple sectors in a single disk operation. The maximum value of the sector count is dependent on the physical sector size, ranging from 128 with 128-byte sectors, to 4 with 4096-byte sectors. Thus, the BIOS can transfer up to 16K directly to or from the TPA with a single operation.

The BIOS can directly transfer all of the specified sectors to or from the DMA buffer in one operation and then count down the remaining calls to READ or WRITE.

If the disk format uses a skew table to minimize rotational latency when single records are transferred, it is more difficult to optimize transfer time for multisector transfers.   One way of utilizing the multisector count with a skewed disk format is to place the sector numbers and associated DMA addresses into a table until either the residual multisector count reaches zero, or the track number changes. Then you can sort the saved requests by physical sector to allow all of the required sectors on the track to be read in one rotation. Each sector must be transferred to or from its proper DMA address.

When an error occurs during a multisector transfer, you can either reset the multiple sector counters in the BIOS and return the error immediately, or you can save the error status and return it to the BDOS on the last READ or WRITE call of the MULTIO operation.

BIOS Function 24: FLUSH

Force Physical Buffer Flushing for User-supported Deblocking

Entry Parameters: None

Returned Values: A=00H if no error occurred
                        A=001H if physical error occurred
                        A=002H if disk is Read-Only

The flush buffers entry point allows the system to force physical sector buffer flushing when your BIOS is performing its own record blocking and deblocking.

The BDOS calls the FLUSH routine to ensure that no dirty buffers remain in memory. The BIOS should immediately write any buffers that contain unwritten data.

Normally, the FLUSH function is superfluous, because the BDOS supports blocking/deblocking internally. It is required, however, for those systems that support blocking/deblocking in the BIOS, as many CP/M 2.2 systems do.

Note: if you do not implement FLUSH, the routine must return a zero in register A. You can accomplish this with the following instructions:

```
xra     a
ret
```

3.4.4 Memory Select and Move Functions

This section defines the memory management functions MOVE, XMOVE, SELMEM, and SETBNK.

BIOS Function 25:   MOVE

Memory-to-Memory Block Move

Entry Parameters: HL=Destination address
                         DE=Source address
                         BC=Count

Returned Values: HL and DE must point to
                         next bytes following move operation

The BDOS calls the MOVE routine to perform memory to memory block moves to allow use of the Z80 LDIR instruction or special DMA hardware, if available. Note that the arguments in HL and DE are reversed from the Z8O machine instruction, necessitating the use of XCHG instructions on either side of the LDIR. The BDOS uses this routine for all large memory copy operations. On return, the HL and DE registers are expected to point to the next bytes following the move.

Usually, the BDOS expects MOVE to transfer data within the currently selected bank or common memory. However, if the BDOS calls the XMOVE entry point before calling MOVE, the MOVE routine must perform an interbank transfer.

BIOS Function 27: SELMEM

Select Memory Bank

Entry Parameters: A=Memory Bank

Returned Values;   None

The SELMEM entry point is only present in banked systems. The banked version of the CP/M 3 BDOS calls SELMEM to select the current memory bank for further instruction execution or buffer references. You must preserve or restore all registers other than the accumulator, A, upon exit.

BIOS Function 28:   SETBNK

Specify Bank for DMA Operation

Entry Parameters: A=Memory Bank

Returned Values: None

SETBNK only occurs in the banked version of CP/M 3. SETBNK specifies the bank that the subsequent disk READ or WRITE routine must use for memory transfers.   The BDOS always makes a call to SETBNK to identify the DMA bank before performing a READ or WRITE call. Note that the BDOS does not reference banks other than 0 or 1 unless another bank is specified by the BANK field of a Data Buffer Control Block (BCB).

BIOS Function 29: XMOVE

Set Banks for Following MOVE

Entry Parameters: B=destination   bank
                         C=source bank

Returned Values: None

XMOVE is provided for banked systems that support memory-to- memory DMA transfers over the entire extended address range. Systems with this feature can have their data buffers located in an

alternate bank instead of in common memory, as is usually required. An XMOVE call affects only the following MOVE call. All subsequent MOVE calls apply to the memory selected by the latest call to SELMEM. After a call to the XMOVE function, the following call to the MOVE function is not more than 128 bytes of data. If you do not implement XMOVE, the first instruction must be a RET instruction.

3.4.5 Clock Support Function

This section defines the clock support function TIME.

BIOS Function 26: TIME

Get and Set Time

Entry Parameters: C=Time Get/Set Flag

Returned values: None

The BDOS calls the TIME function to indicate to the BIOS whether it has just set the Time and Date fields in the SCB, or whether the BDOS is about to get the Time and Date from the SCB. On entry to the TIME function, a zero in register C indicates that the BIOS should update the Time and Date fields in the SCB. A OFFH in register C indicates that the BDOS has just set the Time and Date in the SCB and the BIOS should update its clock. Upon exit, you must restore register pairs HL and DE to their entry values.

This entry point is for systems that must interrogate the clock to determine the time. Systems in which the clock is capable of generating an interrupt should use an interrupt service routine to set the Time and Date fields on a regular basis.

3.5 Banking Considerations

This section discusses considerations for separating your BIOS into resident and banked modules. You can place part of your customized BIOS in common memory, and part of it in Bank 0. However, the following data structures and routines must remain in common memory:

   o   the BIOS stack
   o   the BIOS jump vector
   o   Disk Parameter Blocks
   o   memory management routines
   o   the CHRTBL data structure
   o   all character I/O routines
   o   portions of the disk I/O routines

You can place portions of the disk I/O routines in the system bank, Bank 0. In a banked environment, if the disk I/O hardware supports DMA transfers to and from banks other than the currently selected bank, the disk I/O drivers can reside in Bank 0. If the system has a DMA controller that supports block moves from memory to memory between banks, CP/M 3 also allows you to place the blocking and deblocking buffers in any bank other than Bank 1, instead of common memory.

If your disk controller supports data transfers only into the currently selected bank, then the code that initiates and performs a data transfer must reside in common memory. In this case, the disk I/O transfer routines must select the DMA bank, perform the transfer, then reselect Bank 0. The routine in common memory performs the following procedure:

1) Selects the DMA bank that SETBNK saved.
2) Performs physical I/O.
3) Reselects Bank 0.
4) Returns to the calling READ or WRITE routine in Bank 0.

Note that Bank 0 is in context (selected) when the BDOS calls the system initialization functions BOOT and DRVTBL; the disk I/O routines HOME, SELDSK, SETTRK, SETSEC, SETDMA, READ, WRITE, SECTRN, MULTIO, and FLUSH; and the memory management routines KMOVE and SETBNK.

Bank 0 or Bank 1 is in context when the BDOS calls the system initialization routines WBOOT, DEVTBL, and DEVINI; the character I/O routines CONST, CONIN, CONOUT, LIST, AUXOUT, AUXIN, LISTST, CONOST, AUXIST, and AUXOST, the memory select and move routines MOVE and SELMEM, and the clock support routine TIME.

You can place a portion of the character I/O routines in Bank 0 if you place the following procedure in common memory.

1) Swap stacks to a local stack in common.
2) Save the current bank.
3) Select Bank 0.
4) Call the appropriate character I/O routine.
5) Reselect the saved bank.
6) Restore the stack.

3.6 Assembling and Linking Your BIOS

This section assumes you have developed a BIOS3.ASM or BNKBIOS3.ASM file appropriate to your specific hardware environment. Use the Digital Research Relocatable Macro Assembler RMAC to assemble the BIOS. Use the Digital Research Linker LINK-8 OTM to create the BIOS3.SPR and BNKBIOS3.SPR files. The SPR files are part of the input to the GENCPM program.

In a banked environment, your CP/M 3 BIOS can consist of two segments: a banked segment and a common segment. This allows you to minimize common memory usage to maximize the size of the TPA. To prepare a banked BIOS, place code and data that must reside in common in the CSEG segment, and code and data that can reside in the system bank in the DSEG segment. When you link the BIOS, LINK-80 creates the BNKBIOS3.SPR file with all the CSEG code and data first, then the DSEG code and data.

After assembling the BIOS with RMAC, link your BNKBIOS using LINK-80 with the [B] option. The [B] option aligns the DSEG on a page boundary, and places the length of the CSEG into the BNKBIOS3.SPR header page.

Use the following procedure to prepare a BIOS3.SPR or BNKBIOS3.SPR file from your customized BIOS.

1)   Assemble your BIOS3.ASM or BNKBIOS3.ASM file with the relocatable
       assembler RMAC.COM to produce a relocatable file of type REL. Assemble
       SCB.ASM to produce the relocatable file SCB.REL.

       Assembling the Nonbanked BIOS:

       A>RMAC BIOS3

       Assembling the Banked BIOS:

       A>RMAC BNKBIOS3

2)   Link the BIOS3.REL or BNKBIOS3.REL file and the SCB.REL file with
       LINK-80 to produce the BIOS3.SPR or BNKBIOS3.SPR file. The [OS] option
       with LINK causes the output of a System Page Relocatable (SPR) file.

       Linking the Nonbanked BIOS:

       A>LINK BIOS3[OS]=BIOS3,SCB

       Linking the Banked BIOS:

       A>LINK BNKBIOS3[B]=BNKBIOS3.SCB

The preceding examples show command lines for linking a banked and nonbanked BIOS. In these examples, the BIOS3.REL and BNKBIOS3.REL are the files of your assembled BIOS. SCB.REL contains the definitions of the System Control Block variables. The [B] option implies the [OS] option.

End of Section 3

Section 4

CP/M 3 Sample BIOS Modules

This section discusses the modular organization of the example CP/M 3 BIOS on your distribution disk. For previous CP/M operating systems, it was necessary to generate all input/output drivers from a single assembler source file. Such a file is difficult to maintain when the BIOS supports several peripherals. As a result, Digital Research is distributing the BIOS for CP/M 3 in several small modules.

The organization of the BIOS into separate modules allows you to write or modify any I/O driver independently of the other modules. For example, you can easily add another disk I/O driver for a new controller with minimum impact on the other parts of the BIOS.

4.1 Functional Sumary of BIOS Modules

The modules of the BIOS are BIOSKRNL.ASM, SCB.ASM, BOOT.ASM, MOVE.ASM, CHARIO.ASM, DRVTBL.ASM, and a disk I/O module for each supported disk controller in the configuration.

BIOSKRNL.ASM is the kernel, root, or supervisor module of the BIOS. The SCB.ASM module contains references to locations in the System Control Block. You can customize the other modules to support any hardware configuration. To customize your system, add or modify external modules other than the kernel and the SCE.ASM module.

Digital Research supplies the BIOSKRNL.ASM module. This module is the fixed, invariant portion of the BIOS, aiid the interface from the BDOS to all BIOS functions. It is supplied in source form for reference only, and you should not modify it except for the equate statement described in the following paragraph.

You must be sure the equate statement (banked equ true) at the start of the BIOSKRNL.ASM source file is correct for your system configuration. Digital Research distributes the BIOSKRNL.ASM file for a banked system. If you are creating a BIOS for a nonbanked system, change the equate statement to the following:

banked equ false

and reassemble with RMAC. This is the only change you should make to the BIOSKRNL.ASM file.

Table 4-1 summarizes the modules in the CP/M 3 BIOS.

Table 4-1. CP/M 3 BIOS Module Function Summary

Module   Function

BIOSKRNL.ASM

Performs basic system initialization, and dispatches character and disk I/O.

SCB.ASM module

Contains the public definitions of the various fields in the System Control Block.
The BIOS can reference the public variables.

BOOT.ASM module

Performs system initialization other than character and disk I/O. BOOT loads the
CCP for cold starts and reloads it for warm starts. CHARIO.ASM module

Performs all character device initialization, input, output, and status polling.
CHARIO contains the character device characteristics table.

DRVTBL.ASM module

Points to the data structures for each configured disk drive. The drive table
determines which physical disk unit is associated with which logical drive.
The data structure for each disk drive is called
an Extended Disk Parameter Header (XDPH).

Disk I/O modules

Initialize disk controllers and execute READ and WRITE code for disk
controllers. You must provide an XDPH for each supported unit, and a separate
disk I/O module for each controller in the system. To add another disk controller
for which a prewritten module exists, add its XDPH names to the DRVTBL and
link in the new module.

Table 4-1. (continued)

Module   Function

MOVE.ASM module

Performs memory-to-memory moves and bank selects.

4.2 Conventions Used in BIOS Modules

The Digital Research RMAC relocating assembler and LINK-80 linkage editor allow a module to reference a symbol contained in another module by name. This is called an external reference. The Microsoft relocatable object module format that RMAC and LINK use allows six-character names for externally defined symbols. External names must be declared PUBLIC in the module in which they are defined. The external names must be declared EXTRN in any modules that reference them.

The modular BIOS defines a number of external names for specific purposes. Some of these are defined as public in the root module, BIOSKRNL.ASM. Others are declared external in the root and must be defined by the system implementor. Section 4.4 contains a table summarizing all predefined external symbols used by the modular BIOS.

External names can refer to either code or data. All predefined external names in the modular BIOS prefixed with a @ character refer to data items. All external names prefixed with a ? character refer to a code label. To prevent conflicts with future extensions, user-defined external names should not contain these characters.

4.3 Interactions of Modules

The root module of the BIOS, BIOSKRNL.ASM, handles all BDOS calls, performs interfacing functions, and simplifies the individual modules you need to create.

4.3.1 Initial Boot

BIOSKRNL.ASM initializes all configured devices in the following order:

1) BIOSKRNL calls ?CINIT in the CHARIO module for each of the 16 character devices and initializes the devices.

2) BIOSKRNL invokes the INIT entry point of each XDPH in the FD1797SD module.

3)BIOSKRNL calls the ?INIT entry of the BOOT module to
initialize other system hardware, such as memory
controllers, interrupts, and clocks. It prints a sign-on
message specific to the system, if desired.

4) BIOSKRNL calls ?LDCCP in the BOOT module to load the CCP
into the TPA.

5) The BIOSKRNL module sets up Page Zero of the TPA with the
appropriate jump vectors, and passes control to the CCP.

4.3.2 Character I/O Operation

The CHARIO module performs all physical character I/O. This module contains both the character device table (@CTBL) and the routines for character input, output, initialization, and status polling. The character device table, @CTBL, contains the ASCII name of each device, mode information, and the current baud rate of serial devices.

To support logical to physical redirection of character devices, CP/M 3 supplies a 16-bit assignment vector for each logical device.   The bits in these vectors correspond to the physical devices. The character I/O interface routines in BIOSKRNL handle all device assignment, calling the appropriate character I/O routines with the correct device number. The BIOSKRNL module also handles XON/XOFF processing on output devices where it is enabled.

You can use the DEVICE utility to assign several physical devices to a logical device. The BIOSKRNL root module polls the assigned physical devices, and either reads a character from the first ready input device that is selected, or sends the character to all of the selected output devices as they become ready.

4.3.3 Disk I/O Operation

The BIOSKRNL module handles all BIOS calls associated with disk I/O. It initializes global variables with the parameters for each operation, then invokes the READ or WRITE routine for a particular controller.   The SELDSK routine in the BIOSKRNL calls the LOGIN routine for a controller when the BDOS initiates a drive login. This allows disk density or media type to be automatically determined.

The DRVTBL module contains the sixteen-word drive table, @DTBL. The order of the entries in @DTBL determines the logical to physical drive assignment. Each word in @DTBL contains the address of a DPH, which is part of an XDPH, as shown in Table 4-10. The word contains a zero if the drive does not exist. The XDPH contains the addresses of the INIT, LOGIN, READ, and WRITE entry points of the I/O driver for a particular controller. When the actual drivers are called, globally accessible variables contain the various parameters of the operation, such as the track and sector.

4.4 Predefined Variables and Subroutines

The modules of the BIOS define public variables which other modules can reference. Table 4-2 contains a summary of each public symbol and the module that defines it.

Table 4-2. Public Symbols in CP/M 3 BIOS

Symbol	Function and Use	Defined in Module
@ADRV	Byte, Absolute drive code	BIOSKRNL
@CBNK	Byte, Current CPU bank	BIOSKRNL
@CNT	Byte, Multisector count	BIOSKRNL
@CTBL	Table, Character device table	CHARIO
@DBNK	Byte, Bank for disk I/O	BIOSKRNL
@DMA	Word, DMA address	BIOSKRNL
@DTBL	Table, Drive table	DRVTBL
@RDRV	Byte, Relative drive code (UNIT)	BIOSKRNL
@SECT	Word, Sector address	BIOSKRNL
@TRK	Word, Track number	BIOSKRNL
?BANK	Bank select	MOVE
?Ci	Character device input	CHARIO
?CINIT	Character device initialization	CHARIO
?CIST	Character device input status	CHARIO
?CO	Character device output	CHARIO
?COST	Character device output status	CHARIO
?INIT	General initialization	BOOT
?LDCCP	Load CCP for cold start	BOOT
?MOVE	Move memory to memory	MOVE
?PDEC	Print decimal number	BIOSKRNL
?PDERR	Print BIOS disk error header	BIOSKRNL
?PMSG	Print message	BIOSKRNL
?RLCCP	Reload CCP for warm start	BOOT
?XMOVE	Set banks for extended move	MOVE
?TIME	Set or Get time	BOOT

The System Control Block defines public variables that other modules can reference. The System Control Block variables @CIVEC, @COVEC, @AIVEC, @AOVEC, and @LOVEC are referenced by BIOSKR,-NL.ASM. The variable @BNKBF can be used by ?LDCCP and ?RLCCP to implement interbank block moves.   The public variable names @ERMDE, @FX, @RESEL, @VINFO, @CRDSK, @USRCD, and @CRDf4A are used for error routines which intercept BDOS errors. The publics @DATE, @HOUR, @MIN, and @SEC can be updated by an interrupt-driven real-time clock. @MXTPA contains the current BDOS entry point.

Disk I/O operation parameters are passed in the following global variables, as shown in Table 4-3.

Table 4-3. Global Variables in BIOSKRNL.ASM

Variable   Meaning

@ADRV   Byte; contains the absolute drive code (0 through F for A through P) that CP/M is referencing for READ and WRITE operations. The SELDSK routine in the BIOSKRNL module obtains this value from the BDOS and places it in @DRV. The absolute drive code is used to print error messages.

@RDRV   Byte; contains the relative drive code for READ and WRITE operations. The relative drive code is the UNIT number of the controller in a given disk I/O module.   BIOSKRNL obtains the unit number from the XDPH. This is the actual drive code a driver should send to the controller.

@TRK   Word; contains the starting track for READ and WRITE.

@SECT   Word; contains the starting sector for READ and WRITE.

@DMA   Word; contains the starting disk transfer address.

@DBNK   Byte; contains the bank of the DMA buffer.

@CNT   Byte; contains the physical sector count for the operations that follow.

@CBNK   Byte; contains the current bank for code execution.

Several utility subroutines are defined in the BIOSKRNL.ASM module, as shown in Table 4-4.

Table 4-4. Public Utility Subroutines in BIOSKRNL.ASK

utility I   meaning

?PMSG   Print string starting at <HL>, stop at null (0).

?PDEC   Print binary number in decimal from HL.

?PDERR   Print disk error message header using current disk parameters: <CR><LF>BIOS Error on d:, T- nn, S-nn.

All BIOS entry points in the jump vector are declared as public for general reference by other BIOS modules, as shown in Table 4-5.

Table 4-5.   Public Names in the BIOS Jump Vector

Public Name	Function
?BOOT	Cold boot entry
?WBOOT	Warm boot entry
?CONST	Console input status
?CONIN	Console input
?CONO	Console output
?LIST	List output
?AUXO	Auxiliary output
?AUXI	Auxiliary input
?HOME	Home disk drive
?SLDSK	Select disk drive
?ST12RK	Set track
?STSEC	Set sector
?STDMA	Set DMA address
?READ	Read record
?WRITE	Write record
?LISTS	List status
?SCTRN	Translate sector
?CONOS	Console output status
?AUXIS	Auxiliary input status
?AUXOS	Auxiliary output status
?DVTBL	Return character device table address
?DEVIN	Initialize character device
?DRTBL	Return disk drive table address
?MLTIO	Set multiple sector count
?FLUSH	Flush deblocking buffers (not implemented)
?MOV	Move memory block
?TIM	Signal set or get time from clock
?BNKSL	Set bank for further execution
?STBNK	Set bank for DMA
?XMOV	Set banks for next move

4.5 BOOT Module

The BOOT module performs general system initialization, and loads and reloads the CCP. Table 4-6 shows the entry points of the BOOT module.

Table 4-6. BOOT Module Entry Points

Module   Meaning

?INIT   The BIOSKRNL module calls ?INIT during cold start to perform
                        hardware initialization other than character and disk I/O.   Typically, this
                        hardware can include time-of-day clocks, interrupt systems, and special
                        I/O ports used for bank selection.

?LDCCP   BIOSKRNL calls ?LDCCP during cold start to load the CCP into the
                        TPA. The CCP can be loaded either from the system tracks of the boot
                        device or from a file, at the discretion of the system implementor. In a
                        banked system, you can place a copy of the CCP in a reserved area of
                        another bank to increase the performance of the ?RLCCP routine.

?RLCCP   BIOSKRNL calls ?RLCCP during warm start to reload the CCP into the
                        TPA. In a banked system, the CCP can be copied from an alternate bank
                        to eliminate any disk access.   Otherwise, the CCP should be loaded from
                        either the system tracks of the boot device or from a file.

4.6 Character I/O

The CHARIO module handles all character device interfacing. The CHARIO module
contains the character device definition table @CTBL, the character input routine ?CI , the
character output routine ?CO, the character input status routine ?CIST, the character output
status routine ?COST, and the character device initialization routine ?CINIT.

The BIOS root module, BIOSKRNL.ASM, handles all character I/O redirection.   This
module determines the appropriate devices to perform operations and executes the actual
operation by calling ?CI, ?CO, ?CIST, and ?COST with the proper device number(s).

@CTBL is the external name for the structure CHRTBL described in Section 3 of this
manual. @CTBL contains an 8-byte entry for each physical device def-ined by this BIOS. The
table is terminated by a zero byte after the last entry.

The first field of the character device table, @CTBL, is the 6- byte device name. This
device name should be all upper-case, left- justified, and padded with ASCII spaces (20H).

The second field of @CTBL is 1 byte containing bits that Indicate the type of device and its current mode, as shown in Table 4-7.

Table 4-7. Mode Bits

Mode Bits	Meaning
00000001	Input device (such as a keyboard)
00000010	output device (such as a printer)
00000011	Input/output device (such as a terminal or modem)
00000100	Device has software-selectable baud rates
00001000	Device may use XON protocol
00010000	XON/XOFF protocol enabled

The third field of @CTBL is 1 byte and contains the current baud rate for serial devices. The high-order nibble of this field is reserved for future use and should be set to zero. The low-order four bits contain the current baud rate as shown in Table 4-8. Many systems do not support all of these baud rates.

Table 4-8. Baud   Rates for Serial Devices

Decimal	Binary	Baud Rate
0	0000	none
1	0001	50
2	0010	75
3	0011	110
4	010 0	134. 5
5	0101	150
6	0110	300
7	0111	600
8	1000	1200
9	1001	1800
10	1010	2400
11	1011	3600
12	1100	4800
13	1101	7200
14	1110	9600
15	1111	19200

Table 4-9 shows the entry   points to the routines in the CHARIO module. The BIOSKRNL module calls these routines to perform machine-dependent character I/O.

Table 4-9. Character Device Labels

Label   Meaning

?Ci   Character Device Input

> ?CI is called with a device number in register B. It should wait for the next available input character , then return the character in register A. The character should be in 8-bit ASCII with no parity.

?CO   Character Device Output

> ?CO is called with a device number in register B and a character in register C. It should wait until the device is ready to accept another character and then send the character. The character is in 8-bit ASCII with no parity.

?CIST   Character Device Input Status

> ?CIST is called with a device number in register B. It should return with register A set to zero if the device specified has no input character ready; and should return with A set to 0FFH if the device specified has an input character ready to be read.

?COST   Character Device Output Status

> ?COST is called with a device number in register B. It should return with register A set to zero if the device specified cannot accept a character immediately, and should return with A set to 0FFH if the device is ready to accept a character.

?CINIT Character Device Initialization

> ?CINIT is called for each of the 16 character devices, and initializes the devices. Register C contains the device number. The ?CINIT routine initializes the physical character device specified in register C to the baud rate contained in the appropriate entry of the CHRTBL. You only need to supply this routine if I/O redirection has been implemented. It is referenced only by the DEVICE utility supplied with CP/M 3.

4.7 Disk I/O

The separation of the disk I/O section of the BIOS into several modules allows you to support each particular disk controller independently from the rest of the system. A manufacturer can supply the code for a controller in object module form, and you can link it into any existing modular BIOS to function with other controllers in the system.

The data structure called the Extended Disk Parameter Header, or XDPH, contains all the necessary information about a disk drive. BIOSKRNL.ASM locates the XDPH for a particular logical drive using the Drive Table. The XDPH contains the addresses of the READ, WRITE, initialization, and login routines. The XDPH also contains the relative unit number of the drive on the controller, the current media type, and the Disk Parameter Header (DPH) that the BDOS requires. Section 3 of this manual describes the Disk Parameter Header.

The code to read and write from a particular drive is independent of the actual CP/M logical drive assignment, and works with the relative unit number of the drive on the controller. The position of the XDPH entry in the DRVTBL determines the actual CP/M 3 drive code.

4.7.1 Disk I/O Structure

The BIOS requires a DRVTBL module to locate the disk driver. it also requires a disk module for each controller that is supported.

The drive table module, DRVTBL, contains the addresses of each XDPH defined in the system. Each XDPH referenced in the DRVTBL must be declared external to link the table with the actual disk modules.

The XDPHs are the only public entry points in the disk I/O modules. The root module references the XDPHs to locate the actual I/O driver code to perform sector READS and WRITES. When the READ and WRITE routines are called, the parameters controlling the READ or WRITE operation are contained in a series of global variables that are declared public in the root module.

4.7.2 Drive Table Module (DRVTBL)

The drive table module, DRVTBL, def ines the CP/M absolute drive codes associated with the physical disks.

The DRVTBL module contains one public label, @DTBL. @DTBL is a 16-word table containing the addresses of up to 16 XDPH'S. Each XDPH name must be declared external in the DRVTBL. The first entry corresponds to drive A, and the last to drive P. You must set an entry to 0 if the corresponding drive is undefined. Selecting an undefined drive causes a BDOS SELECT error.

4.7.3 Extended Disk Parameter Headers (XDPHS)

An Extended Disk Parameter Header (XDPH) consists of a prefix and a regular Disk Parameter Header as described in Section 3. The label of a XDPH references the start of the DPH. The fields of the prefix are located at relative offsets from the XDPH label.

The XDPHs for each unit of a controller are the only entry points in a particular disk drive module. They contain both the DPH for the drive and the addresses of the various action routines for that drive, including READ, WRITE, and initialization. Figure 4-1 shows the format of the Extended Disk Parameter Header.

```
ADDRESS          LOW BYTE          HIGH BYTE
              0               7 8             15

XDPH-10      ┌──────────────────────────────────┐
             │        addr of sector WRITE        │
XDPH-8       ├──────────────────────────────────┤
             │        addr of sector READ         │
XDPH-6       ├──────────────────────────────────┤
             │        addr of drive LOGIN         │
XDPH-4       ├──────────────────────────────────┤
             │        addr of drive INIT          │
XDPH-2       ├─────────────────┬────────────────┤
             │      unit        │     type        │              start of
XDPH+0       ├─────────────────┴────────────────┤      ◄─────── regular DPH
             │       addr of translate table      │
XDPH+2       ├─────────────────┬────────────────┤
             │        0         │      0          │
XDPH+4       ├─────────────────┼────────────────┤
             │        0         │      0          │
XDPH+6       ├─────────────────┼────────────────┤
             │        0         │      0          │
XDPH+8       ├─────────────────┼────────────────┤
             │        0         │      0          │
XDPH+10      ├─────────────────┼────────────────┤
             │    Media Flag    │      0          │
XDPH+12      ├─────────────────┴────────────────┤
             │           addr of DPB              │
XDPH+14      ├──────────────────────────────────┤
             │           addr of CSV              │
XDPH+16      ├──────────────────────────────────┤
             │           addr of ALV              │
XDPH+18      ├──────────────────────────────────┤
             │          addr of DIRBCB            │
XDPH+20      ├──────────────────────────────────┤
             │          addr of DTABCB            │
XDPH+22      ├──────────────────────────────────┤
             │           addr of HASH             │
XDPH+24      ├─────────────────┬────────────────┘
             │    hash bank     │
             └─────────────────┘
```

Figure 4-1. XDPH Format

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Table 4-10 describes the fields of each Extended Disk Parameter Header.

Table 4-10. Fields of Each XDPH

Field   Meaning

WRITE   The WRITE word contains the address of the sector WRITE routine for
             the drive.

READ   The READ word contains the address of the sector READ routine for the
             drive.

LOGIN   The LOGIN word contains the address of the LOGIN routine for the
             drive.

INIT   The INIT word contains the address of the first-time initialization code for
         the drive.

UNIT   The UNIT byte contains the drive code relative to the disk controller.
             This is the value placed in @RDRV prior to calling the READ, WRITE,
             and LOGIN entry points of the drive.

TYPE   The TYPE byte is unused by the BIOS root, and is reserved for the driver
         to keep the current density or media type to support multiple-format disk
         subsystems.

regular DPH   The remaining fields of the XDPH comprise a standard DPH, as
             discussed in Section 3 of this manual.

4.7.4 Subroutine Entry Points

The pointers contained in the XDPH reference the actual code entry points to a disk
driver module. These routines are not declared public. Only the XDPH itself is public. The
BIOS root references the XDPHs only through the @DTBL. Table 4-11 shows the BIOS
subroutine entry points.

Table 4-11. Subroutine Entry Points

Entry Point   meaning

WRITE   When the WRITE routine is called, the address of the XDPH is passed in
             registers DE. The parameters for the WRITE operation are contained in
             the public variables @ADRV, @RDRV, @TRK, @SECT, @DMA,
             and @DBNK. The WRITE routine should return an error code in register
             A. The code 00 means a successful operation, 01 means a permanent error
      occurred, and 02 means the drive is write-protected if that feature is
      supported.

READ   When the READ routine is called, the address of the XDPH is contained in
             registers DE. The parameters for the READ operation are contained in
             the public variables @ADRV, @RDRV, @TRK, @SECT, @DMA, and
             @DBNK. The READ routine should return an error code in register A. A
      code of 00 means a successful operation and 01 means a permanent error
      occurred.

LOGIN   The LOGIN routine is called before the BDOS logs into the drive, and
             allows the automatic determination of density. The LOGIN routine can
             alter the various parameters in the DPH, including the translate table
             address (TRANS) and the Disk Parameter Block (DPB) .   The LOGIN
             routine can also set the TYPE byte. On single media type systems, the
             LOGIN routine can simply return. When LOGIN is called, the registers
             DE point to the XDPH for this drive.

INIT   The BOOT entry of the BIOSKRNL module calls each INIT routine
             during cold start and prior to any other disk accesses. INIT can perform
             any necessary hardware initialization, such as setting up the controller and
      interrupt vectors, if any.

4.7.5   Error Handling and Recovery

   The READ and WRITE routines should perform several retries of an operation that
produces an error. If the error is related to a seek operation or a record not found condition, the
retry routine can home or restore the drive, and then seek the correct track. The exact sequence
of events is hardware-dependent.

When a nonrecoverable error occurst the READ or WRITE routines can print an error message informing the operator of the details of the error. The BIOSKRNL module supplies a subroutine, ?PDERR, to print a standard BIOS error message header. This routine prints the following message:

BIOS Err on D: T-nn S-nn

The D: is the selected drive, and T-nn and S-nn display the track and sector number for the operation. The READ and WRITE routines should print the exact cause of the error after this message, such as Not Ready, or Write Protect. The driver can then ask the operator if additional retries are desired, and return an error code to the BDOS if they are not.

However, if the @ERMDE byte in the System Control Block indicates the BDOS is returning error codes to the application program without printing error messages, the BIOS should simply return an error without any message.

4.7.6 Multiple Sector I/O

The root module global variable @CNT contains the multisector count.   Refer to Sections 2.5 and 3.4.3 for a discussion of the considerations regarding multirecord I/O.

4.8 MOVE Module

The MOVE Module performs memory-to-memory block moves and controls bank selection.   The ?MOVE and ?XMOVE entry points correspond directly to the MOVE and XMOVE jump vector routines documented in Section 3. Table 4-12 shows the entry points for the MOVE module.

CP/M 3 Sytem Guide   4.8 MOVE Module

Table 4-12. Move Module Entry Points

Entry Point   Meaning

?MOVE Memory-to-memory move

> ?MOVE is called with the source address for the move in register DE, the
> destination address in register HL, and the byte count in register BC. If
> ?XMOVE has been called since the last call to ?MOVE, an interbank
> move must be performed. On return, registers HL and DE must point to
> the next bytes after the MOVE. This routine can use special DMA
> hardware for the interbank move capability, and can use the Z8O LDIR
> instruction for intrabank moves.

?XMOVE Set banks for one following ?MOVE

> ?XMOVE is called with the destination bank in register B and the source
> bank in register C. Interbank moves are only invoked if the DPHs specify
> deblocking buffers in alternate banks. ?XMOVE only applies to one call
> to ?MOVE. (Not implemented in the example.)

?BANK Set bank for execution

> ?BANK is called with the bank address in register A.   This bank address
> has already been stored in @CBNK for future reference. All registers
> except A must be maintained upon return.

4.9 Linking Modules into the BIOS

The following lines are examples of typical link commands to build a modular BIOS ready
for system generation with GENCPK:

LINK BNKBIOS3[b]=BNKBIOS,SCB,BOOT,CHARIO,MOVE,DRVTBL,<disk-modules>

LINK BIOS3[os]=BIOS,SCB,BOOT,CHARIO,MOVE,DRVTBL,<disk-modules>

End of Section 4

Section 5

System Generation

This section describes the use of the GENCPM utility to create a memory image CPM3.SYS file containing the elements of the CP/M 3 operating system.   This section also describes customizing the LDRBIOS portion of the CPMLDR program, and the operation of CPMLDR to read the CPM3.SYS file into memory.   Finally, this section describes the procedure to follow to boot CP/M 3.

In the nonbanked system, GENCPM creates the CPM3.SYS file from the BDOS3.SPR and your customized BIOS3.SPR files. In the banked system, GENCPM creates the CPM3. SYS f i le from the RESBDOS3. SPR f i le, the BNKBDOS3.SPR file, and your customized BNKBIOS3.SPR file.

If your BIOS contains a segment that can reside in banked memory, GENCPM separates the code and data in BNKBIOS3.SPR into a banked portion which resides in Bank 0 just below common memory, and a resident portion which resides in common memory.

GENCPM relocates the system modules, and can allocate physical record buffers, allocation vectors, checksum vectors, and hash tables as requested in the BIOS data structures. It also relocates references to the System Control Block, as described on page 27. GENCPM accepts its command input from a file, GENCPM.DAT, or interactively from the console.

5.1 GENCPM Utility

Syntax:

  GENCPM [AUTO | AUTO DISPLAY}

Purpose:

GENCPM creates a memory image CPM3.SYS file, containing the CP/M 3 BDOS and customized BIOS. The GENCPM utility performs late resolution of intermodule references between system modules. GENCPM can accept its command input interactively from the console or from a file GENCPM.DAT.

In the nonbanked system, GENCPM creates a CPM3.SYS file from the BDOS3.SPR and BIOS3.SPR files. In the banked system, GENCPM creates the CPM3.SYS file from the RESBDOS3.SPR, the BNKBDOS3.SPR and the BNKBIOS3.SPR files. Remember to back up your CPM3.SYS file before executing GENCPM, because GENCPM deletes any existing CPM3.SYS file before it generates a new system.

Input Files:

Banked System   Nonbanked System

BNKBIOS3.SPR   BIOS3.SPR
RESBDOS3.SPR   BDOS3.SPR
BNKBDOS3.SPR

optionally GENCPM.DAT

Output File:

CPM3.SYS

optionally GENCPM.DAT

GENCpm determines the location of the system modules in memory and, optionally, the number of physical record buffers allocated to the system.   GENCPM can specify the location of hash tables requested by the Disk Parameter Headers (DPHS) in the BIOS. GENCPM can allocate all required disk buffer space and create all the required Buffer Control Blocks (BCBs). GENCPM can also create checksum vectors and allocation vectors.

GENCPM can get its input from a file GENCPM.DAT. The values in the file replace the default values of GENCPM. If you enter the AUTO parameter in the command line GENCPM gets its input from the file GENCPM.DAT and generates a new system displaying only its sign-on and sign-off messages on the console. If AUTO is specified and a GENCPM.DAT file does not exist on the current drive, GENCPM reverts to manual generation.

If you enter the AUTO DISPLAY parameter in the command line, GENCPM automatically generates a new system and displays all questions on the console.   If AUTO DISPLAY is specified and a GENCPM.DAT file does not exist on the current drive, GENCPM reverts to manual generation.   If GENCPM is running in AUTO mode and an error occurs, it reverts to manual generation and starts from the beginning.

The GENCPM.DAT file is an ASCII file of variable names and their associated values. In the'following discussion, a variable name in the GENCPM.DAT file is referred to as a Question Variable. A line in the GENCPM.DAT file takes the following general form:

Question Variable = value I ? I ?value <CR><LF>

   value = #decimal value
          or hexadecimal value
          or drive letter (A - P)
          or Yes, No, Y, or N

You can specify a default value by following a question mark with the appropriate value, for example ?A or ?25 or ?Y. The question mark tells GENCPM to stop and prompt the user for input, then continue automatically. At a ?value entry, GENCPM displays the default value and stops for verification.

The following pages display GENCPM questions. The items in parentheses are the default values.   The Question Variable associated with the question is shown below the explanation of the answers to the questions.

Program Questions:

Use GENCPM.DAT for defaults (Y) ?
> Enter Y - GENCPM gets its default values from the file GENCPM.DAT.
>
> Enter N - GENCPM uses the built-in default values.
>
> No Question Variable is associated with this question

Create a new GENCPM.DAT file (N) ?
> Enter N - GENCPM does not create a new GENCPM.DAT fil,
>
> Enter Y - After GENCPM generates the new CPM3.SYS file it creates a new GENCPM.DAT file containing the default values.
>
> Question Variable: CRDATAF

Display Load Table at Cold Boot (Y) ?
> Enter Y - On Cold Boot the system displays the load table containing the filename, filetype, hex starting address, length of system modules, and the TPA size.
>
> Enter N - System displays only the TPA size on cold boot.
>
> Question Variable: PRTMSG

Number of console columns (#80) ?
> Enter the number of columns (characters-per-line) for your console.
>
> A character in the last column must not force a new line for console editing in CP/M 3. If your terminal forces a new line automatically, decrement the column count by one.
>
> Question Variable: PAGWID

Number of lines per console page (#24) ?
        Enter the number of the lines per screen for your console.

        Question Variable: PAGLEN

Backspace echoes erased character (N) ?
        Enter N - Backspace (Ctrl-H, 08H) moves back one column and erases the
    previous character.

        Enter Y - Backspace moves forward one column and displays the previous
    character.

        Question Variable: BACKSPC

Rubout echoes erased character (Y) ?

        Enter Y - Rubout (7FH) moves forward one column and displays the previous
        character.

        Enter N - Rubout moves back one column and erases the previous character.

        Question Variable: RUBOUT

Initial default drive (A:) ?
        Enter the drive code the prompt is to display at cold boot.

        Question Variable: BOOTDRV

Top page of memory (FF) ?
        Enter the page address that is to be the top of the operating system. OFFH is the
        top of a 64K system.

        Question Variable: MEMTOP

Bank-switched memory (Y) ?
        Enter Y - GENCPM uses the banked system files.

        Enter N - GENCPM uses the nonbanked system files.

        Question Variable: BNKSWT

Common memory base page (CO) ?
        This question is displayed only if you answered Y to the previous question. Enter
    the page address of the start of common memory.

        Question Variable: COMBAS

Long error messages (Y) ?

>   This question is displayed only if you answered Y to bank- switched memory.

>   Enter Y - CP/M 3 error messages contain the BDOS function number and the name of the file on which the operation was attempted.

>   Enter N - CP/M 3 error messages do not display the function number or file.

>   Question Variable: LERROR

Double allocation vectors (Y) ?

>   This question is displayed only if you answered N to bank- switched memory. For more information about double allocation vectors, see the definition of the Disk Parameter Header ALV field in Section 3.

>   Enter Y - GENCPM creates double-bit allocation vectors for each drive.

>   Enter N - GENCPM creates single-bit allocation vectors for each drive.

>   Question Variable: DBLALV

Accept new system definition (Y) ?

>   Enter Y   GENCPM proceeds to the next set of questions.

>   Enter N   GENCPM repeats the previous questions and displays your previous input in the default parentheses. You can modify your answers.

>   No Question Variable is associated with this question.

Number of memory segments (#3) ?

>   GENCPM displays this question if you answered Y to bank- switched memory.

>   Enter the number of memory segments in the system. Do not count common memory or memory in Bank 1, the TPA bank, as a memory segment. A maximum of 16 (0 - 15) memory segments are allowed.   The memory segments define to GENCPM the memory available for buffer and hash table allocation. Do not include the part of Bank 0 that is reserved for the operating system.

>   Question Variable: NUMSEGS

CP/M 3 Base,size,bank (8E,32,00)
    Enter memory segment table:
        Base,size,bank (00,8E,00) ?
        Base,size,bank (00,CO,02) ?
        Base,size,bank (00,CO,03) ?

        Enter the base page, the length, and the bank of the memory segment.

        Question Variable: MEMSEGO# where   0 to F hex

Accept new memory segment table entries (Y) ?
        Enter Y   GENCPM displays the next group of questions.

        Enter N   GENCPM displays the memory segment table definition questions
        again.

        No Question Variable is associated with this question.

Setting up directory hash tables:
        Enable hashing for drive d: (Y)

        GENCPM displays this question if there is a Drive Table and if the DPHs for a
        given drive have an OFFFEH in the hash table address field of the DPH. The
        question is asked for every drive d: defined in the BIOS.

        Enter Y - Space is allocated for the Hash Table. The address and bank of the
        Hash Table is entered into the DPH.

        Enter N - No space is allocated for a Hash Table for that drive.

        Question Variable: HASHDRVD where d = drives A-P.

Setting up Blocking/Deblocking buffers:
        GENCPM displays the next set of questions if either or both the DTABCB field
        or the DIRBCB field contain OFFFEH.

Number of directory buffers for drive d: (#l) ? 10
        This question appears only if you are generating a banked system. Enter the
        number of directory buffers to allocate for the specified drive.   In a banked
        system, directory buffers are allocated only inside Bank 0. In a nonbanked
     system, one directory buffer is allocated above the BIOS.

        Question Variable: NDIRRECD where d = drives A-P.

Number of data buffers for drive d: (#l) ? 1

> This question appears only if you are generating a Banked system. Enter the
> number of data buffers to allocate for the specified drive. In a banked system,
> data buffers can only be allocated outside Bank 1, and in common. You can only
> allocate data buffers in alternate banks if your BIOS supports interbank moves.
> In a nonbanked system, data buffers are allocated above the BIOS.
>
> Question Variable: NDTARECD where d = drives A-P.

Share buffer(s) with which drive (A:) ?

> This question appears only if you answered zero to either of the above questions.
> Enter the drive letter (A-P) of the drive with which you want this drive to   share
> a buffer.
>
> Question Variable: ODIRDRVD for directory records where d = drives A-P.
>
> Question Variable: ODTADRVD for data records where d drives A-P.

Allocate buffers outside of Commom (N) ?

> This question appears if the BIOS XMOVE routine is implemented.
>
> Answer Y - GENCPM allocates data buffers outside of common and Bank 0.
>
> Answer N - GENCPM allocates data buffers in common.
>
> Question Variable: ALTBNKSD where d = drives A-P.

Overlay Directory buffer for drive d: (Y) ?

> This question appears only if you are generating a nonbanked system.
>
> Enter Y   this drive shares a directory buffer with another drive.
>
> Enter N   GENCPM allocates an additional directory buffer above the BIOS.
>
> Question Variable: OVLYDIRD where d = drives A-P.

Overlay Data buffer for drive d: (Y) ?
> This question appears only if you are generating a nonbanked system.

> Enter Y - this drive shares a data buffer with another drive.

> Enter N - GENCPM allocates an additional data buffer above the BIOS.

> Question Variable: OVLYDTAD for directory records where d = drives A-P.

Accept new buffer definitions (Y) ?
> Enter Y   GENCPM creates the CPM3.SYS file and terminates.

> Enter N   GENCPM redisplays all of the buffer definition questions.

> No Question Variable is associated with this question.

Examples:

The following section contains examples of two system generation sessions. If no entry follows a program question, assume RETURN was entered to select the default value in parentheses. Entries different from the default appear after the question mark.

EXAMPLE OF CONTENTS OF GENCPM.DAT FILE

combas = c0 <CR>
lerror = ? <CR>
numsegs   3 <CR>
memseg00   00,80,00 <CR>
memseg01   0d,b3,02 <CR>
memseg0f   ?00,c0,10 <CR>
hashdrva   y <CR>
hashdrvd   n <CR>
ndirreca   20 <CR>
ndtarecf   10 <CR>

EXAMPLE OF SYSTEM GENERATION WITH BANKED MEMORY

A>GENCPM

CP/M 3.0 System Generation
Copyright (C) 1982, Digital Research

Default entries are shown in (parens).
Default base is Hex, precede entry with # for decimal

Use GENCPM.DAT for defaults (Y) ?
Create a new GENCPM.DAT file (N) ?
Display Load Map at Cold Boot (Y) ?
Number of console columns (#80) ?
Number of lines in console page (#24) ?
Backspace echoes erased character (N) ?
Rubout echoes erased character (N) ?
Initial default drive (A:) ?
Top page of memory (FF) ?
Bank switched memory (Y) ?
Common memory base page (CO) ?
Long error messages (Y) ?
Accept new system definition (Y) ?
Setting up Allocation vector for drive A:
Setting up Checksum vector for drive A:
Setting up Allocation vector for drive B:
Setting up Checksum vector for drive B:
Setting up Allocation vector for drive C:
Setting up Checksum vector for drive C:
Setting up Allocation vector for drive D:
Setting up Checksum vector for drive D:

***   Bank 1 and Common are not included ***
***   in the memory segment table.   ***

Number of memory segments (#3) ?
CP/M 3 Base,size,bank (8B,35,00)
Enter memory segment table:
 Base,size,bank (00,8B,00)   ?
 Base,size,bank (OD,B3,02)   ?
 Base,size,bank (00,CO,03)   ?
 CP/M 3 Sys   SBOOH 3500H Bank 00
 Memseg No. 00 OOOOH BBOOH Bank 00
 Memseg No. 01 ODOOH B300H   Bank 02
 Memseg No. 02 OOOOH COOOH   Bank 03
Accept new memory segment   table entries (Y) ?
Setting up directory hash   tables:
 Enable hashing for drive   A: (Y) ?
 Enable hashing for drive   B: (Y) ?
 Enable hashing for drive   C: (Y) ?
 Enable hashing for drive   D: (Y) ?

Setting up Blocking/Deblocking buffers:
 The physical record size is 0200H:
      Available space in 256 byte pages:
      TPA = 00F4H, Bank 0 = 00BBH, Other banks = 0166H
            Number of directory buffers for drive A: (#32) ?
      Available space in 256 byte pages:
      TPA = 00F4H, Bank 0 = 0049H, Other banks = 0166H
            Number of data buffers for drive A: (#2) ?
            Allocate buffers outside of Common (N) ?
      Available space in 256 byte pages:
      TPA = 00F0H, Bank 0 = 0049H, Other banks = 0166H
            Number of directory buffers for drive B; (#32) ?
      Available space in 256 byte pages:
      TPA = 00F0H, Bank 0 = 0007H, Other banks = 0166H
            Number of data buffers for drive B: (#0) ?
            Share buffer(s) with which drive (A:) ?
 The physical record size is 0080H:
      Available space in 256 byte pages:
      TPA = 00F0H, Bank 0 = 0007H, Other banks = 0166H
            Number of directory buffers for drive C: (410) ?
      Available space in 256 byte pages:
      TPA = 00F0H, Bank 0 = 0001H, Other banks = 0166H
            Number of directory buffers for drive D: (#0) ?
            Share buffer(s) with which drive (C:) ?
      Available space in 256 byte pages:
      TPA = 00F0H, Bank 0 = 0001H, Other banks = 0166H
 Accept new buffer definitions (Y) ?
 BNKBIOS3 SPR F600H 0600H
 BNKBIOS3 SPR BI00H 0F00H
 RESBDOS3 SPR F000H 0600H
 BNKBDOS3 SPR 8700H 2A00H

 *** CP/M 3.0 SYSTEM GENERATION DONE

In the preceding example GENCPM displays the resident portion of
BNKBIOS3.SPR first, followed by the banked portion.

EXAMPLE OF SYSTEM GENERATION WITH NONBANKED MEMORY

A>GENCPM
CP/M 3.0 System Generation
Copyright (C) 1982, Digital Research
Default entries are shown in (parens).
Default base is Hex, precede entry with   for decimal
Use GENCPM.DAT for defaults (Y) ?
Create a new GENCPM.DAT file (N) ?
Display Load Map at Cold Boot (Y) ?
Number of console columns (#80) ?
Number of lines in console page (#24) ?
Backspace echoes erased character (N) ?
Rubout echoes erased character (N) ?
Initial default drive (A:) ?
Top page of memory (FF) ?
Bank switched memory (Y) ? N
Double allocation vectors (Y) ?
Accept new system definition (Y) ?
Setting up Blocking/Deblocking buffers:
The physical record size is 020OH:
   Available space in 256 byte pages:
   TPA = 00D8H
     Directory buffer required
     and allocated for drive A:
   Available space in 256 byte pages:
   TPA = 00D5H
       Overlay Data buffer for drive A: (Y) ?
   Available space in 256 byte pages:
   TPA = 00D5H
       Overlay Directory buffer for drive B: (Y) ?
       Share buffer(s) with which drive (A:) ?
   Available space in 256 byte pages:
   TPA = 00D5H

Overlay Data buffer for drive B: (Y) ?
Share buffer(s) with which drive (A:) ?

The physical record size is 00B0H:

Available space in 256 byte pages:
TPA = 0005H

Overlay Directory buffer for drive C: (Y) ?
Share buffer(s) with which drive (A:) ?

Available space in 256 byte pages:
TPA = 00D5H

Overlay Directory buffer for drive D: (Y) ?
Share buffer(s) with which drive (C;) ?

Available space in 256 byte pages:
TPA = 00D5H

Accept new buffer definitions (Y) ?

BIOS3   SPR F300H 0B00H
BDOS3   SPR D600H 1D00H

*** CP/M 3.0 SYSTEM GENERATION DONE

A>

5.2 Customizing the CPMLDR

The CPMLDR resides on the system tracks of a CP/M 3 system disk, and loads the CPM3.SYS file into memory to cold start the system. CPMLDR contains the LDRBDOS supplied by Digital Research, and must contain your customized LDRBIOS.

The system tracks for CP/M 3 contain the customized Cold Start Loader, CPMLDR with the customized LDRBIOS, and possibly the CCP.

The COPYSYS utility places the Cold Start Loader, the CPMLDR, and optionally the CCP on the system tracks, as shown in Table 5-1.

Table 5-1.   Sample CP/M 3 System Track Organization

Track	Sector	Page	Memory Address	CP/M 3 Module Name
00	01		Boot Address	Cold Start Loader
00	02	00	0100H	CPMLDR
.				
.				and
.				
00	21	09	0A80H	LDRBDOS
00	22	10	0B00H	LDRBIOS
.				
.				
00	26	12	0D00H	and
01	01	12	0D80H	
01	26	25	1A00H	CCP

Typically the Cold Start Loader is loaded into memory from Track 0, Sector 1 of the system tracks when the reset button is depressed. The Cold Start Loader then loads CPMLDR from the system tracks into memory.

Alternatively, if you are starting from an existing CP/M 2 system, you can run CPMLDR.COM as a transient program. CP/M 2 loads CPMLDR.COM into memory at location 100H. CPMLDR then reads the CPM3.SYS file from User 0 on drive A and loads it into memory.

Use the following procedure to create a customized CPMLDR.COM file, including your customized LDRBIOS:

1)   Prepare a LDRBIOS.ASM file.

2)   Assemble the LDRBIOS file with RMAC to produce a LDRBIOS.REL file.

3)   Link the supplied CPMLDR.REL file with the LDRBIOS.REL file you created to produce a CPMLDR.COM file.

   A>LINK CPf4LDR[LlOO]=CPNLDR,LDRBIOS

   Replace the address 100 with the load address to which your boot loader loads CPMLDR.COM. You must include a bias of 100H bytes for buffer space when you determine the load address.

The CPMLDR requires a customized LDRBIOS to perform disk input and console output. The LDRBIOS is essentially a nonbanked BIOS. The LDRBIOS has the same JMP vector as the regular CP/M 3 BIOS. The LDRBIOS is called only to perform disk reads (READ) from one drive, console output (CONOUT) for sign-on messages, and minimal system initialization.

The CPMLDR calls the BOOT entry point at the beginning of the LDRBIOS to allow it to perform any necessary hardware initialization. The BOOT entry point should return to CPMLDR instead of loading and branching to the CCP, as a BIOS normally does. Note that interrupts are not disabled when the LDRBIOS BOOT routine is called.

Test your LDRBIOS completely to ensure that it properly performs console character output and disk reads. Check that the proper tracks and sectors are addressed on all reads and that data is transferred to the proper memory locations.

You should assemble the LDRBIOS.ASM file with a relocatable origin of 0000H. Assemble the LDRBIOS with RMAC to produce a LDRBIOS.REL file. Link the LDRBIOS.REL file with the CPMLDR.REL file supplied by Digital Research to create a CPMLDR.COM .file. Use the L option in LINK to specify the load origin (address) to which the boot loader on track 0 sector 1 loads the CPMLDR.COM file.

Unnecessary BIOS functions can be deleted from the LDRBIOS to conserve space. There is one absolute restriction on the length of the LDRBIOS; it cannot extend above the base of the banked portion of CP/M 3. (GENCPM lists the base address of CP/M 3 in its load map.)   If you plan to boot CP/M 3 from standard, single-density, eight-inch floppy disks, your CPMLDR must not be longer than 1980H to place the CPMLDR.COM file on two system tracks with the boot sector. If the CCP resides on the system tracks with the Cold Start Loader and CPMLDR, the combined lengths must not exceed 1980H.

5.3 CPKLDR Utility

Syntax:

    CPMLDR

Purpose:

CPMLDR loads the CP/M 3 system file CPM3.SYS into Bank 0 and transfers control to the BOOT routine in the customized BIOS. You can specify in GENCPM for CPMLDR to display a load table containing the names and addresses of the system modules.

The CPM3.SYS file contains the CP/M 3 BDOS and customized BIOS. The file CPM3.SYS must be on drive A in USER 0.   You can execute CPMLDR under SID or DDT to help debug the BIOS.   A $B in the default File Control Block (FCB) causes CPMLDR to execute a RST 7 (SID breakpoint) just before jumping to the CP/M 3 Cold Boot BIOS entry point.

Input File:

    CPM3.SYS

Examples:

    A>CPMLDR
    CP/M V3.0 Loader
    Copyright (C) 1982, Digital Research

    BNKBIOS3 SPR F600H 0A00H
    BNKBIOS3 SPR BB00H 0500H
    RESBDOS3 SPR F100H 0500H
    BNKBDOS3 SPR 9A00H 2100H

    60K TPA
    A>

In the preceding example, CPMLDR displays its name and version number, the Digital Research copyright message, and a four-column load table containing the filename, filetype, hex starting address, and length of the system modules. CPMLDR completes its sign-on message by indicating the size of the Transient Program Area (TPA) in kilobytes. The CCP then displays the system prompt, A>.

5.4   Booting CP/M 3

The CP/M 3 cold start operation loads the CCP, BDOS, and BIOS modules into their proper locations in memory and passes control to the cold start entry point (BIOS Function 0: BOOT) in the BIOS. Typically, a PROM-based loader initiates a cold start by loading sector 0 on track I of the system tracks into memory and jumping to it. This first sector contains the Cold Start Loader. The Cold Start Loader loads the CPMLDR.COM program into memory and jumps to it. CPMLDR loads the CPM3.SYS file into memory and jumps to the +BIOS cold start entry point.

To boot the CP/M 3 system, use the following procedure:

1)   Create the CPM3.SYS file.

2)   Copy the CPM3.SYS file to the boot drive.

3)   Create a CPMLDR.COM for your machine.

4)   Place the CPMLDR.COM file on your system tracks using SYSGEN with CP/M
        2 or COPYSYS with CP/M 3. The boot loader must place the CPMLDR.Com file
   at the address at which it originated. If CPMLDR has been linked to load   at
   100H, you can run CPMLDR under CP/M 2.

The COPYSYS utility handles initialization of the system tracks. The source of COPYSYS
is included with the standard CP/M 3 system because you need to customize COPYSYS to
support nonstandard system disk formats.   COPYSYS copies the Cold Start Loader, the
CPMLDR.COM file, and optionally the CCP to the system tracks. Refer to the COPYSYS.ASM
source file on the distribution disk.

End of Section 5

Section 6

Debugging the BIOS

This section describes a sample debugging session for a nonbanked CP/M 3 BIOS. You must create and debug your nonbanked system first, then bring up the banked system.   Note that your system probably displays addresses that differ from the addresses in the following example.

You can use SID, Digital Research' s Symbolic Debugger Program, running under CP/M 2.2, to help debug your customized BIOS. The following steps outline a sample debugging session.

1) Determine the amount of memory available to CP/M 3 when the debugger and CP/M 2.2 are in memory. To do this, load the debugger under CP/M 2.2 and list the jump instruction at location 0005H. In the following example of a 64K system, C500 is the base address of the debugger, and also the maximum top of memory that you can specify in GENCPM for your customized CP/M 3 system.

    A>SID
    CP/M 3 SID - Version 3.0
    #L5
    0005 JMP C500

              .

              .

              .

2) Running under CP/M 2.2, use GENCPM to generate a CPM3.SYS file, which specifies a top of memory that is less than the base address of the debugger, as determined by the previous step. Allow at least 256K bytes for a patch area.   In this example, you can specify C3 to GENCPM as the top of memory for your CP/M 3 system.

    A>GENCPM

    .

    .

    Top page of memory (FF)? C3

    .

    .

    .

3) Now you have created a system small enough to debug under SID. Use SID to load the CPMLDR.COM file, as shown in the

following example:

A>SID CP14LDR.COM
CP/M 3 SID - Version 3.0
NEXT MSZE PC END
0E80 0EB0 0100 D4FF

4)   Use the I command in SID, as shown in the next example, to place the characters
        $B into locations 005DH and 005EH of the default FCB based at 005CH. The $B
        causes CPMLDR.COM to break after loading the CPM3.SYS file into memory.

        #I$B

5)   Transfer control to CPMLDR using the G command:

        #G

        At this point, the screen clears and the following information appears:

        CP/M V3.0 LOADER
        Copyright (c) 1982, Digital Research

        BIOS3   SPR AA00 0B00
        BDOS3   SPR 8B00 1F00

        34K TPA

        01A9

6)   With the CP/M 3 system in the proper location, you can set passpoints in your
        BIOS. Use the L command with the address specified as the beginning of the
        BIOS by the CPMLDR load table as shown in step 5 above. This L command
        causes SID to display the BIOS jump vector which begins at that address.   The
        jump vector indicates the beginning address of each subroutine in the table. For
        example, the first jump instruction in the example below is to the Cold Boot
        subroutine.

        #LAA00

The output from your BIOS might look like this:

JMP AA68
JMP AA8E
JMP ABA4
JMP ABAF
JMP ABCA

7)   Now set a passpoint in the Cold BOOT routine. Use the P command with an
      address to set a passpoint at that address.

      #PAA68

8)   Continue with the CPMLDR.COM program by entering the G command,
      followed by the address of Cold Boot, the first entry in the BIOS jump vector.

      #GAA00

9)   In response to the G command, the CPMLDR transfers control to the CP/M 3
      operating system. If you set a passpoint in the Cold BOOT routine, the program
      stops executing, control transfers to SID, and you can begin tracing the BOOT
      routine.

10)   When you know the BOOT routine is functioning correctly, enter passpoints for
      the other routines you want to trace, and begin tracing step by step to determine
      the location of problems.

      Refer to the Digital Research Symbolic Instruction Debugger User's Guide (SID) in the
Programmer's Utilities Guide for the CP/M Family of Operating Systems for a discussion of all the
SID commands.

End of Section 6

Appendix A

Removable Media Considerations

All disk drives under CP/M 3 are classified as either permanent or removable. In general, removable drives support media changes; permanent drives do not. Setting the high-order bit in the CKS field in a drive's Disk Parameter Block (DPB) marks the drive as a permanent drive.

The BDOS file system distinguishes between permanent and removable drives. If a drive is permanent, the BDOS always accepts the contents of physical record buffers as valid. In addition, it also accepts the results of hash table searches on the drive.

On removable drives, the status of physical record buffers is more complicated. Because of the potential for media change, the BDOS must discard directory buffers before performing most directory related BDOS function calls. This is required because the BDOS detects media changes by reading directory records. When it reads a directory record, the BDOS computes a checksum for the record, and compares the checksum to the currently stored value in the drive's checksum vector . If the checksum values do not match, the BDOS assumes the media has changed. Thus, the BDOS can only detect a media change by an actual directory READ operation.

A similar situation occurs with directory hashing on removable drives. Because the directory hash table is a memory-resident table, the BDOS must verify all unsuccessful hash table searches on removable drives by accessing the directory.

The net result of these actions is that there is a significant performance penalty associated with removable drives as compared to permanent drives. In addition, the protection provided by classifying a drive as removable is not total. Media changes are only detected during directory operations. If the media is changed on a drive during BDOS WRITE operations, the new disk can be damaged.

The BIOS media flag facility gives you another option for supporting drives with removable media. However, to use this option, the disk controller must be capable of generating an interrupt when the drive door is opened. If your hardware provides this support, you can improve the handling of removable media by implementing the following procedure:

1) Mark the drive as a permanent drive and set the DPB CKS parameter to th'e total number of directory entries, divided by four. For example, set the CKS field for a disk with 96 directory entries to 8018H.

2)   Implement an interrupt service routine that sets the @MEDIA flag in the System
          Control Block and the DPH MEDIA byte for the drive that signaled the door
          open condition.

By using the media flag facility, you gain the performance advantage associated with permanent drives on drives that support removable media. The BDOS checks the System Control Block @MEDIA flag on entry for all disk-related function calls. If the flag has not been set, it implies that no disks on the system have been changed. If the flag is set, the BDOS checks the DPH MEDIA flag of each currently logged-in disk. If the DPH MEDIA flag of a drive is set, the BDOS reads the entire directory on the drive to determine whether the drive has had a media change before performing any other operations on the drive. In addition, it temporarily classifies any permanent disk with the DPH MEDIA flag set as a removable drive. Thus, the BDOS discards all directory physical record buffers when a drive door is opened to force all directory READ operations to access the disk.

To summarize, using the BIOS MEDIA flag with removable drives offers two important benefits. First, because a removable drive can be classified as permanent, performance is enhanced. Second, because the BDOS immediately checks the entire directory before performing any disk-related function an the drive if the drive's DPH MEDIA flag is set, disk integrity is enhanced.

End of Appendix A

Apendix B

Auto-density Support

AUto-density support refers to the capability of CP/M 3 to support different types of media on a single drive. For example, some floppy-disk drives accept single-sided and double-sided disks in both single-density and double-density formats. Auto-density support requires that the BIOS be able to determine the current density when SELDSK is called and to subsequently be able to detect a change in disk format when the READ or WRITE routines are called.

To support multiple disk formats, the drivers BIOS driver must include a Disk Parameter Block (DPB) for each type of disk or include code to generate the proper DPB parameters dynamically. In addition, the BIOS driver must determine the proper format of the disk when the SELDSK entry point is called with register E bit 0 equal to 0 (initial SELDSK calls). If the BIOS driver cannot determine the format, it can return OOOOH in register pair HL to indicate the select was not successful. Otherwise, it must update the Disk Parameter Header (DPH) to address a DPB that describes the current media, and return the address of the DPH to the BDOS.

Note: all subsequent SELDSK calls with register E bit 0 equal to 1, the BIOS driver must continue to return the address of the DPH returned in the initial SELDSK call. The value 0000H is only a legal return value for initial SELDSK calls.

After a driver's SELDSK routine has determined the format of a disk, the driver's READ and WRITE routines assume this is the correct format until an error is detected. If an error is detected and the driver determines that the media has been changed to another format, it must return the value OFFH in register A and set the media flag in the System Control Block. This signals the BDOS that the media has changed and the next BIOS call to the drive will be an initial SELDSK call. Do not modify the drivers DPH or DPB until the initial SELDSK call is made. Note that the BDOS can detect a change in media and will make an initial SELDSK call, even though the BIOS READ and WRITE routines have not detected a disk format change. However, the SELDSK routine must always determine the format on initial calls.

A drive's Disk Parameter Header (DPH) has associated with it several uninitialized data areas: the allocation vector, the checksum vector, the directory hash table, and physical record buffers. The size of these areas is determined by DPB parameters. If space for these areas is explicitly allocated in the BIOS, the DPB that requires the most space determines the amount of memory to allocate. If the BIOS defers the allocation of these areas to GENCPM, the DPH must be initialized to the DPB with the largest space requirements. If one DPB is not largest in all of the above categories, a false one must be constructed so that GENCPM allocates sufficient space for each data area.

End of Appendix B

Appendix C

Modifing a CP/M 2 BIOS

If you are modifying an existing CP/M 2.2 BIOS, you must note the following changes.

o The BIOS jump vector is expanded from 17 entry points in CP/M 2.2 to 33 entry points in CP/M 3. You must implement the necessary additional routines.

o The Disk Parameter Header and Disk Parameter Block data structures are expanded.

See Section 3 of this manual, "CP/M 3 BIOS Functional Specifications," for details of the BIOS data structures and subroutines. The following table shows all CP/M 3 BIOS functions with the changes necessary to support CP/M 3.

Table C-1. CP/M 3 BIOS Functions

Function   Meaning

BIOS Function 00: BOOT

> The address for the JMP at location 5 must be obtained from @MXTPA in the System Control Block.

BIOS Function 01: WBOOT

> The address for the JMP at location 5 must be obtained from @MXTPA in the System Control Block. The CCP can be reloaded from a file.

BIOS Function 02: CONST

> Can be implemented unchanged.

BIOS Function 03: CONIN

> Can be implemented unchanged. Do not mask the high-order bit.

Table C-1. (continued)

Function   Meaning

BIOS Function 04: CONOUT

      Can be implemented unchanged.

BIOS Function 05: LIST

      Can be implemented unchanged.

BIOS Function 06:   AUXOUT

      Called PUNCH in CP/M 2. Can be implemented unchanged.

BIOS Function 07: AUXIN

      Called READER in CP/M 2. Can be implemented unchanged. Do not mask the high-order bit.

BIOS Function 08: HOME

      No change.

BIOS Function 09: SELDSK

      Can not return a select error when SELDSK is called with bit 0 in register E equal to 1.

BIOS Function 10: SETTRK

      No change.

BIOS Function 11: SETSEC

      Sectors are physical sectors, not logical 128-byte sectors.

BIOS Function 12: SETDMA

      Now called for every READ or WRITE operation. The DMA buffer can now be greater than 128 bytes.

Table C-1. (continued)

Function   meaning

BIOS Function 13: READ

READ operations are in terms of physical sectors.   READ can return a 0FFH error code if it detects that the disk format has changed.

BIOS Function 14: WRITE

WRITE operations are in terms of physical sectors. If write detects that the disk is Read-Only, it can return error code 2. WRITE can return a 0FFH error code if it detects that the disk format has changed.

BIOS Function 15: LISTST

Can be implemented unchanged.

BIOS Function 16: SECTRN

Sectors are physical sectors, not logical 128-byte sectors.

The following is a list of new BIOS functions:

BIOS Function   17: CONOST

BIOS Function   18: AUXIST

BIOS Function   19: AUXOST

BIOS Function   20: DEVTBL

BIOS Function   21: DEVINI

BIOS Function   22; DRVTBL

BIOS Function   23: MULTIO

BIOS Function   24: FLUSH

BIOS Function   25: MOVE

BIOS Function   26: TIME

CP/M 3 System Guide   C Modifying a CP/M 2 BIOS
    BIOS Function 27:   SELMEM

    BIOS Function 28: SETBNK

    BIOS Function 29: XMOVE

    BIOS Function 30: USERF

    BIOS Function 31: RESERV1

    BIOS Function 32: RESERV2

End of Appendix C

Appendix D
CPM3.SYS File Format

Table D-1. CPH3.SYS File Format

Record	Contents
0	Header Record (128 bytes)
1	Print Record (128 bytes)
2-n	CP/M 3 operating system in reverse order, top down.

Table D-2. Header Record Definition

Byte	Contents
0	Top page plus one, at which the resident portion of CP/M 3 is to be loaded top down.
1	Length in pages (256 bytes) of the resident portion of CP/M 3.
2	Top page plus one, at which the banked portion of CP/M 3 is to be loaded top down.
3	Length in pages (256 bytes) of the banked portion of CP/M 3.
4-5	Address of CP/M 3 Cold Boot entry point.
6-15	Reserved.
16-51	Copyright Message.
52	Reserved.
53-58	Serial Number.
59-127	Reserved.

The Print Record is the CP/M 3 Load Table in ASCII, terminated by a dollar sign ($).

End of Appendix D

All the listings in Appendixes E through I are assembled with , the cP/M Relocating Macro Assembler, and cross-referenced XREF , an assembly language cross-reference program used with . listings are output from the XREF program. The assembly sources are on your distribution disk as ASM files.

```
1                                    title   'Root module of relocatable BIOS for CP/M 3.0'
2
3                                    ; version 1.0 15 Sept 82
4
5      FFFF    =      true      equ -l
6      0000    =      false     equ not true
7
8      FFFF    =      banked  equ true
9
10
11                   ;               Copyright (C),  1982
12                   ;               Digital Research, Inc
13                   ;                  P.O. Box 579
14                   ;               Pacific Grove, CA  93950
15
16
17                   ;   This is the invariant portion of the modular BIOS and is
18                   ;        distributed as source for informational purposes only.
19                   ;        All desired modifications should be performed by
20                   ;        adding or changing externally defined modules.
21                   ;        This allows producing "standard" I/O modules that
22                   ;        can be combined to support a particular system
23                   ;        configuration.
24
25     000d    =      cr        equ 13
26     000A    =      1f        equ 10
27     0007    =      bell      equ 7
28     0011    =      ctlQ      equ 'Q'-'@'
29     0013    =      ctlS      equ 'S'-'@'
30
31     0100    =      ccp       equ 0100h      ; CCP gets loaded  the TPA
32
33                           cseg                 ; GENCPM puts CSEG stuff in common memory
34
35
36                   ; variables in system data page
37
38                   extrn @covec,@civec,@aovec.@aivec,@lovec ; I/O redirection vectors
39                   extrn @mxtpa                ; addr of system entry point
40                   extrn @bnkbf                ; 128 byte scratch buffer
41
42                   ; initialization
43
44                   extrn ?init                 ; general initialization and signon
45                   extrn ?ldccp,?rlccp             ; load & reload CCP for BOOT & WBOOT
46
```

```
47                        ; user defined character I/O routines
48
49              extrn 7ci,?co,?cist,?cost          ; each take device in <B>
50              extrn ?cinlt                       ; (re)initialize device in <C>
51              extrn @ctbl                        ; physical character device table
52
53              ; disk communication data items
54
55              extrn @dtbl                        ; table of pointers to XDPHs
56              public @adrv,@rdrv,@trk,@sect       ; parameters for disk I/O
57              public @dma,@dbnk,@cnt             ;    "          "     "
58
59               ; memory control
60
61              public @cbnk                       ; current bank
62              extrn ?xmove,?move                 ; select move bank, and block move
63              extrn ?bank                        ; select CPU bank
64
65              ; clock            support
66
67              extrn ?time                        ; siqnal time operation
68
69                ; general utility routines
70
71              public ?pmsg,?pdec     ; print message, print number from 0 to 65535
72              public ?pderr                  ; print BIOS disk error message header
73
74              maclib modebaud            ; define mode bits
75
76
77              ; External names for BIOS entry points
78
79              public ??boot,?wboot,?const,?conin,?cono,?list,?auxo,?auxi
80              public ?home,?sldsk,?sttrk ,?stsec,?stdma,7read,?write
81              public ?lists,?sctrn
82              public ?conos,?auxis,?auxos,?dvtbl,?devin,?drtbl
83              public 7mltio,?flush,?mov,7tim,?bnksl,7stbnk,?xmov
84
85
86               ; BIOS Jump vector
87
58                                      ' All BIOS routines are invoked by calling these
89                                      ;      entry points.
90
91      0000    C30000 ?boot:  jmp      boot     ; initial entry on cold start
92      0003    C36C00 ?wboot. jmp      wboot    ; reentry on program exit, warm start
93
94      0006    C37701 ?const. jmp      const    ; return console input Status
95      0009    C39201 ?conin: jmp      conin    ; return console input character
96      000C    C30A00 ?cono:  jmp      conout   ; send console output character
97      000F    C3E600 ?list:  jmp      list     ; send list output character
98      0012    C3E000 ?auxo:  jmp      auxout   ; send auxilliary output character
99      0015    C39801 ?auxi:  jmp      auxin    ; return auxilliary input character
100
101     0018    C36E00 ?home:  jmp      home     ; met disks to logical home
```

```
102    001B    C33F00 ?sldsk:  jmp     seldek   ; select disk drive, return disk parm info
103    00lE    C37100 ?sttrk:  jmp     settrk   ; Set disk track
104    0021    C37700 ?stsec:  jmp     setsec   ; set disk sector
105    0024    C37000 ?stdma:  jmp     setdma   ; set disk I/O memory address
106    0027    C39400 ?read:   jmp     read     ; read physical block(s)
107    002A    C3AA00?write:   jmp     write    ; write physical block(s)
108
109    002d    C31201 ?lists:  jmp     listat   ; return list device Status
110    0030    C38900 ?sctrn:  jmp     sectrn   ; translate logical to physical sector
111
112    0033    C30601 ?conos:  jmp     conost   ; return console output status
113    0036    C37D01 ?auxis:  jmp     auxibt   ; return aux input status
114    0039    C30C01 ?auxoS:  jmp     auxost   ; return aux output status
115    003C    C3d200 ?dvtbl:  jmp     devtbl   ; return address of device def table
116    003F    C30000 ?devin:  jmp     ?cinit   ; change baud rate of device
117
118    0042    C30600 ?drtbl:  jmp     getdrv   ; return address of disk drive table
119    0045    C3CB00?mltio:   jmp     multio   ; Set multiple record count for disk I/O
120    0048    C3CF00 ?flush:  jmp     flush    ; flush BIOS maintained disk caching
121
122    004B    C30000 ?mov:    jmp     ?move    ; block move memory to memory
123    004E    C30000 ?tim:    jmp     ?time    ; Signal Time and date operation
124    0051    C32502 ?bnksl:  jmp     bnksel   ; select bank for code execution and DMA
125    0054    C38500 ?stbnk:  jmp     setbnk   ; select different bank for disk I/O DMA
126    0057    C30000 ?xmov:jmp         ?xmove; set source and destination banks for one 127
128    005a    C30000 jmp     0               ; reserved for system implementor
129    0050    C30000 jmp     0               ; reserved for future expansion
130    0060    C30000 jmp     0               ; reserved for future expansion
131
132
133                            ; BOOT
134                            ;            Initial entry point for SyStem startup.
135
136                            dseg            ; this part can be banked
137
138            boot:
139    0000    310200          lxi     sp,boot$stack
140    0003    0E0F            mvi     c,15     ; initialize all 16 character devices
141            c$init$loop:
142    0005    C5CD0000C1      push b ! call ?cinit ! pop b
143    000A    0dF20500        dcr     c ! jp c$init$loop
144
145    000E    CD0000 call ?init                ; perform any additiunal system initialization
146                            ; and print signon message
147
148    0011    0100102100      lxi b,16*256+0 ! lxi h,@dtbl    ; Init all 16 logical disk drives
149            d$init$loop:
150    0017    C5              push b       ; save remaining count and abs drive
151    0018    5E235623        mov e,m ! inx h ! mov d,m ! inx b        ; grab @drv entry
152    00IC    7BB2CA3600      mov a,e ! ora d ! jz d$init$next         ; if null, no drive
153    0021    E5              push h       ; save @drv pointer
154    0022    EB              xchg         ; XDPH address in <HL>
155    0023    2B2B7E32EE      dcx h ! dcx h ! mov a,m ! sta @RDRV ; get relative drive code
156    0029    7932ED00        mov a,c ! sta @ADRV       ; get absolute drive code
157    002D    2B              dcx h        ; point to init pointer
```

```
158     002E    562B5E mov d,m ! dcx h ! mov e,  ; get init pointer
159     0031    EBCDB6Dl        xchg ! call ipchl  ; call init routine
160     0035    El              pop h              ; recover @drv pointer
161                     d$init$next:
162     0036    C1              pop b              ; recover counter and drive #
163     0037    0C05C21700      inr c ! dcr b ! jnz d$init$loop  ; and loop for each drive
164     003C    C36300 jmp boot$l

166                             cseg               ; following in resident memory

168                     boot$l:
169     0063    CD7800          call set$jumps
170     0066    CD0000          call ?ldccp                    ; fetch CCP for first time
171     0069    C30001          jmp ccp


174                     ; WBOOT
175                     ;    Entry for system restarts.

177                     wboot:
178     006C    31D200          lxi sp,boot$stack
179     006F    CD7800          call set$jumps         ; initialize page zero
180     0072    CD0000          call ?rlccp            ; reload CCP
181     0075    C30001          jmp ccp                ; then reset jmp vectors and exit to ccp


184             set$jumps:

186                     if banked
187     0078    3E01CDSl00      mvi a,1 ! call ?bnksl
188                     ndif

190     007D    3EC3            mvi a,JMP
191     007F    3200003205      sta 0 ! sta 5          ; met up jumps in page zero
192     0085    2103002201      lxi h,?wboot ! shld I   ; BIOS warm start entry
193     0085    2A00002206      lhld @MXTPA ! shld 6    ; BDOS system call entry
194     0091    C9              ret


197     0092                    ds 64
198     00D2    =     boot$stack    equ $


201                     ; DEVTBL
202                     ;    Return address of character device table

204                     devtbl:
205     00D2    210000C9        lxi h,@ctbl ! ret


208                     ; GETDRV
209                     ;    Return address of drive table

211                     getdrv:
212     00D6    210000C9        lxi h,@dtbl ! ret
```

```
213
214
215
216                     ; CONOUT
217                     ;     Console Output.  Send character            in <C>
218                     ;                 to all selected           devices
219
220              conout;
221
222    00DA   2A0000        lhld @covec    ; fetch console output bit vector
223    00DD   C3E900        jmp out$scan
224
225
226                     ; AUX0UT
227                     ;       Auxiliary Output. Send character in <C>
228                     :                   to all selected devices
229
230           auxout:
231    00E0   2A0000        lhld @aovec    ; fetch aux output bit vector
232    00E3   C3K900        jmp out$Scan
233
234
235                     ; LIST
236                     ;       List Output.  Send character in <C>
237                     ;                to all selected devices.
238
239           list:
240    00E6   2A0000        lhld @lovec     ; fetch list output bit vector
241
242           out$scan:
243    00E9   0600          mvi b,         ; Start with device 0
244           co$next:
245    00EB   29            dad h          ; shift out next bit
246    00EC   D2FF00 jnc not$out$device
247    00EF   E5            push h         ; save the vector
248    00F0   C5            push b         ; save the count and character
249           not$out$ready:
250    00Fl   CD2C0IB7CA    call coster ! ora a ! jz not$out$ready
251    00F8   CIC5          pop b !  puSh b  ; restore and resave the character and device
252    00FA   CD0000        call ?co       ; if device selected, print it
253    00FD   C1            pop b          ; recover count and character
254    00FE   El            pop h          ; recover the rest of the vector
255           not$out$device:
256    00FF   04            inr b          ; next device number
257    0100   7CBS          mov a,h ! ora 1   ; see if any devices left
258    0102   C2EB00        jnz co$next    ; and go find them. . .
259    0105   C9            ret
260
261
262                     ; CONOST
263                     ;       Console Output Status.  Return true if
264                     ;           all selected console output devices
265                     ;           are ready.
266
267           conost:
```

```
268     0106    2A0000          lhld @covec     ; get console output bit vector
269     0109    C31501          jmp ost$scan
270
271
272                             ; AUXOST
273                             ;       Auxiliary Output Status.  Return true if
274                             ;               all selected auxiliary output devices
275                             ;               are ready.
276
277             auxost:
278     0l0C    2A0000          lhld @aovec     ; get aux output bit vector
279     0I0F    C31501          jmp ost$scan
280
281
282                             ; LISTST
283                             ,       List Output Status.  Return true if
284                             ;               all selected list output devices
285                             ;               are ready.
286
287             listst:
288     0112    2A0000          lhld @lovec       ; get list output bit vector
289
290                     ost$scan:
291     0115    0600            mvi b,0           ; start with device 0
292                     cos$next:
293     0117    29              dad h             ; check next bit
294     0118    E5              push h            ; save the vector
295     0119    C5              push b            ; save the count
296     0llA    3EFF            mvi a,0FFh        ; assume device ready
297     011C    DC2C01          cc coster         ; check status for this device
298     0llF    C1              pop b             ; recover count
299     0120    El              pop h             ; recover bit vector
300     0121    B7              ora a             ; see if device ready
301     0122    C8              rz                ; if any not ready, return false
302     0123    05              dcr b             ; drop device number
303     0124    7CB5            mov a,b! ora 1    ; see if any more selected devices
304     0126    C21701          jnz cos$next
305     0129    F6FF            ori 0FFh          ; all selected were ready, return true
306     012B    C9              ret
307
308             coster:                           ; check for output device ready. including optional
309                                               ;  xon/xorf support
310     012C    682600  mov     l,b ! mvi h,0     ; make device code 16 bits
311     012F    E5              push h                           ; save it in stack
312     0130    292929  dad     h ! dad h ! dad h ; offset into device characteristics tbl
313     0133    11060019        lxi     d,@ctbl+6 ! dad d        ; make address of mode byte
314     0137    7EE610 mov      a,m ! ani mb$xonoff
315     013A    El              pop     h       ; recover console number in <HL>
316     013B    CA0000          jz      ?cost   ; not a xon device, go get output status direct
317     013E    11280219        lxi     d,xofflist ! dad d ; make pointer to proper xon/xoff flag
318     0142    CD5D0l          call cisti              ; see if this keyboard has character
319     0145    7EC46F01        mov     a,m ! cnz cii     ; get flag or read key if mny
320     0149    FEIIC2500I       cpi     ctlq ! jnz not$q; if its a ctl-Q,
321     014E    3EFF            mvi     a,0FFh   ; set the flag ready
322             not$g:
```

```
323    0150    FE13C25701    cpi     ctls ! jnz not$s    ; if its a ctl-S,
324    0155    3E00          mvi     a,00h    ; clear the flag
325                  not$s:
326    0157    77            mov     m,a      ; save the flag
327    0158    CD6601        call costl         ; get the actual output status,
328    0158    A6            ana     m        ; and mask with ctl-Q/ctl-S flag
329    01SC    C9            ret              ; return this am the status
330
331            cistl:                         ; get input status with <BC> and <HL> saved
332    01SD    CSES          push b ! push h
333    015F    CD0000        call ?cist
334    0162    ElCI          pop     h ! pop b
335    0164    87            ora     a
336    0165    C9            ret
337
338            costl                          ; get output status, saving <BC> &  <HL>
339    0166    CSE5          push b ! push h
340    0168    CD0000        call ?cost
341    0168    E1Cl          pop     h ! pop b
342    016D    87            ora     a
343    016E    C9            ret
344
345            cil:                           . get input, saving <BC> & <HL>
346    016F    CSES          push b ! push h
347    0171    CD0000        call ?ci
348    0174    ElC1          pop     h ! pop b
349    0176    C9            ret
350
351
352            ; CONST
353            ;         Console Input Status.  Return true if
354            ;             any selected console input device
355            ;             has an available character.
356
357            const
358    0177    2A0000        lhld @civec        ; get console input hit vector
359    017A    C38001        jmp     ist$scan
360
361
362            ; AUXIST
363            ;         Auxiliary Input        Status.  Return true if
364            ;             any selected auxiliary input device
365            ;             has an available character.
366
367            auxist:
368    017D    2A0000        lhld @aivec        ; get aux input bit vector
369
370            ist$scan:
371    0180    0600          mvi     b,0        ; start   with device 0
372            cis$next:
373    0182    29            dad     h        ; check  next hit
374    0183    3E00          mvi     a,0        , assume device not ready
375    0185    DCSD0l        cc cistl           ; check status for this device
376    0188    B7C0          ora     a ! rnz    ; if any ready, return true
377    018A    04            inr     b        ; next device number
```

```
378    0188   7CB5            mov     a,h ! ora 1 ; see if any more selected devices
379    0180   C28201          jnz     cis$next
380    0190   AF              xra     a          ; all selected were not ready. return false
381    0191   C9              ret

382
383
384                   ; CONIN
385                   ;         Console Input. Return character from first
386                   ;                ready console input device.
387
388           conin:
389    0192   2A0000 lhld @Civec
390    0195   C39B01 jmp      in$scan
391
392
393                      ; AUXIN
394                      ;    Auxiliary Input.  Return character from    first
395                      ;           ready auxiliary input device.
396
397           auxin:
398    0198   2A0000      lhld @aivec
399
400                   in$scan:
401    0198   E5              push h          ; save bit vector
402    019C   0600            mvi b,0
403                   ci$next:
404    0191   29              dad h           ; shift out next bit
405    019F   3100            mvi a,0         ; insure zero a  (nonexiatant device not ready) .
406    0lAl   DC5D0l          cc cisti        ; see if the device has a character
407    01A4   B7              ora a
408    0lA5   C2B201          jnz ci$rdy      ; this device has a character
409    0lA8   05              dcr b           ; else, next device
410    0lA9   7CB5            mov a,h ! ora 1 ; see if any more devices
411    0lAB   C29E01 jnz ci$next    ; go look at them
412    0IAE   El              pop h           ; recover bit vector
413    0lAF   C39B01          jmp in$scan     ; loop til we find a character
414
415                   ci$rdy:
416    0152   El              pop h           ; discard extra stack
417    0183   C30000          jmp ?ci
418
419
421                   ;       Utility Subroutines
421
422
423                   ipchl:                      ; vectored CALL point
424    01B6   E9              pchl
425
426
427                   ?pmsg:                      ; print message @<HL> up to a null
428                                               ; saves <BC> & <DE>
429    01B7   C5              push b
430    01B8   D5              push d
431                   pmsg$loop:
432    01B9   7EB7CAC801     mov a,m ! ora a ! jz pmsg$exit
```

```
433     01BE    4FE5            mov c,a ! push h
434     01C0    CD0C00E1        call ?cono ! pop h
435     01C4    23C3B901        inx h ! jmp pmsg$loop
436                     pmsg$exit:
437     01C8    Dl              pop d
438     01C9    C1              pop h
439     0lCA    C9              ret
440
441                     ?pdec:                          ; print binary number 0-65535 from <HL>
442     0ICB    01F30111F0      lxi b,tablel0! lxi d,-10000
443                     next:
444     01D1    3E2F            mvi a, '0'-l
445                     pdecl:
446     01D1    E53Cl9D2DE      push h! inr a! dad d! jnc stoploop
44?     0109    3333C3D301      inx sp! inx sp! jmp pdecl
448                     stoploop:
449     01DE    D5C5            push d! push b
450     01E0    4FCD0C00        mov c,a! call ?cono
451     01E4    C1D1            pop b! pop d
452                     nextdigit:
453     01E6    El              pop h
454     01E7    0ASF03          ldax b! mov e,a! inx b
455     0llA    0A5703          ldax b! mov d,a! inx b
456     01E0    7BB2C20101      mov a,e! ora d! jnz next
457     01F2    C9              ret
458
459                     tabel10:
460     01F3    l8FC9CFFF6      dw      -l000,-l00,-10,-l,0
461
462                     ?pderr:
463     01FD    210100CD87      lxi h,drive$msg ! call ?pmsg       ; error header
464     0203    3AE000C641      lda @adrv ! adi 'A'  ! mov c,a ! call ?cono   ; drive code
469     020C    211300C0B7      lxi h,track$msg ! call ?pmsg       . track header
466     0212    2AEF00CDCB      lhld @trk ! call ?pdec             ; track number
467     0218    211800C0B7      lxi h,sector$msg ! call ?pmsg      ; sector header
468     0211    2AFI00CDCB      lhld @sect ! call ?pdec            ; sector number
469     0224    C9              ret
470
471
472                     : BNKSEL
473                     ;     Bank Select.  Select CPU bank for further execution.
474
475             bnksel
476 0225 323B02              sta @cbnk              ; remember current bank
477 0228     C30000          jmp ?bank              ; and go exit through users
478                                                 ; physical bank select routine
479
480
481     0228    FFFFFFFFFFxofflist      db     -1,-1,-1,-l,-l,-1,-l,-1      ; ctl-s clears to zero
482     0233    FFFFFFFFFF              db     -1,-1,-1,-1,-1,-1 ,-1,-1
483
484
485
486                             dseg                ; following resides in banked memory
487
```

```
488
489
490                    ; Disk I/O interface routines
491
492
493                 ; SELDSK
494                 ;    Select Disk Drive.  Drive code in <C>.
495                 ;        Invoke login procedure for drive
496                 ;        if this is first select.  Return
497                 ;        address of disk parameter header
498                 ;          in <HL>
499
500             seldsk:
501    003F   7932ED00      mov a,c ! sta @adrv      ; save drive select code
502    0043   69260029      mov l,c ! mvi h,0 ! dad h ; create index from drive code
503    0047   01000009      lxi h,@dtbl ! dad b      ; get pointer to dispatch table
504    0045   7E23666F      mov a,m !  inx h ! mov h,m ! mov l,a ; point at disk descriptor
505    004F   54C8          ora h ! rz          ; if no entry in table, no disk
506    0051   7BE601C26D    mov a,e ! ani 1 ! jnz not$first$select      ; examine login bit
507    0057   E5EB          push h ! xchg     ; put pointer in stack & <DE>
508    0059   2lFEFF197E    lxi h,-2 ! dad d ! mov a,m ! sta @RDRV     ; get relative drive
509    0061   2IFAFFI9      lxi h,-6 ! dad d    ; find LOGIN addr
510    0065   7E23666F      mov a,m !  inx h ! mov h,m ! mov l,a ; get addr of LOGIN routine
511    0069   CDB60l        call ipchl          ; call LOGIN
512    006C   El            pop h               ; recover DPH pointer
513            not$first$select:
514    006D   C9            ret
515
516
517                 ; HOME
518                 ;    Home selected drive.  Treated as SETTRK(0).
519
520             home:
521    006E   010000 lxi b,0        ; same as set track zero
522
523
524                 ; SETTRK
525                 ;    Set Track. Saves track address from <BC>
526                 ;        in @TRE for further operations.
527
528             settrk:
529    0071   6960          mov l,c ! mov h,b
530    0073   22EF00        shld @trk
531    0076   C9            ret
532
533
534                 ; SETSEC
535                 ;    Set Sector.  Saves sector number      from <BC>
536                 ;        in @sect for further operations.
537
538             setsec
539    007?   6960          mov l,c ! mov h,b
540    0079   22F100        shld @sect
541    007C   C9            ret
542
```

```
543
544                    ; SETDMA
545                    ;    Set Disk Memory Address.  Saves DMA address
546                    ;        from <BC> in @DMA and sets @DBNK to @CBNK
547                    ;        so that further disk operations take place
548                    ;        in current bank.
549
550              setdma
551    0070   6960          mov l,c ! mov h,b
552    007F   22F300        shld @dma
553
554    0082   3A3B02        lda @cbnk        ; default DMA bank is current hank
555                                          ; fall through to set DMA bank
556
557                    ; SETBNK
558                    ;    Set DiBk Memory Bank.  Saves bank number
559                    ;        in @DBNK for future disk dBtB
560                    ;        transfers.
561
562              setbnk
563    0085   32F600        sta @dbnk
564    0088   C9            ret
565
566
567                    ; SECTRN
568                    ;    Sector Translate.  Indexes skew table in <DE>
569                    ;        with sector in <BC>.  Returns physical Sector
570                    .        in <HL> If no skew table (<DE>=0) then
571                    ;        returns physical=logical.
572
573              sectrn:
574    0089   6960          mov l,c ! mov h,b
575    0088   7AB3C8        mov a,d ! ora e ! rz
576    008E   EB096E2600    xchg ! dad b ! mov l,m ! mvi h,0
577    0093   C9            ret
578
579
580                    ; READ
581                    ;    Read physical record from currently selected drive,
582                    .        Finds address of proper read routine from
583                    .        extended disk parameter header (XDPH) .
584
585              read:
586    0094   2AED002600    ihId @adrv ! mvi h,0 ! dad h   ; get drive code and double it
587    009A   11000019      lxi d,@dtbl ! dad d            ; make address of table entry
588    009E   7E23666F      mov a,m ! inx h ! mov h,m ! mov l,a    ; fetch table entry
589    00A2   E5            push h        ; save address of table
590    00A3   llF8FFl9      lxi  d,-8 ! dad d              ; point to read routine ddress
591    00A7   C3BDOO        jmp rw$common     ; use common code
592
593
594                    ; WRITE
595                    ;    Write physical sector from currently selected drive.
596                    .        Finds address of proper write routine from
597                    ;        extended disk parameter header (XDPH) .
```

```
598
599                      write:
600    00AA    2AED002600      lhld @adrv ! mvi h,0 ! dad h    ; get drive code and double it
601    00B0    11000019        lxi d,@dtbl ! dad d             ; make address of table entry
602    0084    7E23666F        mov a,B ! inx h ! mov h,m ! mov l,a    ; fetch able entry
603    0088    E5              push h          ; save address of table
604    0089    llF6FFl9        lxi d,-l0 ! dad d         ; point to write routine address
605
606                      rw$common:
607    00BD    7E23666F        mov a,m ! inx h ! mov h,m ! mov l,a    ; get address of routine
608    00Cl    Dl              pop d           ; recover address of table
609    00C2    1518            dcx d ! dcx d           ; point to relative drive
610    00C4    IA32EE00        ldax d ! sta @rdrv              ; get relative drive code and post it
611    00C8    1313            inx d ! inx d          ; point to DPN again
612    00CA    E9              pchl            ; leap to driver
613
614
615                  ; MULTIO
616                  ;     Set multiple sector count. Saves passed count in
617                  ;          @CNT
618
619            multio
620    00CB    32F500C9        sta @cnt ! ret
621
622
623                  ; FLUSH
624                  ;     BIDS deblocking buffer flush.  Not implemented.
625
626            flush:
627    00CF    AFC9            xra a ! ret            ; return with no error
628
629
630
631                  ; error message components
632    00D1    oDoAo74249drive$msg     db      cr,lf,bell,'BIOS Error on ',0
633    00E3    3A2o542Dootrack$msg     db      ' T-',0
634    00E8    2C20S32D00sector$msg   db      ', S-',0
635
636
637                  ; disk communication data items
638
639    00ED                        @adrv ds              1         ; currently melected dimk drive
640    00EE                        @rdrv   ds            1         ; controller relative disk drive
641    00EP                        @trk    ds            2         ; current track number
642    00Fl                        @eect   ds            2         ; Current Sector number
643    00F3                        @dma    ds            2         ; Current DMA address
644    00F5    00                  @cnt    db            0         ; record count for multisectortransfer
645    00F6    00                  @dbnk   db            0         ; bank for DMA operations
646
647
648                        cseg            ; common memory
649
650    023B    00                  @cbnk   db            0         ; bank fOr processor operations
651
652
```

653	023C			end	
AUXIN	0198	99	397#		
AUXIST		017D	113	367#	
AUXOST		0l0C	114	277#	
AUXOUT		00E0	98	230#	
BANKED		FFFF	8#	186	
BAUDll0		0003			
BAUD12000		0008			
BAUD134		0004			
BAUDl50		0005			
BAUDl800		00009			
BAUD19200		000F			
BAUD2400		000A			
BAUD300		0006			
BAUD3600		000B			
BAUD4800		000C			
BAUD50		0001			
BAUD600		0007			
BAUD7200		000D			
BAUD75		0002			
BAUD9600		000E			
BAUDNONE		0000			
BELL		0007	27#	632	
BNKSEL		0225	124	475#	
BOOT		0000	91	138#	
BOOT1	0063	164	168#		
BOOTSTACK		00D2	139	178	1981
CCP		0100	31#	171	181
CI1		016F	319	345#	
CINEXT		019E	403#	411	
CINITLOOP		0005	141#	143	
CIRDY	01B2	408	415#		
CISNEXT		0182	372#	379	
CIST1		015D	318	331#	375	406
CONEXT		00EB	244#	258	
CONIN	0192	95	388#		
CONOST		0106	112	267#	
CONOUT		00DA	96	220#	
CONST	0177	94	357#		
COSNEXT		0117	292#	304	
COST1	0166	327	3381		
COSTER		012C	250	297	3081
CR		000D	25#	632	
CTLQ		0011	281	320	
CTLS		0013	291	323	
DEVTBL		00D2	115	2041	
DINITLOOP		0017	1491	163	
DINITNEXT		0036	152	1611	
DRIVEMSG		00]D1	463	6321	
FALSE		0000	6#		
FLUSH		00CF	120	6261	
GETDRV		00D6	118	211#	
HOME		006E	101	5201	
INSCAN		019B	390	4001	413
IPCHL		*01B6	159	4231	511

ISTSCAN	0180	359	3701			
LF	000A	26#	632			
LIST	00E6	97	2391			
LISTST	0112	109	2879			
MBINOUT	0003					
MBINPUT	0001					
MBOUTPUT	0002					
MBSERIAL	0008					
MBSOFTBAUD	0004					
MBXONXOFF	0010	314				
MULTIO	00CB	119	6191			
NEXT	0lD1	443#	456			
NEXTDIGIT	01E6	452#				
NOTFIRSTSELECT	006D	506	513#			
NOTOUTDEVICE	00FF	246	255#			
NOTOUTREADY	00Fl	249#	250			
NOTQ	0150	320	322#			
HOTS	0157	323	325#			
OSTSCAN	0115	269	279	290#		
OUTSCAN	00E9	223	232	242#		
PDECL	01D3	445#	447			
PMSGEXIT	01C8	432	436#			
PMSGLOOP	01B9	431#	435			
READ	0094	106	SBS#			
RWCOMMON	00BD	591	606#			
SECTORMSG	00E8	46?	634#			
SECTRN	0089	110	573#			
SELDSK	003F	102	500#			
SETBNK	0085	125	562#			
SETDMA	007D	105	550#			
SETJUMPS	0078	169	179	184#		
SETSEC	0077	104	538#			
SETTRK	0071	103	528#			
STOPLOOP	0lDE	446	448#			
TABLEl0	01F3	442	459#			
TRACKMSG	00E3	465	633#			
TRUE	FFFF	S#	6	8		
WBOOT	006C	92	177#			
WRITE	00AA	107	599#			
XOFFLIST	022B	317	481#			
?AUXI	0015	79	99#			
?AUXIS	0036	82	113#			
?AUXO	0012	79	98#			
?AUXOS	0039	82	114#			
?BANK	0000	63	477			
?BNKSL	0051	83	l24#	187		
?BOOT	0000	79	91#			
?CI	0000	49	347	417		
?CINIT	0000	50	116	142		
?CIST	0000	49	333			
?CO	0000	49	252			
?CONIN	0009	79	95#			
?CONO	000C	79	96#	434	450	464
?CONOS	0033	82	112#			
?CONST	0006	79	941			

?COST	0000	49	316	340			
?DEVIN	003F	82	116#				
?DRTBL	0042	82	118#				
?DVTBL	003C	82	115#				
?FLUSH	0048	83	1201				
?HOME	0018	80	l0ll				
?INIT	0000	44	145				
?LDCCP	0000	45]	170				
?LIST	000F	79	97#				
?LISTS	002D	81	109#				
?MLTIO	0045	83	119#				
?MOV	004B	83	1221				
?MOVE	0000	62	122				
?PDEC	0ICB	71	4411	466	468		
?PDERR	0IFD	72	4621				
?PMSG	01B7	71	4271	463	465]	467	
?READ	0027	80	106#				
?RLCCP	0000	45	180				
?SCTRN	0030	81	1101				
?SLDSK	001B	80	1021				
?STBNK	0054	83	125#				
?STDMA	0024	80	1051				
?STSEC	0021	80	1041				
?STTRK	00lE	80	1031				
?TIM	004E	83	1231				
?TIME	0000	67	123				
?WBOOT	0003	79	921	192			
?WRITE	002A	80	1071				
?XMOV	0057	83	1261				
?XMOVE	0000	62	126				
@ADRV	00ED	56	156	464	501	586	600	639#
@AIVEC	0000	38	368	398			
@AOVEC	0000	38	231	278			
@BNKBF	0000	40					
@CBNK	023B	61	476	554	650#		
@CIVEC	0000	38	358	389			
@CNT	00F5	57	620	6441			
@COVEC	0000	38	222	268			
@CTBL	0000	51	205	313			
@DBNK	00F6	57	563	645#			
@DMA	00F3	57	552	643#			
@DTBL	0000	55	148	212	503	587	601
@LOVEC	0000	38	240	288			
@MXT'PA	0000	39	193				
@RDRV	00EE	56	155	508	610	640#	
@SECT	00F1	56	468	540	642#		
@TRK	00EF	56	466	530	641#		

End of Appendix E

Appendix F
System Control Block Definidon for CP/M 3 BIOS

The SCB.ASM module contains the public definitions of the fields in the System Control Block. The BIOS can reference public variables.

```
1              title 'System Control Block Definition for CP/M3 BIOS'
2
3              public @civec, @covec, @aivec, @aovec, @lovec, @bnkbf
4              public @cradma, @crdsk, @vinfo, @resel, @fx, @usrcd
5              public @mltio, @ermde, @erdsk, @media,  @bflgs
6              public @date, @hour, @min, @sec,  ?erjmp, @mxtpa
7
8
9   FE00 =     srb*base equ    0FE00H               , Baseof the SCB
10
11  FE22 =     @CIVEC   equ    scb$base+22h ; Console Input Redirection
12                                          ; vector (word.  r/w)
13  FE24 =     @COVEC   equ    scb$base+24h ; Console Output Redirection
14                                          ; Vector (word,  r/w)
15  FE26 =     @AIVEC   equ    scb$base+26h ; Auxi1iary Input Redirection
16                                          ; Vector (word,  r/w)
17  FE2B =     @AOVEC   equ    scb$base+28h ; Auxiliary Output Redirection
18                                          ; Vector (word. r/w)
19  FE2A =     @LOVEC   equ    scb$base+2Ah ; List Output Redirection
20                                          ; Vector (word,  r/w)
21  FE35 =     @BNKBF   equ    scb$base+35h ; Address of 128 Byte Buffer
22                                          ;  for Banked BIOS (word, r/o)
23  FE3C =     @CRDMA   equ    scb$base+3Ch ; Current DMA Address
24                                          ; (word.  r/o)
25  FE3E =     @CRDSK   equ    scb$base+3Eh ; Current Disk (byte. r/o)
26  FE3F =     @VINFO   equ    scb$base+3Fh ; BDOS Variable "INFO"
27                                          ; (word,  r/o)
29  FE41 =     @RESEL   equ    scb$base+41h ; FC0 Flag (byte,  r/o)
29  FE43 =     @FX  equ   scb$base+43h . BDOS Function )br Error
30                                          ; Mess age  (byte,  r/o)
31  FE44 =     @USRCD   equ    scb$base+44h ; current User Code (byte, r/o)
32  FE4A =     @MLTIO   equ    scb$base+4Ah ; Current Multi-Sector Count
33                                          ; (byte. r/w)
34  FE4B =     @ERMOE   equ    scb$base+4Bh ; BDOS Error Mode (byte. r/o)
35  FE51 =     @BROSK   equ    scb$base+5lh ; BDOS Error Disk (byte.r/o)
36  FE54 =     @MED!A   equ    scb$base+54h ; Set by BIOS to indicate
37                                          ; open door (byte. r/w)
38  FE57 =     @BFLOS   equ    scb$base+57h ;  BDOS Message Size Flag (byte.
r/o)
39  FE58 =     @iDATE   equ    scb$base+58h ; Date in Days Since I Jan 78
40                                          ; (word,  r/w)
```

```
41    FE5A  =    @HOUR    equ    scb$base+5Ah ;  Hour in BCD (byte. r/w)
42    FE5B  =    @MIN equ    scb$base+58h ; Minute in BCD (byte. r/w)
43    FE5c  =    @SEC equ    scb$base+5Ch ; Second in BCID (byte. r/w)
44    FE5F  =    @ERJMP    equ    scb$base+5Fh ; BDOS Error "Message Jump
45                                     ; (word.  r/w)
46    FE62  =    @MXTPA    equ    scb$base+62h ;  Top of User TPA
47                                     ; (address at 6, 7)(word, r/o)
4B    0000            end
```

Appendix G
Equates for Mode Byte Bit Fields

```
                    ; equates for mode byte bit fields
mb$input            equ 0000$000lb  ; device may do input
mb$output           equ 0000$00l0b  ; device may do output
mb$in$out           equ mb$input+mb$output
mb$soft$baud        equ 0000$0l00b      ; software selectable baud rates
mb$serial           equ 0000$l000b      ; device may use protocol
mb$xon$xoff         equ 000l$0000b      ; XON/XOFF protocol enabled
baud$none           equ    0        ; no baud rate associated with device
baud$50             equ    1        ; S0 baud
baud$75             equ    2        ; 75 baud
baud$ll0            equ    3        ; 110] baud
baud$134            equ    4        ; 134.5 baud
baud$150            equ    5        ; 150] baud
baud$300            equ    6        ; 300 baud
baud$600            equ    7        ; 600 baud
baud$1200           equ    8        ; 1200 baud
baud$1800           equ    9        ; 1900 baud
baud$2400           equ    10       ; 2400 baud
baud$3600           equ    11       ; 3600 baud
baud$4800           equ    12       ; 4800 baud
baud$7200           equ    13       ; 7200 baud
baud$9600           equ    14       ; 9600 baud
baud$19200          equ    15       ; 19.2k baud
```

Listing G-1. Equates for Node Byte Fields: NODEBAUD.LIB

End of Appendix G

Appendix H
Macro Definitions for CP/M 3 BIOS Data Structures

Macro Definitions for CP/M3 BIOS Data Structures.
```
; dtbl  <dph0,dphl,...>        - drive table
; dph   translate$table,       - disk parameter header
;          disk$Parameter$block,
;          checksum$size,                (optional)
;          alloc$size                    (optional)

; skew  sectors,               - skew table
;          skew$factor,
;          first$sector$number

; dpb   physical$sector$size,  - disk parameter block
;          physical$sectors$per$track;
;          number$tracks,
;          block$size,
;          number$dir$entries,
;          track$offset,
;          checksum$vec$size    (optional)

;         Drive Table.  Contains 16 one word entries.

dtbl macro ?list
local ?n
?n       set 0
         irp ?drv,<?list>
?n       set ?n+1
             dw   ?drv
         endm

         if ?n > 16
.'Too many drives. Max 16 allowed'
         exitm
         endif

         if ?n < 16
             rept (16-?n)
             dw 0
             endm
         endif
endm
```

```
dph     macro ?trans,?dpb,?csize,?asize
        local ?csv,?alv
                dw ?trans                   ; translate table address
                db 0,0,0,0,0,0,0,0,0     ; BDOS Scratch area
                db 0    ; media flag


                dw ?dpb         ; disk parameter block
        if not nul ?csize
                dw ?csv         ; checksum vector
        else
                dw 0FFFEh       ; checksum vector allocated by GENCPM
        endif
        if not nul ?asize
                dw ?alv         ; allocation vector
        else
                dw 0FFFEh       ; alloc vector allocated by GENCPM
        endif
                dw 0fffeh,0fffeh,0fffeh; dirbeb, dtabcb, hash alloc'd by GENCPM
                db 0    ; hash bank
        if not nul ?csize
?csv    ds      ?csize  ; checksum vector
        endif
            if not nul   ?asize
?alv    ds      ?asize  ; allocation vector
        endif
endm

dpb macro ?psize,?pspt,?trks,?bls,?ndirs,?off,?ncks
        local ?spt,?bsh,?blm,?exu,?dsm,?drm,?al0,?all,?cks,?psh,?psm
        local ?n
;; physical sector mask and physical sector shift
        ?psh    set 0
        ?n      set ?psize/128
        ?psm    Set ?n-l
                rept 8
                ?n      set ?n/2
                        if ?n = 0
                        exitm
                        endif
                ?psh    set ?psh + 1
                endm
        ?spt    set ?pspt*(?psize/128)
```

```
?bsh    set 3
?n      set ?bls/1024
        rept 8
        ?n      set ?n/2
                if ?n - 0
                exits
                endif
        ?bsh    set ?bsh + 1
        endm
?blm    set ?bls/128-1
?size   set (?trks-?Off)*?spt
?dsm    set ?size/(?bls/128)-1

?exm    set ?bls/1024
        if ?dsm > 255
                if ?bls - 1024

.'Error, can"t have this size disk with 1k block size'
                exitm
                endif
        ?exm  set ?exm/2
        endif
?exm    set ?exm-1
?all    set 0
?n      set    (?ndirs*32+?b1s-l)/?bls
        rept ?n
        ?all    set (?all shr    1) or 8000h
        endm
?al0    set high ?all
?all    set low ?a11
?drm    set ?ndirs-l
if not nul ?ncks
   ?cks set ?ncks
else
   ?cks set ?ndirs/4
endif
    dw  ?spt            ; 128 byte records per track
    db  ?bsh,?blm       ; block shift and mask
    db  ?exm            ; extent mask
    dw  ?dsm            ; maximum block number
    dw  ?drm            ; maximum directory entry number
    db  ?al0,?al1       ; alloc vector for directory
    dw  ?cks            ; checksum size
    dw  ?0ff            ; offset for system tracks
    db  ?psh,?psm       ; physical sector size shift and mask
endm
```

```
;
gcd macro ?m,?n
        ;; greatest common divisor of m,n
                        ;;      produces value gcdn as result
                        ;;      (used in sector translate table generation)
        ?gcdm  set ?m  ;;variable for m
        ?gcdn  set ?n  ;;vsrisble for n
        ?gcdr  set 0    ;;variable for r
                rept    65535
                ?gcdx  set ?gcdm/?gcdn
                ?gcdr  set ?gcdm - ?gcdx*?gcdn
                        if ?gcdr = 0
                        exitm
                        endif
                ?gcdm   set ?gcdn
                ?gcdn   set ?gcdr
                endm
        endm

skew macro ?secs,?skf,?fsc
;;         generate the translate table
        ?nxtsec    set 0   ;;next sector to fill
        ?nxtbas     set 0   ;;moves by one on overflow
        gcd %?secs,?skf
        ;; ?gcdn - gcd(?secs,skew)
        ?neltst    set ?secs/?gcdn
        ;; neltst is number of elements to generate
        ;; before we overlap previous elements
        ?nelts   set ?neltst        ;;counter
                rept ?secs                  ;;once for each sector
                db      ?nxtsec+?fsc
                ?nxtsec set ?nxtsec+?skf
                        if ?nxtsec >= ?secs
                        ?nxtsec  set ?nxtsec-?secs
                        endif
                ?nelts  set ?nelts-l
                        if ?nelts = 0
                        ?nxtbas  set ?nxtbas+l
                        ?nxtsec  set ?nxtbas
                        ?nelts     set ?neltst
                        endif
                endm
        endm
```

End of Appendix H

Appendix I
ACS 8000-15 BIOS Modules

1.1   Boot Loader Module for CP/M 3

The BOOT.ASM module performs system initialization other than and disk I/O. BOOT loads the CCP for cold starts and it for warm starts. Note that the device drivers in the Research sample BIOS initialize devices for a polled, and an interrupt-driven, environment.

```
1                        title   'Boot loadar module for Cp/M 3.0'
2
3     FFFF   -        true equ -1
4     0000   =        false equ not true
5
6     FFFF   =        banked  equ true
7
8                          public  ?init,?ldccp,?rlccp,?time
9                    extrn   ?pmsg,?conin
10                   extrn   @civec,@covec,@aivec,@aovec,@lovec
11                   extrn   @cbnk,?bnksl
12
13                   maclib ports
14                   maclib z80
15
16    0005 =        bdos   equ 5
17
18                        if banked
19    0001 =        tpa$bank        equ 1
20                        else
21    tpa$bank        equ 0
22                        endif
23
24                        dseg    ; init done from banked memory
25
26                   ?init:
27    0000 2100802200     lxi h,08000h ! shld @civec ! shld @covec ; assign console to CRT:
28    0009 2100402200     lxi h,04000h ! shld @lovec              ; assign printer to LPT:
29    000F 2100202200     lxi h,02000h ! shld @aivec ! shld @aovec ; assign AUX to CRTl:
30    0018 21EF00CD2S     lxi h,init$table ! call out$blocks     ; set up misc hardware
31    00IE 218700CD00     lxi h,signon$msg ! call ?pmsg          ; print signon message
32    0024 C9             ret
33
34                   out$blocks:
35    0025 7EB7C847       mov a,m ! ora a ! rz ! mov b,a
36    0029 234E23         inx h ! mov c,m ! inx h
37                        outir
38    002C+EDB3  DB     0EDH,0B3H
```

```
39      002E C32500            jmp out$blocks
40
41
42                             cseg    ; boot loading most be done from resident memory
43
44               ;             This version of the boot loader loads the CCP from a file
45               ;             called CCP.COM on the system drive (A:).
46
47
48               ?ldccp:
49                             ; First time, load the A:CCP,COM file into TPA
50      0000 AF32DB00          xra a ! Sta ccp$fcb+15         ; zero extent
51      0004 21000022EC        lxi h,0 ! shld fcb$nr          ; start at beginning of file
52      000A llCC00CD73        lxi d,ccp$fcb ! call open      ; open file containing CCP
53      0010 3CCA4A00          inr a ! jz no$CCP              ; error if no file. . '
54      0014 110001CD78        lxi d,0l00h ! call setdma      ; Start of TPA
55      001A 118000CD7D        lxi d,128 ! call setmulti      ; allow up to 16k bytes
56      0020 llCC00CD82        lxi d,ccp$fcb ! call read      ; load the thing
57                                                            ; now,
58                                                            ;  copy CCP to bank 0 for reloading
59      0026 2100010180        lxi    h;0l00h ! lxi b,0C80h   ; clone 3.125K, just in case
60      002C 3A0000F5          lda    @cbnk ! push psw        ; save current bank
61               ld$1:
62      0030 3E01CD0000        mvi    a,tpa$bank ! call ?bnks ; select TPA
63      0035 7EF5              mov    a,m ! push psw          ; get a byte
64      0037 3E02CD0000        mvi    a,2 ! call ?bnksl       ; select extra bank
65      003C Fl77              pop    psw ! mov m,s ; save the byte
66      003E 230B              inx    h ! dcx b               ; bump pointer, drop count
67      0040 78B1              mov    a,b ! ora c             ; test for done
68      0042 C23000            jnz    ld$1
69      0045 FlCD0000          pop    psw ! call ?bnksl       ; restore original bank
70      0049 C9                ret
71
72               no$CCP:                                      ; here 1f we couldn't find the file
73      004A 2lAB00CD00        lxi    h,ccp$msg ! call ?pms ; report this. . .
74      0050 CD0000            call ?conin                    ; get a response
75      0053 C30000            jmp    ?ldccp                  ; and try again
76
77
78               ?rlccp:
79      0056 2100010180        lxi    h,0l00h ! lxi b,0C80h  ; clone 3.125K
80               rl$l:
81      005C 3B02CD0000        mvi    a,2 ! call ?bnksl       ; select extra bank
82      0061 7EF5              mov    a,m ! push psw          ; get a byte
83      0063 3E01CD0000        mvi    a,tpa$bank ! call ?bnksl ; select TPA
84      0068 Fl77              pop    psw ! mov m,a; save the byte
```

```
85      006A 230B            inx    h ! dcx b                  ; bump pointer, drop count
86      006C 78B1            mov    a,b ! ora c                ; test for done
87      006E C25C00          jnz    rl$1
88      0071 C9              ret
89
90                          ; No external clock.
91                ?time:
92      0072 C9              ret
93
94                  ; CP/M BDOS Function Interfaces
95
96          open:
97      0073 0E0FC30500      mvi    c,15 ! jmp bdos; open file control block
98
99          setdma:
100     0078 0EIAC30500      mvi    c,26 ! jmp bdos    ; set data transfer address
101
102         setmulti:
103     0070 0E2CC30500      mvi    c,44 ! jmp bdos    ; set record count
104
105         read:
106     0082 0E14C30500      mvi    c,20 ! jmp bdos    ; read records
107
108
109     0087  0D0A0D0A43signon$msg db    13,l0,13,10,'CP/M Version 1.0, sample
                                                            BIOS',13,l0,0
110
111     00AB  0D0A42494Fccp$msg  db    13,l0,'BIOS Err on A: No CCP.COM file',0
112
113
114     00CC  0143435020ccp$fcb  db    1,'CCP    ','COM',0,0,0,0
115     00DC                     ds    16
116     00EC 000000   fcb$nr            db    0,0,0
117
118     00BF  0326CFFF07init$table db   3,p$zpio$3a,0CFh,0FFh,07h  ; set up config port
119     00F4 0327CF0007          db   3,p$zpio$3b,0CFh,000h,07h ;set up bank port
120     00F9 012500              db   1,p$bank$select,0      ; select bank 0
121     00FC 00                  db   0                      ; end of init$table
122
123     00FD                     end


BANKED            FFFF    6#    18
BC                0000
BDOS              0005    16#   97     100   103   106
CCPFCB            00CC    50    52      56   114#
CCPMSG            00AB    73    lll#
```

BE	0002			
FALSE	0000	4#		
FCBNR	00BC	51	ll6#	
EL	0004			
INITTABLE	00EF	30		119#
IX	0004			
IY	0004			
1,01	0030	61#	68	
NOCCP	004A	53	72#	
OPEN	0073	52	96#	
OUTBLOCKS	0025	30	34#	39
PBANKSELECT	0025	120		
PBAUDCON1	000C			
PBAUDCON2	0030			
PBAUDCON34	0031			
PBAUDLPT1	000E			
PBAUDLPT2	0032			
PBOOT	0014			
PCENTDATA	0011			
PCENTSTAT	0010			
PCON2DATA	002C			
PCON2STAT	002D			
PCON3DATA	002E			
PCON3STAT	0021			
PCON4DATA	002A			
PCON4STAT	002B			
PCONFIGURATION	0024			
PCRTDAT'A	00IC			
PCRTSTAT	001D			
PFDCMND	0004			
PFDDATA	0007			
PFDINT	0008			
PFDMISC	0009			
PFDSBCTOR	000E			
PFDSTAT	0004			
PFDTRACK	0005			
PINDEX	0001			
PLPT2DATA	0028			
PLPT2STAT	0029			
PLP'TDATA	001E			
PLPTSTAT	0011			
PRTC	0033			
PSELECT	0008			
PWD1797	0004			
PZCTCl	000C			
PZCTC2	0030			

PZDART	00IC					
PZDNA	0000					
PZPIO1	0008					
PZPIOIA	000A					
PZPIO1B	000B					
PZPIO2	0010					
PZPIO2A	0012					
PZPIO2B	0013					
PZPIO3	0024					
PZPIO3A	002E	118				
PZPIO3B	0027	119				
PZSIO1	0028					
PZSIO2	002C					
RIAD	0082	56	105#			
RL1	005C	80#	87			
SETDMA	0078	54	99#			
SETMULTI	007D	55	102#			
SIGNONMSG	0087	31	109#			
TPABANK	0001	19#	21#	62	83	
TRUE	FFFF	3#	4	6		
?BNKSL	0000	11	62	64	69	81	83
?CONIN	0000	9	74			
?INIT	0000	8	26#			
?LDCCP	0000	8	484	75		
?PMSG	0000	9	31	73		
?RLCCP	0056	8	78#			
?TINE	0072	8	914			
@AIVEC	0000	10	29			
@AOVEC	0000	10	29			
@CBNK	0000	11	60			
@CIVEC	0000	10	27			
@COVEC	0000	10	27			
@LOVEC	0000	10	28			

I.2   Character I/O Handler for Z80 Chip--based System

The CHARIO.ASM module performs all character device , input, output, and status polling. CHARIO contains character device characteristics table.

```
1                         title 'Character I/O handler for z80 chip based system'
2
3                         ; Character I/O for the Modular CP/M 3 BIOS
4
5                         ; limitations:
6
7                         ;         haud rates 19200;7200,3600,1800 and 134
8                         ;             are approximations.
9
10                        ;         9600 is the maximum baud rate that is likely
11                        ;             to work,
13                        ;         haud rates 50, 75, and 110 are not supported
14
15
16                        public  ?cinit,?ci,?co,?cist,?cost
17                        public  @ctbl
18
19                        maclib Z80              ; define Z80 op codes
20                        maclib ports    ; define port addresses
21                        maclib modebaud        ; define mode bits and baud equates
22
23     0006 = max$devices     equ 6
24
25                        cseg
26
27             ?cinit:
28     0000 79FE06CA42     mov a,c ! cpi max$devlces ! jz cent$init ; init parallel printer
29     0006 D0             rnc                       ; invalid device
30     0007 692600         mov l,c ! mvi h,0       ; make 16 bits from device number
31     000A E5             push h                   ; save device in stack
32     000B 292929         dad h ! dad h ! dad h   ; *8
33     000F 11E900196E     lxi d,@ctbl+7 ! dad d ! mov l;m ; get baud rate
34     0013 7DFE07         mov a,l ! cpi baud$600  ; see if baud > 300
35     0016 3E44D21D00     mvi a,44h ! jnc hi$speed  ; if > 600, use *16 mode
36     001B 3FC4           mvi a,0C4h               ;    else, use *64 mode
37             hi$speed:
38     0010 323501         sta sio$reg$4
39     0020 2600111B01     mvi h,0 ! lxi d,speed$table ! dad d    ; point to counter entry
40     0026 7E322F01       mov a,m ! sta speed     ; get and save ctc count
41     002A El             pop h                    ; recover
42     0028 11DC0019       lxi d,data$ports ! dad d  ; point at SIO port address
```

```
43      002F 7E3C323001        mov a,m ! inr a ! sta sio$port  ; get and save port
44      0034 IIFAFF19          lxi d,baud$ports-data$ports ! dad d     ; offset to baud rate port
45      0038 7E322C01          mov a,B ! sta ctc$port          ; get and save
46      003C 212801            lxi h,serlal$init$tbl
47      003F C34500            jmp stream$out
48
49              cent$init:
50      0042 213901            lxi h,pio$init$tbl
51
52              stream$out:
53      004S 7FB7C8            mov a,m ! ora a ! rz
54      0048 47234F23          mov b,a ! inx h ! mov c;m ! inx h
55                             outir
56      004C+EDB3  DB          0EDH,0B3H
57      004E C34500            jmp stream$out
58
59
60              ?ci:           ; character input
61
62      0051 78FE06D263        mov a,b ! cpi 6 ! jnc null$input ; can't read from centronics
63              cil:
64      0057 C06600CA57        call ?cist ! jz cii     ; wait for character ready
65      0050 00                dcr c ! inp a           ; get data
66      00SE+ED78              DB    0EDH,A*8+40H
67      0060 E67F              ani 7Fh                 ; mask parity
68      0062 C9                ret
69
70              null$lnput:
71      0063  3E1A             mvi a,lAh       ; return a ctl-Z for no device
72      0065  C9               ret
73
74              ?ciat:         ; character input Status
75
76      0066  78FE06D27D       mov a,b ! cpi 6 ! jnc null$status ; can't read from centronics
77      006C  682600           mov l,b ! mvi h,0       ; make device number 16 bits
78      006F  llDC00l9         lxi d,data$ports ! dad ; make pointer to port address
79      0073  4E0C             mov c,m ! inr c         ; get SIO status port
80                             inp a                   ; read from status port
81      0075+ED78              DB    0EDH,A*8+40H
82      0077  E601             ani l                   ; isolate RxRdy
83      0079  C8               rz       ; return with zero
84      007A  F6FF             ori 0FFh
85      007C  C9               ret
86
87              null$status:
88      0070  AFC9             xra a ! ret
```

```
89
90                    ?co:                              ; character output
91    007F   78FE06CA9E  mov a,b ! cpi 6 ! jz centronics$out
92    0085   029000      jnc null$Output
93    0088   79F5        mov a,c ! push psw    ; save character from <C>
94    008A   C5          push b                ; save device number
95                    co$spin:
96    008B   CDB300CA8   call ?cost ! jz co$spin  ; wait for TxEmpty
97    0091   E16C2600    pop h ! mov l,h ! mvi h,0      ; get device number in <HL>
98    0095   11DC0019    lxI d,data$ports ! dad d       ; make address of port address
99    0099   4E          mov c,m      ; get port address
100   009A   Fl          pop psw ! outp a      ; send data
101  009B+ED79           DB     0EDH,A*8+41H
102               null$output:
103   0090   C9          ret
104
105               centronics$out:
106   009E   DBl0E620C2  in p$centstat ! ani 20h ! jnz csntronics$out
107   00A5   79D311      mov a,c ! out p$centdata       ; give printer data
108   00A8   DBI0F60lD3  in p$centstat ! ori 1 ! out p$centstat  ; set strobe
109   00AE   E67ED310    ani 7Eh ! out p$centstat               ; clear strobe
110   00B2   C9          ret
111
112                   ?cost:                            ; character output status
113   00B3   78FE06CACD  mov a,b ! cpi 6 ! jz cent$stat
114   00B9   027000      jnc null$status
115   00BC   682600      mov l,b ! mvi h,0
116   00BF   11DC0019    lxi d,data$ports ! dad d
117   00C3   4E0C        mov c,m ! inr c
118                      inp a    ; get input status
119  00CS+ED78           DB     0EDH,A*8+40H
120   00C7   E604C8      ani 4 ! rz         ; test transmitter empty
121   00CA   F6FFC9      ori 0FFh ! ret   ; return true if ready
122
123
124              cent$stat:
125   00CD   DBl02F      in p$centstat ! cas
126   0000   E620C8      ani 20h ! rz
127   0003   F6FFC9      ori 0FFh ! ret
128
129              baud$ports:          ; CTC ports by physical device number
130   0006   0C0E3031    db     p$baud$conl, p$baud$lptl, p$baud$con2, p$baud$con 34
131   000A   3132        db     p$baud$con34,p$baud$lpt2
132
133              data$ports:          ; serial base ports by physical device number
134   00DC   lClE2C2E    db     p$crt$data,p$lpt$data,p$con2data,p$con3data
```

```
135    00E0  2A28            db    p$con4data,p$lpt2data
136
137
138    00E2  4352542020@ctbl    db 'CRT '    ; device 0, CRT port 0
139    00E8  0F              db mb$in$out+mb$serial+mb$softbaud
140    00E9  0E              db baud$9600
141    00EA  4C50542020  db 'LPT '    ; device 1, LPT  port 0
142    00F0  1F              db mb$in$out+mb$serial+mb$softbaud+mb$xonxoff
143    00FI  QE              db baud$9600
144    00F2  4352543120  db 'CRTl '    ; device 2, CRT port 1
145    00F8  0F              db mb$in$out+mb$serlal+mb$softbaud
146    00F9  0E              db baud$9600
147    00FA  4352543220  db 'CRT2 '    ; device 3, CRT port 2
148    0100  0F              db mb$'in$out+mb$serial+mb$softbaud
149    0101  CE              db baud$9600
150    0102  4352543320  db 'CRT3 '    ; device 4, CRT port 3
151    0108  0F              db 'mb$in$out+mb$serial+mb$softbaud
152    0L09  0E              db baud$9600
153    0l0A  5641582020  db 'VAX '    ; device 5, LPT port 1 used for VAX interface
154    0110  0F              db mb$in$out+mb$serial+mb$softbaud
155    0111  0E              db baud$9600
156    0112  43454E2020  db 'CEN '    ; device 6, Centronics rerallel printer
157    0118  02              db mb$output
158    0119  00              db baud$none
159    0llA 00        db 0              ; table terminator
160
161
162    011B 00FFFFFFE9Speed$table db 0,255,255,255,233,208,104,208,104,69,52,35,
                                         26,17,13,7
163
164                  serial$init$tbl
165    012B  02              db    2         ; two bytes to CTC
166    012C          ctc$port      ds    I          ; port addresS of CTC
167    012D  47              db    47h     ; CTC mode byte
168    012E          Speed  ds    1        ; baud multiplier
169    012F  07              db    7          ; 7 bytes to SIO
170    0130          Sio$port      ds    1         ; port address of SIO
171    0131  180311104    db    18h,3,0Elh,4
172    0135          sio$reg$4     ds    1
173    0136 05EA          db    5,0EAh
174    0138 00              db    0        ; terminator
175
176    0139 02130F07  pio$init$tbl  db       2,p$zpio$2b,0Fh,07h
177    0130 0312CFF807    db    3,p$zpio$2a,0CFh,0F8h,07h
178    0142  00              db 0
179
```

180 0143		end				
BAUDII0	0003					
BAUD1200	0008					
BAUD134	0004					
BAUD150	0005					
BAUD1800	0009					
BAUO19200	000F					
BAUD2400	000A					
BAUD300	0006					
BAUD3600	000B					
BAUD4800	000C					
BAUD50	0001					
BAUD600	0007	34				
BAUD7200	0000					
BAUD75	0002					
BAUD9600	000E	140	143	146	149	152 155
BAUDNONE	0000	158				
BAUDPORTS	0006	44	129#			
BC	0000					
CENTINIT	0042	28	49#			
CENTRONICSOUT	00911	91	105#	106		
CENTSTAT	00C0	113	124#			
CII	0057	63#	64			
COSPIN	008B	95#	96			
CTCPORT	012C	45	166#			
DATAPORTS	00DC	42	44	78	98	116 133#
DE	0002					
HISPEED	001D	35	37#			
HL	0004					
IX	0004					
IY	0004					
MAXDEVICES	0006	23#	28			
MBINOUT	0003	139	142	145	148	151 154
MBINPUT	0001					
MBOUTPUT	0002	157				
MBSERIAL	000B	139	142	145	148	151 154
MBSOFTBAUD	0004	139	142	145	148	151 154
MBXONXOFF	0010	142				
NULLINPUT	0063	62	70#			
NULLOUTPUT	0090	92	102#			
NULLSTATUS	0070	76	87#	114		
PBANKSELECT	0025					
PBAUDCON1	000C	130				
PBAUDCON2	0030	130				
PBAUDCON34	0031	130	131			
PBAUDLPT1	000E	130				

PBAUDLPT2   0032   131
PBOOT   0014
PCENTDATA   0011   107
PCENTSTAT   0010   106   108   108   109   125
PCON2DATA   002C   134
pCON2STAT   002D
PCON3DATA   002E   134
pCON3STAT   002F
PCON4DATA   002A   135
PCON4STAT   002B
PCONFIGURATION 0024
PCRT'DATA   001C   134
PCRTSTAT   001D
PFDCMBD   0004
PFDDATA   0007
PFDINT   0008
PFDMISC   0009
PFDSECTOR   0006
PFDSTAT   0004
PFDTRACK   0005
PINDEX   000F
PIOINITTBL   0139   50   176#
PLPT2DATA   0028   135
PLPT2ST'AT   0029
PLPTDATA   001E   134
PLPTSTAT   001F
PRTC   0033
PSELECT   0008
PWD1797   0004
PZCTCl   000C
PZCTC2   0030
PZDART   001C
PZDMA   0000
PZPIO1   0008
PZPIOlA   000A
PZPIO1B   000B
PZPIO2   0010
PZPIO2A   0012   177
PZPIO2B   0013   176
PZPIO3   0024
PZPIO3A   0026
PZPIO3B   0027
PZSIO1   0028
PZSIO2   002C
SERIALINITTBL   012B   46   164#
SIOPORT   0130   43   170#

SIOREG4		0135	38	172#	
SPEED		012E	40	168#	
SPEEDTABLE		011B	39	162#	
STREAMOUT		0045	47	52#	57
?CI		0051	16	60#	
?CINIT		0000	16	27#	
?CIST		0066	16	64	74#
?CO		007F	16	90#	
?COST	0083	16	96	112#	
@CTBL		00E2	17	33	138#

1.3   Drive Table

The DRVTBL.ASM module points to the data structures for each
configured disk drive. The drive table determines which physical
disk unit is associated with which logical drive.   The data
structure for each disk drive is called an Extended Disk Parameter
Header (XDPH) .

```
1                              public @dtbl
2                              extin fdsd0,fdsdl
3
4                              cseg
5
6        0000   00000000  @dtbl       dw fdsd0,fdsdl
7        0004   0000000000    dw 0,0,0,0,0,0,0,0,0,0,0,0,0,0 ; drives C-P non-existent
8
9        0020           end
FDSDO                  0000   2      6
FDSDl          0000   2      6
@DTBL                  0000   1      6#
```

Listing I-3. Drive Table

1.4   Z80 DMA single-density Disk Handler

The FDl797SD module initializes the disk controllers for thedisks described in the Disk
Parameter Headers and Disk Parameter Blocks contained in this module. FDl797SD is written
for hardware that supports Direct Memory Access (DMA) .

```
1                     title 'wd1797 w/ Z80 DMA Single density diskette handler'
2
3                ;      CP/M-80 Version 3     --  Modular BIOS
4
5                ;        Disk I/O Module for wd1797 based diskette systems
6
7                ;     Initial version 0.01,
8                           Single density floppy only.    - jrp, 4 Aug
9
10                dseg
11
12             ; Disk drive dispatc))ing tables for linked BIOS
13
14             public  fdsd0,fdsdl
15
16             ; Variables containing parameters passed by BDOS
17
```

```
18                    extrn   @adrv,@rdrv
19                    extrn   @dma,@trk,@sect
20                    extrn   @dbnk
21
22              ; System Control Block variables
23
24               extrn   @ermde        ; BDOS error mode
25
26              ; Utility routines in standard BIOS
27
28              extrn    ?wboot  ; warm       hoot vector
29              extrn    ?pmsg   ; print message @<HL> up to 00, saves <BC> & <DE>
30              extrn    ?pdec   ; print  binary number in <A> from 0 to 99,
31              extrn    ?pderr  ; print BIOS disk error header
32              extrn    ?conin,?cono   ; con in and out
33              extrn    ?const  ; get console status
34
35
36              ; Port Address Equates
37
38                    saclib   ports
39
40              ; CP/M 3 Disk derinition macros
41
42                    maclib  cpm3
43
44              ; Z80 macro library instruction definitions
45
46                    maclib  z80
47
48              ; common control characters
49
50     000b = cr      equ 13
51     000A =         lf       equ 10
52     0007 = bell    equ 7
53
94
55              ; Extended                           Disk Parameter Headers (XPDNS)
56
57     0000 E600          dw      fd$write
58     0002 DC00          dw      fd$read
59     0004 DB00          dw      fd$login
60     0006 BE00          dw      fd$init0
61     0008 0000          db      0,0              ; relative drive zero
62              fdsd0  dph    trans,dpbsd,16,31
63     000A+A400          DW TRANS           ; TRANSLATE TABLE ADDRESS
```

```
64      000C+0000000000    DB 0,0,0,0,0,0,0,0,0          ; BDOS SCRATCH AREA
65      0015+00            DB 0          ; MEDIA FLAG
66      0016+0000          DW DPBSD              ; DISK PARAMETER BLOCK
67      0018+2300          DW ??0001             ; CHECKSUM VECTOR
68      001A+3300          DW ??0002             ; ALLOCATION VECTOR
69      001C+FEFFFEFFFE    DW 0FFFEH,0FFFEH,0FFFEH  ; DIRBCB, DTABCB, HASH
                                                       ALLOC'D BY GENCPM
70      0022+00            DB 0          ; HASH BANK
71      0023+         ??0001 DS    16    ; CHECKSUM VECTOR
72      0033+         ??0002 DS    31    ; ALLOCATION VECTOR
73
74      0052 E600          dw     fd$write
79      0054 DC00          dw     fd$read
76      0056 DB00          dw     fd$login
77      0058 CD00          dw     fd$initl
78      00SA 0100          db     1,0     ; relative drive one
79                 fdsdl   dph    trans,dpbsd,16,31
80      005C+A400          DW TRANS           ; TRANSLATE TABLE ADDRESS
81      005E+0000000000    DB 0,0,0,0,0,0,0,0,0          ; BDOS SCRATCH AREA
82      0067+00            DB 0          ; MEDIA FLAG
83      0068+0000          DW DPBSD              ; DISK PARAMETER BLOCK
84      006A+7500          DW ??0003             ; CHECKSUM VECTOR
85      006C+8500          DW ??0004             ; ALLOCATION VECTOR
86      006E+FEFFFEFFFE    DW 0FFFEH,0FFFEH,0FFFEH ; DIRBCB, DTABCB, HASH
                                                       ALLOC'D BY GENCPM
87      0074+00            DB 0                  ; HASH BANK
88      0075+ 770003       DS    16    ; CHECKSUM VECT0R
89      0085+ 770004       DS    31    ; ALLOCATION VECTOR
90
91                         cseg    ; DPB must be resident
92
93                 dpbsd   dpb 128,26,77,1024,64,2
94      0000+1A00          DW     ??0005 ; 128 BYTE REC0RDS PER TRACK
95      0002+0307          DB     ??0006,??000  ; BLOCK SHIFT' AND MASK
96      0004+00            DB     ??0008 ; EXTENT MASK
97      000S+F200          DW     ??0009 ; MAXIMUM BLOCK NUMBER
98      0007+3F00          DW     ??0010 ; MAXIMUM DIRECTORY ENTRY NUMBER
99      0009+C000          DB     ??0011,??0012 ; ALLOC VECTOR FOR DIRECTORY
100     0008+1000          DW     ??0013 ; CHECKSUM SIzE
101     000D+0200          DW     2       ; OFFSET FOR SYSTEM TRACKS
102     000F+0000          DB     ??0014,??0015 ; PHYSICAL SECTOR SIZE SHIFT AND
                                                  MASK
103
104                        dseg    ; rest is banked
105
```

```
106                    trans   skew 26,6,1
107    00A4+0l                 DB    ?NXTSEC+1
108    00A5+07                 DB    ?NXTSEC+1
109    00A6+0D                 DB    ?NXTSEC+1
110    00A7+13                 DB    ?NXTSEC+1
111    00A8+19                 DB    ?NXTSEC+1
112    00A9+05                 DB    ?NXTSEC+1
113    00AA+0B                 DB    ?NXTSEC+1
114    00AB+1l                 DB    ?NXTSEC+1
115    00AC+17                 DB    ?NXTSEC+1
116    00AD+03                 DB    ?NXTSEC+1
117    00AE+09                 DB    ?NXTSEC+1
118    00AF+0F                 DB    ?NXTSEC+1
119    00B0+15                 DB    ?NXTSEC+1
120    00BI+02                 DB    ?NXTSEC+1
121    00B2+09                 DB    ?NXTSEC+1
122    00B3+0E                 DB    ?NXTSEC+1
123    00B4+14                 DB    ?NXTSEC+1
124    00B5+1A                 DB    ?NXTSEC+1
125    00B6+06                 DB    ?NXTSEC+1
126    00B7+0C                 DB    ?NXTSEC+1
127    00B8+12                 DB    ?NXTSEC+1
128    00B9+18                 DB    ?NXTSEC+1
129    00BA+04                 DB    ?NXTSEC+1
130    00BB+0A                 DB    ?NXTSEC+1
131    00BC+10                 DB    ?NXTSEC+1
132    00BD+16                 DB    ?NXTSEC+1
133
134
135
136                    ; Disk I/O routines for standardized BIOS interface
137
138                    ; Initialization entry point.
139
140                    ;      called for first time initialization.
141
142
143                    fd$init0
144    00BE 2ICE00            lxi h,init$table
145                    fd$init$next:
146    00CI 7EB7CB           mov a,m ! ora a ! rz
147    00C4 47234E23         mov b,a ! inx h ! mov c,m ! inx h
148                          outir
149    00C8+EDB3             DB    0EDH,0B3H
150    00CA C3C100           jmp fd$init$next
151
```

```
152                     fd$initl:      ; all initialization done by drive 0
153     00CD C9                 ret
154
155     00CE 040A    init$table db    4,p$zpio$1A
156     00D0 CFC217FF      db       ll00llllb, 11000010b, 000l0lllb,llllllllb
157     00D4 040B          db       4,p$zpio$lB
158     00D6 CFDDl7FF      db       ll00llllb, ll0lll0lb, 000l0lllb,llllllllb
159     00DA 00             db 0
160
161
162                 fd$login
163                         ; This entry is called when a logical drive is about to
164                         ; be logged into for the purpose of density determination.
165
166                         ; It may adjust the parameters contained in the disk
167                         ; parameter header pointed at by <DE)
168
169     00DB C9             ret                ; we have nothing to do in
170                                            ;      simple single density only environment.
171
172
173                         ; disk READ and WRITE entry points.
174
175                         ; these entries are called with the following arguments:
176
177                         ; relative drive number in @rdrv (8 bits)
178                         ; absolute drive number in @adrv (8 bits)
179                         ; disk transfer address in @dma (16 bitS)
180                         ; disk transfer bank    in @dbnk (8 bits)
181                         ; disk track address    in @trk (16 bits)
182                         ; disk sector address   in @sect (16 bits)
183                         ; pointer to XDPH in <DE>
184
185                         ; they transfer the appropriate data, perform retries
186                         ; if necessary, then return an error code in <A>
187
188                 fd$read:
189     00DC 211802         lxi h,read$msg           ; point at " Read "
190     00DF 3E880601        mvi a,88h ! mvi b,0l h ; 1797  read + Z80DMA direction
191     00E3 C3ED00          jmp rw$common
192
193                 fd$write
194     00E6 211F02         lxi h,write$msg          ; point at " Write "
195     00E9 3EA80605        mvi a,0A8h ! mvi b,05h ; 1797 write + Z80DMA direction
196                   ;        jmp wr$common       ; fall through
197
```

```
198                     rw$common:                  ; seek to correct track (if necessary),
199                                                 ; initialize DMA controller,
200                                                 ; and issue 1797 command.
201
202     0QED 222702     shld operation$name   ; save message for errors
203     00F0 321102     sta disk$command        ; save 1797 command
204     00F3 7832A802   mov a,b ! sta zdma$direction  ; save Z80DMA direction code
205     00F7 2A0000229F lhld @dma ( shld  zdma$dma  ; get and save DMA address
206     00FD 3A00006F26 lda @rdrv ! mov 1,a ! mvi h, 0 ; get controller-relative disk drive
207     0103 11160219   lxi d,select$table ! dad d      ; point to select mask for drive
208     0107 7E321202   mov a,m ! sta select$mask      ; get select mask and save it
209     0108 D308       outp$Select     ; select drive
210                  more$retries:
211     0l0D 0E0A       mvi c,l0          ; allow 10 retries
212                  retry$operation:
213     0l0F C5         push b  ; save retry counter
214
215     0110 3A12022113 lda select$mask ! lxi h,old$select ! cmp m
216     0117 77         mov m,a
217     0118 C22D01     jnz new$track  ; if not same drive as last, seek
218
219     011B 3A00002114 lda @trk ! lxi h,old$track ! csp m
220     0122 77         mov m,a
221     0123 C22001     jnz new$track  ; if not same track, then seek
222
223     0126 DB09E602C2 in p$fdmisc ! ani 2 ! jnz same$track ; head still loaded, we are OK
224
225                  new$track:     ; or drive or unloaded head means we should . .
226     012D CDA90l    call check$seek          ; . . . read address and seek if wrong track
227
228     0130 011B41    lxi b,16667              ; 100 ms / (24 t states*250 ns)
229                  spin$loop:               ; wait      for head/seek settling
230     0133 0B        dcx b
231     0134 78B1      mov a,b ! ora c
232     0136 C23301    jnz spin$loop
233
234                  same$track
235     0139 3A00000305 lda @trk ! out p$fdtrack           ; give 1797 track
236     013E 3A0000D306 lda @sect ! Out p$fdsector        ;      and sector
237
238     0143 219A02    lxi h,dma$block        ; point to dma command block
239     0146 010011    lxi b,dmab$length*256 + p$zdma      ; command block length and
                                                           port address
240                  outir   ; send commands to Z80 DMA
241     0149+EDB3      DB      0EDH,0B3H
242
```

```
243    0148 DB2S          in p$bankse)ect       ; get old value of bank select port
244    014D E63F47        ani 3Fh ! mov b,a     ; mask off DMA bank and save
245    0150 3A00000F0F    lda @dbnk ! rrc ! rrc ; get DMA bank to 2 hi-order bits
246    0155 E6C0B0        ani 0C0h ! ora b      ; merge with other bank stuff
247    0158 D325          out p$bankselect      ; and select the correct DMA bank
248
249    0l5A 3A1102        lda disk$command      ; get 1797 command
250    015D CDDS0l        call exec$co"""and    ; start it then wait for IREQ and read status
251    0160 321502        sta disk$status       ; save    status for error messages
252
253    0163 C1            pop b                 ; recover retry counter
254    0164 B7C8          ora a ! rz            ; check status and return to BDOS if no error
255
256    0166 E610          ani 000l$0000b        ; see if record not found error
257    0168 C4A901        cnz check$seek        ; if a record not found, we might need to
                                                  seek
258
259    0168 0DC20F01      dcr c ! jnz retry$operation
260
261                       ; suppress error message if BDOS is returning errors to application. . .
262
263    016F 3A0000FEFF    lda @ermde ! cpi 0FFh ! jz hard$error
264
265                       ; Had permanent error, print message like:
266
267                       ; BIOS Err on d: T-nn,   S-mm, <operation> <type>, Retry ?
268
269    0177 CD0000        call ?pderr           ; print     message header
270
271    017A 2A2702CD00    lhld operation$name ! call ?pmsg        ; last function
272
273                       ; then, messages for all indicated error bits
274
275    0180 3A1502        lda disk$status       ; get Status byte from last error
276    0183 212902        lxi h,error$table     ; point   at table of message addresses
277            errml:
278    0186 5E235623      mov e,m ! Inx h ! mov d,m ! inx     h ; get next message address
279    018A 87F5          add a ! push psw      ; shift   left and push residual bits with status
280    018C EBDC0000EB    xchg ! cc ?pmsg ! xchg ; print            message, saving table pointer
281    0191 F1C28601       pop psw ! jnz errml   ; if any more bits left, continue
282
283    0195 218A02CD00    lxi h,error$msg ! call ?pmsg   ; print  <BEL>, Retry (Y/N) ? "
284    019B CDF50I        call u$conin$echo     ; get operator response
285    019E FE59CA0D01    cpi 'Y' ! jz more$retries ; Yes, then retry 10 more times
286            hard$error:                      ; otherwise,
287    01A3 3E01C9        mvi a,1 ! ret         ; return hard error to BD0S
```

```
288
289                     cancel:                                ; here to abort job
290     01A6 C30000         jmp ?wboot           ; leap directly to warmstart vector
291
292
293                         ; subroutine to seek if on wrong track
294                         ; called both to set up  new track or drive
295
296                     check$seek:
297     01A9 C5             push b  ; save error counter
298     0lAA CDEl01         call read$id        ; try to read ID, put track in <B>
299     0lAD CABE01         jz id$ok            ; if OK, we're DE
300     0lB0 CDCE0l         call step$out     ; else step towards Trk 0
301     01B3 CDEl0l         call read$id       ; and try again
302     01B6 CABE01         jz id$ok           ; if OK, we're OK
303     01B9 CDD301         call restore       ; else, restore the drive
304     01BC 0600           mvi b,0; and make like we are at track
305                     id$ok:
306     0lBE 78D305         mov a,b ! Out p$fdtrack        ; send current track to track port
307     0lCl 3A0000B8Cl     lda @trk ! cmp b ! pop b ! rz  ; lf its desired track, we are done
308     01C7 D307           out p$fddata    ; else, desired track to data port
309     01C9 3E1A           mvi a,000ll0l0b         ; seek wi 10 ms. steps
310     0lCB C3D501         jmp exec$command
311
312
313
314                 step$out:
315     0lCE 3E6A           mvi a,0ll0l0l0b; step out once at 10 ms.
316     0100 C3DS0l         jmp exec$command
317
318                 restore:
319     01D3 3E0B           mvi a,0000l0llb          ; restore at 15 ms
320                 ;       jmp exec$command
321
322
323                 exec$command:                ; issue 1797 command, and wait for IREQ
324                                              ;      return Status
325     0105 0304           out p$fdcmnd        ; send 1797 command
326                 wait$IREQ:                   ; spin til IREQ
327     0107 DB08E640CA    in p$fdint ! ani 40h ! jz wait$IREQ
328     0lDE 0804           in p$fdstat          ; get 1797 Status and clear IREQ
329     0IE0 C9             ret
330
331                 read$id:
332     0IEl 21AB02         lxi h,read$id$block    ; set up DMA controller
```

```
333    0lE4 0100F              lxi b,length$id$dmab*256 + p$zdma ; for READ ADDRESS
                                                                   operation
334                           outir
335    01E7+EDB3              DB     0EDH,0B3H
336    01E9 3EC4             mvi a,ll000l00b                 ; issue  1797 read address command
337    0lEB CDD50l           call exec$command              ; wait for IREQ and read status
338    0lEE E69D             ani 10011101b                  ; mask status
339    0lF0 21110046         lxi h;id$buffer ! mov b,m       ; get actual track number in <B>
340    01F4 C9               ret                            ; and return with z flag true for OK
341
342
343                   u$conin$echo:             ; get console input, echo it, and shift to upper case
344    0lF5 CD000087CA    call ?const ! ora a ! jz u$cl     ; see if any char already struck
345    01FC CD0000C3FS    call ?conin ! jmp u$conin$echo  ; yes, eat it and try again
346                   u$cl:
347    0202 CD0000FS       call ?conin ! push psw
348    0206 4FCD0000       mov c,a ! call ?cono
349    020A   FlFE6lD8     pop psw ! cpi 'a' ! rc
350    020E D620           sui 'a'-'A'                      ; make upper case
351    0210   C9           ret
352
353
354    0211          disk$command ds    1         ; current wd1797 command
355    0212          select$mask   ds    1         ; current drive select code
356    0213          old$select    ds    1         ; laat drive selected
357    0214          old$track     ds    1         ; last track seeked to
358
359    0215          diik$status   ds    1         ; last error status code for messages
360
361    0216   1020   select$table  db     000l$0000b,00l0$0000b ; for now use drives C and
                                                                    D
362
363
364                  ; error message components
365
366    0218   2C20s26s6lread$msg  db      ', Read',0
367    021F   2C20577269write$msg db      ', Write',0
368
369    0227   1802   operation$name    dw     read$msg
370
371                  ; table of pointers to error message strings
372                  ;   first entry is for bit 7 of 1797 status byte
373
374    0229   3902   error$table  dw     b7$msg
375    022B   4502               dw     b6$msg
376    0220   4F02               dw     b5$msg
```

377	022F	5702		dw	b4$msg
378	0231	6A02		dw	b3$msg
379	0233	7002		dw	b2$msq
380	0235	7C02		dw	bl$msg
381	0237	8302		dw	b0$msg
382					
383	0239	204E6F7420b7$msg	db		' Not ready,',0
384	0245	2050726F74b6$msq	db		' protect,',0
385	024F	204661756Cb5$msg	db		' Fault,',0
386	0257	205265636Fb4$msg	db		' Record not found,',0
387	026A	204352432Cb3$msg	db		' CRC,',0
388	0270	204C6F7374b2$msg	db		' Lost dsta,',0
389	027C	2044524551b1$msg	db		' DREQ,',0
390	0283	2042757379b0$msg	db		' Busy,',0
391					
392	028A	2052657472error$msg		db	' Retry (Y/N) ? ',0
393					
394					
395					
396		; command string for Z80DMA device for normal operation				
397					
398	029A	C3	dma$block	db	0C3h	; reset DMA channel
399	0298	14		db	14h	; channel A is incrementing memory
400	029C	28		db	28h	; channel B is fixed port address
401	029D	8A		db	8Ah	; RDY is high, CE/ only, stop on E0B
402	029E	79		db	79h	; program all of ch. A, xfer B->A (temp)
403	029F		zdma$dma	ds	2	; starting DMA address
404	02A1	7F00		dw	128-1	; 128 byte sectors in SD
405	02A3	85		db	85h	; xfer byte at a time, ch B is 8 bit address
406	02A4	07		db	p$fddata	; ch B port address (1797 data port)
407	02A5	CF		db	0CFh	; load B as source register
408	02A6	05		db	05h	; ;'fer A->B
409	02A7	CF		db	0CFh	; load A as source register
410	02A8		zdma$direction	ds	1	; either A->B or B->A
411	02A9	CF		db	0CFh	; load final source register
412	02AA	87		db	87h	; enable DMA channel
413	0011	=	dmab$length	equ	$-dma$block	
414						
415						
416						
417	02AB	C3	readidblock	db	0C3h	; reset DMA channel
418	02AC	14		db	14h	; channel A is incrementing memory
419	02AD	28		db	28h	; channel B is fixed port address
420	02AE	8A		db	8Ah	; RDY is high, CE/ only, stop on EOB
421	02AF	7D		db	7Dh	; program all of ch. A, xfer A->B (temp)
422	02B0	1100		dw	id$buffer	; starting DMA address

```
423    0282   0500                    dw      6-1      ; Read ID always xfers 6 bytes
424    02B4   85                      db      85h      ; byte xfer, ch B is 8 bit address
425    02B5   07                      db      p$fddata ; ch B port address (1797 data port)
426    02B6   CF                      db      0CFh     ; load dest (currently source) register
427    02B7   01                      db      0lh      ; xfer B->A
428    02B8   CF                      db      0CFh     ; load source register
429    0259   87                      db      87h      ; enable DMA channel
430    000F   =      length$id$dmab   equ     $-read$id$block
431
432                          cseg    ; easier to put          ID buffer in common
433
434    0011          id$buffer    ds      6        ; buffer to hold ID field
435                                ; track
436                                ; Side
437                                ; Sector
438                                ; length
439                                ; CRC 1
440                                ; CRC 2
441
442    0017                 end
```

FDLOGIN	00DB	59	76	1621
FDREAD	00DC	58	75	188#
FDSD0	000A	14	621	
FDSDl	005C	14	791	
FDWRITE	00E6	57	74	193#
HARDERROR	01A3	263	286#	
HL	0004			
IDBUFFER	0011	339	422	4341
IDOK	0lBE	299	302	3051
INITTABLE	00CE	144	1551	
IX	0004			
IY	0004			
LEMGTMIDDMAB	000F	333	430#	
LF	000A	511		
MORERETRIES	0l0D	2101	285	
NEWTRACK	012D	217	221	225#
OLDSELECT	0213	215	356#	
OLDTRACK	0214	219	3571	
OPERATIOMMAME	0227	202	271	3691
PBANkSELECT	0025	243	247	
PBAUDCON1	000C			
PBAUDCON2	0030			
PBAUDCON34	0031			
PBAUDLPT1	000E			
PBAUDLPT2	0032			
PBOOT	0014			
PCENTDATA	0011			
PCENTSTAT	0010			
PCON2DATA	002C			
PCON2STAT	002D			
PCON3DATA	002E			
PCON3STAT	002F			
PCON4DATA	002A			
PCON4STAT	002B			
PCONFIGURATION	0024			
PCRTDATA	001C			
PCRTSTAT	001D			
PFDCMND	0004	325		
PFDDATA	0007	308	406	425
PFDINT	0008	327		
PFDMISC	0009	223		
PFDSECTOR	0006	236		
PFDSTAT	0004	329		
PFDTRACK	0005	235	306	
PINDEX	000?			
PLPT2DATA	0028			

PLPT2STAT	0029				
PLPTDATA	001E				
PLPTSTAT	001F				
PRTC	0033				
PSELECT	0008	209			
PWD1797	0004				
PZCTCl	000C				
PZCTC2	0030				
PZDART	001C				
PZDMA	0000	239	333		
PZPIO1	0008				
PzPIOlA	000A	155			
PZPIO1B	000B	157			
PZPIO2	0010				
PzPIO2A	0012				
PZPIO2B	0013				
PZPIO3	0024				
PZPI03A	0026				
PzPIO3B	0027				
PZSIO1	0028				
PZSIO2	002C				
READID	01E1	298	301	331#	
READIDBLOCK	02AB	332	417#	430	
READMSG	0218	189	366#	369	
RESTORE	01D3	303	318#		
RETRYOPERATION	0l0F	212#	259		
RWCOMMON	C0ED	191	198#		
SAMETRACK	0139	223	234#		
SELECTMASK	0212	208	215	355#	
SELECTTABLE	0216	207	361#		
SPINLOOP	0133	229#	232		
STEPOUT	0lCE	300	314#		
TRANS	00A4	62	63	79	80	106#
UCI	0202	344	346#		
UCONINECHO	0lF5	284	343#	345	
WAITIREQ	0107	326*	327		
WRITEMSG	021F	194	367*		
ZDMADIRECTION	02A8	204	410#		
ZDMADMA	029F	205	403*		
?CONIN	0000	32	345	347	
?CONO	0000	32	348		
?CONST	0000	33	344		
?PDEC	0000	30			
?PDERR	0000	31	269		
?PMSG	0000	29	271	280	283
?WBOOT	0000	28	290		

@ADRV	0000	18			
@DBNK	0000	20	245		
@DMA	0000	19	205		
@ERMDE	0000	24	263		
@RDRV	0000	18	206		
@SECT	0000	19	236		
@TRK	0000	19	219	235	307

I.5   Bank and Move Module for CP/M 3 Linked BIOS

The MOVE.ASM module performs memory-to-memory moves and bankselects .

```
1                title 'bank & move module for CP/M3 linked BIOS'
2
3                      cseg
4
5                      public ?move,?xmove,?bank
6                      extrn @cbnk
7
8                      maclib z80
9                      maclib ports
10
11          ?xmove:        ; ALTOS can't perform interbank moves
12    0000 C9     ret
13
14                    ?move:
15    0001 EB     xchg                     ; we are passed source in DE and dest in HL
16                ldir                     ; use Z80 block move instruction
17    0002+EDB0   DB     0EDH,0B0H
18    0004 EB     xchq                     ; need next addresses in same regs
19    0005 C9      ret
20
21                                         ; by exiting through bank select
22          ?bank:
23    0006 C5      push b ; save register b for temp
24    0007 171717E618    ral ! ral ! ral ! ani lBh  ; isolate bank in proper bit position
25    000C 47      mov b,a                  ; save in reg B
26    0000 DB25    in p$bankselect          ; get old memory control byte
27    000F E6E7B0 ani 0E7h ( ora b          ; mask out old and merge in new
28    0012 0325    out p$bankselect         ; put new memory control byte
29    0014 C1      pop b   ; restore register b
30    0015 C9      ret
31
32                                         ;      128 bytes at a time
33
34    0016         end
BC              0000
DE              0002
HL              0004
IX              0004
IY              0004
PBANKSELECT     0025   26                      28
PBAUDCON1       000C
PBAUDCON2       0030
```

```
PBAUDCON34        0031
PBAUDLPT1         000E
PBAUDLPT2         0032
PBOOT             0014
PCENTDATA         0011
PCENTSTAT         0010
PCON2DATA         002C
PCON2STAT         002D
PCON3DATA         002E
PCON3STAT         002F
PCON4DATA         002A
PCON4STAT         002B
PCONFIGURATION    0024
PORTDATA          001C
PCRTSTAT          001D
PFDCMND           0004
PFDDATA           0007
PFDINT            000B
PFDMISC           0009
PFDSECTOR         0006
PFDSTAT           0004
PFDTRACK          0005
PINDEX            000F
PLPT2DATA         0028
PLPT2STAT         0029
PLPTDATA          001E
PLPTSTAT          001F
PRTC              0033
PSELECT           000B
PWD1797           0004
PZCTCl            000C
PZCTC2            0030
PZDART            001C
PZDMA             0000
PZPIO1            0008
PZPIOlA           000A
PZPIO1B           000B
PZPIO2            0010
PZPIO2A           0012
PZPIO2B           0013
PZPIO3            0024
PZPI03A           0026
PZPIO3B           0027
PZSIO1            002B
PZSIO2            002C
?BANK             0006    5       22#
```

```
?MOVE              0001   5      14#
?XMOVE             0000   5      11#
@CBNK              0000   6
```

1.6   I/o Port Addresses for Z80 Chip-based System: PORTS.LIB

This listing is the PORTS.LIB file on your distributiondiskette. It contains the port addresses for the Z80 chip-basedsystem with a Western Digital 1797 Floppy Disk Controller.

I/O Port addresses for Z80 chip set based system with wd1797 FDC

```
                   ; chip bases

p$zdma           equ   0
p$wd1797         equ   4
p$zpio1          equ   8
p$zctcl          equ   12
P$zpio2          equ   16
p$boot           equ   20      ; OUT disables boot EPROM
p$zdart          equ   28      ; console 1 and printer 1
p$zpio3          equ   36
p$zsio1          equ   40
p$zsio2          equ   44
p$zctc2          equ   48


                   ; diskette controller chip ports

p$fdcmnd         equ   p$wdl797+0
p$fdstat         equ   p$wdl797+0
p$fdtrack        equ   p$wd1797+1
p$fdsector       equ   p$wd1797+2
p$fddata         equ   p$wd1797+3


                   ; parallel I/O 1

p$select         equ p$zpiol+0
p$fdint          equ p$zpiol+0
p$fdmisc         equ p$zpiol+1
p$zpiola         equ p$zpiol+2
p$zpiolb         equ p$zpiol+3


                   ; counter timer chip 1

p$baudconl       equ p$zctcl+0
p$baudlptl       equ p$zctcl+2
```

p$index   equ p$zctcl+3

; parallel I/O 2, Centronics printer interface

p$cent$stat   equ p$zpio2+0
p$cent$data   equ p$zpio2+1
p$zpio2a   equ p$zpio2+2
p$zpio2b   equ p$zpio2+3

; dual asynch rcvr/xstr, console and serial printer ports

pcrtdata   equ p$zdart+0
pcrtstat   equ p$zdart+1
plptdata   equ p$zdart+2
plptstat   equ p$zdart+3

; Third Parallel I/0 device

p$configuration equ p$zpio3+0
p$bankselect   equ p$zplo3+1
p$zpio3a   equ p$zpio3+2
p$zpio3b   equ p$zpio3+3

; Serial I/0 device l, printer 2 and console 4

p$lpt2data   equ p$zsiol+0
p$lpt2stat   equ p$zsiol+1
p$con4data   equ p$zsiol+2
p$con4stat   equ p$zsio1+3

; Serial I/0 device 2, console 2 and 3

p$con2data   equ p$zsio2+0
p$con2stat   equ p$zsio2+1
p$con3data   equ p$zsio2+2
p$con3stat   equ p$zsio2+3

; second Counter Timer Circuit

p$baudcon2   equ p$zctc2+0
p$baudcon34   equ p$zctc2+1
p$baudlpt2   equ p$zctc2+2
p$rtc   equ p$zctc2+3

PCRTSTAT	001D		
PFDCMND	0004		
pFDDATA	0007		
PFDINT	0008		
PFDMISC	0009		
PFDSECTOR	0006		
PFDSTAT	0004		
PFDTRACK	0005		
PINDEX	000F		
PLPT2DATA	0028		
PLPT2STAT	0029		
PLPTDATA	001E		
PLPTSTAT	001F		
PRTC	0033		
PSELECT	0008		
PWD1797	0004		
PZCTCl	000C		
PZCTC2	0030		
PZDART	001C		
PZDMA	0000		
PZPIO1	0008		
PZPIO1A	000A		
PZPIO1B	000B		
PZPIO2	0010		
PZPIO2A	0012		
PZPIO2B	0013		
PZPI03	0024		
PZPI03A	0026		
PZPIO3B	0027		
PZSIO1	002B		
PZSIO2	002C		
?BANK	0006	5	22#
?MOVE	0001	5	14#
?XMOVE	0000	5	11#
@CBNK	0000	6	

1.7   Sauple Submit File for ASC 8000-15 System

Digital Research used this SUBMIT file to build the sample BIOS.

;Submit file to build sample BIOS for ACS 8000-15 single-density system

```
rmac bioskrnl
rmac buot
rmac move
rmac chario
rmac drvtbl
rmac fdl797sd
rmac scb
link bnkbios3[b,q]=bioskrnl,boot,move,chario,drvtbl,fd17975d,scb
gencpm
```

Listing 1-7. Sample Submit File for ASC 8000-15 System

End of Appendix I

Appendix
Public Entry Points for CP/M 3 Sample BIOS Modules

Module Name	Public Entry Point	Function	Input Parameter		Return Value
BIOSERNL					
	?PMSG	Print Message	HL points to msg		none
	?PDEC	Print Decimal	HL=number	none	
	?PDERR	Print BIOS Disk Err Msg Header	none		none
CHARIO					
	?CINIT	Char Dev Init Dev Parms in @CTBL	C=Phys Dev #		none
	?CIST	Char Inp Dev St	B=Phys 0ev #		A=00 if no input A=0FFH if input char available
	?COST	Char Out 0ev St	B=Phys Dev #	A=00 if output busy A=0FFH if output ready	
	?CI	Char Dev Input	B=Phys Dev #		A=next available input char
	?CO	Char Dev Output	B=Phys Dev # C=Input Char		
MOVE					
	?MOVE	Memory to Memory Move	BC=byte count DE=start source adr HL=start dest adr		DE,HL point to next bytes after move
	?xMOVE	Set Banks for Extended Move	B=Dest Bank C=Source Bank		BC,DE,HL are unchanged
	?BANK	Select Bank	A=Bank Number		All unchanged
BOOT					
	?INIT	System Init	none		none
	?LDCCP	Load CCP	none	none	
	?RLCCP	Reload CCP	none	none	
	?TIME	Get/Set Time	C=000H if get C=0FFH if set		none

Listing J-1. Public Entry Points for cP/M 3 Sample BIOS Modules

End of Appendix J

Appendix K
Public Data Items in CP/M 3 Sample BIOS Modules

Table K-1. Public Data Items

Module Name	Public Data	Description
BIOSKRNL		
	@ADRV	Absolute Logical Drive Code
	@RDRV	Relative logical drive code (UNIT)
	@TRK	Track Number
	@SECT	Sector Address
	@DMA	DMA Address
	@DBNK	Bank for Disk I/O
	@CNT	Multi-sector Count
	@CBNK	Current CPU Bank
CHARIO		
	@CTBL	Character Device Table
DRVTBL		
	@DTBL	Drive Table

End of Appendix K

CP/M 3 BIOS   Function Summary

Table L-1. BIOS Function Jump Table Summary

No.	Function	Input	Output
0	BOOT	None	None
1	WBOOT	None	None
2	CONST	None	A=0FFH if ready
			A=00H if not ready
3	CONIN	None	A=Con Char
4	CONOUT	C=Con Char	None
5	LIST	C=Char	None
6	AUXOUT	C=Char	None
7	AUXIN	None	A=Char
8	HOME	None	None
9	SELDSK	C=Drive 0-15	HL=DPH addr
		E=Init Sel Flag	HL=000H if invalid dr.
10	SETTRK	BC=Track No	None
11	SETSEC	BC=Sector No	None
12	SETDMA	BC=.DMA	None
13	READ	None	A=00H if no Err
			A=01H if Non-recov Err
			A=0FFH if media changed
14	WRITE	C=Deblk Codes	A=00H if no Err
			A=01H if Phys Err
			A=02H if Dsk is R/O
			A=0FFH if media changed
15	LISTST	None	A=00H if not ready
			A=0FFH if ready
16	SECTRN	BC=Log Sect No	HL=Phys Sect No
		DE=Trans Tbl Adr	
17	CONOST	None	A=00H if not ready
			A=0FFH if ready
18	AUXIST	None	A=00H if not ready
			A=0FFH if ready
19	AUXOST	None	A=00H if not ready
			A=0FFH if ready
20	DEVTBL	None	HL=Chrtbl addr
21	DEVINI	C=Dev No 0-15	None
22	DRVTBL	None	HL=Drv Tbl addr
			HL=0FFFFH
			HL=0FFFEH

23	MULTIO	C=Mult Sec Cnt	None
24	FLUSH	None	A=000H if no err
			A=00IH if phys err
			A=002H if disk R/O
25	MOVE	HL=Dest Adr	HL & DE point to next
		DE=Source Adr	bytes following MOVE
		BC=Count	
26	TIME	C=Get/Set Flag	None
27	SELMEM	A=Mem Bank	None
28	SETBNK	A=Mem Bank	None
29	XMOVE	B=Dest Bank	None
		C=Source Bank	
30	USERF	Reserved for System Implementor	
31	RESERV1	Reserved for Future Use	
32	RESERV2	Reserved for Future Use	

End of Appendix L

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