

SAGE CP/M-68K

Stride Micro

May 1984

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Introduction to Sage CP/M-68K

Digital Research Inc., and has been available on smaller microcomputers for many years. CP/M-68K is the version of CP/M that runs on the Motorola MC68000 family of microprocessors. It is a high performance, single-user operating system, with these major features:

- CP/M-80 and CP/M-86 file compatibility.
- Supports from 64 kilobytes to 16 megabytes of RAM memory.
- Any amount of RAM memory may be configured as RAM disk.
- Supports from 1 to 16 disk drives.
- Each disk drive may contain up to 512 megabytes with a maximum of 1024 directory entries.
- The C language.
- Sophisticated software development tools.
- Standard CP/M utilities.
- Multiple programs can co-exist in RAM.
- Full access to MC68000 hardware features is allowed.

Included with CP/M-68K is a C compiler and run-time library that are subset compatible with Unix™ version 7. This provides a bridge from Unix to CP/M-68K. C programs which were developed under the Unix operating system can easily be ported to CP/M-68K.

Compilers available for CP/M-68K include FORTRAN-77, Pascal and Basic-Plus from Silicon Valley Software, CB68K from Digital Research (compatible with CB80), and Whitesmith's C compiler. Also available is APL.68000 from The Computer Company.

Manual Organization

This manual tells you everything you need to know to bring up and use CP/M-68K on the SAGE II and SAGE IV computers. The features and utilities that SAGE has added are fully described, along with the differences between the way SAGE has implemented CP/M-68K, and the way that the

*Introduction to Sage CP/M-68K
Manual Organization*

Digital Research CP/M-68K manuals describe the implementation.

To get started, you should read Section II, "Installation of CP/M-68K". It explains how to boot CP/M-68K, and how to make backup copies of your CP/M distribution disks. If you are a new SAGE owner, you should read the detailed instructions in the SAGE GETTING STARTED MANUAL to find out how to unpack your computer, connect your terminal and power cables, and get ready to power up.

Section III describes the SAGE4UTL utility program. This very important program allows you to format floppy diskettes, copy bootstrap loader programs, prepare Winchester disk drives for shipping, and reconfigure CP/M-68K to your tastes.

Section IV describes the CP/M-68K utility programs that SAGE has provided, except for SAGE4UTL and WFORMAT.

If you are the owner of a SAGE IV with a Winchester hard disk drive, Section V tells you how to get CP/M-68K loaded onto the Winchester, and how to set things up so that you can boot from the Winchester. This chapter also describes the WFORMAT program.

Section VI tells you how to bring up CP/M-68K in a Multi-user environment.

Section VII describes the SAGESUBS.LIB library, which provides some useful SAGE-dependent C functions.

Section VIII provides some general information on the SAGE implementation of CP/M-68K, and on the facilities available to you. You should read this chapter before attempting to reconfigure CP/M-68K.

Appendix A lists the differences between this release of CP/M-68K and previous releases.

Appendix B lists the bugs in CP/M-68K that SAGE has found.

Appendix C tells you how to reassemble and link the SAGE BIOS Interface and the bootstraps. If you should wish to modify these files, you must have this information.

Notation The notation `^ <character>` means that the `<character>` is to be typed as a control character, that is, with the CONTROL key held down while simultaneously typing the specified character. For example, the notation `^C` means that you should hold the

CONTROL key down while typing the letter C.

The other common abbreviation used in this manual is <cr>, which directs you to press the Carriage Return key, usually marked RETURN or ENTER.

INTRODUCTION

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SAGE CP/M-88K May 1984.

Section 2

Installation of CP/M-68K

sections I through V of the SAGE GETTING STARTED MANUAL. These sections tell you how to unpack your computer, connect your terminal and get ready to power up your computer.

The act of inserting a diskette into your computer and making CP/M-68K operational is called "booting". The term comes from the expression "pulled up by your bootstraps". When you turn on your computer, a small program called the "bootstrap" is loaded from the floppy diskette. This bootstrap program then loads the CP/M-68K operating system from the diskette.

Before powering up your computer, make sure that both switch Sw5 and switch Sw6 of GROUP-A are in the down position. This will cause your computer to boot to the SAGE Debugging Tool when you turn on the power. Now, turn on the power to your computer. Your terminal screen will display the following:

```
SAGE IV Startup Test [2.x]
Copyright SAGE Computer 1983
RAM Size = xxxxK"
>
```

CP/M-68K is provided on four floppy diskettes, labelled A, B, C and UTILITY. The diskettes contain the following files:

This diskette contains the first half of the original CP/M-68K distribution files in alphabetical order. Files starting with the letters A through C are on this diskette.

This diskette contains the second half of the original distribution files. Files starting with the letters C through Z are on this diskette.

This is a bootable diskette containing several SAGE utilities and relocated versions of most of the CP/M-68K utility programs.

Installation of CP/M-68K

This disk contains additional SAGE utilities. Sections V through VIII describe the contents of this diskette in detail.

The C diskette is "bootable", meaning that it is the one that you place in your left-hand floppy diskette drive (#4) to bring CP/M-68K up. Place the C diskette into your left-hand (or upper) floppy drive. The floppy should be inserted label-side up. After inserting the diskette, type the following command:

```
IF <cr>
```

This tells your computer that you want to initialize or boot CP/M-68K from the floppy diskette. If all goes well, the following lines will be displayed on your terminal screen:

```
SAGE CP/M-68K Bootstrap v2.0  
  
SAGE CP/M-68K v1.1   xxxK TPA  
  
A>STARTUP  
  
A>  
A>   Welcome to SAGE CP/M-68K!  
A>  
  
A>SETENV TERM DUMB  
  
A>SETENV PATH |A0:  
  
A>
```

If the message "Not BOOT Disk" is displayed instead, you either have the diskette in the drive incorrectly, or you did not insert the correct diskette. Review the SAGE GETTING STARTED MANUAL to find out what you did wrong. If any other problems occur, contact your dealer or SAGE Computer for help.

You have now booted CP/M-68K for the first time on your SAGE computer.

Before doing anything else, you must create backup copies of your four CP/M-68K diskettes.

If you have a SAGE IV, there is some additional configuration that you must do before you can use the Winchester disk. This configuration is described in

Section V of this manual.

Backing Up CP/M-68K Diskettes

The very first thing that you should do after booting CP/M-68K for the first time is to make at least two backup copies of each of your four CP/M-68K diskettes. These diskettes are write-protected and cannot be modified. You should back up the diskettes BEFORE you change any configuration options.

Below are the steps involved in backing up your diskettes:

1. You must format some blank diskettes for your drives. The disk format defines how the data is stored on the diskette. It is slightly different for different disk drives and computer systems. For example, diskettes on the SAGE IV can be formatted for either 40 track or 80 track drives. Brand new diskettes must always be formatted for your drives.
2. Next, you must copy all of the files on the original diskette to the newly formatted diskette.
3. Next, you must check the new diskettes to make sure that they work.
4. Finally, you must store the original diskettes and at least one backup copy in a safe place away from extremes of temperature, dust and stray magnetic fields.
5. After making two backups of each disk, you should keep the original CP/M-68K disks and one of the backup copies in a safe place. You can use the second backup set as a work copy. If you need more safety, you can make additional backup copies.

INSTALLATION

Formatting a Diskette

Every brand new diskette must be formatted before you can use it. This only needs to be done once for a new disk. Formatting a disk a second time will destroy any data previously recorded on the disk. To format a disk, you must use the SAGE4UTL program, which is on the bootable CP/M-68K disk, disk C.

If you have two floppy diskette drives, you can keep your system disk C in the left-hand (#4) (or upper) drive, and put the diskette that you want to format in the right-hand (#5) (or lower) drive. If you have only one drive, you must

*Installation of CP/M-68K
Formatting a Diskette*

remove diskette C from the drive after you have loaded SAGE4UTL, and replace it with the diskette that you want to format.

Following is the dialog you will go through to format a disk. Your screen should now look as follows:

A>.....

SAGE4UTL<cr>

(At this point, you may remove diskette C from your left-hand drive, if you desire.)

Select Menu option <CR to exit>:.....

C

Format the Left or Right drive (L or R)?..

R

or, if diskette is in the left drive then

L

(At this point, you should place your blank diskette in the left-hand or right-hand drive.)

Ready to format disk in LEFT drive?.....

Y

The computer will then print the following pattern on the screen while it is formatting your diskette:

Installation of CP/M-68K

Copying a Diskette

If you have two floppy diskette drives on your computer, press the Y key. Press N if you only have one floppy drive. Next, FCOPY will print the following:

```
Insert diskette to copy in LEFT drive and press any key:
```

Insert the diskette that you want to back up, and press any key on the keyboard. If you have only a single floppy drive, FCOPY will then begin the copy. If you have two drives, FCOPY will print this message:

```
Insert the blank diskette in RIGHT drive and press any key:
```

Insert your blank diskette, and press any key. FCOPY will then begin the copy.

If you have one diskette drive, FCOPY will ask you to swap diskettes after it has copied about 32 tracks.

The Startup File

CP/M-68K has the ability to execute several commands automatically whenever you boot up. As distributed, CP/M is configured to execute the script file STARTUP.SUB. Typically, commands to initialize RAM disk and set the type of terminal you are using are placed in the startup file. Below is the startup file distributed with CP/M-68K, with comments describing the purpose of the commands:

```
setenv TERM dumb (sets the type of terminal)
setenv PATH |a0: (tells where the terminal description file is)
:
: Welcome to CP/M-68K
:
```

To initialize RAM disk, you can place the following line in your startup file:

```
INIT E:
```

If you have configured RAM disk to be a drive besides E:, you must change the E: in the INIT command.

Terminal Type Configuration

Now that you have made backup copies of your distribution diskettes, you are ready to tell CP/M what kind of terminal you have. This step is optional, but many of the SAGE utilities will work better if they know what kind of terminal you are working with.

The terminal type is set by editing the STARTUP.SUB startup command file. The first line in the file as distributed is:

```
setenv TERM dumb
```

This says that you are using a dumb terminal, with no special features. You must change the 'dumb' into the type of terminal you are using. The file TERMCAP contains descriptions for all of the terminals known to CP/M. On the next page is a list of common terminals in TERMCAP:

There are many others — see the file TERMCAP for a complete list. If you don't find your terminal in TERMCAP, it is possible to add a new type.

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Configuring CP/M-68K with Sage4utl

SAGE4UTL is a utility program provided by SAGE for CP/M-68K, for both SAGE II and SAGE IV computers. It allows you to redefine system parameters for the various devices: terminal, printer, disks, etc. Most of the parameters will rarely need to be changed. Changing the floppy format to read diskettes written on other computer systems is a frequent use. Changing the serial port characteristics, such as baud rate, is another common use.

SAGE4UTL also provides facilities to format floppy diskettes and copy bootstrap programs. For those of you who have a Winchester disk, SAGE4UTL can move the heads of your disk to a parking track, allowing you to move your computer without endangering the data on the Winchester disk.

The CP/M-68K version of SAGE4UTL is almost identical to the version found on the Pascal p-System. The major difference is that there are some options specific to CP/M-68K.

SAGE4UTL runs under both Single-User and Multi-User CP/M-68K. However, under Multi-User, many on-line changes may not be allowed. The changes that are allowed depend on your user capabilities; if you are configured as a system manager, you can change almost anything. Other users can only change the configuration of devices that belong to them.

CONFIG. 68K
WITH SAGE4UL

Running Sage4utl

SAGE4UTL is executed by typing its name at the CP/M-68K prompt:

```
SAGE4UTL <cr>
```

After a few moments, your terminal screen will display the following, which is the top-level menu:

```
SAGE4UTL Configuration Utility version 2

A - On-line Configuration
B - BIOS File Configuration
C - Floppy Formatter
D - Bootstrap Copy
E - Prepare Drives for Shipping

Select Menu option <CR to exit, I to leave>:
```

If you have a SAGE II (no Winchester disk), option E (Prepare Drives for Shipping) will not be displayed.

SAGE4UTL has many menus. The menus are organized in a tree structure; where there are certain options which take you down a level in the tree, to another menu. Selecting options from a menu is done by pressing the corresponding letter. Either upper or lower case may be used, and no <cr> carriage return is required after the letter. Pressing carriage return causes you to return to the menu the next level higher in the tree. In other words, <cr> causes you to retrace the path you took to get to a menu.

Any time SAGE4UTL is asking you to select a menu item, you may press the exclamation point (!). This takes you instantly back to the top-level menu. If you have made any changes, you will be asked if you want to keep the changes before you are returned to the top-level menu.

On-Line Configuration

Top-level option 'A' allows you to make on-line changes to the CP/M-68K configuration. These changes take effect as soon as you leave SAGE4UTL, but they will be gone the next time you reboot CP/M-68K. Also, a few changes are either not allowed or have no effect when made on-line. This option is most useful for changing device characteristics, such as baud rate and parity. The next section describes all of the configuration options available.

After you have made your changes, SAGE4UTL will ask:

```
Make online changes?
```

Pressing the letter Y will cause the changes to take effect, and pressing N will discard your changes and let you start over again.

Any on-line changes to the terminal configuration are double-checked by SAGE4UTL. This is because changes are applied immediately, and may garble the following terminal output until the corresponding changes are made to the actual terminal.

Bios File Configuration

Top-level option 'B' allows you to make permanent changes to the CP/M-68K configuration. These changes will not take effect until you reboot CP/M-68K. The BIOS file contains the program that interfaces CP/M-68K to the input and output devices on the SAGE computer. It is loaded into memory every time you boot CP/M-68K.

After selecting option B, you will be asked for the name of the BIOS file to configure, with the following prompt:

```
Enter BIOS filename:
```

The normal name of the BIOS file is SAGEBIOS.SYS. If the BIOS file is not on the current disk, you can put a disk letter at the front of the filename. For example, you can specify the BIOS file on drive A: as A:SAGEBIOS.SYS.

After you type the file name in, SAGE4UTL will try to find the file on the disk. If the file is found, the following message will appear:

```
BIOS version x.y header read successfully.  
size including buffers: xxx bytes.  
  
Press <space> to continue:
```

Pressing the space bar will put the top-level configuration menu on the screen. See 'Configuration' below for the full details. Do not make file changes to your master diskettes.

CONFIG. 68K
WITH SAGE4UL

Floppy Formatter

Top-level option 'C' allows you to format floppy diskettes. Brand new floppies must be formatted before they may be used. Once a floppy is formatted, however, you should never have to format it again.

WARNING Formatting a floppy diskette will destroy any information already recorded on it.

After selecting option C, the screen will clear and you will be asked if you want to format the left-hand floppy or the right-hand floppy. If the floppy drives on your computer are mounted vertically instead of horizontally, the left-hand drive is the top one. This is the message that you will see:

```
Do you want to format the Left or Right drive (L or R)?
```

You specify the left-hand floppy by pressing the letter L, or the right-hand floppy by pressing the letter R. Next, you will see this on the screen:

```
<type of floppy is displayed here>
```

```
Are you ready to format the diskette in the <LEFT or RIGHT> drive?
```

Pressing the letter Y will start the format, and pressing N will allow you to change your mind and not format anything. You should make sure that the correct diskette is in the correct drive. Just to be safe, it is a good idea to remove your system diskette from the computer before starting the format. Be sure to put it back in when the format is done!

While the diskette is being formatted, a single dot is printed on the screen for every track that is formatted. After the diskette is formatted, every track will be verified by reading it back. This ensures that the format operation was successful. As an example, this is what will appear on the screen during a format of a standard SAGE 8-sector, 80 cylinder (160 track) diskette:

Formatting...

Verifying...

After the diskette has been formatted, the following message will appear:

Do you have more diskettes to format?

Pressing the letter Y will allow you to format another diskette. Pressing N will take you back to the main SAGE4UTL menu.

It is important not to abort SAGE4UTL (by typing Control-C) while a floppy is being formatted. This is because SAGE4UTL changes your logical channel map while it is formatting the floppy. If you abort SAGE4UTL in the middle of a format, it is possible that the floppy drive will be mapped to the wrong channel, causing a crash of CP/M-68K.

Problems that may occur while formatting are usually problems with the floppy diskette itself. Here are some problems that you may encounter:

1. You cannot format a diskette that is "write protected". Check to see if a small tab is stuck over a notch in the side of the diskette. This generally (but not always) means that the disk is write-protected. Remove the label if you are sure that you want to destroy information that is on the diskette.
2. The diskette itself may be damaged. Check for obvious scratches, dirt or other indications that the diskette is defective. Sometimes even brand new diskettes will not format.
3. If none of the diskettes in a box will format, you may have purchased the wrong kind of diskettes. Diskettes used by SAGE computers should be labelled Double Sided, Double Density, Soft Sectored, 96/100 TPI.
4. Another common problem is that you have not seated the diskette properly in the drive. The latch should make a clear, crisp sound as it closes. If it doesn't, open the drive and reseat the diskette.

CONFIG. 68K
WITH SAGE4UL

Bootstrap Copy

Top-level option 'D' allows you to copy the CP/M-68K bootstrap program to a floppy diskette or a Winchester disk. This must be done for a new diskette, or for the Winchester disk, before you can boot from the disk. The CP/M-68K bootstrap program is stored on blocks 0 through 4 on a disk. Since this area is normally not accessible to CP/M-68K because it is part of the CP/M reserved tracks, a special procedure is required.

The same bootstrap program is used for both floppies and Winchester disks. There is, however, a separate bootstrap for Multi-User CP/M-68K. The distribution diskette contains both bootstraps, named BOOT.SYS and MUBOOT.SYS respectively.

When you select option C, the following question will be asked:

Source file or drive <just CR quits>:

SAGE4UTL must know where to find the bootstrap program. You can either read the bootstrap from blocks 0 through 4 of an already bootable disk, or you can read it from a file (normally BOOT.SYS or MUBOOT.SYS). To read the bootstrap from a bootable disk, just supply the disk letter. For example, if you entered 'A:' the bootstrap would be read from drive A:.

After the bootstrap has been successfully read, you will be asked:

Destination file or drive <just CR quits>:

Again, you can enter either a disk letter, or a filename. Normally, you will supply a disk letter (be sure it's followed by a colon), but you can create a new bootstrap file by supplying a filename.

After you have written the bootstrap to a disk, you can then boot from the disk. For a successful boot under Single-User, the disk must also have the files SAGEBIOS.SYS and CPM.SYS. Multi-User requires only CPM.SYS.

Prepare Drives for Shipping

Whenever you move your SAGE IV computer, the heads of the Winchester disk drives should be moved to a track beyond the normal recording area of the disk. This "shipping track" is specified in the low-level Winchester Information (described later). This protects the data surface while you are moving or shipping your computer. Once the heads are positioned over the shipping track, no further accesses to the drives should be made. Power down the system when SAGE4UTL tells you it is safe to do so.

The SAGE 40 megabyte Winchester disk automatically parks the heads of the disk when the power is turned off. Because of this, it is not necessary to use this option before shutting down your computer.

The following messages will appear when you select top-level option E:

```
Drive 0 positioned for shipping.  
Drive 1 positioned for shipping.  
  
.  
.  
.  
  
Ready to power system down.  
  
Press the space bar to continue:
```

The option to continue is provided in case option E is selected accidentally. You should not press the space bar before turning off the power to your computer. The drives should be prepared for shipping any time the system is moved. To be safe, you should also prepare the drives for shipping every time you power your system down.

Configuration

The configuration control manager is entered from either the On-line Configuration option or the BIOS File option. A menu will appear, offering you several options:

CONFIG. 68K
WITH SAGE4UL

Configuring CP/M-68K with Sage4utl Configuration

```
On-line Configuration Control

A - Terminal
B - Remote Channel
C - Left Floppy
D - Right Floppy
E - RAM Disk
F - Printer
G - Extra Serial Port #1
H - Extra Serial Port #2
I - Extra Serial Port #3
J - Extra Serial Port #4
K - Parallel Port
L - CP/M Disk Drive Configuration
M - Low Level Configuration
```

This is the top-level configuration menu. Normally, you will be most interested in options A through K, as these options control the physical characteristics of the various SAGE devices. Option L, Low Level Configuration, allows you to alter some low-level characteristics of the floppies and Winchester disks, and configure the CP/M-68K specific information.

In many of the menus that follow, an asterisk will be found after one of the menu options. The asterisk (*) shows you which of the possible options is currently active.

Option A: Terminal Configuration

The Terminal Configuration option lets you alter the configuration of the console terminal. The Terminal Configuration Control menu appears when you select this option:

```
Terminal Configuration Control

A - Terminal baud rate          DIP Switch
B - Terminal parity            DIP Switch
C - Terminal stop bits         1 stop bit
D - Terminal data bits         8 data bits
E - BIOS Xon/Xoff handling     Off
F - BREAK to debugger          Off
```

Option 'A' allows you to set the baud rate of the terminal. The following menu appears when you select this option:

Baud Rate Selection	
A	19200 baud
B	9600 baud
C	4800 baud
D	2400 baud
E	2000 baud
F	1800 baud
G	1200 baud
H	600 baud
I	300 baud
J	200 baud
K	150 baud
L	110 baud
M	75 baud
N	50 baud
O	DIP Switch *

You can select the appropriate baud rate by pressing its corresponding letter. The asterisk shows you the current setting.

The DIP Switch setting for options A and B means that the terminal baud rate and parity is automatically set from the setting of the GROUP A switches on the back of the computer. Refer to section II.04, "DiP Switch Settings", in the SAGE GETTING STARTED MANUAL. The DIP Switch option is recommended by SAGE.

Option 'B' lets you set the parity of the terminal. This is the menu you get:
(The asterisk marks the current selection.)

Parity Selection	
A	Even parity
B	Odd parity
C	Disabled parity
D	DIP Switch *

If the baud rate setting (option A) is DIP switch, then the parity setting must also be DIP switch. SAGE4UTL will not let you set the parity if the terminal baud rate is set to DIP switch. The DIP Switch option is recommended by SAGE.

Option 'C' allows you to set the number of stop bits for each byte transmitted over the terminal cable. You get this menu when you select C:

CONFIG. 68K
WITH SAGE4UL

Configuring CP/M-68K with Sage4utl Configuration

Stop Bit Selection

A - 1 stop bit •
x - 1.5 stop bits
C - 2 stop bits

The usual setting for stop bits is 1. If you are running your terminal at a baud rate less than 300, the usual setting is 2 stop bits.

Option 'D' allows you to set the number of data bits in each byte transmitted. This is the menu you get:

Data Bit Selection

A - 5 data bits
B - 6 data bits
C - 7 data bits
D - 8 data bits •

The number of data bits is almost always 8. This should be changed only for special applications.

Option 'E' lets you set how console output stalling is handled. Under CP/M-68K, console output may be temporarily stalled by typing Control-S (Xoff), and resumed by typing Control-Q (Xon). There are two ways that this is implemented under CP/M-68K: CP/M-68K handles it itself, or the SAGE BIOS handles it at interrupt level. You can specify which method to be used with the SAGE4UTL program.

CP/M-68K Stalling. The default method of stalling output to the terminal is to let CP/M-68K itself handle the stall and resume characters. CP/M-68K constantly checks the keyboard while it is sending data to your terminal. If a Control-S is typed, output to the terminal is stalled by CP/M-68K until you type Control-Q. This has the advantage of letting CP/M-68K decide when to recognise Control-S and Control-Q as stall and resume characters. This is important, because certain text editors (such as Mince) and other programs use Control-S and Control-Q as command characters.

The disadvantage of this method appears when you are running a terminal at less than 19200 or 9600 baud, as you might with Multi-User CP/M-68K. Since characters to be sent to the terminal are stored in a buffer before they are actually sent, CP/M-68K is running ahead of the terminal at slower baud rates. This means that if you type Control-S, up to 256 characters may be

sent before the stalling actually occurs.

BIOS Stalling. This is the optional method of stalling output to the terminal. When using BIOS stalling, CP/M-68K never sees Control-S and Control-Q characters. All stalling of console output is handled at interrupt level by the SAGE BIOS. The advantage of this method is that the stalling always occurs immediately, rather than after the entire terminal output buffer has been transmitted to the terminal. The disadvantage is that Control-S and Control-Q will never be sent to a program, which means that programs such as Mince that use Control-S and Control-Q as command characters will not work properly.

Option 'F' controls whether the BREAK key on your terminal is ignored, or causes a return to the SAGE Debugging Tool. Pressing F toggles the setting between On and Off. If set to Off, the BREAK key is ignored. If you set this option to Off, you can turn off the terminal while your computer is executing a program, without causing the program to be continuously interrupted by the powered down terminal.

If you set the option to On and accidently hit the BREAK key, leaving you in the debugger, you can continue without damage by typing the debugger command GO.

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Option B: Remote Channel

The Remote Channel is configured in much the same manner as the terminal:

Remote Serial Channel Control	
A - Remote baud rate	9600 baud
B - Remote parity	Even parity
C - Remote stop bits	1 stop bit
D - Remote data bits	7 data bits
E - Xon/Xoff for input	Off
F - Xon/Xoff for output	Off
G - DSR polling	On
H - DSR polling interval	16384

The baud rate, parity, stop bits and data bits menus for the Remote channel are nearly identical to the terminal menus, except that there are no DIP switch selections for the Remote channel. Additional settings for the Remote channel are Xon/Xoff for input and output, and DSR polling. These are described below.

Xon/Xoff Protocol. The Xon/Xoff protocol is a method used to keep a computer receiving data over a serial cable from losing data if the incoming data cannot be processed as fast as it comes in. A typical case is when data is being transferred over a serial link to your computer to be stored on a diskette. The data buffer could fill up and overflow while the computer is writing the previously received data to the diskette. This is the Xon/Xoff on input option.

Another example is when the receiving device is a terminal. The user might want to stall output temporarily to allow time to read what is on the screen. Since Xoff is Control-S, you can type Control-S to stall the output to the terminal, and Control-Q (Xon) to resume. This is the Xon/Xoff on output option.

When using the Xon/Xoff protocol on input, your computer (you, in the case of a terminal) will send an Xoff character when the receive buffer is nearly full (240 out of 255 bytes of data). This leaves some room for the transmitting end to respond to the Xoff by stopping transmission. Your computer will then process the characters in the input buffer. When the amount of room available is 1/2 of the buffer (128 bytes), the Xon character is sent to turn on transmission again.

This protocol can only be used when the Xon/Xoff characters are never contained in the data. Thus, this method will not work when transmitting binary data.

The Xon/Xoff protocol may be configured for either direction of transmission, or for both directions for every serial device on the computer except the terminal. CP/M-68K itself handles Xon/Xoff for the terminal.

Data Set Ready Protocol. Sometimes you may want your computer to receive or send binary data over a serial line. Since binary data may contain Xon and Xoff characters, you can't use the Xon/Xoff protocol. In this case, you must use the DSR protocol.

Whenever a character is about to be transmitted over the serial line, the Data Set Ready (DSR) line is checked. If the DSR line is not active, a delay is scheduled before the next text. The delay is controlled by option H, and is the number of 64000ths of a second between checks of the DSR line. When the DSR line is active again, the character is transmitted.

The Data Set Ready line is used instead of the more common Clear To Send line, because of a problem in the hardware serial interface. See section II.12, "Modem Port", in the SAGE TECHNICAL MANUAL for a description of this problem.

DSR protocol is only available on the Remote channel, and not the terminal or Extra serial channels. Protocol is not normally required with the terminal channel, and Clear To Send protocol works properly with the Extra serial channels.

Option C and D: Left and Right Floppy Drives

These options allow you to control the configuration of the floppy drives at a high level. Low level control of the floppy configuration is also available, through the Low Level Configuration menu. The menu described here predefines several of the most commonly used formats. This is the menu that is displayed:

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Right (or Left) Floppy Drive Selection

- A - SAGE double sided, 80 track (640k)
- B - SAGE double sided, 40 track (320k)
- C - IBM single sided, 40 track (160k)
- D - IBM double sided, 40 track (320k)
- E - Network Consulting single sided, 40 track (200k)
- F - Network Consulting double sided, 40 track (400k)
- G - Network Consulting double sided, 80 track (800k)
- H - Softech Universal Medium, single, 35 track (140k)
- I - SAGE double sided, 80 track, 10 sector (800k)
- J - Non-standard drive configuration
- K - No drive equipped

80 track (96 tracks per inch) floppies may only be read on computers equipped with 80 track drives. 40 track (48 tracks per inch) diskettes may be read on 80 track drives, but can't be written.

Note Only SAGE 80 track or 40 track diskette formats may be used to bootstrap CP/M-68K. The SAGE Debugging Tool bootstrap command (IF) does not handle all of the many formats which are configurable with SAGE4UTL.

Option J, Non-standard drive configuration, is for display purposes only and may not be selected with this menu. You have a non-standard drive configuration if you change any of the low level floppy configuration parameters, which are accessed through the Low Level Configuration menu.

Option I, SAGE 10 sector format, provides 160K more storage on a disk, but placing 10 sectors on a diskette is stretching the limits of the floppy disk drives and diskette media. You can select this format, but some computers may not be able to access 10 sectors per track reliably.

Option E: RAM Disk Configuration

RAM disk is a method of using some of your program memory (TPA) as a disk device. This provides extremely fast response, as there is virtually none of the latency associated with rotating disks, such as floppies and Winchester. This option allows you to configure the amount of RAM disk you want. CP/M-68K is shipped with RAM disk disabled.

This is the RAM disk configuration menu:

RAM Disk Configuration Control	
A - TPA size (0 = all free memory)	OK
B - Base of RAM disk (0 = disabled)	OK
C - Top of RAM disk (0 = to BIOS)	OK

You can specify the size of RAM disk in two ways. You can specify the program memory (TPA) size in K bytes, in which case all remaining RAM between the top of the TPA and the RAM disk top address is allocated as RAM disk. Or, you can specify a specific base address at which RAM disk will start. If you specify a specific base address, the TPA size in the menu will be updated to reflect the TPA size that will result from such a base address. Your TPA size should be at least 64K. If it isn't, CP/M-68K will not boot properly.

It is important to keep in mind that the TPA size is an estimate. When CP/M-68K boots, the TPA size that you will actually have will be a few K bytes less than what you have configured. The actual size is displayed by the boot sign on message.

If you specify a RAM disk top address of 0, all memory from the base of the RAM disk to the base of the BIOS will be used for RAM disk. This is the normal setting. You can, however, specify a top address for RAM disk. Specifying a base address of 0 disables RAM disk.

When CP/M-68K boots, the RAM disk is uninitialized. You must run the CP/M program INIT to initialize the RAM disk directory, before storing any files on RAM disk. The best way to do this is to place the INIT command in the STARTUP command file so that it is automatically executed when you boot up.

Before you can access RAM disk, you must associate a CP/M drive with the RAM disk. By default, CP/M drive E: is associated with RAM disk. If you wish, you can change this with option 'L', CP/M Drive Configuration.

Option F: Printer Configuration

This option is used to configure the physical device that the logical printer device is associated with. Here are the possibilities:

(The asterisk to the right marks the current selection)

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Printer Port Assignment	
A	Remote serial channel
B	Parallel port
C	Extra serial channel #1
D	Extra serial channel #2
E	Extra serial channel #3
F	Extra serial channel #4
G	Disable

CP/M-68K allows you to use either the parallel port, the remote serial port, or any of the four extra serial ports (SAGE IV only). The use of each port provides different advantages, as described below. Which port the printer uses is determined with the SAGE4UTL program, main menu, option F, Printer Configuration.

Parallel Port. Using the parallel port provides you with complete hardware handshaking, and allows you to send data to the printer at the fastest possible speed. However, not all printers support a parallel interface, and the length of a parallel cable is limited.

Remote Serial Port. This port allows you to send data to the printer at up to 19200 baud, and a serial cable may be much longer than a parallel cable. Xon/Xoff handshaking is supported. Most serial printers support Xon/Xoff handshaking, but for those that don't, Data Set Ready handshaking is also supported with this port only. Unfortunately, the remote port was designed to connect to Data Communications Equipment, such as a modem, and most serial printers are Data Terminal Equipment. This means that transmit and receive wires in the printer cable (pins 2 and 3) must be reversed.

Extra Serial Ports. If you have a SAGE IV, these ports may be used. These have the same advantages as the remote port, except that Data Set Ready handshaking is not supported, and the transmit and receive wires do NOT need to be reversed.

Option G through J: Extra Serial Channel #1-#4

These options only have meaning on a SAGE IV. You can alter the settings when using a SAGE II, but they will have no effect. The extra serial channel setup menus are much like the terminal and remote channel menus:

Extra Serial Channel #x Configuration Control	
A - Baud rate	19200 baud
B - Parity	Even Parity
C - Stop bits	1 stop bit
D - Data bits	8 data bits
E - Xon/Xoff for input	On
F - Xon/Xoff for output	On

Note 200 baud is not a supported baud rate for the Extra serial channels, even though this baud rate will appear in the baud rate menu.

Option K: Parallel Port

This option controls the protocol of the parallel printer port. There are two protocols supported; interrupt-driven, or scheduled polling. Here is the menu:

Parallel Port Configuration Control	
A - Interrupt (vs Scheduled Polling)	On
B - Polling attempts before delay	500
C - Delay before re-polling	236

Interrupt-driven protocol is preferred, as it involves the lowest overhead. This is especially important under Multi-User, however not all printers operate correctly in an interrupt mode. When the interrupt-driven protocol is used, data to be sent to the parallel port is stored in a buffer. When the port is ready to transmit a byte of data, it will interrupt the computer and fetch a byte from the buffer. While the port is busy, the computer can be performing other tasks.

The Scheduled Polling protocol is used for printers which use the Centronics Parallel Port definition, but rely on the computer polling the Busy signal from the printer to determine when the next transmission is possible. Rather than causing the computer to wait in a tight loop for the Busy signal, the SAGE uses a method called Scheduled Polling. After a character is sent to the printer, the BIOS will poll the Busy line a selected number of times (option B). If the printer has an internal buffer, it will probably be able to receive the next character within a reasonably short time. If the printer is still busy after the specified number of polling cycles, a configurable delay (option C) is scheduled which releases the processor for other work. After each delay interval, the

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processor checks the Busy signal to see if the printer is still busy. In this manner, a normally polled printer will not completely tie up the processor.

Option L: CP/M Disk Drive Configuration

The SAGE implementation of CP/M-68K allows you to configure the characteristics of every drive known to CP/M. The following characteristics may be configured with SAGE4UTL:

The physical device the CP/M drive is associated with. The number of directory entries on the disk drive. The directory track offset. The CP/M allocation block size. Whether the drive is removable or fixed.

This is the menu that you get when you select option L:

```
CP/M Disk Drive Configuration
A - CP/M Drive and Device Association
B - CP/M Drive Parameters
```

Option 'A'. This option lets you assign a CP/M drive (such as A:, G:, etc.) to any SAGE disk device or RAM disk. The following menu appears when you select this option. The menu shows the current configuration of each CP/M drive.

```
CP/M Drive and Device Associations
A - Drive A: LEFT floppy diskette
B - Drive B: RIGHT floppy diskette
C - Drive C: Winchester disk, partition 5
D - Drive D: Winchester disk, partition 6
E - Drive E: RAM disk
F - Drive F: Winchester disk, partition 7
G - Drive G: Not configured
H - Drive H: Not configured
I - Drive I: Not configured
J - Drive J: Not configured
K - Drive K: Not configured
L - Drive L: Not configured
M - Drive M: Not configured
N - Drive N: Not configured
O - Drive O: Not configured
P - Drive P: Not configured
```

Selecting any of the options, A through P, produces the following menu for the corresponding CP/M drive:

```
CP/M Drive and Device Association
A - LEFT floppy diskette
B - RIGHT floppy diskette *
C - RAM disk
D - Winchester disk
E - Disable
```

The asterisk shows you the current assignment for the CP/M drive. Selecting any of the options assigns the CP/M drive to the specified physical device. If you select option D, you will be asked for the Winchester partition number to associate the drive with.

Option 'B'. When this option is selected, the current CP/M parameters for each CP/M drive is displayed on the screen. Here is the standard drive configuration:

```
A - Drive A: Offset: 2, Entries: 64, Block size: 2048, Removable
B - Drive B: Offset: 2, Entries: 64, Block size: 2048, Removable
C - Drive C: Offset: 1, Entries: 256, Block size: 4096, Fixed
D - Drive D: Offset: 1, Entries: 256, Block size: 4096, Fixed
E - Drive E: Offset: 0, Entries: 128, Block size: 2048, Fixed
F - Drive F: Offset: 1, Entries: 256, Block size: 4096, Fixed
G - Drive G: No device associated
H - Drive H: No device associated
I - Drive I: No device associated
J - Drive J: No device associated
K - Drive K: No device associated
L - Drive L: No device associated
M - Drive M: No device associated
N - Drive N: No device associated
O - Drive O: No device associated
P - Drive P: No device associated
```

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After assigning a CP/M drive to a physical device, you must set the parameters for the device. If you have not yet done this, a configuration line of the following form is displayed for the drive:

```
x - Drive x: CP/M parameters not configured
```

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To configure a drive, simply type its letter when the configuration lines are displayed. The following menu will appear:

CP/M Disk Drive Information	
A - Allocation block size	2048
B - Directory track offset	2
C - Number of directory entries	64
D - Media type	Removable

Option 'A' lets you set the allocation block size in bytes. A menu allowing you to select one of 1024, 2048, 4096, 8192 or 16384 bytes is displayed. The standard value for floppy diskettes and RAM disk is 2048, and the normal value for Winchester disks is 4096. The selection of the allocation block size depends on both the size of the disk in question, and the efficiency of disk accesses. The following table shows the largest disk that may be represented by each allocation block size:

Allocation Size	Maximum Disk Size	Number of 512-byte Blocks
1024	256K	512
2048	64M	131072
4096	128M	262144
8192	256M	524288
16384	512M	1048576

The larger the block size, the more efficient disk accesses will be. However, disks are allocated only in multiples of blocks. Therefore, an entire block will be allocated for even a small file. For example, if your block size is 16384 bytes and you create a file with 5 bytes in it, 16379 bytes are wasted.

Option 'B' lets you set the directory track offset. This is normally 2 for floppy diskette drives, 1 for Winchester drives, and 0 for RAM disk. The directory track offset allows you to reserve space at the beginning of the diskette for the bootstrap program.

Option 'C' lets you specify the number of directory entries that a disk has. This number is allocated in multiples of 32. The standard configuration is 64 directory entries for floppy diskettes, 256 for Winchester drives, and 128 for RAM disk.

Option 'D' lets you specify whether a disk is removable or fixed. This is very important. If you specify a removable disk (such as a floppy diskette) as fixed, and then swap the removable disk with another disk, CP/M will read incorrect

data from new disk. Truly fixed disks such as Winchester disks and RAM disk should be specified as fixed, however, as this increases disk throughput.

There is an important fact to keep in mind when you are configuring the CP/M drive parameters. These parameters are actually associated with the physical device that the CP/M drive is associated with, and not the CP/M drive itself; you are really configuring the physical device and not the CP/M drive. This means that once you configure a CP/M drive, the physical device associated with the drive will keep that configuration, even if other CP/M drives are subsequently associated with the physical device.

Low Level Configuration

Low Level Configuration is provided so that you can make changes to the SAGEBIOS channel map, and to physical disk device characteristics. Also, there is some CP/M-68K specific information that you can configure. Caution: changes should only be made on a completely backed up system. This is the Low Level Configuration menu:

```
Low Level Configuration

A - BIOS Channel Map (channels 0 to 15)
B - BIOS Channel Map (channels 16 to 31)
C - Left Floppy Details
D - Right Floppy Details
E - Shared Floppy Details
F - Winchester #1 Details
G - Winchester #2 Details
H - Winchester #3 Details
I - Winchester #4 Details
J - Operating System Information
K - Auxiliary Device Information
```

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Options A and B: BIOS Channel Map

Options A and B allow you to reconfigure the BIOS Channel Map. The most common changes made to the Channel Map are for the hard disk partitions. Refer to the section "BIOS Channel Map" in Chapter 3 for a discussion on how channels and devices are mapped together.

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Low Level Configuration

Note

Either online or BIOS file changes may be made to the Channel Map. However, online changes to the CP/M disk channels are very dangerous, and can cause CP/M-68K to crash. In particular, reassigning a channel to a larger disk will cause a crash the next time the disk is accessed. Reassigning a channel to a smaller disk is generally safe, however. Also, if you assign a channel that was not assigned to any disk at boot time, all accesses to the new disk will fail with Select Error. As a general rule, you should avoid making online changes to disk channels.

Below is the Channel Map configuration as distributed for CP/M-68K:

BIOS Channel Map (0 to 15)

A - Channel 0 device = 0	Q - Channel 0 subdevice = 0
B - Channel 1 device = 1	R - Channel 1 subdevice = 0
C - Channel 2 device = 2	S - Channel 2 subdevice = 0
D - Channel 3 device = 0	T - Channel 3 subdevice = 0
E - Channel 4 device = 4	U - Channel 4 subdevice = 0
F - Channel 5 device = 5	V - Channel 5 subdevice = 0
G - Channel 6 device = 6	W - Channel 6 subdevice = 0
H - Channel 7 device = 7	X - Channel 7 subdevice = 0
I - Channel 8 device = 8	Y - Channel 8 subdevice = 0
J - Channel 9 device = 9	Z - Channel 9 subdevice = 5
K - Channel 10 device = 0	0 - Channel 10 subdevice = 0
L - Channel 11 device = 11	1 - Channel 11 subdevice = 0
M - Channel 12 device = 0	2 - Channel 12 subdevice = 0
N - Channel 13 device = 0	3 - Channel 13 subdevice = 0
O - Channel 14 device = 0	4 - Channel 14 subdevice = 0
P - Channel 15 device = 0	5 - Channel 15 subdevice = 0

BIOS Channel Map (16 to 31)

A - Channel 16 device = 0	Q - Channel 16 subdevice = 0
B - Channel 17 device = 9	R - Channel 17 subdevice = 8
C - Channel 18 device = 9	S - Channel 18 subdevice = 7
D - Channel 19 device = 0	T - Channel 19 subdevice = 0
E - Channel 20 device = 0	U - Channel 20 subdevice = 0
F - Channel 21 device = 0	V - Channel 21 subdevice = 0
G - Channel 22 device = 0	W - Channel 22 subdevice = 0
H - Channel 23 device = 0	X - Channel 23 subdevice = 0
I - Channel 24 device = 0	Y - Channel 24 subdevice = 0
J - Channel 25 device = 0	Z - Channel 25 subdevice = 0
K - Channel 26 device = 0	0 - Channel 26 subdevice = 0
L - Channel 27 device = 0	1 - Channel 27 subdevice = 0
M - Channel 28 device = 0	2 - Channel 28 subdevice = 0
N - Channel 29 device = 0	3 - Channel 29 subdevice = 0
O - Channel 30 device = 0	4 - Channel 30 subdevice = 0
P - Channel 31 device = 0	5 - Channel 31 subdevice = 0

Every CP/M drive is associated with a channel in the Channel Map. The following table shows the correspondence between channel and CP/M drive:

Drive	Channel
Drive A:	4
Drive B:	5
Drive C:	9
Drive D:	10
Drive E:	11
Drive F:	12
Drive G:	13
Drive H:	14
Drive I:	15
Drive J:	16
Drive K:	17
Drive L:	18
Drive M:	19
Drive N:	20
Drive O:	21
Drive P:	22

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Options C & D: Left/Right Floppy Configuration

These options allow you to change low level parameters of the floppy diskette driver. Note that most of these selections require knowledge of floppy diskette recording techniques and controller information. The low level floppy parameters are rarely changed from the standard configuration, unless you are attempting to read or write to a non-standard diskette format. These values are set for you automatically by the High Level Floppy Menu. This is the low level floppy configuration menu:

Low Level Left Floppy Configuration	
A - Number of sides	2
B - Number of cylinders	80
C - Sectors per track	8
D - bytes per sector	512
E - Retries before error	3
F - Motor on delay factor	9600
G - Data length	255
H - Gap 3 parameter	42
I - Gap 3 for format	80
J - Pattern for format	E5 (hex)
K - Skew for format	0
L - IBM track format	Off
M - NCI 16 sects/track	Off
N - R75d 48 on 96 TPI	Off
O - Read after write	On
P - Ignore errors	Off

Option 'A': This asks for 0, 1 or 2 sides. 1 and 2 are specified for single and double sided diskettes, respectively. 0 is specified if your computer is not equipped with the diskette drive.

Option 'B': This asks for the number of cylinders on the diskette. Cylinders and tracks are often used in the same context. A cylinder represents a head position which may access a track on each side of a double sided diskette. Common values for the number of cylinders are 35, 40 and 80.

Option 'C': This is the number of sectors per track. Typical values are 8 512-byte sectors, or 16 256-byte sectors. It is possible to format a diskette with 10 512-byte sectors per track, giving you an extra 1024 bytes per track, but this stretches the limits of the floppy drives and may not work well on some systems. Note that the Gap 3 parameter and Gap 3 for Format parameter must also be modified for a specific Sectors Per Track and Bytes Per Sector combination.

Option 'D': This is the number of bytes per sector. This is always a power of two, and is usually 128, 256 or 512 bytes per sector. Note that the Gap 3 parameter and Gap 3 for Format parameter must also be modified for a specific Sectors Per Track and Bytes Per Sector combination.

Option 'E': This is the number of times the floppy diskette driver retries a read or write operation when an error occurs. An error code is returned only if the error is still occurring after the operation has been retried the specified number of times. CP/M-68K is normally shipped with 3 retries, but this may be increased to attempt to access data on a marginal diskette.

Option 'F': This is the period of time that the floppy diskette driver will wait for the drive motors to come up to speed. The delay should be given as the number of 1/64000ths of a second to delay.

Option 'G': This is the Data Length. This parameter is used by the controller when the sector size is less than 256 bytes per sector. In these cases, the Data Length is the number of bytes per sector (typically 128). For all other cases, the Data Length should be set to 255.

Option 'H': This is the Gap 3 parameter. See the next option for more details.

Option 'I': This is the Gap 3 for Format parameter. This and the Gap 3 parameter are required by the floppy diskette controller for read and write operations to avoid the splice point between the data field and the ID field of contiguous sectors on the diskette. The value depends on the combination of bytes per sector, sectors per track, and density selection. Suggested values from the controller documentation are:

Density	BPS	SPT	Gap 3	Gap 3 for Format
Single	128	18	7	9
	128	16	16	25
	256	8	24	48
	512	4	70	135
Double	256	18	10	12
	256	16	32	50
	512	8	42	80

Option 'J': This is the pattern that every byte on the diskette is initialized with when the diskette is formatted. The value required by CP/M-68K is E5 hex.

Option 'K': This is a sector skew factor, and is normally zero. This specifies how physical sector numbers are to be skewed across the track. Under certain conditions, skewing sectors can improve performance. The 10 512-byte sectors per track formats generally specify a 2-sector skew, which improves performance when accessing the diskette over track boundaries, and improves the soft error rate during reading and writing. On 10 sector IBM and NCI format, the skew is reversed for side 1 because the tracks on side 1 are accessed in decreasing order.

Option 'L': This sets IBM track format compatibility on or off. For double sided IBM diskettes, data is stored in ascending track order on side 0, and then back in descending track order on side 1. The normal SAGE method is to

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store data on side 0 and then side 1 of each track before stepping the head to the next cylinder.

Option 'M': This will set the option to use a special sector numbering scheme developed by Network Consulting Inc. This scheme was implemented by NCI for their BIOS on the IBM Personal Computer. It allows their software to automatically distinguish between their 10 sector per track diskettes and the normal 8 sector per track IBM standard diskettes. Sectors are numbered from 9 to 18, except the first sector on the device which is numbered 1.

Option 'N': This controls the feature which allows reading of 48 track per inch diskettes on a 96 TPI drive. The 96 TPI drive is stepped two physical tracks for every track normally requested. Writing to a 48 TPI diskette in this manner is not allowed, because it is very unreliable.

Option 'O': This controls rereading sectors that have just been written. This Read after Write feature verifies that the controller can read back the information that was just written without detectable errors. This option slows down the writing process, but should be left enabled to insure valid operation.

Option 'P': This controls error reporting from the floppy diskette driver software. If this option is turned off, all errors from the controller are ignored. Errors should never be ignored in normal operation. This option is provided to allow a head alignment procedure to be performed using a special alignment diskette which contains unreadable data. The driver software must continue to read the diskette so that signals may be observed with test equipment, even though the controller is detecting errors.

Option E: Shared Floppy Configuration

This option allows you to change some low level floppy information that is shared between both floppies. Every change will affect BOTH floppy drives, and care should be taken to verify that this is really what you want to do. Here is the shared floppy configuration menu:

Shared Low Level Floppy Configuration	
A - Step time (milliseconds)	6
B - Head load time	3
C - Head unload time	1
D - Double density	On

Option 'A': This asks for the head step rate. This is the number of milliseconds allowed between head step pulses by the floppy diskette controller. The value may be any even number between 2 and 32 milliseconds. The default value is 6 milliseconds.

Options 'B' and 'C' These parameters are set by the factory and should not be modified.

Option 'D': This lets you set the data density. The drives provided on SAGE computers normally operate in double density mode. The single density option should only be required to access data from another system that provides only single density drives. The Sectors Per Track, Bytes Per Sector and Gap 3 values must all be coordinated with the density selection.

There is one thing you should be careful of when changing to single density. Since this option affects both floppy diskette drives, either RAM disk or a Winchester disk partition must be your default CP/M drive. If one of the floppy drives is your default drive, CP/M will not be able to read the disk when you leave SAGE4UTL.

Options F through I: Winchester Configuration

These options allow the Winchester driver to be reconfigured for other types of drives. Normally, this is only done by the factory or service centers.

Option J: Operation System Information

This option gives you access to the Operating System Information menu, which lets you reconfigure CP/M disk drive characteristics, the disk buffering system characteristics, and the CP/M startup command. This is the menu you get when you select option J:

Operating System Information	
A - Number of disk I/O buffers	3
B - Size of buffers in 512-byte blocks	8 (4096 bytes)
C - System startup command	Disabled
D - Disable startup command	

Option 'A' allows you to set the number of buffers that the disk buffering system uses. You can have from 1 to 256 buffers. You must always have at least one buffer. The default configuration is three buffers, which does not

take full advantage of the buffering system, but you can easily increase the number of buffers. The more buffers you allocate, the better the buffering system will work, but more buffers use up more of your RAM memory.

Option 'B' allows you to set the size of each buffer. Buffers may be from 1 to 32 512-byte blocks long, which is 512 bytes to 16384 bytes, in 512-byte multiples. The default is 8 blocks (4096 bytes). The ideal buffer size for floppy diskettes is 8 blocks, as this reads an entire floppy track at a time. The ideal size for Winchester disks would be 19 blocks (an entire track), but this makes the buffers too large - you would not have many buffers before you ran out of memory, and buffer fragmentation would become a problem (see Tradeoffs below). Buffers containing 8 block buffers still work well with Winchester disks, because the CP/M disk allocation block size for Winchesters is normally 8 blocks(4096 Bytes).

Option 'C' lets you specify a command that CP/M will execute when it first boots. The maximum length of the command is 16 characters. The command can be a SUBMIT script, which lets you do complex operations with a single startup command. A common use of the startup command is to run the CP/M INIT program to initialize the directory of the RAM disk immediately after CP/M comes up.

Option 'D' disables the startup command, if there is one active.

Option K: Auxiliary Device Information

The following menu appears when you select this option:

Auxiliary Device Information	
A - Keyboard	0000
B - Terminal	0000
C - Left Floppy	2121
D - Right Floppy	2121
E - Parallel Port	0000
F - Remote Input	0000
G - Remote Output	0000
H - RAM Disk	2200
I - Extra Serial Port #1	0000
J - Extra Serial Port #2	0000
K - Extra Serial Port #3	0000
L - Extra Serial Port #4	0000
M - Winchester #1	
N - Winchester #2	
O - Winchester #3	
P - Winchester #4	

Under CP/M-68K, the Auxiliary Device Information is only used with the floppy diskette drives, Winchester drives, and RAM Disk. CP/M drive parameter information is kept in the Auxiliary Device Information words. The fields in this word are encoded in the following form:

15	13	12	7	6	4	3	1	0
BLKSIZ	DIRSIZ	OFFSET	unused				REMOV	

where

BLKSIZ represents the allocation block size of the CP/M disk. This is encoded as follows:

- 0 = 1024 bytes
- 1 = 2048 bytes
- 2 = 4096 bytes
- 3 = 8192 bytes
- 4 = 16384 bytes

DIRSIZ represents the number of directory entries on the CP/M disk. DIRSIZ * 32 gives the number of directory entries (bits 7..12).

OFFSET is the track offset of the directory. This is the number of reserved tracks before the CP/M directory starts, and is used to leave room for bootstrap programs (bits 4..6).

REMOV If this bit is non-zero, the disk is marked as removable. This should be normally set to removable for floppy diskette drives, but set to fixed for Winchester disk drives and RAM disk.

**CONFIG. 68K
WITH SAGE4UL**

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Section 4

Sage CP/M-68K Utilities

This chapter describes the operation of the utility programs written by SAGE and distributed with CP/M-68K. Here is a list of these utilities:

ALLOC	Program that displays a map of allocated disk blocks.
HALT	Program that leaves CP/M-68K and re-enters the SAGE Debugging Tool monitor.
LMODEM	Program that allows file transfers between two computers over a modem line.
PRINTENV	Program that displays the current value of all environment variables.
SETENV	Program that allows you to set the value of an environment variable.
TOCPM	Program that transfers files from p-System floppy diskettes to CP/M-68K disks.

The WFORMAT program is described in Section V, Winchester Disk Configuration. SAGE4UTL is described in Section III.

ALLOC - Disk Allocation Map

The ALLOC program displays a map of CP/M disk allocation blocks that have been allocated. This can be used, for example, to find out if a disk is getting fragmented. Fragmentation is where you have many free blocks on the disk, but they are scattered widely across the disk. This does not reduce the capacity of the disk, but it does reduce the efficiency of file operations. If a

disk becomes fragmented, it can be compacted again by copying all files off the disk, initializing the disk, and copying all files back onto the disk.

ALLOC may be executed in either of the following ways:

```
ALLOC <cr>  
ALLOC x: <cr>
```

The first form shows you the allocation map for the current default drive. The second form shows you the map for any drive x:

HALT - Halt CP/M-68K Operation

This program stops the execution of CP/M and exits to the Sage Debugging Tool monitor. Executing HALT is the proper way to bring down CP/M-68K. Under the Multi-User BIOS, HALT causes your CP/M process to be rebooted.

LMODEM - Little MODEM Program

This program allows you to use your computer as a terminal, accessing another computer over a modem. LMODEM also has the ability to transfer files between your computer and the remote computer, using Ward Christensen's XMODEM protocol. LMODEM was originally published in the November 1983 issue of BYTE magazine, and was written by David Clark. The SAGE version has been modified slightly to take advantage of some special features of the SAGE computer.

LMODEM is executed simply by typing its name. LMODEM assumes that you have already used SAGE4UTL to set the baud rate, parity, stop bits, etc. of the Remote Port. After executing LMODEM, you will be 'on-line'. This means that whatever you type will be sent to the remote system over the modem, and whatever the remote system sends through the modem will be displayed on the screen.

LMODEM accepts a special command character. Control-]. To type this character, hold down the CONTROL key and press the right bracket,]. When you do this, the following message will appear: do this, the following message will appear:


```
command <? for help>
```

LMODEM is now waiting for a single command character. If you type another Control-], the Control-] character itself will be sent to the remote system. If you type a question mark, the following menu of commands will appear:

```
Commands
c - toggle capturing of text
k - keep the captured text
r - receive a file
s - send a file
q - exit to CP/M
```

After the menu appears, you are back on-line and must press another Control-] to issue a command.

The C command character toggles you in and out of capture mode. When you are in capture mode, all data that passes through LMODEM program from the remote system is remembered. A subsequent K command will allow you to keep the captured text in a file.

The R and S commands allow you to receive and send a file, respectively. The file transfer is performed using Ward Christensen's XMODEM protocol. The remote system must have a program similar to LMODEM in order to transfer a file. If the other system is a SAGE computer, LMODEM itself will work.

The Q command returns to CP/M. Any captured text that has not been saved in a file is lost. The Q command does NOT hang up the phone.

PRINTENV - Print Environment Variables

The environment is a special area of memory used to hold symbolic variables. Each variable may have a value. Environment variables may be put to any use; as an example, SAGE4UTL and WFORMAT use the TERM variable to determine the type of terminal you are using.

The PRINTENV program displays all of the current environment variables, and their values. PRINTENV is invoked simply by typing its name.

SETENV - Set Environment Variable

This program allows you to set the value of an environment variable. If the variable does not already exist, it is created. If the variable already exists and has a value, the old value is replaced by the new value. SETENV is executed as:

```
SETENV <variable> <value> <cr>
```

The <variable> argument is the variable name. This name may be any length. It may be specified in either upper or lower case, but it is always converted to upper case before being placed in the environment. The variable name may contain any characters, but should normally be restricted to letters and numbers.

The <value> argument is the value to assign to the variable. The value can be any length. All characters in the value are converted to lower case. The value may contain any characters, but if it contains any asterisks, spaces or tabs, it must be enclosed in single quotes. Here are some examples:

```
SETENV TERM qume  
SETENV FOOBAR 'this is the value of FOOBAR'  
SETENV MYNAME ''
```

The last example is how you place a variable in the environment without an associated value. Also, this is the way to remove the value of an already existing variable.

TOCPM p-SYstem - CP/M Transfer Program

This program transfers files from a p-System disk to CP/M. TOCPM is executed by typing its name:

```
TOCPM <cr>
```

TOCPM will then display the following lines:

```
TOCPM version 2.0
```

```
Which CP/M drive contains the p-System disk?
```

TOCPM is waiting for you to type the CP/M drive letter (A through P) of the drive that contains the p-System disk. This can either be a p-System floppy diskette, or it can be a Winchester disk partition. After you type the letter of the drive, TOCPM will display the following:

```
This is p-System volume xxxxxx:
```

```
p-System file name (? for directory, <CR> to exit).
```

You may then type the name of a p-System file that is on the disk. If you type a question mark as the filename, TOCPM will display the directory of the p-System disk.

If you type a filename, TOCPM will ask you the name of the CP/M file, and whether the file is a Text or a Data file.

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UTILITIES

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Section 5

Winchester Disk Configuration

This chapter is of interest only to owners of the SAGE IV with a Winchester hard disk drive. SAGE II owners can skip this chapter.

While reading this chapter, it is assumed that you are aware of the different types of Winchester disks available with SAGE IV computers, and that you know which type you have. Also, it is assumed that you know about the Winchester disk partitioning scheme. Please read Sections III and IV of the SAGE TECHNICAL MANUAL for more information.

Configuration of CP/M for a Winchester disk involves two steps — first, you must decide how you are going to partition your Winchester disk, and use the WFORMAT program to do so. Next, you must assign CP/M drives to each disk partition that you want to use with CP/M. This second step is optional if you use the default CP/M configuration.

Disk Partitioning for CP/M-68K

CP/M-68K is preconfigured to use partition numbers 5, 6 and 7 as CP/M drives C:, D: and F:. If this configuration is acceptable, all you must do is add partitions 5, 6 and 7 to your format information file (FMTINFO under CP/M). You don't need to have all three of these partitions; any combination of the three will do. However, you will get a CP/M Select Error if you try to access a partition that you haven't configured on your disk.

You are not restricted to partitions 5, 6 and 7. CP/M can be configured to use any partition number, and up to 16 partitions (one for each of the 16 possible CP/M drives, A: through P:).

CP/M can handle a partition size up to 512 megabytes; so, if you wish, you can have one large partition that covers the entire disk. This is not recommended, however, as the CP/M file system tends to get inefficient with large partition sizes. We have found that a good partition size is 11,514 blocks, as this covers all of a 6 megabyte Winchester, half of a 12 megabyte

Winchester, and one third of an 18 megabyte Winchester.

If you ordered your SAGE IV and CP/M-68K together, you can avoid the disk partitioning step by using the configuration stored on your Winchester disk when it was shipped to you. The default configuration is partitions 1, 2 and 3. Partitions 1 and 2 are floppy-sized partitions, 1280 blocks long. Partition 3 covers the remainder of the disk.

The Format Information File — FMTINFO

The format information file describes your current Winchester disk partition configuration. Also, any bad tracks on your disk are marked in this file. Under CP/M, this file is called FMTINFO. It is called FORMATINFO.TEXT under the Pascal p-System.

The file may be maintained under either the p-System or CP/M. If you have previously used your SAGE IV with the p-System, then you already have a p-System FORMATINFO.TEXT file that describes your current disk configuration and bad tracks. You can either continue to maintain this file under the p-System, or you can transfer it to CP/M and maintain it there. To transfer the file to CP/M, first copy the file to a p-System floppy. Next, use the TOCPM utility described in Chapter 4 to copy the p-System FORMATINFO.TEXT file to the CP/M file FMTINFO.

When you received your SAGE IV, a p-System FORMATINFO.TEXT file was supplied by SAGE. If you have never used your Winchester disk before, this file will still be present on the disk. This file is on partition 1 of the Winchester disk. If you plan to use the p-System with your Winchester disk, in addition to CP/M, you may wish to leave this file on partition 1 and maintain it there with the p-System. If you wish to maintain this file under CP/M, you can copy it from partition 1 to a floppy with the SAGE utility GETFMT. GETFMT may be found on the CP/M-68K Utility diskette. You execute GETFMT like this:

```
GETFMT <cr>
```

and it will automatically read FORMATINFO.TEXT from partition 1 of your Winchester disk, and write it as the file FMTINFO on your floppy diskette. This is the recommended procedure for CP/M users.

Mapping CP/M Drives to Partitions

All CP/M disk drive configuration is done with the SAGE4UTL program. All changes of this type must be made to the BIOS file, and not on-line. On-line changes can cause CP/M-88K to crash.

To associate a CP/M drive with a Winchester partition, you must enter the CP/M Disk Drive Configuration menu in SAGE4UTL, and then enter the CP/M Drive and Device Association menu. You will then see the following menu:

```
CP/M Drive and Device Associations
A - Drive A: LEFT floppy diskette
B - Drive B: RIGHT floppy diskette
C - Drive C: Winchester disk, partition 5
D - Drive D: Winchester disk, partition 6
E - Drive E: RAM disk
F - Drive F: Winchester disk, partition 7
G - Drive G: Not configured
H - Drive H: Not configured
I - Drive I: Not configured
J - Drive J: Not configured
K - Drive K: Not configured
L - Drive L: Not configured
M - Drive M: Not configured
N - Drive N: Not configured
O - Drive O: Not configured
P - Drive P: Not configured
```

Selecting any of the options, A through P, produces the following menu for the corresponding CP/M drive:

```
CP/M Drive and Device Association
A - LEFT floppy diskette
B - RIGHT floppy diskette *
C - RAM disk
D - Winchester disk
E - Disable
```

The asterisk shows you the current assignment for the CP/M drive. Selecting any of the options assigns the CP/M drive to the specified physical device. If you select option D, you will be asked for the Winchester partition number to

associate the drive with.

After you associate a CP/M disk drive with a physical device, you must configure the CP/M disk characteristics for that device. This is done with the CP/M Drive Parameters menu in SAGE4UTL. CP/M characteristics that must be configured are:

- Allocation block size.
- Number of CP/M directory entries.
- Number of reserved tracks.
- Fixed/Removable volume flag.

(See Section III on SAGE4UTL for more details.)

Using a CP/M Winchester Partition

After you have set up your disk partitions and configured CP/M to use the partitions, you must check to see that the configuration works properly. You can do this by running the CP/M STAT utility program. Type in a command line of the following form:

```
STAT x:DSK: <cr>
```

where 'x' is the CP/M drive that you want to test. For example, to see if drive C: is working, you would type the following command:

```
STAT C:DSK: <cr>
```

STAT will print out some information about the drive, including the size of the associated partition in bytes, and the number of directory entries. If STAT issues a CP/M Select Error instead, then something is wrong with the configuration. If STAT issues a CP/M Read Error, then either something is wrong with the configuration, or your Winchester disk needs to be formatted. If you have problems, see the section Potential Problems, below.

Once STAT prints out a list of drive information for a partition properly, you are ready to use that partition. Before copying files to the partition, you must initialize the CP/M directory. This is done with the INIT command:


```
INIT x <cr>
```

where 'x' is the drive that you want to initialize. After the drive has been initialized, you may copy files to it with the PIP utility.

To make a CP/M partition bootable, you must copy the bootstrap BOOT.SYS to the partition. This is done with SAGE4UTL - see Section III for full details.

WFORMAT under CP/M-68K

The WFORMAT program is used to format and verify Winchester disks, and to maintain bad track and partition maps. The operation of WFORMAT under CP/M-68K is exactly the same as described in the TECHNICAL MANUAL, with the exception that the format information file is usually called FMTINFO under CP/M. WFORMAT may be found on the CP/M-68K Utility diskette. The following is an example FMTINFO file for CP/M for an 18 megabyte Winchester disk:

```
Drive 0, Heads 6
Bad Track Map
  Cylinder 201, Head 1
  Cylinder 202, Head 1
Device Map
  Partition 0: Cylinder 0, Head 0 to Cylinder 305, Head 5
  Partition 1: Cylinder 0, Head 1, Blocks = 1280
    Name = BOOT
    System = CPM
  Partition 2: Blocks = 1280
    Name = SCRATCH
    System = CPM
  Partition 3: Cylinder 34, Head 1 to Cylinder 304, Head 5
    System = CPM
```

WFORMAT is executed under CP/M by typing its name in response to the CP/M prompt:

```
WFORMAT <cr>
```

Refer to Section IV of the SAGE TECHNICAL MANUAL for instructions on the operation of WFORMAT.

Potential Problems (HELP!)

This section describes some of the problems you may encounter while configuring your Winchester disk, and what to do to correct these problems.

If you get CP/M Select Errors after you have configured your partitions, there are two things that could be wrong. First, you may not have properly associated CP/M drives with partitions. Make sure that all CP/M drive channels that are associated with the Winchester disk use device 9, and that the subdevice number is the same as the Winchester partition that you want to use. Next, check the CP/M drive configuration. You must have at least 32 directory entries, and your Allocation Block size must be at least 2048 bytes. If you change the partition number a CP/M drive is associated with, it is easy to forget to change the CP/M configuration.

Configuring Multi-User CP/M-68K

CONF: MULTI-
USER: CPM-68K

This chapter describes the steps you must take to configure CP/M-68K to work with the Multi-User BIOS. In this chapter, it is assumed that you have read the information on the Multi-User BIOS in the SAGE GETTING STARTED MANUAL, and the SAGE TECHNICAL MANUAL, and are familiar with the Multi-User concept.

Setting up a CP/M-68K user is much like setting up a p-System user. There is, however, some additional information that you must provide before CP/M will work properly. Here is a list of the additional information you must provide:

- CP/M drive to physical device mapping.
- CP/M drive characteristics.
- The number of CP/M disk buffers.
- The size of each CP/M disk buffer.

The p-System program MU.UTIL contains a special menu for configuring this information. This menu is found under option D of each user's configuration menu. This is what the menu looks like:

```

CP/M Information
A - Number of disk I/O Buffers          3
B - Size of buffer in 512-byte blocks    8
C - CP/M Disk Drive Configuration
  
```

Option 'A' allows you to set the number of disk I/O buffers. This is the same as the disk I/O buffers under Single-User, set with SAGE4UTL. SAGE has found that good numbers range from 3 to 16.

Option 'B' is the size of each buffer in 512-byte blocks. A good value for this is 8, as it produces 4096-byte buffers. This value works well since the size of a track on a floppy diskette is 4096 bytes, and the CP/M allocation block size for Winchester disks is also usually 4096 bytes.

Option 'C' lets you configure each CP/M drive.

Configuring the CP/M Drives

Before you can use option 'C' of the CP/M Information menu, you must assign each CP/M drive that you intend to use to a physical device. This is done through the Channel Map.

The following table shows which channels are used to access which CP/M drives:

Device	Channel
Drive A:	4
Drive B:	5
Drive C:	9
Drive D:	10
Drive E:	11
Drive F:	12
Drive G:	13
Drive H:	14
Drive I:	15
Drive J:	16
Drive K:	17
Drive L:	18
Drive M:	19
Drive N:	20
Drive O:	21
Drive P:	22

CONF. MULTI-
USER, CPM-68K

The following table shows the device numbers that may be placed in these channels:

Device	Number
LEFT Floppy	4
RIGHT floppy	5
All Winchester partitions	9
RAM disk #1	11
RAM disk #2	21
RAM disk #3	22
RAM disk #4	24

Any device numbers other than the above are illegal. Individual Winchester partitions are specified by placing the partition number in the subdevice field of the Channel Map.

After you have decided which CP/M drives will be mapped to which physical devices, and have made the appropriate changes to the Channel Map, you are ready to configure the CP/M parameters for each drive. This is done with Option 'C' of the CP/M Information menu.

When you select option 'C', you will get the following menu:

Configuring Multi-User CP/M-68K
Configuring the CP/M Drives

CP/M Disk Drive Configuration

A - Disk Drive A
B - Disk Drive B
C - Disk Drive C
D - Disk Drive D
E - Disk Drive E
F - Disk Drive F
G - Disk Drive G
H - Disk Drive H
I - Disk Drive I
J - Disk Drive J
K - Disk Drive K
L - Disk Drive L
M - Disk Drive M
N - Disk Drive N
O - Disk Drive O
P - Disk Drive P

Selecting one of the options will produce a menu that looks like this:

Disk Drive x: Configuration	
A - Logical Block Size	4096
B - Directory Track Offset	1
C - Number of Directory Entries	512
D - Disk Media	Fixed

CONF. MULTI-
USER, CPM-68K

These options are described in Section III, SAGE4UTL.

When setting these options, remember that they are actually associated with physical devices, and not logical CP/M drives. Therefore, when you configure another user that shares physical devices with a previously configured user, the shared devices will already be configured. In other words, users that share CP/M drives must also share the CP/M parameters for those drives.

Preparing the CP/M Users

Before your CP/M users can boot, you must decide which CP/M drive you want them to boot from. This is done with Option 'F', Boot Device in the User Configuration Menu for each user. The number in this option is the channel in the Channel Map that is used to boot the user. Therefore, you must put the channel number of the CP/M drive that you want the user to boot from. For example, if you want the CP/M user to boot from CP/M drive C:, you would put channel 9 as the Boot Device, as channel 9 is used to access CP/M drive C:.

Once you have set the Boot Device channel number, you must exit MU.UTIL and the p-System, and boot up Single-User CP/M from a floppy. You must then configure the Single-User CP/M to read each CP/M user's boot partition. For example, if you have two CP/M users, booting from the Winchester disk partitions 3 and 7 respectively, you can configure the Single-User CP/M to access partitions 3 and 7 as CP/M drives C: and D:. You must use SAGE4UTL to do this, and you must make a BIOS file change and reboot the Single-User CP/M.

Now that you can access each CP/M user's boot partition, you must perform the following steps for each partition:

- Initialize the partition with the CP/M INIT program.
- Copy the file CPM.SYS onto the partition.
- Copy any other files that you wish the user to have access to.
- Copy the bootstrap MUBOOT.SYS using SAGE4UTL.

After performing the above steps, you are ready to boot your Multi-User system.

Sharing Physical Devices

Multiple CP/M users can share devices, with the restriction that two users cannot write to the same device at the same time.

In the case of floppy drives, you must simply make sure that only one user uses a floppy drive at a time. If your SAGE has two floppy drives, two users can each access a different drive at the same time; you must simply make sure that they do not try to access the **SAME** drive at the same time.

Shared Winchester partitions require more preparation before they are shared. The only safe way to share a Winchester partition is to allow no more than one user to write to the partition, and make the partition read-only for all other users. This is a good way to share programs and read-only data among all CP/M users.

SageSubs Library

This chapter describes SAGESUBS, a library of functions callable from C to perform a few useful SAGE-dependent operations. **bdos() – Do a CP/M BDOS Call**

This function lets you do a CP/M BDOS call from C. Any of the BDOS functions listed in the CP/M-68K Programmer's Guide are allowed. The function returns the result of the BDOS call.

```
long    bdos(function, arg1, arg2)
int     function;
long    arg1, arg2;
```

where:

function	is the BDOS function code to perform.
arg1, arg2	are the arguments to the BDOS function. If the arguments are not required, they may be omitted.

getenvp() – Get Environment Pointer

This function returns a pointer to the environment space. The environment is a 5120-byte area of memory that can be used as a scratch pad. The normal use of the environment is to keep a list of variables and associated values. The programs SETENV and PRINTENV maintain these variables.

getenvp() does not assign any meaning to the environment space; it simply returns a pointer to the beginning of it.

```
char    *getenvp();
```

gettime() – Get System Uptime

This function returns the time in seconds since CP/M was bootstrapped, as a value of type 'long'.

```
long    gettime();
```

initbrk() – Initialize Break Character

This function allows you to set a Break character, which is a character that causes a transfer to a user-supplied routine when it is typed. Normally, no Break character is enabled.

Control is transferred to your Break routine at interrupt level. Therefore, you cannot safely perform any I/O operations while in the routine. The safest thing to do is to set a flag that is checked periodically by your program. When the flag is set, it indicates to the main program that the Break character has been typed.

The Break character is disabled whenever a program returns to CP/M.

```
initbrk(routine, key)
int      (*routine)();
char     key;
```

where:

function is the address of the routine to execute when the Break key is pressed.

key is the Break character. When this key is pressed, the Break routine is entered.

remin() – Remote Input

This function fetches a character from the remote input (modem) port. If no character is ready to be fetched, remin() will wait until a character is received.

```
char     remin()
```

remout() – Remote Output

This function sends a character to the remote output (modem) port.

```
remout(c)
char     c;
```

where:

c is the character to transmit.

stalloff() – Turn Off BIOS Xon/Xoff Handling

This function turns off BIOS handling of Xon/Xoff (Control-S and Control-Q). These characters will still stall and resume console output, but CP/M

itself will be implementing them, not the BIOS. Having CP/M handling Xon/Xoff has the advantage that CP/M can control when it wants to recognize Control-S as the stall character, but has the disadvantage that at lower baud rates, the Control-S will not be recognized immediately.

```
stalloff()
```

stallon() - Turn On BIOS Xon/Xoff Handling

This function turns on BIOS handling of Xon/Xoff (Control-S and Control-Q). These characters will now stall and resume console output at interrupt level, which causes them to take effect immediately at lower baud rates. However, CP/M no longer has any control over them when Control-S is recognized.

```
stallon()
```

tioq() - Test I/O Queue

This function lets you test the status of an I/O queue. If a character is ready to be read in an input queue, or if an output queue is empty, the function returns TRUE (non-zero). tioq() accepts one argument, the number of the queue to test:

1	Keyboard input queue
2	Terminal output queue
6	Printer output queue
7	Remote input (modem) queue
8	Remote output (modem) queue

An important point to keep in mind is that this function tests the LOGICAL devices, and not the PHYSICAL devices. This means, for example, that if you have used the Channel Map (see Section III, SAGE4UTL) to reassign printer output to go to Extra Serial Port #1, tioq() actually tests the Extra Serial Port #1 queue and not the parallel printer port.

```
int      tioq(queue)
int      queue;
```

uclear() - Unit Clear

This function does a unit clear on a specified BIOS channel. This is the same as the p-System UNITCLEAR function. Uclear() cancels all I/O to the specified channel, and resets the hardware to its power-up state.

If an error occurs, uclear() returns the error code. See the end of this chapter for a list of errors.

```
int    uclear(channel)
int    channel;
```

where:

channel is the channel number to clear.

uread() — Unit Read

This function does a unit read on a specified channel, and is the same as the p-System UNITREAD function. This is a very low level way of reading data from a channel, and entirely bypasses CP/M (including the BIOS Interface buffering system). An error code is returned by uread(); see the end of this chapter for a list of error codes.

Special BIOS operations can be accomplished with this function; see the SAGE TECHNICAL MANUAL, BIOS Function 11 for full details.

```

int    uread(channel, address, length, block, control)
int    channel;
char   *address;
long   length;
long   block;
int    control;

```

where:

Channel is the channel number to read from.

Address is the address at which the data read from the channel is stored.

Length is the number of bytes to read. This can be any size, as long there is enough space pointed to by 'address' to hold the data.

Block is the block number to read. This is ignored for non-blocked devices, such as the terminal.

Control is a special control word. This is usually set to 0; if you set it to 1, the read will be done asynchronously if you are reading from a disk device. This means that `uread()` will return immediately, without waiting for the operation to complete. You must then use the `ustatus()` function to find out when the operation completes. Other bits in this control word have other, device-dependent meanings; see the SAGE TECHNICAL MANUAL for full details.

`ustatus()` - Unit Status

This function does a unit status operation on a channel, and is the same as the p-System UNITSTATUS function. See the SAGE TECHNICAL MANUAL, BIOS Function 13 for details on the information returned by `ustatus()`. An error code is returned by `ustatus()`; see the end of this chapter for a list of error codes.

```

int    ustatus(channel, address, control)
int    channel;
char   *address;
int    control;

```

where:

Channel is the channel number to get the status of.

Address is a pointer to a 60-byte area of memory to receive the status. The information placed in this area by `ustatus()` depends on the device, and is described in the SAGE TECHNICAL MANUAL, BIOS Function 13.



Control is either a 0 or a 1. If set to a 0, the `ustatus()` function fetches status information for the output direction of a device. If 1, information is fetched for the input direction.

`uwrite()` - Unit Write

This function does a unit write on a specified channel, and is the same as the p-System `UNITWRITE` function. This is a very low level way of writing data from a channel, and entirely bypasses CP/M (including the BIOS Interface buffering system). An error code is returned by `uwrite()`; see the end of this chapter for a list of error codes.

You can do some special BIOS operations with this function; see the SAGE TECHNICAL MANUAL, BIOS Function 12 for full details.

```
int    uwrite(channel, address, length, block, control)
int    channel;
char   *address;
long   length;
long   block;
int    control;
```

where:

Channel is the channel number to write to.

Address is the address at which the data to write to the channel may be found.

Length is the number of bytes to write. This can be any size.

Block is the block number to write. This is ignored for non-blocked devices, such as the terminal.

Control is a special control word. This is usually set to 0; if you set it to 1, the write will be done asynchronously when you are writing to a disk device. This means that `uwrite()` will return immediately, without waiting for the operation to complete. You must then use the `ustatus()` function to find out when the operation completes. Other bits in this control word have other, device-dependent meanings; see the SAGE TECHNICAL MANUAL for full details.

Unit I/O Error Codes

There are two sets of error codes; those returned from the floppy driver and those returned by the Winchester driver.

Floppy Driver Error Codes

- 0 No error - the operation was successful.
- 1 Floppy controller would not respond.
- 2 Floppy controller returned 'invalid command' error.
- 3 Recalibrate or Seek failure.
- 4 No diskette (as a result of a read or write timeout).
- 5 Missing Address Mark error.
- 6 No Data Found error.
- 7 Overrun error.
- 8 CRC Error error.
- 9 End Of Cylinder error.
- 10 Write Protect Violation error.
- 11 Address Out Of Range error.
- 12 Wrong Cylinder error.

Winchester Driver Error Codes

- 0 No error.
- 1 Could not initialize VCO.
- 3 Recalibrate or Seek failure.
- 4 Drive not ready.
- 6 Timeout while waiting for data.
- 8 CRC error.
- 9 Verify error.
- 10 Write Protect Violation error.
- 11 Block Number out of range.
- 12 Wrong Cylinder error.

The following two errors can occur for any BIOS function:

- 14 Illegal device number.
- 15 Illegal request number.



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SAGE CP/M-68K May 1984.

General Information

This chapter gives you some general information on the SAGE implementation of CP/M-68K. In particular, differences between the way SAGE has implemented CP/M and the way Digital Research describes the implementation in their manuals is outlined.

SAGE Basic Input/Output System (BIOS)

CP/M-68K never accesses any of your peripheral devices (serial ports, disk drives, etc) directly. All requests for input and output to these devices are made through a supervisory program called the SAGE Basic Input/Output System, or BIOS. Currently, all operating systems supplied by SAGE use the same BIOS, including the Pascal p-System and Modula-2.

The SAGE BIOS was originally written for the p-System, and therefore does not interface directly to CP/M-68K. SAGE has implemented a "BIOS Interface", which interfaces the CP/M BIOS calling sequences to the SAGE BIOS. This BIOS Interface also implements disk block buffering to increase the speed of disk operations.

There are currently two versions of the SAGE BIOS; Single-User and Multi-User. The Single-User BIOS allows only a single copy of CP/M-68K to be running on the computer. The Multi-User BIOS allows multiple copies of CP/M to run at the same time, allowing more than one person to use the computer at once.

Devices

All of the various pieces of equipment attached to your SAGE computer are called "devices". Examples of devices are the floppy diskette and Winchester disk drives, the printer port, and the serial channels. Every physical device is assigned a unique number, which is used to refer to the device when input and output requests are made of the SAGE BIOS. Here is a list of the devices on

General Information
SAGE Basic Input/Output System (BIOS)

the SAGE computer, and their respective Single-User BIOS device numbers:

<u>Device</u>	<u>Number</u>
Keyboard (for input)	1
Terminal (for output)	2
Left (top) floppy	4
Right (bottom) floppy	5
Parallel printer port	6
Remote Input (modem)	7
Remote Output (modem)	8
Winchester drives (all of them)	9
RAM Disk	11
Extra serial channel #1	13
Extra serial channel #2	14
Extra serial channel #3	16
Extra serial channel #4	18

The devices are numbered slightly differently in the Multi-User BIOS:

<u>Device</u>	<u>Number</u>
Keyboard (for input)	1
Terminal (for output)	2
Left (top) floppy	4
Right (bottom) floppy	5
Parallel printer port	6
Remote Input (modem)	7
Remote Output (modem)	8
Winchester drives (all of them)	9
RAM Disk #1	11
Extra serial channel #1 (input)	13
Extra serial channel #1 (output)	14
Extra serial channel #2 (input)	15
Extra serial channel #2 (output)	16
Extra serial channel #3 (input)	17
Extra serial channel #3 (output)	18
Extra serial channel #4 (input)	19
Extra serial channel #4 (output)	20
RAM Disk #2	21
RAM Disk #3	22
RAM Disk #4	23

Currently, devices numbers 3, 10, 12, and all numbers above 23 are unassigned and reserved for future expansion.

BIOS Channel Map

Input and output requests are never made directly to a physical device. Instead, requests are made through a "channel". The SAGE BIOS contains 32

channels used to perform input and output, numbered from 0 to 31. These are called the BIOS Channel Map. Any physical device on the SAGE may be assigned to any of these channels. The Channel Map may be changed with the SAGE4UTL program (see Section IV). Any physical device may be assigned to any channel. Normally, however, most channel numbers are mapped to the corresponding physical device. For example, the channel used to access the left floppy (device 4) is usually channel 4.

A channel is configured by setting two pieces of information: the device number the channel is associated with, and a special number called the subdevice. The subdevice is currently used only with the Winchester disk. All Winchester disk drives are specified by device 9 in the Channel Map. Different disk drives and partitions are denoted with the subdevice in the Channel Map. Section IV explains this in detail.

CP/M-68K has a fairly simple interface to the BIOS. CP/M always uses certain channels to perform input and output to particular CP/M devices. For example, channel 1 and 2 are always used for console input and output, respectively. Here is a table of the association between CP/M-68K devices and BIOS channels:

<u>Device</u>	<u>Channel</u>
Console input (CON:)	1
Console output (CON:)	2
Printer output (LST:)	6
Auxiliary input (AXI:, RDR:)	7
Auxiliary output (AXO:, PUN:)	8
Drive A:	4
Drive B:	5
Drive C:	9
Drive D:	10
Drive E:	11
Drive F:	12
Drive G:	13
Drive H:	14
Drive I:	15
Drive J:	16
Drive K:	17
Drive L:	18
Drive M:	19
Drive N:	20
Drive O:	21
Drive P:	22

This channel arrangement is very powerful. For example, you could set up your SAGE computer to be a remote system, accessed through a telephone line, by re-assigning channels 1 and 2 to be associated with devices 7 and 8.

respectively. This will cause all console input and output to be sent through the Remote Serial Port, rather than through the Console Serial Port.

Below is the default Channel Map configuration. The Channel Map may be changed with the SAGE4UTL program.

Channel 0 device = 0	Channel 0 subdevice = 0
Channel 1 device = 1	Channel 1 subdevice = 0
Channel 2 device = 2	Channel 2 subdevice = 0
Channel 3 device = 0	Channel 3 subdevice = 0
Channel 4 device = 4	Channel 4 subdevice = 0
Channel 5 device = 5	Channel 5 subdevice = 0
Channel 6 device = 6	Channel 6 subdevice = 0
Channel 7 device = 7	Channel 7 subdevice = 0
Channel 8 device = 8	Channel 8 subdevice = 0
Channel 9 device = 9	Channel 9 subdevice = 1
Channel 10 device = 9	Channel 10 subdevice = 2
Channel 11 device = 11	Channel 11 subdevice = 0
Channel 12 device = 9	Channel 12 subdevice = 3
Channel 13 device = 0	Channel 13 subdevice = 0
Channel 14 device = 0	Channel 14 subdevice = 0
Channel 15 device = 0	Channel 15 subdevice = 0
Channel 16 device = 0	Channel 16 subdevice = 0
Channel 17 device = 0	Channel 17 subdevice = 0
Channel 18 device = 0	Channel 18 subdevice = 0
Channel 19 device = 0	Channel 19 subdevice = 0
Channel 20 device = 0	Channel 20 subdevice = 0
Channel 21 device = 0	Channel 21 subdevice = 0
Channel 22 device = 0	Channel 22 subdevice = 0
Channel 23 device = 0	Channel 23 subdevice = 0
Channel 24 device = 0	Channel 24 subdevice = 0
Channel 25 device = 0	Channel 25 subdevice = 0
Channel 26 device = 0	Channel 26 subdevice = 0
Channel 27 device = 0	Channel 27 subdevice = 0
Channel 28 device = 0	Channel 28 subdevice = 0
Channel 29 device = 0	Channel 29 subdevice = 0
Channel 30 device = 0	Channel 30 subdevice = 0
Channel 31 device = 0	Channel 31 subdevice = 0

If a channel is assigned to device 0, it is disabled. The above configuration sets up CP/M drives A: and B: as the left and right floppy diskette drives, respectively, and CP/M drives C:, D: and F: as Winchester drive partitions 1, 2 and 3. CP/M drive E: is set up as the RAM disk.

CP/M-88K BIOS Interface

The BIOS Interface accepts input and output requests from CP/M, and calls on the SAGE BIOS to perform the requests. In addition to this basic function, the BIOS Interface also implements a disk buffering scheme to increase the speed of disk operations. Disk buffering uses some of your memory to

temporarily store data that has been recently read from the disk. Another method available to increase the speed of disk operations is RAM disk.

Disk buffering automatically and transparently keeps the most recently used disk data in memory, where it can be accessed much more quickly than a disk can be. Some of your computer's memory is statically partitioned into equal-sized buffers that hold one or more disk blocks. Every time an access to a floppy or Winchester disk is initiated, the buffers in memory are searched first. If the data requested is found in a buffer, the physical disk need not be accessed.

A Least Recently Used (LRU) scheme is used. When a new disk buffer is needed, the buffer that has not been referenced the longest amount of time is used. If this buffer has been modified, it is first written to the physical disk before it is used to hold new data from the disk.

Whenever a program finishes running and returns control to CP/M-68K, all modified buffers are written to disk. This also happens if you type Control-C when CP/M-68K is expecting a command.

CP/M-68K Bootstrap Loaders

CP/M-68K comes with two bootstrap loader programs, BOOT.SYS and MUBOOT.SYS. These bootstraps are for Single-User and Multi-User CP/M, respectively. The same bootstrap is used for both floppy diskettes and Winchester Partitions.

The SAGE implementation of the CP/M bootstrap operation is different than that described in the CP/M-68K System Guide from Digital Research. The standard bootstrap procedure is to load the CPM.SYS file, which has been previously relocated to execute at a fixed address, into memory. The standard CPM.SYS file contains the CCP, BDOS and BIOS segments of CP/M. The SAGE procedure is different. The actual tasks of the bootstrap loader depend on whether you are booting Single-User or Multi-User CP/M.

The CPM.SYS file is the same for both Single-User and Multi-User. CPM.SYS contains the CCP and BDOS segments of CP/M, and the BIOS Interface segment. The actual SAGE BIOS file is not a part of CPM.SYS, and is loaded separately. CPM.SYS is left relocatable in the SAGE implementation, so that it may easily be loaded at any memory location.

Under Single-User, the bootstrap program loads the SAGE BIOS from the file SAGEBIOS.SYS, at the highest memory location available. The BIOS is


```
*****  
*                               *  
*      Transient Program Area (TPA)      *  
*                               *  
Location 400 hex: *****  
*                               *  
*      Exception Vectors      *  
*                               *  
Location 0 hex: *****
```

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INFORMATION

General Information
Memory Configuration

Multi-User Configuration

Note: SAGE BIOS is located at top of memory.

```
Top of partition: *****
*
*          CP/M-68K and BIOS Interface          *
*
*-----*
*
*          LRU Disk I/O Buffers                  *
*
*-----*
*
*          Transient Program Area (TPA)          *
*
Base + 400 hex: *****
*
*          Exception Vectors                     *
*
Partition base: *****
```


Appendix A – Changes to CP/M–68K

Outlined below are the changes made to CP/M–68k for the current release. This list of changes is not in any particular order, but we believe it to be complete.

1. Multi–User CP/M–68k is now supported. This is NOT the same thing as Digital Research's Concurrent CP/M. Instead, it is the same as Multi–User p–System. In fact, you can even run p–System users and CP/M–68k users concurrently on a single Sage computer.
2. Xon/Xoff handshaking for the console may now be either left to CP/M (as it was before), or you can have the BIOS do it at interrupt level. The problem with doing it at interrupt level is that it interferes with the Mince Search and Quote commands. A special version of Mince has been released that turns off BIOS handshaking when it runs, and turns it back on again after leaving.
3. The implementation of RAM disk has been completely redone. Previous versions of CP/M–68k allocated RAM disk when the system was booted. Space for the RAM disk was taken from the TPA. The new method uses the RAM disk device in SAGEBIOS, which is compatible with Multi–User.
4. RAM disk must now be initialized immediately after every cold boot of CP/M. Previous releases automatically initialized the directory of RAM disk, but you must run INIT to initialize the directory with this release. This feature was added because under Multi–User, multiple users may be sharing RAM disk. If it was automatically initialized when a user booted CP/M, a user could destroy previously created files. Also, a user may not have write access to RAM disk, causing an automatic initialization to fail.
5. RAM disk may now be assigned to any CP/M drive. Previously, only drive E: could be RAM disk.
6. The Bootstrap has been rewritten. It is now much smaller than it was before, and a serious bug preventing booting if your CPM.SYS file got

too large has been fixed.

7. The same program, SAGE4UTL, is used on both Sage IIs and Sage IVs. There is no longer a SAGEUTIL program.
8. SAGE4UTL has been completely rewritten, and is now more similar to the p-System version, SAGE4UTL. There was a multitude of bugs in the old SAGE-UTL: these have all been fixed. Also, a few new features have been added. The new SAGE4UTL is written using Whitesmith's C Compiler; this means that it may no longer be compiled with the Digital Research C Compiler.
9. Disk drives are now completely interchangeable; that is, you can now assign floppy drives to be something besides A and B, and you can assign RAM disk to be something besides E. You can also now assign the Winchester drives to A, B, or E. The distributed configuration is, however, still with the floppies as drive A and B, RAM disk as E, and the Winchester as C, D, and F.
10. CP/M now knows the capabilities of many terminals. This information is kept in the file TERMCAP, and is used by SAGE4UTL, WFORMAT and other programs.
11. A Unix-like environment space has been added. You can keep variables and associated values in the environment. The programs SETENV and PRINTENV maintain the environment. When you boot the environment variable HOME is automatically set with the value of the drive you booted from.

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Appendix C Re-Assembling CP/M-68K

If you make any custom modifications to the BIOS Interface or the bootstrap programs, you will want to reassemble them.

To reassemble the BIOS Interface, you must type in the following command line:

```
as68 -l -n bios.s
```

After assembling BIOS.S, you must link it with CPMLIB to produce a CPM.SYS file that can be loaded by the bootstrap. This is the command line to do this:

```
lo68 -r -ucpm -o cpm.sys cplib bios.o
```

The resulting CPM.SYS file is ready to be loaded by the bootstrap.

To reassemble a bootstrap, you must type one of the following command lines:

```
as68 boot.s
as68 muboot.s
```

Before you can use the bootstraps, you must first pass them through LO68:

```
lo68 -t400 -o boot.sys boot.o
lo68 -t400 -o muboot.sys muboot.o
```

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