WAVE MATE, INCORPORATED
BULLET CP/M 3.0 SOFTWARE MANUAL

Revision A

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SECTION 1 - INTRODUCTION

1.1 THE WAVE MATE BULLET

This manual is a supplement to the documentation published by Digital Research, Incorporated (DRI). The information contained herein is intended to cover those aspects of CP/M 3 which are specific to the Wave Mate BULLET system.

Experienced CP/M users will find that a brief review of this document is sufficient to get started immediately with CP/M 3 on the BULLET. Users not familiar with CP/M are encouraged to obtain and review the CP/M 3 Users Guide published by DRI prior to using CP/M 3 on the BULLET. The forward and introductory section of the user's guide are particularly helpful for those just becoming acquainted with computers.

CP/M 3 on the BULLET computer fully utilizes the hardware features of the system. The implementation takes full advantage of the ability of CP/M 3 to support a banked memory system greater than 64K bytes. Although CP/M 3 can be configured in a nonbanked system, the banked system is the only one distributed and supported on the BULLET. Users reviewing the DRI documentation will note references to nonbanked versions, which may be ignored. By supporting the banked version, all the features of CP/M 3 are available to the user. The nonbanked version does not provide as many features. Some of the additional features of the banked system are: greater transient program area, typically 60K; hashed directory lookup to reduce directory search time; input line editing functions to allow editing of command lines before executing; buffering of directory sectors; plus additional features discussed in the DRI documentation.

To support and enhance CP/M 3 on the BULLET, Wave Mate has developed a new Customized Basic Input Output System (C-BIOS). This C-BIOS provides additional performance features which include: multiple floppy diskette track buffers, keyboard typeahead, and real time clock support. The C-BIOS has been implemented in the modular fashion discribed in the DRI documentation, thus is easily maintained and modified.

1.2 THE FIRST TIME THROUGH

The most important step to perform when you first receive your system is to make a copy of the system release diskette. This is very important. Until this is done, inadvertent damage to the system release diskette may prevent use of your system until a replacement can be obtained. Once this copy has been made, the system release diskette should be placed in a safe place to ensure that the original is available if future copies are ever needed.

The process of copying a diskette is frequently referred to as "backing up". To back up a system diskette, boot in the system and place a blank diskette in drive B. Since the system release diskette is created in double density format, ensure you use a diskette certified for double density. If the diskette is not certified for double density, it will eventually fail to read properly, invariably at an inopportune time. Type in the command "FORMAT". The utility will then prompt for a disk drive specification. Type "B:" followed by a carriage return. The physical diskette parameters contained in the C-BIOS table for drive B will then be displayed. A request for confirmation is then made, and the formatting can be started by typing "YES" followed by a carriage return. Note: at any point prior to typing the "YES", the operation may be cancelled by typing a control-C at the beginning of the line. The control-C is typed by holding down the "CTRL" key and pressing the "C" key.

If the diskette formats without error, you may exit the FORMAT utility and complete the back up process. To exit the FORMAT utility, simply type a carriage return in response to each prompt until the system prompt "A>" is displayed. Now you should execute the utility "COPYSYS" to make the newly formatted diskette into a diskette which will boot. The utility will prompt for a drive, and you should type an "A" followed by a carriage return. The utility will copy the system over to the new diskette to create a working, bootable diskette. Insure you affix the copyright notices to the new diskette as described in your license agreement.

The files on the system release diskette may now be copied over to the new bootable diskette by using the PIP utility. To copy all files to the new diskette with PIP, type the following command:

```
PIP B:  A:*.*[O]
```

There is one space between the "PIP" and the "B:"; and the character in brackets is the letter "O", not a zero. Terminate the command with a carriage return. As PIP copies each file over to the new diskette, the name of the

file will be displayed. For further information on using PIP, please consult the DRI documentation or use the HELP utility.

1.3 THE WAVE MATE C-BIOS

Several important notes should be kept in mind when writing or using software on the BULLET with CP/M and the Wave Mate C-BIOS. It is important to recognize that the C-BIOS uses interrupts and operates the Z80 in interrupt mode 2. Accordingly, any user program which changes the interrupt mode or interrupt vector page will probably crash the system. Programs which disable interrupts will interfere with the C-BIOS and prevent keyboard input through the C-BIOS if the interrupts are disabled. It is recommended that application programs do not disable interrupts. Additionally, if the user program does not allow sufficient stack space for the program counter, the results are unpredictable when an interrupt occurs. It is strongly recommended that application programs allow sufficient stack space. The C-BIOS does not use any additional stack during the interrupt service routines; however, the interrupt automatically pushes the program counter onto the stack. If the program has not allowed sufficient space for this data, unpredictable reactions can occur depending upon what data was damaged and when.

Irrecoverable disk errors occurring during diskette writes are also handled somewhat differently under the Wave Mate C-BIOS. C-BIOS calls for diskette writes never return an error to the caller except for write protected disk errors. The data is not written immediately, but is buffered pending a C-BIOS track buffer operation. Accordingly, if an error occurs during the actual write operation, it is too late to return the error to the caller. In this event, the message:

```
IRRECOVERABLE DISK ERROR, PRESS CONTROL-C TO REBOOT
```

is displayed on the user console and the user must enter a control-C to execute a warm boot.

1.4 AUTO-DENSITY FEATURE

For eight inch disk drives the C-BIOS is capable of recognizing a variety of different diskette formats. When a disk is first logged on the C-BIOS scans if or a match with a DPB in the DRVTBL module. If a match is found the C-BIOS makes a successful return to BDOS. Once logged on, C-BIOS will use the same DPB for that drive. To change to a different format a disk reset must be issued. The simplest way to do this is to type in a control-C when the CCP promt is displayed.

SECTION 2 - UTILITY COMMANDS

This section describes additional utility commands provided by Wave Mate and modification made to the CP/M utility command COPYSYS.

2.1 THE FORMAT UTILITY

The FORMAT utility provides a method to initialize new diskettes. Frequently, diskettes are purchased which do not have a prerecorded soft sectored format upon them or the prerecorded format may not correspond with the format being used. It must be emphasized that the purchased diskette must be certified by the manufacturer for the format which is to be used. While a diskette which is certified only as single density may frequently be formatted as double density, such a practice invariably leads to future errors in reading/writing the diskette. If the diskette is not marked or otherwise certified as single or double density, it should be assumed to be a reject and unsuitable for use.

The exact number and size of sectors which will fit on a diskette track is variable depending upon diskette drive speed and gaps between sectors. If the diskette drive is rotating at the exact speed specified by the manufacturer, the number of bytes that can be recorded upon a track is as follows:

DISK SIZE	SPEED	BYTES PER TRACK FM/MFM
5-inch	300 rpm	3125/6250
8-inch	360 rpm	5208/10416

Note that the double density (MFM) mode provides exactly twice as many bytes per track as the single density (FM) mode; however, the gaps are slightly different so twice as many data sectors is not always available. The user should be aware that diskette drive speed variation of plus or minus three percent should be allowed for, and the preceding figures adjusted accordingly.

The following formats are utilized on all Wave Mate system release diskettes:

DISK SIZE	TRACKS	SECTORS
5-inch	80	5
8-inch	77	26
SECTOR SIZE	DENSITY	
1024	Double	
256	Double	

In formatting the diskette, the FORMAT utility uses either the single density or double density format described in Appendix C.

When the FORMAT utility is used, it obtains the parameters from the C-BIOS disk parameter block (DPB) to determine what format to write. Since the DPB is accepted without further verification by FORMAT, it is possible to create a DPB with parameters which are impossible to realize; i.e., 12000 bytes/track on an 8-inch double density diskette. This error is only detected when FORMAT does the verification pass on the diskette. At this time, the data not written on the diskette will result in errors in those sectors not successfully written during the format pass. The user constructing a DPB must compute a format which will actually fit on the diskette track.

2.2 THE MEMTEST UTILITY

The MEMTEST utility provides a useful method to verify the operation of the memory system over the most rigorous of operating conditions. In Z80 based systems, the worst case memory timing occurs during the opcode fetch. This means that it is extremely difficult to test memory under worst case conditions and even more difficult to test for pattern sensitive locations under these conditions. The Wave Mate MEMTEST diagnostic utility overcomes this problem by utilizing the DMA controller to move test pattern bytes at worst case timing conditions. MEMTEST also uses a proven test pattern algorithm which is independent of memory cell topology. This pattern is designed to check physically adjacent bits within the memory chip which change state together.

To test the memory system, type "MEMTEST". Since this utility destroys all data currently in the memory, you must reboot the system to terminate the diagnostic. If any errors are reported, record the results and repeat the test. If the error occurs again, the board should be returned to Wave Mate for repair. It is important to note that the address may not be exactly the same, but the bit position will be since each bit represents one chip. For example, if the following results are determined:

MEMORY ERROR ADDRESS: 01823B, WRITE DATA: 55, READ DATA: 51
MEMORY ERROR ADDRESS: 018239, WRITE DATA: 55, READ DATA: 51

then the diagnosis is: pattern sensitive bit 2 in 01823X area.

If the second result shows no errors, it is likely that the first error was due to other factors. Factors which could

cause a one time error include alpha particles or line voltage fluctuations or spikes.

The memory system in all BULLET computers is carefully tested prior to shipment, and it is unlikely that errors will occur in the field. The MEMTEST utility should be executed periodically to check for component degradation or failure. At a minimum, it is recommended that MEMTEST be executed at least once per month.

2.3 THE COPYSYS UTILITY

The COPYSYS utility provided by DRI has been modified by Wave Mate to allow copying the system tracks to and from different format diskettes. When copying the system tracks, COPYSYS automatically inserts the appropriate diskette parameters into the system loader during the COPYSYS operation. The user should note, however, that COPYSYS does not change the CPM3.SYS file. Moving the CPM3.SYS file to a different format diskette may result in a diskette which will not boot properly. When changing diskette formats, the user must create a new CPM3.SYS which is compatible with the target format.

SECTION 3 - SYSTEM ORGANIZATION

3.1 SYSTEM DEFAULTS

As provided on the system release diskette, the BULLET implementation of CP/M 3 provides for an initial boot with: a serial console running asynchronously at 9600 baud, a centronics type printer, and an auxillary asynchronous RS-232-C port at 9600 baud. The cold boot parameters for the system console are maintained in the file named CONBAUD.SYS and may be changed by editing and reassembling the file. As an alternative to reassembly, there are several other CONBAUD files on the disk which may be used to replace the 9600 baud CONBAUD.SYS file (refer to Appendix A). Floppy disk drive step rates are either 3 or 6 milliseconds, for 8-inch and 5-inch drives respectively.

Keyboard typeahead is implemented utilizing the vectored interrupts of the Z80 system. The typeahead buffer is a simple 80-character ring buffer. Typed characters are processed on a first-in/first-out basis with the following exceptions:

Control-C Is inserted in the buffer and causes any other contents of the ring buffer to be discarded.

Control-S Is inserted at the head of the ring buffer.

Control-Q Is inserted at the head of the ring buffer.

The control-C key is generally used to indicated an operator request for abort, thus typeahead is no longer desired. The control-S and control-Q keys are used by many terminals to temporarily stop and restart output to a terminal device, thus they should be processed immediately.

3.2 COLD BOOTING THE SYSTEM

The BULLET cold boot process is implemented as follows: The hardware and boot PROM on the BULLET selects the physical unit 0 and issues a restore command to the drive. When the restore command terminates, the PROM issues a command to read sector 1. Once the controller starts to read sector 1, the PROM reads bytes into memory starting at location 0 until the entire sector has been read. During this time, the actual physical sector size is of no consequence. Upon completion of a sucessful read of this sector, the PROM transfers control to the program in the sector just read into RAM.

Since the physical size of the sector just read in may vary from 128 to 1024 bytes in size, the code to be executed during the next phase of the cold boot process is restricted to 128 bytes. This 128 bytes consists of a program which reads in the remainder of the sectors on the operating system tracks, and data which describes the format of the diskette. This data consists of a copy of the disk parameter block (DPB) which was used when the COPYSYS utility created the system tracks on the diskette. This DPB includes most of the Wave Mate extensions to the DPB. There are 21 bytes of the extended DPB located in the last 21 bytes of the 128-byte record read into location 0 during the cold boot. This DPB is also accessed by the loader to determine the disk characteristics of the drive for further load operations.

The loader program begins with the next 128-byte record and is loaded into the physical memory address starting at 100 hexadecimal. This is accomplished independently of the size of the physical sectors by re-reading physical sector 1 starting at the memory address of 80 hexadecimal.

By placing the DPB in a standard location in the first 128-byte record, the code executed by the loader is independent of the physical format of the diskette. This allows the COPYSYS utility to copy the loader to different disk formats. The COPYSYS utility has been modified to place a copy of the DPB for the target drive into the first record of the diskette. This procedure eliminates the need to generate a myriad of loaders, each one dependent upon a specific disk organization.

After the remaining sectors on the system tracks are read into memory, control is passed to the loader program at 100 hexadecimal. The disk directory is then searched for the data file named CONBAUD.SYS, which contains the initialization data for the console. The source for this file is included on the system release diskette and may be edited and reassembled using the MAC assembler. The user may do this to change the baud rate or other parameters for the console at boot time. A typical change would be to increase the baud rate from the 9600 baud used for the system release diskette to 19.2K baud.

When the CONBAUD.SYS file is found and the console initialized, the directory is next searched for a file named CPM3.SYS. This file contains the load records for CP/M 3.0 and the C-BIOS. When this file is found, the loader proceeds to load the records into memory. Upon completion of this process, the loader transfers control to CP/M 3.0, the system is initialized, the console command processor is loaded, and the system is ready for user input.

3.3 SYSTEM GENERATION

All the data and utilities required to create a new CPM3.SYS file are present on the system release diskette. The most common reason to change CPM3.SYS is to modify, add, or delete logical disk drives in the system. The Wave Mate C-BIOS for CP/M 3.0 has been written in the modular manner discussed in the DRI documentation. In addition to the modules mentioned in the DRI manual, there is an additional module named CLOCK in the Wave Mate implementation.

The user will note that several of the modules have been recoded using the Zilog Z80 mnemonics instead of Intel 8080. The module most likely to be changed, the DRVTBL, is in a form which may be assembled using the RMAC assembler on the system release diskette. If the user needs to change the modules containing Z80 mnemonics; they may be assembled using the Microsoft M80 assembler, they may be edited to allow use of the Z80 macros with RMAC, or they may be assembled using the Cromemco assembler. Also included on the system release disk is a SUBMIT file named GENCBIOS.SUB. This file contains the following command line which is used to link all the modules of the C-BIOS together prior to executing GENCPM:

```
LINK BNKBIOS3[B]=BIOSKRNL,BOOT,CHARIO,DRVTBL,SCB,FDDRV,MOVE,CLOCK
```

The sources to the floppy disk driver and the clock module are not included on the system release diskette. These modules contain code which is proprietary to Wave Mate. Although the floppy disk driver is not provided in source format, the user may change virtually any parameter associated with the floppy disk drive by changing the parameters in the DRVTBL module. The floppy disk driver uses the 16K bytes of memory in physical bank 1 from C000 - FFFF hexadecimal for disk track buffering. This memory is divided into track buffers based upon the largest disk drive logged in. For example, if only mini floppies with five sectors of 1024 bytes each are utilized, there will be three track buffers of 5K each allocated. If 8-inch drives are logged on with 26 sectors of 256 bytes each, there will be two track buffers of 6.5K each allocated.

The DRVTBL module has been extended to provide additional parameters for the Wave Mate floppy disk driver. These parameters have been added to the disk parameter block (DPB) as follows:

NAME	SIZE	USE
SPT	word	As defined in DRI documentation
BSH	byte	As defined in DRI documentation
BLS	byte	As defined in DRI documentation
EXM	byte	As defined in DRI documentation
DSM	word	As defined in DRI documentation
DRM	word	As defined in DRI documentation
AL0	byte	As defined in DRI documentation
AL1	byte	As defined in DRI documentation
CKS	word	As defined in DRI documentation
OFF	word	As defined in DRI documentation
PSH	byte	As defined in DRI documentation
PHM	byte	As defined in DRI documentation
DEN	byte	Boolean flag, single/double density
SIDE	byte	Boolean flag, single/double sided
RPS	byte	Number of 128 byte records/physical sector
SRAT	byte	Bits 0 and 1 of disk controller step rate code
WPTRK	byte	Track number to enable write precompensation
RTO	byte	Read track time-out value in 1/10 seconds
WTO	byte	Write track time-out value in 1/10 seconds

The Wave Mate extensions to the DPB are further described, as follows:

DEN — This boolean flag instructs the disk driver as to whether the diskette is recorded in single or double density. If it is 00, the diskette is defined as single density. If it is FF, the diskette is defined as double density.

SIDE — This boolean flag instructs the disk driver as to whether the diskette is recorded as single or double sided. If it is 00, the diskette is defined as single sided. If it is FF, the diskette is defined as double sided.

RPS — This value is the number of 128-byte records per physical sector. It is computed by dividing the physical sector size by 128. For a 256-byte physical sector, it would be 2.

SRAT — Bits 1 and 0 of this field define the step rate to be used for disk commands which position the read/write heads. The step rate depends upon whether the disk is 5-inch or 8-inch, according to the following table:

Five-inch drives:		Eight-inch drives:	
bits	rate	bits	rate
00	6 MS	00	3 MS
01	12 MS	01	6 MS
10	20 MS	10	10 MS
11	30 MS	11	15 MS

WPRTK — This field selects the physical cylinder number at which write precompensation is to be en-

abled. The recommended value is 0, which will enable write precompensation over the entire disk.

RTO This field is the read track buffer time-out constant in tenths of a second. On the system release diskette, the value is 22 decimal: 2.2 seconds after the last read activity on the track, the data is discarded. This time is nominal and will depend upon other disk activity. If this field is set to 0, there is no time-out of the data.

WTO This field is the write track buffer time-out constant in tenths of a second. On the system release diskette, the value is 15 decimal: 1.5 seconds after the last write activity to the track, the modified sectors in the track buffer are flushed to disk. This time is nominal and depends upon other disk activity. If this field is set to 0, there is no time-out of the data.

Note that the organization of the Wave Mate BULLET floppy disk driver contemplates that the physical sector size defined in the DPB is always 128 bytes, regardless of the actual physical sector size. This provides for the disk driver to perform all the blocking and deblocking. Since floppy disk I/O is track oriented, the blocking/deblocking overhead is eliminated. Thus for a disk having 1024-byte physical sectors, the PSH and PHM fields are zero and the RPS field contains 8. In generating the DPB, the user need not be concerned with these particulars since the DSKDEF.LIB file contains macros which will construct the DPB given a minimum of parameters. Prior to creating a new DRVTBL module, the user should carefully study and understand the module provided on the release diskette to ensure correct alteration of the parameters affecting the DPBs.

3.4 REGISTER USAGE

Since CP/M 3 is an 8080 based operating system, the user may expect the 8080 register subset of the Z80 in the BULLET to be affected as described in the DRI documentation during BDOS or BIOS calls. To provide additional application program flexibility, the C-BIOS does not alter the contents of the IX or IY registers, thus the application does not need to save them.

Although the C-BIOS does not presently use any of the alternate registers, users should consider them as reserved for future C-BIOS enhancements. Accordingly, application programs should either refrain from using these registers or save them prior to any BDOS or C-BIOS calls.

APPENDIX A

FILES PROVIDED ON SYSTEM RELEASE DISKETTE

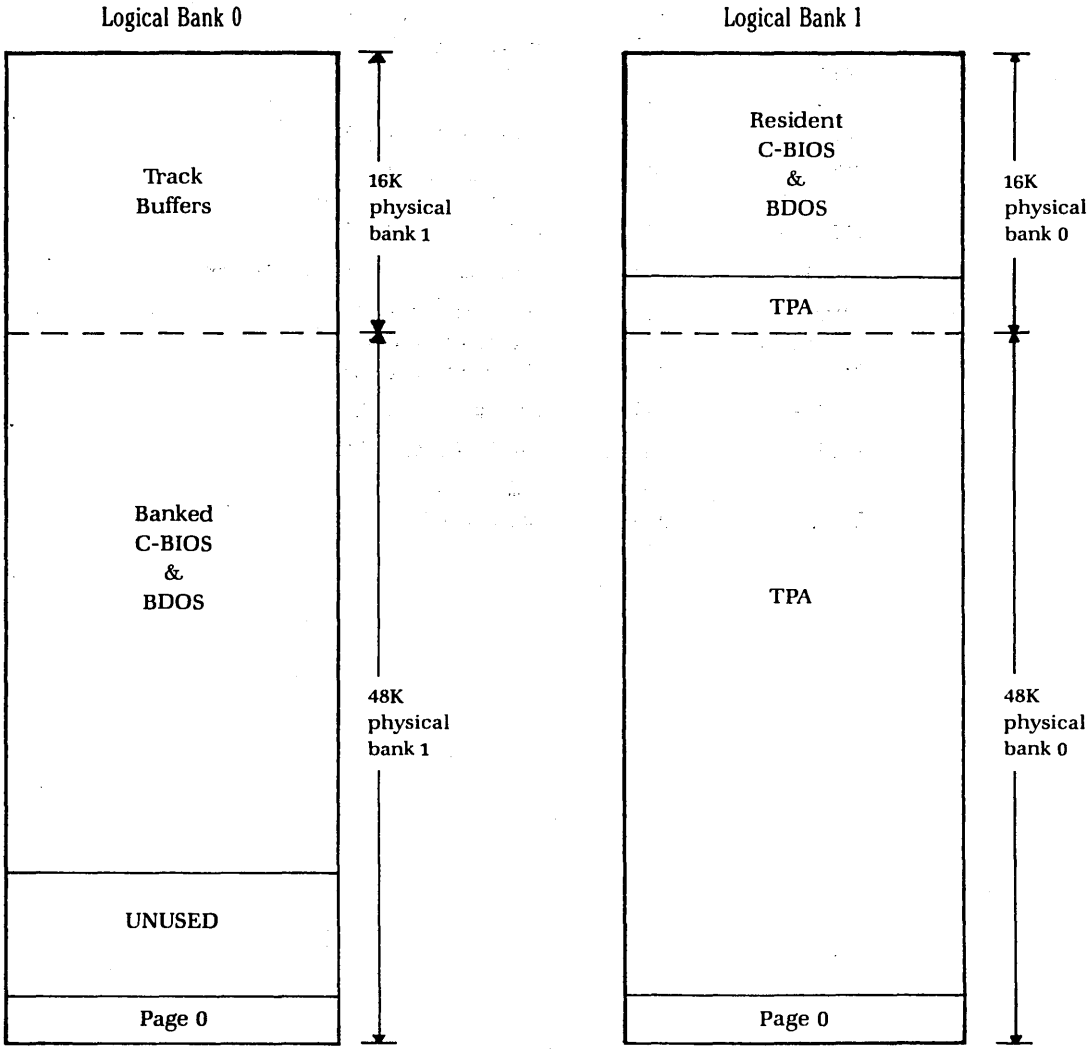
CCP	.COM	Console command processor
COPYSYS	.COM	Utility to create a new boot disk
DATE	.COM	Utility to set system date & time
DEVICE	.COM	Utility to assign logical devices
DIR	.COM	Utility to display disk directories
DUMP	.COM	Demo utility to dump disk files
ED	.COM	Text editing utility
ERASE	.COM	Utility to remove disk files
FORMAT	.COM	Utility to format new diskettes
GENCOM	.COM	Utility to create RSX modules
GENCPM	.COM	Utility to generate a new CPM3.SYS
GET	.COM	I/O redirection module
HELP	.COM	Utility to get help information
HEXCOM	.COM	Utility to create com files from hex
INITDIR	.COM	Utility to enable directory date stamps
LIB	.COM	Utility to maintain library modules
LINK	.COM	Utility to link relocatable modules
MAC	.COM	Macro assembler for 8080 code
MEMTEST	.COM	Memory system test diagnostic
PATCH	.COM	Utility to apply patches
PIP	.COM	File transfer utility
PUT	.COM	I/O redirection module
RENAME	.COM	Utility to rename disk files
RMAC	.COM	Relocatable macro assembler
SAVE	.COM	Utility to save core image
SET	.COM	Utility to set passwords, etc.
SETDEF	.COM	Utility to define drive search path
SHOW	.COM	Utility to display disk parameters
SID	.COM	Debug utility for 8080 code
SUBMIT	.COM	Utility to run batch jobs
TYPE	.COM	Utility to display text file on console
XREF	.COM	Utility to cross reference assembly code
CONBAUD	.SYS	Data for console baud rate
CPM3	.SYS	CP V3.0 operating system
CONBAUD	.012	Data for 1200 baud system console
CONBAUD	.048	Data for 4800 baud system console
CONBAUD	.096	Data for 9600 baud system console
CONBAUD	.192	Data for 19200 baud system console
CONBAUD	.384	Data for 38400 baud system console
CALLVERS	.ASM	Source program for demo RSX module
CONBAUD	.ASM	Source data for CONBAUD.SYS
DRVTBL	.ASM	Source data for DRVTBL.REL
DUMP	.ASM	Source program for demo DUMP.COM
ECHOVERS	.ASM	Source program for demo RSX module
RANDOM	.ASM	Source program for random I/O demo
SCB	.ASM	Source data for SCB.REL

BIOSKRNL	.Z80	Source module for BIOSKRNL.REL
BOOT	.Z80	Source module for BOOT.REL
CHARIO	.Z80	Source module for CHARIO.REL
IOEQUS	.Z80	Equates for WAVE MATE C-BIOS
MOVE	.Z80	Source module for MOVE.REL
BIOSKRNL	.REL	Module for C-BNKBIOS
BOOT	.REL	Module for C-BNKBIOS
CHARIO	.REL	Module for C-BNKBIOS
CLOCK	.REL	Module for C-BNKBIOS
CPMLDR	.REL	Module for cold loader
DRVTBL	.REL	Module for C-BNKBIOS
FDDRV	.REL	Module for C-BNKBIOS
MOVE	.REL	Module for C-BNKBIOS
SCB	.REL	Module for C-BNKBIOS
BNKBDOS3	.SPR	BDOS module in SPR format
BNKBIOS3	.SPR	C-BIOS module in SPR format
RESBDOS3	.SPR	BDOS module in SPR format
GENCBIOS	.SUB	Submit file to generate BNKBIOS3.SPR
DISKDEF	.LIB	Macros for DRVTBL.ASM
MODEBAUD	.LIB	Equates for baud rates
Z80	.LIB	Macros for Z80 opcodes
GENCPM	.DAT	Data file for GENCPM
HELP	.HLP	Data file for HELP.COM
HIST	.UTL	Utility for SID
TRACE	.UTL	Utility for SID

APPENDIX B

WAVE MATE BULLET MEMORY MAP

CP/M 3.0
Memory Map



APPENDIX C

DISKETTE FORMATS USED BY FORMAT UTILITY

IBM 3740 FORMAT (SINGLE DENSITY)

	NUMBER OF BYTES	HEX	VALUE DESCRIPTION
Header:	40	FF	
	6	00	
	1	FC	Index mark
	26	FF	
Each sector:	6	00	
	1	FE	ID address mark
	1		Track Number (0 to nn)
	1		Side Number (00 or 01)
	1		Sector Number (1 to nn)
	1	00	Size = 128 bytes/sector
	2		Header CRC bytes
	11	FF	
	6	00	
	1	FB	DATA address mark
	128	E5	Data field
	2		Data CRC bytes
	27	FF	
End of track:	247	FF	End of track fill

IBM SYSTEM 34 FORMAT (DOUBLE DENSITY)

	NUMBER OF BYTES	HEX	VALUE AND DESCRIPTION
Header:	80	4E	
	12	00	
	3	C2	
	1	FC	Index mark
	50	4E	
Each sector:	12	00	
	3	A1	
	1	FE	ID address mark
	1		Track Number (0 to nn)
	1		Side Number (00 or 01)
	1		Sector Number (1 to nn)
	1	01	Size = 256 bytes/sector
	2		Header CRC bytes
	22	4E	
	12	00	
	3	A1	
	1	FB	DATA address mark
	256	E5	Data field
	2		Data CRC bytes
	54	4E	
End of track:	598	4E	End of track fill