CP/M 68K

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I INTRODUCTION TO SAGE CP/M-68K

Welcome to CP/M-68K and the SAGE computer. CP/M-68K is a product of Digital Research and has long been available on 8-bit machines, specifically the Z80. Digital Research is an eight year old company in Pacific Grove Ca. Their users include over 800,000 systems, 700 OEMs and 600 independent software houses.

CP/M-68K is the version of CP/M for the Motorola MC68000 family of microprocessors. It is a high performance single-user, single-tasking operating system.

CP/M-68K features a flexible application program interface and powerful system utilities combined with a C compiler to provide a complete software development environment.

The major features of CP/M-68K are:

CP/M and CP/M-86 Compatibility

Supports from 64 Kilobytes to 16 Megabytes of RAM

Support for 1 to 16 logical Disk Drives of up to 512 M bytes each.

C Language

Sophisticated Software Development Tools

Standard CP/M Utilities

Multiple Programs can Co-exist in Ram

Resident System Extensions

Allows full access to MC68000 hardware features

Cross Development tools.

The package includes a C compiler and run-time library which 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 transported to run under CP/M-68K.

II INSTALLATION

The SAGE boot program resides in PROM and is the same for all operating systems. Refer to the detailed instructions in the section on INSTALLATION in Volume 1 of the SAGE Users' Manual to unpack your computer, connect your terminal and get it ready to power up.

Briefly: on power up, the screen should display:

```
 ------------------------------------------------
|                                                |
|  Sage II Startup Test                          |
|  RAM SIZE = xxx K                              |
|                                                |
|  Booting from Floppy                           |
|  Put in BOOT disk and press a key (Q for quit) |
 ------------------------------------------------
```

To boot from a floppy, Sw5 of GROUP-A should be up, Sw6 should be down.

Put the BOOT floppy for CP/M in the left-hand drive. Once you press a key, the machine will boot to the command line of CPM. This is a simple prompt:

```
A>
```

If "Not BOOT disk" is displayed, you have the diskette in wrong or it is not the correct diskette. Diskettes go in with the label up.

II.01 BACKING UP SYSTEM FILES

Keeping back-up copies of your files is one of the first things a programmer learns, usually the hard way. Losing your only copy of a day's work is painful. Having to re-type in even an hour of changes is valuable time lost.

The first thing you, as a new user of a SAGE II, must do is backup the diskettes that SAGE sent you. These diskettes are write protected and cannot be written to. We suggest that the user make a set of working system masters which are configured for his system, and then use them to generate system diskettes for everyday usage. This means:

1. Format your 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 systems. For example, on the SAGE II, diskettes can be formatted for either 40 track or 80 track drives. Brand new diskettes must always be formatted for your drives.

2. Copy system files to the new formatted diskettes. ALL files are copied to the diskette.

3. Check the new diskettes to make sure they work. Store the original diskettes in a safe place away from extremes of temperature, dust, and stray magnetic fields.

These operations will now be described in detail.

II.02 FORMATTING A DISKETTE

Your system diskette should be in the left-hand drive (A).
Your new diskette should be in the right-hand drive (B).

Note that the system diskette can be removed to prevent formatting the wrong diskette by mistake and losing your system data.

The screen prompts:	**You type:**
A>	SAGEUTIL <CR>
C(onfigure, B(oot Copy, F(ormat, Q(uit	F <cr>
Floppy Diskette Formatter Drive to be formatted (A or B)?	B <cr>
Is diskette ready for formatting in drive B?	Y <cr>
.... Verification .... Format complete More diskettes to format?	Y if more N if done
C(onfigure, B(oot Copy, F(ormat, Q(uit	Q

Now you should be back at the "A>" prompt line.

Note that your should format enough diskettes to backup all of the system masters sent with your order and also a few extra for work disks.

II.03 COPYING DISTRIBUTION DISKETTES

Now that you have formatted diskettes, copy the distribution diskettes:

The screen shows:	You type:
A>	..... COPY
MODE FUNCTION ALL Copy the whole disk BOOT Copy the Boot tracks FILES Copy the non-boot tracks END End this program	
A>	..... ALL
Enter SOURCE drive__	..... A
Enter DESTINATION drive__	..... B
(^C TO ABORT)	
RETURN to copy ALL from A to B	<cr>
*** COPYING TRACKS *** xx	
Do you wish to repeat the copy?	..... Put in another master and another formatted diskette. Type Y to copy.

Repeat until all of the master diskettes are copied. Type "N" to the last question. Now you should be back at the "A>" prompt:

A>

Note that this method makes a complete copy of the image of the left diskette on the right diskette. The bootstrap area will be copied.

II.04 CHECKOUT OF NEW SYSTEM DISKETTE

1. Remove both diskettes.
2. Put the new system diskette in the left side (A).
3. RESET the computer.
4. Your system should boot to the "A>" prompt. (See the Power-up section).

III Sage Utility Routine

The SAGEUTIL program (SAGEUTIL.C) sets up parameters for the hardware and software of the CP/M system. It is a powerful menu driven utility routine. SAGEUTIL formats disks, configures the BIOS, and copies the bootstrap loader.

The CP/M-68K version of SAGEUTIL has almost identical instructions to the p-System version which is documented in Volume 1 of the Sage Owner's manual. However, there are a few differences so users familiar with the p-System version should not assume identical operation. One of the obvious difference is that:

All entries must be terminated with a carriage return.

SAGEUTIL is started by typing "SAGEUTIL" from the CP/M-68K prompt:

```
A>
```

The system now displays:

```
SAGE Computer System Utility Package - Version X.X

C(onfigure, B(oot, F(ormat, Q(uit?
```

III.01 BIOS CONFIGURATION MANAGER

Typing a 'C' at the outer level prompt line will cause the utility to enter the BIOS Configuration Manager and ask:

O(n-line, or F(ile change to BIOS?

The O(n-line option will only change the copy of the parameters which is operating in memory. This option is used for temporary changes that only affect the current computing session. Note that the Memory and System options (see following descriptions) are not allowed to be changed on-line.

The F(ile option will ask:

BIOS file name?

The user should specify the device and file name of the BIOS file to be modified (or examined), typically B:SAGEBIOS.SYS. The device driver configuration parameters are located in the BIOS file. This data is read in for examination and/or modification by the configuration manager. The utility will report:

The main prompt line for the Configuration Manager is:

T(erminal, R(emote, F(loppys, M(emory-disk, P(rinter, S(ystem, Q(uit ?

Choose the device to be changed: the terminal, the remote serial channel, the floppy drives, the RAM Disk storage device, the printer, or the System parameters and type the first letter of the option, then a <cr>.

At the end of the session (type Q(uit or <CR> at main prompt). If changes have been made to the configuration information the utility asks:

Ready to write changes to your file ?
or
Ready to write changes to memory?

The user then should type 'Y' resulting in the message:

BIOS changes saved, Type space to continue.

Changes made to memory involving the terminal configuration are questioned by the utility before installing. This is because the changes are applied immediately and may garble the following terminal output until the corresponding changes are made in the terminal.

Changes made on-line to disk parameters will not take affect until a CNTRL-C is typed from the command line.

Changes made to a file will **not** take affect until the system is re-booted using the modified BIOS.

III.02 TERMINAL CONFIGURATION

Typing 'T' to the Configuration Manager prompt displays a prompt line for information to configure the terminal serial channel:

```
B(aud-rate, P(arity, S(top-bits, D(ata-bits, O(ptions, Q(uit
```

Selecting B(aud-rate displays:

```
Currently using xxxxx baud rate

A( 19200 baud        H(   600 baud
B(  9600 baud        I(   300 baud
C(  4800 baud        J(   200 baud
D(  2400 baud        K(   150 baud
E(  2000 baud        L(   110 baud
F(  1800 baud        M(    75 baud
G(  1200 baud        N(    50 baud

X(use DIP switch specified baud rate
Q(uit

Select baud rate from above:
```

The DIP switch refers to PORT A switches on the back of the computer. Appendix A in Volume 1 describes the switch settings.

Selecting P(arity displays:

```
Currently parity is xxxx

D(isable parity
E(ven parity
O(dd parity
Q(uit

Select parity option:
```

Selecting S(top-bits displays:

```
Currently x stop bit(s) assigned

A( 1 stop bit
B( 1.5 stop bits
C( 2 stop bits
Q(uit

Select stop bit option:
```

Selecting D(ata-bits displays:

```
Currently using x data bits
A( 5 data bits
B( 6 data bits
C( 7 data bits
D( 8 data bits
Q(uit

Select data size option:
```

Selecting O(ptions displays:

```
Terminal Options

B(REAK KEY is ignored    or    B(REAK KEY enters PROM Debugger
```

The actual BREAK KEY on normal terminals generates a continuous signal which causes the receiving USART to detect framing errors. The normal option for the BIOS is to ignore framing errors. If a large number of continuous framing errors (>255) is detected the USART receive channel is turned off and checked only at one second intervals. This allows the terminal to be turned off (often causing continuous framing errors) without turning off the SAGE II computer. The computer can continue to execute a program without being continuously interrupted by the powered down terminal.

The optional mode for the BREAK key (or framing errors) is to enter the PROM Debugger. This mode should only be selected when troubleshooting programs at a low level. All normal program information is preserved and the program may be resumed by typing 'GO' to the Debugger. The Break key mode may be toggled by selecting the 'B' option.

III.03 REMOTE CHANNEL CONFIGURATION

Typing 'R' to the Configuration Manager prompt displays:

```
B(aud-rate, P(arity, S(top-bits, D(ata-bits, O(ptions, Q(uit?
```

The baud rate, parity, stop bit, and data bit selections are the same as described for the Terminal Channel. The O(ptions selection displays:

```
I - XON/XOFF for Input is Disabled
O - XON/XOFF for Output is Disabled
D - Data Set Ready is checked before transmitting
P - Polling interval (in 1/64000's second)  16000

Select option to change <CR for none>
```

The XON/XOFF protocol is a method used to keep the receiving system from losing data if the incoming data cannot be processed fast enough and the input buffer fills up. A typical case would be where data is being transferred over the remote serial link to be stored on a diskette. The buffer could fill up and overflow while the program is writing the previously received data to diskette.

Using XON/XOFF protocol, the receiving system will send an XOFF character (13H) when the receive buffer is nearly full (240 out of 255 characters). This leaves some room for the transmitting end to respond to the XOFF by stopping transmission. The receiving program will then process characters in the input buffer. When the amount of room available is 1/2 of the buffer (128 characters) the XON character (11H) is sent to turn the transmitting driver back on. This protocol can only be used where the XON and XOFF characters are unique and are never contained in the data. Thus this method will not work for transmitting binary images of files.

The XON/XOFF protocol may be configured for either direction of transmission or both directions of transmission. When set up in the Input mode, the receiver will transmit XON and XOFF characters to control the transmitting from the opposite system. When set up in the Output mode, the receiver will respond to XON and XOFF characters which are received to start and stop the transmit direction.

The 'I' and 'O' selections will toggle the Input and Output XON/XOFF selections between Enabled and Disabled.

The 'D' selection is provided to control a transmit check on Data Set Ready. When low level signal handshaking is needed on the Remote Serial channel, the Data Set Ready input should be used instead of the Clear to Send input (see writeup on Hardware- Printer Port). When a character is transmitted the DSR bit is checked. If DSR is not active, a delay is scheduled (value controlled by 'P' selection) before the next test. The 'D' selection will toggle the enabling or disabling of the DSR check. When the check is enabled, the 'P' selection will ask:

Polling interval?

This is the delay in 1/64000's second between polling attempts of the Data Set Ready signal.

III.04 FLOPPY PARAMETER MAINTENANCE

Typing 'F' to the Configuration Manager prompt requests:

```
    Select drive number (A or B or just CR quits) ?
```

When the drive is selected the utility will reply:

```
Current drive A setup:

SAGE double side, 80 track (1280 blocks)

A - SAGE double side, 80 track (1280 blocks)
B - SAGE double side, 40 track ( 640 blocks)
C - IBM single side, 40 track (320 blocks)
D - IBM double side, 40 track (640 blocks)
E - Network Consulting single side, 40 track ( 400 blocks)
F - Network Consulting double side, 40 track ( 800 blocks)
G - Network Consulting double side, 80 track (1600 blocks)
H - Softech Universal Medium, single side, 35 track (280 blocks)
I - No drive equipped
Z - Non standard type

Select floppy option (or CR to quit):
```

The appropriate letter may be typed to select the option desired. The 80 track (96 TPI) diskettes may only be accessed on systems with 80 track drives. The 40 track (48 TPI) diskettes may be read on an 80 track drive but cannot be written. Note that only SAGE 80 track or 40 track diskettes may be used to start (bootstrap) the system. The PROM driver used for bootstrapping does not handle all the varied formats which are configurable by the BIOS.

IBM initially provided only single sided drives on their personal computer. Therefore when they came out with double sided drives, they deviated from the optimum cylinder orientation so that the the same scheme would read both the single sided and double sided drives. With the IBM track format, data is stored in ascending track order on side zero and then back in descending track order on side one. The normal SAGE II method is to store data on side zero and then side one of each track before stepping the head to the next cylinder.

A special sector numbering scheme was developed by Network Consulting Incorporated 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. The SAGE II provides a compatibility mode to this format but does not attempt to automatically distinguish which format is being used. Note: Attempting to record ten 512 byte sectors of data on a track will generally work but does stretch the drive specifications. This format may not be reliable on all systems.

The 'Universal Medium' (TM) is a concept proposed by Softech Microsystems for distribution of UCSD p-System application software. This format is thought to be readable by the highest number of p-System implementations. The format may be written by 40 track (48 TPI) drives only but may be read on any SAGE system.

The 'Z' selection for Non standard type will bring up an alternate menu which allows changing low level parameters of the floppy disk driver. Note that most selections require knowledge of floppy disk recording protocols and possibly controller information. The alternate menu is shown below:

```
Current drive A setup:

A - number of Sides:      2     K - bytes per sector:     512
B - cylinders:           80     L - Gap 3 parameter:       42
C - sectors per Track:    8     M - Data length:          255
D - IBM track format:    No     N - Step rate:              4
E - Density:            Dbl     O - Gap 3 for format:      80
F - Retries               3     P - Pattern for format:   229
G - Ignore errors:       No     R - Skew for format:       0
H - Read 48 on 96 TPI:   No     Z - standard options
I - NCI 10 sects/trk:    No
J - Read after write:    No

Select item to change (or CR to quit):
```

Note that selections "F" and "J" are of great value in trying to recover data from bad diskettes. By increasing the number of times the computer tries to read the disk (F) some lost files might be recovered. The read after write option (J) checks the data just after it is written so that you will know immediately that you data was not properly saved.

Selecting 'A' will ask for 0, 1 or 2 sides for the diskette. Zero should be specified if the drive is not equipped. This will return an early error without having to go through a timeout process.

Selecting 'B' 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.

Selecting 'C' asks for the number of sectors per track. Typical values are 8 for 512 byte sectors or 16 for 256 byte sectors. Note that the Gap 3 parameter and the Gap 3 for formatting also must be modified for a specific Sectors per Track and Bytes per Sector combination. Also the density selection interacts with all these parameters.

Selecting 'D' toggles the IBM track format compatibility on or off. For double sided diskettes, data is stored in ascending track order on side zero and then back in descending track order on side one. The normal SAGE II method is to store data on side zero and then side one of each track before stepping the head to the next cylinder.

Selecting 'E' asks 'S(ingle or D(ouble density. The drives provided on the SAGE II will normally be used in the double density mode. The single density option should only be required to access data from another system which provides only single density drives. The Sectors per Track, Bytes per Sector, and Gap 3 values must all be coordinated with the density selection.

Selecting 'F' asks for the number of retries. This question should be answered with the number of retries that the diskette driver should make before returning an error. The system is normally shipped with 3 retries specified but this may be increased to attempt to access data on a marginal diskette. A carriage return is necessary as a multiple digit number may be typed.

Selecting 'G' will toggle on or off the ignoring of errors from the floppy controller. The controller errors should never be ignored in normal operation. This option is only provided to allow a head alignment procedure to be performed using a special alignment diskette which contains unreadable data. The driver must continue to read the diskette so that signals may be observed with test equipment, even though the controller is detecting errors.

Selecting 'H' will toggle on or off a feature which allows reading of 48 TPI diskettes on a 96 TPI drive. Note that writing to a 48 TPI diskette is not allowed because the 48 TPI drives cannot read the data. The 96 TPI drive is stepped two physical tracks for every track normally requested by the driver.

Selecting 'I' will toggle on or off an option to use a special sector numbering scheme developed by Network Consulting Incorporated. 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).

Selecting 'J' will toggle on or off an option to perform a read of information from sectors which have just been written. This Read after Write feature verifies that the controller can read back the information without detectable errors. This option slows down the writing process but should be left enabled as it provides a valuable "front-line" defense against bad media.

Selecting 'K' will ask for the number of bytes per sector. Typically this is 512 for 8 sectors per track or 256 for 16 sectors per track. Note that the Gap 3 parameter and the Gap 3 for formatting also must be modified for a specific Bytes per Sector, Sectors per Track and density combination. Note also that selections of Bytes per Sector above 512 are not currently supported.

Selecting 'L' will ask for the Gap 3 parameter (in decimal). This parameter is required by the controller for Read and Write commands to avoid the splice point between the data field and the ID field of contiguous sectors. The value depends on the combination of Bytes per Sectors, 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

Selecting 'M' will ask for Data Length. This parameter is only 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 is normally set to 255.

Selecting 'N' will ask for Step Rate. This is the number of milliseconds allowed between head step pulses by the controller. The value may be varied between 2 to 32 milliseconds (only even number values are supported).

Selecting 'O' will ask Gap 3 for formatting. Values for this parameter are used when formatting a diskette and are contained in the Gap 3 table under selection 'L'.

Selecting 'P' will ask for a Pattern for formatting. This value (0 to 255) is written into each data byte during the formatting of a diskette. The normal default value is 229 (E5 hex).

Selecting 'R' will ask for a Skew factor. This value is normally zero. The 10 sector per track formats generally specify a two sector skew to be formatted onto the diskette. This improves the performance when accessing the diskette over track boundaries. The IBM format is normally identical to the standard SAGE 8 sector per track format as the difference is only in where the data is written. On 10 sector per track diskettes with IBM format, the skew is reversed for head one because the tracks are accessed in decreasing order. The special NCI format also requires use of the IBM format selection.

Selecting 'Z' will toggle the menu back to the standard options.

III.05 MEMORY DISK

This option determines the size of RAM Disk and the size of the TPA (Transient Program Area). See the CP/M memory map for the locations of these areas.

Type 'M' <cr> to the Configuration Manager for these options.

If RAM Disk is enabled the screen will show:

RAM Disk Configuration

TPA is xxxK (RAM Disk fills remaining available memory)

E(nable / D(isable RAM Disk, Q(uit

If RAM Disk is DISABLED the screen will show:

RAM Disk Configuration

RAM Disk is disabled (TPA fills available memory)

E(nable / D(isable RAM Disk, Q(uit

Select one of these options:

E - asks " Enter TPA size in kilobytes? "
Type in the size of the TPA: EXAMPLE: 128
The size is in units of 1024 bytes (K bytes)
D - Disables RAM Disk.
Q - Exits RAM Disk configuration manager.

III.06 PRINTER CONFIGURATION

Typing 'P' to the Configuration Manager prompt displays the current printer configuration along with the menu:

```
Modes:
A( Printer on Remote Channel
   (set up using Remote serial channel parameters)
B( printer on parallel port with interrupts
C( printer on parallel port with scheduled polling
D( printer is disabled

L( inefeed after carriage return is printed
```

The 'A' option is used when the printer is to be driven from the auxiliary (Remote) serial channel. When used with this option the XON/XOFF protocol for Output or Data Set Ready protocol may be specified (under the Remote Configuration section) for printers which will provide this data to control system transmission.

The 'B' option is used for printers which conform to the standard Centronics parallel port protocol with an Acknowledge signal which produces an interrupt to say that the character has been received.

The 'C' option is used for printers which use the Centronics parallel port definition but rely on the system polling the Busy signal from the printer to determine when the next transmission is possible. Using this option, after a character is output the routine will poll the Busy line for a selected number of times. If the printer has an internal buffer it may 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 is scheduled which releases the processor for other work. After each delay interval the processor returns to check if the printer is busy. In this manner a normally polled printer will not completely tie up the processor. The 'C' option displays:

```
Printing on parallel port with scheduled polling
   P(olling attempts before scheduled delay     xxx
   D(elay in 1/64000's second before repolling  xxx

 Select P(olling, D(elay, Q(uit:
```

The 'L' option will toggle on on or off an option to inhibit the automatic printing of a Linefeed after each Carriage Return. Some printers cannot disable their internal Linefeed generation after a Carriage return. The p-System operating system does not have a standard method (via SETUP) of inhibiting automatic Linefeed generation during general output to the PRINTER: device.

III.07 SYSTEM PARAMETER CONFIGURATION

Typing 'S' to the Configuration Manager prompt displays the current System Parameter configuration along with the menu. This is an example of a typical setup.

```
A(Drive Configuration:
  1( Logical block size:       2048   3( Number of directory entries: 64
  2( Directory track offset:      2   4( Disk media:       removable

B(Drive Configuration:
  1( Logical block size:       2048   3( Number of directory entries: 64
  2( Directory track offset:      2   4( Disk media:       removable

E(Drive Configuration:(RAM Disk)
  1( Logical block size:       2048   3( Number of directory entries:  64
  2( Directory track offset:      0   4( Disk media:            fixed

F(Disk I/O buffer size:        4096
G(Number of disk I/O buffers:     3
Q(uit

       Enter selection (A - Q)?
```

A,B, or E ...Drive Configuration

The system configuration defines these parameters for each floppy and RAM Disk:

- logical block size
- directory track offset
- directory size
- whether the floppy is fixed or removable.

The RAM Disk is always considered fixed and has a track offset of zero.

NOTE: You cannot alter the drive configuration on-line, but you can view them. "On-line" changes will have no effect as they will not be updated.

Once a drive (A,B, or E) has been selected the screen will display:

Enter subgroup (1 - 4, Q)?

Typing 1 - 4 selects the corresponding subgroup as follows:

1...Block size (1024,2048,4096,8102,16384)?
This the logical block size used by CP/M-68K for disk allocation.

2...Directory offset (0-7) tracks?
This is the track where the directory starts (standard is 2).

3...Number of directory entries?
This is the number of entries in the directory. The number must be an even multiple of 32 (32,64,96...). Any other number will be decreased to the nearest multiple of 32.

4...Fixed or Removable
This switches the disk type from fixed media to removable media and visa versa.

Q...QUIT
Skips request.

F(Disk I/O buffer size:

Typing F from the SYSTEM CONFIGURATION menu will allow you to change the buffer size. The screen displays:

F - Enter buffer size in bytes

Enter the buffer size in bytes (the buffer size should be a track size) It will be rounded off to within 512 bytes. The maximum length is 16384 bytes and the minimum length is 512.

G(Number of disk I/O buffers:

Typing G from the menu will allow you to change the number of I/O buffers. The screen displays:

G - Enter number of I/O buffers (1 - 16)?

Enter the number of I/O buffers wanted. A maximum of 16 are allowed.

Q(uit Typing Q leaves system configuration. The changes will not be saved until prompted.

NOTE: CP/M does not use the clock features of the SAGE, so there is no ADJUST option here as there is in the p-System SAGEUTIL.

III.08 BOOTSTRAP COPY UTILITY

The Bootstrap Copy Utility is selected from the outer level Utility prompt line with the character 'B'. It is specifically for the SAGE II computer system. The routine will copy the bootstrap from blocks 0 & 1 of a device to another device or from a file to a device. The routine insures that the data is a SAGE bootstrap by checking the first four characters of the information for the characters 'BOOT'.

The Bootstrap Copy Utility will ask:

```
Source file or device <just CR quits> ?
```

Once a file or device number(examples A, A:) is specified the utility asks:

```
Ready to load bootstrap from file xxxxxxxx
or                              volume x
```

If the reply is 'Y' the utility will ask:

```
Destination file or device <just CR quits> ?
```

Note that a transfer of a bootstrap to a file is currently not supported.

Once the destination device number is specified the utility asks:

```
Ready to copy bootstrap to volume x?
```

If the reply is 'Y' <cr> the utility will perform the transfer.

III.09 FLOPPY DISK FORMATTER

The Floppy Diskette Formatter is selected from the outer level Utility prompt line with the character 'F'. This function is necessary to initialize diskettes with address information so that the hardware floppy controller can determine where to read and write the user's data. Caution: Formatting a diskette will destroy any previous data recorded on the diskette. The Formatter Utility will ask:

Drive to be formatted (A or B) ?

Once answered the utility will reply with the current configuration set up in the BIOS for that drive. The formatter will only format diskettes according to the current floppy configuration. If formatting for a different configuration is desired, the SAGEUTIL C(onfiguration option must be used to alter the floppy assignment. The format routine will ask:

Is diskette ready for formatting in drive x?

The user should make sure that the wrong drive (typically containing the system diskette) has not been selected, and that the diskette to be formatted has been placed in the drive before answering 'Y' <cr>. The utility will reply with 'Format Started' and print a dot for each track as it is formatted. The 48 TPI diskettes will print two lines of 40 dots (each cylinder has two tracks, one on each side of the diskette). The 96 TPI diskettes will print four lines of 40 dots. After the formatting information has been written the utility displays 'Verification' and reads back all the tracks, again printing a dot for each track processed.

After successfully formatting a diskette the utility will display:

Format Complete

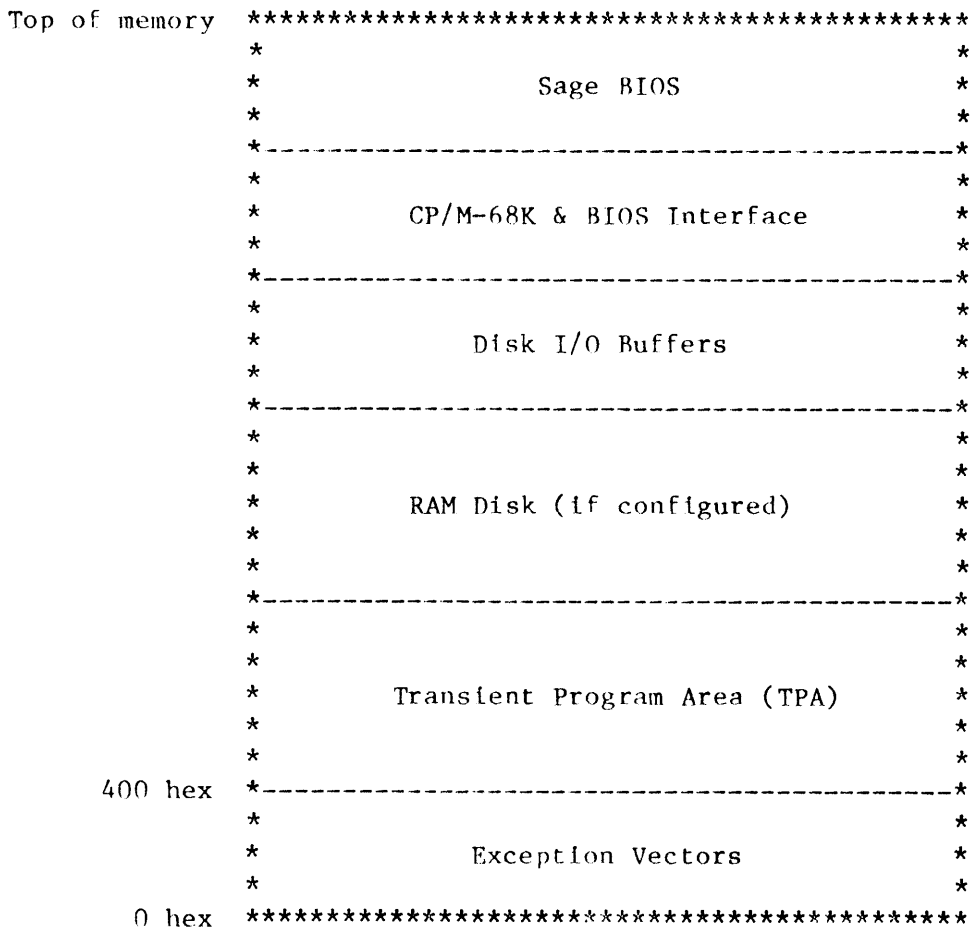
More diskettes to format?

If the user answers 'Y' the utility resumes by asking again if the diskette is reading for formatting.

If an error occurs (any error including soft errors), the formatter will inform you. The format process must complete without any errors in order to insure good data areas. If you consistantly have problems formatting disks, try changing to a better brand, or cleaning the disk heads.

IV CP/M-68K memory configuration

CP/M-68K, Sage BIOS, RAM Disk (if configured) and the Disk I/O buffers reside at the top of the available memory. The TPA starts at 400 hex (1024 decimal) and ends just below the CP/M-68K area. The following diagram illustrates the memory layout:



V Sage CP/M-68K Bootstrap loader (BOOT.S)

There are several differences between the standard release and the Sage release of the CP/M-68K bootstrap procedure. These differences are in the CP/M-68K bootstrap loader and the BIOS initialization routine.

The CP/M-68K bootstrap loader resides in the boot area of the disk at track 0. The PROM boot routine loads 1K of the bootstrap from disk to address 400 hex in memory and starts the bootstrap execution. The boot disk must be configured to support a logical block size of 2k blocks. The disk size itself must not be less than 257 blocks. The directory size and the directory offset are configurable by SAGEUTIL.

Once loaded, the bootstrap loads another 1k of code which is its own extension code. Then it reads the directory of the boot floppy and searches for the files SAGEBIOS.SYS and CPM.SYS. The positions of CP/M-68K.SYS and SAGEBIOS.SYS are found on the disk. Note: these files should be the first ones transferred to the disk when it is built so that they will load faster.

SAGEBIOS.SYS is loaded into the top of memory (see map).

The buffers areas are allocated in memory after SAGEBIOS.

CPM.SYS is loaded into memory just after the buffer areas.

The relocation data in read in to the TPA and the necessary address relocation is done for CP/M.

Control jumps to the beginning of CP/M. A program call _INIT starts. _INIT does the following:

Allocates the disk I/O buffers
Allocates the RAM Disk area if RAM Disk is configured
Checks the size of TPA.

If the TPA is larger than the available space, RAM Disk is automatically de-allocated to provide room. If there is still not enough room, the number of disk I/O buffers are reduced. At least one buffer will always be left. The Data in the TPA area is lost when CP/M-68K is rebooted from disk.

At this point the 'Sign-on' message appears:

CP/M-68K 1.1 (xxx TPA)

VI RAM Disk

RAM Disk is an optional area of RAM that is configured to look like a disk. It provides very fast temporary "disk" storage. It can provide a temporary file medium for the C compiler or the 68000 assembler.

RAM Disk will remain until CP/M-68K is rebooted. The PROM boot supports commands (IFR, IFR0, IFR1 etc.) to re-boot without clearing the RAM Disk contents but these commands are not currently implemented for CP/M.

RAM Disk is controlled exactly as the other disks used in the system except that RAM Disk does not use the disk I/O buffers and therefore does not need to be flushed. The BIOS interface contains the routines to drive RAM Disk. Requests can be made directly to the BIOS.

The RAM Disk size is configured by setting the TPA size, the disk I/O buffer size and the number of disk I/O buffers. RAM Disk is contained in the remaining memory. RAM Disk is considered drive E: when it is configured. RAM Disk cannot be re-configure on-line.

RAM Disk configuration control is supported in SAGEUTIL (Sage's utility routine).

VII Sage CP/M-68K BIOS Interface (BIOS.S)

The Sage BIOS contains the low level drivers for the disks, console, and printer. It is a memory image, location independent file which resides at the top of memory. Section X of Volume I of the SAGE Users' Manual describes the BIOS calls which are "TRAP" entry points.

The BIOS interface accepts BIOS requests from the BDOS or user programs and resolves them by calling Traps 9 - 15 to the Sage BIOS.

The BIOS interface uses the configuration information contained in the Sage BIOS to setup the disks for CP/M-68K. When a disk is selected for the first time, configuration information in the Sage BIOS is retrieved to generate the CP/M- 68K configuration data. See the section on SAGEUTIL for information on how to change the configuration.

The BIOS disk I/O buffers are used to convert the floppy format to the internal disk format of 128 byte sectors. The buffers also provide higher disk throughput. The buffer size should not be allocated larger than the track size of the disk. No matter how large the buffer size is, the maximum transfer size is limited to a track. Increasing the number of buffers however, can be used to enhance system throughput. The more buffers there are greater the amount of disk data kept in memory.

The BIOS uses a LRU (Least Recently Used) buffering scheme. The buffer which has been idle for the longest amount of time is used for current disk request. This enhances system throughput but can cause strange results if care is not taken when floppies are swapped. Always enter a CNTRL-C to "warm boot" the system when exchanging floppies.

After PIP is loaded into memory from the source disk, the disk can be replaced with another disk and a file transferred from that source without any problems. Changing the destination disk is not advised.

VIII CP/M-68K and Boot Generation

VIII.01 COPYING A BOOT

Normally you will not have to generate a boot. The SAGEUTIL BOOT COPY program will allow you to copy an existing boot from another diskette. Then using PIP copy the CPM.SYS and SAGEBIOS.SYS from the current boot disk to the new boot disk.
EXAMPLE:

```
A>SAGEUTIL

C(onfigure, Boot copy, F(ormat, Q(uit?
```

Type B and a carriage return to enter the Boot copy routine.

```
Bootstrap Copy Utility
Source file or device <just CR quits> ?
```

Type a: to load the boot file.

```
Destination file or device <just CR quits> ?
```

Type b: to store the boot file on the new disk.
Exit Sage utility routine.

```
A>pip b:=a:sagebios.sys
B>pip b:=a:cpm.sys
```

The new disk is now bootable.

VIII.02 BUILDING A NEW BOOT

The generation of the bootstrap loader (BOOT.68K) is accomplished with these steps:

1. First assemble the program BOOT.S to create the object file.

```
A>as68 -n boot.s
```

2. Link the object file to run at address 400 in memory.

```
A>lo68 -t400 -o boot.68k boot.s
```

3. Use SAGETUTIL to copy the binary file into the boot area. This is track 0, blocks 0-4 of the diskette.

```
A>SAGEUTIL

C(onfigure, Boot copy, F(ormat, Q(uit?
```

Type B and a carriage return to enter the Boot copy routine.

```
Bootstrap Copy Utility
Source file or device <just CR quits> ?
```

Type boot.68k to load the boot file.

```
Enter starting track ?
```

This is the track containing the directory (standard value is 2).

```
Enter number of directory entries?
```

This is the number of directory entries on boot disk (standard value is 64).

```
Destination file or device <just CR quits> ?
```

Type b: and a carriage return to write the loader to the destination disk.

Quit SAGEUTIL as the new bootstrap has been loaded on the destination floppy.

VIII.03 BUILDING CP/M-68K

In the SAGE version of CP/M-68K, the relocation bits are maintained in the CP/M-68K system file (CPM.SYS). Both the CP/M-68K file and the SAGEBIOS are stored in the user area of the boot disk.

CP/M-68K is generated with these steps:

The BIOS file is assembled producing an object file (BIOS.O).

```
A>as68 -l bios.s
```

This file is linked with the CP/M-68K library (CPMLIB) producing a relocatable CP/M-68K system file called CPM.REL.

```
A>lo68 -r -ucpm -o cpm.rel cpmlib bios.o
```

CPM.REL and SAGEBIOS.SYS are copied to the new boot disk.

```
A>pip b:cpm.sys=a:cpm.rel
```

CPM.REL is copied as CPM.SYS.

```
A>pip b:=a:sagebios.sys
```

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