I M P O R T A N T

Note that the M-F-B 2 system should only be moved or shipped with the heads "PARKed" in the special landing zone provided. See the M-F-B 2 Supplementary Information sheet for further details.

I M P O R T A N T

TABLE OF CONTENTS

1. INTRODUCTION

Congratulations on your choice of a Gemini microcomputer, the all British, full specification computer system which is about to lead you into a world of sophisticated yet straightforward computing.

For the technically minded, the Gemini is a 64k system using two Z80 microprocessors and supporting a variety of interfaces to allow it to control a wide range of peripheral equipment.

Your Gemini computer uses the industry-standard CP/M Operating System. CP/M (produced by Digital Research Inc) is in use on millions of microcomputers world-wide, and provides a standard interface between the Gemini and software, enabling literally thousands of applications programs to be run on the Gemini without modification.

For the non-technical, this simply means that you have bought a machine which compares with the best available microcomputers while retaining the simplicity of operation that makes this tool as easy to use as a typewriter or a pocket calculator.

Your Gemini computer system is based upon the MultiBoard range of microcomputer boards, which means that it has been designed for easy and extensive expansion. Possibilities include:

Additional 5.25", 8" or 3.5" floppy disk drives
A Winchester drive
Colour output boards, including high-resolution for CAD applications
Additional memory in various forms
Analogue to Digital Conversion
Additional RS232 Serial I/O
Parallel I/O
MultiNet local area network (lan)
Arithmetic co-processor
IEEE488 interface

The MultiBoard range is constantly expanding. Your local Gemini dealer can give you further details.

2. INSTALLATION

2.1. UNPACKING

It is almost certainly too late to tell you how to go about unpacking your machine, but there are still a few points well worth mentioning:

First of all, if you opened the carton with a knife, please check that the various cables have not been nicked. Apart from the obvious dangers of a damaged mains cable, computers are very keen on having the right signals in the right places and any suspect cables should be replaced - do not try to repair damaged cables unless you are absolutely confident that you know what you are doing.

Next, tempting though it may seem to throw away the packaging, we do recommend that you tuck it away safely in a store room or attic. Should you ever have to move the machine from one site to another or return it for repairs or servicing, the only safe way is in the original packaging which has been designed to afford maximum protection.

Finally, please check the contents of your carton against the list below to make sure that everything has arrived safely. If there are any items missing or damaged, then immediately contact the dealer from whom you purchased the computer.

Gemini computer
Keyboard
Video Monitor
Keyboard cable (may already be attached to keyboard)
Coax lead (computer to monitor)
Mains lead (computer to mains electricity supply)
Master CP/M disk

The following documentation is included with the computer:

The Gemini Computer Users Manual
Digital Research CP/M User Guide
Digital Research licence details and registration form
80-BUS News magazines

Technical Manuals covering MultiBoard Components are available separately from your Gemini dealer, and include:

GM813 CPU/RAM Hardware Manual
GM812 IVC or GM832 SVC Hardware Manual
GM812 IVC or GM832 SVC Software Manual
GM829 FDC Hardware Manual
Z80 CPU Manual
Z80 PIO Manual
WD179X-02 FDC Manual

2.2. SITING

The Gemini Computer is designed to operate in a normal interior working enviroment over a temperature range from about 10'C to about 40'C (approx 50'F to 100'F).

A dirty, dusty or damp enviroment is as objectionable to your Gemini as it would be to yourself. It is worth giving some thought to siting the equipment with a view to avoiding bumping into it, spilling coffee down the vents or accumulating industrial grime. The fan (at the back of your computer) and the ventilation slots should not be obstructed. The fan filter should be easily accessible so that the filter may be changed regularly.

Sites exposed to direct sunlight, radiators and other sources of direct heat should be avoided.

Please note the remarks in section 2.3 (Mains supply and fuses) concerning siting of mains supply outlets.

As a general rule, put your Gemini in a place where you would be comfortable spending a full working day yourself.

2.3. MAINS SUPPLY AND FUSES

Fit a suitable plug (preferably with an integral 3 amp fuse) to the mains electricity cable supplied with your Gemini.

Should it ever be necessary to replace the fuse in the mains plug, a 3A fuse must be used - any higher value puts your equipment and its guarantee at risk.

If the power-on indicator goes out, the fuse inside your computer may need replacing. This fuse should be replaced by your Gemini dealer if you have any doubts about either the cause of the failure or about your ability to perform the replacement.

The Gemini is not unduly sensitive to mains-borne interference but, as with all computer equipment, reasonable effort should be made to ensure a 'clean' electricity supply. You should avoid sharing a ring main with heavy equipment such as lift motors, photocopiers and the like.

Should you decide to install a mains outlet socket specifically for your Gemini, please ask your electrical contractor to ensure that the socket is not powered from the same phase as heavy duty motors. The outlet should be situated as closely as possible to your Gemini in order to avoid trailing cables.

The Gemini is factory set to operate on your local voltage. Should you plan to take the equipment to a place where the mains supply operates at a different voltage, please contact your Gemini dealer who will advise you on the modifications required.

2.4. INSTALLATION AND INTERCONNECTING

Please install your computer in the following order:

1) Fit a mains plug to the mains leads of the computer and monitor.

2) Plug one end of the keyboard cable into the connector on the back of the computer and the other end into the back of the keyboard case. (The keyboard end of the cable may already be attached directly to the keyboard.)

3) Plug the video cable into the back of the computer and to your monitor. A standard phono plug has been fitted (since this is the common type of connector used). If your dealer has provided a monitor with a different type of connector, please ask him to fit a suitable plug to this lead as well.

4) If a printer is to be used, connect this to the computer using the cable supplied separately by your dealer. If you want to make up your own cable, please check your connections against those shown in sections 8.2 and 8.3 of this manual.

5) Connect the monitor to the computer and mains supply.

6) Turn to section 4.1 before powering up.

3. THE MANUAL

3.1. ABOUT THE MANUAL

While this manual contains all the information you will need to install and operate your Gemini computer, it will not teach you to become a computer programmer. If you have purchased any programming languages or applications packages with your Gemini, then separate manuals will have been supplied and you should study these carefully to allow you to get the very best from your installation.

As a first step it is suggested that you read this manual thoroughly - not with the aim of becoming an instant expert, but so that you can develop a familiarity with the syntax, style and general layout of the computer.

This manual does not attempt to teach the user about CP/M or how to use the standard CP/M software. It covers the implementation of CP/M on the Gemini and as such it concerns itself mainly with the part of CP/M written by Gemini to incorporate the advanced features of your computer (this part being called the BIOS) and several augmentations to standard CP/M. It also covers the six Gemini-supplied routines FORMAT, BACKUP, READCAS, WRITCAS, SAVEKEYS and CONFIG. It is assumed that other CP/M manuals will be read in conjunction with this one. For those totally unfamiliar with CP/M books such as

The CP/M Handbook by Rodney Zaks, or
The Osborne CP/M users guide by Thom Hogan

will be found useful. As with most things with a high technical content, it may take several readings of the manuals before everything makes sense.

For those users wanting to get to more detailed grips with the innards of the machine there is a complete set of minor manuals describing each of the MultiBoard cards installed inside your Gemini. These are available from your Gemini dealer at a nominal cost.

3.2. SYNTAX USED IN THE MANUAL

If you have used a typewriter, you will already be familiar with the idea of having to press more than one key at a time (for example, using the SHIFT key in conjunction with an alphabetic character to give the upper case version of that character). Unfortunately the computer has a variation on this which, while it is simple enough to use, can cause some confusion to the newcomer.

The SHIFT key is used - just as on a typewriter - to give the upper case version of an alphabetic character and, in the case of most other keys, to give the upper symbol shown on the relevant key. In use the SHIFT key must be held down while the character key is being pressed, and this action is indicated in this manual as, for example, SHIFT/A. The CONTROL key works in the same manner as the SHIFT key, and the use of it is shown by either, for example, CONTROL/C or more usually ^C.

So far so good. Now comes the less familiar idea: Some keys are used to tell the computers that the sequence following their use are for internal use only. The ESCAPE (ESC) key is one of these and it is used rather differently from the SHIFT key. To make the use of such a key quite clear, it will be printed here as <ESC> 2 meaning that the first key must be pressed and then released before the sequence following is entered.

Beware of holding any key (other than CONTROL or SHIFT) down for longer than about half a second, since the entry will 'auto repeat'.

Computers respond to numbers presented in binary notation. In order to make this more intelligible to humans, control programs and their like convert ordinary numbers into binary groups. However, by convention (and because IBM originally liked it) Hexadecimal notation is often used. Hexadecimal numbers are to the base sixteen and use the numbers 0 to 9 and the letters A to F, and where they are used in this manual they will generally be followed by the letter H. For example, the decimal number 123 is equivalent to 7BH in hexadecimal notation.

If Hexadecimal notation leaves you completely numb for the moment, don't worry. Wherever it may be necessary for you to enter hexadecimal numbers (and you need never do so unless you want to change our implementation of CP/M, use Assembly Language, or use the most advanced features of our Video Controller to alter the video presentation) these are given in the documentation.

4. OPERATION AND SOFTWARE

4.1. POWER UP PROCEDURE & USE OF DISK DRIVES

Please refer to Section 2.4 for installation and interconnection details.

This section assumes that you are now in front of a minimum Gemini computer consisting of:

COMPUTER
KEYBOARD
MONITOR

If a printer is to be connected, please check that the pin-out of your cable matches the description given in Section 8.2 (for a parallel printer) or Section 8.3 (serial port).

Please follow the following instructions step-by-step:

1) With the mains turned off at the power outlet (wall socket etc) plug in the computer and video monitor.

2) Ensure that there are no disks in the disk drive unit(s).

3) Turn the mains on at the power outlet.

4) Turn the monitor on according to the instructions in the manufacturers handbook and allow it about a minute to warm up. Check that the power-on indicator (if fitted) shows on.

5) Turn the computer on. The power-on indicator will light.

6) Adjust the brightness and contrast controls to give the clearest display possible.

A display should appear on your screen telling you to insert a disk in drive A. If it does not, then please check that all the power-on indicators are alight before calling your Gemini dealer for advice. It often helps to have a second person try to get the system running before giving up in despair!

You can now call in the CP/M operating system which gives you access to all the software provided. Please turn to Section 4.2, Entry to CP/M for further details.

When your system is awaiting insertion of a disk after power-up or reset, you can enter CONTROL/S to put your Gemini under the control of SIMON (see section 7.3).

USE OF THE FLOPPY DISK DRIVES

To Insert A Disk
Place the disk in a drive slot with the write-protect notch uppermost and with the oval read/write cutout pointing inwards.
Push the disk firmly in as far as possible.
Push the door flap to the left to lock the disk into place.

To Remove A Disk
Ensure that the disk is not being accessed - the simplest way is to look at the drive access light. Wait until they are both out before removing a disk.

1015 type drives:
Push the door flap to the left to release the disk lock.
Then push the door flap to the right to eject the disk.
Withdraw the disk from the drive.

1115 type drives:
Open the door flap by placing the thumb under it and pulling to the right.
Withdraw the disk from the drive.

NOTE:
It is very important that you do NOT use the master CP/M disk supplied with your computer for your day-to-day computing. The master disk is supplied with a write-protect label (silver, on one edge) fitted, and this should NOT be removed as it protects the disk from accidental erasure or deletion of files.

You should normally work with a COPY of this disk. This should be done by FORMATTING a blank disk (see section 6.1) and then taking a BACKUP copy of the master disk (also section 6.2).

4.2. ENTRY TO CP/M

Following power-on or reset your Gemini clears the screen, puts up a sign-on message, and then monitors the disk drives waiting for a Gemini CP/M system to be loaded from drive A. As soon as it finds one it will automatically load and execute the CP/M. If no disk is present, or the drive door is not closed, it will look to see if a Winchester disk drive is present. If there is no Winchester drive, or if there is one present but it is not yet 'ready' (this taking approximately 30 seconds after switch-on) a message will appear:

"Insert Disk in drive A".

The message will blink on and off until the Winchester drive is 'ready', or until a disk is placed in the floppy disk drive and the drive door closed. Once this has happened the monitor will attempt to read in the first sector of the first track of the disk, which should hold the loader that will be used to read in the full CP/M system. If no errors occur the CP/M system will load and the CP/M sign-on message will appear, followed by the usual CP/M prompt, "A>".

If the CP/M system does not load, the most likely error message will be -

"*** No GEMINI CP/M system on this disk ***".

This means that the disk in drive A does not contain a valid Gemini CP/M system on its system tracks, and so it should be replaced by one that has. When the drive door is opened to remove the disk the message will revert to

"Insert Disk in Drive A".

Two other possible error messages may occur. These are:

"Read error while loading the Boot sector - press any key to repeat", and

"Read Error during System load - press any key to repeat".

In these cases the software has been unable to read the disk successfully, and the load has been halted. At this point two options are open. The first is to press any key on the keyboard which will result in a new attempt to load the CP/M system. This may be all that is necessary, as, because of the small amount of space available, the Read routines do not contain any sophisticated retry procedures, and just give up at the first sign of trouble. If the error message is repeated, then the fault is likely to be with the particular disk being used, and it should only be necessary to use another disk (containing a system) to start the system up. In the case of a Winchester unit it may be necessary to put a fresh CP/M system onto the system track.

Once in CP/M you will have access to all of the facilities described below. With floppy disk based systems you are advised to use the BACKUP routine to create a working CP/M disk. Users of Winchester based systems are referred to the additional section that will have been provided with this manual. In all cases, your master disk should not have its write protect tab removed and should be stored in a safe place.

If you type CONTROL/S whilst the "Insert Disk in Drive A" message is flashing, control will be passed to the SImple boot MONitor (SIMON) and a range of simple commands will be available (see section 7.3). Whilst under the control of SIMON the system will ignore the disk drives totally, unless the BOOT command is given.

4.3. RESET, OR WHAT TO DO WHEN IT ALL JAMS UP

At the rear of the machine you will see a black button marked reset.

It can happen, particularly when using ESCape sequences inappropriately, that your computer freezes totally and refuses to respond to any keyboard or program commands. The most common cause is that it is waiting for an external signal such as a handshake from a non-existent printer or an empty light-pen socket.

To recover from this it is necessary to get a signal directly to the heart of the system, by-passing all the normal input and output systems. The answer is the RESET button which is linked directly to the Z80 chip where it forces a RESET cycle (see Mostek MK 3880 CPU manual for further details if required) over-riding any software instructions.

The computer responds to this by behaving exactly as though it had just been switched on (in fact a reset pulse is delivered automatically at power-up) and you will have to re-boot your CP/M disk (see section 4.2 - Entry to CP/M) if this has been removed.

Use of the RESET button is A) a last resort, and B) dangerous if certain procedures (such as a write to disk) are taking place. That's why the button is hidden away at the back of the machine.

TRY TO AVOID IT.....

4.4. USE OF THE KEYBOARD

The following instructions apply only to the keyboard supplied as standard with the Gemini. Should you for any reason change this keyboard for another, you should refer to the appropriate manufacturer's handbook for details.

The precise response of your Gemini to any keyboard entry will depend, in part at least, on the software currently controlling the computer. The following description assumes that you are working in conjunction with the computer freshly turned on and under the control of CP/M.

Rollover
The keyboard has n key rollover. i.e. if the pressing of any number of keys overlaps, the electronics will be able to distinguish each individual key from any others, and will treat them all as separate keystrokes.

The Keyboard Buffer
The keyboard buffer will store up to 64 characters as they are entered, even though the computer may be too busy to display the entries or to respond to them at the time of entry.
In other words, whenever you type a series of key commands the computer will remember that these have been entered and will respond to them as and when it is ready. It is important to be careful when anticipating a series of entries and to be absolutely sure that you know what you are doing.
Certain software packages will ignore the first character typed into the buffer. In such cases type a space before making your entry. Some packages will abandon their current operation if a character is typed whilst they are running and certain others will discard all characters that are typed whilst they are running. In these cases type-ahead may not be used.

Alphanumeric Keys
The main body of keys forms an almost standard typewriter and you will find that pressing any of them results in the letter or character shown on the keytop being displayed on the screen.

Repeat Keystrokes
Holding a key down for more than about half a second results in the Auto-Repeat taking over. The key will be repeated at a rate of about ten characters a second until the key is released. This provides a considerable saving in both wear and tear on both the keyboard and your fingers!

Shift Keys
You will notice that everything appears in lower case (small letters) on the screen. Holding either of the SHIFT keys down while you type will result in upper case (capital) letters being displayed. Similarly, holding a SHIFT key down while you press a numeric key results in the second (upper) character on the keytop being displayed, and in the case of the Function Keys provides a second set of user-definable keycodes.

Caps. Lock
Press the key marked CAPS LOCK; it will either stay down, or a light will illuminate within the key, depending on the keyboard type. From now on all alphabetic characters will appear in upper case only. There will be no change as far as any of the other keys are concerned. Pressing the CAPS LOCK key again will release it, and the keyboard will revert to its previous mode.

Escape
The Escape key (marked ESC) returns the code 1BH to the computer. This will be used by certain applications programs to quit the particular operation in progress.
If used under 'Edit Mode' this key can be used as the first part of a control sequence by the Video Controller. (See 'On-Screen Editing' and section 7.1.)

TAB
The TAB key will advance the cursor to the next tabulate position. The TAB key returns the same code as CONTROL/I and may be used in its place.

Control Characters
By holding down the CONTROL key and typing certain letters, control commands will be sent to the computer. The supplied manual on CP/M details the functions of these commands. Note that certain CONTROL codes are available on the Gemini keyboard as a single key. For example:

TAB	=	CONTROL/I
BACKSPACE	=	CONTROL/H
RETURN	=	CONTROL/M

Backspace and Delete
The BACK SPACE key allows you to move the cursor back along the line (from right to left), and as it moves it erases any characters that it comes to. This is used mainly for correcting typing mistakes at the time of entry. In certain application programs the BACK SPACE key may move back along the line, but not erase the characters. In these instances the delete (DEL) key is usually used to remove unwanted characters.

RETURN
The use of the RETURN key indicates to the computer that the instruction line just entered is now complete and ready for interpretation by the controlling software.

EDIT
The EDIT key is used to put the Gemini into 'Edit Mode' (see 'On-Screen Editing'. It can also be used for redefining the Function keys directly from the keyboard. (Note that it can also redefine itself!!)

The Function Keys
The keyboard has additional keys in the form of a row of special function keys along the top of the keyboard, (labelled F0-F9 and EDIT), four cursor control keys, and a separate numeric pad to the right of the main keys. These additional keys, in both their NORMAL and SHIFTED modes, may be programmed (via the Video Controller Boards software) to return one or more characters to the host computer every time that they are pressed. In order that the Video Controller can distinguish these special keys the keyboard returns unique double-byte codes from these keys. The Video Controller software replaces each double-byte code by a single character or string of characters from an internal table. This table is held in the workspace RAM of the Video Controller, and may be modified at any time, either by program, or directly from the keyboard. On Power-up or Reset an initial table is copied into the Video Controller RAM. The necessary information is given in the Video Controller manual for those able to program type EPROMs who wish to change the default strings.

Each of these keys, with the exception of shift/EDIT, can be re-defined to produce any character or string of characters required. For example F0 could be set up to hold the string "pip a:=b:*.*[v]<CR>". The key definitions may be set up in two ways:-

a) By the User at the keyboard, and
b) By program using an escape sequence.

Defining keys from the keyboard.
Typing shift/EDIT on the keyboard will draw the response:

*** List/Edit a Function key ***

If a function key is now pressed, the current definition of that key is listed on the screen. All control codes in the string are displayed in the expanded form of ^<character> (e.g. a carriage return would appear as ^M). This is followed by the message:

*** List/Edit complete ***

The Video Controller Board's monitor program has put this information directly onto the screen, NOTHING HAS BEEN SENT TO THE HOST COMPUTER and it is totally unaware of what has happened.

If instead of hitting a function key shift/EDIT is pressed again the following string will appear:

*** Press the function key to be defined, then type in a string ***
*** followed by any function key ***

At this point you can select the function key you wish to redefine. Type it followed by the string you wish to enter. As you type in the string it will be echoed to the screen, once again with control characters being expanded to the form ^<character>. NOTE it is assumed that any character typed is to be part of the string, thus if you hit "backspace" ^H will appear on the screen and the control/H will be entered into the string. If you make a mistake you will have to start again.

The entry of a new definition is ended when any function key is pressed. (No recursive definitions are allowed!). At this point the following messages will appear:

*** New definition entered ***
*** List/Edit complete ***

If no string was entered the function key will no longer return any characters, and if the key is "listed" the following message will appear:

*** Function key undefined ***
*** List/Edit complete ***

As above, the Host system IS TOTALLY UNAWARE of what is happening, and it is possible to re-define the keys at any time in this manner.

If you get too carried away with your definitions you will see the message:

*** IVC internal error - table overflow ***

This should not normally happen as the table can use up to 512 bytes which gives an average of about 8 characters per key (assuming the numeric pad is redefined as well).

N.B. It is perfectly possible to enter a null string for a key definition and effectively disable it. (It will be ignored until redefined).

Defining keys by software.

A key, or number of keys, may be redefined by software by using an escape sequence (<ESC> f ...) within the User program - see the Video Controller section. Variations of the same sequence will also:

a) reset the key definitions to their default (or power-up) state.
b) cause the Video Controller to send to the Host the table of the current function key definitions.

Creating keyboard re-definition programs.

The simple routine SAVEKEYS is supplied on the Gemini master disk, and is described in the Video Controller section. This is for setting up COM files holding particular sets of key definitions. Thus it is possible to easily set up files such as KPEN.COM and KWS.COM that could be executed before running programs such as PEN or WORDSTAR to customise the key settings appropriately. When run SAVEKEYS invites the user to use the SHIFT/EDIT mode to define all the function keys to his requirements. When this has been done the current function table is read and written away to disk along with a small program which will reload it.

Special Keyboards

The keyboard of your Gemini computer is also available in special versions. Currently special keyboards arranged for German, French, Danish and Swedish use are available. Contact your local Gemini dealer for further details.

5. SPECIAL FEATURES

5.1. DISK ERROR HANDLING

The Gemini CP/M BIOS traps all disk errors and reports them to the user specifying the drive, track and sector they occured on together with the type of error that occurred. Three options are then offered:-

a) Y - Retry (note up to eight retries may have already been attempted).
b) N - Return the error to CP/M (in which case a BDOS error message will appear).
c) ^C - Abort and restart by typing ^C.

If an error occurs on a floppy disk drive then, before typing in any command to the computer, check that there is a disk in the drive, that the disk is the correct way round, and that the drive door closes correctly. It is also sometimes useful to remove the floppy disk from the drive, and then replace it, closing the drive door slowly - this may have the effect of repositioning the disk more accurately. Having done the above, type 'Y'.

Possible error messages are:-

Not Ready — Occurs if the drive door is open (or there is no disk in the drive) when the software tries to read a disk in that drive. If desired a disk can be inserted and/or the door closed and "Y" typed in order to continue.

Disk Write Protected. — Occurs when an attempt is made to write to a disk with a write-protect tab fitted. Either remove the tab and type "Y" to continue, or ^C to abort.

Write Fault — This message is caused by a signal from the disk drive itself.

Record Not Found. — Occurs when the controller has been unable to locate an error free header record containing the correct track and sector numbers, or it has been unable to locate the following data block. If it is possible to read the disk after several attempts of typing "Y" in response to the Retry? request it is advisable to copy the disk to another one and to reformat the one giving errors. If the error persists the information in that sector will have been lost.

CRC Error — A CRC error has occured in a data block. For comments see above. If it is a source file that is being read it may be possible to ignore the error (type "N" in response to retry? and <return> in response to the BDOS error message) and, if it is a minor one, find it and correct it within your editor.

Lost Data — This should not occur. If it does it implies that the CPU clock rate is too slow. The minimum CPU clock rate that the software can run with is 2MHz without any Wait States.

5.2. ON-SCREEN EDITING

Limited on-screen editing has been provided within the Gemini CP/M BIOS. It must be emphasised from the start that CP/M itself does not cater for this, and so this feature is a compromise, and if invoked at the wrong time can have some unexpected results.

The assumption made within the Gemini CP/M BIOS is that when this feature is invoked CP/M will be in its "buffered line input" mode. (i.e. the running program or the CCP has requested input via the BDOS function call 10, or handles input in a similar manner.) Thus 'Edit Mode' may be used any time the system is in command mode (i.e. When there is a CCP prompt (e.g. A>) at the beginning of the current line, and also within certain programs (e.g. MBASIC).

The edit mode is entered by pressing the EDIT key or by typing Control/@. (To change this character see CONFIG and SAVEKEYS.) The system acknowledges that it has entered edit mode by changing the form of the cursor to a solid non-blinking cursor. The cursor control keys become operative, and the cursor can be positioned anywhere on the screen and the display corrected or changed. Shift/<- and shift/-> will delete characters from a line, or enable new ones to be inserted. Shift/<cursor-up> and Shift/<cursor-down> will delete existing lines from the display, or insert blank lines.

When in 'Edit Mode' it is also possible to use a number of the Video Controller commands directly - in general these are the SINGLE and DOUBLE byte commands that do NOT request any information back from the Video Controller. All of these commands are given in the Video Controller section. For example, if the line being edited is some way back up the screen, the screen can be partially cleared by moving the cursor to the end of that line and typing <ESC> % (clear to end-of-screen); part of a line may be cleared by typing <ESC> * (clear to end-of-line); the screen may be inverted by typing <ESC> I, or restored to normal by typing <ESC> J; and so on. It is probably worth spending some time 'playing' with all the various options just to see how powerful and useful the 'Edit Mode' can be. Note that if certain multiple byte commands are used, or any command that requests characters or data back from the Video Controller, then it is likely that the system will 'lock'. It will then be necessary to 'reboot' the system - see Sections 4.2 and 4.3.

N.B. If it is desired to enter any control characters on the line being edited they must be entered with a leading ^ - i.e. exactly the way CP/M echoes a control character. (Note that this is only applicable within edit mode). If a control/Z is required in the line then ^ followed by Z should be typed. If the line being edited contains an up-arrow character then this should be preceeded by another ^ to prevent the following character being converted into a control character. i.e. ^^ is converted to a single ^ when return is pressed.

When "Return" is typed the contents of the line currently holding the cursor are returned to CP/M, the edit mode terminates, and the cursor is reset to its previous form. Note, therefore, that only lines up to 80 characters long may be edited. The edit mode routine automatically leaves out any prompt at the start of a line from the character string it returns to CP/M, and so these do not have to be specifically edited out. This only applies to the following prompts:- A> B>..etc * - and #. Any others should be edited out.

5.3. SCREEN DUMP

The contents of the screen display can be 'dumped' to the currently selected list device (printer). This feature can only be used within 'Edit Mode', and is invoked by typing CONTROL/D. In response to this a string of 80 asterisks will be output to the printer followed by a copy of the current contents of the screen. The listing is then delimited by another string of asterisks.
Note that the normal restrictions of entering 'Edit Mode' still apply.

5.4. DRIVE M

Support is provided for the addition of a "Memory drive" - Drive M. This feature utilises either the page-mode feature of the Gemini GM802 and GM862 RAM boards (which is also included on the GM813 CPU/RAM board used in the Gemini), or the Gemini GM833 512K RAM-DISK board, and requires that one or more of these boards is added to the system. The Gemini CP/M BIOS treats this additional memory as though it were a disk drive, responding to the CP/M logical drive letter of M (for Memory). As no mechanical movement is involved in accessing this drive, and the data transfer rate is very high, this drive has a very high performance even exceeding that of Winchester drives. Thus the run-time of any program that requires any amount of disk activity, either through having various overlays or manipulating data on disk, will be considerably enhanced by running it on drive M.

However unlike Winchester drives and floppy disks drive M is volatile, and all data on drive M is lost when the system is powered down. Thus it is necessary to copy the relevant programs/data files to drive M initially, and to copy any changed files back to a disk before powering down.

When the BIOS "cold starts" it checks the M-drive to see if it has already been initialised. If it appears that the drive is already in use no intialisation is performed. Thus the Reset switch on the system can be pressed without losing the contents of the M-drive. One side-effect of this is that if the M-drive directory is corrupted by a run-away program - an extremely unlikely event - it may be necessary to power-down the system and start again in order to make the M-drive operable once more.

To use the M-drive one of the following hardware configurations is required:

a) The system memory resides in page 0 of the four possible pages. (GM813, the CPU/RAM board used in the Gemini, is already configured for this.)
   Up to three additional GM802 boards (or one GM862 board) may be added to the system, each board (or bank) having its page-mode enabled, and each board (or bank) being set to successively higher page numbers. (i.e. One extra board (or bank) should be set for page 1, two extra boards (or banks) for pages 1 and 2 respectively, and so on.)
   Finally two locations in the BIOS should be patched so that the software knows what it has to support. This can be done using option 8 of CONFIG.

b) GM833 boards may be added to the system, the first board having its 'Track' address set to 0, and each additional board being set to consecutive addresses.
   Depending upon the exact configuration of the Gemini CP/M system being used, the BIOS will either set itself up automatically, or will require one location of the BIOS to be modified. Again, option 8 of CONFIG should be used, and this will give full instructions.

6. UTILITY ROUTINES

The following routines are supplied on your CP/M disk to provide additional, easy to use facilities not available under standard CP/M.

FORMAT
BACKUP
READCAS
WRITCAS
CONFIG
SAVEKEYS

6.1. FORMAT

This program is used to **Format** and/or **Verify** disks before use.

On running it will clear the screen and ask for the skew required (see below for an explanation of skew). A skew of 2 is suggested, but experiment to see which suits your application. Too small a skew will increase the delay between typing ^C and getting the CP/M prompt, though it may well speed up the loading of .COM type files. Too large a skew will slow the disk system down unnecessarily.

Following this a prompt for the drive to use will appear. Type the desired drive number (A, B, C or D). (Note that the Format program only formats the floppy disk drives, and with Winchester based systems A will correspond to the first FLOPPY disk drive, B to the second FLOPPY drive, etc. Also note that the Format program is intended for use with 5.25" disks only.)

You may then enter **F** to format the disk or **V** to verify that the disk is readable by the system. **V** is a non-destructive routine and may be used on disks containing "live" data. The **F** command automatically performs a verification after formatting.

Following the formatting sequence, and before verifying the disk, the program comments on the average drive rotational speed. It will either say "Average drive speed Ok", or "Average drive speed out of limits". In the latter case the drive speed has been found to be more than 1.5% in error, and steps should be taken to have this corrected.

During the verification phase the software will report any time it has to re-read a sector, and also displays the error type returned by the disk controller. After four retries the head is restored to track 0 and the software tries again. Once the retry count reaches eight that sector is considered unreadable and is abandoned, the software moving on to the next sector. Ideally no retries should occur, but possibly one or two might. Any disk that produces a large amount of retries should be regarded with suspicion, and any one that has an unreadable sector should not be used.

Format contains its own in-built disk drivers and does not use any of the Gemini BIOS routines for disk access. It is for this reason that any Winchester drive is ignored.

Format Technical Information

The following section is provided to give the user an insight into the technical philosophy behind the floppy disk format chosen for the Gemini system. It is not required reading for general use of the equipment, and may be omitted.

Disk format

The disk is formatted in double density, and uses a physical sector size of 512 bytes. By using a larger sector size than the original CP/M 128 bytes it has been possible to increase the storage capacity of a disk. Each track of the disk holds 10 sectors, and there are 80 tracks on the disk. However due to the blocking/deblocking (see on) CP/M sees a disk of 80 tracks with 40 128-byte sectors per track. Two tracks have been reserved for the system, and because of the capacity of the disk (390k) the directory size has been set at a maximum of 128 entries. (Use STAT DSK: to see this). (Double-sided drives, as fitted to certain models of the Gemini range will have the same number of sectors per track, but will have 160 tracks - 80 each side).

In order to be upwards compatible with double sided drives, the disk definition tables within CP/M have been set up so that disk space is allocated in blocks of 4k bytes. If it had been set up for the more usual 2k allocation, the internal formats of the double-sided and single-sided directories would have been incompatible.

Blocking/Deblocking

All CP/M software transfers data to and from the disk 128 bytes at a time. This is due to the fact that this was the sector size on the machine that CP/M was originally written for (and is also a widely used IBM standard). It is only now with new technology and increasing packing densities that larger sector sizes become more attractive. In order to achieve this and still be compatible with previous CP/M software, (and also to allow programs to maintain economical 128-byte buffers rather than larger ones), some software is interposed between CP/M and the disk drivers. This software maintains a physical sector buffer in memory (512 bytes in size in our case) through which all the CP/M data transfers are passed. Those who are interested in the inner workings of this software are referred to the CP/M 2.2 Alteration Guide, section 12 and Appendix G.

Sector skewing

In the literature on CP/M you may come across a mention of "sector skew". The reason for sector skew and how it is achieved is explained below.

If CP/M accessed the sectors of a track sequentially the response of the disk system would be extremely slow. The reason for this is that often after one sector of the disk has been read the controlling program spends a short time processing before it reads the next sector. In the simplest case BDOS will be calculating the next sector of the file and setting up the disk drivers for the next transfer. An example of a longer process is the warm boot, when the reloaded CP/M system proceeds to read the directory of the disk on the logged-in drive. After reading a sector it proceeds to extract the disk allocation information from the directory entries in that sector before reading the next sector, a process which can take some milliseconds to complete. By the time the next transfer is requested the read head of the

drive will be well past the header record of the next sector, if not several more sectors as well. If the next wanted sector was the one that physically followed the previous one, then a delay of almost one complete disk revolution would occur before the requested sector could be read/written. To get round this problem CP/M utilises a sector translation routine within the BIOS. This uses a look up table to translate a logical CP/M sector number to a physical sector number on the disk surface. The translation table for example may start 1,4,7,10... which would mean that the software has the time it takes two sectors to pass the drive head available to it before it will miss the next wanted sector and have to wait.

The time delay between disk accesses, (and hence skew required), is application dependent, and CPU clock rate dependent (the slower the clock rate, the longer the processor takes). So rather than selecting a compromise value for the Gemini format, no translation at all is done within the BIOS. To obtain a skew the disk is formatted with the sectors in a jumbled order, rather than being in sequential order, so that when the sectors are read/written in numerical order, a delay of several physical sectors can occur before the next wanted sector is found. This can be done by the format program as sectors are identified on the disk not by their physical position in relation to the index hole, but by the sector number written into the sector headers by the format program. For example if the Format program is told to use a skew of two it writes the sector numbers on the disk in the following order:- 0,4,7,1,5,8,2,6,9,3. From this it can be seen that having accessed one sector, two other sectors must pass under the head before the sector with next sequential sector number is found.

By taking this approach a skew factor can be chosen to suit an individual system, and yet the disk can be successfully read on any other Gemini system. This is because the skewing is achieved by placing the sectors in different positions on the disk while still maintaining physical sector numbers (as read by the 1797 FDC controller integrated circuit) that match the logical sector numbers. By contrast the table translation method with a skew of two would access the physical sectors in the order 0,3,6,9 etc, and one with a skew of three in the order 0,4,8, etc.

6.2. BACKUP

This utility has been provided as a means of making backup copies of floppy disks. The CP/M PIP utility can obviously be used for this purpose, (e.g. PIP B:=A:*.*[V] to backup all files on drive A to drive B), and has the advantage that it repacks the files on the disk on the way, but it can take a long time to copy a large number of files. Also a separate program (SYSGEN) has to be used to copy the CP/M system track across.

On running BACKUP it prompts for the source and destination drives. It is permissible to enter the same drive letter for both drives. In this case BACKUP will pause before loading the buffer from the source disk and will ask for it to be inserted. Similarly it will ask for the destination disk to be inserted before writing the buffer out. This will be repeated until the source disk is copied. The larger the size of the running CP/M system (and hence BACKUPs buffer), the sooner the copy will be completed. In the single drive case it is advisable to Write Protect the source disk with a tab to guard against inserting it at the wrong time. Note that BACKUP only works with 5.25" FLOPPY disk drives. With Winchester based systems BACKUP may be used to duplicate floppy disks - in this case note that the first floppy drive will be taken as drive A, the second as drive B, etc.

BACKUP includes its own disk drivers and physically copies a direct image of the source disk to the destination disk (including the system track) and then verifies it. The copy procedure terminates when the end of the disk is reached, or when it reads a entire buffer of 0E5Hs indicating that CP/M has not written any data past that point. (The Format program fills all sectors with 0E5H). There is no blocking/deblocking and no CP/M overhead of opening and closing files. Hence it only takes a few minutes to make an up-to-date copy of a working disk. It also provides an easy way for people with single drive systems to backup their disks.

6.3. READCAS and WRITCAS

These two routines allow CP/M files to be written to and read from a cassette recorder connected to the 1200 baud Kansas City (CUTS) cassette port at the rear of the machine. See section 8.7, cassette socket.

The command **WRITCAS FILENAME.EXT** will dump the disk file **FILENAME.EXT** out to cassette, giving it the name of **FILENAME** without any extension.

The command **READCAS FILENAME** will allow a file to be read in from cassette and stored on disk under the name **FILENAME**. (Note there is no type included in the filename).

The routines automatically set up the 8250 UART for the cassette transfer, and on completion of the read/write, reset it to its previous setting of baud rate and selection of cassette or RS232 interface. The tape format used is the same as that used by the RP/M operating system fitted to non-disk Gemini systems. Thus these two routines provide the means for transfering user-written programs between CP/M and RP/M. RP/M is the Monitor program that is supplied with the Gemini MultiBoard system, when used in a small cassette based environment. This compatibility allows files to be transferred between cassette-based and disk-based systems.

6.4. CONFIG

The CONFIG utility has been provided to ease the problem of customising the configuration of the Gemini BIOS on your CP/M disk to your personal requirements.

Details of printers, baud rates, cursor styles and so on may be defined using this self-documenting, menu-driven program that will directly modify the patch area (see section 7.2) of a CP/M system, whilst displaying the effect of the changes it is making.

Since this program will re-create your CP/M in a modified form, on floppy disk based systems you should only run CONFIG with a copy of the master disk supplied. The master disk should be stored safely with its write-protect tab left permanently in place.

CONFIG is run by typing CONFIG **filename** where <filename> is a valid CP/M file name (e.g. b:movcpm.com). This file should be either a copy of **MOVCPM.COM** or a system image that has been saved after MOVCPM has been run (e.g. **CPM64.COM**). If <filename> is omitted then CONFIG will load the **system** track off the default drive, and modifications can be made to this.

If <filename> or the system track does not contain a valid system image then CONFIG will output an error message and return to CP/M. Once CONFIG is loaded and has verified that the named file contains a valid system the main menu will appear offering the following options:-

0. Exit to CP/M permanently recording any changes
1. Change I/O drivers used (IOBYTE)
2. Set cursor appearance
3. Change "Edit mode" character
4. Change the Uart paramters
5. Change I/O port assignments (if I/O board added)
6. Set up LIST control
7. Set up an "Auto Execute" command
8. Set up a "Memory drive"

Typing any number in the range 0-8 will take you to the appropriate option, you will be shown a display of the current (default) values programmed into your system, and you will be prompted for the changes you wish to make. Additional information is displayed to assist you, but you may find it useful to refer to section 7.2 in this manual when altering some of the parameters.

On completion of any modification you will be returned to the main menu to allow you to select further options.

The new information will not be processed and written back to your disk until option 0 (Exit to CP/M) has been selected. If at any time you wish to abandon CONFIG without any of the changes made being written to disk, return to the main menu and type ^C.

Option 0 - Exit to CP/M
Your modifications will be written to the current CP/M disk where their values will replace the original ones. Note that if <filename> was specified the changes will only have been made to the disk file and have yet to be transferred to the system track (see below). If <filename> was omitted then the system track will be modified and the modified disk (in the case of floppy disk based systems) must be put in drive A. In all cases the RESET button must be pressed in order to load and run the modified system.

Option 1 - Change I/O drivers
This allows a selection of different driver routines to be used by the CP/M CONSOLE, READER, PUNCH and LIST functions. It is a simple way of redifining the IOBYTE.

Option 2 - Set cursor appearance
This allows you to take advantage of the Video Controller's ability to define any cursor you require. The options include:

CURSOR ON/OFF
NON BLINKING, SLOW BLINKING, FAST BLINKING
CURSOR SIZE

Option 3 - Change the Edit Mode character
Edit mode is normally entered by typing ^@ or using the EDIT key (which is normally programmed to return ^@) but this combination may be replaced using this option.

Option 4 - Change the UART parameters
The following features may be redifined to any of the values shown:

Data bits: 6, 7, 8
Stop bits: 1, 2
Parity: None, Even, Odd
Baud rate: 50, 75, 110, 150, 300, 600, 1200, 1800, 2400, 3600, 4800, 7200, 9600
On-board memory: Off, On
RS232/Cassette select
RTS: On, Off
DTR: On, Off

Option 5 - Change I/O port assignments
Normally port B8 is used to drive the serial I/O devices while B4 is used by the parallel printer driver. However, in the case of the Gemini MultiNet system (for example) port B4 is used by the Network Interface Board. Therefore the ports used may be changed (when, for example, adding a Gemini I/O card to your system) and this option allows you to define new port addresses for these functions.

Option 6 - Set up LIST control
This allows you to adapt your BIOS to suit your printer. You will be asked for the following details:
Are form feeds accepted by your printer?
Do you want automatic page breaks included in your output?
Number of rows and columns on your page.
Number of lines to be left clear around the perforations

Option 7 - Set up an "Auto Execute" command
When CP/M is first loaded (after power on, a reset or a boot from SIMON) it can be made to execute an initial command, program or initialisation routine. You will be asked to type in the command line to be used by CP/M when first started.

Option 8 - Set up a "Memory drive"
This option allows a "Memory drive" facility to be added to the Gemini by the addition of extra memory boards. See Memory Drive - section 5.4.

Running the new CP/M system
If <filename> was specified when CONFIG was run, when you exit CONFIG the changes are only made to the disk file, they have yet to be transferred to the system tracks. If MOVCPM has been modified a new system will have to be generated (MOVCPM 64 * - to generate a 64k system) and then SYSGEN run to write the new system to the system tracks of the disk.

The following example illustrates the use of CONFIG, MOVCPM and SYSGEN.
All user input is underlined, and <CR> represents the "Return" key.

```
A>config movcpm.com<CR>                    -Run CONFIG on
.....                                            MOVCPM.COM
.....
.....
writing changes to specified file
A>movcpm 64 *<CR>                          -Generate a new
                                                 system.
Constructing 64k CP/M vers 2.2
Ready for "SYSGEN" or
"SAVE 42 CPM64.COM"
A>sysgen<CR>                               -Write to disk
SYSGEN VER 2.0
Source Drive name (or Return to skip)<CR>
Destination Drive name (or Return to reboot)A
Destination on A, then type Return<CR>
**Function complete**
Destination Drive name (or return to reboot)<CR>
A>
```

At this stage the new system is on the system tracks of the disk in Drive A. In order to get the new version of the BIOS loaded into memory the RESET button should be pressed.

6.5. SAVEKEYS

The SAVEKEYS utility is provided to allow the Gemini user to easily set the codes returned by the function keys to those required by specific programs. The SAVEKEYS program is described in the section on the Video Controller.

7. FURTHER TECHNICAL INFORMATION

7.1. WHAT IS A VIDEO CONTROLLER ?

In order to fully appreciate the function and use of the Video Controller it is necessary to understand its place within the system.

A computer by itself can only process information, but first of all that information must be fed into it and then a way is needed to output the results to the user. Since the most common method (at least from the users point of view) is via a keyboard and Video Monitor it makes sense to give this interface a degree of flexibility and even of intelligence.

The Video Controller provides these functions. By using a CRTC (CRT controller) and some complex electronics with a second Z80 computer chip dedicated to it alone, it can be made to present information on a Video Monitor in a variety of formats, and can provide a number of sophisticated functions, such as screen editing, screen lock, clear to end-of-screen, and many more. It also provides a number of additional features (light pen port, programmable character generator, additional RAM) which may be exploited by the experienced user. This second Z80 also looks after the keyboard, providing the user-programmable key capability, and also storing away every character that is pressed on the keyboard, even when the main computer is not ready to receive further input. This leaves the main Z80 free to run the user's program without having to spend valuable computing time on the house-keeping work of handling the keyboard input and controlling the video display.

A full manual covering the Video Controller is supplied with your computer. This includes details of the software controlling this board as well as explaining how its control program (monitor) functions and how it may amended.

7.2. GEMINI CP/M IMPLEMENTATION

The software supplied with your Gemini computer consists of a 5.25" disk containing your uniquely serialised distribution copy of CP/M 2.2. The disk already has a working 64k system on its system track, and this holds the BIOS appropriate to the Gemini. The BIOS (Basic Input/Output Subroutines) is the set of routines which interfaces the standard CP/M CCP and BDOS routines to the particular hardware being supplied, and these routines have been specially written for the Gemini.

As there is room for it on the system tracks a comprehensive BIOS has been supplied for the Gemini with a variety of features included in it, which are highlighted in the following sections. (Also see Disk error handling - section 5.1). As a result, in a Gemini CP/M system of a particular size, the CCP, BDOS and BIOS will be found at lower addresses than those in the standard 8" system referred to in the CP/M manuals. If you wish to know exactly where a Gemini system is located, use DDT or a similar program to look at the JMP instruction at address 0. This JMP is to the Warm Boot entry point in the BIOS, and so the start of the BIOS can be found from this.

Note that the increased size of the BIOS is allowed for within MOVCPM and so in using it the desired physical memory size of running system should still be used. i.e. MOVCPM 64 will generate a system that uses 64k of memory.

INPUT/OUTPUT

Keyboard Routine
The Keyboard routine supports the Gemini keyboard connected via the Video Controller board. This is the normal connection point for the keyboard as in this case the keyboard is fully buffered and there is no danger of the system losing characters. In some cases it is even possible to "type ahead".

CRT Routine
For details of the control codes supported by the CRT routine see the Video Controller section of this manual.

On-Screen editing and Screen Dump
Limited on-screen editing has been provided within the BIOS, a very unusual feature for CP/M systems. The code required to enter 'Edit' mode may be user-defined, see Patch Area below, CONFIG (section 6.4) and the section on screen-editing. It is also possible to 'dump' the screen contents to a printer.

Serial Printers
A serial printer is supported by the BIOS, either directly or in handshaking mode. See below (Port Addresses) and section 8.3 - RS232 Serial Port.

Parallel Printers
A Centronics type parallel printer is supported by the Gemini BIOS. See 'Port Addresses' below, and section 8.2 - Parallel I/O Port.

Memory Drive
A memory drive facility can be supported by adding either Gemini GM802 64K RAM boards, a Gemini GM862 RAM board, or Gemini GM833 RAM-DISK boards to the system.

CUSTOMISATION

This section describes an area of the BIOS where certain variables have been grouped. By changing the contents of these locations it is possible to customise the system (in a limited way) to suit your personal environment. The most likely customisation options have been built in to the menu driven program **CONFIG**, and only in the more ambitious cases will it be necessary to patch this area directly. However reading the following section will help you to understand some of the questions **CONFIG** will ask you.

IOBYTE

The BIOS fully implements the CP/M IOBYTE function which allows logical to physical mapping of various drivers. The BIOS provides specific routines for I/O which CP/M calls. These support a Console, (Keyboard and screen in our case), Tape reader (cassette interface or RS232), Tape punch (cassette interface or RS232), and a List device (a printer of some kind).

What the IOBYTE does is to define which of various alternative routines should be used to service a particular request. The IOBYTE is held in memory at address 3 and is subdivided into four fields of two bits each as shown below:-

msb - L L P P R R C C - lsb

These four fields are LIST PUNCH READER CONSOLE

As each field consists of two bits it can take any one of four values. The purpose of the field is to define which of four alternative routines the function is to use. This is covered more fully below in the section on the Patch Area. When any of the four I/O routines are called the first thing each does is to examine the relevant field of the IOBYTE and using the value found there execute one of four alternatives.

CP/M itself does not use the IOBYTE, but the STAT command can be used to temporarily change its value (see your CP/M manual).

Patch Area

To ease the problem of customisation (mainly for different printers) a "patch" area has been provided immediately following the jump table at the start of the BIOS. These values may be changed by using DDT or a similar program (e.g. ZSID) either to make a temporary change on a running system, or permanently on a system image just before "SYSGEN"ing a disk with it.

In the "SYSGEN" image the area can be found at 2133H or 2139H (depending on the Gemini BIOS version) irrespective of the system size. With a running system the jump address at 0 should be examined (use DDT again) to find the start of the BIOS area. For example if 0 holds JP 0B203H then the BIOS origin is at 0B200H and the patch area can be found at 0B233H (0B239H). Hence XX in the following section would be replaced by B2.

Address	Name	Value	Purpose
XX33 (XX39)	IIOBYT	15	Initial value of the IOBYTE. The IOBYTE is reset to this value on Cold and Warm starts.
XX34 (XX3A)	MS	xx	Loop counter used to obtain a delay of 1ms. Should be set to 4BH for a 4MHz system clock, 3CH for 4MHz + wait, and 26H for 2MHz.
XX35 (XX3B)	IVCCUR	28 08	These two bytes define the type of cursor to be used on the Video Controller while the system is not waiting for input. (See Video Controller software section for details). They are initially set to a value that results in a non-blinking cursor.
XX37 (XX3D)	EMCHAR	80	(80H+Null). This character is the one that is recognised as the "enter screen edit mode" command. Note that the keyboard can never return the character or control code selected for this. (CONTROL/@ (also normally returned by the 'EDIT' key) has been selected for this as it is extremely unlikely that the control code "null" would ever be required by any program).
XX38 (XX3E)	USET	03	UART line control word. (See the CPU hardware manual). Default value sets the UART up for 8-bits, 1 stop bit, no parity.
XX39 (XX3F)	UMODE	0F	Control word for UART. Bit 0 controls the DTR output. Bit 1 controls the RTS output. Bit 2=0 Selects the cassette interface Bit 2=1 Selects the RS232 interface Bit 3=0 Enables the on-board memory. Bit 3=1 Disables the on-board memory. Default set for RS232 and on-board memory paged out.
XX3A (XX40)	UBAUD	34 00	Sets the UART baud rate. This is the value which is programmed into the UART's divisor latches. (See the CPU hardware manual). Stored here with least sig. byte first. Default value is for 2400 baud.

*****User I/O initialisation*****

The following three bytes can be set to a jump to a routine to initialise any special user I/O routines added to the system. This address is "Call"ed following a Cold start, but not after a Warm start.

XX3C	(XX42)	USRIOI	C9	RETurn
XX3D	(XX43)		00	NOP
XX3E	(XX44)		00	NOP

*****Port Addresses****

In the following section the base port addresses are defined for the serial routines. Two common serial routines are used for all four fields (Console,Punch,Reader,List), and assume either an 8250 UART or a 6402 type UART. If the port address is greater than 7FH, then the 8250 routines are used. If it is in the range 00-7FH then the 6402 routines are used.

The lowest address of the UART is read from this area. This approach allows (for example) a high speed serial printer to be added to the system being driven through a UART on a Gemini GM818 Serial I/O board. All that is necessary from a software point of view to support this addition is to change the value of LISTP from B8 to the lowest address of the UART on the IO board, say A0H. The final address in this section of the table is that of a PIO if you wish the software to support a Centronics-type parallel printer. Once again the address to set is the lowest of the four that a PIO occupies.

XX3F	(XX45)	TTYP	B8	TTY serial port address.
XX40	(XX46)	RDRP	B8	Reader serial port address.
XX41	(XX47)	PUNP	B8	Punch serial port address.
XX42	(XX48)	LISTP	B8	List serial port address.
XX43	(XX49)	PPORT	B4	List parallel port number. Set to 0 if no parallel printer.

****List Control****

In the following section a limited amount of enhanced support is provided for the list device if required. For example if you use a simple roll-feed printer that does not recognise form feeds you may find it advantageous to set FCNTRL to 6 to provide a small gap everytime a form feed occurs in the list stream.

XX44 (XX4A)	FFCNTRL	00	Form feed control. If set to:- 00=Pass to printer unaltered. FF=Translate to multiple line feeds (see LPAGE and LGAP). nn=Translate to exactly nn linefeeds.
XX45 (XX4B)	LPAGE	00	Lines per page. If set to 00=No paging. nn=nn printed lines per page.
XX46 (XX4C)	LGAP	00	Gap between pages. If set to 00=no gap. nn=Gap of nn lines.

The following section holds seven tables, with each table consisting of four addresses. These four addresses are the addresses of the four alternative routines available for a particular IOBYTE field. Also shown is the name by which STAT refers to a particular field, and also the binary contents of the IOBYTE in the position of that field. For example if you wish to temporarily redefine the list device and use STAT LST:=TTY: to do it, then STAT will set bits 6 & 7 of the IOBYTE to 00. The list routine, finding its field (bits 6 & 7) set to 00, will use the routine whose address it finds at address XX77, ie SEROUT (serial out) in the unmodified case.

****IOBYTE control fields and address tables****

	Address	STAT ref.	IOBYTE field		Current routine used	
Console Status						
	XX47	(XX4D)	TTY:	XXXXXX00	SERST	0=Serial
	XX49	(XX4F)	CRT:	XXXXXX01	SCAN	1=Keyboard
	XX4B	(XX51)	BAT:	XXXXXX10	SERST	2=Serial
	XX4D	(XX53)	UC1:	XXXXXX11	SCAN	3=Keyboard
Console Input						
	XX4F	(XX55)	TTY:	XXXXXX00	SERIN	0=Serial
	XX51	(XX57)	CRT:	XXXXXX01	BLINK	1=Keyboard
	XX53	(XX59)	BAT:	XXXXXX10	SERIN	2=Serial
	XX55	(XX5B)	UC1:	XXXXXX11	BLINK	3=Keyboard
Console Output						
	XX57	(XX5D)	TTY:	XXXXXX00	SEROUT	0=Serial
	XX59	(XX5F)	CRT:	XXXXXX01	CRT	1=Screen
	XX5B	(XX61)	BAT:	XXXXXX10	CRT	2=Screen
	XX5D	(XX63)	UC1:	XXXXXX11	CRT	3=Screen
Reader Input						
	XX5F	(XX65)	TTY:	XXXX00XX	BLINK	0=Keyboard
	XX61	(XX67)	PTR:	XXXX01XX	SERIN	1=Serial
	XX63	(XX69)	UR1:	XXXX10XX	BLINK	2=Keyboard
	XX65	(XX6B)	UR2:	XXXX11XX	BLINK	3=Keyboard
Punch Output						
	XX67	(XX6D)	TTY:	XX00XXXX	CRT	0=Screen
	XX69	(XX6F)	PTP:	XX01XXXX	SEROUT	1=Serial
	XX6B	(XX71)	UP1:	XX10XXXX	CRT	2=Screen
	XX6D	(XX73)	UP2:	XX11XXXX	CRT	3=Screen
List Status						
	XX6F	(XX75)	TTY:	00XXXXXX	SERST	0=Serial
	XX71	(XX77)	CRT:	01XXXXXX	READY	1=Screen
	XX73	(XX79)	LPT:	10XXXXXX	HSST	2=Serial with Handshake
	XX75	(XX7B)	UL1:	11XXXXXX	CENTST	3=Centronics parallel
List Output						
	XX77	(XX7D)	TTY:	00XXXXXX	SEROUT	0=Serial
	XX79	(XX7F)	CRT:	01XXXXXX	CRT	1=Screen
	XX7B	(XX81)	LPT:	10XXXXXX	HSHAKE	2=Serial with Handshake
	XX7D	(XX83)	UL1:	11XXXXXX	CENTRO	3=Centronics parallel

**********User Area**********

The following 32-byte area is free and provides an area where a small user routine may be patched in. The appropriate address above should be changed to point to this area.

XX7F (XX85) USER: DEFS 32

*****Memory Disk*****

Address	Value	Purpose
XXA2	00	Set to the number of additional GM802 memory boards, GM862 memory banks, or whether a GM833 board is added to the system 00 = No extra boards, so no M-drive. 01 = One extra memory board included. 02 = Two extra memory boards included. 03 = Three extra memory boards included. 80 = One GM833 RAM-DISK board included.
XXA3 (XXA9)	40	Set to the size of the additional memory boards (or banks) in Kbytes. 40H = 64K. This feature allows partially populated boards to be used in the system, or some of the extra RAM to be reserved for other uses. (e.g. entering 60 (3CH) would result in the top 4K of each additional 64K board (or bank) being ignored by the M-drive software.)

7.3. SIMON (A SImple MONitor)

SIMON is a simple monitor that resides in the Boot EPROM. Its sole purpose is to provide a debugging aid in the event of problems with the hardware. Obviously if the problem is a severe one SIMON itself will not run. It is to be hoped its services will never be required.

Entry to SIMON is achieved by typing CONTROL/S whilst the "Insert Disk in drive A" message is present.

SIMON expects input from the keyboard, automatically converting all alphabetic characters to upper case. It is not forgiving of typing errors, (backspace is not recognised), and the only acceptable control code is RETURN.

When SIMON is waiting for input, the prompt '>>' is displayed. All inputs to SIMON consists of a command letter followed by one or more hexidecimal numbers separated from each other by spaces, and terminated by a carriage return. In this section of the manual Hexadecimal numbers are not suffixed by 'H'.

The commands are summarised below and then explained in greater detail.

B - Boot disk
C - Copy memory
E - Execute from an address
F - Fill memory with a byte
M - Modify memory
O - Output to a port
Q - Query a port
T - Tabulate memory contents

COMMANDS

B

Boot from disk. This command does not wait for a <carriage-return> before executing. It results in a jump being made to the start of the EPROM and is equivalent to pressing the RESET key, and so another attempt will be made to Boot CP/M in from disk.

C <start> <destination> <length>

This command copies the number of bytes specified in <length> from address <start> to address <destination>. The bytes are copied by the LDIR instruction, and so due care must be exercised if it is desired to copy intact between two areas of memory that overlap.

E <address>

This command results in a CALL to <address>. This enables manually entered test routines to be executed. Return to SIMON can simply be effected by a RETurn.

F <start> <end> <value>

This command fills the memory from <start> to <end> inclusive with the byte <value>.

M <address>

This command allows the contents of memory to be displayed and optionally changed. SIMON will respond with:-

```
>>M1000<RETURN>   (Command typed in response to prompt)
1000 - FE _   Cursor
```

Typing a RETURN will leave the contents unaltered and the next location will be displayed. If it is desired to change the contents then the new value should be typed followed by SPACE or RETURN. Any non-hex character typed will cause the command to abort without the current location being modified. When a location is modified SIMON checks to ensure that the new value has been written successfully. If it has not then the command aborts with the error message -What? This also occurs if an attempt is made to enter a number greater than OFFH.

Typing a '-' causes SIMON to move back to the previous address. This allows any erroneous value to be modified without having to terminate the command and restart it.

O <port> <value>

Outputs the number <value> to port address <port>.

Q <port>

Inputs from port address <port> and displays in Hex the byte fetched.

T <address> <lines>

Displays the contents of memory in Hex starting at address <address>. 16 consecutive bytes are displayed per line, with the address of the first byte being the first item on the line. The command terminates when <lines> lines have been displayed.

Several vectors into the EPROM are provided for those writing short test routines. These addresses should be CALLed to provide the required function.

F000	COLD	Cold start
F003	CHRIN	Get a character from the keyboard. All lower-case characters are converted to upper-case, and the character is echoed to the screen.
F006	CHROUT	Output a character to the screen.
F009	P2HEX	Print <A> as two Hex characters
F00C	P4HEX	Print <HL> as four Hex characters
F00F	SPACE	Print a space
F012	CRLF	Print a carriage-return

7.4. TECHNICAL SPECIFICATIONS

PHYSICAL CHARACTERISTICS
Width 45cm (18")
Depth 30cm (12")
Height 17.5cm (7")
Approximate Weight - Computer 14kg (31lb)
Keyboard 2.25kg (5lb)
Entire system packed for delivery 17.5kg (39lb)(including packing)

ELECTRICAL CHARACTERISTICS
Mains supply: 220-240 volts AC/50Hz

INPUT/OUTPUT FACILITIES
1 volt (peak to peak) video socket (75 ohms)
EIA RS232C/V24
Dual Parallel input/output ports (Mostek MK 3881)
(wired as Centronics standard to Amphenol connector)
1200 baud CUTS cassette recorder interface
Light pen interface
ASCII encoded keyboard socket.

BUS SYSTEM
77 way '80-BUS' (details available from your dealer on request)

DISK DRIVES
FLOPPY
1 or 2 Micropolis 1015/1115F5 or 1015/1115F6 5.25" flexible disk drives
Capacity: 400K or 800K per drive (formatted)
Head life in normal use: 10,000 hours

WINCHESTER
0 or 1 Rodime RO201, RO202 or RO203 5.25" fixed disk drive
Capacity: 5.4M, 10.8M or 16.2M (formatted)

FLOPPY DISK FORMAT
Single or double-sided, double density, soft sectored
96 tracks per inch
512 bytes per sector, 10 sectors per track, 80 tracks
CP/M block allocation size: 4K
Physical Sector Skew: 2

PROCESSORS
1 x Z80A at 4MHz - no wait states
plus: 1 x Z80A at 4MHz(IVC) or 1 x Z80B at 6MHz(SVC)

KEYBOARD
87 keys
n key rollover
Caps. lock
Cursor control keys
Numeric keypad
User-defineable function keys
Full ASCII encoding

VIDEO - IVC
80 x 25 (standard) display
Other programmable display formats
Inverse video
160 x 75 pixel graphics
128 character programmable character set
Other functions through software instructions

VIDEO - SVC
As IVC plus:
256 character programmable character set
Selectable display attributes
Selectable foreign character sets
256 x 256 pixel graphics mode
Buzzer

MEMORY
(1) Z80A 64K dynamic RAM
2K phantom ROM bookstrap

(2) Units with IVC
Z80A 4K monitor ROM
2K workspace RAM
2K screen RAM
2K character generator ROM
2K character generator RAM

(2) Units with SVC
Z80B 8K monitor ROM
2K workspace RAM
8K software selectable as:
(a) 2K screen RAM
2K alternate screen RAM
4K character generator RAM
or (b) 8K graphics RAM

8. EXPANDING YOUR GEMINI COMPUTER

8.1. INTRODUCTION TO THE EXPANSION SOCKETS

There are several ways of expanding your Gemini computer.

a) The various input and output sockets at the back of the machine allow you to attach a wide variety of peripherals such as printers, modems, light pens and so on.

b) The Floppy Disk Controller board used inside the system can control up to four floppy disk drives (mixed between 5.25" and 8") as well as a Winchester drive. Additional Winchester or floppy disk drives may be added to your Gemini using one of the available disk sub-systems

c) Your Gemini computer can be turned into a MultiNet Superstation, allowing disk files to be stored on a MultiNet Fileserver system, and allowing print output to be sent to a printer attached to the Fileserver.

d) The spare bus sockets (inside) allow you to add compatible cards from the Gemini MultiBoard range for more exotic additions. These currently include colour graphics, RAM-DISKs, and a variety of I/O boards, such as IEEE488, Serial I/O, Analogue to Digital convertors, and others.

This section describes the standards used at the various sockets; please ensure that any additional purchases are going to be compatible - if in any doubt, consult your Gemini dealer before connecting anything to your Gemini.

Always use the numbers embossed on plugs and sockets as your reference when wiring up connectors.

The sockets available are as follows:

Parallel Input/Output Controller (PIO)
(only those lines required for the Centronics standard printer interface are wired to the connector).
RS-232 (serial)port
Keyboard port
Video output
Light pen socket
Cassette recorder socket

The removable panel at the back of the machine may be used to run additional cables in and out of your computer. This may either be:

1) Removed completely
2) Drilled for particular connections
3) Replaced by a similar panel already fitted with the required connectors.

8.2. PARALLEL INPUT/OUTPUT PORT

The parallel I/O port has been specifically wired to drive a Centronics-type parallel printer, but it may also be used for a multitude of other applications.

When used in conjuction with the built-in print controlling routines, it is important that this socket be wired to your printer correctly. The diagram below shows details of the signals present at each pin.

The address of the PIO supporting the printer is specified in the Patch Area of the BIOS (see sections 6.4 and 7.2) and can be changed if, for example, an I/O board is added and the printer connected to that.

PIN NO	SIGNAL
1	STROBE
2	DATA 0
3	DATA 1
4	DATA 2
5	DATA 3
6	DATA 4
7	DATA 5
8	DATA 6
9	DATA 7
11	BUSY
16	Signal Ground
17	Frame Ground
19-30,33	Signal Ground

The in-built software drivers for a Centronics type parallel printer assume that the PIO has been connected in the following manner, which is the way the Gemini is connected as standard.
The eight data wires of the interface should be connected to the B-side of the PIO, bit 0 to bit 0, and so on. The "busy" line should be connected to bit 0 of the A-side of the PIO, and the "strobe" line to bit 1 of the A-side. The "acknowledge" line is ignored.

(Note that a standard Centronics interface includes pull-up resistors on the data and strobe lines in the printer. The PIO specification guarantees a low output voltage of 0.4V maximum when sinking 2ma (on both the A-side and the B-side). Although PIOs may apparently drive the printer interface directly, it might be advisable to include a TTL buffer between the PIO and printer if the pull-up resistors are of a low value.)

8.3. THE RS-232 SERIAL PORT

This is a standard RS-232C port and is suitable for connection to a wide range of peripheral devices such as serial printer, modems and terminals.

A serial printer can be supported, either directly, or in a handshaking mode. The handshake signal is used to signify whether the printer is able to accept characters from the processor or not. It allows a printer to be connected by a high baud rate interface to ensure that it is driven at its maximum printing rate and never has to wait for the processor. Without handshake the serial transmission rate has to be set to a low enough rate to ensure that the printer cannot be overdriven and characters lost. The port is controlled by an 8520 UART and selection of parity, stop bits and baud rates are all software controlled.

The cassette and RS232 interfaces share the same UART; READCAS and WRITCAS will temporarily re-program the UART to run at 1200 baud, regardless of any existing settings, which will be restored after use.

Use of the CONFIG program supplied on your disk (see section 6.4 - Utility routines) will simplify programming of the UART. Programming of other values should be undertaken with reference to the Gemini MultiBoard CPU manuals and, for particularly complex jobs, to the National Semiconductor data sheet INS 8250.

Serial driver routines are provided for both an 8250 type UART (as fitted to the CPU card installed in the Gemini), and also for a 6402 type UART (as used on the 80-BUS compatible Nascom I/O board). This is covered more fully in section 7.2, but the handshaking software is specific to the 8250 UART and will not work with a 6402. (As the 6402 lacks any modem control signals).

The handshake signal should be an RS232 level signal, (although a TTL level signal will work), which should be connected to the CTS input of UART. A low value on this line signifies that the printer is off-line or the buffer is full, and that it cannot accept characters. A high level signifies that characters can be sent to the printer.

The address of the UART supporting the printer is specified in the BIOS Patch Area (see section 7.2) and can be changed to suit.

PIN NO	SIGNAL	
1	FRAME GROUND	FG
2	RECEIVE DATA	RD
3	TRANSMIT DATA	TD
4	REQUEST TO SEND	RTS
5	CLEAR TO SEND	CTS
6	DATA SET READY	DSR
7	SIGNAL GROUND	SG
8	DATA CARRIER DETECT	DCD
20	DATA TERMINAL READY	DTR

8.4. KEYBOARD SOCKET

While this socket is primarily designed to be used in conjunction with the keyboard supplied, it should be quite simple to connect other ASCII encoded keyboard provided that the pins are correctly matched. Gemini Microcomputers cannot, however, accept any responsibility whatsoever for the effects caused by using any keyboard other than that supplied.

PIN NO.	SIGNAL
1	+5 volts
2	STROBE
3	GROUND
4	GROUND
5	D5
6	D4
7	D6
8	GROUND
9	GROUND
10	D2
11	D3
12	D0
13	D1
14	POWER LED DRIVE
15	-12 volts

8.5. VIDEO OUTPUT SOCKET

A 1 volt (peak to peak) video signal suitable for driving most commercially available monitors is present at this socket.

Connection to the monitor should be made using the lead provided. The monitor end of this lead is fitted with a phono plug as standard to match the majority of monitors in general use. If your monitor requires a different type of connector you should obtain one from your Gemini dealer who will fit it for you if required.

The signal present at this socket will NOT drive domestic television sets through the aerial socket.

8.6. LIGHT PEN SOCKET

Although the light pen socket was designed for use specifically with the Arfon Microelectronics Light Pen and any software provided with this, it should be possible to connect other commercially available pens.

The 5 pin DIN connector provides + 12 volts, + 5 volts and ground together with two inputs: a strobe input (a "cleaned up" version of the phototransistor output) and a switch input.

The light pen address is returned in the light pen address registers, and this in turn is converted by the Video Controller to an X,Y co-ordinate. See the section on the Video Controller for further details.

PIN NO	SIGNAL
1	+12 volts
2	GROUND
3	ENABLE
4	+5 volts
5	STROBE

8.7. TAPE CASSETTE SOCKET

A five-pin DIN socket is provided for connection to a cassette tape recorder. It is advisable to record in mono on the right hand channel although many machines perform as well or better in stereo. Due to the wide variations between tape recorders, it may be necessary to experiment with record and playback levels to obtain error free results.

Your Gemini dealer can provide a lead suitable for connecting your Gemini to a tape cassette recorder if required.

The routines READCAS and WRITCAS are provided for the transfer of cassette files to/from disk. See the section on Utility programs.

PIN NO	SIGNAL
1	OUTPUT
2	GROUND
3	INPUT
4	No connection
5	No connection

8.8. INSERTION OF MULTIBOARDS

Your Gemini system is built around the Gemini MultiBoard concept; a series of 8" x 8" (20cm x 20cm) printed circuit boards (PCBs) which plug directly into a 77-way bus to "80-BUS" standards. The separately available CPU manual (GM813 CPU Hardware) describes the 80-BUS standard in full.

Your Gemini system may be expanded by the addition of further 80-BUS compatible boards. There is a wide range of these available, and you should contact your Gemini dealer for further details.

A number of manufacturers other than Gemini Microcomputers Ltd are providing 80-BUS compatible circuit boards; care should be taken to ensure that boards other than Gemini MultiBoards conform exactly to the 80-BUS standards. Gemini Microcomputers does not accept responsibility for damage caused by the use of non-MultiBoard PCBs.

1) Access to the 80-Bus

First of all, disconnect the computer from the mains and then unplug the mains lead from the back of the machine.
Unscrew the four screws on the bottom edges of the two sides and lift the lid off carefully. When refitting the cover, please make sure that the ventilation slots are at the front.

2) Insertion of MultiBoards

When plugging a board into the spare bus sockets, ensure that the keyway matches up with the keyblock in position 72 of the socket.

You may find it necessary to unplug the multiway ribbon cable from the disk controller board to clear a way for your new board. Note the orientation of the cable when you disconnect it, and remember to reconnect it!

The board should be pushed firmly into the socket (but without undue force) until its front edge lines up tidily with the edges of the other boards already installed. The component side should face the same direction as those of the other boards in the system.

To remove a board, pull gently from alternate front corners, while pushing firmly against the card guide mounting rails to prevent flexing of the bus plane. Do not jerk the board as there is a possibility of damaging the board, the socket and the bus plane itself.

3) Replace the case cover in the reverse order to 1.

9. MAINTAINING YOUR GEMINI COMPUTER

9.1. CLEANING

Superficial dirt and dust may be removed from the computer (which should be turned off during cleaning) with a barely damp cloth. Proprietry cleaners should only be used if they are declared suitable for use on general paintwork.

Never use solvents or spirits to clean any part of the system.

Do not attempt to clean floppy disks, plugs or sockets, or inside any part of the computer.

Proprietary disk drive cleaning equipment (such as the Verbatim head cleaning kit) may be used provided that the manufacturers' instructions are followed with care.

Do not allow cleaning fluids to spill inside any part of the system.

IMPORTANT
The metal cover protecting the fan and its filter should be removed at monthly intervals and the filter should be shaken free of dust. If dust buildup appears to be excessive you are advised to obtain a supply of replacement filters from your Gemini dealer who will also advise you how often these should be changed.

9.2. SERVICING

Your Gemini has been designed to require little or no regular servicing other than occasional replacement of the fan filter, as described in the previous section. There are no user-serviceable parts in the system and you should, therefore, always refer back to your Gemini dealer whenever you suspect that servicing might be necessary.

Replacement of the plug-in electronic circuit boards may be undertaken by the user under certain circumstances - section 8.8 explains how to reach, remove and replace these.