COMMODORE 64 CP/M® OPERATING SYSTEM

USER'S GUIDE

commodore COMPUTER

USER'S MANUAL STATEMENT

"This equipment generates and uses radio frequency energy and if not installed and used properly, that is, in strict accordance with the manufacturer's instructions, may cause interference to radio and television reception. It has been type tested and found to comply with the limits for a Class B computing device in accordance with the specifications in Subpart J of Part 15 of FCC rules, which are designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- reorient the receiving antenna
- relocate the computer with respect to the receiver
- move the computer away from the receiver
- plug the computer into a different outlet so that computer and receiver are on different branch circuits.

"If necessary, the user should consult the dealer or an experienced radio/television technician for additional suggestions. The user may find the following booklet prepared by the Federal Communications Commission helpful: 'How to Identify and Resolve Radio-TV Interference Problems.' This booklet is available from the U.S. Government Printing Office, Washington, D.C. 20402, Stock No. 004-000-00345-4."

COMMODORE 64 CP/M® OPERATING SYSTEM USER'S GUIDE

PRELIMINARY

Published by
Commodore Business Machines, Inc.
and
Howard W. Sams & Co., Inc.

First Edition—1983
First Printing—1983

Printed in the United States of America

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION TO CP/M ON YOUR COMMODORE 64

- Overview of CP/M on Your Commodore 64
- How To Use This Manual
- Digital Research License Information
- Registration Information
- Warranty and Service Information
- Get More out of Your Commodore Computer

Your purchase of the Commodore Z80 add-on microprocessor cartridge puts you in the elite group of owners of a *dual processor home microcomputer.* No one but Commodore—the originator of the home microcomputer—could design and manufacture an inexpensive home or personal computer that accommodates the *two most common microprocessors in the microcomputer industry:*

- the Commodore MOS 6510 (6502 type) microprocessor
- the Z80A microprocessor

The 6510 microprocessor is the main processor on your Commodore 64. The 6510 is a specially designed variation of the widely distributed 6502 microprocessor found in many popular home and office computers. The 6510 runs the same instruction set as the 6502 but includes some special features that make it work more efficiently in your Commodore 64.

It is the 6510 main processor that is active when your Commodore 64 is running in *native mode.* In native mode, your Commodore 64 is controlled by its Commodore 64 Kernal operating system, Screen Editor, and the BASIC V2.2 interpreter. Native mode gives you access to a vast library of Commodore 64 applications packages from Commodore or from one of the many independent Commodore 64 software developers around the world.

When you add your Z80 cartridge to the system and start Digital Research's CP/M® operating system, you open the door to more than **15,000 CP/M-based application programs.** CP/M is the most popular 8-bit operating system and is used for business applications throughout the world.

If you have a special application need, it's very likely that a CP/M package exists to meet it. CP/M applications are available in such areas as:

- financial reporting
- financial analysis
- investment planning
- word processing
- law
- real estate

- farm management
- restaurant management
- data base
- exotic language compilers (PL/I, PASCAL, C)
- and many, many more

1.1 OVERVIEW OF CP/M ON YOUR COMMODORE 64

CP/M on your Commodore 64 can run in a maximum of 48K (1K = 1024 characters) of memory. The rest of memory is occupied by the Commodore 64 Kernal routines that provide input/output support for CP/M.

While you are running CP/M under the Z80 processor, the 6510 main processor acts as an input/output processor. When the 6510 is active, your Commodore 64 is executing in *native mode*. When it's running in native mode, your Commodore 64 "knows" how to handle its keyboard, screen, and peripherals (disks and printer). Rather than duplicate this facility to run under the Z80 processor, CP/M simply calls on the 6510 main processor to perform these tasks.

In addition to CP/M, you get a set of custom utilities that make it easy for you to run CP/M on your Commodore 64. You get:

- The **COPY** utility that formats diskettes in the CP/M format; easily produces backups of CP/M diskettes, even on single-drive systems; and copies the important CP/M system tracks.
- The **CONFIG** utility that makes it easy for you to inform CP/M of changes to your system peripherals, load the Commodore 64 function keys for use under CP/M, and re-define keyboard characters to yield any code you want.
- The **MOVCPM** utility that allows you to create a different sized version of CP/M without the need to learn Z80 Assembler language. MOVCPM relocates *all* of CP/M, including the BOOT and BIOS programs.

You can **load anything** you like into the **eight Commodore 64 Function Keys.** When CP/M is started, the eight function keys are loaded with the following CP/M commands (<CR> stands for RETURN):

F1 *Z* DIR*X*CR*Z*
F2 *Z* DIR B:*X*CR*Z*
F3 *Z* STAT *.**X*CR*Z*
F4 *Z* STAT B:*.**X*CR*Z*
F5 *Z* COPY*X*CR*Z*
F6 *Z* CONFIG*X*CR*Z*
F7 *Z* DDT*X*CR*Z*
F8 *Z* DDT

CP/M on your Commodore 64 supports **upper and lower case characters.** You can toggle between upper case only and upper/lower case using the Commodore (C=) key. For special applications, you can **redefine the codes** returned to your CP/M programs from the keyboard or sent to the screen from your programs.

1.2 HOW TO USE THIS MANUAL

The very first thing to do is to read the ***Digital Research License Agreement*** in Section 1.3. Next, *fill in and mail* the Digital Research CP/M Registration Card at the end of this manual as soon as possible.

With those tasks accomplished, it's time to start running CP/M on your Commodore 64. **Chapter 2 tells you how to use your Z80 cartridge.** Read this chapter *before* you try to plug it in.

The distribution version of Commodore 64 CP/M assumes that you have a *VIC 1515/1525 printer and a single VIC 1541 disk drive.* If your Commodore 64 is equipped with some other combination, consult **Chapter 3 for information on using your peripherals.**

Chapter 4 is where things really get started. Read this chapter to learn **how to bring up CP/M on your system.** This chapter also tells you about the *Commodore 64 specific CP/M utilities* that you'll need and talks about using the *Commodore 64 keyboard* with CP/M.

IMPORTANT! *BE SURE* TO MAKE A BACKUP COPY OF YOUR CP/M DISTRIBUTION DISKETTES *BEFORE* YOU BEGIN PLAYING WITH CP/M. IF YOU DESTROY THESE DISKETTES, YOU LOSE CP/M. SO BE CAREFUL!

ONCE YOU HAVE MADE A COPY OF THE DISTRIBUTION DISKETTES (USE THE FORMAT AND BACKUP FEATURES OF THE COPY UTILITY), PUT THE ORIGINALS IN A COOL, DRY PLACE, AWAY FROM MAGNETIC FIELDS. DON'T USE THEM AGAIN UNLESS YOU ABSOLUTELY HAVE TO (FOR EXAMPLE, IF YOU ACCIDENTALLY DESTROYED ALL OF YOUR OPERATING COPIES)!

The distribution version of CP/M (the one that you get on the distribution diskette) is for a *44K CP/M system.* You should use this version if you have the *IEEE interface cartridge.* If you don't, look in **Chapter 4** to **learn how to construct a 48K version** that can take advantage of the additional 4K of RAM available on your system.

Chapter 5 is a reference section which includes descriptions of *all of the CP/M commands and utility programs* that you need to function in the CP/M environment. Chapter 5 shows you how to *execute programs* under CP/M and talks about *CP/M files and file naming conventions.*

Chapter 6 is for those of you who want to get involved in the **technical workings of CP/M on your Commodore 64.** You DO NOT have to know any of this material to use CP/M. If interested, you can look into the first few sections of Chapter 6 to get an idea of *how CP/M is implemented* on the Commodore 64 and *how CP/M itself is structured.*

The balance of Chapter 6 is for the technically sophisticated user. You can learn about the *BOOT and BIOS programs* written to support CP/M on the Commodore 64 and you can learn how to *cross-call routines between the two processors.* To understand these sections fully, you should have a strong working knowledge of both 6510 (6502) and Z80 Assembler language.

Chapter 7 provides you with the **engineering details of your Z80 cartridge and your Commodore 64.** If you understand computer hardware, you can look here to see how they did it.

This manual is intended to get you started in CP/M. If you want to *explore the depths of the CP/M* operating system, look in your local bookstore for one (or more) of the

many CP/M books published in the last few years. We've listed some of them in the **Bibliography,** Appendix B. Skim the books to see which one you like best.

Likewise, this manual does not provide a tutorial in the use of the Z80 microprocessor. If you're interested in *programming the Z80 in Assembler,* you'll need detailed references. The **Bibliography** contains a list of some of the Z80 books you can find in your bookstore.

1.3 DIGITAL RESEARCH LICENSE INFORMATION

IMPORTANT: Commodore's license with Digital Research requires that each purchaser of the Commodore 64 CP/M system register with Commodore so that accurate records can be maintained of all CP/M users.

Because Digital Research requires this information, we have provided a post card for you to fill out and send in. The serial number of your CP/M system disk is stamped on the labels of the disks you receive with your Z80 cartridge and CP/M information. Please fill out the card and send it to us.

READ THE LICENSE AGREEMENT CAREFULLY.

1.3.1 Digital Research License Agreement

DIGITAL RESEARCH
Box 579, Pacific Grove, California 93950
SOFTWARE LICENSE AGREEMENT

IMPORTANT:

All Digital Research programs are sold only on the condition that the purchaser agrees to the following license. READ THIS LICENSE CAREFULLY. If you do not agree to the terms contained in this license, return the packaged diskette UNOPENED to your dealer and your purchase price will be refunded. If you agree to the terms contained in this license, fill out the REGISTRATION information and RETURN by mail to Commodore.

DIGITAL RESEARCH agrees to grant and the Customer agrees to accept, on the following terms and conditions, nontransferable and

nonexclusive licenses to use the software program(s) (Licensed Programs) herein delivered with this agreement.

TERM:

This agreement is effective from the date of receipt of the above referenced program(s) and shall remain in force until terminated by the Customer upon one month's prior written notice, or by Digital Research as provided below.

Any license under this Agreement may be discontinued by the Customer at any time upon one month's prior written notice. Digital Research may discontinue any license or terminate this Agreement if the Customer fails to comply with any of the terms and conditions of this Agreement.

LICENSE:

Each program license granted under this Agreement authorizes the Customer to use the Licensed Program(s) in any machine-readable form on any single computer system (referred to as System). A separate license is required for each System on which the Licensed Program(s) will be used.

This Agreement and any of the licenses, programs, or materials to which it applies may not be assigned, sublicensed, or otherwise transferred by the Customer without prior written consent from Digital Research. No right to print or copy, in whole or in part, the Licensed Program(s) is granted except as hereinafter expressly provided.

PERMISSION TO COPY OR MODIFY LICENSED PROGRAMS:

The Customer shall not copy, in whole or in part, any Licensed Programs which are provided by Digital Research in printed form under this Agreement. Additional copies of printed materials may be acquired from Digital Research.

Any Licensed Program which is provided by Digital Research in machine-readable form may be copied, in whole or in part, in printed or machine-readable form in sufficient number for use by the Customer with the designated System, to understand the contents of such machine-readable material, to modify the Licensed Program as provided below, for backup purposes, or for archive purposes, provided, however, that no more than five (5) printed copies will be in existence under any license at any one time without prior written consent from Digital Research. The Customer agrees to maintain appropriate records of the number and location of all such copies of Licensed Programs. The original, and any copies of the Licensed Programs, in whole or in part, which are made by the Customer shall be the property of Digital Research. This does not imply, of course, that

Digital Research owns the media on which the Licensed Programs are recorded. The Customer may modify any machine-readable form of a Licensed Program for his or her own use and merge it into other program material to form an updated work, provided that, upon discontinuance of the license for such Licensed Program, the Licensed Program supplied by Digital Research will be completely removed from the updated work. Any portion of the Licensed Program included in an updated work shall be used only if on the designated System and shall remain subject to all other terms of this Agreement.

The Customer agrees to reproduce and include the copyright notice of Digital Research on all copies, in whole or in part, in any form, including partial copies of modifications, of Licensed Programs made hereunder.

PROTECTION AND SECURITY:

The Customer agrees not to provide or otherwise make available any Licensed Program including but not limited to program listings, object code, and source code, in any form, to any person other than the Customer or Digital Research employees, without prior written consent from Digital Research, except with the Customer's permission for purposes specifically related to the Customer's use of the Licensed Program.

DISCONTINUANCE:

Within one month after the discontinuance of any license under this Agreement, the Customer will furnish to Digital Research a certificate certifying that through his or her best effort, and to the best of his or her knowledge, the original and all copies, in whole or in part, in any form, including partial copies in modifications, of the Licensed Program(s) received from Digital Research or made in connection with such license have been destroyed, except that, upon prior written authorization from Digital Research, the Customer may retain a copy for archive purposes.

DISCLAIMER OF WARRANTY:

Digital Research makes no warranties with respect to the Licensed Programs. The sole obligation of Digital Research shall be to make available all published modifications or updates made by Digital Research to Licensed Programs which are published within one (1) year from date of purchase, provided the Customer has returned the Registration Card delivered with the Licensed Program.

LIMITATION OF LIABILITY:

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO,

THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT WILL DIGITAL RESEARCH BE LIABLE FOR CONSEQUENTIAL DAMAGES EVEN IF DIGITAL RESEARCH HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

GENERAL:

If any of the provisions, or portions thereof, of the Agreement are invalid under any applicable statute or rule of law, they are to that extent to be deemed omitted.

1.4 REGISTRATION INFORMATION

Please fill out the CP/M Registration Card that is enclosed with your Z80 cartridge and CP/M system. Mail the completed card to:

DIGITAL RESEARCH
P.O. Box 579
Pacific Grove, CA 93950

We need the information on the card to provide information on system updates and to inform you of related new products. The serial number of your CP/M system is the number stamped on the label of the CP/M disks.

1.5 WARRANTY

If your unit is defective when you buy it, return it immediately to the original place of purchase. Your dealer will be able to give you the fastest service if you have problems. You can also send your unit directly to Commodore for replacement. The warranty card enclosed in your unit's package lists addresses for service. Be sure to enclose your receipt and a note explaining the problem. See your warranty card for more information.

1.6 GET MORE OUT OF YOUR COMMODORE COMPUTER

Commodore wants you to know that our support for users only starts with your purchase of a Commodore computer. That's why we've created two publications with Commodore information from around the world, and a "two-way" computer information network with valuable input for users in the U.S. and Canada from coast to coast.

In addition, we wholeheartedly encourage and support the growth of Commodore User's Clubs around the world. They are an excellent source of information for every Commodore computer owner, from the beginner to the most advanced. The magazines and network, which are more fully described below, have the most up-to-date information about how to get involved with the User's Club in your area.

Finally, your local Commodore dealer is a useful source of Commodore support and information.

1.6.1 POWER/PLAY: The Home Computer Magazine

For entertainment, learning at home and practical home applications, **POWER/PLAY** is the prime source of information for Commodore home users. From it you will learn where your nearest user clubs are and what they're doing. You'll also learn about software, games, programming techniques, telecommunications, and new products. **POWER/PLAY** is your personal connection to other Commodore users, outside software and hardware developers, and to Commodore itself. Published quarterly, it sells for $10.00 a year.

1.6.2 COMMODORE: The Microcomputer Magazine

Widely read by educators, businessmen, and students as well as by home computerists, **COMMODORE Magazine** is our main vehicle for sharing information on the more technical use of Commodore systems. Regular departments cover business, science and education, programming tips, and "excerpts from a technical notebook." There are many other features of interest to anyone who uses or is thinking

about purchasing Commodore equipment for business, scientific, or educational applications. **COMMODORE** is the ideal complement to **POWER/PLAY**. *It is published bimonthly, and subscriptions are $15.00 a year.*

1.6.3 COMMODORE INFORMATION NETWORK: The Paperless User Magazine

This is the magazine of the future. To supplement and enhance your subscriptions to **POWER/PLAY** and **COMMODORE** magazines, the **COMMODORE INFORMATION NETWORK**—our "paperless magazine"—is available now over the telephone using your Commodore computer and modem.

Join our computer club, get help with a computing problem, "talk" to other Commodore friends, or get up-to-the-minute information on new products, software, and educational resources. Soon you will even be able to save yourself the trouble of typing in the program listings you find in **POWER/PLAY** or **COMMODORE** by downloading direct from the Information Network (a new user service planned for early 1983). The best part is that most of the answers are there even before you ask the questions.

To call our electronic magazine, you need only a modem and a subscription to CompuServe™, one of the nation's largest telecommunications networks. (To make it easy for you, Commodore includes a FREE one year subscription to CompuServe™ in each VICMODEM package.)

Just dial your local number for the CompuServe™ data bank and connect your phone to the modem. When the CompuServe™ video text appears on your screen, type G CBM on your computer keyboard. When the **COMMODORE INFORMATION NETWORK** table of contents, or "menu," appears on your screen, choose from one of our sixteen departments, make yourself comfortable, and enjoy the paperless magazine that other magazines are writing about.

For more information, visit your Commodore dealer or contact CompuServe™ customer service at 800-848-8990 (in Ohio, 614-457-8600).

COMMODORE INFORMATION NETWORK

Main Menu Description	Commodore Dealers
Direct Access Codes	Educational Resources
Special Commands	User Groups
User Questions	Descriptions
Public Bulletin Board	Questions and Answers
Magazines and Newsletters	Software Tips
Products Announced	Technical Tips
Commodore News Direct	Directory Descriptions

CHAPTER 2

SETTING UP YOUR COMMODORE 64

- Unpacking and Connecting the Z80 Cartridge
- Installing the Z80 Cartridge
- Connecting Disk Drives

It's very easy to set up your Commodore 64 to run CP/M. You turn off your computer, plug in the Z80 cartridge, turn on your disks and computer and get started. Follow the directions in this chapter carefully.

REMEMBER: YOU *MUST TURN OFF* YOUR COMMODORE 64 *BEFORE* YOU INSERT THE Z80 CARTRIDGE *IF YOU INSERT THE CARTRIDGE WITH THE POWER ON, YOU WILL DESTROY THE CARTRIDGE!!*

2.1 UNPACKING AND CONNECTING THE Z80 CARTRIDGE

Before using CP/M on your Commodore 64, you must correctly connect your Commodore 64 to your TV and peripherals. For instructions on connecting your Commodore 64 to your TV, disk, and printer, read the manual that comes with your computer.

When you purchase CP/M for your Commodore 64, you get these items:

1. Z80 cartridge.
2. CP/M system disk.
3. Other disk.
4. User's manual.

Before you can connect your Z80 cartridge, you must know where to connect it. Figure 2.1 shows a diagram of the side and back panel connections for your computer.

Your Commodore 64 has these *side panel* connections:

1. **Power socket.** The free end of the cable from the power supply is attached here to supply power to your Commodore 64.
2. **Power switch.** This turns the power to your Commodore 64 on and off.
3. **Game ports.** These accept a joystick, one or more game controllers, or lightpen equipment. *The lightpen plugs into port 1 only.*

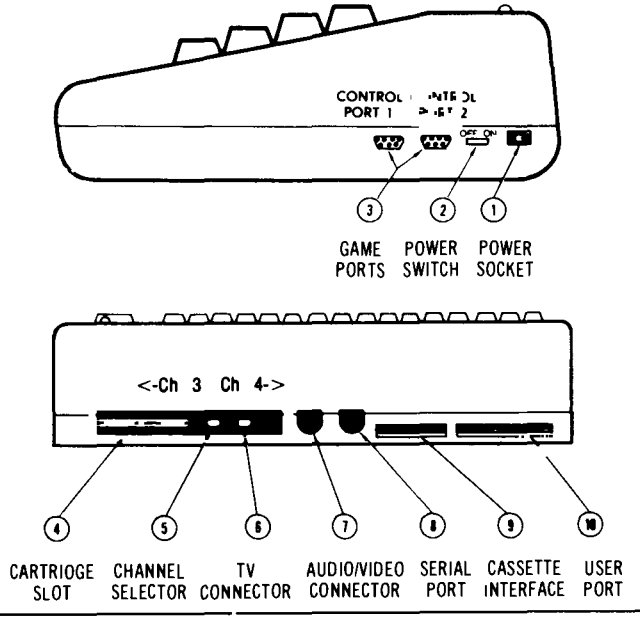


Figure 2.1 Commodore 64 Panel Connections Diagram

Your Commodore 64 has these *back panel connections:*

4. **Cartridge slot.** The rectangular slot to the left accepts program or game cartridges. *This is the connection for your Z80 cartridge.*
5. **Channel selector.** Use this switch to select the TV channel that will display your computer's picture.
6. **TV connector.** This connector supplies the picture and sound to your TV.
7. **Audio & video output.** This connector supplies direct audio (which you connect to your stereo system) and "composite" video (which you connect to a monitor).
8. **Serial port.** This is the connection for your VIC peripherals (1541 drives and 1515/1525 printer). You *must* connect your VIC disk drive to this port and your VIC printer to your VIC disk drive.
9. **Cassette interface.** This is the connection for your DATASSETTE™ recorder.

10. **User port.** This is a port for various interface cartridges such as the VICMODEM or RS-232 communications cartridge.

2.2 INSTALLING THE Z80 CARTRIDGE

Now that you know where your Commodore 64 connections are, you're ready to install your Z80 cartridge. You connect the Z80 cartridge directly to your Commodore 64 if you are using the VIC 1541 disk drive. You connect the Z80 cartridge to an IEEE interface cartridge if you're using the CBM 4040 disk drives or the CBM 4022 printer.

2.2.1 Using the Z80 Cartridge with VIC Peripherals

If you're using *VIC peripherals* like the VIC 1541 disk drives and the VIC 1525 printer, follow these easy steps:

1. TURN OFF THE POWER TO YOUR COMPUTER!
2. Install the Z80 cartridge in the cartridge slot marked 4 in the diagram in Figure 2.1.
3. Turn on your computer and you're ready to start using CP/M on your Commodore 64.

REMEMBER! IF YOU INSERT THE Z80 CARTRIDGE WITH THE POWER TO THE COMPUTER TURNED ON, YOU WILL DAMAGE THE CARTRIDGE!

2.2.2 Using the Z80 Cartridge with CBM Series Peripherals

If you're using *CBM series peripherals* like a CBM 4040 disk drive or a CBM 4022 printer, you follow a slightly different procedure for connecting the Z80 cartridge. Remember, you need to use the IEEE interface cartridge if you're using a CBM peripheral.

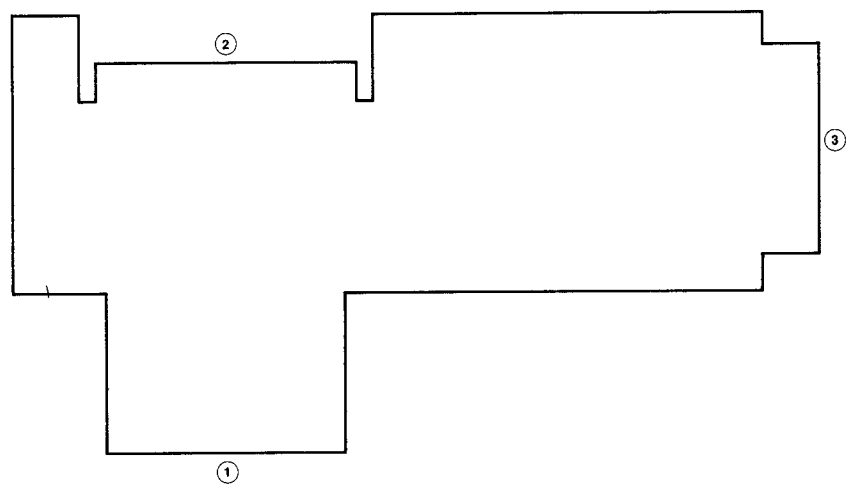
The IEEE interface cartridge has a connector for other

cartridges (like the Z80 cartridge) and also has a connector for the CBM peripherals. Figure 2.2 shows a diagram of the IEEE cartridge connections.

Follow these easy steps to connect your Z80 cartridge to your Commodore 64 when you're using the IEEE Interface cartridge and CBM series peripherals:

1. **TURN OFF THE POWER TO YOUR COMPUTER!**
2. Install the IEEE interface cartridge in the cartridge slot marked 4 in the diagram in Figure 2.1.
3. Install the Z80 cartridge into the IEEE cartridge slot as shown in the diagram in Figure 2.2.
4. Connect your CBM peripherals to the connector on the IEEE cartridge.
5. Turn on your computer and you're ready to start using CP/M on your Commodore 64.

REMEMBER: IF YOU INSERT THE Z80 CARTRIDGE WITH THE POWER TO THE COMPUTER TURNED ON, YOU WILL DAMAGE THE CARTRIDGE!



1 [illegible] THIS END INTO THE IEEE 488 SLOT OF YOUR [illegible] JTER
2 [illegible] E HERE
3 [illegible] ADDI [illegible] EE CONNECTORS HERE

Figure 2.2 IEEE Interface Cartridge Diagram

2.3 CONNECTING DISK DRIVES

The method you use to connect your disk drives depends on the types of drives you use. You can use either a VIC series disk drive (like the 1541) or a CBM series single or dual disk drive (like the 4040) with your Commodore 64.

You don't have to write any special code to use your disk drives under CP/M. The system accesses your disk drives as Drive A and Drive B, regardless of which type of drive you're actually using.

If you use a single disk drive, CP/M uses Drive A and uses a virtual drive for Drive B (CP/M will prompt you to change the physical disk in the drive when you ask for Drive B). If you're using a CBM series dual drive, CP/M uses Drive A and Drive B.

2.3.1 Connecting VIC 1541 Disk Drives

You can use one VIC 1541 disk drive. Like all Commodore peripherals, the VIC 1541 disk drive can be "daisy chained." That is, you can connect your VIC disk drive to a VIC printer.

Connect the single VIC disk drive to the *serial port* (marked 8 in the diagram in Figure 2.1). For full details on connecting a VIC 1541 disk drive to your Commodore 64, see the manual that comes with the drives.

If you're also using a VIC 1525 printer, connect the printer to the connector in the back of your VIC 1541 disk drive.

2.3.2 Connecting CBM Series Disk Drives

When using CBM series peripherals (like the CBM 4040 disk drive or the CBM 4022 printer), you need to connect your peripherals to the IEEE interface cartridge. Figure 2.2 shows a diagram of the IEEE interface cartridge.

You can daisy chain your CBM printer to your CBM disk drive. For more details on connecting your CBM disk drive, see the manual that comes with your IEEE interface cartridge.

CHAPTER 3

USING YOUR COMMODORE 64 PERIPHERALS FROM CP/M

- Printer Interface
- The Commodore 64 Serial Interface
- The IEEE Interface Cartridge
- Daisy Chaining Peripherals
- The Commodore 64 User Port

CP/M, as implemented on your Commodore 64, can access any standard Commodore 64 peripheral (except the RS-232 port and the modem) using standard CP/M device access protocols. This involves calls to the appropriate CP/M BDOS functions. (You can also call the BIOS directly, although this is not recommended.)

The actual peripheral interface drivers reside in the CP/M BIOS. This special BIOS, unique to your Commodore 64, is in two parts. One part executes under the Z80 add-on processor and the other under the 6510 main processor.

Peripheral device access is *set up through a series of parameters* by the Z80 part of the BIOS. The actual device access is carried out by the 6510 part of the BIOS operating in Commodore 64 native mode.

You must configure CP/M—using the CONFIG utility—so that it knows what kind of printer you have and how many disk drives you have. If you change the type of printer or the number of disk drives on the system, you must use the CONFIG utility to inform CP/M of the change.

3.1 PRINTER INTERFACE

CP/M must know what type of printer you have. Generally you will have a VIC 1515, VIC 1525, or CBM 4022 printer. For purposes of the CONFIG utility, the 1515 and 1525 are the same, and the 4022 represents any CBM series printer.

The VIC 1515 and 1525 printers use the standard Commodore 64 serial bus. The 4022 printer (or any other CBM series printer) requires the optional IEEE interface cartridge.

Once you have properly attached the printer to your Commodore 64 and have run the CONFIG utility under CP/M, you can print using programs that run under CP/M or using standard CP/M BDOS calls from Z80 Assembler language programs.

3.2 THE COMMODORE 64 SERIAL INTERFACE

Your Commodore 64 comes standard with a bit serial interface through which you communicate with the Commodore 64 disk drives and printers. Access to the Commodore 64 serial interface is handled automatically under CP/M.

If you attach a nonstandard device to the Commodore 64 bit serial interface, you must prepare code to handle that device. The actual device handling code must execute in Commodore 64 native mode (under the 6510 main processor). Of course, you also need device handling code to run under the Z80, controlling execution of the native mode device-handling routine.

3.3 THE IEEE INTERFACE CARTRIDGE

If you want to connect your Commodore 64 to IEEE bus compatible devices. you can do that using the *IEEE interface cartridge.*

The IEEE interface cartridge plugs into the cartridge slot on the rear of your Commodore 64. The interface cartridge includes a slot for plugging in your Z80 cartridge. (See the instructions that come with your IEEE interface cartridge.)

The interface cartridge allows you to attach Commodore's own IEEE-compatible peripherals. These more capable, more expensive peripherals are usually available only for Commodore's business computers. The IEEE interface cartridge also provides a link to a multitude of IEEE–bus-based products. For example, many industrial and scientific instruments and devices are controlled using the IEEE bus protocols. With the IEEE interface cartridge, your Commodore 64 can control and collect data from these devices.

NOTE: If you do acquire the IEEE interface cartridge, you will have 44K—NOT 48K—available for CP/M. Be sure to generate a 44K version of CP/M before you install the IEEE interface cartridge.

If you are also installing IEEE bus peripherals, especially disk drives, remember to run the CONFIG utility on your 44K CP/M, informing it of your new peripherals.

3.4 DAISY CHAINING PERIPHERALS

The advanced architecture of the standard Commodore 64 serial bus and of the Commodore IEEE serial bus permits peripherals to be linked to one another in a "daisy chain."

Daisy chaining of peripherals means that you need not buy another interface card or connector every time you add a peripheral to your Commodore 64. The peripherals simply connect to each other to be accessed through a single port on your Commodore 64.

You can daisy chain VIC peripherals on the standard Commodore 64 serial bus or CBM series peripherals through the IEEE interface cartridge, as shown in Figure 3.1.

VIC PERIPHERALS SYSTEM

(Uses Standard Commodore 64 Serial Port)

Computer ⟶ VIC Disk Drive ⟶ VIC Printer

CBM PERIPHERALS SYSTEM

(Requires IEEE Interface Cartridge)

Computer ⟶ CBM Dual Disk Drive ⟶ CBM Printer

or

Computer ⟶ CBM Printer ⟶ CBM Dual Disk Drive

Figure 3.1 Daisy Chaining Peripherals.

NOTE: You can also attach the single drive (2031) version of the CBM 4040 disk drive to the IEEE interface cartridge on your Commodore 64.

3.5 THE COMMODORE 64 USER PORT

Your Commodore 64 user port can accommodate some useful optional devices. Most interesting from CP/M are the VICMODEM and the RS-232 communications cartridge.

If you acquire one of these cartridges and you want to access it from CP/M, you must write the processing code for execution in native mode under the 6510 main processor. This is necessary because these cartridges generate nonmaskable interrupts which must be handled by the 6510 processor.

You can gain access to special code for handling these cartridges through BIOS65 function codes 7, 8, or 9. (See the discussion of the CP/M BIOS in Chapter 6 for details on using these function codes.)

In designing this code, you should consider receiving a certain number of characters—say 128 or 256—into a shared buffer. When you have received these characters, inform the device you are communicating with that you are not ready to receive data. You can then safely switch control from the 6510 main processor to the Z80, which can do whatever is required with those characters.

For detailed information on programming for the RS-232 port, see the *Commodore 64 Programmer's Reference Manual.*

CHAPTER 4

GETTING STARTED

- Bringing CP/M onto Your Commodore 64
- The COPY Utility
- The CONFIG Utility
- Generating a New CP/M System with SYSGEN

This chapter tells you how to start using CP/M on your Commodore 64. Read it *carefully.* It's very easy to bring CP/M onto your computer, but you should be sure that you understand the information in this chapter before you start CP/M or run any programs under it.

In this chapter you will learn:

- how to load and run your CP/M system
- how to format new disks and make backup copies of your system
- how to use the special Commodore 64 CP/M utilities
- how to generate a new version of CP/M
- how to use the special Commodore 64 keyboard under CP/M

The distribution 44K version of CP/M assumes that you are using the IEEE interface cartridge. If you don't have the IEEE interface cartridge, you can generate a 48K version of CP/M by following the instructions in Section 4.4.

4.1 BRINGING CP/M ONTO YOUR COMMODORE 64

It is easy to bring CP/M onto your Commodore 64. Before you load CP/M, be sure that you've correctly installed your Z80 cartridge and your disk drive(s) and printer. If you haven't done this, read Chapter 2 for installation instructions.

After installing your Z80 cartridge and peripherals, follow the instructions in Section 4.1.1 to load your CP/M system. Once you've loaded CP/M and made copies of the system disks for backup, you're ready to try any of the commands in Chapter 5.

NOTE: Remember to make copies of your CP/M disks before you do any other processing. You need a backup copy of the disks that you purchased.

4.1.1 Starting CP/M

To bring CP/M onto your Commodore 64 system, you start the computer and load the CP/M system. Just follow these easy steps and *make a backup copy of your system disks right after you get CP/M to start for the first time:*

1. Turn on your equipment (peripherals and computer). Your Commodore 64 will print its usual "sign on" message:

   ```
   **** COMMODORE 64 BASIC V2 ****
   64K RAM SYSTEM 38911 BASIC BYTES FREE
   READY.
   ```

2. Put the disk marked Commodore CP/M®*V.64 into your disk drive. This disk contains your CP/M system.

3. Your Commodore 64 is in native mode. Type the following:

   ```
   LOAD "*",8 <CR>
         or
   LOAD "CPM", 8
   ```

4. Your Commodore 64 reads the disk and answers:

   ```
   SEARCHING FOR * (or CPM instead of *)
   LOADING
   READY.
   ```

5. The Commodore 64 segment of CP/M is now loaded into your computer. To load the Z80 segment and begin executing CP/M, type:

   ```
   RUN <CR>
   ```

6. Your Commodore 64 now reads the disk again to load the CP/M system into your Z80. While it is loading CP/M, your computer will print a row of 27 asterisks (*) across the top of the screen. When CP/M is loaded, your Commodore 64 will print:

```
COMMODORE 64 nnK CP/M vers 2.2
Copyright © 1979, Digital Research
Copyright © 1982, Commodore
A>
```

7. Your CP/M system is now loaded and ready to run. Enter the following CP/M command to get a list of the files on your CP/M disk:

```
DIR <CR>
```

CAUTION! BEFORE PROCEEDING, MAKE A BACKUP COPY OF YOUR CP/M DISKS!

4.1.2 Making Copies of Your CP/M System Disk

Now that you've started CP/M, you *must* make backup copies of your system disks. It is bad practice to use the disks that you purchased as your standard operating disks. You could accidentally destroy the disk and then you would not be able to run your CP/M system.

So, *make a backup copy and use the copy as your CP/M system disk.* After you make the backup copy, *store your original disk in a cool, dry place, away from magnetic fields.*

To make your backup copy:

1. Use the COPY utility on your CP/M disk to format a new disk. The COPY utility is discussed in detail in Section 4.2.
2. Then use the COPY utility to copy your CP/M disk to the backup disk. The COPY utility prompts you along the way, depending on the number of drives you're using. Just follow its instructions.
3. Store your original disks in a *safe* place, somewhere cool, dry, and away from magnetic fields.

4.2 THE COPY UTILITY

The COPY utility is a special Commodore 64 CP/M utility that allows you to:

- FORMAT a diskette for use with CP/M.
- Make a BACKUP of a CP/M diskette.
- Copy the CP/M SYSTEM TRACKS from one diskette to another.

You should use this utility to make a backup copy of your CP/M system disks as soon as you get CP/M up and running. Each COPY utility function is described in a separate section below.

To load the COPY utility, enter:

```
COPY<CR>
```

CP/M loads the COPY.COM file and writes:

```
COMMODORE 64 COPY UTILITY 1.0
1. FORMAT DISK
2. BACKUP DISK
3. COPY SYSTEM TRACKS ONLY
4. EXIT
PLEASE CHOOSE FUNCTION (1-4)
```

You then choose which COPY utility function you want to use and answer the questions that COPY asks.

4.2.1 Formatting a Disk with the COPY Utility

You must *format* a diskette before you can write any information on it. You must format disks that you'll use under CP/M with the COPY utility.

You format disks when:

- You get new disks and you want to prepare them to be used with CP/M.
- You want to *erase all* of the information currently on a disk.

To use the COPY function to format disks, you enter *1* as follows:

```
...COPY utility messages...
PLEASE CHOOSE FUNCTION (1-4)      1
FORMAT DISK UTILITY
INITIALIZES DISK FOR CP/M
CAUTION! FORMAT ERASES ALL DATA
PLACE DISK TO BE FORMATTED IN
DRIVE 0 AND PRESS ENTER
    OR
PRESS SPACEBAR TO RETURN TO MENU
```

Now, *remove your system disk from the drive* and place the new disk (the one that you want to format) into the drive.

CAUTION! REMEMBER THAT YOU MUST *REMOVE YOUR SYSTEM DISK* OR ELSE YOU WILL *ERASE YOUR SYSTEM DISK!!*

COPY now writes formatting information to your disk. Any information on the disk will be erased and all of the tracks are made available for data. No files remain on the disk after you run COPY's FORMAT. COPY writes these messages during the formatting:

```
FORMATTING DISK, PLEASE WAIT...
FORMAT COMPLETE
PRESS ANY KEY TO CONTINUE
```

You can now format another disk, copy information to your newly formatted disk, or exit back to CP/M, depending on your answer. If you want to format another disk, you need to insert the disk to be formatted into the drive. If you want to copy information, follow the instructions from COPY. If you're exiting back to CP/M, you should put your CP/M system disk into the drive.

NOTE: Remember that COPY *erases* all information from the disk when you use the COPY FORMAT option.

4.2.2 Creating a Disk Backup with the COPY Utility

You can also use the COPY utility to make backup copies of an entire diskette. While making a backup copy, COPY uses a master disk and a slave disk. The *master disk* is the disk that you want to make a copy of (the original disk); the *slave disk* is a formatted disk that will be written to (the copy).

If you are using a single-drive system, the COPY utility will prompt you to insert the master or slave disk into the drive. Be careful when making copies of a disk. Keep track of your master disk so that you don't accidentally copy garbage over your information (and erase your master disk in the process).

To use COPY's BACKUP function, enter a *2* in response to the "choose function" message and follow the instructions from COPY:

```
PLEASE CHOOSE FUNCTION (1-4)    2
DISK BACKUP UTILITY
THE ENTIRE MASTER DISK IS
COPIED TO THE SLAVE DISK
INSERT MASTER DISK IN DRIVE 0
PRESS RETURN (OR SPACEBAR FOR MENU)
```

Now insert the disk that you want to copy *from* into the disk drive. If you decide that you don't really want to copy your disk, simply press the SPACE bar and COPY returns to its original menu.

Once the master disk is ready, press the RETURN key. COPY then reads a number of sectors from the disk into memory and writes:

```
INSERT SLAVE DISK IN DRIVE 0
PRESS RETURN
```

Put the disk you want to copy *to* into the drive and press the carriage return. *Be careful to keep the master and slave disks in order.*

COPY now writes the information from memory onto the

slave disk and then asks that the master disk be replaced in the drive. This alternating master/slave disk placement will continue until the entire master disk is copied onto the slave disk. At that time, COPY returns to its main menu.

4.2.3 Copying the System Tracks with the COPY Utility

You can copy the CP/M system tracks to another disk through the COPY system track copy function. This function copies only the system tracks, not any other information, from a master disk to a slave disk.

You need the CP/M system tracks on any disk from which you intend to "warm start" CP/M (start CP/M without having to reinsert the system disk). You may want to copy the system tracks to a disk containing a program that you will run often. That way, when you hit a CTRL -C to warm start CP/M, you don't have to replace the disk with your system disk.

To copy the system tracks using COPY, enter *3* for your selection from COPY's main menu. Then follow the instructions:

```
PLEASE CHOOSE FUNCTION (1-4)    3
SYSTEM TRACK COPY UTILITY
COPIES SYSTEM TRACKS FROM MASTER DISK
TO SLAVE DISK
INSERT MASTER DISK IN DRIVE 0
PRESS RETURN (OR SPACEBAR FOR MENU)
```

The disk with the COPY utility contains the CP/M system tracks (otherwise, you wouldn't have been able to start your system). Simply press the RETURN key or, if you really don't want to make a copy, press the SPACE bar.

When you press the RETURN key, COPY reads the system tracks into memory and then writes:

```
INSERT SLAVE DISK IN DRIVE 0
PRESS RETURN
```

Remove the master disk from the drive and insert the disk on which you want the system tracks copied into the drive. When you press the RETURN key, COPY will write the CP/M system tracks (tracks 0 and 1) to the disk in the drive. After the system tracks are written, COPY returns to its main menu.

4.3 THE CONFIG UTILITY

You use the Commodore CP/M CONFIG utility to *change* the current I/O configuration for your CP/M system. Commodore provides the CONFIG utility so that you can add peripherals to your CP/M system quickly and easily.

CP/M needs to know what peripherals you're using. For example, if you're using only a single disk drive, CP/M will prompt you to change the diskette in the drive when you log to another disk. If you're using two drives, a properly configured CP/M will simply use the second physical drive.

NOTE: You CANNOT mix VIC (serial) peripherals and CBM (IEEE interface) peripherals on the same system.

Each of the CONFIG changes is described in a separate section below. To use the CONFIG utility, you enter:

```
CONFIG <CR>
```

CP/M then loads the file called CONFIG.COM and writes:

```
COMMODORE 64 I/O CONFIGURATION UTILITY
THE CURRENT I/O ASSIGNMENTS ARE:
   NUMBER OF DRIVES: 1
   PRINTER TYPE: 1515
   INITIAL CAPS MODE: ON
DO YOU WISH TO:
   1. CHANGE NUMBER OF DISK DRIVES
   2. CHANGE PRINTER TYPE
   3. CHANGE INITIAL CAPS MODE
```

4. CHANGE FUNCTION KEY ASSIGNMENTS
5. CHANGE KEY CODES
6. SAVE CURRENT I/O SETUP ON DISK
7. RETURN TO CP/M

PLEASE ENTER SELECTION (1-7)

You simply select the type of change that you want to make and answer the questions that CONFIG asks. CONFIG makes all the necessary changes to your CP/M system, for both the Commodore 64 native code and the Z80 code. Adding or changing peripherals to your Commodore 64 CP/M system is as easy as running CONFIG and answering the questions.

4.3.1 Using CONFIG to Change the Number of Disk Drives

The CP/M system that you receive assumes that you are using a single disk drive. You may actually have the CBM 4040 dual disk drives. CONFIG toggles back and forth between one and two disk drives.

To change the number of drives, you run CONFIG like this:

CONFIG<CR>

when the CONFIG Messages are printed, choose selection 1.

CONFIG then processes your answer and changes the number of drives available to CP/M. If you originally had *one* disk drive, CONFIG prints:

COMMODORE 64 I/O CONFIGURATION UTILITY

THE CURRENT I/O ASSIGNMENTS ARE:

NUMBER OF DRIVES: 2

PRINTER TYPE: 1515

INITIAL CAPS MODE: ON

DO YOU WISH TO:

rest of CONFIG messages...

PLEASE ENTER SELECTION (1-7)

If you had *two* disk drives when you started CONFIG, you will see this for the number of drives:

```
NUMBER OF DRIVES: 1
```

4.3.2 Using CONFIG to Change the Printer Type

Your original CP/M system assumes that you will be using a VIC 1515 or (1525) printer. You may want to add a CBM 4022 (or other CBM) printer. CONFIG toggles back and forth between 1515 and 4022 printer types.

To change the printer type, you run CONFIG like this:

```
CONFIG<CR>
```

when the CONFIG Messages are printed, choose selection 2.

CONFIG then processes your answer and changes the printer type. If you originally had a VIC 1515 printer, CONFIG prints:

```
COMMODORE 64 I/O CONFIGURATION UTILITY
THE CURRENT I/O ASSIGNMENTS ARE:
   NUMBER OF DRIVES: 1
   PRINTER TYPE: 4022
   INITIAL CAPS MODE: ON
DO YOU WISH TO:
```

rest of CONFIG messages...

```
PLEASE ENTER SELECTION (1-7)
```

If you had a CBM 4022 printer when you started CONFIG, you get this for the printer type:

```
PRINTER TYPE: 1515
```

4.3.3 Using CONFIG to Change the Initial Caps Mode

Your original CP/M system assumes that you will be using the all caps mode (all upper case letters when you press the

keys). CONFIG toggles back and forth between initial caps ON and OFF.

With initial caps ON, you get only upper case letters. With initial caps OFF, you get upper and lower case letters. Remember that you can also toggle between caps ON and OFF at any time by pressing the C= key.

To change the initial caps mode, you run CONFIG like this:

```
CONFIG<CR>
```

when the CONFIG Messages are printed, choose selection 3.

CONFIG then processes your answer and changes the printer type. If you originally had initial caps ON, CONFIG prints:

```
COMMODORE 64 I/O CONFIGURATION UTILITY
THE CURRENT I/O ASSIGNMENTS ARE:
   NUMBER OF DRIVES: 1
   PRINTER TYPE: 1515
   INITIAL CAPS MODE: OFF
DO YOU WISH TO:
```

rest of CONFIG messages...

```
PLEASE ENTER SELECTION (1-7)
```

If you had initial caps OFF when you started CONFIG, you will see this:

```
INITIAL CAPS MODE: OFF
```

4.3.4 Using CONFIG to Change the Function Key Assignments

Your CP/M system loads initial values into the eight Commodore 64 function keys. You can change any of these function key values through CONFIG.

If you save the new I/O configuration to disk, the new values will be loaded into the function keys when you next start CP/M. If you don't save the new configuration to disk,

the function keys are loaded with the new values but are reset to the original values when you next start CP/M.

To change the function key values, you run CONFIG like this:

```
CONFIG<CR>
```

when the CONFIG Messages are printed, choose selection 4.

CONFIG then prints:

```
F1: "DIR"<CR>
F2: "DIR B:"<CR>
F3: "STAT *.*"<CR>
F4: "STAT B:*.*"<CR>
F5: "COPY"<CR>
F6: "CONFIG"<CR>
F7: "DDT"<CR>
F8: "DDT"
ENTER FUNCTION KEY NUMBER (1-8)
  TO CHANGE PRESET VALUES.
ENTER 9 TO LEAVE FUNCTION
  KEY UTILITY.
```

To change function key 8 to "PIP<CR>", use CONFIG like this:

```
ENTER FUNCTION KEY NUMBER (1-8)     8

TYPE IN TEXT USING "RETURN"
OR "CTRL-Z" AS TERMINATOR

F8: "PIP<RETURN KEY>"
ENTER FUNCTION KEY NUMBER (1-8)     9
```

This changes the value in function key 8 to PIP<CR> while you are using CP/M.

If you end your new key entry with a CTRL -Z , instead of a RETURN the function key is loaded *without a terminating carriage return.*

If you want to save this value as the initial value for function key 8 for the next time you start CP/M, you must also choose CONFIG selection 6 to save the new I/O configuration to disk. Otherwise, the next time you boot CP/M, your function keys will contain the same initial values as they did this time; any changes you made through CONFIG will be lost.

4.3.5 Using CONFIG to Change the Key Codes

Your CP/M system loads a table containing the hexadecimal values for each of the Commodore 64 keyboard keys. You can change any of these function key values through CONFIG. Appendix D contains a table of ASCII characters, hexadecimal values, and the Commodore 64 keyboard characters.

NOTE: Be careful if you change the alphabetic characters. You may not be able to recover if you change characters that you need to run CP/M programs or commands. If you SAVE the character changes on disk (through CONFIG selection 6), you may have trouble recovering at all.

To change the keyboard key values, you run CONFIG like this:

```
CONFIG<CR>
```

when the CONFIG Messages are printed, choose selection 5.

CONFIG then prints:

```
PRESS KEY TO EXAMINE KEY CODE
TO CHANGE KEY CODE, ENTER DATA IN
HEXADECIMAL AFTER "CHANGE TO"
TO EXIT KEY CODE MODE, TYPE "RETURN"
TWICE AFTER "PRESS KEY"
TO KEEP CURRENT KEY CODE, TYPE
"RETURN" AFTER "CHANGE TO"
```

PRESS KEY (you press the "Q" key)

IS 51 IN CAPS MODE—CHANGE TO 71

You just changed the capital *Q* (hexadecimal value 51) to a lower case *q* (hexadecimal value 71). You won't be able to enter a capital Q unless you use CONFIG to change it back again. If you don't want to make any more changes, just press the RETURN key *twice* to return to the CONFIG main menu.

4.3.6 Using CONFIG to Save the New I/O Setup

Once you've made changes to your I/O assignments through CONFIG, you may or may not want to save the new assignments. You will probably want to save the new information if you've changed the disk drive or printer data. You may not want to save the I/O information if you've changed the function key assignments for a special run and don't want the new values to be used the next time you start CP/M.

To save your new I/O assignments to disk, select 6 from the CONFIG menu. CONFIG then writes information to your CP/M system data and the next time you start CP/M, the new information will be used.

Remember, you can make changes that only affect the current CP/M version (the one in memory when you make the changes) if you want some special-purpose alterations. If you don't select CONFIG choice 6, the alterations will not be in effect the next time you load CP/M.

4.4. GENERATING A NEW CP/M SYSTEM WITH SYSGEN

You can generate CP/M on your Commodore 64 to run in any memory size from 20K to 48K. If you are using the standard Commodore 64 serial bus to attach your peripherals—disk and printer—you should use a 48K version of CP/M. If you acquire the IEEE interface cartridge, you must

use a 44K version of CP/M. You may also want to generate a smaller version of CP/M if you need space to load a 6510 routine that you are invoking from a CP/M program.

NOTE: If you don't intend to save the new CP/M on an existing CP/M disk, the first step in generating a new version of CP/M is to **format** a disk. Disk formatting is discussed in detail in Chapter 4 under the COPY utility

Once you have the disk formatted for CP/M, you must use the **COPY** utility to copy the **System tracks** from one of your existing CP/M disks to the new disk. This operation places the 6510 loader into its proper place

---

Once you have properly initialized your disk, you use a series of CP/M utility programs to generate the new version of CP/M and save it on your disk. These utilities are:

- MOVCPM
- SAVE
- SYSGEN

These utilities have a number of options on their use. In the following discussions, we consider only the most frequently used options. A more detailed exploration of all the utility options is found in Chapter 5.

In general, you will be generating either a 44K or a 48K version of CP/M on your Commodore 64. We'll use generating a 48K version as an example. Other versions are generated in exactly the same way but with a different memory size specified.

4.4.1 Relocating CP/M

MOVCPM is a system utility that *relocates* the CP/M operating system to execute in any memory size you specify.

To generate a 48K version of CP/M, you enter:

```
MOVCPM 48 *
```

where:

48 is the memory size

* instructs MOVCPM to leave the relocated CP/M image in memory.

MOVCPM responds with:

```
CONSTRUCTING 48K CP/M vers 2.2
READY FOR "SYSGEN" OR
"SAVE 37 CPM48.COM"
```

This is the end of MOVCPM execution. You follow this by running either the SYSGEN or the SAVE utility. Normally, you use the SYSGEN utility. Use the SAVE utility if you want to "patch" the operating system.

NOTE: Your Commodore 64 version of MOVCPM properly adjusts *all* of the CP/M code, including the BOOT80 and BIOS80 programs. You do NOT have to reassemble these programs and use DDT to patch them into the new version of the operating system as you do on less capable CP/M systems.

Execution of MOVCPM as shown above leaves a copy of the relocated CP/M operating system, including BOOT80, CCP, BDOS, and BIOS80, in the Transient Program Area (TPA) ready to be saved as a file on your disk or written directly to the system tracks. (To learn more about CP/M structure, read Chapter 6.)

If you choose to save a copy, you can SYSGEN it later.

4.4.2 Saving the New System

The SAVE built-in command writes the content of the TPA (in this case, a copy of your newly relocated CP/M) to the specified disk file. The MOVCPM command tells you how many 256-byte pages to save. MOVCPM on your Commodore 64 always tells you to save 37 pages.

To save your relocated verion of CP/M, enter:

```
SAVE 37 CPM48.COM
```

This command will write the relocated CP/M to a file named "CPM48.COM". This is a full copy of a 48K version of the CP/M operating system. You can use the saved copy of CP/M in subsequent SYSGEN commands or for direct alteration under DDT.

4.4.3 Using SYSGEN

A version of CP/M that you have saved in a disk file cannot be directly executed. You must first SYSGEN it to the system tracks of a CP/M disk.

SYSGEN *writes the specified version* of the CP/M operating system to the proper locations *on the system tracks* of a CP/M disk. SYSGEN can read a version of the operating system from one of two places:

- The system tracks of diskette.
- A memory image of CP/M loaded into the TPA by the MOVCPM or DDT programs.

If you are using a file containing a SAVEd version of CP/M, you must first bring it into memory with the DDT program. In our example, you enter:

```
DDT CPM48.COM
```

then exit from DDT with a G0 command.

If your source for the new version of CP/M is the system tracks of your disk or a memory resident image, you simply enter:

```
SYSGEN
```

and SYSGEN responds with:

```
SOURCE DRIVE NAME
(OR RETURN TO SKIP)
```

At this point you can specify the drive (A or B) whose system tracks you want read. If you simply hit the RETURN key, SYSGEN assumes that a copy of CP/M is already loaded into the TPA.

Whatever way you get the CP/M version loaded into memory, SYSGEN will ask you:

```
DESTINATION DRIVE NAME
(OR RETURN TO REBOOT)
```

If you respond with a destination drive name (A or B), SYSGEN will write CP/M to the system tracks of that drive.

If you simply hit the RETURN key, SYSGEN will reboot from whatever disk is currently in Drive A.

NOTE: IF you SYSGEN a CP/M system that is different in size from the one you ran the SYSGEN under, DO NOT try to reboot from a disk containing the new system. This will cause the operating system to crash Re-insert the disk from which you loaded SYSGEN before you tell it to reboot

---

To test a newly SYSGENed version of CP/M, you'll have to start it from native mode on your Commodore 64.

4.5 THE COMMODORE 64 KEYBOARD AND SCREEN WITH CP/M

The Commodore 64 has a full typewriter-style keyboard that behaves as such when you are running CP/M. All of the CP/M CTRL shifted control codes operate as they are supposed to. In addition, the STOP/RUN key on your Commodore 64 keyboard acts like a CTRL-C to produce a warm boot of the CP/M operating system.

In the Commodore 64 version of CP/M, you have the option of using only upper case or both upper and lower case. You *toggle* between them using the Commodore key on the keyboard. You can use the CONFIG utility to tell CP/M to start with upper only or with upper/lower case enabled.

Table 5.3 contains a complete list of the **special CP/M control keys.** These are identical to those defined for CP/M, with a few additional functions taken from your Commodore 64 keyboard.

The Commodore 64 graphics characters and screen color control are not generally available to CP/M. But there is no reason that you can't store values into your Commodore 64 6567 Video Interface Chip's control registers just as you do when running in native mode. To arrive at the proper addresses for the control registers, examine Section 6.1.3, which explains the address mapping between the Z80 and 6510 processors.

The control values that you insert into the registers are the same as those you use in native mode. As an example, suppose you want to use your Commodore 64 graphics character set. Running in native mode, you simply touch the graphics key to switch on the graphics character set. From a CP/M program running under the Z80, you have to control it directly through a store into the appropriate 6567 control register.

The character set selection control register is at

6510 address 53,272 decimal or $D018 hexadecimal

which converts to the Z80 address base:

Z80 address 49,176 decimal or $C018 hexadecimal

The character set control register normally contains a $17. To invoke the graphics character set, you must store a $15 in the register:

```
MVI A,15H       ;LOAD THE CONTROL VALUE IN A
STA 0C018H      ;STORE $15 IN THE 6567 CONTROL REGISTER
```

Once you've executed this code, the graphics character set is available to you. This operation *does not* change the character codes reaching your CP/M programs from the keyboard—only the display is changed.

You can use the same technique to alter colors, activate Sprites, or even play music through your Commodore 64 6581 Sound Interface Device. If you want to store characters directly into the screen matrix, remember to store Commodore 64 screen codes, *not* ASCII codes.

To use the dynamic features of your Commodore 64 from CP/M, all you have to do is remember that the 6510 addresses for the control registers must be reduced by $1000 (4096) in your CP/M programs.

CHAPTER 5

CP/M OPERATION

- How to Use This Chapter
- CP/M File Naming Conventions
- Input/Output Hardware Conventions
- CP/M Command Structure
- CP/M Commands

This chapter tells you how to use CP/M on your Commodore 64. It is *not* a detailed lesson on CP/M and its internal workings. It *is* an introduction to CP/M's conventions and notations, and an introduction to the commands that you can use under CP/M.

If you want detailed information on the internal workings of CP/M, get one of the many fine books listed in Appendix B, the Bibliography. That level of detail is far beyond the scope of this book.

5.1 HOW TO USE THIS CHAPTER

Section 5.2 describes the CP/M file naming conventions. You should follow some reasonable conventions for naming your own files so that you can easily identify their contents.

Section 5.3 discusses the CP/M disk identification conventions. CP/M uses disk A and disk B; your Commodore 64 identifies these disks as disk 0 and disk 1. Section 5.3 also tells you how CP/M differs when you use the VIC 1541 or the CBM 4040 drive.

Section 5.4 describes the CP/M command structure and gives a table of all the CP/M commands that you get with your Commodore 64 CP/M system.

Section 5.5 provides *brief* descriptions of the CP/M commands. If you need more detail, see one or more of the CP/M books listed in Appendix B. Some books are more technical than others, so find the one with the amount of detail you are most comfortable with.

5.2 CP/M FILE NAMING CONVENTIONS

When you are using CP/M on your Commodore 64, you should follow the CP/M file naming conventions. CP/M files have the general format:

[DISK-ID:] FILENAME [.TYPE]

where:

DISK-ID is an optional disk drive identifier (such as A or B) that is needed when you want to use a file not on the currently logged disk.

FILENAME is a one- to eight-character name used to identify your file to CP/M.

TYPE is an optional one- to three-character name used to further identify your file.

Some examples of CP/M filenames are:

A:SAMPLE.BAS	A BASIC sample program stored on the disk on Drive A.
MY.TXT	A text file.
PROGRAM.COM	A program that is executable.
10/25/82.DRY	A diary entry.

CP/M lets you use any alphabetic or numeric character in your file names, as well as some special characters. CP/M reserves a few of the special characters for its own use. You *cannot* use the following characters in a CP/M file name:

< > . , ; : = ? * [ ]

With some software packages, files must be named with specific types, such as SUB for a SUBMIT file or ASM for an Assembly Language source file. Read the information with your software packages to see if you need to follow any naming conventions for that package's files.

Even if you don't have to follow any specific rules in naming your files, you should try to use reasonable naming conventions. In this way, when you get a directory listing (a list of all the files on a disk), you will have some idea of what's in the files.

A file named MORTGAGE.BAS is easier to recognize as the set of source statements for a BASIC program that calculates mortgage rates than a file named X127GY9.123. In other words, it makes sense to name your data files in ways that represent their contents. For example, a file named

01/15/83.DTA could contain the data you collected on January 15, 1983.

Since there are so many CP/M users (over 500,000 to date), certain standard filename types have been adopted. The most commonly used types are shown in Table 5.1.

Table 5.1 Commonly Used CP/M File Types

TYPE	FUNCTION OR CONTENTS
*.ASM	Assembly language source file
.BAK	Backup file
.BAS	BASIC program source file (for some BASIC interpreters like CBASIC)
*.COM	Directly executable transient program
.DAT	Data file
.DOC	Document or text file (required by some word processing packages)
*.HEX	File containing data in hexadecimal format; an Intel HEX format object code file
.INT	Output file from some compilers (CBASIC, JRT PASCAL) that contains intermediate code
*.LIB	Library file
.LST	Program listing (usually output from a language processor like a compiler, interpreter, or assembler)
.PRN	Print file (usually output from an assembler or compiler)
.PRT	Print file (usually output from an interpreter or compiler)

Table 5.1 Commonly Used CP/M File Types

TYPE	FUNCTION OR CONTENTS
.SRC	Source file from the CP/M User's Group
*.SUB	Command file for a SUBMIT run
.SYM	Symbol table file (generated by some compilers, assemblers, and interpreters)
.TEX	Text file (required by some word processors)
.TXT	Text file (required by some word processors)
*.$$$	Either a temporary file or an improperly saved (and unusable) file

NOTE: Those filename types marked with an asterisk (*) must be adopted if you want to use associated software packages or system functions. That is, all CP/M directly executable programs must be named "filename.COM."

5.3 INPUT/OUTPUT HARDWARE CONVENTIONS

CP/M has certain conventions that must be followed when you are reading files from a disk or writing files to a disk.

The first disk drive physically attached to the system is called drive A. The next is drive B. When you are using a single 1541 disk drive, your Commodore 64 CP/M uses a slightly different way of telling which disk is in the drive (this is described in some detail below).

When you begin CP/M, you will be "logged" to drive A and you will see the prompt "A>" on your screen. This means that if you specify a filename in a command and you don't

specify a disk-id before the filename, the disk on drive A will be searched for the file.

You can log to drive B by entering the command:

```
B:
```

After entering the B: command, any filename that you specify without a disk-id preceding the filename will be read from or written to drive B.

You can change back and forth between drive A and drive B by simply entering the above command. You can tell which drive you're currently accessing by looking at the prompt: it will be **A>** when you're using drive A or **B>** when you're using drive B.

Your Commodore 64 CP/M can use either the VIC 1541 single disk drive or the CBM 4040 dual disk drive. Read the sections below that cover the type of disk drive you have attached to your Commodore 64.

5.3.1 Loading Programs from Disk: Single Drive

It is easy to load and run a CP/M program. You first place the program disk into your disk drive and then enter the filename followed by a carriage return, for example:

```
MYPROG <CR>
```

CP/M then goes to the currently logged disk and looks for the file called MYPROG.COM. If CP/M finds this file, the data in the file are read into the computer's memory and CP/M begins executing those instructions.

If the file is not found on the disk, then CP/M prints the filename followed by a question mark:

```
MYPROG?
```

In such cases, check to see if you have the correct disk in the drive, log to the correct disk, or correct the program name.

For a single-drive system, if you are logged to drive A and your program is on drive B, then remove disk A from the drive, insert disk B, and enter:

B:OTHERPGM <CR>

CP/M will first ask that the appropriate disk be placed in the drive by writing:

INSERT DISK B INTO DRIVE 0, PRESS RETURN

You should put the appropriate disk into the drive and press the RETURN key. CP/M will then search the disk for the file called OTHERPGM.COM, load the file, and run it.

5.3.2 Loading Programs from Disk: Dual Drive

When using the CBM 4040 dual disk drive, you don't have to physically change the disk in the drive when you want to log to another disk. Since there are two drives, you can insert two disks into the drive: disk A and disk B.

When you enter the B> command to log to disk B, CP/M will not ask you to insert a disk into the drive. Instead, CP/M will use the disk already in drive B.

If you want to change which disk is in a drive, you should change the disk and then tell CP/M that a different disk is in the drive by entering a CTRL -C command. This makes CP/M read the directory from the disk and keeps you from writing over information that you want to keep.

You must have the Commodore 64 IEEE interface cartridge when you use the CBM 4040 dual disk drive. You cannot plug the dual disk drive into the Commodore 64 without the interface cartridge.

5.4 CP/M COMMAND STRUCTURE

Your Commodore 64 CP/M system includes a Console Command Processor (CCP) through which you interact with CP/M. The CCP reads and interprets the commands you enter at the keyboard.

The CP/M commands are listed in Table 5.2 and described in some detail later in this chapter.

In general, the CP/M commands are of two types:

- *Built-in commands* which are a part of the CCP itself. Being part of the CP/M operating system, built-in commands are included whenever you load CP/M.
- *Transient commands* which are loaded into the Transient Program Area (TPA) from a disk and then executed. Transient commands reside on the disk as COM files.

Table 5.2 CP/M Commands

COMMAND NAME	BUILT-IN (B) or TRANSIENT (T)	COMMAND FUNCTION
pgm-name	T	Load and execute the program stored on the disk as file *pgm-name*.COM.
x:	B	Change the currently logged disk to disk *x*.
ASM	T	Load the CP/M assembler and assemble the specified program from the disk.
DDT	T	Load the CP/M debugger (DDT) and begin executing the debugger.
DIR	B	List the filenames in the disk directory.
DUMP	T	Dump the contents of the specified file to the screen in hexadecimal format.
ED	T	Load and execute the CP/M text editor program.
ERA	B	Erase the specified file(s) from the disk.

Table 5.2 (Continued)

COMMAND NAME	BUILT-IN (B) or TRANSIENT (T)	COMMAND FUNCTION
LOAD	T	Produce an executable (COM) file from an assembled (HEX) file.
MOVCPM	T	Recreate the CP/M system for the specified memory size.
PIP	T	Copy specified file(s).
REN	B	Rename the specified file.
SAVE	B	Save the contents of memory as the specified file on the disk.
STAT	T	Provide status information about specified files, no file, or all files, and list the number of available bytes remaining on the disk.
SUBMIT	T	Read the specified file and execute the commands in a batch processing mode.
SYSGEN	T	Create a new CP/M system diskette.
TYPE	B	Type the contents of the specified file onto the screen.
USER	B	Change the currently logged user number to the specified value.
XSUB	T	Allow the entering of data as well as CP/M commands in a SUBMIT file.

In addition to the commands listed in Table 5.2, your CP/M system includes a number of built-in *line editing*

commands. The CP/M line editing commands, shown in Table 5.3, have the general form:

CTRL -x

where:

CTRL means hold down the CONTROL key on your Commodore 64.
x is one of the keys on your Commodore 64 keyboard.

Table 5.3 CP/M Built-in Line Editing Commands

COMMAND	FUNCTION
CTRL -C or RUN/STOP	Perform a CP/M *warm-start.*
CTRL -E	Move to the beginning of the next line.
CTRL -H or DEL	Delete one character and erase it from the screen.
CTRL -J	Perform a carriage return and line feed.
CTRL -M or RETURN	Perform a carriage return.
CTRL -P	Toggle printer/console output. On first use, send all screen messages to the printer; one next use, send all screen messages to the screen.
CTRL -R	Repeat the current command line.
CTRL -S	Temporarily halt listing of data on the screen. Press any key to continue listing.
CTRL -U or CTRL -X	Cancel current command line.
C=	Toggle between all upper case and upper/lower case letters. C= is the Commodore key.

5.5 CP/M COMMANDS

This section gives you a brief description of the Commodore 64 CP/M commands. It is *not* intended to be a detailed description of how CP/M commands operate, nor does it attempt to describe every possible way you can use the CP/M commands.

If you need to learn how CP/M works or if you need more detail on how the commands work, you should purchase one or more of the excellent CP/M teaching texts on the market. Skim these books and pick those that present the information in a way that you can easily understand.

The following notation is used in describing the CP/M commands:

- *Underlined* words show arguments (parameters) which you replace with your own values.
- **BOLDFACE** keywords must be entered *exactly* as shown.
- A *vertical bar* (|) separates arguments where you may select any one of the list of arguments.
- *Square brackets* ([ ]) are used to show *optional arguments*. You select any or none of the arguments listed, depending on your needs.
- *Braces* ({ }) show that you *must* choose one of the arguments.

5.5.1 *pgm-name* (Load and Run a CP/M Program)

Format: [*disk-id:*]*filename*<CR>

where:

disk-id is an optional disk identifier.

filename is the name of the file containing the program to be loaded and run. Programs must be stored in files named *filename*.COM.

Description:

CP/M programs are stored in files named *filename*.COM. When you type the name of one of

these program files and hit the carriage return key, CP/M does the following:

1. Searchs the currently logged disk or the disk specified by *disk-id* for the program file *filename*.COM.
2. Loads the program file into memory.
3. Begins executing the instructions in the program.

If the file is not found on the disk, CP/M prints a message like this:

```
FILENAME?
```

When you get this message, make sure you have the correct disk in the disk drive, that you've spelled the program filename correctly, and that the program is stored in a COM file.

Example 1:

To load and execute your program which is stored in the file MYPROG.COM, enter:

```
MYPROG <CR>
```

CP/M searches the currently logged disk for the file MYPROG.COM, loads the file, and begins executing the instructions. If the file is not on the disk, you will see the error message:

```
MYPROG?
```

Example 2:

You have a single drive system and are currently logged to disk A. You want to load and run the program XYZ from disk B. Enter the CP/M command:

```
B:XYZ <CR>
```

CP/M then responds with:

```
PLACE DISK B INTO THE DISK DRIVE AND HIT RETURN
```

Put the appropriate disk into the disk drive and press the RETURN key. Then, CP/M searches for the file named XYZ.COM, loads the file, and begins executing its instructions.

5.5.2 *x*: (Change the Currently Logged Disk)

Format: *disk-id:*

where:
disk-id is the disk identifier

Description:

Under CP/M, you are always "logged" to a disk. You can tell which disk CP/M is using by looking at the prompt message. If it's "A>", you're logged to disk A; if it's "B>", you're logged to disk B.

You can change the logged disk by entering:

DISK-ID:

CP/M then asks you to insert the appropriate disk into the disk drive and hit the carriage return. CP/M remembers which disk you're currently logged to and will request another disk if you ask for a file or program and use the *disk-id* qualifier.

Example:

You have a single drive system and are currently logged to disk A. You want to log to disk B. To do this, you would enter:

```
B: <CR>
```

CP/M then writes:

```
INSERT DISK B INTO DRIVE 0, PRESS RETURN
```

When you insert the disk into the drive and hit the carriage return, CP/M is logged to that disk. The CP/M prompt will now be:

```
B>
```

5.5.3 ASM

Format: **ASM***filename*[*.parms*]

where:

filename is the name of the file containing the program to be assembled. The file *must* be named *filename*.ASM.

parms contains up to three characters specifying the drive(s) for the source file, HEX file, and PRN file.

Description:

The ASM command loads and executes the CP/M Assembler which processes 8080 instructions. The CP/M Assembler:

1. Assembles the assembly language statements contained in the file *filename*.ASM.
2. Generates an object file in hexadecimal format and places the object file in *filename*.HEX.
3. Produces a print file in *filename*.PRN.

The *parms* string is an optional character string which tells the assembler where to read and write its files. You can specify up to three characters in *parms*. Each character position has a special meaning:

- Position 1: The source drive for the file containing the assembly language statements.
- Position 2: The destination drive for the object (HEX) file.
- Position 3: The destination drive for the print (PRN) file.

If you specify a "Z" for positions 2 and/or 3, the assembler will not generate a HEX (position 2) or PRN (position 3) file. If you specify an "X" for position 3, the listing will appear on your screen instead of in a file. Table 5.4 lists the ASM error messages.

NOTE: CP/M was written for the Intel 8080 microprocessor. The Z80 processor in your Commodore 64 is compatible with the 8080 processor but offers a much larger instruction set, more internal registers, and other advantages.
If you want to use the full Z80 instruction set, you'll have to get an assembler that recognizes the Z80 instructions.

Table 5.4 ASM Error Messages

ERROR CODE	MEANING
D	Data error. The data element cannot be placed into the specified data area. For example, you cannot put the value 500 in a one-byte area.
E	Expression error. The assembler could not evaluate the expression.
L	Label error. The label is used out of context. This could be a duplicate label.
N	Not implemented. You tried to use a feature that is not implemented, such as using macros.
O	Overflow. The expression is too complicated to evaluate.
P	Phase error. A label's value changed between passes of the assembler.
R	Register error. The value specified as a register does not match the value needed by the op code.
S	Syntax error. The statement contains a syntax error and could not be evaluated.
U	Undefined lable. You used a label which does not exist in the program.
V	Value error. There is an improperly formed operand in the expression.

Examples:

ASM APROG.BBB	Assemble the assembly language program contained in the file B:APROG.ASM and put the object file in B:APROG.HEX and the print file in B:APROG.PRN.
ASM PGM2.BZZ	Assemble the assembly language program contained in the file B:PGM2.ASM. Do not generate either the object (HEX) file or the print (PRN) file.
ASM PGMFOR.AAX	Assemble the assembly language program contained in the file A:PGMFOR.ASM. Put the object file (PGMFOR.HEX) onto Disk A. Print the listing on the screen.

5.5.4 DDT

Format: **DDT** [[*disk-id:*]*filename*[*.type*]]

where:

disk-id is an optional disk identifier.

filename.type is a valid CP/M filename for the file containing the information to be loaded and processed by DDT.

Description:

DDT is the CP/M Dynamic Debugging Tool which you can use to interactively test and debug programs. You can load *any* file into memory using DDT. If you load an executable file, you can directly control its execution from your console.

NOTE: You can also use DDT to look at a file in both ASCII and hexadecimal format.

DDT loads the file into the TPA (Transient Program Area) in memory. You can then use the commands shown in Table 5.5 to operate on the information in the TPA.

You must know 8080 assembly language instructions to use DDT. If you don't know the assembly language instructions, don't try to use DDT. Appendix B gives a list of some of the currently available Z80 assembly language books.

NOTE: DDT recognizes only the subset of Z80 instructions that is identical to the Intel 8080 microprocessor instruction set.

Table 5.5 DDT Commands

COMMAND	MEANING
As	Assemble. Begin entering assembly language instructions at address *s*.
D[*s*[,*f*]]	Display. Display the contents of memory in both hexadecimal and ASCII formats. Begin at address *s* and end at address *f*. If you don't specify *f*, 16 display lines are shown. If you don't specify *s*, the starting address is the current display address.
Fs,*f*,c	Fill memory. Fill memory with the hexadecimal byte *c*. Begin storing the byte *c* at location *s* and end at location *f*. You use the F command to fill a block of memory with one value, for example, all zeros or blanks.
G[*s*] [,*b1*[,*b2*]]	Go. Begin executing the instructions at location *s* with optional breakpoints at locations *b1* and

Table 5.5 (Continued)

COMMAND	MEANING
	b2. If you don't specify location *s*, execution begins at the current address.
H*c1*,c2	Hexadecimal sum/difference. Add (or subtract, depending on the signs) the hexadecimal constants *c1* and c2.
I*filename*[.*type*]	Input. Insert the filename *filename.type* into the default file control block for the TPA. You must use an R command to actually read the file.
L[*s*[*f*]]	List. List the assembly language mnemonics beginning at address *s* and ending at address *f*. If you don't specify a value for *s*, the listing begins at the current address. If you don't specify a value for *f*, 12 lines are listed.
M*s,f,d*	Move a block of information. Move the contents of a block of memory. Begin moving data from address *s* and end at address *f*. Move the information to address *d*.
R[*o*]	Read a disk file. Read the file whose filename and type are in the file control block into the program area beginning at offset *o*. You use an I command to set the file information in the file control block. If you don't specify an offset value, the file is read into memory beginning at address 100H.

Table 5.5 (Continued)

COMMAND	MEANING
S*s*	Examine and modify memory values. DDT begins processing at location *s*. All addresses and their contents are listed. If you hit a carriage return, the contents are not changed. If you want to change the value, enter a new value before you hit the carriage return. To stop the listing, hit a period (.).
T[*n*]	Trace program execution. DDT traces execution and displays registers and flags for *n* steps. *n* may be 1 through 65535. If you don't specify a value for *n*, DDT executes and traces one statement.
U[*n*]	Untrace. This performs the same processing as the T command except that the registers and flags are not displayed for each step.
X[*r*]	Examine and modify CPU registers. The examine command lets you examine and optionally modify the contents of the CPU registers shown in Table 5.6. If you don't specify a value for *r*, all of the CPU registers are displayed in the format shown in Table 5.7.

Table 5.6 DDT CPU Registers/Status Flags

NAME	MEANING	VALUE
STATUS FLAGS:		
C	Carry flag	0/1
Z	Zero flag	0/1
M	Minus flag	0/1

Table 5.6 (Continued)

NAME	MEANING	VALUE
STATUS FLAGS:		
E	Even parity flag	0/1
I	Interdigit carry	0/1
REGISTERS:		
A	Accumulator	0-FF
B	BC register pair	0-FFFF
D	DE register pair	0-FFFF
H	HL register pair	0-FFFF
S	Stack pointer	0-FFFF
P	Program counter	0-FFFF

Examples:

DDT	Loads DDT and waits for you to enter commands.
DDT PROG.COM	Loads DDT and reads the file PROG.COM into the TPA (address 100H). DDT then waits for you to enter commands.

Table 5.7 DDT CPU Register/Flag Display Format

CfZfMfEfIf A=bb B=dddd D=dddd H=dddd S=dddd P=dddd inst

where:

C, Z, M, E, and *I* are processor status flags shown in Table 5.6

A, B, D, H, S, and *P* are the registers shown in Table 5.6

f is a 0 or 1 flag value

bb is a byte value (0 through 255)

dddd is a double byte value

inst is the disassembled 8080 instruction at the location addressed by program counter (P)

5.5.5 DIR

Format: **DIR** [*disk-id*:] [*filename.type*]

where:

disk-id is an optional disk identifier.

filename is an optional valid one- to eight-character CP/M filename.

type is a valid one- to three-character CP/M file type. You need to specify a *type* if you use the *filename* parameter.

Description:

You use a **DIR** command to display the directory of files on a certain disk *disk-id.* If you don't supply a *disk-id* parameter, DIR lists the directory of the disk in the drive currently logged to the system.

You can use the CP/M wildcard (* and ?) characters in your *filename* and *type* parameters. These characters are acted upon as follows:

- **question mark (?)**

  Use a question mark (?) to represent a *single* character in a filename or type. DIR will use the ? to match on *any* character that occupies that position in the filename or type. For example,

  ```
  DIR PGM?.COM
  ```

  will display all files that have the first three characters PGM, any fourth character and the type COM. This format will match only files with names PGMx.COM. It will *not* match PGMxxx.COM.

- **asterisk (*)**

  Use an asterisk (*) to represent an *entire* filename or type or the *remainder* of a filename or type. DIR will match on *any* characters in the positions indicated by the *. For example,

  ```
  DIR PGM*.COM
  ```

will display all files that have the first three characters PGM, *regardless of the length of the filename*, and the type COM.

If you use a *disk-id* value, DIR will display only those files on the indicated disk. If you omit the *disk-id* value, DIR displays the files on the currently logged disk.

Examples:

DIR	Display the directory of the currently logged disk. The names of all files on the disk are shown.
DIR B:	Display the directory of Disk B.
DIR B:TEST.COM	Display the directory information for file TEST.COM on Disk B. You can use this form of the DIR command to check whether the file you want is on that disk.
DIR *.BAK	Display the information from the currently logged disk for all files which are of the type BAK.
DIR TEST*.BAK	Display the information from the currently logged disk for all files that are of the type BAK and whose filenames contain the first four characters TEST. This will display the files TEST.BAK, TEST1.BAK, TESTXXX.BAK, TEST1234.BAK, or any other file with the first four characters TEST and type BAK.
DIR TEST??.BAK	Display the information from the currently logged disk for all files that are of type BAK and have a four- to six-character filename beginning with the letters TEST. This will display the files TEST.BAK, TEST1.BAK, or TESTXX.BAK but will *not* display the file TEST1234.BAK.

5.5.6 DUMP

Format: **DUMP** [*disk-id:*]*filename.type*

where:

disk-id is an optional disk identifier.

filename is valid CP/M filename of the file whose contents are to be displayed.

type is a valid one- to three-character CP/M file type.

Description:

You use a **DUMP** command to display the contents of a file in hexadecimal format. The file information is shown on the screen.

Examples:

DUMP A:DATA.TST	Dump the contents of the DATA.TST file on Drive A to the screen. The file information is shown in hexadecimal format.
DUMP MY.DTA	Dump the contents of the MY.DTA file, which is on the currently logged disk, to the screen.

5.5.7 ED

Format: **ED** [*disk-id*:]*filename*[.*type*] [[*disk-id2*:] [*filename2*[.*type2*]]]

where:

disk-id is an optional disk identifier.

filename is the name of the file containing the data to be edited.

type is a valid CP/M file type for the file containing the data to be edited.

disk-id2 is an optional disk identifier needed when you want the edited file to be written to a disk other than the disk being edited.

filename2 is the name of the output file when you want the edited filename to differ from the original filename.

type2 is the type for the output file when you want the edited file to have a different type than the original file.

Description:

You use the **ED** command to run the CP/M context editor to create or change CP/M source language, data, and text files. ED works on the data in its buffer, using a character pointer to keep track of its current position. Be sure that you understand how to use ED; you could lose your edited file if you're not careful!

If the file exists when you enter the ED command, CP/M opens it and prepares to operate on it. If the file does not exist, CP/M creates a new file with the specified name. CP/M names its temporary file *filename*.$$$ while you are editing the information.

When you are finished editing the file, CP/M changes the name of the original file to *filename*.BAK and writes the edited information to the file named *filename.type* when you tell ED to write the data. If you don't tell ED to write the edited information to the file, you will lose the edited data. You must tell ED *everything*!

If you want to write the edited file to a disk other than the one containing the original file, specify a *disk-id2* parameter.

If the file that you are editing is too large to fit in memory, you must tell CP/M's ED processor when to swap information to its work files. The amount of data that can be processed without swapping depends on the size of your CP/M system. The standard Commodore 64 CP/M system is a 44K version.

You use the control characters shown in table 5.8 and the commands shown in table 5.9 when you are editing a file using ED.

Remember that the CP/M ED editor is not a very complex editor. It works in its buffers, and you must tell it *everything*. After you enter the command that tells ED what file to edit, you must tell ED to read in a specified number of lines from the file. In the same way, after you have finished editing, you must be sure to close the processing with an E command to save your edited data.

NOTE: Some ED commands (F, I, N, and S) when entered in upper case, automatically translate all subsequent lower case entries to upper case. If you enter these commands in lower case (f, i, n, s), the automatic translation to upper case is not done, and data can be entered in both upper and lower case

---

Table 5.8 CP/M ED Control Characters

CHARACTER	MEANING
CTRL -L	Used as a logical carriage return/line feed within a string.
CTRL -X	Line delete.
CTRL -Z	String terminator/separator.
DELETE	Delete the previous character.

Table 5.9 CP/M ED Commands*

COMMAND	FUNCTION
n:	Move the character pointer to the beginning of line n.
[+/−]n	Move the character pointer up (−) or down (+) *n* lines and type the line.
***n*A**	Append *n* lines from the original file *filename* to the buffer in memory.

Table 5.9 (Continued)

COMMAND	FUNCTION
0A	Append enough lines from the file to half fill the buffer.
#A	Append enough lines from the file to fill the buffer or reach the end of file.
[+/−]B	Move to the top (B) or bottom (−) of the buffer.
[+/−]*n*C	Move the buffer character pointer forward (+) or backward (−) *n* characters in the buffer.
[+/−]*n*D	Delete *n* characters from the buffer. Delete the characters before (−1) or after (+) the character pointer.
E	End the ED session. Rename the original file to *filename*.BAK. Close the files and save the new file.
***n*F*string*[^Z]**	Find the character string *string* *n* times. If you don't supply a value for *n*, the *string* is found only once. You use the CTRL -Z (^Z) to end the *string* when you want to enter another ED command on the same line as the F command. This command performs an automatic translation to upper case. To find a character string that includes lower case letters, use the f form of this command.
H	Save the new (edited) file. Rename the original file to *filename*.BAK.

Table 5.9 (Continued)

COMMAND	FUNCTION
	Re-edit the file using the new file as the original file. This is the same as entering an E (end edit) command and then running the ED editor again on the newly saved file.
I<CR>	Enter insert mode. You must enter a CTRL -Z (^Z) to end insert mode. When you use an I command, you can enter only upper-case characters. The character pointer is moved to the end of the inserted text when you enter the CTRL -Z. To enter both upper-case and lower-case information, use the I command described below.
I*string*(^Z)	Insert the character string *string* at the position in the buffer pointed to by the character pointer. The CTRL -Z marks the end of the string to be inserted. The character pointer is moved to the end of the inserted string. You can enter only upper-case characters with the I command. To insert both upper-case and lower-case information, use the i*string* command described below.
i<CR>	Enter insert mode. You must enter a CTRL -Z (^Z) to end insert mode. When you use an i command, you can enter both upper-case and lower-case characters. The character pointer is moved to

Table 5.9 (Continued)

COMMAND	FUNCTION
	the end of the inserted text when you enter the CTRL -Z.
i*string* [^Z]	Insert the character string *string* at the position in the buffer pointed to by the character pointer. The CTRL -Z marks the end of the string to be inserted. The character pointer is moved to the end of the inserted string. You can enter both upper- and lower-case characters with the i command.
***n*Jstring^Zstring2^Zstring3** [^Z]	Juxtapose strings. Find *string1*. Add *string2* to the end of *string1* and delete all characters from the end of *string2* up to but not including the first character of *string3*. You use the optional final CTRL -Z (^Z) when you want to enter another ED command on the same line.
[+/−]*n*K	Delete the following (+) or previous (−) *n* lines.
[+/−]*n*L	Move the character pointer up (−) or down (+) *n* lines. If *n* is zero (0), move the character pointer to the beginning of the current line.
***n*Mcommands**[^Z]	Execute the ED *commands* *n* times. If *n* is zero (0) or one (1), repeat the ED *commands* until an error occurs. You use the terminating CTRL -Z (^Z) to enter an-

Table 5.9 (Continued)

COMMAND	FUNCTION
	other ED command on the same line. Any ED commands after the ^Z are executed only once and are not treated as part of the M command.
*n*N*string* [^Z]	Find the *n*th occurrence of the character string *string*. You use the optional terminating CTRL -Z (^Z) when you want to enter another ED command on the same line. The N command performs an automatic translation from lower case to upper case. If you want to find a string containing lower-case letters, use the **n** form of this command.
O	End the ED session and keep the original file. Do not apply any of the changes made during the session.
[+/−]*n*P	Display *n* pages. Each page is 24 lines. Display the *n* pages before (−) or after (+) the current position of the character pointer. If you supply a zero (0) for *n*, the current line and the next 23 lines are listed.
Q	Abandon the editing session. Do not save the new (edited) file. Return to CP/M.
R[*filename*]	Read the file and insert the text into the buffer. Move the character pointer to the end of the inserted

Table 5.9 (Continued)

COMMAND	FUNCTION
	text. If you supply a *filename*, ED reads the file *filename*.LIB. If you don't supply a value for *filename*, ED reads the file X$$$$$$$$.LIB.
*n*S*string1* ^Z*string2* [^Z]	Find *string1* and replace it with *string2*. Repeat this substitution *n* times. If you do not supply a value for *n*, the substitution is performed once. You use the terminating CTRL -Z (^Z) when you want to enter another ED command on the same line. The **S** command performs an automatic translation from lower case to upper case. If you want to use lower-case letters in your strings, use the **s** form of this command.
[+/−]*n*T	Display the previous (−) or following (+) *n* lines. If *n* is zero (0), or if *n* is not supplied, display the current line. **B#T** displays the entire buffer.
[+/−]U	Translate all characters in the buffer to upper case. Plus (+) turns on the translation. Minus (−) turns off the translation.
[+/−/0]V	Turn on (+) or off (−) the line number display. The 0 displays the amount of free buffer space in bytes and the total buffer size.
[*n*]W	Write the following *n* lines to the temporary output file

Table 5.9 (Continued)

COMMAND	FUNCTION
	filename.$$$. If you do not specify a value for *n*, only the current line is written to the file.
[*n*]X	Write the following *n* lines to the temporary file X$$$$$$$.LIB. You can retrieve these lines with an R command (this is an easy way to move a block of lines). If *n* is zero (0), ED will **DELETE** the X$$$$$$$.LIB file.
*n*Z	Wait *n* seconds before resuming ED processing.

*NOTES: You can use the operand *n1*::*n2* for any *n* or n operand in the ED commands shown in this table. If you use the *n1*::*n2* form, the ED processor will operate on the lines *n1* through *n2*. If you use this form and omit either *n1* or *n2*, ED assumes the current line for the missing operand.

You can use a # for *n* in the ED commands. # means to use the largest possible value (65535) for *n*

Many of the ED commands show a +/− form. You do not need to specify the plus (+) sign. You do need to specify the minus (−) sign if you want to move backward in the file

The F, I, N, and S commands perform an automatic translation to upper case. If you want to enter both upper and lower case data, use the commands f, i, n, and s.

Example:

ED PGMTST.ASM	Edit the file PGMTST.ASM. If the file exists, you must remember to read in the data with an A command before attempting to edit it.

5.5.8 ERA

Format: **ERA** [*disk-id*:]*filename.type*

where:

disk-id is an optional disk identifier.

filename is a valid CP/M filename.

type is a valid CP/M file type.

Description:

You use an **ERA** command to erase one or more files from your disk. If you don't specify a *disk-id* parameter, the file is erased from the currently logged disk.

ERA accepts the wildcard (*) notation for the *filename* and *type* parameters. This allows you to erase a group of files with a single command. Be careful that you don't erase files that you want to keep when you use the wildcard notation.

Examples:

ERA TEST.DTA	Erase the file TEST.DTA from the currently logged disk.
ERA B:MY.PGM	Erase the file MY.PGM from disk B.
ERA *.BAK	Erase all files with a type BAK from the currently logged disk.
ERA A:*.*	**CAUTION.** Erase *all* files from disk A. (CP/M asks you whether you really want to erase all fimes from the disk.)
ERA TEST.*	Erase all files with the filename TEST from the currently logged disk. This would erase, for example, TEST.DTA, TEST.PGM, TEST.ASM, TEST.BAK, TEST.xxx.

5.5.9 LOAD

Format: **LOAD** [*disk-id*:]*filename*

where:

disk-id is an optional disk identifier.

filename is the name of the file containing output from the assembler.

Description:

You use a **LOAD** command to process the output from the assembler (see the description of the ASM command) and produce an executable program file. The input file must be named *filename*.HEX. The output file is named *filename*.COM.

You run the output from the LOAD processor by entering the filename and hitting a carriage return (see the description on loading and executing a CP/M program in Section 5.5.1).

Example:

LOAD ASMPGM2	Process the file ASMPGM2.HEX (which was created by the assembler) and produce an executable program in the file ASMPGM2.COM.

5.5.10 MOVCPM

Format: **MOVCPM** [{ * | *size* }] [*]

where:

the first * tells CP/M to calculate the amount of memory available for its use.

size is a two-digit number from 20 through 48 which is the maximum amount of memory available for CP/M in your Commodore 64. You use 44 for a 44K version of CP/M.

the second * tells CP/M to leave the new version in memory for later SYSGEN or SAVE command processing.

Description:

You use a **MOVCPM** command to configure (prepare) a new copy of your CP/M system. Changing CP/M to expect a different memory size is called "moving" the system. The MOVCPM command operates in either of these ways, depending on which parameters you use:

1. "Move" CP/M and immediately execute the new, different sized system. Do not save it on disk.
2. "Move" CP/M and prepare the new system to be saved to disk by a later SYSGEN or SAVE command. *The new CP/M system is* **NOT** *written to the disk. You must use a SYSGEN or SAVE command to actually write out the new version of the system.*

If you do not specify any parameters and use a MOVCPM command like this:

```
MOVCPM <CR>
```

CP/M will determine how much memory is available, create a new system, and immediately use the new system.

If you specify the first parameter, you can tell CP/M how much memory it can use by:

- Using the * which tells CP/M to use all available memory.
- Using the *size* parameter which tells CP/M to use *size*K bytes of memory.

You can use any decimal integer between 20 and 48 for the *size* value.

If you want to save the new version of CP/M on a disk, you must use the second * parameter and you must supply a first parameter (either *size* or *). You can use this type of command:

```
MOVCPM * * <CR>
```

CAUTION: MOVCPM WILL *ONLY CREATE* A NEW VERSION OF CP/M. THE NEW VERSION IS *NOT SAVED TO A DISK* UNTIL YOU USE A SAVE OR SYSGEN COMMAND!

Examples:

MOVCPM	Create a new version of CP/M, use all available memory, and immediately execute the new version. Do not save this version.
MOVCPM 40 *	Create a new version of CP/M using 40K of memory. Do not execute the version but prepare it to be saved to disk through a SAVE or SYSGEN command.
MOVCPM 28	Create a 28K version of CP/M and execute it. Do not save this version.

5.5.11 PIP

Format: **PIP**
or
PIP *destination=source[parameter]*

where:

destination tells where you want to copy the file to. *destination* is in the form:

[disk-id:]filename.type

source tells which file to copy. *source* has the same format as *destination.*

parameter is one or more valid PIP parameters separated by zero or more blanks and enclosed in square brackets [ ].

Description:

You use **PIP**, CP/M's *Peripheral Interchange Program,* to copy files. It doesn't matter what's in the file. PIP

simply copies from the destination file to the source file. The source and destination files can be on the same disk or can be on different disks.

You can specify only the *disk-id* for the *destination* when the file is to be copied to a file with the same *filename.type* on another disk. You can use the wildcard (*) notation for any part of the *source filename* and/or *type.*

You use the *parameters*, or PIP commands, shown in Table 5.10 to have PIP perform some operations on the file during the copy process.

You can use PIP in two different ways:

1. Invoking PIP as a program by entering:

```
PIP <CR>
```

In this use, PIP is loaded and returns an * on the next line. You can then enter PIP commands, one per line, until you have finished copying all the files you want to copy. You end the PIP session by hitting a carriage return when PIP prints its * prompt message.

2. Invoking PIP with a command string, by entering:

```
PIP A:NEW.DTA=B:OLD.DTA <CR>
```

In this use, PIP is loaded and copies the file B:OLD.DTA to the new file A:NEW.DTA. After the copying is complete, PIP reboots CP/M and returns control to CP/M.

PIP can also copy from device to device. For this type of operation, you can use any of the devices shown in Table 5.11. PIP also uses some "devices" to perform special operations. These are shown in Table 5.12.

You can use PIP to copy the contents of several files to one file (*concatenate* several files). You do this by specifying the source filenames, separated by commas. For example, to copy files FILE1.DTA, FILE2.DTA, and FILE3.DTA to the single file ALLDATA.BAK, you use the command:

```
PIP ALLDATA.BAK=FILE1.DTA,FILE2.DTA,FILE3.DTA
```

In the above example, the entire contents of FILE1.DTA are copied to ALLDATA.BAK. Next, PIP copies the entire con-

tents of FILE2.DTA to ALLDATA.BAK, beginning the copy at the end of the current contents of ALLDATA.BAK (the end of the copied FILE1.DTA). FILE3.DTA is then copied at the end of the FILE2.DTA data in ALLDATA.BAK.

NOTE: Be careful when concatenating ASCII files. ASCII files end with a ^ Z (CTRL -Z) that PIP copies, along with the data, into your output file. This produces a file with multiple end-of-file markers embedded in it. Many programs will stop reading the file at the first ^ Z.

Table 5.10 PIP Command Parameters

COMMAND	FUNCTION
D*n*	Delete all characters after the *n*th column. Use this when you want to send data to your printer and the data are longer than your printer's carriage. You get only the first *n* characters.
E	Echo the characters to the console during the copy operation.
F	Remove form feed characters during the copy operation. For feed characters are ASCII value 0CH or CTRL -L (^L).
G*n*	Get the file from a different user area. The *n* can be any decimal integer between 0 and 15.
H	Check the files for correct Intel Hexadecimal format records.
I	Ignore any null records when transferring Intel Hexadecimal records. Null records are those that contain only 00H.

Table 5.10 (Continued)

COMMAND	FUNCTION
L	Convert all upper-case letters to lower-case letters during the copy operation. Only the letters A-Z are converted to a-z. All other characters are unchanged.
N	Append a line number to the beginning of each copied line. A line is a record that ends in an ASCII CR/LF (carriage return/ line feed), which you usually insert when you press the RETURN key. The line numbers begin at one (1) and are incremented by one (1).
O	Copy object files and non-ASCII files. Treat the CTRL -Z (^Z; end-of-file marker as any other character.
Pn	Add a page feed (form feed) every *n* lines copied. The ASCII form feed character is CTRL -L (^L) or 0CH. You use this when you are copying from a file to your printer.
Qs ^ Z	Copy only a section of the file. Stop the copy operation when PIP finds the string *s*. The CTRL -Z (^Z) marks the *end* of the string to be found. The characters in string s are converted to upper case *only* when you specify the destination and source parameters when you invoke PIP. The conversion to upper case is *not* done when you load PIP into memory and enter several commands to PIP's prompt of *.

Table 5.10 (Continued)

COMMAND	FUNCTION
R	Copy system files. System files have the SYS attribute.
Ss^Z	Copy only a section of the file beginning with the first occurrence of the string *s*. The CTRL -Z (^Z) marks the end of the string *s*. See the description of lower- to upper-case conversion for the *s* string in the Q command description.
T*n*	Set tab stops at every *n* column. This is useful when you are sending output to your printer from a file. The ASCII tab character is 09H or CTRL -I (^ I)
V	Verify the copy operation by comparing the source and destination files after the copy is complete.
W	Override the read only attribute and copy into a read only (R/O) file.
Z	Zero the parity bit (8th bit) on ASCII characters.

Examples:

`PIP A:FIRST.DTA=B:TEST.DTA`

Copy the file from disk B called TEST.DTA to the file on disk A called FIRST.DTA.

`PIP B:=A:*.*` Copy all files from disk A to disk B.

```
PIP CHAPT1.BAK=CHAPT.ONE
```

Copy the file CHAPT.ONE to the file CHAPT1.BAK. Both files are on the same disk.

```
PIP CON:=TEST.DTA
```

Print the file TEST.DTA on the console.

```
PIP B:BACKUP.PGM=A:PROG234.COM[R]
```

Copy the system file PROG234.COM on disk A to BACKUP.PGM on disk B.

```
PIP X.Y=A.B,C.D
```

Copy the two files A.B and C.D to the file X.Y.

```
PIP
*B:=A:SYSFILE.XXX[R]
*A:=B:WORDPROG.COM
*B:=A:*.BAK
*<CR>
```

Copy several files. First, copy the system file SYSFILE.XXX from disk A to disk B. Then copy the program WORDPROG.COM to disk A. Finally, copy all files that have the type BAK from disk A to disk B.

Table 5.11 PIP Logical Devices

NAME	DEVICE
CON:	Console display as PIP output. Keyboard as PIP input.
LST:	The CP/M list device (printer) for PIP output.
PRN:	A special form of the CP/M LST device. PRN handles tabs, determines page breaks, and number lines.

Table 5.12 Special PIP Devices

NAME	DEVICE
NUL:	Send 40 null characters (ASCII value is zero) to the file or device.
EOF:	Send an end-of-file mark (ASCII value is 1AH) or ^Z (CTRL-Z) to the ASCII (not binary) file or device.

5.5.12 REN

Format: **REN**

Format: **REN**[*disk-id:*]*new-file*=*old-file*

where:

disk-id is an optional disk identifier.

new-file is the *new* filename. This must be a valid CP/M filename of the form *filename*[.*type*].

old-file is the current filename. This must be a valid CP/M filename of the form filename[.type].

Description:

You use a **REN** command to change the name of an existing file. The current filename *old-file* is changed to the new filename *new-file*. You *cannot* use the wildcard form of a CP/M filename when you use the REN command. You must specify a valid CP/M filename, but you can specify a blank *type*.

If you are renaming a file that is on the currently logged disk, you don't need to specify the *disk-id* parameter. You *cannot* specify two *disk-id* parameters. REN changes the name of the file on the same disk on which the file resides; it does *not* copy the file to another disk. If you want to change the filename and also move the file to another disk, use the PIP command.

Examples:

```
REN A:PRODPGM.COM=TESTPGM.COM
```

Change the name of the file

TESTPGM.COM on disk A to PRODPGM.COM.

REN DATA.ARC=DATA.182

Change the name of the file DATA.182 on the currently logged disk to DATA.ARC.

REN B:DATAFILE=TEST.DTA

Change the name of the file TEST.DTA on disk B to DATAFILE.

5.5.13 SAVE

Format: **SAVE** *page-num* [*disk-id:*]*filename*[*.type*]

where:

page-num is the number of 256-byte pages from the TPA to save to the specified file.

disk-id is an optional disk identifier.

filename.type is the name of the file to which CP/M will write the *page-num**256 bytes.

Description:

You use a **SAVE** command to save *page-num* pages (where 1 page = 256K bytes) to the specified file. CP/M copies the information from the TPA which begins at location 100H. You also use the SAVE command when you use the MOVCPM command to create a new version of CP/M.

You must calculate the number of pages to be saved by dividing the amount of data by 256. You can use DDT to determine the size of your program. When you load a program into the TPA using DDT, DDT will tell you the size of the loaded data. Then, calculate the number of 256-byte pages that this represents.

For example, if you want to save the information from location 100H through 4FFH into the file NEWPGM.CM, you would use the command:

SAVE 4 NEWPGM.COM

You use the *disk-id* parameter when you want to save the information to a disk that is not the currently logged disk.

Examples:

SAVE 1 A.B — Save the contents of memory locations 100H through 1FFH to the file A.B.

SAVE 10 B:PGM.TST — Save the contents of memory locations 100H through AFFH to the file PGM.TST on disk B.

SAVE 5X — Save the contents of memory locations 100H trough 5FFH to the file X on teh currently logged disk.

5.5.14 STAT

Format: **STAT**
or
STAT *command*

where:

command is a valid STAT command as described below.

Description:

You use a **STAT** command to display or change status information for a CP/M disk, file, group of files, device, or user number.

To *display* status information, you use one of these forms of the STAT command:

- **STAT** [*disk-id*:]

This shows the number of bytes remaining on disk *disk-id*. If you omit *disk-id*, STAT provides the in-

formation on the currently logged disk. The STAT message is (see Table 5.13 for the valid options):

disk-id: Option, Space: nnK

- **STAT** [*disk-id:*]**DSK:**

  This shows the drive characteristics for disk *disk-id*. If you omit *disk-id*, STAT provides information related to the currently logged disk. The STAT information is:

disk-id:	Drive Characteristics
1088:	128 Byte Record Capacity
136:	Kilobyte Drive Capacity
64:	32 Byte Directory Entries
64:	Checked Directory Entries
128:	Records / Extent
8:	Records / Block
34:	Sectors / Track
2:	Reserved Tracks

- **STAT** [*disk-id:*]*filename*[*.type*]

  This shows the characteristics of the file(s) specified. You can use the wildcard (*) notation for the *filename* and/or *type* parameters. If you don't specify a *disk-id* parameter, STAT uses the currently logged disk.

  The STAT information for the specified file(s) is shown as:

Recs **Bytes** **Ext** **Acc**
nnn *n*K *e* *Options disk-id:filename.type*

...for each file specified...
Bytes Remaining on *disk-id:* nnK

where:

nnn is the number of 128-byte records for the file.

*n*K shows the file size in 1024-byte blocks.

e shows the number of extents used for the file.

Options shows a valid STAT option from Table 5.13.

disk-id:filename.type shows the filename.

If you specify a file which is not on the disk, STAT returns an error message:

FILE NOT FOUND

- **STAT {DEV: | VAL: | USR:}**

  This shows the information for the CP/M devices (**DEV:**), STAT commands and external peripheral options (**VAL:**), or user numbers (**USR:**). This function refers to the I/O byte, which is not implemented and always returns the default device assignments.

Table 5.13 STAT Command Options

OPTION	MEANING
DSK:	Show the characteristics of the specified drive.
DEV:	Show the characteristics of the CP/M system devices.
USR:	Show the files related to each USER number on the specified disk.
VAL:	Show the possible STAT commands and devices.

NOTE: The DEV· and VAL· options refer to the I/O byte, which is not implemented in the Commodore 64 BIOS.

To *change* status information, you use one of these forms of the STAT command (valid STAT attributes are shown in Table 5.14):

- **STAT** *disk-id*:**=R/O**

  This changes the disk *disk-id* to a temporary read only mode (**R/O**).

- **STAT** [*disk-id:*]*filename*[.*type*]=$*x*
  where *x* is {**R/O** | **R/W** | **SYS** | **DIR**}

  This changes the specified file(s) to read only (**R/O**), read/write (**R/W**), system (**SYS**), or nonsystem (**DIR**). You can use the wildcard (*) notation for the *filename* and/or *type* parameters. To change all your program files on disk A to read only, you enter the command:

  STAT A:*.COM $R/O

Table 5.4 STAT Command Attributes

ATTRIBUTE	MEANING
DIR	Set the non-SYSTEM attribute for the file(s).
R/O	Set the file or disk to read only.
R/W	Set the file to read/write.
S	Show the size(s) of the file(s) based on the file last record number(s).
SYS	Set the SYSTEM attribute for the file(s).

Examples:

STAT *.*	Show the statistical information for all files on the currently logged disk.
STAT A.B	Show the statistical information for the file A.B on the currently logged disk.
STAT DSK:	Show the statistical information for the currently logged disk.
STAT *.COM $R/O	Set all files on the currently logged disk which have a *type* COM (CP/M program files) to read only.
STAT NEW.DTA $R/W	Set the file NEW.DTA to read/write.

5.5.15 SUBMIT

Format: **SUBMIT** [*disk-id*:]*filename* [*parameters*]

where:

disk-id is an optional disk identifier.

filename is the name of the file containing the CP/M commands. This file must be named *filename*.SUB.

parameters are optional parameters passed to the SUBMIT commands.

Description:

You use a **SUBMIT** command to send a group of commands to CP/M for execution. SUBMIT makes your Commodore 64 operate in *batch* mode where, with a single command. you can execute any number of programs or utilities.

The file containing the commands must have a *type* SUB. This file can contain any CP/M *commands.* CP/M creates a file called $$$.SUB as a temporary work file when you execute a SUBMIT command.

NOTE: All commands in a SUBMIT file must be in upper case.

For example, you could have these commands in file DISK DTA.SUB:

```
DIR
STAT *.*
ERA *.BAK
STAT DSK:
```

To execute all four of these CP/M commands, you simply enter:

```
SUBMIT DISKDTA <CR>
```

Remember, CP/M then executes the commands in the file *in the order in which the commands appear in the file.* SUBMIT processing only executes commands. It does not pass any information to the programs it executes. If you want to pass data to the programs, use the XSUB command.

You can *chain* from one .SUB file to another. Whenever a SUB file finds another SUBMIT command, the first file is stored and the second file becomes active. When the second file's commands are finished, the first .SUB file becomes active at the command following the SUBMIT command. For example, you could have these two files:

File A.SUB contains:

```
STAT DSK:
SUBMIT B
STAT DSK:
```

File B.SUB contains:

```
ERA *.BAK
DIR
```

When you enter the command:

```
SUBMIT A
```

the following commands are executed:

```
STAT DSK:
ERA *.BAK
DIR
STAT DSK:
```

You can also pass parameters to the .SUB file. The parameters are sequentially numbered in the file and have the form:

```
$n
```

where:

n starts at 1 and is incremented by 1.

The parameters can be any information required by the commands in your .SUB file. They can be filenames, disk id's, file types, or anything that you need. SUBMIT does a straight substitution of the parameter values for the parameter indicators ($*n*) in the .SUB file before passing the commands to CP/M. The first parameter goes to all occurrences of $1; the second to $2, etc.

Suppose you want to check the status of your disk and then edit a file. You could have a file called DSKEDIT.SUB that contains this information:

```
STA $1:DSK:
ED $2.$3
STAT $1:$2.$3
```

Then, to check the status of Disk A and edit the file MY.DTA, you would use this submit command:

```
SUBMIT DSKEDIT A MY DTA
```

SUBMIT processing replaces the parameter indicators with the values in your SUBMIT command and the data in file. When passed to CP/M for processing, DSKEDIT.SUB looks like this:

```
STAT A:DSK:
ED MY.DTA
STAT A:MY.DTA
```

When you are using SUBMIT parameters, you can enter these special characters through the parameter string:

- To enter a $ as data, you must enter two consecutive $$. This is transferred to the command line as a $. Thus, to enter the value "$XY" as a parameter, you must use $$XY.
- To enter a control character, use the up-arrow symbol (^) followed by the control character. To enter CTRL-X, you would enter the character string ^X.

You can have a SUBMIT command as the *last* command in a .SUB file. This lets you *chain* from one .SUB command file to another.

Examples:

SUBMIT STARTUP	This executes the CP/M commands in the file called STARTUP.SUB.
SUBMIT NEW A B	This executes the CP/M commands in the file called NEW.SUB. The value "A" is passed to any $1 indicators in the file. The value "B" is passed to any $2 indicators.

5.5.16 SYSGEN

Format: **SYSGEN** [[*disk-id*:]*filename.type*]

where:

disk-id is an optional disk identifier.

filename.type is the name of the file that will contain the new copy of the system.

Description:

You use a **SYSGEN** command to create a new copy of your CP/M operating system. The CP/M system is stored on special tracks called the *system tracks* (tracks 0 and 1). These tracks never appear in the file directory listing and you cannot read or write to these tracks as part of processing any normal program.

You need the system tracks on any disk from which you may do a warm or cold start. It's a good idea to have a copy of the system on most disks that contain programs. Whenever you enter a CTRL-C (^C), CP/M reloads part of its system tracks (the BDOS and CCP) in a *warm start.*

You use the SYSGEN command to copy these tracks from one disk to another or to create a new copy of the system after you have used a MOVCPM command.

You use a SYSGEN command in one of these three ways:

1. To copy your CP/M system from one disk to another. You do not make any changes to the system; you simply copy it.
2. You use MOVCPM to create a different sized version of CP/M and you use SYSGEN to copy it to a disk.
3. You use DDT to make special changes to your copy of CP/M and you use SYSGEN to write the system to a disk.

SYSGEN does not destroy any information currently on the user area of a disk. SYSGEN simply writes a new copy of the CP/M system on the disk.

If you specify a *disk-id* parameter, SYSGEN does not ask for the source drive but uses the value you selected for *disk-id.*

If you want to create a new copy of CP/M after using MOVCPM to create a new version, you follow this procedure. The text that you enter is shown in boldface. The messages from CP/M are shown in italics.

SYSGEN <CR>
COMMODORE 64 SYSGEN VERSION 2.0
SOURCE DRIVE NAME
(OR RETURN TO SKIP) **<CR>**
DESTINATION DRIVE NAME
(OR RETURN TO SKIP) **B<CR>**
DESTINATION ON B, THEN TYPE RETURN **<CR>**
FUNCTION COMPLETE

To copy a version of CP/M from one disk to another, follow the above procedure but supply the appropriate answers for the source and destination drives.

NOTE: If you SYSGEN onto your current system disk a version of CP/M that is a different size from the one you're running, you CANNOT warm start the system. The location of operating system components will not match and the CP/M will crash.

Example:
To copy the system tracks from your current disk to another disk, enter:

```
SYSGEN <CR>
```

and answer the questions that CP/M asks.

5.5.17 TYPE

Format: **TYPE** [*disk-id*:]*filename.type*

where:
disk-id is an optional disk identifier.

filename.type is the name of the file to be listed on your screen.

Description:

You use a **TYPE** command to list an ASCII format file on your screen. If you don't specify a *disk-id* value, CP/M uses the currently logged disk. You must specify a valid CP/M filename. TYPE does *not* accept the wildcard (*) notation.

You can use a CTRL -P (^P) before you enter your TYPE command and the listing will appear on your screen and on your printer. All commands and data continue to appear on both the screen and the printer until you enter another ^P.

You can stop the TYPE listing by pressing any key. You can *temporarily stop* the listing by pressing a CTRL -s (^S); you restart the listing by pressing any key.

Remember that TYPE displays the contents of the specified file, assuming that the file contains ASCII characters. If you TYPE a program file (.COM), you will see garbage on your screen. Be sure that you are listing a text file when you use TYPE.

Examples:

TYPE A:BILLS.LST	List the contents of the file on disk A called BILLS.LST.

TYPE X	List the contents of the file called X on the currently logged disk.

5.5.18 USER

Format: **USER** [*user-num*]

where:

user-num is a decimal integer between 0 and 15.

Description:

You use a **USER** command to display and change the current user number. CP/M assumes a default user number of zero (0).

Once you change the user number, you can access only those files associated with the new user number. You can always enter a user number 0 to return to the default setup.

To *display* the current user number enter:

```
USER <CR>
```

To *change* the current user number to 5 enter:

```
USER 5
```

You should not change the user number unless you want to protect certain files from use by those who do not know the associated user number. In a single-user CP/M system, it's generally unnecessary to change the user number.

Examples:

USER 2	Change the user number to 2.
USER	Display the current user number.

5.5.19 XSUB

Format: **XSUB**

Description:

You use an **XSUB** command when you want to enter more than commands in a .SUB file. XSUB is a subset of SUBMIT processing and *CANNOT* be entered as a response to the CP/M prompt. XSUB may appear *only* in a SUBMIT (.SUB) file. Read the description of the SUBMIT command for full details on how .SUB files are processed.

XSUB must be the *first* command in your .SUB file. You can enter parameters on an XSUB command in the same way as for a SUBMIT command.

XSUB allows you to enter data that would normally be entered through the keyboard for some programs. If you are using a program that accepts buffered console input (uses BDOS function 10), then the program will accept the answers from the XSUB file instead of waiting for you to enter data from the keyboard. Not all programs do this, but all the CP/M utilities and commands do accept data in this manner.

Example:

You want to submit a file that will run DDT and load the file you specify. Your file called DDTRUN.SUB contains:

```
XSUB
DDT
I$1.$2
R
```

You can submit this file and specify that the file WORDPROC.DTA be read into memory through DDT by entering:

```
SUBMIT DDTRUN WORDPROC DTA
```

This SUBMIT command accepts the DDT commands to read the file WORDPROC.DTA into memory by processing the information after the XSUB command.

CHAPTER 6

CP/M ON THE COMMODORE 64

- The Structure of CP/M
- The BOOT Programs
- The BIOS Programs
- CP/M Disk Organization
- The CP/M BDOS
- Calling a Z80 Program from the 6510
- Calling a 6510 Program from the Z80
- Program Execution under CP/M

- Z80 Schematic
- Commodore 64 Schematic

In this chapter, you will find technical information about implementing CP/M on your Commodore 64. You will need this information only if you intend to make changes or additions to CP/M as supplied with your Commodore 64 and its Z80 cartridge.

CP/M was one of the first microcomputer operating systems designed to run on machines of more than one manufacturer. It is written in Intel 8080 Assembler language. The Z80 add-on processor on your Commodore 64 executes a superset of the 8080 machine language. Any program written for the 8080 processor will run on the Z80, but the reverse may not be true.

When CP/M is running on your Commodore 64, *the 6510 main processor and the Z80 add-on processor* are alternately active. The two processors trade control of the computer according to what operations are required. Because device drivers already reside in your Commodore 64 operating system, all input and output is performed by the 6510. The Z80 runs only the CP/M operating system, its utilities, and applications.

In addition to the standard functions required by the CP/M operating system, you can access your own *special purpose routines* running in 6510 native mode. This is useful, for example, if you want to attach an instrument to the optional IEEE interface cartridge on your Commodore 64. You could then easily code a driver for the instrument and gain access to it through a well defined, and protected, interface.

6.1 THE STRUCTURE OF CP/M

The principal component of CP/M is the **Basic Disk Operating System (BDOS)**. All requests for operating system services — disk input/output, printer output, screen output — are carried out through a set of standard calls to the BDOS.

NOTE: It is possible to call entry points in the CP/M BIOS directly. This technique is NOT recommended unless you are very sure of what you are doing. WARNING. Direct BIOS calls may be incompatible with future CP/M releases.

A second major component of CP/M is the **Console Command Processor (CCP)**. The CCP analyzes and interprets the commands that you enter from the keyboard, initiating whatever action you request. Of the resident CP/M system, the CCP occupies the lowest memory areas (see Figure 6.3).

Transient programs (those not a permanent part of the BDOS) are loaded into the **Transient Program Area (TPA)** and may, if they need the space, overlay the CCP when executing.

If a program executing in the TPA does overlay the CCP, the CCP must be reloaded when the transient program terminates. You will see this CCP reload operation (a "warm boot") as a line of asterisks appearing on your screen after a program has finished.

The final major component of CP/M is the **Basic Input/Output System (BIOS)**. This has nothing to do with the BASIC language. The BIOS is the component of CP/M that allows CP/M to be run on a variety of machines. The BIOS forms a bridge between the BDOS and the individual characteristics of the machine that it runs on. Each machine has a specially tailored BIOS that supports the hardware and peripherals attached to it.

The CP/M BIOS is much like the CBM Kernal in your Commodore 64. Like the Kernal, the BIOS contains a set of standard routines that give you access to hardware functions.

Your Commodore 64 has a unique BIOS that provides easy access to the standard Commodore 64 peripherals, either serial or IEEE.

6.1.1 How CP/M Works on Your Commodore 64

Four specially tailored assembly language programs and the CP/M operating system are required to run CP/M on your Commodore 64. Two of the assembly language programs run under the 6510 microprocessor and two under the Z80 microprocessor:

- 6510 CP/M BOOT program (BOOT65)
- Z80 CP/M BOOT program (BOOT80)

- 6510 BIOS (BIOS65)
- Z80 BIOS (BIOS80)

The BOOT programs "bootstrap" CP/M. That is, they load it into memory, initialize some areas, and begin its execution. Once the BOOT programs have completed their tasks, they are no longer needed and the memory they occupied is used for other purposes.

CP/M comes from Digital Research as a core operating system. It needs an add-on software component called a **BIOS (Basic Input/Output System).** The BIOS contains a set of entry points that perform specific "primitive" tasks for CP/M, such as:

- Set the track number for the next read or write operation.
- Write a character to the printer.
- Read a character from the keyboard.

CP/M is not concerned with how these tasks are performed. All this work is taken care of in the custom BIOS written specifically to support a certain hardware environment. It is this BIOS that allows CP/M to run many different machines equipped with many different peripherals.

On your Commodore 64, the CP/M BIOS is in two parts. One part runs under the Z80 add-on processor (BIOS80) and the other under the 6510 Commodore 64 main processor (BIOS65). This arrangement allows the 6510 to serve as an *input/output processor* for the Z80, handling all disk, printer, keyboard, and screen input or output.

The 6510 part of the BIOS initiates execution of CP/M under the Z80 processor by transferring control to the Z80 BOOT program, which loads CP/M and BIOS80. Whenever a processor is switched on, it resumes execution at the instruction immediately following the instruction that switched it off. This means that when the Z80 returns control to the 6510, execution will resume within BIOS65.

When a CP/M program, running on the Z80, requests an input/output operation, the Z80 BIOS places a *function code and any required parameter values* at predetermined locations in memory. Remember, memory is shared between the two processors, which makes it very easy for them to pass data back and forth.

Once these parameter values are in place, BIOS80 switches the Z80 out and the 6510 in. The 6510 resumes execution in the 6510 portion of the BIOS. BIOS65 examines the function code passed to it by BIOS80 and initiates the indicated action.

Once the 6510 has completed the action, BIOS65 places return values and/or flag values into predetermined locations and switches control back to the Z80 processor.

Under the Z80 processor, execution resumes where it left off in BIOS80. BIOS80 examines the shared memory areas to determine the success or failure of the requested function and carries out any other action necessary to complete the function.

6.1.2 6510 Memory Use

Figure 6.1 shows the memory allocation as seen from the 6510 running in native mode. Figure 6.2 shows details on the BIOS65 memory area.

6510 CP/M Memory Map

```
6510
ADDRESS

$FFFF

$F000
          6510 KERNAL ROM
$E000
          6510 I/O SYSTEM
$D000
          48K RAM AVAILABLE FOR Z80
                RUNNING CP/M
$1000
          BIOS65 AND SHARED DATA AREAS
$0800
          0400 TO 07FF SCREEN RAM
          0000 TO 03FF ZERO PAGE AND 6510 STACK
$0000
```

The addresses shown are for the 6510 microprocessor. For Z80 addresses, subtract $1000 hexadecimal from the addresses shown (see Section 6.1.3 for an explanation of Z80/6510 address conversion).

NOTE: If you add the IEEE interface cartridge to your Commodore 64 system, you can run only a 44K version of CP/M The top 4K ($C000—$D000) of the CP/M 48K area is used to handle the IEEE interface cartridge

---

BIOS65 Memory Map

6510 ADDRESS	
$1000	
$0F00	
$0E00	
$0D00	
	BIOS65
$0C00	
$0B00	
$0A00	
	SHARED DATA
$0900	
	DISK I/O BUFFER
$0800	

The addresses shown are for the 6510 microprocessor. For Z80 addresses, add $F000 hexadecimal to the addresses shown (see Section 6.1.3 for an explanation of Z80/6510 address conversion).

6.1.3 Addresses under CP/M

You can see from the memory map in Figure 6.3 that the Z80 processor uses the memory between $1000 and $BFFF—a 48K byte area. CP/M, however, makes use of fixed areas in the zero page ($0000–$0100) of memory. This area is also required by the Commodore 64 operating system.

To avoid a conflict in the use of the zero page and to provide space for BIOS65, all Z80 addresses have $1000 added to them. Thus, the Z80 address $0000 becomes actual address $1000. Table 6.1 shows the mapping between Z80 addresses and actual memory addresses.

NOTE: If you are using the optional IEEE interface cartridge, you have only 44K bytes available for CP/M. The IEEE bus access routines require an additional 4K at the high end of the CP/M memory ($B000– $BFFF).

Table 6.1 Z80 to 6510 Actual Address Mapping

Z80 ADDRESS	ACTUAL (6510) ADDRESS
0000->0FFF	1000->1FFF
1000->1FFF	2000->2FFF
2000->2FFF	3000->3FFF
3000->3FFF	4000->4FFF
4000->4FFF	5000->5FFF
5000->5FFF	6000->6FFF
6000->6FFF	7000->7FFF
7000->7FFF	8000->8FFF
8000->8FFF	9000->9FFF
9000->9FFF	A000->AFFF
A000->AFFF	B000->BFFF
B000->BFFF	C000->CFFF
C000->CFFF	D000->DFFF
D000->DFFF	E000->EFFF
E000->EFFF	F000->FFFF
F000->FFFF	0000->0FFF

NOTE: Notice that to access the 6510 low addresses, you reference the Z80 high addresses.

6.1.4 Z80 Memory Use

The amount of memory available to CP/M on your Commodore 64 depends on your hardware configuration. If you are using the standard *Commodore 64 serial disk drives and printer,* **CP/M can occupy a maximum of 48K bytes.** If you have acquired the *IEEE interface cartridge,* **CP/M can occupy a maximum of 44K bytes.** The IEEE interface cartridge consumes 4K at the high end of the CP/M address space (see Figure 6.1).

You can, of course, generate a CP/M system that is smaller than the maximum available space. You can do that if you need space for a routine that must run in Commodore 64 native mode (under the 6510 processor). You can, for example, generate a 40K CP/M version and have 8K (or 4K if you have the IEEE cartridge) available for your Commodore 64 native mode routine. Figure 6.3 shows a diagram of the Z80 address space.

Z80 Memory Map

ADDRESS 44K	ADDRESS 48K	
$AFFF	$BFFF	
		BIOS80
$AA00	$BB00	
		BDOS
$9C06	$AC06	
		CCP
$9400	$A400	
		TPA
		(44K—33,792 bytes)
		(48K—37,888 bytes)
$0100	$0100	
		ZERO PAGE
$0000	$0000	

Many microcomputer operating systems use the zero page of memory (addresses between $0000 and $0100) to hold important values. Both CP/M and your Commodore 64

operating system do this. Table 6.4 shows the contents of the CP/M Zero Page.

Table 6.2 CP/M Zero Page

ADDRESS	CONTENT
$0000– $0003	Contains a jump instruction to the warm start entry point in the BIOS.
$0004	Contains the current default disk drive number (0=A and 1=B) in the low order 4 bits and the I/O byte in the high order 4 bits.
$0005– $0007	Contains a jump instruction to the BDOS main entry point. The value stored in locations $0006– $0007 is the lowest address *required* by CP/M. You also use this jump instruction (or the address) when you make direct BDOS calls.
$0038– $003A	This is Restart Location 7 and is used by DDT for programmed breakpoints (an RST 7 instruction causes a call to this location).
$005C– $006C	This is the first default file control block for use by transient programs.
$006C– $007C	This is the second default file control block for use by transient programs.

Table 6.2 (Continued)

ADDRESS	CONTENT
$007D – $007F	This location contains the random record position for random file access via the first default file control block.
$0080 – $00FF	This is the default 128-byte disk input/output buffer. This area also receives the command line that you enter when your program is loaded by the CCP.

NOTE: The areas of the zero page not shown in this table are reserved for future use. You should not use any of these areas in programs you write unless you are sure of their use

6.2 THE BOOT PROGRAMS

The BOOT programs — BOOT65 and BOOT80 — are used to load CP/M from disk. Once they have completed this task, the memory they occupy is used for other purposes.

The **BOOT65** program is in the file called "CP/M" that you LOAD and RUN to start execution of the CP/M operating system on your Commodore 64. You can find a listing of this program in Appendix E. The actual assembly language program source is available on one of your CP/M system diskettes.

You LOAD and RUN BOOT65 as you would any BASIC program on your Commodore 64. If you LIST it, you will see that it contains a single BASIC statement:

```
10 SYS (2036)
```

This statement transfers control to the actual BOOT65 code located at decimal address 2036.

The program then reads in the BIOS65 and BOOT80 pro-

grams and places them at the correct locations in memory. Finally, BOOT65 transfers control to the startup code in BIOS65.

The **BOOT80** program is a Z80 assembly language program that is the first program to execute when the Z80 processor is switched on. You can find a listing of this program in Appendix E. The actual assembly language program source is available on one of your CP/M system diskettes.

BOOT80 is loaded by the BOOT65 program at the Z80 reset address $0000 (6510 address $1000). When the Z80 is first turned on, it always begins execution at address $0000.

BOOT80 loads:

- Z80 BIOS (BIOS80)
- CP/M CCP (CP/M Command Processor)
- CP/M BDOS (Basic Disk Operating System)

When these programs are loaded, BOOT80 transfers control to the cold start entry point in BIOS80, thus beginning actual CP/M operating system execution.

6.3 THE BIOS PROGRAMS

The BIOS (Basic Input/Output System) is the specially tailored link between the CP/M operating system and the individual peripherals — printer, disk drives, screen — attached to your Commodore 64.

Each computer that runs CP/M has its own unique BIOS. On your Commodore 64 the BIOS is in two parts:

- BIOS65 executes under the 6510 main processor.
- BIOS80 executes under the Z80 add-on processor.

These two portions of the BIOS operate together to make your Commodore 64 peripherals available to CP/M.

Why are there two programs for the BIOS? Your Commodore 64 already has code in place to handle its peripherals. Thus more memory is made available for CP/M and your CP/M-based applications by simply providing a link to that existing code, rather than trying to re-implement the peripheral-handling code on the Z80.

In operation, BIOS80 is called from CP/M with a request

for an input/output operation. BIOS80 places required parameter values and a function flag in certain memory locations, then switches control from the Z80 back to the 6510 Commodore 64 main processor.

The 6510 resumes execution where it left off in BIOS65. BIOS65 examines the function code stored in memory to find out what it should do, carries out the task (usually an input/output request), places the result in a predetermined memory location, and switches the Z80 back on.

The Z80 resumes execution where it left off in BIOS80. BIOS80 retrieves the results passed to it from BIOS65 and returns the proper information to CP/M.

BIOS80 is called from the CP/M BDOS to perform the following functions:

- cold start boot
- warm start boot
- console (keyboard) status check
- get keyboard character (console input)
- write character to screen (console output)
- print a character (lister output)
- move disk head to the home position
- select disk
- set track to read/write
- set sector to read/write
- read disk sector
- write disk sector
- check printer status (lister status)
- sector translation

The *punch* and *reader* functions of the BIOS are meaningless on your Commodore 64. These are null routines in BIOS80.

Some of the functions listed above simply cause values to be placed in predefined memory locations. Others result in a transfer to the 6510 portion of the BIOS where the actual work is performed.

Before BIOS80 switches control back to the 6510, it places a *function code* at location $F900 ($0900 relative to the 6510). This code, which currently ranges from 0 to 9 and 255, tells BIOS65 what action is required. These function codes and their meanings are shown in Table 6.3.

Table 6.3 BIOS80/BIOS65 Function Codes

NUMBER	FUNCTION
0	Read the specified sector
1	Write the specified sector
2	Get a character from the keyboard
3	Write a character to the screen
4	Check the printer status
5	Write a character to the printer
6	Disk format command
7	Jump to 6510 address $0E00
8	Jump to 6510 address $0F00
9	Jump indirect via a 6510 address stored at $F906
10–>254	Reserved for future use
255	Execute a cold start reset on your Commodore 64

Table 6.4 BIOS80/BIOS65 Communication Addresses

ADDRESS		CONTENT
Z80	6510	
$F900	$0900	Command register: contains one of the function codes as shown in Table 6.2.
$F901	$0901	Data register: used to pass data and error indicators between the two BIOS.
$F902	$0902	Sector register: contains the current sector number for disk read and write requests.
$F903	$0903	Track register: contains the current track number for disk read and write requests.
$F904	$0904	Drive register: contains the disk drive number for disk read and write requests.
$F905	$0905	Keyboard register: contains the last character read from the keyboard.

BIOS65 and BIOS80 communicate with each other through a series of contiguous memory locations as shown in Table 6.4.

6.4 CP/M DISK ORGANIZATION

Your Commodore 64 CP/M BIOS programs provide a completely compatible interface between your disks and the CP/M BDOS. All disk-related functions expected by the CP/M BDOS are available through your BIOS programs.

The organization of a CP/M disk is different from the organization of a standard Commodore 64 disk. The CP/M disk has somewhat less capacity than a Commodore 64 format disk.

A Commodore 64 CP/M disk is formatted as **35 tracks containing 17 256-byte sectors (0–16)** where *track 1 is the outermost* track and track 35 is the innermost track. A Commodore 64 CP/M disk can hold a maximum of **136,000 characters of *user data*.**

Notice that the full disk capacity (152,320 characters) is not available for user data storage.

Table 6.5 shows the allocation of tracks on your Commodore 64 CP/M format disk.

Table 6.5 CP/M Disk Track/Sector Allocations

TRACK	SECTOR	CONTENT
1	0	BOOT65 (Commodore 64 file "CPM")
1	1–>4	BIOS65
1	5	BOOT80
1	6–>13	CP/M CCP (Command Processor)
1&	14–>16	CP/M BDOS
2	0–>10	
2	11–>16	BIOS80
3	0–>7	CP/M Disk Directory
3	8–>16	CP/M Disk Space
4–>17	0–>16	CP/M Disk Space
18	0–>16	Commodore 64 Directory
19–35	0–>16	CP/M Disk Space

NOTE: The Commodore 64 Directory written on track 18 allows you to start CP/M from Commodore 64 running in native mode This directory shows that only a single file—CPM—exists on the disk. The standard Commodore 64 Block Availability Map (BAM) indicates that the disk is completely full.

6.5 THE CP/M BDOS

The CP/M **Basic Disk Operating System** (BDOS) provides a standard interface between CP/M application programs and the hardware on which they run. All input/output and operating system service requests are routed through the BDOS. Because of this, you don't have to write device-specific code into your application program for every system that it might run on. The device-specific code for a particular system is written only once – in the CP/M BIOS.

The standard BDOS interface means that software can be written and run on *any system able to support CP/M*, as long as the software developer stays within the BDOS standard.

The 39 BDOS functions (numbered 0 – 37 and 40 decimal) perform tasks valuable in almost any application. For example, they

- Read a character from the keyboard.
- Write a character to the keyboard.
- Open a disk file.
- Print a string.
- Write to the printer.
- Delete a file.
- Create a file.

For a list of the BDOS functions, see Table 6.6.

You *call the BDOS* from Z80 Assembler or other languages through the *BDOS jump vector* **at Z80 address $0005**. This jump vector contains a single jump instruction:

```
JMP BDOS-ADDRESS
```

The *bdos-address* varies with the size of the CP/M system you have generated. The JMP instruction itself is placed at location $0005 when CP/M is loaded.

To use the BDOS functions, you code:

```
CALL 5
```

When the BDOS has completed the function, it returns control to the statement following the CALL statement.

NOTE: Bytes 6 and 7 of the BDOS jump vector contain the lowest address required by CP/M (stored as low byte/high byte). This means that your application program can use memory up to, but not including, this address.

BDOS functions are numbered. Some require that you pass to them the parameter values or the address of a parameter in certain registers. Some return an indicator or error code in a register.

When calling a BDOS function, you always **load the BDOS function code in register C.** If the function requires that you *pass it parameters*, you place:

- Single-byte parameters in register E.
- Double-byte parameters in register pair DE.

If the function *returns a value* to you, you find:

- Single-byte returns in register A.
- Double-byte returns in register pair HL.

NOTE: The BDOS does NOT preserve values stored in the Z80 registers. If you want to protect values stored in registers, you should push them onto the stack before you call the BDOS. You can then pop them off the stack on return from the BDOS call.

6.5.1 Sample BDOS Function Call

As an example of a BDOS function call, we will use Function 1, the Console (keyboard) Input function. Function 1 returns in register A the last character entered from the keyboard. To use Function 1, you can write code like the following:

```
        MVI C,1         ;LOAD FUNCTION 1 INTO REGISTER C
;       CALL 0005H      ;CALL THE BDOS JUMP VECTOR
;   WHEN THE BDOS HAS A CHARACTER, IT RETURNS HERE
;   REGISTER A CONTAINS THE INPUT CHARACTER
;
        STA KEYCHAR     ;STORE REGISTER A IN KEYCHAR
                        VARIABLE
```

Table 6.6 BDOS Functions

FUNCTION (Register C)	DESCRIPTION
0	**SYSTEM RESET** INPUT: NONE RETURN: NONE Returns control to the CCP and resets CP/M as though you rebooted.
1	**CONSOLE INPUT** INPUT: NONE RETURN: A ← character input Reads a character from the keyboard. Examines the character to see if it is a CP/M control character.

Table 6.6 (Continued)

FUNCTION (Register C)	DESCRIPTION

2 CONSOLE OUTPUT

INPUT: E ← character to display
RETURN: NONE

Writes a character to the screen.

3 READER INPUT

INPUT: NONE
RETURN: A ← character read

This function is not supported on your Commodore 64.

4 PUNCH OUTPUT

INPUT: E ← character to punch
RETURN: NONE

This function is not supported on your Commodore 64.

5 LIST OUTPUT

INPUT: E ← character to print
RETURN: NONE

Writes a character to your printer.

Table 6.6 (Continued)

FUNCTION (Register C)	DESCRIPTION

6 DIRECT CONSOLE I/O

INPUT: E ← character to display (output)
E ← OFFH (input)
RETURN: A ← character (input)
A ← status (output)

Performs raw console input (read from keyboard) and output (write to screen). Characters are transferred through the BDOS without being examined or changed.

7 GET I/O BYTE

INPUT: NONE
RETURN: A ← I/O byte

The I/O byte function is not supported on your Commodore 64.

8 SET I/O BYTE

INPUT: E ← new I/O byte
RETURN: NONE

The I/O byte function is not supported on your Commodore 64.

9 PRINT STRING

INPUT: DE ← string address
RETURN: NONE

Writes the character string to the screen. The string must terminate with a "$".

Table 6.6 (Continued)

FUNCTION (Register C)	DESCRIPTION

10 READ CONSOLE BUFFER

INPUT: DE ← buffer address
RETURN: characters in buffer

Reads from the keyboard until a carriage return or CTL-M is entered or until the keyboard buffer overflows.

11 GET CONSOLE STATUS

INPUT: NONE
RETURN: A ← console status

Checks the keyboard status. A contains 0FFH if a character is ready; 00H if not.

12 RETURN VERSION NUMBER

INPUT: NONE
RETURN: HL ← version number

Returns the CP/M version number.

13 RESET DISK SYSTEM

INPUT: NONE
RETURN: NONE

Resets the entire disk system to its initial state.

Table 6.6 (Continued)

FUNCTION (Register C)	DESCRIPTION

14 SELECT DISK

INPUT: E ← disk number to select
RETURN: NONE

Selects a disk (A=0 and B=1).

15 OPEN FILE

INPUT: DE ← address of FCB
RETURN: A ← directory code

Opens a disk file for processing. Returns a 255 in A if the file could not be found.

16 CLOSE FILE

INPUT: DE ← address of FCB
RETURN: A ← directory code

Closes a disk file. Returns a 255 in A if the file could not be found.

17 SEARCH FOR FIRST

INPUT: DE ← address of FCB
RETURN: A ← directory code

Searches for the first file matching the name given in the FCB. Returns a 255 in A if no match was found.

Table 6.6 (Continued)

FUNCTION (Register C)	DESCRIPTION

18 SEARCH FOR NEXT

INPUT: NONE
RETURN: A ← directory code

Similar to Function 17, but begins search where 17 left off. Also returns a 255 in A if no match was found.

19 DELETE FILE

INPUT: DE ← address of FCB
RETURN: A ← directory code

Deletes a disk file. Returns a 255 in A if the file could not be found.

20 READ SEQUENTIAL

INPUT: DE ← address of FCB
RETURN: A ← directory code

Reads the next 128-byte record into the memory pointed to by the current DMA address. Returns a 00H in A if the read succeeded; non-zero if end-of-file was encountered.

21 WRITE SEQUENTIAL

INPUT: DE ← address of FCB
RETURN: A ← directory code

Table 6.6 (Continued)

FUNCTION (Register C)	DESCRIPTION

Writes the 128-byte record pointed to by the current DMA address. Returns a 00H in A if the write succeeded; a non-zero for a full disk.

22 MAKE FILE

INPUT: DE ← address of FCB
RETURN: A ← directory code

Creates the disk file named in the FCB. Returns a 255 in A if the create failed.

23 RENAME FILE

INPUT: DE ← address of FCB
RETURN: A ← directory code

Renames a disk file. The name of the file is in the first 16 bytes of the FCB, the new name is in the next 16 bytes. Returns a 255 in A if the rename fails.

24 RETURN LOGIN VECTOR

INPUT: NONE
RETURN: HL ← login vector

Returns the disk login vector. The least significant bit of L represents Disk A and the next Drive B. When set to 1, the drive is online.

Table 6.6 (Continued)

FUNCTION (Register C)	DESCRIPTION

25 RETURN CURRENT DISK

INPUT: NONE
RETURN: A ← current disk number

Returns the number of the currently logged disk (0=A and 1=B).

26 SET DMA ADDRESS

INPUT: DE ← DMA address
RETURN: NONE

Sets the address of the 128-byte disk sector buffer.

27 GET ADDR (ALLOC)

INPUT: NONE
RETURN: HL ← ALLOC address

Returns the address of the allocation vector of the current disk.

28 WRITE PROTECT DISK

INPUT: NONE
RETURN: NONE

Protects the current disk from being written to.

Table 6.6 (Continued)

FUNCTION (Register C)	DESCRIPTION

29 GET READ ONLY VECTOR

INPUT: NONE
RETURN: HL ← read only vector

Returns a vector indicating which drives are temporarily write-protected. The least significant bit of L represents Disk A and the next Drive B. When set to 1, the drive is write-protected.

30 SET FILE ATTRIBUTES

INPUT: DE ← address of FCB
RETURN: A ← directory code

Sets read only and system file attributes.

31 GET ADDR (DISK PARMS)

INPUT: NONE
RETURN: HL ← address of DPB

Returns the address of the Disk Parameter Block.

32 SET/GET USER CODE

INPUT: E ← user code (SET)
E ← 0FFH (GET)
RETURN: A ← user code (GET)

Table 6.6 (Continued)

FUNCTION (Register C)	DESCRIPTION
	Returns or sets the current user code (user number).

33 READ RANDOM

INPUT: DE ← address of FCB
RETURN: A ← return code

Performs a random record read on a disk file. Return codes are:

01 reading unwritten data
03 cannot close current extent
04 seek to unwritten extent
06 seek past end of disk

34 WRITE RANDOM

INPUT: DE ← address of FCB
RETURN: A ← return code

Performs a random record write to a disk file. Return codes are:

01 reading unwritten data
03 cannot close current extent
04 seek to unwritten extent
05 out of directory space
06 seek past end of disk

Table 6.6 (Continued)

FUNCTION (Register C)	DESCRIPTION

35 COMPUTE FILE SIZE

INPUT: DE ← address of FCB
RETURN: file size

Returns the size of the file, in records, to the random record field of the FCB.

36 SET RANDOM RECORD

INPUT: DE ← address of FCB
RETURN: NONE

Sets the random record number of a record that was read sequentially. The random record number is placed into the random record field of the FCB.

37 RESET DRIVE

INPUT: DE ← drive vector
RETURN: NONE

Resets the disk drives indicated in the drive vector. The least significant bit of L represents Disk A and the next Drive B. When set to 1, the drive is reset.

38 NOT USED

39 NOT USED

Table 6.6 (Continued)

FUNCTION (Register C)	DESCRIPTION
40	**WRITE RANDOM WITH ZERO FILL** INPUT: DE ← address of FCB RETURN: A ← return code Identical to WRITE RANDOM (Function 34), except that new blocks are zero-filled before data is moved into them.

6.6 CALLING A Z80 PROGRAM FROM THE 6510

You sometimes may want to call a Z80 routine from your Commodore 64 while it is running in native mode. You may, for example, want to take advantage of the Z80 register structure or its extended instruction set, which make some routines easier to write or more efficient to execute.

When you first switch on your Z80 processor, it will *always* begin execution at its reset address:

6510 ADDRESS $1000—Z80 ADDRESS $0000

To call a Z80 routine from the 6510, you must either:

- Load the routine at 6510 address $1000.
- Place a Z80 jump instruction at 6510 address $1001 that transfers control to the actual code location.

In BOTH cases, 6510 address $1000 (Z80 $0000) must contain a **NOP instruction ($00).** This is a requirement of the processor switching hardware. Of course, if you place a jump instruction at 6510 address $1001, you must load the actual Z80 routine elsewhere in memory.

On subsequent calls to the Z80, routine execution will resume at the instruction following the *last instruction executed* before the Z80 switched itself off. It does NOT resume execution at the reset address.

6.6.1 Some Examples

Suppose you load some Z80 code at 6510 address $1000. You can transfer control to that code by switching on the Z80 processor:

```
LDA     #0      ;LOAD ZERO INTO A
STA     $DE00   ;STORE ZERO IN THE MODE SWITCH
                LOCATION
NOP             ;REQUIRED BY THE SWITCH
                HARDWARE
```

The first time this code is executed, the Z80 will start executing instructions at $0000 (6510 address $1000); that address must contain a NOP instruction. Subsequent executions of the code (without turning off your Commodore 64) will cause the Z80 to resume execution where it left off when it switched the 6510 back on.

Assume now that you have loaded your Z80 code at 6510 address $B000. This corresponds to a Z80 address of $A000. You can get to this routine by using code similar to the following:

```
LDA     #$00    ;OPCODE FOR A NOP INSTRUCTION
STA     $1000   ;MEET THE SWITCHING
                REQUIREMENT
LDA     #$C3    ;Z80 JUMP INSTRUCTION OPCODE
STA     $1001   ;FIRST BYTE OF JUMP INSTRUCTION
LDA     #$00    ;LOW BYTE OF Z80 JUMP ADDRESS
STA     $1002   ;NEXT BYTE OF JUMP INSTRUCTION
LDA     #$A0    ;HIGH BYTE OF Z80 ADDRESS
STA     $1003   ;LAST BYTE OF JUMP INSTRUCTION
LDA     #0      ;LOAD ZERO INTO A
STA     $DE00   ;STORE ZERO IN THE MODE
                SWITCH LOCATION
NOP             ;REQUIRED BY THE SWITCH
                HARDWARE
```

Subsequent executions of this code (without turning off your Commodore 64) will cause the Z80 to resume execution where it left off when it switched the 6510 back on. You could thus use address $1000 for other purposes after calling the Z80 routine the first time.

You can return from your Z80 routine by using the code below:

```
MVI  A,1      ;LOAD ONE INTO A
STA  0CE00H   ;STORE ONE IN MODE SWITCH
              LOCATION
              ;TO TURN ON THE 6510
NOP           ;REQUIRED BY THE HARDWARE
              AFTER A MODESW

;
;THE NEXT TIME IT IS SWITCHED ON, THE Z80 RESUMES
EXECUTION HERE
;
```

NOTE: You MUST follow the mode switching store instruction with a NOP instruction.

6.7 CALLING A 6510 PROGRAM FROM THE Z80

There may be times when you want the 6510, running in Commodore 64 native mode, to perform some special tasks for you.

For example, suppose you add the IEEE expansion cartridge to your Commodore 64 in order to attach an IEEE standard instrument. Instruments require special control commands that can be issued only by the 6510 main processor.

The 6510 portion of the BIOS (BIOS65) includes a facility for calling your own code. This facility is implemented through the BIOS function codes 7, 8, and 9.

- BIOS **function code 7** instructs BIOS65 to transfer control to:

  6510 ADDRESS $0E00—Z80 ADDRESS $FE00

- BIOS **function code 8** instructs BIOS65 to transfer control to:

  6510 ADDRESS $0F00—Z80 ADDRESS $FF00

- BIOS **function code 9** instructs BIOS65 to transfer control indirectly to the instruction whose address is stored at:

  6510 ADDRESS $0907—Z80 ADDRESS $F907

The code that you load at these locations MUST end with a 6510 RTS instruction. This instruction returns control to BIOS65, which can then switch the Z80 processor back on.

As you see, function codes 7 and 8 always transfer control to the same location. If you use both functions 7 and 8, your programs cannot be larger than $100 bytes (256 decimal). If you use only function code 7, you can expand your program into the function code 8 space. This gives you a maximum program size of $200 bytes (512 decimal).

If you need more space than you can get under function codes 7 and 8, you can use function code 9. When you pass function code 9 to BIOS65, it transfers control *to the address* stored at 6510 location $0F07. This address can be anywhere in the 6510 address space.

NOTE: When you use BIOS function 9, the indirect address you store at Z80 address $FF07 (6510 address $0F07) MUST be a 6510 base address.

6.7.1 Switching on the 6510

If you are going to use a 6510 routine, you have to know how to switch on the 6510 processor. The two processors

cannot operate at the same time. When you switch one of them on, the other is automatically switched off.

Processor switching is controlled by storing a *mode switch* value in:

6510 ADDRESS $DE00—Z80 ADDRESS $CE00

The *mode switch* values are:

0 → activates the Z80 processor
1 → activates the 6510 processor

Suppose you load some 6510 code at 6510 address $0E00 that you wish to execute from a Z80 program. You can do that using code like the following:

```
        MVI  A,7        ;LOAD THE FUNCTION CODE INTO A
        STA  0F900H     ;STORE THE FUNCTION CODE IN
                        COMMAND REGISTER
;
;                       PREPARE ANY OTHER PARAMETERS
                        REQUIRED
                        BY THE CODE YOU HAVE
;                       PLACED AT 6510 ADDRESS $0E00—Z80
                        ADDRESS $FE00
;
        MVI  A,1        ;LOAD ONE INTO A
        STA  0CE00H     ;STORE ONE IN MODE SWITCH
                        LOCATION
                        ;TO TURN ON THE 6510
        NOP             ;REQUIRED BY THE HARDWARE
                        AFTER A MODESW
;
;                       AFTER COMPLETION OF THE 6510
                        ROUTINE, Z80 RESUMES
                        EXECUTION HERE
;
```

From the example above, you can see that it's easy to call a 6510 routine from the Z80. The 6510 routine that you write does not have to switch control back to the Z80. The BIOS65 program takes care of the return to the Z80.

NOTE: You MUST follow the mode-switching store instruction with a NOP instruction.

You must, of course, load your 6510 routine into the correct memory location before you transfer control to it. If you use BIOS function 9, you must also load the 6510 address of the code to be executed in indirect address location $F907 (Z80).

6.8 PROGRAM EXECUTION UNDER CP/M

Programs destined to execute under CP/M must be stored in a disk file and have a file name extension of **.COM** (see Chapter 5 for an explanation of CP/M file-naming conventions and details on executing programs). User programs running under CP/M are loaded into the **Transient Program Area** (TPA) for execution.

You execute a program under CP/M simply by entering its name (without the extension). The general form is:

```
[DISKID:]PROGRAM-FILENAME
```

where *diskid* is an optional disk identifier (A or B) and *program-filename* is the name of the file that contains your program. The program file MUST have the extension **.COM**.

Suppose, for example, that you have a program stored in a file named STARTREK.COM. To execute that program, you respond to the CP/M prompt (usually A>) with:

```
STARTREK
```

CP/M will then load the file STARTREK.COM into the TPA (Transient Program Area) and transfer control to it (at location $100). When STARTREK completes its execution, it returns to CP/M via a Z80 RET instruction or via a jump to location $0000. The return via a jump to location $0000 causes a warm start reboot of CP/M.

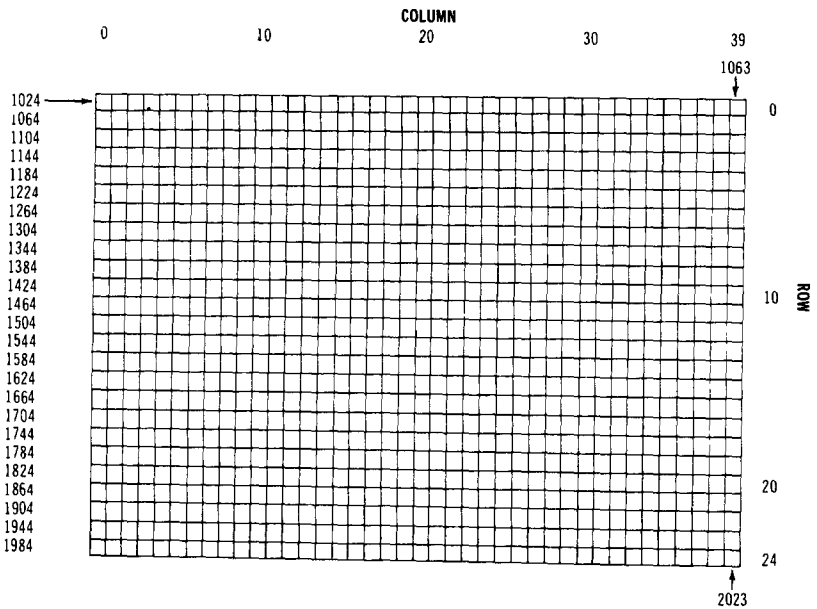
APPENDICES

APPENDIX A

COMMODORE 64 MEMORY MAP

The following charts list which memory locations control placing characters on the screen, and the locations used to change individual character colors, as well as showing character color codes.

SCREEN MEMORY MAP

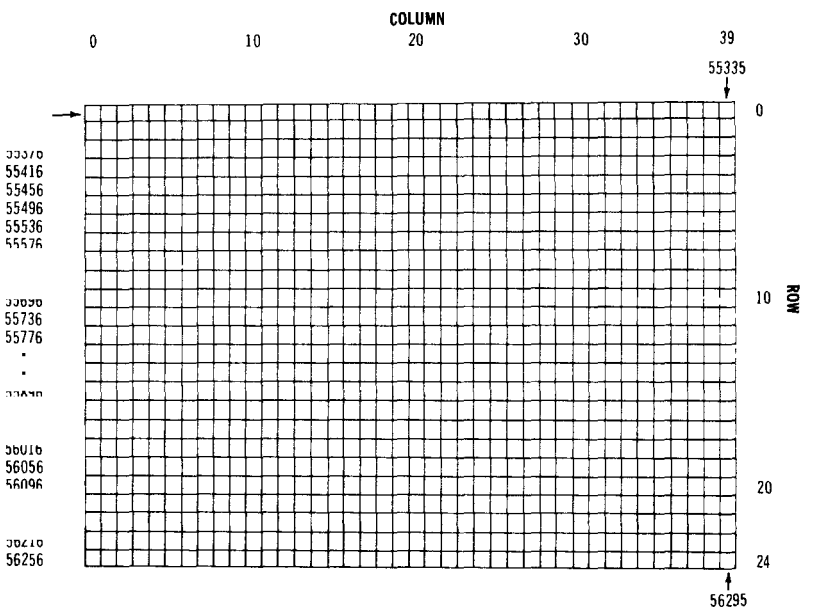


The actual values to POKE into a color memory location to change a character's color are:

Ø	BLACK	8	ORANGE
1	WHITE	9	BROWN
2	RED	1Ø	Light RED
3	CYAN	11	GRAY 1
4	PURPLE	12	GRAY 2
5	GREEN	13	Light GREEN
6	BLUE	14	Light BLUE
7	YELLOW	15	GRAY 3

For example, to change the color of a character located at the upper left-hand corner of the screen to red, type: POKE 55296,2.

COLOR MEMORY MAP



APPENDIX B

BIBLIOGRAPHY

This bibliography lists a variety of currently available CP/M and Z80 books. Look at several books covering the topics that interest you before you make your selection.

Each author covers the topics from a different viewpoint. Find the book that you feel most comfortable with. Some people prefer a more technical discussion and should select a book with in-depth technical detail. Others like a less technical approach and should seek a book that is easy to understand.

You also can subscribe to a new magazine devoted exclusively to CP/M:

The User's Guide to CP/M Systems and Software
Box 3050
Stanford, CA 94305

You may be interested in joining the CP/M User's Group, which provides software written by members for their CP/M systems. Software is often available for only a copying charge. You can contact the CP/M User's Group through:

CP/M User's Group
c/o Lifeboat Associates
1651 Third Avenue
New York, NY 10028

B.1 CP/M Books

This list gives some of the most recent CP/M books in alphabetical order by title. It is by no means a list of all the CP/M books available today. The prices shown are subject to change.

CP/M Handbook With MP/M by Rodnay Zaks, SYBEX, paper, $14.95

This is a reference guide to CP/M, written in a readable style for beginners.

CP/M Primer by Stephen Murtha, Howard W. Sams, paper, $14.95

This book helps both the first-time microcomputer user and the experienced user who is just beginning to use CP/M.

CP/M Word Processing by Chris DeVoney, Que Corporation, paper, $16.50

This book covers the use of word processing packages developed to run under the CP/M operating system. It contains detailed evaluations of 17 popular CP/M word processing packages and tells how to decide which word processor best meets your needs.

How to Get Started with CP/M by Carl Townsend, Dilithium Press, paper, $13.95

This book describes the CP/M operating system in an easy, comfortable style. It eases the reader into understanding the details of this widely used microcomputer operating system.

Osborne CP/M User Guide by Thom Hogan, Osborne, paper, $12.99

One of the most complete and up-to-date CP/M books available. This book contains easy-to-understand descriptions of the CP/M operating system and commands. It also contains detailed technical information for more experienced users.

Using CP/M by Judi Fernandez and Ruth Ashley, John Wiley, paper, $12.95

This is a complete, detailed introduction to the use of CP/M, written in an easy-to-understand style.

Vanloves CP/M Software Directory edited by Rolland Love and Gerald Van Diver, Vital Information, paper, $24.95.

This up-to-date computer resource for CP/M describes peripherals, software, and accessories for CP/M systems. It includes a bibliography and lists of user groups, magazines, supplies, and computer accessories.

B.2 Z80 Books

8080/Z80 Assembly Language by Alan Miller, John Wiley, paper, $10.95

A step-by-step guide to programming the 8080 and Z80 microprocessors. This book helps intermediate and advanced programmers to get even more out of their 8080/Z80.

Programming the Z80 by Rodnay Zaks, SYBEX, paper, $15.95

This book covers the Z80 from basic concepts through advanced programming techniques. Exercises are offered to measure reader comprehension along the way. The book's topics range from hardware organizations to data structures.

Z80 and 8080 Assembly Language Programming by Kathe Spracklen, Hayden Book Co., paper, $9.70

This book covers programming techniques and gives complete instruction sets for the 8080 and Z80 microprocessors. Each chapter includes exercises and answers to help readers learn to use the Z80 and 8080 more efficiently.

Z80 Microcomputer Design Projects by William Barden, Howard W. Sams, paper, $13.95

This book gives a solid, in-depth look at the popular Z80 microprocessor. It provides a complete look at the internal architecture of the Z80.

Z80 Microcomputer Handbook by William Barden, Howard W. Sams, paper, $11.95

This book is designed to teach you about the Z80. There is extensive coverage of Z80 machine language and the Z80 assembler language.

Z80 Microcomputer Programming and Interfacing, Books 1 and *2* by Elizabeth Nichols, Howard W. Sams, paper, Book 1—$12.95, Book 2—$12.95, Book 1 & 2—$24.95

Book 1 introduces computers to readers who have no background in computer science. Book 2 assumes a familiarity with Book 1 and continues an in-depth discussion of the design and use of the popular Z80 microprocessor. Both volumes are written in a self-teaching format with exercises and answers.

Z80 User's Manual by Joseph Carr, Prentice-Hall, paper, $15.95

An all-in-one guide to the Z80. This book is useful for both beginning and advanced Z80 users. It includes in-depth technical details for the Z80.

APPENDIX C

CP/M COMMAND LIST

This appendix is a simple listing of CP/M commands. For details on these commands, see Chapter 5.

Load and execute a program:
[*disk-id*:]*filename* <CR>

Change the currently logged disk:
disk-id:

Assemble a Z80 assembler program:
ASM *filename*[.*parms*]

ASM error codes are given in Table 5.4.

Run the CP/M debugger:
DDT [[*disk-id*:]*filename*[.*type*]]

DDT commands are given in Table 5.5.

Get a directory listing:
DIR [*disk-id*:][*filename.type*]

Dump a file in ASCII and hexadecimal format:
DUMP [*disk-id*:]*filename.type*

Edit a file:

ED [*disk-id*:]*filename*[.*type*] [[*disk-id2*:] [*filename2*[.*type2*]]]

ED control characters are given in Table 5.8.
ED commands are given in Table 5.9.

Erase a file:

ERA [*disk-id*:]*filename.type*

Create an executable module from ASM output:

LOAD [*disk-id*:]*filename*

Copy a new version of CP/M:

MOVCP [{ * | *size* }] [*]

Copy a file or disk:

PIP *destination*=*source*[*command-parameters*]

Table 5.10 gives PIP logical devices.
Table 5.11 gives special PIP devices.
Table 5.12 gives PIP command parameters.

Rename a file:

REN [*disk-id*:]*new-file*= *old-file*

Save *page-num* 256-byte pages of memory beginning at the start of the TPA (100 hexadecimal):

SAVE *page-num* [*disk-id*:]*filename*[. *type*]

Get disk and I/O device status information:

STAT *command*

Table 5.13 shows STAT command options.
Table 5.14 shows STAT command attributes.

Submit a file for batch execution:

SUBMIT [*disk-id:*]*filename* [*parameters*]

Generate a new CP/M system:

SYSGEN [[*disk-id:*]*filename.type*]

Print a file to the screen:

TYPE [*disk-id:*]*filename.type*

Change the user number:

USER [*user-num*]

Include keyboard data in your SUBMIT file:

XSUB

APPENDIX D

ASCII, CHR$, AND HEXADECIMAL CHARACTER CODES

When running in *native mode* your Commodore 64 uses two sets of character codes:

- CHR$ Codes (see Appendix F of your Commodore 64 User's Guide).
- Screen Display Codes (see Appendix E of your Commodore 64 User's Guide).

CP/M employs another character code set called the **ASCII Character Codes** (shown in Table D.1 below).

NOTE: The CTRL-Shifted column of Table D.1 shows the values generated when you hold the CTRL key down and press the character key.

When you use the CONFIG utility to alter character code values, you must supply the ASCII *hexadecimal* value of the new character. Therefore, the character code values shown in Table D.1 are expressed in hexadecimal.

If you're not sure what a hexadecimal value is, don't worry. Look up the character in Table D.1 and use the value shown (including the letters).

Table D.1 ASCII Character Codes (Hexadecimal Values)

CHARACTER	HEX VALUE	CTRL SHIFTED
RUN/STOP	03	03
INS/DEL	08	18
RETURN	0D	0D
CLR/HOME	1B	7F
LEFT/RIGHT	1C/1D	1D
UP/DOWN	1E/1F	1F
SPACE	20	20

Table D.1 (Continued)

CHARACTER	HEX VALUE	CTRL SHIFTED
!	21	21
"	22	22
#	23	23
$	24	24
%	25	25
&	26	26
'	27	27
(	28	28
)	29	29
*	2A	2A
+	2B	2B
,	2C	7B
-	2D	2D
.	2E	7D
/	2F	5C
0	30	00
1	31	31
2	32	32
3	33	33
4	34	34
5	35	35
6	36	36
7	37	37
8	38	7B
9	39	7D
:	3A	7B
;	3B	7D
@	40	60
a	41	01
b	42	02
c	43	03
d	44	04
e	45	05
f	46	06
g	47	07
h	48	08
i	49	09
j	4A	0A

Table D.1 (Continued)

CHARACTER	HEX VALUE	CTRL SHIFTED
k	4B	0B
l	4C	0C
m	4D	0D
n	4E	0E
o	4F	0F
p	50	10
q	51	11
r	52	12
s	53	13
t	54	14
u	55	15
v	56	16
w	57	17
x	58	18
y	59	19
z	5A	1A
£	5C	7C
↑	5E	7E
←	5F	5F
A	61	01
B	62	02
C	63	03
D	64	04
E	65	05
F	66	06
G	67	07
H	68	08
I	69	09
J	6A	0A
K	6B	0B
L	6C	0C
M	6D	0D
N	6E	0E
O	6F	0F
P	70	10
Q	71	11
R	72	12
S	73	13

Table D.1 (Continued)

CHARACTER	HEX VALUE	CTRL SHIFTED
T	74	14
U	75	15
V	76	16
W	77	17
X	78	18
Y	79	19
Z	7A	1A
F1	80	81
F2	81	81
F3	82	83
F4	83	83
F5	84	85
F6	85	85
F7	86	87
F8	87	87

APPENDIX E

BIOS AND BOOT LISTINGS

This appendix gives the source listings for the BIOS and BOOT programs on the 6510 and the Z80.

Xerox to Commodore 64 Receive Utility


```
0100 =          TPA     EQU     100H    ;START ADDRESS OF PROGRAM
005C =          FCB     EQU     005CH   ;FILE CONTROL BLOCK
0080 =          DMADDR  EQU     0080H   ;DMA ADDRESS
000D =          CR      EQU     0DH     ;CARRIAGE RETURN
0006 =          ACK     EQU     06H
0015 =          NAK     EQU     15H
0000 =          BOOT    EQU     0000H
0005 =          BDOS    EQU     0005H
0E00 =          SIO     EQU     0E00H
FF00 =          MEM     EQU     0FF00H  ;BUFFER MEMORY
0300 =          PGM65   EQU     0300H
0080 =          SIZE65  EQU     128
                ;
                ;       SYNTAX FOR COMMAND IS
                ;
                ;       RECEIVE FILENAME.EXT
                ;
0100            ORG     TPA
                ;
0100 31D802             LXI     SP,STACK  ;SET UP LOCAL STACK
                ;
                ;       CHECK FOR VALID FILENAME
                ;
0103 113B02             LXI     D,NONAME  ;NONAME MESSAGE
0106 3A5D00             LDA     FCB+1
```

```
0109 FE20              CPI     ' '
010B CAE201            JZ      DONE        ;IF SPACE, NO NAME GIVEN
                ;
010E 115802            LXI     D,BADNAM    ;CHECK FOR AMBIGUOUS NAME
0111 215C00            LXI     H,FCB
0114 3E3F              MVI     A,'?'
0116 0610              MVI     B,16        ;COUNTER
                ;
0118 BE         QLOOP: CMP     M           ;IS IT '?'
0119 CAE201            JZ      DONE        ;IF SO, BAD NAME
                ,
011C 23                INX     H
011D 05                DCR     B
011E C21801            JNZ     QLOOP       ;DO 16 TIMES
                ,
0121 118000            LXI     D,DMADDR
0124 CD1702            CALL    SETDMA
                ;
                ;       TRANSFER 6510 CODE TO $E00 (0FE00H)
                ,
                ;
                ;
0127 0680              MVI     B,SIZE65
0129 210003            LXI     H,PGM65
012C 1100FE            LXI     D,0FE00H
                ,
012F 78                MOV     A,B
0130 A7                ANA     A
0131 CA3C01            JZ      SKIP
0134 7E         LOADLP MOV     A,M
0135 12                STAX    D
0136 23                INX     H
0137 13                INX     D
0138 05                DCR     B
0139 C23401     ;      JNZ     LOADLP
                ;       GET READY BY OPENING FILES
                ;
013C 115C00     SKIP:  LXI     D,FCB
013F CD1D02            CALL    DELETE
0142 115C00            LXI     D,FCB
0145 CD2302            CALL    MAKE
                ;
```

```
0148 117602          LXI     D,NODIR
014B 3C              INR     A          ;WAS 255 IF NO FILE SPACE
014C CAE201          JZ      DONE
                     ;
014F 118000          LXI     D,DMADDR
0152 CD1702          CALL    SETDMA
                     ;
0155 AF      READS:  XRA     A
0156 32B702          STA     POINT
                     ;
                     ;
0159 3E06    GNEXT:  MVI     A,ACK      ;SEND INITIAL ACK
015B 32FFFE  GBLK.   STA     0FEFFH     ,I/O LOCATION
                     ;
015E 3E07            MVI     A,7
0160 3200F9          STA     0F900H
0163 3E01            MVI     A,1
0165 3200CE          STA     0CE00H
0168 00              NOP
                     ;
                     ;       NEED TEST FOR ERROR
                     ;
0169 3AFFFE          LDA     0FEFFH
016C A7              ANA     A
016D C2C401          JNZ     AGAIN
                     ;
                     ,
0170 118000          LXI     D,DMADDR
0173 3AB702          LDA     POINT
0176 B3              ORA     E
0177 5F              MOV     E,A
0178 2100FF          LXI     H,MEM
017B 7E              MOV     A,M
017C FE3A            CPI     ':'
017E C2C401          JNZ     AGAIN
                     ;
0181 AF              XRA     A
0182 32B602          STA     BADDAT
0185 CDE801          CALL    GYBTE
0188 A7              ANA     A
0189 CAD901          JZ      FINISH
```

```
018C FE20          CPI   32
018E C2C401        JNZ   AGAIN
                   ;
                   ;
0191 0E00    GETQ: MVI   C,0      ;CHECKSUM
0193 47            MOV   B,Z      ;COUNTER
                   ;
0194 C5      GQLP: PUSH  B
0195 CDE801        CALL  GBYTE
                   ;
0198 12            STAX  D
0199 1C            INR   E
019A C1            POP   B
019B 81            ADD   C
019C 4F            MOV   C,A
019D 05            DCR   B
019E C29401        JNZ   GQLP
                   ;
01A1 C5            PUSH  B
01A2 CDE01         CALL  CBYTE
01A5 C1            POP   B
01A6 81            ADD   C
01A7 C2C401        JNZ   AGAIN
                   ;
01AA 3AB602        LDA   BADDAT
01AD B7            ORA   A
01AE C2C401        JNZ   AGAIN
                   ;
                   ;
01B1 3AB702        LDA   POINT
01B4 C620          ADI   32
01B6 32B702        STA   POINT
01B9 FE80          CPI   128
01BB C25901        JNZ   GNEXT
                   ;
01BE CDC901        CALL  SWRITE
01C1 C35501        JMP   READS
                   ;
01C4 3E15    AGAIN: MVI  A,NAK
01C6 C35801        JMP   GBLK
                   ;
```

```
01C9 115C00     SWRITE:  LXI     D,FCB
01CC CD2902              CALL    WRITE
01CF 119502              LXI     D,DFULL
01D2 B7                  ORA     A
01D3 C2E201              JNZ     DONE
                 ;
01D6 C9                  RET
01D7 00                  NOP
01D8 00                  NOP
                 ;
01D9 115C00     FINISH:  LXI     D,FCB
01DC CD2F02              CALL    CLOSE
01DF 11A102              LXI     D,EOTRAN
                 ;
01E2 CD3502     DONE.    CALL    PRINT
01E5 C30000              JMP     BOOT
                 ;
                 ;
                 ;
01E8 CDF501     GBYTE:   CALL    GNIB
01EB 87                  ADD     A
01EC 87                  ADD     A
01ED 87                  ADD     A
01EE 87                  ADD     A
01EF 47                  MOV     B,A
01F0 CDF501              CALL    GNIB
01F3 80                  ADD     B
01F4 C9                  RET
                 ;
01F5 23         GNIB:    INX     H
01F6 7E                  MOV     A,M
01F7 FE30                CPI     '0'
01F9 DA1102              JC      NOTHEX
01FC FE3A                CPI     '9'+1
01FE DA0E02              JC      NUMBER
0201 FE41                CPI     'A'
0203 DA1102              JC      NOTHEX
0206 FE47                CPI     'F'+1
0208 D21102              JNC     NOTHEX
                 ;
020B D637       ALPHA:   SUI     'A'-10
```

```
020D C9                 RET
                        ;
020E D630       NUMBER: SUI     '0'
0210 C9                 RET
                        ;
0211 3EFF       NOTHEX: MVI     A,0FFH
0213 32B602             STA     BADDAT
0216 C9                 RET
                        ;
                        ;
                        ;
0217 0E1A       SETDMA: MVI     C,26
0219 CD0500             CALL    BDOS
021C C9                 RET
                        ;
021D 0E13       DELETE: MVI     C,19
021F CD0500             CALL    BDOS
0222 C9                 RET
                        ;
0223 0E16       MAKE.   MVI     C,22
0225 CD0500             CALL    BDOS
0228 C9                 RET
                        ;
0229 0E15       WRITE:  MVI     C,21
022B CD0500             CALL    BDOS
022E C9                 RET
                        ;
022F 0E10       CLOSE.  MVI     C,16
0231 CD0500             CALL    BDOS
0234 C9                 RET
                        ;
                        ;
0235 0E09       PRINT.  MVI     C,9
0237 CD0500             CALL    BDOS
023A C9                 RET
                        ;
023B 46494C454E NONAME: DB      'FILENAME MUST BE SPECIFIED',0DH,0DH,'$'
                        ;
0258 414D424947 BADNAM: DB      'AMBIGUOUS FILES NOT
                                ALLOWED',0DH,0DH,'$'
```

```
0276 4E4F204449  NODIR:   DB      'NO DIRECTORY SPACE AVAILABLE'
0292 0D0D24              DB      0DH,0DH,'$'
                 ;
0295 4449534B20  DFULL:   DB      'DISK FULL'
029E 0D0D24              DB      0DH,0DH,'$'
                 ;
                 ;
02A1 5452414E53  EOTRAN:  DB      'TRANSFER COMPLETE.',0DH,0DH,'$'
                 ;
02B6             BADDAT:  DS      1
02B7             POINT:   DS      1
                 ;
02B8                      DS      32
02DB =           STACK    EQU     $
```

Commodore 64 Copy Utility 1.0


```
0100                      ORG     100H
                 ;
                 ;        EQUATES
                 ;
F800 =           BUFFER   EQU     0F800H
F900 =           CMD      EQU     0F900H
F901 =           DATA     EQU     0F901H
F902 =           SECTOR   EQU     0F902H
F903 =           TRACK    EQU     0F903H
F904 =           DISKNO   EQU     0F904H
0001 =           OFF      EQU     1
CE00 =           MODESW   EQU     0CE00H
0000 =           VICRD    EQU     0
0001 =           VICWR    EQU     1
0006 =           VICFMT   EQU     6
0005 =           BDOS     EQU     0005H
0000 =           BOOT     EQU     0000H
000D =           CR       EQU     0DH      ;CARRIAGE RETURN
000A =           LF       EQU     0AH      ;LINE FEED
```

```
000C =          CLS     EQU     0CH     ;CLEAR SCREEN
                ;
0100 316B06     START:  LXI     SP,STACK
0103 111403             LXI     D,COPMSG
0106 CD0503     ;       CALL    PRINT   ;PROGRAM NAME, ETC.
0109 CD0003     IN1TO4: CALL    CONIN
                ;
010C FE31               CPI     '1'
010E CA2301             JZ      FORMAT
                ;
0111 FE32               CPI     '2'
0113 CAD701             JZ      BACKUP
                ;
0116 FE33               CPI     '3'
0118 CA7B01             JZ      SYSTEM
                ;
011B FE34               CPI     '4'
011D CA0000             JZ      BOOT
                ;
0120 C30901             JMP     IN1TO4
                ;
0123 11A603     FORMAT  LXI     D,FMTMSG ;FORMAT A DISK
0126 CD0503             CALL    PRINT
                ;
0129 CDDB02             CALL    CRORRS  ;GET KEYBOARD INPUT
012C CA0001             JZ      START   ;IF RUN/STOP, GO TO MENU
                ;
012F 116104             LXI     D,FMTING ;FORMATTING MESSAGE
0132 CD0503             CALL    PRINT
                ;
0135 3E06               MVI     A,VICFMT
0137 CD0A03             CALL    IO6510  ;SEND FORMAT COMMAND TO
                                        6510
                ;
013A 3A01F9             LDA     DATA    ;CHECK FOR ERROR
013D A7                 ANA     A
013E C27501             JNZ     FMTERR
                ;
0141 2100F8             LXI     H,BUFFER ;FILL DISK BUFFER WITH E5's
0144 3EE                MVI     A,0E5H  ; FOR DIRECTORY SECTORS
0146 77         FMT0:   MOV     M,A
```

```
0147 2C              INR     L
0148 C24601          JNZ     FMT0        ;DO THIS 256 TIMES
                     ;
014B 3E03            MVI     A,3
014D 3203F9          STA     TRACK       ;DIRECTORY TRACK
                     ;
0150 3E00            MVI     A,0
0152 3204F9          STA     DISKNO      ;FORCE DRIVE 0
                     ,
0155 3E00            MVI     A,0         ;INITIAL SECTOR
                     ;
0157 3202F9  FMT1:   STA     SECTOR      ;SET SECTOR
015A 3E01            MVI     A,VICWR     ;GET READY FOR WRITE
015C CD0A03          CALL    IO6510      ;GO DO IT
015F 3A01F9          LDA     DATA        ;A=0 IF OK
0162 A7              ANA     A
0163 C27501          JNZ     FMTERR
                     ;
0166 3A02F9          LDA     SECTOR
0169 3C              INR     A
016A FE08            CPI     8           ;DO ONLY SECTORS 0-7
016C C25701          JNZ     FMT1        ;LOOP UNTIL DONE
                     ;
016F 118704          LXI     D,FMTDON
0172 C37502          JMP     DONE
                     ;
0175 119A04  FMTERR: LXI     D,FMTERM
0178 C37502          JMP     DONE
                     ;
017B 11D304  SYSTEM: LXI     D,SYSMSG    ;SYSTEM TRACKS ONLY
017E CD0503          CALL PRINT
                     ;
0181 112905          LXI     D,SRCMSG
0184 CD0503          CALL    PRINT
                     ;
0187 116905          LXI     D,PRSMSG
018A CD0503          CALL    PRINT
018D CDDB02          CALL    CRORRS
$190 CA0001          JZ      START       ;IF SPACEBAR, GO TO MENU
                     ;
0193 CDEA02          ;       CALL    CRLF
```

```
0196 216B06            LXI     H,MEM     ;BEGINNING OF MEMORY SPACE
                                         ***
                ;
0199 3E01              MVI     A,1
019B CD8402            CALL    RDTRK     ;READ TRACK 1
                ,
019E 3E02              MVI     A,2
01A0 CD8402            CALL    RDTRK     ;READ TRACK 2
                ;
01A3 3E12              MVI     A,18
01A5 CD8402            CALL    RDTRK     ;READ TRACK 18
                ,
01A8 114905            LXI     D,DSTMSG  ;PRINT DESTINATION MESSAGE
01AB CD0503            CALL    PRINT
                ;
01AE 110F06            LXI     D,RTNMSG
01B1 CD0503            CALL    PRINT
                ,
01B4 CD0003    SYS1:   CALL    CONIN
01B7 FE0D              CPI     CR        ,WAIT FOR CARRIAGE RETURN
01B9 C2B401            JNZ     SYS1
                ;
01BC CDEA02            CALL    CRLF
                ;
01BF 216B06            LXI     H,MEM     ;SETUP FOR WRITE ***
                ;
01C2 3E01              MVI     A,1
01C4 CDAE02            CALL    WRTRK
                ,
01C7 3E02              MVI     A,2
01C9 CDAE02            CALL    WRTRK
                ,
01CC 3E12              MVI     A,18
01CE CDAE02            CALL    WRTRK
                ;
01D1 118E05            LXI     D,SYSDON
01D4 C37502            JMP     DONE
                ;
01D7 11AC05    BACKUP: LXI     D,BAKMSG  ;BACKUP DISK
01DA CD0503            CALL    PRINT
                ;
```

```
01DD 116905          LXI    D,PRSMSG
01E0 CD0503          CALL   PRINT
01E3 CDDB02          CALL   CRORRS
01E6 CA0001          JZ     START
01E9 CDEA02          CALL   CRLF
                     ;
01EC 3E01            MVI    A,1          ;START WITH TRACK 1
01EE 3203F9          STA    TRACK
                     ;
01F1 3E05            MVI    A,5          ;DO OUTER LOOP 5 TIMES
01F3 324A06          STA    OUTER
                     ;
01F6 3A03F9  BKLP:   LDA    TRACK
01F9 324806          STA    WTRACK       ;SAVE FOR WRITE TRACK
                     ;
01FC 3E07            MVI    A,7
01FE 324906          STA    INNER        ;INNER LOOP COUNTER
                     ;
0201 112905          LXI    D,SRCMSG
0204 CD0503          CALL   PRINT
                     ;
0207 110F06          LXI    D,RTNMSG
020A CD0503          CALL   PRINT
                     ;
020D CD0003  BKRD1:  CALL   CONIN
0210 FE0D            CPI    CR
0212 C20D02          JNZ    BKRD1
                     ;
0215 216B06          LXI    H,MEM        ;START OF AVAILABLE MEMORY
                     ,
0218 3A03F9  BKRD:   LDA    TRACK
021B CD8402          CALL   RDTRK
021E 3A03F9          LDA    TRACK
0221 3C              INR    A
0222 3203F9          STA    TRACK
0225 3A4906          LDA    INNER
0228 3D              DCR    A
0229 324906          STA    INNER
022C C21802          JNZ    BKRD
                     ;
022F 3A4806          LDA    WTRACK
```

```
0232 3203F9          STA     TRACK     ;RESTORE TRACK POINTER
0235 3E07            MVI     A,7
0237 324906          STA     INNER     ;INNER COUNTER
                     ;
023A 114905          LXI     D,DSTMSG
023D CD0503          CALL    PRINT
0240 110F06          LXI     D,RTNMSG
0243 CD0503          CALL    PRINT
                     ;
0246 CD0003  BKWR1:  CALL    CONIN
0249 FE0D            CPI     0DH
024B C24602          JNZ     BKWR1
                     ;
024E 216B06          LXI     H,MEM     ;START OF MEMORY AGAIN
                     ;
0251 3A03F9  BKWR:   LDA     TRACK
0254 CDAE02          CALL    WRTRK
0257 3A03F9          LDA     TRACK
025A 3C              INR     A
025B 3203F9          STA     TRACK
025E 3A4906          LDA     INNER
0261 3D              DCR     A
0262 324906          STA     INNER
0265 C25102          JNZ     BKWR
                     ;
0268 214A06          LXI     H,OUTER
026B 35              DCR     M
026C C2F601          JNZ     BKLP
                     ;
                     ;
026F 11FC05          LXI     D,BAKDON
0272 C37502          JMP     DONE
                     ;
0275 CD0503  DONE.   CALL    PRINT     ,PRINT DONE MESSAGE
                     ;
0278 11B804          LXI     D,ANYKEY
027B CD0503          CALL    PRINT
027E CD0003          CALL    CONIN     ,WAIT FOR ANY KEY
0281 C30001          JMP     START
                     ;
0284 3203F9  RDTRK:  STA     TACK      ,A=TRACK ON ENTRY
```

```
0287 3E00          MVI   A,0        ;START WITH SECTOR 0
                   ;
0289 3202F9  RD1:  STA   SECTOR
028C 3E00          MVI   A,VICRD    ;READ SECTOR COMMAND
028E CD0A03        CALL  IO6510     ;GO DO IT
0291 3A01F9        LDA   DATA
0294 A7            ANA   A
0295 C2FA02        JNZ   RDERR      ,READ ERROR IF <>0
                   ;
0298 1100F8        LXI   D,BUFFER
029B 1A      RD2:  LDAX  D          ;GET CHARACTER FROM BUFFER
029C 77            MOV   M,A        ; AND PUT IN MEMORY
029D 13            INX   D
029E 23            INX   H          ;BUMP POINTERS
029F 7B            MOV   A,E        ;DONE 256 YET?
02A0 A7            ANA   A
02A1 C29B02        JNZ   RD2        ;JUMP IF NO
                   ;
02A4 3A02F9        LDA   • SECTOR
02A7 3C            INR   A
02A8 FE11          CPI   17         ,17 = LAST SECTOR + 1
02AA C28902        JNZ   RD1
                   ;
02AD C9            RET
                   ;
02AE 3203F9  WRTRK: STA   TRACK      ;A = TRACK ON ENTRY
02B1 3E00          MVI   A,0
                   ;
02B3 3202F9  WR1:  STA   SECTOR
02B6 1100F8        LXI   D,BUFFER
02B9 7E      WR2:  MOV   A,M
02BA 12            STAX  D          ,PUT CHAR IN BUFFER
02BB 23            INX   H
02BC 13            INX   D          ,INCREMENT POINTERS
028D 7B            MOV   A,E        ;DONE 256 YET?
02BE A7            ANA   A
02BF C2B902        JNZ   WR2        ;JUMP IF NO
                   ;
02C2 3E01          MVI   A,VICWR    ;SECTOR WRITE COMMAND
02C4 CD0A03        CALL  IO6510     ;GO DO IT
                   ;
```

```
02C7 3A01F9          LDA     DATA
02CA A7              ANA     A
02CB C2F402          JNZ     WRERR       ;JUMP IF WRITE ERROR
02CE 3A02F9          LDA     SECTOR
02D1 3C              INR     A
02D2 FE11            CPI     17          ;17=LAST SECTOR+1
02D4 C2B302          JNZ     WR1         ;KEEP READING
                     ;
02D7 C9              RET
                     ;
02D8 FE20    CR1.    CPI     20H         ;SPACEBAR?
02DA C8              RZ
                     ;
02DB CD0003  CRORRS. CALL    CONIN
02DE FE0D            CPI     CR          ;CARRIAGE RETURN
02E0 C2DB02          JNZ     CR1
                     ;
02E3 A7              ANA     A           ;KILL ZERO FLAG
02E4 C9              RET
                     ;
02E5 0E02    CONOUT: MVI     C,2
02E7 C30500          JMP     BDOS
                     ;
02EA 1E0D    CRLF:   MVI     E.CR
02EC CDE502          CALL    CONOUT
02EF 1E0A            MVI     E,LF
02F1 C3E502          JMP     CONOUT
                     ,
02F4 111D06  WRERR:  LXI     D,WRMSG
02F7 C37502          JMP     DONE
                     ;
02FA 113306  RDERR:  LXI     D,RDMSG
02FD C37502          JMP     DONE
                     ;
0300 0E01    CONIN:  MVI     C,1
0302 C30500          JMP     BDOS
                     ;
0305 0E09    PRINT:  MVI     C,9
0307 C30500          JMP     BDOS
                     ,
030A 3200F9  IO6510: STA     CMD         ,PUT A IN 6510 COMMAND
                                         REGISTER
```

```
030D 3E01                   MVI     A,OFF
030F 3200CE                 STA     MODESW    ;TURN OFF Z80
0312 00                     NOP
0313 C9                     RET
                    ;
                    ;
                    ;       TEXT AND MESSAGES:
                    ;
0314 0C0A434F4D COPMSG: DB      CLS,LF,'COMMODORE 04 UTILITY 1 0'
0333 0D0A0A             DB      CR,LF,LF
0336 2020312E20         DB      1. FORMAT DISK',CR,LF
0349 2020322E20         DB      ' 2. BACKUP DISK',CR,LF
035C 2020332E20         DB      ' 3. COPY SYSTEM TRACKS ONLY',CR,LF
037B 2020342E20         DB      ' 4. EXIT',CR,LF,LF
0388 504C454153         DB      'PLEASE CHOOSE FUNCTION (1-4) $'
                    ,
03A6 0C0A464F52 FMTMSG: DB      CLS,LF,'FORMAT DISK UTILITY',CR,LF,LF
03BE 494E495449         DB      'INITIALIZES DISK FOR CP/M',CR,LF
03D9 0A43415554         DB      LF,'CAUTION! FORMAT ERASES ALL
                                DATA',CR,LF,LF
03FD 504C414345         DB      'PLACE DISK TO BE FORMATTED IN',CR,LF
041C 4452495645         DB      'DRIVE 0 AND PRESS ENTER',CR,LF,LF
0436 202020204F         DB      ' OR',CR,LF,LF
043F 5052455353         DB      'PRESS SPACEBAR TO RETURN TO MENU $'
                    ;
0461 0D0A0A464F FMTING: DB      CR,LF,LF,'FORMATTING DISK, PLEASE WAIT...'
0483 0D0A0A24           DB      CR,LF,LF,'$'
                    ,
0487 464F524D41 FMTDON: DB      'FORMAT COMPLETE',CR,LF,LF,'$'
                    ;
049A 492043414E FMTERM: DB      'I CANNOT FORMAT THIS DISK!',CR,LF,LF,'$'
                    ;
04B8 5052455353 ANYKEY: DB      'PRESS ANY KEY TO CONTINUE $'
                    ;
04D3 0C0A535953 SYSMSG: DB      CLS,LF,'SYSTEM TRACK COPY UTILITY',CR,LF,LF
04F1 434F504945         DB      'COPIES SYSTEM TRACKS FROM MASTER
                                DISK',CR,LF
0518 544F20534C         DB      'TO SLAVE DISK',CR,LF,LF,'$'
                    ;
0529 494E534552 SRCMSG: DB      'INSERT MASTER DISK IN DRIVE 0',CR,LF,'$'
0549 494E534552 DSTMSG: DB      'INSERT SLAVE DISK IN DRIVE 0',CR,LF,'$'
```

```
0569 5052455353 PRSMSG: DB      'PRESS RETURN (OR SPACEBAR FOR MENU) $'
                ;
058E 5359535445 SYSDON: DB      'SYSTEM TRACK COPY COMPLETE',CR,LF,LF,'$
                ;
05AC 0C0A444953 BAKMSG: DB      CLS,LF,'DISK BACKUP UTILITY',CR,LF,LF
05C4 5448452045         DB      'THE ENTIRE MASTER DISK IS ',CR,LF
05E0 434F504945         DB      'COPIED TO THE SLAVE DISK',CR,LF,LF
05FB 24                 DB      '$'
                ;
05FC 4241434B55 BAKDON: DB      'BACKUP COMPLETE',CR,LF,LF,'$'
                ;
060F 5052455353 RTNMSG: DB      'PRESS RETURN $'
                ;
061D 0D0A0A4449 WRMSG:  DB      CR,LF,LF,'DISK WRITE ERROR',CR,LF,'$'
                ;
0633 0D0A0A4449 RDMSG:  DB      CR,LF,LF,'DISK READ ERROR',CR,LF,'$'
                ;
0648            WTRACK  DS      1
0649            INNER   DS      1
064A            OUTER   DS      1
064B                    DS      32
066B =          STACK   QU      $
066B =          MEM     EQU     $       ;***
```

Z80 Bootstrap Routine for the Commodore 64

This routine is loaded from Track 1, Sector 5 of the Commodore 64 CP/M disk by a routine in BIOS65.

The load address is 0000H (with respect to the Z80 CPU). When the Z80 is enabled this program loads the Z80 BIOS and CCP and BDOS into RAM and jumps to it.

```
3400 =          CCP     EQU     3400H
                ;CCP    EQU     0000H   ;FOR MAKING BOOT0.HEX
                ;CCP    EQU     0100H   ;FOR MAKING BOOT1.HEX
001C =          NSECTS  EQU     1CH
```

```
F903  =          TRACK    EQU    0F903H
F902  =          SECTOR   EQU    0F902H
F904  =          DISKNO   EQU    0F904H
FCFF  =          IOTYPE   EQU    0FCFFH      ;IO SETUP BYTE IN 8IOS65
4A33  =          KYBDMD   EQU    CCP+1633H   ;CAPS LOCK FLAG
0000  =          VICRD    EQU    0
F900  =          CMD      EQU    0F900H
0001  =          OFF      EQU    01H
CE00  =          MODESW   EQU    0CE00H
F901  =          DATA     EQU    0F901H
F800  =          BUFFER   EQU    0FB00H
4A00  =          8OOT     EQU    CCP+1600H
                 ;
0000             ORG      0000H       ;Z80 RESET LOCATION
                 ;
0000 00          NOP                  ;NOP REQUIRED FOR HARDWARE
0001 110034      LXI      D,CCP       ;START OF LOAD ADDRESS
0004 3E00        MVI      A,0
0006 3204F9      STA      DISKNO      ;LOAD IN FROM DRIVE A
0009 2601        MVI      H,1         ;READ BEGINNING TRK 1, SEC 6
000B 2E06        MVI      L,6
000D 7C          LOAD1    MOV      A,H
000E 3203F9      STA      TRACK
0011 7D          MOV      A,L
0012 3202F9      STA      SECTOR
0015 3E00        MVI      A,VICRD     :SECTOR READ COMMAND
0017 3200F9      STA      CMD
001A 3E01        MVI      A,OFF
001C 3200CE      STA      MODESW      ;TURN OFF SELF
001F 00          NOP
0020 3A01F9      LDA      DATA        ;WAS TRANSFER OK?
0023 B7          ORA      A
0024 C20D00      JNZ      LOAD1       ;JUMP IF NO
                 ;
                 ;        OUTPUT '*' TO SHOW LOADING
                 ;
0027 3E2A        MVI      A,'*'
0029 3201F9      STA      DATA
002C 3E03        MVI      A,3
002E 3200F9      STA      CMD
0031 3E01        MVI      A,OFF
```

```
0033 3200CE      STA     MODESW
0036 00          NOP
                 ;
                 ;       MOVE SECTOR TO MEMORY
                 ;
0037 0100F8              LXI     B,BUFFER
003A 0A          LOAD2:  LDAX    B
003B 12                  STAX    D
003C 0C                  INR     C
003D 1C                  INR     E
003E C23A00              JNZ     LOAD2
                 ;
                 ;       UPDATE POINTERS
                 ;
```

CP/M Version 2.2 System Relocator — 2/80

CP/M Relocator Program, Included with the Module To Perform the Move from 900H to the Destination Address

Modified for Use on the Commodore 64


```
0041                     INR     D
0042 2C                  INR     L
0043 7D                  MOV     A,L
                 ;
                 ;       CHECK FOR END OF TRACK
                 ;
0044 FE11                CPI     17
0046 DA4C00              JC      LOAD3
0049 24                  INR     H
004A 2E00                MVI     L,0
```

```
011E C21801             JNZ     QLOOP   ;DO 16 TIMES
                ;
0121 118000             LXI     D,DMADDR
0124 CD0D02             CALL    SETDMA
                ;
0127 3E07               MVI     A,07H   ;1200 BAUD DATA
0129 D300               OUT     0
                ;
012B 3E18               MVI     A,18H
012D D306               OUT     6
012F 210001             LXI     H,0100H
0132 CD0602             CALL    SETUP
0135 21C103             LXI     H,03CLH
0138 CD0602             CALL    SETUP
013B 214404             LXI     H,0444H
013E CD0602             CALL    SETUP
0141 216805             LXI     H,0568H
0144 CD0602             CALL    SETUP
                ;
0147 115C00             LXI     D,FCB
014A CD1302             CALL    OPEN
014D 116002             LXI     D,NOFILE
0150 3C                 INR     A       ;WAS 255 IF NO FILE
0151 CAA201             JZ      DONE
                ;
0154 CDFC01     WTACK:  CALL    SIN     ;WAIT FOR INITIAL ACK
0157 FE06               CPI     ACK
0159 C25401             JNZ     WTACK
                ;
015C 3E00       RDNEXT: MVI     A,0
015E 328F02             STA     POINT   ;QUARTER SECTOR POINTER
                ;
0161 115C00             LXI     D,FCB
0164 CD1902             CALL    READ
0167 B7                 ORA     A
0168 C28B01             JNZ     EOF
                ;
0168 CDA801     AGAIN·  CALL    SEND    ;SEND 32 8YTES
                ;
016E CDFC01     WTANS:  CALL    SIN
0171 FE15               CPI     NAK
```

```
0173 CA6801            JZ      AGAIN     ;BAD CHECKSUM, SEND AGAIN
                ;
0176 FE06              CPI     ACK
0178 C26E01            JNZ     WTANS     ;IF NOT ACK, KEEP WAITING
                ;
0178 3A8F02            LDA     POINT     ;POINT TO QUARTER
017E C620              ADI     32
0180 328F02            STA     POINT
0183 FE80              CPI     128
0185 CA5C01            JZ      RDNEXT    ;IF 0, READ ANOTHER SECTOR
                ;
0188 C36B01            JMP     AGAIN     ;SEND NEXT QUARTER
                ;
0188 3E3A       EOF:   MVI     A,':'     ;OUTPUT START OF STRING
018D CDF001            CALL    SOUT
                ;
0190 3E30              MVI     A,'0'
0192 CDF001            CALL    SOUT
                ;
0195 3E30              MVI     A,'0'
0197 CDF001            CALL    SOUT
                ;
019A 3E0D              MVI     A.CR
019C CDF001            CALL    SOUT
                ;
019F 117A02            LXI     D,EOTRAN
                ;
01A2 CD1F02     DONE·  CALL    PRINT
01A5 C30000            JMP     BOOT
                ;
01A8 3E3A       SEND:  MVI     A,':'
01AA CDF001            CALL    SOUT
                ;
01AD 3E20              MVI     A,32
01AF CDD901            CALL    SHOUT     ;NUMBER OF DATA BYTES
                ;
01B2 0E00              MVI     C,0       ;CLEAR CHECKSUM
01B4 218000            LXI     H,DMADDR
01B7 3A8F02            LDA     POINT     ;POINT TO SECTOR QUARTER
01BA B5                ORA     L
01BB 6F                MOV     L,A       ,OR DATA INTO LSB
                ;
```

```
01BC 79          SEND1:  MOV     A,C     ;FORM CHECKSUM
01BD 86                  ADD     M
01BE 4F                  MOV     C,A
01BF 7E                  MOV     A,M     ;GET CHARACTER
                 ;
01C0 E5                  PUSH    H       ;SAVE ADDRESS
01C1 CDD901              CALL    SHOUT   ;OUTPUT HEX DIGITS
01C1 E1                  POP     H
                 ;
01C5 2C                  INR     L       ;NEXT BYTE
01C6 7D                  MOV     A,L
01C7 E61F                ANI     1FH     ;CHECK FOR MOD 32
01C9 C2BC01              JNZ     SEND1   ;DO 32 TIMES
                 ;
01CC 79                  MOV     A,C     ;FIX CHECKSUM
01CD EEFF                XRI     OFFH
01CF 3C                  INR     A
01D0 CDD901              CALL    SHOUT
                 ;
01D3 3E0D                MVI     A,0DH
01D5 CDF001              CALL    SOUT
01D8 C9                  RET
                 ;
01D9 F5          SHOUT:  PUSH    PSW
01DA 0F                  RRC
01DB 0F                  RRC
01DC 0F                  RRC
01DD 0F                  RRC
01DE CDE201              CALL    SNOUT   ;OUTPUT HIGH NIBBLE
                 ;
01E1 F1                  POP     PSW
01E2 E60F        SNOUT:  ANI     0FH     ;MASK OFF BITS
01E4 FE0A                CPI     10
01E6 DAEE01              JC      SNUM
01E9 C637                ADI     'A'-10
01EB C3F001              JMP     SOUT
                 ;
01EE C630        SNUM:   ADI     '0'
                 ;
01F0 F5          SOUT:   PUSH    PSW
01F1 DB06        SOUT1:IN        06H     ;XEROX CHANNEL A CONTROL
```

```
01F3 E604              ANI     04H
01F5 CAF101            JZ      SOUT1
                       ,
01F8 F1                POP     PSW
01F9 D304              OUT     04H         ;XEROX CHANNEL A DATA
01FB C9                RET
                       ;
01FC DB06    SIN:      IN      6
01FE E601              ANI     01H
0200 CAFC01            JZ      SIN
0203 DB04              IN      4
0205 C9                RET
                       ;
0206 7C      SETUP:    MOV     A,H
0207 D306              OUT     6
0209 7D                MOV     A,1
020A D306              OUT     6
020C C9                RET
                       ;
020D 0E1A    SETDMA:   MVI     C,26
020F CD0500            CALL    BDOS
0212 C9                RET
                       ;
0213 0E0F    OPEN:     MVI     C,15
0215 CD0500            CALL    BDOS
0218 C9                RET
                       ,
0219 0E14    READ:     MVI     C,20
0218 CD0500            CALL    BDOS
021E C9                RET
                       ;
021F 0E09    PRINT:    MVI     C,9
0221 CD0500            CALL    BDOS
0224 C9                RET
                       ;
0225 46494C454E NONAME:  DB    'FILENAME MUST BE SPECIFIED',0DH.0DH,'$'
                       ;
0242 414D424947 BADNAM:  D8    'AMBIGUOUS FILES NOT
                               ALLOWED',0DH,0DH,'$'
                       ;
0260 492043414E NOFILE:  DB    'I CANNOT FIND THAT FILE',0DH,0DH,'$'
                       ;
```

```
027A 5452414E53 EOTRAN:  DB      'TRANSFER COMPLETE.',0DH,0DH,'$'
                 ;
028F            POINT:   DS      1
                 ;
0290                     DS      32
02B0 =          STACK    EQU     $
```

I/O Configuration Utility for Commodore 64


```
FC00 =          IOMEM    EQU     0FC00H
F800 =          BUFFER   EQU     0F800H
FCFF =          IOTYPE   EQU     0FCFFH
FC10 =          FNBASE   EQU     0FC10H
FD00 =          KYBASE   EQU     0FD00H
0001 =          VICWR    EQU     1
F900 =          CMD      EQU     0F900H
F901 =          DATA     EQU     0F901H
F902 =          SECTOR   EQU     F902H
F903 =          TRACK    EQU     0F903H
F904 =          DISKNO   EQU     0F904H
F905 =          KYCHAR   EQU     0F905H
0033 =          KYBDMD   EQU     33H
0001 =          CRPOS    EQU     1
F28D =          SHFTST   EQU     0F28DH
0063 =          LASTKY   EQU     63H
0066 =          MSGPTR   EQU     66H
0009 =          CONINV   EQU     09H
0001 =          OFF      EQU     01H
CE00 =          MODESW   EQU     0CE00H
                 ;
0000 =          BOOT     EQU     0000H
0005 =          BDOS     EQU     0005H
000C =          CLS      EQU     0CH
000D =          CR       EQU     0DH
000A =          LF       EQU     0AH
0100                     ORG     100H
                 ;
```

```
0100 318308      START:  LXI     SP,STACK    ;INITIALIZE STACK PTR
0103 115E04              LXI     D,IOMSG
0106 CD7101              CALL    PRINT
                 ;
0109 3AFFFC              LDA     IOTYPE
010C E601                ANI     01H         ;# OF DISKS
010E C631                ADI     '1'         ;FORM ASCII
0110 5F                  MOV     E,A
0111 CD7601              CALL    CONOUT
                 ;
0114 11C204              LXI     D,PRTMSG
0117 CD7101              CALL    PRINT
                 ;
011A 11D604              LXI     D,P1515
011D 3AFFFC              LDA     IOTYPE
0120 E602                ANI     02H         ;CHECK PRINTER TYPE
                 ;
0122 CA2801              JZ      ST1         ;1515 IF=0
                 ;
0125 11DD04              LXI     D,P4022     ;4022 IF=1
                 ;
0128 CD7101      ST1:    CALL    PRINT
                 ;
0128 11E404              LXI     D,CAPMSG
012E CD7101              CALL    PRINT
                 ;
0131 11FB04              LXI     D,ONMSG     ;ASSUME ON
0134 3AFFFC              LDA     IOTYPE
0137 E620                ANI     20H         ;BIT 5
                 ;
0139 CA3F01              JZ      ST2
013C 110005              LXI     D,OFFMSG
                 ;
013F CD7101      ST2:    CALL    PRINT
                 ;
0142 110605              LXI     D,MENU
0145 CD7101              CALL    PRINT
                 ;
0148 CD7B01      ST3:    CALL    KEYIN
0148 FE31                CPI     '1'
014D CA9201              JZ      CHGDRV
                 ;
```

```
0150 FE32              CPI     '2'
0152 CA9D01            JZ      CHRPRT
                ;
0155 FE33              CPI     '3'
0157 CAB601            JZ      CHGCAP
                ;
015A FE34              CPI     '4'
015C CAC001            JZ      CHGFNC
                ;
015F FE35              CPI     '5'
0161 CACD02            JZ      CHGKEY
                ;
0164 FE36              CPI     '6'
0166 CA1A04            JZ      SAVDSK
                ;
0169 FE37              CPI     '7'
016B CA0000            JZ      BOOT
                ;
016E C34801            JMP     ST3     ;NOT A VALID RESPONSE
                ;
0171 0E09      PRINT:  MVI     C,9
0173 C30500            JMP     BDOS
                ;
0176 0E02      CONOUT: MVI     C,2
0178 C30500            JMP     BDOS
                ;
017B 1EFF      KEYIN:  MVI     E,0FFH
017D 0E06              MVI     C,6
017F C30500            JMP     BDOS
                ;
0182 2A0100    CONIN:  LHLD    BOOT+1
0185 2E09              MVI     L,CONINV
0187 E9                PCHL
                ;
0188 3200F9    IO6510: STA     CMD
018B 3E01              MVI     A,OFF
018D 3200CE            STA     MODESW
0190 00                NOP
0191 C9                RET
                ,
0192 3AFFFC    CHGDRV: LDA     IOTYPE
```

```
0195 EE01              XRI     01H
0197 32FFFC            STA     IOTYPE
019A C30001            JMP     START
                ;
019D 21FFFC    CHGPRT: LXI     H,IOTYPE
01A0 7E                MOV     A,M
01A1 E602              ANI     02H
01A3 CAAD01            JZ      CHGP1
                ;
01A6 7E                MOV     A,M     ;GET IOTYPE
01A7 E6F1              ANI     0F1H    ;CLEAR BITS FOR 1515 PRINTER
01A9 77                MOV     M,A
01AA C30001            JMP     START
                ;
01AD 7E        CHGP1:  MOV     A,M     ;GET IOTYPE
01AE E6FB              ANI     0FBH    ;CLEAR BIT 2
01B0 F60A              ORI     0AH     ;SET BITS FOR 4022 PRINTER
01B2 77                MOV     M,A
01B3 C30001            JMP     START
                ;
01B6 21FFFC    CHGCAP: LXI     H,IOTYPE
01B9 7E                MOV     A,M
01BA EE20              XRI     20H     ;INVERT BIT
01BC 77                MOV     M,A
01BD C30001            JMP     START
                ;
01C0 11707     CHGFNC: LXI     D,FNKMSG
01C3 CD7101            CALL    PRINT
                ;
01C6 3E00              MVI     A,0
01C8 325F08            STA     KYMODE
01CB 11A007    FNNEXT: LXI     D,FM1
01CE CD7101            CALL    PRINT
01D1 3A5F08            LDA     KYMODE
01D4 C631              ADI     '1'
01D6 5F                MOV     E,A
01D7 CD7601            CALL    CONOUT
01DA 11A407            LXI     D,FM2
01DD CD7101            CALL    PRINT
                ;
01E0 CDA802            CALL    CALCAD
                ;
```

```
01E3 7E          FN2      MOV     A,M
01E4 23                   INX     H
01E5 FE20                 CPI     20H
01E7 DAF301               JC      CONTRL
                  ;
01EA 5F                   MOV     E,A
01EB E5                   PUSH    H
01EC CD7601               CALL    CONOUT
01EF E1                   POP     H
01F0 C3E301               JMP     FN2
                  ;
01F3 F5          CONTRL.  PUSH    PSW
01F4 1E22                 MVI     E,'"'
01F6 CD7601               CALL    CONOUT
01F9 F1                   POP     PSW
01FA FE00                 CPI     0
01FC CA0502               JZ      CRLF
                  ;
01FF 11A907               LXI     D,CRM
0202 CD7101               CALL    PRINT
0205 11AE07      CRLF:    LXI     CD,CRLFM
0208 CD7101               CALL    PRINT
                  ;
020B 215F08               LXI     H,KYMODE
020E 34                   INR     M
020F 7E                   MOV     A,M
0210 FE08                 CPI     8
0212 C2CB01               JNZ     FNNEXT
                  ;
0215 11B107               LXI     D,FNINST
0218 CD7101               CALL    PRINT
                  ,
021B CD7B01      ASKAGN.  CALL    KEYIN
021E D631                 SUI     '1'
0220 DA1B02               JC      ASKAGN
                  ;
0223 FE08                 CPI     8
025  CA0001               JZ      START
0228 D21B02               JNC     ASKAGN
                  ;
022B 325F08               STA     KYMODE
                  ;
```

```
022E 111C08            LXI     D,FM3
0231 CD7101            CALL    PRINT
                ;
0234 11A007            LXI     D,FM1
0237 CD7101            CALL    PRINT
                ;
023A 3A5F08            LDA     KYMODE    ;GET CURRENT FN #
023D C631              ADI     '1'       ;FORM ASCII
023F 5F                MOV     E,A
0240 CD7601            CALL    CONOUT
0243 11A407            LXI     D,FM2
0246 CD7101            CALL    PRINT
0249 CDA802            CALL    CALCAD
024C 225D08            SHLD    KYADDR
                ;
024F 3E00              MVI     A,0
0251 326208            STA     NUMCHR
                ,
0254 CD7B01    INLOOP: CALL    KEYIN
0257 FE0D              CPI     0DH
0259 CA8502            JZ      ITSCR
                ;
025C FE08              CPI     08H
025E CAB902            JZ      ITS8S
                ;
0261 FE1A              CPI     1AH
0263 CA9102            JZ      ITSCZ
                ;
0266 FE20              CPI     20H
0268 DA5402            JC      INLOOP
                ;
026B FE80              CPI     80H
026D D25402            JNC     INLOOP
                ;
0270 47                MOV     B,A       ,SAVE CHAR
0271 3A6208            LDA     NUMCHR
0274 FE0F              CPI     15        ;IF ALREADY 15 CHAR,
0276 D25402            JNC     INLOOP    ; NO ROOM FOR 00H
                ;
0279 C5                PUSH    B
027A 58                MOV     E,B
```

```
027B CD7601            CALL    CONOUT
027E C1                POP     B
                       ;
027F CD9902            CALL    OUTPUT
0282 C35402            JMP     INLOOP      ,GO FOR MORE
                       ;
0285 47        ITSCR:  MOV     B,A         ;SAVE CHAR
0286 3A6208            LDA     NUMCHR
0289 FE0F              CPI     15          ;NO ROOM IF 15 CHAR
028B D25402            JNC     INLOOP
                       ;
028E CD9902            CALL    OUTPUT
                       ;
0291 0600      ITSCZ:  MVI     B,0
0293 CD9902            CALL    OUTPUT
0296 C3C001            JMP     CHGFNC
                       ,
0299 2A5D08    OUTPUT. LHLD    KYADDR
029C 3A6208            LDA     NUMCHR
029F 3C                INR     A
02A0 326208            STA     NUMCHR
02A3 3D                DCR     A
02A4 85                ADD     L           ;ADD IN OFFSET
02A5 6F                MOV     L,A
02A6 70                MOV     M,B
02A7 C9                RET
                       ;
02A8 2110FC    CALCAD: LXI     H,FNBASE
02AB 1600              MVI     D,0
02AD 3A5F08            LDA     KYMODE
02B0 17                RAL
02B1 17                RAL
02B2 17                RAL
02B3 17                RAL
02B4 E6F0              ANI     0F0H
02B6 5F                MOV     E,A
02B7 19                DAD     D
02B8 C9                RET
                       ;
02B9 3A6208    ITSBS:  LDA     NUMCHR
02BC FE00              CPI     0
```

```
02BE CA5402            JZ      INLOOP      ;IF 0 JUST GO TO LOOP
                       ;
02C1 3D                DCR     A
02C2 326208            STA     NUMCHR
02C5 326208            STA     NUMCHR
02C5 1E08              MVI     E,08H       ,BACKSPACE
02C7 CD7601            CALL    CONOUT
02CA C35402            JMP     INLOOP
                       ,
                       ,
                       ;
02CD 114306  CHGKEY.   LXI     D,KYINST
02D0 CD7101            CALL    PRINT
                       ;
02D3 112F07  CK0.      LXI     D,PRSMSG
02D6 CD7101            CALL    PRINT
                       ,
02D9 CD8201            CALL    CONIN
02DC 2A0100            LHLD    BOOT+1
02DF 2E33              MVI     L,KYBDMD    ,UNSHIFT=0, CAPS=1
02E1 46                MOV     B,M
02E2 3A8DF2            LDA     SHFTST      ,GET MODIFIER STATUS
02E5 E601              ANI     01H         ;IS SHIFT KEY DOWN?
02E7 CAEC02            JZ      CK1         ;JUMP IF NO
                       ;
02EA 0602              MVI     B,2         ;SHIFT=2
02EC 3A8DF2  CK1.      LDA     SHFTST
02EF E604              ANI     04H         ;IS THE CONTROL KEY DOWN?
02F1 CAF602            JZ      CK2         ,JUMP IF NO
                       ;
02F4 0603              MVI     B,3         ;CONTROL=3
02F6 2A0100  CK2.      LHLD    BOOT+1
02F9 2E63              MVI     L,LASTKY
02FB 7E                MOV     A,M
02FC 326008            STA     KYCHK       ;SAVE FOR EXIT TEST
02FF 87                ADD     A           ;*2
0300 87                ADD     A           ;*4
0301 80                ADD     B           ;ADD IN OFFSET
0302 2100FD            LXI     H,KY8ASE
0305 85                ADD     L
0306 6F                MOV     L,A         ;HL NOW HAS ADDRESS OF KEY
                       ;
```

```
0307 225D08            SHLD    KYADDR    ;ADDRESS OF KEY
030A 78                MOV     A,B       ,8 IS THE MODE
030B 325F08            STA     KYMODE
                ;
030E 2A0100            LHLD    BOOT + 1
0311 2E66              MVI     L,MSGPTR
0313 3600              MVI     M,0
0315 23                INX     H
0316 3600              MVI     M,0       ,DISABLE MESSAGE MODE IF ANY
                ;
0318 113C07            LXI     D,ISMSG
031B CD7101            CALL    PRINT
                ;
031E 2A5D08            LHLD    KYADDR
0321 7E                MOV     A,M       ;GET KEY CODE
0322 CD6A03            CALL    PHEX      , AND PRINT IN HEX
                ;
0325 114107            LXI     D,INMSG
0328 CD7101            CALL    PRINT
                ;
032B 3A5F08            LDA     KYMODE
032E 115E07            LXI     D,UNSH    ;UNSHIFT MODE IF 0
0331 FE00              CPI     0
0333 CA4903            JZ      PMODE
                ;
0336 114607            LXI     D,CAPS
0339 FE01              CPI     1
033B CA4903            JZ      PMODE     ;CAPS MODE IF 1
                ,
033E 114E07            LXI     D,SHIFT
0341 FE02              CPI     2
0343 CA4903            JZ      PMODE     ;SHIFT MODE IF 2
                ,
0346 115607            LXI     D,CONT    ,MUST BE CONTROL MODE
                ;
0349 CD7101    PMODE:  CALL    PRINT
                ,
034C 116607            LXI     D,MODE
034F CD7101            CALL    PRINT
                ;
0352 CD8603            CALL    GHEX
                ;
```

```
0355 C26303            JNZ     ASGKEY
                ;
0358 3A6008            LDA     KYCHK     ,NO CHARACTERS, 2 CR'S?
035B FE01              CPI     CRPOS     ,IS IT CR KEY POSITION?
035D CA0001            JZ      START     ;RESTART IF 2 CR'S
                ;
0360 C3D302            JMP     CK0       ;NEXT KEY
0363 2A5D08  ASGKEY.   LHLD    KYADDR
0366 77                MOV     M,A       ;PUT NEW CHARACTER IN
                                         MEMORY
0367 C3D302            JMP     CK0
                ;
036A F5      PHEX:     PUSH    PSW       ;SAVE CHARACTER
036B 0F                RRC
036C 0F                RRC
036D 0F                RRC
036E 0F                RRC
036F CD7303            CALL    HEX       ;PRINT TOP NIBBLE
                ;
0372 F1                POP     PSW       ;PRINT LOWER NIBBLE
                ;
0373 E60F    HEX:      ANI     0FH       ;4 BITS
0375 FE0A              CPI     10        ;LETTER OR NUMBER?
0377 DA8003            JC      NUM8ER
                ;
037A C637              ADI     'A'-10    ;MAKE HEX LETTER
037C fF                MOV     E,A
037D C37601            JMP     CONOUT
                ;
0380 C630    NUMBER.   ADI     '0'       ,MAKE ASCII NUMBER
0382 5F                MOV     E,A
0383 C37601            JMP     CONOUT
                ;
0386 3E00    GHEX:     MVI     A,0
0388 326208            STA     NUMCHR
                ;
038B CD8201  GH0:      CALL    CONIN
038E FE0D              CPI     0DH
0390 C2A503            JNZ     GH1
                ;
0393 3A6208            LDA     NUMCHR
```

```
0396 FE00           CPI   0
0398 C8             RZ
                    ;
0399 FE02           CPI   2
039B C28B03         JNZ   GH0
                    ;
039E 3EFF           MVI   A,0FFH
03A0 A7             ANA   A
03A1 3A6108         LDA   HEXIN
03A4 C9             RET
                    ;
03A5 FE08     GH1:  CPI   08H
03A7 C2CA03         JNZ   GH4     ,JUMP NOT 8ACKSPACE
                    ,
03AA 3A6208         LDA   NUMCHR
03AD FE00           CPI   0
03AF CA8B03         JZ    GH0
                    ;
03B2 3D             DCR   A
03B3 326208         STA   NUMCHR
03B6 3A6108         LDA   HEXIN
03B9 0F             RRC
03BA 0F             RRC
03BB 0F             RRC
03BC 0F             RRC
03BD E60F           ANI   0FH
03BF 326108         STA   HEXIN
03C2 1E08           MVI   E 08H
03C4 CD7601         CALL  CONOUT
03C7 C38B03         JMP   GH0
                    ;
03CA 47       GH4:  MOV   B,A
03CB 3A6208         LDA   NUMCHR
03CE FE02           CPI   2
03D0 CA8B03         JZ    GH0
                    ;
03D3 78             MOV   A,B
03D4 FE30           CPI   '0'
03D6 DA8B03         JC    GH0
03D9 FE3A           CPI   '9'+1
03DB DAFF03         JC    GOTNUM
                    ;
```

```
03DE FE41              CPI     'A'
03E0 DA8803            JC      GH0
                ;
03E3 FE47              CPI     'F'+1
03E5 DAF203            JC      GOTLET
                ;
03E8 FE61              CPI     'A'
03EA DA8803            JC      GH0
                ;
03ED FE67              CPI     'F'+1
03EF D28803            JNC     GH0
                ;
03F2 F5      GOTLET    PUSH    PSW
03F3 5F                MOV     E,A
03F4 CD7601            CALL    CONOUT
03F7 F1                POP     PSW
03F8 E60F              ANI     OFH
03FA C609              ADI     9
03FC C30504            JMP     MAKNUM
                ;
03FF F5      GOTNUM.   PUSH    PSW
0400 5F                MOV     E,A
0401 CD7601            CALL    CONOUT
0404 F1                POP     PSW
                ;
0405 E60F    MAKNUM:   ANI     0FH
0407 47                MOV     B,A
0408 3A6108            LDA     HEXIN
0408 87                ADD     A
040C 87                ADD     A
040D 87                ADD     A
040E 87                ADD     A
040F 80                ADD     B
0410 326108            STA     HEXIN
                ;
0413 216208            LXI     H,NUMCHR
0416 34                INR     M
0417 C38803            JMP     GH0
                ;
                ;
                ;
```

```
041A 2100FC    SAVDSK  LXI     H,IOMEM
041D 3E03              MVI     A,3
041F 3202F9            STA     SECTOR
0422 1100F8    SAV2:   LXI     D,BUFFER
               ;
0425 7E        SAV1:   MOV     A,M
0426 12                STAX    D
0427 23                INX     H
0428 13                INX     D
0429 7D                MOV     A,L
042A A7                ANA     A
042B C22504            JNZ     SAV1    ;256 TIMES
               ;
042E 3E00              MVI     A,0
0430 3204F9            STA     DISKNO
               ;
0433 3C                INR     A
0434 3203F9            STA     TRACK
               ;
0437 3E01              MVI     A,VICWR
0439 CD8801            CALL    IO6510
043C 3A01F9            LDA     DATA
043F A7                ANA     A
0440 C25204            JNZ     WRERR
               ;
0443 3A02F9            LDA     SECTOR
0446 3C                INR     A
0447 3202F9            STA     SECTOR
044A FE05              CPI     5
044C C22204            JNZ     SAV2    ;WRITE SECTORS 3 AND 4
               ;
044F C30001            JMP     START
               ,
0452 111306    WRERR:  LXI     D,WERMSG
0455 CD7101            CALL    PRINT
0458 CD8201            CALL    CONIN
045B C30001            JMP     START
               ;
               ,
               ;       MESSAGES
               ,
```

```
045E 0C0A434F4D IOMSG:  DB      CLS,LF,'COMMODORE 64 I/O CONFIGURATION
                                UTILITY' CR,LF,LF
0489 5448452043         DB      'THE CURRENT I/O ASSIGNMENTS
                                ARE:',CR,LF,LF
04AC 20204E554D         DB      ' NUMBER OF DRIVES. $'

04C2 0D0A       PRTMSG: DB      CR,LF
04C4 2020505249         DB      ' PRINTER TYPE: $'
                ;
04D6 313531350D P1515:  DB      '1515',CR,LF,'$'
04DD 343032320D P4022   DB      '4022',CR,LF,'$'
                ;
04E4 2020494E49 CAPMSG: DB      ' INITIAL CAPS MODE. $'
                ;
04FB 4F4E0D0A24 ONMSG   DB      'ON',CR,LF,'$'
0500 4F46460D0A OFFMSG: DB      'OFF',CR,LF,'$'
                ;
0506 0A0A       MENU.   DB      LF,LF
0508 444F20594F         DB      'DO YOU WISH TO:',CR,LF,LF
051A 2020312E20         DB      ' 1. CHANGE NUMBER OF DISK DRIVES',CR,LF
053E 2020322E20         DB      ' 2. CHANGE PRINTER TYPE',CR,LF
0559 2020332E20         DB      ' 3. CHANGE INITIAL CAPS MODE',CR,LF
0579 2020342E20         DB      ' 4. CHANGE FUNCTION KEY
                                ASSIGNMENTS',CR,LF
05A0 2020352E20         DB      ' 5. CHANGE KEY CODES',CR,LF
05BB 2020362E20         DB      ' 6  SAVE CURRENT I/O SETUP ON DISK',CR,LF
05DE 2020372E20         DB      ' 7. RETURN TO CP/M',CR,LF,LF
05F5 504C454153         DB      'PLEASE ENTER SELECTION (1-7) $'
                ;
0613 0D0A0A4449 WERMSG: DB      CR,LF,LF,'DISK WRITE ERROR',CR,LF
0628 5052455353         DB      'PRESS ANY KEY TO CONTINUE $'
0643 0C0A       KYINST: DB      CLS,LF
0645 5052455353         DB      'PRESS KEY TO EXAMINE KEY CODE',CR,LF,LF
0665 544F204348         DB      'TO CHANGE KEY CODE, ENTER DATA
                                IN',CR,LF
06B8 2020204845         DB      ' HEXADECIMAL AFTER "CHANGE
                                TO" ',CR,LF,LF
06AB 544F204558         DB      'TO EXIT KEY CODE MODE, TYPE
                                "RETURN" ',CR,LF
06D1 2020205457         DB      ' TWICE AFTER "PRESS KEY" ',CR,LF,LF
06EE 544F204B45         DB      'TO KEEP CURRENT KEY CODE, TYPE',CR,LF
```

```
070E 2020202252          DB      ' "RETURN" AFTER "CHANGE TO" ',CR,LF,LF
072E 24                  DB      '$'
                         ;
072F 0D0A505245 PRSMSG:  DB      CR,LF,'PRESS KEY $'
                         ;
073C 0D49532024 ISMSG:   DB      CR,'IS $'
                         ;
0741 20494E2024 INMSG:   DB      ' IN $'
0746 4341505320 CAPS     DB      'CAPS $'
074E 534849465  SHIFT:   DB      'SHIFT $'
0756 434F4E5452 CONT.    DB      'CONTROL$'
075E 554E534849 UNSH:    DB      'UNSHIFT$'
0766 204D4F4445 MODE.    DB      ' MODE — CHANGE TO $'
                         ;
0779 0C0A544845 FNKMSG:  DB      CLS,LF,'THE FUNCTION KEY ASSIGNMENTS
                                 ARE ',CR,LF,LF
079F 24                  DB      '$'
07A0 20204624   FM1      DB      ' F$'
                         ;
07A4 3A20202224 FM2      DB      ': "$'
                         ;
07A9 3C43523E24 CRM      DB      '<CR>$'
07AE 0D0A24     CRLFM    DB      CR,LF,'$'
                         ;
07B1 0A454E5445 FNINST   DB      LF,'ENTER FUNCTION KEY NUMBER
                                 (1-8) ',CR,LF
07D3 2020544F20          DB      'TO CHANGE PRESET VALUES.',CR,LF,LF
07F0 454E544552          DB      'ENTER 9 TO LEAVE FUNCTION',CR,LF
080B 20204B4559          DB      ' KEY UTILITY. $'
                         ;
081C 0D0A0A5459 FM3      DB      CR,LF.LF,'TYPE IN TEXT. USING
                                 "RETURN" ',CR,LF
083D 20204F5220          DB      ' OR "CTRL-Z" AS TERMINATOR.',CR,LF,LF,'$'
                         ;
085D             KYADDR  DS      2       ;KEYBOARD LOOKUP ADDRESS
085F             KYMODE  DS      1       ;KEYBOARD MODE
0860             KYCHK   DS      1
0861             HEXIN   DS      1
0862             NUMCHR  DS      1
0863                     DS      32
0883 =           STACK   EQU     $
```

System Generation Program, Version for MDS

Modified for use on Commodore 64. The system sectors run linearly from Track 1 Sector to Track 2 Sector 16.

```
0022 =          NSECTS  EQU     34          ,NO. OF SECTORS PER TRACK
0002 =          NTRKS   EQU     2           ;LAST OS TRACK + 1
0003 =          NDISKS  EQU     3           ;NUMBER OF DISK DRIVES
0080 =          SECSIZ  EQU     128         ,SIZE OF EACH SECTOR
0007 =          LOG2SEC EQU     7           ,LOG 2 SECSIZ
0001 =          SKEW    EQU     1           ,SECTOR SKEW FACTOR
                ,
005C =          FCB     EQU     005CH       ;DEFAULT FCB LOCATION
007C =          FCBCR   EQU     FCB+32      ;CURRENT RECORD LOCATION
0100 =          TPA     EQU     0100H       ,TRANSIENT PROGRAM AREA
0900 =          LOADP   EQU     900H        ;LOAD POINT FOR SYSTEM
                                            DURING LOAD/STORE
0005 =          BDOS    EQU     5H          ;DOS ENTRY POINT
0000 =          BOOT    EQU     0           ;JMP TO 'BOOT' TO REBOOT
                                            SYSTEM
0001 =          CONI    EQU     1           ;CONSOLE INPUT FUNCTION
0002 =          CONO    EQU     2           ;CONSOLE OUTPUT FUNCTION
000E =          SELF    EQU     14          ;SELECT DISK
000F =          OPENF   EQU     15          ,DISK OPEN FUNCTION
0014 =          DREADF  EQU     20          ;DISK READ FUNCTION

000A =          MAXTRY  EQU     10          ;MAXIMUM NUMBER OF RETRIES
                                            ON EACH READ/WRITE
000D =          CR      EQU     0DH         ,CARRIAGE RETURN
000A =          LF      EQU     0AH         ,LINE FEED
0010 =          STACKSIZE EQU   16          ,SIZE OF LOCAL STACK
                ;
0001 =          WBOOT   EQU                 1
```

```
                        ;
                                                    ,ADDRESS OF WARM BOOT
                                                    (OTHER PATCH ENTRY
                        ;                           POINTS ARE COMPUTED RELATIVE
                                                    TO WBOOT)
0018  =         SELDSK  EQU     24          ;WBOOT + 24 FOR DISK SELECT
001B  =         SETTRK  EQU     27          ,WBOOT + 27 FOR SET TRACK
                                            FUNCTION
001E  =         SETSEC  EQU     ,,130       ,WBOOT + 30 FOR SET SECTOR
                                            FUNCTION
0021  =         SETDMA  EQU     33          ,WBOOT + 33 FOR SET DMA
                                            ADDRESS
0024  =         READF   EQU     36          ;WBOOT + 36 FOR READ
                                            FUNCTION
0027  =         WRITF   EQU     39          ,WBOOT + 39 FOR WRITE
                                            FUNCTION
                        ;
0100                    ORG     TPA         ;TRANSIENT PROGRAM AREA
0100  C32302            JMP     START
0103  434F505952        DB      'COPYRIGHT @ 1978, DIGITAL RESEARCH '
                        ,
0128  02        OST     DB      NTRKS       ,OPERATING SYSTEM TRACKS
0129  22        SPT:    DB      NSECTS      ,SECTORS PER TRACK (CAN BE
                                            PATCHED)
                        ;
                        GETCHAR:
                        ;       READ CONSOLE CHARACTER TO REGISTER A
012A  0E01CD0500        MVI C,CONIT ' CALL BDOS'
                        ;       CONVERT TO UPPER CASE BEFORE RETURN
012F  FE61D8            CPI 'A' OR 20H ! RC  ;RETURN IF BELOW LOWER CASE A
0132  FE78              CPI ('Z' OR 20H) + 1
0134  D0                RNC     ;RETURN IF ABOVE LOWER CASE Z
0135  E65FC9            ANI 5FH! RET
                        ;
                        PUTCHAR.
                        ;       WRITE CHARACTER FROM A TO CONSOLE
013B  5F0E02CD05        MOV E,A! MVI C,CONO! CALL BDOS! RET
                        ,
                        CRLF·   ;SEND CARRIAGE RETURN, LINE FEED
013F  3E0D              MVI     A,CR
0141  CD3801            CALL    PUTCHAR
0144  3E0A              MVI     A,LF
```

```
0146 CD3801            CALL    PUTCHAR
0149 C9                RET
                ;
                CRMSG:  ;PRINT MESSAGE ADDRESSED BY H,L TIL ZERO
                        ;WITH LEADING CRLF
014A E5CD3F01E1        PUSH H! CALL CRLF! POP H
                                        ;DROP THRU TO OUTMSG0
                OUTMSG:
014F 7EB7C8            MOV A,M! ORA A! RZ
                ;       MESSAGE NOT YET COMPLETED
0152 E5CD3801E1        PUSH H! CALL PUTCHAR! POP H! INX H
015B C34F01            JMP     OUTMSG
                ;
                SEL:
                ;       SELECT DISK GIVEN BY REGISTER A
015B 4F2A010011        MOV C,A! LHLD WBOOT! LXI D,SELDSK! DAD D! PCHL
                ;
                TRK:    ;SET UP TRACK
0164 2A0100            LHLD    WBOOT   ;ADDRESS OF BOOT ENTRY
0167 111B00            LXI     D,SETTRK ;OFFSET FOR SETTRK ENTRY
016A 19                DAD     D
016B E9                PCHL            ;GONE TO SETTRK
                ;
                SEC:    ;SET UP SECTOR NUMBER
016C 2A0100            LHLD    WBOOT
016F 111E00            LXI     D,SETSEC
0172 19                DAD     D
0173 E9                PCHL
                ;
                DMA:    ;SET DMA ADDRESS TO VALUE OF B,C
0174 2A0100            LHLD    WBOOT
0177 112100            LXI     D,SETDMA
017A 19                DAD     D
017B E9                PCHL
                ;
                READ:   ;PERFORM READ OPERATION
017C 2A0100            LHLD    WBOOT
017F 112400            LXI     D,READF
0182 19                DAD     D
0183 E9                PCHL
                ;
                WRITE:  ;PERFORM WRITE OPERATION
```

```
0184 2A0100            LHLD    WBOOT
0187 112700            LXI     D,WRITF
018A 19                DAD     D
018B 0E00              MVI     C,0         ,SET UP NORMAL SECTOR WRITE
018D E9                PCHL
                ;
                DREAD:  ;DISK READ FUNCTION
018E 0E14              MVI     C,DREADF
0190 C30500            JMP     BDOS
                ;
                OPEN:   ,FILE OPEN FUNCTION
0193 0E0FC30500        MVI C,OPENF ! JMP BDOS
                ;
                GETPUT
                ,       GET OR PUT CP/M (RW=0 FOR READ, 1 FOR WRITE)
                ;       DISK IS ALREADY SELECTED
                ,
0198 21B008            LXI     H,LOADP-80H  ;SET UP INITIAL DMADDR
019B 225204            SHLD
                ,
                ;       CLEAR TRACK TO 00
019E 3E00              MVI     A,0         ;START WITH TRACK 0+1
01A0 324F04            STA     TRACK
01A3 4F                MOV     C,A
01A4 CD6401            CALL    TRK         ,TRACK NUMBER TO BIOS
01A7 3E09              MVI     A,9         ,SECTOR 10 (-1)
01A9 325004            STA     SECTOR
01AC C3C301            JMP     RWSEC
                ;
                RWTRK:  ;READ OR WRITE NEXT TRACK
01AF 214F04            LXI     H,TRACK
01B2 34                INR     M           ,TRACK = TRACK + 1
01B3 3A2801            LDA     OST         ;NUMBER OF OPERATING SYSTEM
                                           TRACKS
01B6 BE                CMP     M           ;= TRACK NUMBER ?
01B7 CA2202            JZ      ENDRW       ;END OF READ OR WRITE
                ,
                ,       OTHERWISE NOTDONE, GO TO NEXT TRACK
01BA 4E                MOV     C,M         ,TRACK NUMBER
01BB CD6401            CALL    TRK         ;TO SET TRACK
01BE 3EFF              MVI     A,0FFH      ,COUNTS 0, 1, . .  33
```

```
01C0 325004          STA     SECTOR    ,SECTOR INCREMENTED BEFORE
                                       READ OR WRITE
                     ;
                RWSEC:  ;READ OR WRITE SECTOR
01C3 3A2901          LDA     SPT       ;SECTORS PER TRACK
01C6 215004          LXI     H,SECTOR
01C9 34              INR     M         ;TO NEXT SECTOR
01CA BE              CMP     M         ;A=34 AND M=0 1 2    . 33
                                       (USUALLY)
01CB CAAF01          JZ      RWTRK     ;
01CE 2A5204          LHLD    DMADDR    ;SET UP DMA FOR NEXT ADDR
01D1 118000          LXI     D,80H     ,SECTOR SIZE
01D4 19              DAD     D         ,DMADDR=DMADDR+80H
01D5 225204          SHLD    DMADDR
                     ;
                     ;       READ OR WRITE SECTOR TO OR FROM CURRENT DMA
                             ADDR
01D8 215004          LXI     H,SECTOR
01DB 4E              MOV     C,M       ;VALUE TO C READY FOR SELECT
01DC CD6C01          CALL    SEC       ,SET UP SECTOR NUMBER
01DF 2A5204          LHLD    DMADDR    :BASE DMA ADDRESS FOR THIS
                                       TRACK
01E2 44              MOV     B,H
01E3 4D              MOV     C,L       ;TO BC FOR SEC CALL
01E4 CD7401          CALL    DMA       ,DMA ADDRESS SET FROM B,C
                     ;       DMA ADDRESS SET, CLEAR RETRY COUNT
01E7 AF              XRA     A
01EB 325404          STA     RETRY     ;SET TO ZERO RETRIES
                     ,
                TRYSEC: ;TRY TO READ OR WRITE CURRENT SECTOR
01EB 3A5404          LDA     RETRY
01EE FE0A            CPI     MAXTRY    ;TOO MANY RETRIES?
01F0 DA0702          JC      TRYOK
                     ;
                     ;       PAST MAXTRIES, MESSAGE AND IGNORE
01F3 21C303          LXI     H ERRMSG
01F6 CD4F01          CALL    OUTMSG
01F9 CD2A01          CALL    GETCHAR
01FC FE0D            CPI     CR
01FE C20E03          JNZ     REBOOT
                     ;
```

```
                        ,       TYPED A CR, OK TO IGNORE
0201 CD3F01             CALL    CRLF
0204 C3C301             JMP     RWSEC
                ;
                TRYOK:
                ;       OK TO TRY READ OR WRITE
0207 3C                 INR     A
0208 325404             STA     RETRY       ,READY = RETRY + 1
020B 3A5104             LDA     RW          ;READ OR WRITE?
020E B7                 ORA     A
020F CA1802             JZ      TRYREAD
                ;
                ,       MUST BE WRITE
0212 CD8401             CALL    WRITE
0215 C31B02             JMP     CHKRW       ;CHECK FOR ERROR RETURNS
                TRYREAD:
0218 CD7C01             CALL    READ
                CHKRW:
021B B7                 ORA     A
021C CAC301             JZ      RWSEC       ;ZERO FLAG IF R/W OK
                ;
                ;       ERROR, RETRY OPERATION
021F C3EB01             JMP     TRYSEC
                ;
                ;
                ENDRW.  ;END OF READ OR WRITE, RETURN TO CALLER
0222 C9                 RET
                ;
                ;
                START.
                ;
0223 317504             LXI     SP,STACK    ;SET LOCAL STACK POINTER
0226 212003             LXI     H,SIGNON
0229 CD4F01             CALL    OUTMSG
                ,
                ;       CHECK FOR DEFAULT FILE LOAD INSTEAD OF GET
                ,
022C 3A5D00             LDA     FCB+1       ;BLANK IF NO FILE
022F FE20               CPI     ' '
0231 CA8102             JZ      GETSYS      ;SKIP TO GET SYSTEM MESSAGE
                                            IF BLANK
```

```
0234 115C00            LXI     D,FCB       ;TRY TO OPEN IT
0237 CD9301            CALL    OPEN        ;
023A 3C                INR     A           ,255 BECOMES 00
023B C24702            JNZ     RDOK        ;OK TO READ IF NOT 255
                       ,
                       ;       FILE NOT PRESENT, ERROR AND REBOOT
                       ,
023E 212004            LXI     H,NOFILE
0241 CD4A01            CALL    CRMSG
0244 C30E03            JMP     REBOOT
                       ;
                       ,       FILE PRESENT
                       ,       READ TO LOAD POINT
                       ;
                       RDOK:
0247 AF                XRA     A
0248 327C00            STA     FCBCR       ,CURRENT RECORD = 0
                       ,
                       ,       PRE-READ AREA FROM TPA TO LOADP
                       ,
024B 0E10              MVI     C,(LOADP-TPA)/SECSIZ
                       ,       PRE-READ FILE
                       PRERD
024D C5                PUSH    B           ,SAVE COUNT
024E 115C00            LXI     D,FCB       ;INPUT FILE CONTROL COUNT
0251 CD8E01            CALL    DREAD       ;ASSUME SET TO DEFAULT BUFFER
0254 C1                POP     B           ;RESTORE COUNT
0255 B7                ORA     A
0256 C27B02            JNZ     BADRD       ,CANNOT ENCOUNTER END-OF
                                           FILE
0259 0D                DCR     C           ;COUNT DOWN
025A C24D02            JNZ     PRERD       ;FOR ANOTHER SECTOR
                       ;
                       ;       SECTORS SKIPPED AT BEGINNING OF FILE
                       ;
025D 210009            LXI     H,LOADP
                       RDINP:
0260 E5                PUSH    H
0261 44                MOV     B,H
0262 4D                MOV     C,L         ;READY FOR DMA
0263 CD7401            CALL    DMA         ;DMA ADDRESS SET
```

```
0266 115C00          LXI     D,FCB       ;READY FOR READ
0269 CD8E01          CALL    DREAD       ;
026C E1              POP     H           ;RECALL DMA ADDRESS
026D B7              ORA     A           ;00 IF READ OK
026E C2C702          JNZ     PUTSYS      ,ASSUME EOF IF NOT.
                ;    MORE TO READ, CONTINUE
0271 118000          LXI     D,SECSIZ
0274 19              DAD     D           ;HL IS NEW LOAD ADDRESS
0275 C36002          JMP     RDINP
                ;
                BADRD:  ,EOF ENCOUNTERED IN INPUT FILE
0278 213704          LXI     H,BADFILE
027B CD4A01          CALL    CRMSG
027E C30E03          JMP     REBOOT
                ;
                ;
                GETSYS·
0281 212F03          LXI     H,ASKGET    ;GET SYSTEM?
0284 CD4A01          CALL    CRMSG
0287 CD2A01          CALL    GETCHAR
028A FE0D            CPI     CR
028C CAC702          JZ      PUTSYS      ;SKIP IF CR ONLY
                ;
028F D641            SUI     'A'         ;NORMALIZE DRIVE NUMBER
0291 FE03            CPI     NDISKS      ;VALID DRIVE?
0293 DA9C02          JC      GETC        ;SKIP TO GETC IF SO
                ;
                ;    INVALID DRIVE NUMBER
0296 CD1903          CALL    BADDISK
0299 C38102          JMP     GETSYS      ;TO TRY AGAIN
                ;
                GETC
                ;    SELECT DISK GIVEN BY REGISTER A
029C C641            ADI     'A'
029E 325F03          STA     GDISK       ;TO SET MESSAGE
02A1 D641            SUI     'A'
02A3 CD5B01          CALL    SEL         ;TO SELECT THE DRIVE
                ;    GETSYS, SET RW TO READ AND GET THE SYSTEM
02A6 CD3F01          CALL    CRLF
02A9 215503          LXI     H,GETMSG
02AC CD4F01          CALL    OUTMSG
```

```
02AF CD2A01             CALL    GETCHAR
02B2 FE0D               CPI     CR
02B4 C20E03             JNZ     REBOOT
02B7 CD3F01             CALL    CRLF
                ;
02BA AF                 XRA     A
02BB 325104             STA     RW
02BE CD9801             CALL    GETPUT
02C1 21EA03             LXI     H,DONE
02C4 CD4F01             CALL    OUTMSG
                ;
                ;       PUT SYSTEM
                PUTSYS:
02C7 217303             LXI     H,ASKPUT
02CA CD4A01             CALL    CRMSG
02CD CD2A01             CALL    GETCHAR
02D0 FE0D               CPI     CR
02D2 CA0E03             JZ      REBOOT
02D5 D641               SUI     'A'
02D7 FE03               CPI     NDISKS
02D9 DAE202             JC      PUTC
                ;
                ,       INVALID DRIVE NAME
02DC CD1903             CALL    BADDISK
02DF C3C702             JMP     PUTSYS      ,TO TRY AGAIN
                ;
                PUTC.
                ;       SET DISK FROM REGISTER C
02E2 C641               ADI     'A'
02E4 32AF03             STA     PDISK       ;MESSAGE SET
02E7 D641               SUI     'A'
02E9 CD5B01             CALL    SEL         ;SELECT DEST DRIVE
                ,       PUT SYSTEM, SET RW TO WRITE
02EC 21A003             LXI     H,PUTMSG
02EF CD40A01            CALL    CRMSG
02F2 CD2A01             CALL    GETCHAR
02F5 FE0D               CPI     CR
02F7 C20E03             JNZ     REBOOT
02FA CD3F01             CALL    CRLF
                ;
02FD 215104             LXI     H,RW
```

```
0300 3601                  MVI     M,1
0302 CD9B01                CALL    GETPUT      ;TO PUT SYSTEM BACK ON
                                               DISKETTE
0305 21EA03                LXI     H,DONE
0308 CD4F01                CALL    OUTMSG
030B C3C702                JMP     PUTSYS      ;FOR ANOTHER PUT OPERATION
                   ;
                   REBOOT:
030E 3E00                  MVI     A,0
0310 CD5B01                CALL    SEL
0313 CD3F01                CALL    CRLF
0316 C30000                JMP     BOOT
                   BADDISK:
                           ;BAD DISK NAME
0319 21FC03                LXI     H,QDISK
031C CD4A01                CALL    CRMSG
031F C9                    RET
                   ;
                   ;
                   ;
                   ;       DATA AREAS
                   ;       MESSAGES
0320 5359534745    SIGNON: DB      'SYSGEN VER'
032B 322E30                DB      VERS/0+'0','.',VERS MOD 10+'0'
032E 00                    DB      0
032F 534F555243    ASKGET  DB      'SOURCE DRIVE NAME'
0340 0D284F5220            DB      0DH, '(OR RETURN TO SKIP) ',0
0355 534F555243    GETMSG: DB      'SOURCE ON '
035F               GDISK:  DS      1           ;FILLED IN AT GET FUNCTION
0360 2C20544845            DB      ', THEN TYPE RETURN',0
0373 4445535449    ASKPUT  DB      'DESTINATION DRIVE NAME'
0389 0D284F5220            DB      0DH, '(OR RETURN TO REBOOT) ',0
03A0 4445535449    PUTMSG. DB      'DESTINATION ON '
03AF               PDISK:  DS      1           ;FILLED IN AT PUT FUNCTION
03B0 2C20544845            DB      ', THEN TYPE RETURN',0
03C3 5045524D41    ERRMSG: DB      'PERMANENT ERROR, TYPE RETURN TO
                                   IGNORE',0
03EA 46554E4354    DONE:   DB      'FUNCTION COMPLETE',0
03FC 494E56414C    QDISK:  DB      'INVALID DRIVE NAME (USE A, B, OR C) ',0
0420 4E4F20534F    NOFILE  DB      'NO SOURCE FILE ON DISK',0
                   BADFILE:
```

```
0437 534F555243          DB      'SOURCE FILE INCOMPLETE',0
                 ;
                 ;       VARIABLES
044E             SDISK:  DS      1       ;SELECTED DISK FOR CURRENT
                                         OPERATION
044F             TRACK:  DS      1       ;CURRENT TRACK
0450             SECTOR: DS      1       ;CURRENT SECTOR
0451             RW:     DS      1       ;READ IF 0, WRITE IF 1
0452             DMADDR: DS      2       ;CURRENT DMA ADDRESS
0454             RETRY:  DS      1       ;NUMBER OF TRIES ON THIS
                                         SECTOR
0455                     DS      STACKSIZE*2
                 STACK:
0475                     END
```

Custom BIOS for CP/M 2.2 On Commodore 64

This version has the following attributes:

1. Memory map set up for 52K RAM system with I/O and drivers by BOOT65
2. Disk tables and vectors included for 2 drives
3. The Intel I/O byte is not implemented
4. Punch and reader are null routines
5. Keyboard and message tables are part of BIOS65
6. A 20K to 48K byte CP/M environment can be supported on the Commodore 64 (44K with IEEE)
7. Virtual Drive B is supported for 1540
8. Drive B is not virtual on IEEE disk

```
0000 =           BASE    EQU     0000H   ;BEGINNING OF ADDRESSABLE
                                         RAM
                 ;
002C =           MSIZE   EQU     44      ;CP/M VERSION MEMORY SIZE IN
                                         KILOBYTES
                 ;
                 ;       "BIAS" IS ADDRESS OFFSET FROM 3400H FOR MEMORY
                         SYSTEMS
```

```
                ,       THAN 20K (REFERRED TO AS "B" THROUGHOUT THE
                        TEXT)
                ,
6000 =          BIAS    EQU     (MSIZE-20) *1024
                ,
                ,       NOTE: TO CREATE MOVCPM, THE FOLLOWING CCP
                ,       EQUATES ARE USED.
                ;
                ;CCP    EQU     0000H       ;FOR BIOS0.HEX
                ;CCP    EQU     0100H       ;FOR BIOS1.HEX
                ,
9400 =          CCP     EQU     3400H+BIAS  ;BASE OF CCP
9C06 =          BDOS    EQU     CCP+806H    BASE OF BDOS
AA00 =          BIOS    EQU     CCP+1600H   BASE OF BIOS
0004 =          CDISK   EQU     BASE+0004H  CURRENT DISK NUMBER 0=A,
                                            . . . , 15=P
0003 =          IOBYTE  EQU     BASE+0003H  INTEL I/O BYTE
0000 =          TRANS   EQU     0000H       ;0 IMPLIES NO TRANSLATION
0005 =          ENTRY   EQU     0005H       ;BDOS ENTRY VECTOR
                ,
                ;
                ,       Z80 INSTRUCTIONS
                ;
0018 =          JR      EQU     18H
0038 =          JRC     EQU     38H
0030 =          JRNC    EQU     30H
0028 =          JRZ     EQU     28H
0020 =          JRNZ    EQU     20H
                ;
                ;
                ;       THE FOLLOWING EQUATES DEFINE THE COMMON
                        MEMORY FOR PASSING DATA TO AND FROM THE 6510
                ;       I/O ROUTINES
                ;
F800 =          HSTBUF  EQU     0F800H      ;256 BYTE DISK BUFFER
F900 =          CMD     EQU     0F900H      ;COMMAND REGISTER
F901 =          DATA    EQU     0F901H      ;DATA REGISTER
F902 =          SECTOR  EQU     0F902H      ;SECTOR REGISTER
F903 =          TRACK   EQU     0F903H      ;TRACK REGISTER
F904 =          DISKNO  EQU     0F904H      ;DRIVE NUMBER REGISTER
F905 =          KYCHAR  EQU     0F905H      ;KEYBOARD CHARACTER
                                            REGISTER
```

```
FCFF =          IOTYPE  EQU     0FCFFH      ,IO CONFIGURATION BYTE
                ,
                ;       THE Z80 SHUTS ITSELF OFF BY WRITING "OFF" TO THE
                ,       LOCATION "MODESW"
                ,
0001 =          OFF     EQU     1
CE00 =          MODESW  EQU     0CE00H
                ;
                ;       THE FOLLOWING ARE THE COMMANDS TO THE 6510 I/O
                        ROUTINES
                .
0000 =          VICRD   EQU     0           ;READ SPECIFIED SECTOR
0001 =          VICWR   EQU     1           ;WRITE SPECIFIED SECTOR
0002 =          VICIN   EQU     2           ;DO A KEYBOARD SCAN
0003 =          VICOUT  EQU     3           ,OUTPUT DATA TO SCREEG
0004 =          VICPST  EQU     4           ;GET PRINTER STATUS
0005 =          VICPRT  EQU     5           ;SEND CHARACTER TO PRINTER
0006 =          VICFMT  EQU     6           ,FORMAT DISK COMMAND
0007 =          AUXI    EQU     7           ,JUMP TO $0E00 IN 6510 SPACE
0008 =          AUX2    EQU     8           ;JUMP TO $0F00 IN 6510 SPACE
0009 =          INDIR   EQU     9           ;JUMP INDIRECT VIA 0F906
                ,
                ;
AA00                    ORG     BIOS        ,ORIGIN OF THIS PROGRAM
0016 =          NSECTS  EQU     ($-CCP)/256 ;WARM START SECTOR COUNT
                ;
                ;       JUMP VECTOR FOR INDIVIDUAL SUBROUTINES
AA00 C36CAA             JMP     BOOT        ,COLD START
AA03 C31DAB     WBOOTE: JMP     WBOOT       ,WARM START
AA06 C39AAB             JMP     CONST       ;CONSOLE STATUS
AA09 C3FEAB             JMP     CONIN       ,CONSOLE CHARACTER IN
AA0C C376AC             JMP     CONOUT      ;CONSOLE CHARACTER OUT
AA0F C3B1AC             JMP     LIST        ;LIST CHARACTER OUT
AA12 C3FAAC             JMP     PUNCH       ;PUNCH CHARACTER OUT
AA15 C3FDAC             JMP     READER      ;READER CHARACTER OUT
AA18 C302AD             JMP     HOME        ;MOVE HEAD TO HOME POSITION
AA1B C30CAD             JMP     SELDSK      ;SELECT DISK
AA1E C320AD             JMP     SETTRK      ,SET TRACK NUMBER
AA21 C326AD             JMP     SETSEC      ;SET SECTOR NUMBER
AA24 C32BAD             JMP     SETDMA      ;SET DMA ADDRESS
AA27 C334AD             JMP     READ        ;READ RISK
```

```
AA2A C347AD             JMP     WRITE       ;WRITE DISK
AA2D C3D1AC             JMP     LISTST      ,RETURN LIST STATUS
AA30 C331AD             JMP     SECTRAN     ;SECTOR TRANSLATE
                ;
AA33 00         KYBDMD: DB      00H         ;CAPS LOCK FLAG
                ;
                ;       FIXED DATA TABLES FOR TWO DRIVES
                ;       DISK PARAMETER HEADER FOR DISK 00
AA34 00000000   DPBASE  DW      TRANS,0000H
AA38 00000000           DW      0000H,0000H
AA3C F0AE54AA           DW      DIRBF,DPBLK
AA40 AEAF70AF           DW      CHK00,ALL00
                ,       DISK PARAMETER HEADER FOR DISK 01
AA44 00000000           DW      TRANS,0000H
AA48 00000000           DW      0000H,0000H
AA4C F0AE54AA           DW      DIRBF,DPBLK
AA50 BEAF8FAF           DW      CHK01,ALL01
                ;
                ;
                DPBLK   ;DISK PARAMETER BLOCK, COMMON TO ALL DISKS
AA54 2200               DW      34          .SECTORS PER TRACK
AA56 03                 DB      3           ;BLOCK SHIFT FACTOR
AA57 07                 DB      7           ;BLOCK MASK
AA58 00                 DB      0           ;NULL MASK
AA59 8700               DW      135         ;DISK SIZE-1
AA5B 3F00               DW      63          ;DIRECTORY MAX
AA5D C0                 DB      192         ,ALLOC 0
AA5E 00                 DB      0           ;ALLOC 1
AA5F 1000               DW      16          ;CHECK SIZE
AA61 0200               DW      2           ;TRACK OFFSET
                ;
                .       END OF FIXED TABLES
                ;
                ;       MEMORY INITIALIZED WHEN BIOS READ IN AT BOOT
                        TIME
                ;
AA63 40         LASTKY: DB      40H         ;VECTOR OF LAST KEY PRESSED
AA64 00         TOGGLE: DB      00H         ;CAPS LOCK HOUSEKEEPING
AA65 00         CSTAT:  DB      00H         ;CHARACTER AVAILABLE FLAG
AA66 0000       MSGPTR: DW      0000H       ;MESSAGE POINTER
AA68 00FD       TBLPTR. DW      0FD00H      ;KEYBOARD CODE TABLE
```

```
AA6A 00FC       MSGTBL: DW      0FC00H      ;MESSAGE VECTOR TABLE
                ;
                ;       MISC. CONSOLE EQUATES
                ;
F28D =          SHFTST  EQU     0F28DH      ;CONTROL,COMMODORE,SHIFT
                                            KEYS
F0CC =          FLASH   EQU     0F0CCH      ,CURSOR FLASH ENABLE
F0CF =          CURSOR  EQU     0F0CFH      ;CURSOR CHARACTER
                ;
                ;       INDIVIDUAL SUBROUTINES TO PERFORM EACH
                        FUNCTION
                BOOT:
AA6C 3E20       ,       MVI     A,20H       ;ASCII SPACE
AA6E 32CFF0             STA     CURSOR      ,SET UP CURSOR
AA71 AF                 XRA     A           ;ZERO IN THE ACCUM
AA72 320300             STA     IOBYTE      ;CLEAR THE IOBYTE
AA75 320400             STA     CDISK       ;SELECT DISK ZERO
AA78 32EFAE             STA     CURDSK      ,CLEAR VIRTUAL DISK POINTER
AA7B 32E1AE             STA     HSTACT      ;HOST BUFFER INACTIVE
AA7E 32E3AE             STA     UNACNT      ;CLEAR UNALLOC COUNT
AA81 3EC3               MVI     A,0C3H      ,C3 IS JUMP OPCODE
AA83 320000             STA     0+BASE      . FOR JUMP TO WBOOT
AA86 2103AA             LXI     H,WBOOTE    ;WBOOT ENTRY POINT
AA89 220100             SHLD    1+BASE      ;SET ADDRESS FIELD
                ;
AA8C 320500             STA     5+BASE      ,JUMP TO BDOS OPCODE
AA8F 21069C             LXI     H,BDOS      ,BDOS ENTRY POINT
AA92 220600             SHLD    6+BASE      ;SET ADDRESS FIELD
                ,
AA95 018000             LXI     B,80H+BASE  ,DEFAULT DMA ADDRESS
AA98 CD2BAD             CALL    SETDMA
                ;
AA9B 11A6AA             LXI     D,SIGNON    ;DE POINTS TO SIGNON MSG
AA9E 0E09               MVI     C,9         ;PRINT STRING FUNCTION
AAA0 CD0500             CALL    ENTRY       ;GO TO BDOS
AAA3 C3B9AB             JMP     GOCPM1      ;GET READY FOR CCP
                ;
AAA6 0C0A       SIGNON: DB      0CH,0AH     ;CLEAR SCREEN
AAA8 2020202043         DB      ' COMMODORE 64 20K CP/M VERS 2.2'
AACC 0D0A0A             DB      0DH,0AH,0AH
AACF 2020436F70         DB      ' COPYRIGHT @ 1979, DIGITAL
                                RESEARCH',0DH,0AH
```

```
AAF7 2020202020          DB      ' COPYRIGHT @ 1982, COMMODORE',0DH,0AH
AB1B 0A24                DB      0AH,'$'     ;END OF STRING MARKER
                ;
                ;
                WBOOT:
AB1D 318000              LXI     SP,80H+BASE ;USE SPACE BELOW BUFFER
                                             FOR STACK
AB20 0E00                MVI     C,0         ;SELECT DISK 0
AB22 CD0CAD              CALL    SELDSK
AB25 AF                  XRA     A           ;FORCE DRIVE A
AB26 3204F9              STA     DISKNO      ;ABSOLUTELY, POSITIVELY
AB29 CD79AE              CALL    CHGDSK      ;IF NOT ALREADY SELECTED
AB2C CD02AD              CALL    HOME        ;GO TO TRACK 00
AB2F 3E0D                MVI     A,0DH       ;CARRIAGE RETURN
AB31 CDAAAC              CALL    COUT5       ;OUTPUT IT
                ;
AB34 110094              LXI     D,CCP       ;START OF LOAD
AB37 0616                MVI     B,NSECTS
AB39 2601                MVI     H,1         ;TRACK NUMBER
AB3B 2E06                MVI     L,6         ;SECTOR NUMBER
AB3D 7C          LOAD1:  MOV     A,H
AB3E 3203F9              STA     TRACK
AB41 7D                  MOV     A,L
AB42 3202F9              STA     SECTOR
AB45 3E00                MVI     A,VICRD     ;DISK READ COMMAND
AB47 CD90AB              CALL    IO6510
                ;
AB4A 3A01F9              LDA     DATA
AB4D B7                  ORA     A
AB4E 20ED        J1:     DB      JRNZ, (LOAD1-J1-2) AND 0FFH
AB50 E5                  PUSH    H
AB51 C5                  PUSH    B
AB52 010001              LXI     B,256
AB55 2100F8              LXI     H,HSTBUF    ;DISK BUFFER
AB58 ED                  DB      0EDH        ;LDIR INSTRUCTION
AB59 B0                  DB      0B0H
AB5A 0E2A                MVI     C,'*'       ;SHOW IT'S LOADING
AB5C CD76AC              CALL    CONOUT
AB5F C1                  POP     B
AB60 E1                  POP     H
AB61 05                  DCR     B           ;DECREMENT SECTOR COUNT
```

```
AB62 280B       J2      DB      JRZ,GOCPM-J2-2
AB64 2C                 INR     L               ;NEXT SECTOR
AB65 7D                 MOV     A,L
AB66 FE11               CPI     17
AB68 38D3       J3:     DB      JRC, (LOAD1-J3-2) AND 0FFH
AB6A 24                 INR     H
AB6B 2E00               MVI     L,0
AB6D 18CE       J4:     DB      JR, (LOAD1-J4-2) AND 0FFH
                ;       END OF LOAD OPERATION, SET PARAMETERS AND GO
                        TO CP/M
                GOCPM:
AB6F 3EC3               MVI     A,0C3H          ,C3 IS A JMP INSTRUCTION
AB71 320000             STA     0+BASE          ,FOR JMP TO WBOOT
AB74 2103AA             LXI     H,WBOOTE        ,WBOOT ENTRY POINT
AB77 220100             SHLD    1+BASE          ;SET ADDRESS FIELD FOR JMP AT
                                                0
                ;
AB7A 320500             STA     5+BASE          ;FOR JMP TO BDOS
AB7D 21069C             LXI     H,BDOS          ;BDOS ENTRY POINT
AB80 220600             SHLD    6+BASE          ,ADDRESS FIELD OF JUMP AT 5 TO
                                                BDOS
                ;
AB83 018000             LXI     B,80H+BASE      .DEFAULT DMA ADDRESS IS 80H
AB86 CD2BAD             CALL    SETDMA
                ;
                ;
AB89 3A0400     GOCPM1: LDA     CDISK           ;GET CURRENT DISK NUMBER
AB8C 4F                 MOV     C,A             ;SEND TO THE CCP
AB8D C30094             JMP     CCP             ;GO TO CP/M FOR FURTHER
                                                PROCESSING
                ;
                ;
                ,       MAIN ROUTINE TO TRANSFER EXECUTION TO 6510
                ,
AB90 3200F9     IO6510: STA     CMD             ;PUT A IN 6510 COMMAND
                                                REGISTER
AB93 3E01               MVI     A,OFF
AB95 3200CE             STA     MODESW          ;TURN OFF Z80
AB98 00                 NOP                     ;REQUIRED BY HARDWARE
AB99 C9                 RET
                ;
```

```
                ;
                CONST   ;CONSOLE STATUS, RETURN 0FFH IF CHARACTER READY,
                        00H IF NOT
AB9A 2A66AA             LHLD    MSGPTR      ,MESSAGE MODE?
AB9D 7C                 MOV     A,H
AB9E B5                 ORA     L
AB9F 3EFF               MVI     A,0FFH      ;DATA READY FLAG
ABA1 C0                 RNZ                 ;RETURN IF MSGPTR<>0
                ;
ABA2 3A65AA             LDA     CSTAT       ,ALREADY A CHAR?
ABA5 A7                 ANA     A
ABA6 C0                 RNZ                 ,YES IF NOT 0
                ,
ABA7 3E02               MVI     A,VICIN     ,CHECK KEYBOARD COMMAND
ABA9 CD90AB             CALL    IO6510
                ;
ABAC 3A8DF2             LDA     SHFTST      ,GET STATUS OF CONTROL KEYS
ABAF E602               ANI     02H         ,CHECK FOR COMMODORE KEY
ABB1 2810       J5.     DB      JRZ, CONST0-J5-2 ;JUMPIF NOT PRESSED
                ;
ABB3 3A64AA             LDA     TOGGLE      ;IS THIS AN UPSTROKE?
ABB6 A7                 ANA     A
ABB7 200A       J6.     DB      JRNZ,CONST0-J6-2 ,NO WAITING TO
                                                RELEASE
ABB9 3A33AA             LDA     KYBDMD      ;GET CAPS MODE FLAG
ABBC EE01               XRI     01H         ;TOGGLE MODE BIT
ABBE 3233AA             STA     KYBDMD
ABC1 3E01               MVI     A.1
ABC3 3264AA     CONST0: STA     TOGGLE
                ;
ABC6 3A05F9             LDA     KYCHAR      ,GET SCANNED DATA
ABC9 FE3A               CPI     3AH         ;BAD CONTROL DATA
ABCB 280A       J7:     DB      JRZ,CONST1-J7-2
                ;
ABCD FE3D               CPI     3DH         ;BAD CONTROL DATA
ABCF 2806       J8.     DB      JRZ,CONST1-J8-2
                ,
ABD1 2163AA             LXI     H,LASTKY    ;COMPARE WITH PREVIOUS
ABD4 BE                 CMP     M           ; SCAN DATA
ABD5 2005       J9:     DB      JRNZ,CONST2-J9-2  ;IF DIFFERENT, NEW KEY
```

```
ABD7 AF          CONST1: XRA   A          ;DATA NOT READY FLAG
ABD8 3265AA              STA   CSTAT      ;SAVE FOR LATER
ABDB C9                  RET
                 ;
ABDC F5          CONST2: PUSH  PSW
ABDD 01F401              LXI   B,500
ABE0 0B          CONST3: DCX   B          ;DELAY FOR KEYBOUNCE
ABE1 79                  MOV   A,C
ABE2 B0                  ORA   B
ABE3 20FB        J10:    DB    JRNZ,(CONST3-J10-2) AND 0FFH
                 ;
ABE5 3E02                MVI   A,VICIN    ;GET CHARACTER AGAIN
ABE7 CD90AB              CALL  IO6510
                 ;
ABEA F1                  POP   PSW
ABEB 2105F9              LXI   H,KYCHAR
ABEE BE                  CMP   M
ABEF 20E6        J11:    DB    JRNZ,(CONST1-J11-2) AND 0FFH  ;IF<>0,
                                BOUNCING
                 ;
ABF1 3263AA              STA   LASTKY     ;UPDATE LAST KEY
ABF4 FE40                CPI   40H        ;IF 40H, NO KEY PRESSED
ABF6 28DF        J12:    DB    IRZ,CONST1-J12-2) AND 0FFH
                 ;
ABF8 3EFF                MVI   A,0FFH     ;DATA READY FLAG
ABFA 3265AA              STA   CSTAT      ;SAVE FOR LATER
ABFD C9                  RET
                 ;
                 CONIN:  ;CONSOLE CHARACTER INTO REGISTER A
ABFE 3E00                MVI   A,0        ,TURN ON CURSOR
AC00 32CCF0              STA   FLASH
                 ;
AC03 2A66AA              LHLD  MSGPTR     ;ARE WE IN MESSAGE MODE?
AC06 7C                  MOV   A,H
AC07 B5                  ORA   L
AC08 2044        J13:    DB    JRNZ.CONIN5-J13-2
                 ;
                 ;
AC0A CD9AAB      CONIN1. CALL   CONST     ;CHECK CONSOLE STATuS
AC0D B7                  ORA   A
AC0E 28FA        J14·    DB    JRZ.(CONIN1-J14-2) AND 0FFH  ;UNTIL NEW
```

```
                ;
AC10 AF                 XRA     A
AC11 3265AA             STA     CSTAT       ;CLEAR CSTAT
AC14 3A33AA     CONIN2  LDA     KYBDMD      ;UNSHIFT=0, CAPS=1
AC17 47                 MOV     B,A
AC18 3A8DF2             LDA     SHFTST      ;GET MODIFIER STATUS
AC1B E601               ANI     01H         ;IS A SHIFT KEY DOWN?
AC1D 2802       J15     DB      JRZ,CONIN3-J15-2 ;JUMP IF NO
                ;
AC1F 0602               MVI     B,2         ;SHFIT=2
AC21 3A8DF2     CONIN3  LDA     SHFTST      ;GET MODIFIER STATUS
AC24 E604               ANI     04H         ;IS THE CONTROL KEY DOWN?
AC26 2802       J16:    DB      JRZ,CONIN4-J16-2  ;JUMP IF NO
                ;
AC28 0603               MVI     B,3         ;CONTROL=3
AC2A 3A63AA     CONIN4. LDA     LASTKY      ;GET KEY POSITION
AC2D 87                 ADD     A           ;*2
AC2E 87                 ADD     A           ;*4
AC2F 80                 ADD     B           ;ADD IN OFFSET
AC30 2A68AA             LHLD    TBLPTR      ;GET BEGINNING OF KEYTBL
AC33 85                 ADD     L           ;VECTOR INTO TABLE
AC34 6F                 MOV     L,A
AC35 3E00               MVI     A,0
AC37 8C                 ADC     H
AC38 67                 MOV     H,A
AC39 7E                 MOV     A,M         ;GET CHARACTER FROM TABLE
AC3A FE80               CPI     80H         ;MESSAGE IF >7FH
AC3C 3820       J17:    DB      JRC,CONIN7-J17-2  ;JUMP IF ASCII CHAR
                ;
AC3E 2A6AAA             LHLD    MSGTBI      ;GET BEGINNING OF MVTBL
AC41 E67F               ANI     7FH         ;STRIP OF MESSAGE BIT
AC43 87                 ADD     A           ;*2
AC44 85                 ADD     L           ;VECTOR INTO TABLE
AC45 6F                 MOV     L,A
AC46 3E00               MVI     A,0
AC48 8C                 ADC     H
AC49 67                 MOV     H,A
AC4A 7E                 MOV     A,M         ;LOW ORDER BYTE
AC4B 23                 INX     H
AC4C 66                 MOV     H,M         ;HIGH ORDER BYTE
```

```
AC4D 6F              MOV   L,A
AC4E 46      CONIN5: MOV   B,M          ,GET CHARACTER
AC4F 23              INX   H           ,CHECK NEXT CHARACTER
AC50 7E              MOV   A,M
AC51 A7              ANA   A
AC52 2003    J18:    DB    JRNZ,CONIN6-J18-2   ,IF 0, B HAS LAST CHAR
                     ;
AC54 210000          LXI   H,0000H     ,END OF MESSAGE MODE
AC57 2266AA  CONIN6  SHLD  MSGPTR      ,SAVE MESSAGE POINTER
AC5A 78              MOV   A.B         ;CHECK CHARACTER
AC5B A7              ANA   A           ;MAYBE 1ST IS 0
AC5C 28AC    J19:    DB    JRZ,(CONIN1-J19-2) ND 0FFH   ,IF<>0, NOT
                                       CHAR
                     ;
AC5E F5      CONIN7. PUSH  PSW         ,SAVE CHARACTER
AC5F 3E01            MVI   A,1
AC61 32CCF0          STA   FLASH       ;TURN OFF CURSOR
AC64 2AD1F0          LHLD  0F0D1H      ,
AC67 3AD3F0          LDA   0F0D3H
AC6A 85              ADD   L
AC6B 6F              MOV   L A
AC6C 3EF0            MVI   A,0F0H
AC6E 8C              ADC   H
AC6F 67              MOV   H,A
AC70 7E              MOV   A,M
AC71 E67F            ANI   07FH
AC73 77              MOV   M,A
AC74 F1              POP   PSW         ;GET CHARACTER
AC75 C9              RET               ;DONE
                     ;
                     CONOUT: ;CONSOLE CHARACTER OUTPUT FROM REGISTER C
AC76 3AFFFC          LDA   IOTYPE      ;GET CONFIGURATION BYTE
AC79 E601            ANI   10H         ;BIT 4 = 1 TO IGNORE FILTER
AC7B 79              MOV   A,C         ;GET TO ACCUMULATOR
AC7C 202C    J20     DB    JRNZ,COUT5-J20-2   ,PRINT AS RECEIVED
                     ,
AC7E CDDAAC          CALL  SWAP        ;EXCHANGE UPPER AND LOWER
                                       CASE
AC81 FE0C            CPI   0CH         ,ASCII CLEAR SCREEN?
AC83 2004    J21·    DB    JRNZ,COUT1-J21-2   ;JUMP IF NO
                     ;
AC85 3E93            MVI   A,93H       ;COMMODORE CLEAR SCREEN
                                       CMD
```

```
AC87 1821          J22:    DB      JR,COUT5-J22-2
                   ;
AC89 FE08          COUT1:  CPI     08H             ;ASCII BACKSPACE?
AC8B 2004          J23:    DB      JRNZ,COUT2-J23-2  ;JUMP IF NO
                   ;
AC8D 3E14                  MVI     A,14H           ;COMMODORE BACKSPACE CMD
AC8F 1819          J24:    DB      JR,COUT5-J24-2
                   ;
AC91 FE0A          COUT2:  CPI     0AH             ,LINE FEED?
AC93 2004          J25:    DB      JRNZ,COUT3-J25-2
                   ;
AC95 3E11                  MVI     A,17            ;COMMODORE LINE FEED
AC97 1811          J26:    DB      JR,COUT5-J26-2
                   ;
AC99 FE0D          COUT3:  CPI     0DH             ;CARRIAGE RETURN?
AC9B 2007          J27:    DB      JRNZ,COUT4-J27-2
                   ;
AC9D CDAAAC                CALL    COUT5
ACA0 3E91                  MVI     A,145           ;UP 1 LINE TO NEGATE AUTO LF
ACA2 1806          J28:    DBB     JR,COUT5-J28-2
                   ,
ACA4 FE20          COUT4:  CPI     20H
ACA6 D8                    RC                      ;RETURN IF UNDECODED
                                                   CONTROL CHAR
ACA7 FE80                  CPI     80H
ACA9 D0                    RNC                     ;RETURN IF NOT ASCII
                                                   CHARACTER
                   ;
ACAA 3201F9        COUT5   STA     DATA            ,PUT DATA IN CHARACTER
                                                   REGISTER
ACAD 3E03                  MVI     A,VICOUT        ;SCREEN OUTPUT COMMAND
ACAF 181D          J29:    DB      JR.LIST3-J29-2
                   ;
                   LIST:   ;LIST CHARACTER FROM REGISTER C
ACB1 3AFFFC                LDA     IOTYPE          ;WHAT KIND OF PRINTER?
ACB4 E604                  ANI     04H             ;0 IF 1515, 1 IF 4022
ACB6 79                    MOV     A,C             ,CHARACTER TO REGISTER A
ACB7 2010          J30:    DB      JRNZ,LIST2-J30-2  ,JUMP IF NO SWAP
                   ;
ACB9 3AFFFC                LDA     IOTYPE
ACBC E608                  ANI     08H             ,WHICH TYPE OF SWAP?
```

```
ACBE 79          MOV   A,C          ;GET CHARACTER
ACBF 2005  J31:  DB    JRNZ,LIST1-J31-2
           ;
ACC1 CDDAC       CALL  SWAP         ;SWAP UPPER AND LOWER CASE
ACC4 1803  J32:  DB    JR,LIST2-J32-2
           ;
ACC6 CDEDAC LIST1: CALL SWAP2       ;4022 SWAP ROUTINE
ACC9 3201F9 LIST2: STA  DATA        ,PUT DATA IN REGISTER
ACCC 3E05        MVI   A,VICPRT     ,ASSUME 1540
ACCE C390AB LIST3: JMP  IO6510
           ,
           LISTST: ,RETURN LIST STATUS (0 IF NOT READY, 1 IF READY)
ACD1 3E04        MVI   A,VICPST     ;PRINTER STATUS COMMAND
ACD3 CD90AB      CALL  IO6510
ACD6 3A01F9      LDA   DATA         ;DATA IS STATUS
ACD9 C9          RET
           ;
           SWAP: ;SWAP UPPER AND LOWER CASE FOR COMMODORE-64
ACDA FE41        CPI   41H          ;LESS THAN UC 'A'?
ACDC D8          RC                 ;RETURN IF SO
           ,
ACDD FE5B        CPI   5BH          ;UC LETTER?
ACDF 3809  J33:  DB    JRC,SWAP1-J33-2  ;JUMP IF SO
           ;
ACE1 FE61        CPI   61H          ;LESS THAT LC 'A'
ACE3 D8          RC                 ,RETURN IF SO
           ;
ACE4 FE7B        CPI   7BH          ;LC LETTER?
ACE6 D0          RNC                ;RETURN IF NO
           ;
ACE7 E65F        ANI   5FH          ,TURN OFF BIT 5
ACE9 C9          RET
           ;
ACEA F620  SWAP1: ORI  20H          ;TURN ON BIT 5
ACEC C9          RET
           ;
ACED FE41  SWAP2: CPI  41H          ;CY IF LESS THAN UC 'A'
ACEF D8          RC
ACF0 FE60        CPI   60H          ;CY IF 40H < A < 60H
ACF2 3003  J34:  DB    JRNC,SWAP3-J34-2
           ;
```

```
ACF4 F680               ORI     80H
ACF6 C9                 RET
                ;
ACF7 E65F       SWAP3:  ANI     5FH
ACF9 C9                 RET
                ;
                PUNCH:  ;PUNCH CHARACTER FROM REGISTER C
ACFA 79                 MOV     A,C             ,CHARACTER TO REGISTER A
ACFB 00                 NOP
ACFC C9                 RET                     ;NULL SUBROUTINE
                ;
                ;
                READER: ;READ CHARACTER INTO REGISTER A FROM READER
                        DEVICE
ACFD 3E1A               MVI     A,1AH           ;ENTER END OF FILE FOR NOW
                                                (REPLACE LATER)
ACFF E67F               ANI     7FH             ;REMEMBER TO STRIP PARITY BIT
AD01 C9                 RET
                ,
                ;
                ;* * * * * * * * * * * * * * * * * * * * *
                ;*                                       *
                ;*      CP/M TO HOST DISK CONSTANTS      *
                ;*                                       *
                ,* * * * * * * * * * * * * * * * * * * * *
0400 =          BLKSIZ  EQU     1024            ;CP/M ALLOCATION SIZE
0100 =          HSTSIZ  EQU     256             ,HOST DISK SECTOR SIZE
0011 =          HSTSPT  EQU     17              ;HOST DISK SECTORS/TRK
0002 =          HSTBLK  EQU     HSTSIZ/128      ;CP/M SECTS/HOST BUFF
0022 =          CPMSPT  EQU     HSTBLK * HSTSPT ;CP/M SECTORS/TRACK
0001 =          SECMSK  EQU     HSTBLK-1        ;SECTOR MASK
0001 =          SECSHF  EQU     1               ;LOG2(HSTBLK)
                ;
                ;* * * * * * * * * * * * * * * * * * * * *
                ;*                                       *
                ,*      BDOS CONSTANTS ON ENTRY TO WRITE *
                ;*                                       *
                ,* * * * * * * * * * * * * * * * * * * * *
0000 =          WRALL   EQU     0               ;WRITE TO ALLOCATED
0001 =          WRDIR   EQU     1               ;WRITE TO DIRECTORY
0002 =          WRUAL   EQU     2               ,WRITE TO UNALLOCATED
```

```
                        ;
                        ;       HOME THE SELECTED DISK
                        HOME:
AD02 3AE2AE             J35.    LDA     HSTWRT      ;CHECK FOR PENDING WRITE
AD05 B7                         ORA     A
AD06 2003                       DB      JRNZ,HOMED-J35-2
AD08 32E1AE                     STA     HSTACT      ;CLEAR HOST ACTIVE FLAG
                        HOMED:
AD0B C9                         RET
                        ;
                        SELDSK:
                                ;SELECT DISK
AD0C 210000                     LXI     H,0000H     ;ERROR RETURN CODE
AD0F 79                         MOV     A,C         ;SELECTED DISK NUMBER
AD10 32D8AE                     STA     SEKDSK      ;SEEK DISK NUMBER
AD13 FE02                       CPI     2           ;MUST BE 0-1
AD15 D0                         RNC                 ;NO CARRY IF 2,3,
AD16 6F                         MOV     L,A         ;DISK NUMBER TO HL
AD17 29                         DAD     H           ;MULTIPLY BY 16
AD18 29                         DAD     H
AD19 29                         DAD     H
AD1A 29                         DAD     H
AD1B 1134AA                     LXI     D,DPBASE    ;BASE OF PARM BLOCK
AD1E 19                         DAD     D           ;HL=.DPB(CURDSK)
AD1F C9                         RET
                        ;
                        SETTRK;
                                ;SET TRACK GIVEN BY REGISTERS BC
AD20 60                         MOV     H,B
AD21 69                         MOV     L,C
AD22 22D9AE                     SHLD    SEKTRK      ;TRACK TO SEEK
AD25 C9                         RET
                        ;
                        SETSEC:
                                ;SET SECTOR GIVEN BY REGISTER C
AD26 79                         MOV     A,C
AD27 32DBAE                     STA     SEKSEC      ;SECTOR TO SEEK
AD2A C9                         RET
                        ;
                        SETDMA:
                                ;SET DMA ADDRESS GIVEN BY BC
```

```
AD2B 60                 MOV     H,B
AD2C 69                 MOV     L,C
AD2D 22ECAE             SHLD    DMAADR
AD30 C9                 RET
                ;
                SECTRAN.
                        ;TRANSLATE SECTOR NUMBER BC
AD31 60                 MOV     H,B
AD32 69                 MOV     L,C
AD33 C9                 RET

                ;
                ;*  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *
                ;*                                                        *
                ;*      THE READ ENTRY POINT TAKES THE PLACE OF           *
                ;*      THE PREVIOUS BIOS DEFINITION FOR READ.            *
                ;*                                                        *
                ;*  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *
                READ:
                        ;READ THE SELECTED CP/M SECTOR
AD34 AF                 XRA     A
AD35 32E3AE             STA     UNACNT
AD38 3E01               MVI     A,1
AD3A 32EAAE             STA     READOP      ;READ OPERATION
AD3D 32E9AE             STA     RSFLAG      ;MUST READ DATA
AD40 3E02               MVI     A,WRUAL
AD42 32EBAE             STA     WRTYPE      ;TREAT AS UNALLOC
AD45 1864       J36:    DB      JR,RWOPER-J36 -2    ;TO PERFORM THE READ

                ;
                ;*  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *
                ;*                                                        *
                ;*      THE WRITE ENTRY POINT TAKES THE PLACE OF          *
                ;*      THE PREVIOUS BIOS DEFINITION FOR WRITE.           *
                ;*                                                        *
                ;*  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *
                WRITE:
                        ;WRITE THE SELECTED CP/M SECTOR
AD47 AF                 XRA     A           ,0 TO ACCUMULATOR
AD48 32EAAE             STA     READOP      ,NOT A READ OPERATION
AD4B 79                 MOV     A,C         ;WRITE TYPE IN C
AD4C 32EBAE             STA     WRTYPE
AD4F FF02               CPI     WRUAL       ;WRITE UNALLOCATED?
```

```
AD51 2017       J37:    DB      JRNZ,CHKUNA-J37-2  ;CHECK FOR UNALLOC
                ;
                ;       WRITE TO UNALLOCATED, SET PARAMETERS
AD53 3E08               MVI     A,BLKSIZ/128;NEXT UNALLOC RECS
AD55 32E3AE             STA     UNACNT
AD58 3AD8AE             LDA     SEKDSK     ;DISK TO SEEK
AD5B 32E4AE             STA     UNADSK     ;UNADSK = SEKDSK
AD5E 2AD9AE             LHLD    SEKTRK
AD61 22E5AE             SHLD    UNATRK     ;UNATRK = SECTRK
AD64 3ADBAE             LDA     SEKSEC
AD67 32E7AE             STA     UNASEC     ;UNASEC = SEKSEC
                ;
                ;
                CHKUNA.
                        ;CHECK FOR WRITE TO UNALLOCATED SECTOR
AD6A 3AE3AE             LDA     UNACNT     ;ANY UNALLOC REMAIN?
AD6D B7                 ORA     A
AD6E 2833       J38:    DB      JRZ,ALLOC-J38-2 ;SKIP IF NOT
                ;
                ;               MORE UNALLOCATED RECORDS REMAIN
AD70 3D                 DCR     A          ;UNACNT = UNACNT-1
AD71 32E3AE             STA     UNACNT
AD74 3AD8AE             LDA     SEKDSK     ;SAME DISK?
AD77 21E4AE             LXI     H,UNADSK
AD7A BE                 CMP     M          ;SEKDSK = UNADSK?
AD7B 2026       J39:    DB      JRNZ,ALLOC-J39-2  ;SKIP IF NOT
                ;
                ;       DISKS ARE THE SAME
AD7D 21E5AE             LXI     H,UNATRK
AD80 CD40AE             CALL    TRKCMP     ;SEKTRK = UNATRK?
AD83 201E       J40:    DB      JRNZ,ALLOC-J40-2  ;SKIP IF NOT
                ;
                ;       TRACKS ARE THE SAME
AD85 3ADBAE             LDA     SEKSEC     ;SAME SECTOR?
AD88 21E7AE             LXI     H,UNASEC
AD8B BE                 CMP     M          ;SEKSEC = UNASEC?
AD8C 2015       J41:    DB      JRNZ,ALLOC-J41-2  ;SKIP IF NOT
                ;
                ,       MATCH, MOVE TO NEXT SECTOR FOR FUTURE REF
AD8E 34                 INR     M          ;UNASEC = UNASEC+1
AD8F 7E                 MOV     A,M        ;END OF TRACK?
```

```
AD90 FE22               CPI     CPMSPT      ;COUNT CP/M SECTORS
AD92 3809       J42:    DB      JRC,NOOVF-J42-2  ;SKIP IF NO OVERFLOW
                ;
                ;       OVERFLOW TO NEXT TRACK
AD94 3600               MVI     M,0         ;UNASEC = 0
AD96 2AE5AE             LHLD    UNATRK
AD99 23                 INX     H
AD9A 22E5AE             SHLD    UNATRK      ;UNATRK = UNATRK+1
                ;
                NOOVF:
                        ;MATCH FOUND, MARK AS UNNECESSARY READ
AD9D AF                 XRA     A           ;0 TO ACCUMULATOR
AD9E 32E9AE             STA     RSFLAG      ;RSFLAG = 0
ADA1 1808       J43:    DB      JR,RWOPER-J43-2  ;TO PERFORM THE WRITE
                ;
                ALLOC:
                        ;NOT AN UNALLOCATED RECORD, REQUIRES PRE-READ
ADA3 AF                 XRA     A           ;0 TO ACCUM
ADA4 32E3AE             STA     UNACNT      ;UNACNT = 0
ADA7 3C                 INR     A           ;1 TO ACCUM
ADA8 32E9AE             STA     RSFLAG      ;RSFLAG = 1
                ;
                ;* * * * * * * * * * * * * * * * * * * * * *
                ;*                                         *
                ;*      COMMON CODE FOR READ AND WRITE FOLLOWS  *
                ;*                                         *
                ;* * * * * * * * * * * * * * * * * * * * * *
                RWOPER:
                        ;ENTER HERE TO PERFORM THE READ/WRITE
ADAB AF                 XRA     A           ;ZERO TO ACCUM
ADAC 32E8AE             STA     ERFLAG      ;NOERRORS (YET)
ADAF 3ADBAE             LDA     SEKSEC      ;COMPUTE HOST SECTOR
ADB2 B7                 ORA     A           ;CARRY = 0
ADB3 1F                 RAR                 ;SHIFT RIGHT
ADB4 32E0AE             STA     SEKHST      ;HOST SECTOR TO SEEK
                ;
                ;       ACTIVE HOST SECTOR?
ADB7 21E1AE             LXI     H,HSTACT    ;HOST ACTIVE FLAG
ADBA 7E                 MOV     A,M
ADBB 3601               MVI     M,1         ;ALWAYS BECOMES 1
ADBD B7                 ORA     A           ;WAS IT ALREADY?
```

```
ADBE 2821          J44:    DB      JRZ,FILHST-J44-2  ;FILL HOST IF NOT
                   ;
                   ;       HOST BUFFER ACTIVE, SAME AS SEEK BUFFER?
ADC0 3AD8AE                LDA     SEKDSK
ADC3 21DCAE                LXI     H,HSTDSK  ;SAME DISK?
ADC6 BE                    CMP     M         ;SEKDSK = HSTDSK?
ADC7 2011          J45:    DB      JRNZ,NOMTCH-J45-2
                   ;
                   ;       SAME DISK, SAME TRACK?
ADC9 21DDAE                LXI     H,HSTTRK
ADCC CD40AE                CALL    TRKCMP    ;SEKTRK = HSTTRK?
ADCF 2009          J46.    DB      JRNZ,NOMTCH-J46-2
                   ;
                   ;       SAME DISK, SAME TRACK, SAME BUFFER?
ADD1 3AE0AE                LDA     SEKHST
ADD4 21DFAE                LXI     H,HSTSEC  ;SEKHST = HSTSEC?
ADD7 BE                    CMP     M
ADD8 2824          J47.    DB      JRZ,MATCH-J47-2   ,SKIP IF MATCH
                   ;
                   NOMTCH.
                           ;PROPER DISK, BUT NOT CORRECT SECTOR
ADDA 3AE2AE                LDA     HSTWRT    ;HOST WRITTEN?
ADDD B7                    ORA     A
ADDE C44CAE                CNZ     WRHST     ;CLEAR HOST BUFF
                   ;
                   FILHST:
                           ;MAY HAVE TO FILL THE HOST BUFFER
ADE1 3AD8AE                LDA     SEKDSK
ADE4 32DCAE                STA     HSTDSK
ADE7 2AD9AE                LHLD    SEKTRK
ADEA 22DDAE                SHLD    HSTTRK
ADED 3AE0AE                LDA     SEKHST
ADF0 32DFAE                STA     HSTSEC
ADF3 3AE9AE                LDA     RSFLAG    ;NEED TO READ?
ADF6 B7                    ORA     A
ADF7 C49DAE                CNZ     RDHST     ;YES, IN 1
ADFA AF                    XRA     A         ;0 TO ACCUM
ADFB 32E2AE                STA     HSTWRT    ;NO PENDING WRITE
                   ;
                   MATCH:
                           ;COPY DATA TO OR FROM BUFFER
```

```
ADFE 3ADBAE             LDA     SEKSEC      ;MASK BUFFER NUMBER
AE01 E601               ANI     SECMSK      ,LEAST SIGNIF BITS
AE03 6F                 MOV     L,A         ,READY TO SHIFT
AE04 2600               MVI     H,0         ;DOUBLE COUNT
AE06 29                 DAD     H           ;SHIFT LEFT 7
AE07 29                 DAD     H
AE08 29                 DAD     H
AE09 29                 DAD     H
AE0A 29                 DAD     H
AE0B 29                 DAD     H
AE0C 29                 DAD     H
                ;       HL HAS RELATIVE HOST BUFFER ADDRESS
AE0D 1100F8             LXI     D,HSTBUF
AE10 19                 DAD     D           ;HL = HOST ADDRESS
AE11 EB                 XCHG                ;NOW IN DE
AE12 2AECAE             LHLD    DMAADR      ;GET/PUT CP/M DATA
AE15 0E80               MVI     C,128       ,LENGTH OF MOVE
AE17 3AEAAE             LDA     READOP      ;WHICH WAY?
AE1A B7                 ORA     A
AE1B 2006       J48:    DB      JRNZ,RWMOVE-J48-2   ;SKIP IF READ
                ;
                ;       WRITE OPERATION, MARK AND SWITCH DIRECTION
AE1D 3E01               MVI     A,1
AE1F 32E2AE             STA     HSTWRT      ;HSTWRT = 1
AE22 EB                 XCHG                ,SOURCE/DEST SWAP
                ;
                RWMOVE:
                        ,C INITIALLY 128, DE IS SOURCE, HL IS DEST
AE23 1A                 LDAX    D           ;SOURCE CHARACTER
AE24 13                 INX     D
AE25 77                 MOV     M,A         ;TO DEST
AE26 23                 INX     H
AE27 0D                 DCR     C           ;LOOP 128 TIMES
AE28 20F9       J49:    DB      JRNZ,(RWMOVE-J49-2) AND 0FFH
                ,
                ;       DATA HAS BEEN MOVED TO/FROM HOST BUFFER
AE2A 3AEBAE             LDA     WRTYPE      ;WRITE TYPE
AE2D FE01               CPI     WRDIR       ;TO DIRECTORY?
AE2F 3AE8AE             LDA     ERFLAG      ;IN CASE OF ERRORS
AE32 C0                 RNZ                 ;NO FURTHER PROCESSING
                ,
                ;       CLEAR HOST BUFFER FOR DIRECTORY WRITE
```

```
AE33 B7              ORA     A          ;ERRORS?
AE34 C0              RNZ                ;SKIP IF SO
AE35 AF              XRA     A          ,0 TO ACCUM
AE36 32E2AE          STA     HSTWRT     ;BUFFER WRITTEN
AE39 CD4CAE          CALL    WRHST
AE3C 3AE8AE          LDA     ERFLAG
AE3F C9              RET

                     ;
                     ;* * * * * * * * * * * * * * * * * * * * *
                     ;*                                         *
                     ;*      UTILITY SUBROUTINE FOR 16-BIT COMPARE *
                     ;*                                         *
                     ;* * * * * * * * * * * * * * * * * * * * *
                     TRKCMP:
                          ,HL = .UNATRK OR .HSTTRK, COMPARE WITH SEKTRK
AE40 EB              XCHG
AE41 21D9AE          LXI     H,SEKTRK
AE44 1A              LDAX    D          ;LOW BYTE COMPARE
AE45 BE              CMP     M          ;SAME?
AE46 C0              RNZ                ;RETURN IF NOT
                     LOW BYTES EQUAL, TEST HIGH 1S
AE47 13              INX     D
AE48 23              INX     H
AE49 1A              LDAX    D
AE4A BE              CMP     M          ;SETS FLAGS
AE4B C9              RET

                     ;
                     ;* * * * * * * * * * * * * * * * * * * * *
                     ;*                                         *
                     ;*      WRHST PERFORMS THE PHYSICAL WRITE TO *
                     ;*      THE HOST DISK, RDHST READS THE PHYSICAL *
                     ;*      DISK.                              *
                     ,*                                         *
                     ;* * * * * * * * * * * * * * * * * * * * *
                     WRHST:
                          ;HSTDSK = HOST DISK #, HSTTRK = HOST TRACK #,
                          ;HSTSEC = HOST SECT #. WRITE "HSTSIZ" BYTES
                          ;FROM HSTBUF AND RETURN ERROR FLAG IN ERFLAG.
                          ,RETURN ERFLAG NON-ZERO IF ERROR
AE4C 3E01            MVI     A,VICWR    ;LOAD DISK WRITE COMMAND
AE4E 32EEAE  WRHST0: STA     RW         ,PUT COMMAND IN REGISTER
```

```
AE51 3ADCAE          LDA     HSTSDK      ;GET HOST DISK NUMBER
AE54 3204F9          STA     DISKNO      ; AND PUT IN COMMON AREA
AE57 CD79AE          CALL    CHGDSK      ;CORRECT VIRTUAL DISK?
AE5A 3ADDAE  WRHST2: LDA     HSTTRK      ;GET HOST TRACK NUMBER
AE5D 3C              INR     A           ;ADD 1 FOR VIC OFFSET
AE5E FE12            CPI     18          ;WE WANT TO SKIP TRACK 18
AE60 3801    J50:    DB      JRC,WRHST3-J50-2  ;CARRY IF TRACK<18
AE62 3C              INR     A
AE63 3203F9  WRHST3: STA     TRACK       ;PUT IN COMMON AREA
AE66 3ADFAE          LDA     HSTSEC      ;GET HOST SECTOR NUMBER
AE69 3202F9          STA     SECTOR      ;PUT IN COMMON AREA
AE6C 3AEEAE          LDA     RW          ;GET DISK COMMAND
AE6F CD90AB          CALL    IO6510
AE72 3A01F9          LDA     DATA        ;GET DISK STATUS
AE75 32E8AE          STA     ERFLAG      ; AND STORE IN ERFLAG
AE78 C9              RET
                     ;
AE79 67      CHGDSK: MOV     H,A         ;SAVE DISK NUMBER
AE7A 3AFFFC          LDA     IOTYPE      ;BIT 0 = 0 FOR VIRTUAL
AE7D E601            ANI     01
AE7F C0              RNZ                 ,NOT ZERO IF 2 DRIVES
AE80 3204F9          STA     DISKNO      ;FORCE DRIVE A
AE83 7C              MOV     A,H         ,RESTORE DISK NUMBER
                     ;
AE84 21EFAE          LXI     H,CURDSK    ;IS THIS OUR CURRENT DISK?
AE87 BE              CMP     M
AE88 C8              RZ                  ;RETURN IF OK
                     ;
AE89 77              MOV     M,A         ;SET UP NEW DISK
AE8A C641            ADI     'A'         ;FORM ASCII DRIVE LETTER
AE8C 32AFAE          STA     DSKMNT      ;PUT IN MESSAGE
                     ,
AE8F 21A1AE          LXI     H,MNTMSG    ,INSERT DISK MESSAGE
AE92 CDCCAE          CALL    PMSG        ;GO PRINT IT
AE95 CDFEAB  CHGD1:  CALL    CONIN       .WAIT FOR RETURN
AE98 FE0D            CPI     0DH
AE9A 20F9    J51:    DB      JRNZ,(CHGD1-J51-2) AND 0FFH
AE9C C9              RET
                     ;
                     RDHST:
                             ;HSTDSK = HOST DISK #, HSTTRK = HOST TRACK #,
                             ;HSTSEC = HOST SECT #. READ "HSHSIZ" BYTES
```

```
                                ;INTO HSTBUF AND RETURN ERROR FLAG IN ERFLAG.
AE9D 3E00                       MVI     A,VICRD     ;DISK READ COMMAND
AE9F 18AD       J52             DB      JR,(WRHST0-J52-2) AND 0FFH    ,REST LIKE
                                        WRITE
                ;
AEA1 0D0A496E73 MNTMSG:         DB      0DH,0AH,'INSERT DISK'
AEAF 41         DSKMNT:         DB      'A'
AEB0 20696E746F                 DB      ' INTO DRIVE 0, PRESS RETURN'
AECB 00                         DB      00H
                ;
AECC 7E         PMSG:           MOV     A,M
AECD A7                         ANA     A
AECE C8                         RZ
AECF E5                         PUSH    H
AED0 4F                         MOV     C,A
AED1 CD76AC                     CALL    CONOUT
AED4 E1                         POP     H
AED5 23                         INX     H
AED6 18F4       J53·            DB      JR,(PMSG-J53-2) AND 0FFH
                ;
                ;*  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *
                ;*                                                           *
                ;*          UNINITIALIZED RAM DATA AREAS                     *
                ,*                                                           *
                ;*                                                           *
                ;*  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *
AED8            SEKDSK:     DS      1           ,SEEK DISK NUMBER
AED9            SEKTRK:     DS      2           ;SEEK TRACK NUMBER
AEDB            SEKSEC·     DS      1           ;SEEK SECTOR NUMBER
                ;
AEDC            HSTDSK:     DS      1           ;HOST DISK NUMBER
AEDD            HSTTRK.     DS      2           ;HOST TRACK NUMBER
AEDF            HSTSEC:     DS      1           ;HOST SECTOR NUMBER
                ;
AEE0            SEKHST:     DS      1           ,SEEK SHR SECSHF
AEE1            HSTACT:     DS      1           ,HOST ACTIVE FLAG
AEE2            HSTWRT:     DS      1           ,HOST WRITTEN FLAG
                ,
AEE3            UNACNT.     DS      1           ;UNALLOC REC CNT
AEE4            UNADSK:     DS      1           ;LAST UNALLOC DISK
AEE5            UNATRK:     DS      2           ,LAST UNALLOC TRACK
```

```
AEE7            UNASEC: DS      1           ,LAST UNALLOC SECTOR
                ;
AEE8            ERFLAG. DS      1           ,ERROR REPORTING
AEE9            RSFLAG: DS      1           ,READ SECTOR FLAG
AEEA            READOP  DS      1           ;1 IF READ OPERATION
AEEB            WRTYPE: DS      1           ;WRITE OPERATION TYPE
AEEC            DMAADR: DS      2           ;LAST DMA ADDRESS
AEEE            RW:     DS      1           ,TEMPORARY COMMAND
                                            REGISTER
AEEF            CURDSK: DS      1           ;VIRTUAL DISK POINTER
                ;
                ,       SCRATCH RAM AREA FOR BDOS USE
AEF0  =         BEGDAT  EQU     $           'BEGINNING OF DATA AREA
AEF0            DIRBF:  DS      128         ;SCRATCH DIRECTORY AREA
AF70            ALL00:  DS      31          ;ALLOCATION VECTOR 0
AF8F            ALL01:  DS      31          ;ALLOCATION VECTOR 1
AFAE            CHK00·  DS      16          ,CHECK VECTOR 0
AFBE            CHK01:  DS      16          ;CHECK VECTOR 1
                ;
AFCE  =         ENDDAT  EQU     $           ;END OF DATA AREA
00DE  =         DATSIZ  EQU     $-BEGDAT    ;SIZE OF DATA AREA
AFCE                    END
```

ABOUT THE COMMODORE 64 CP/M® OPERATING SYSTEM USER'S GUIDE...

The Commodore Z80 microprocessor and CP/M® operating system let you turn your Commodore 64 into a dual processor home microcomputer.

CP/M® lets you use more than 15,000 CP/M® application programs. CP/M® software includes widely used business applications such as financial reporting and analysis, investment planning, word processing, farm and restaurant management, data base, exotic language compilers, and much, much more.

The *Commodore 64 CP/M® Operating System User's Guide* tells you how to use the Z80 cartridge and the CP/M® operating system. This manual gives you detailed information on how to bring up CP/M® on your system. We also give you a detailed reference section with descriptions of all the CP/M® commands and utility programs.

For the beginner, this manual offers simple, step-by-step instructions with all the information you need to use CP/M® on your Commodore 64.

For the advanced user, this manual provides detailed information on the technical workings of CP/M® on your Commodore 64 and the engineering details of your Z80 cartridge.

This manual is written in an easy–to–read style and is designed to help you get the most out of the Z80 microprocessor and the CP/M® operating system.

commodore COMPUTER

Commodore Business Machines, Inc.—Computer Systems Division,
950 Airport Rd, West Chester, PA 19380

DISTRIBUTED BY

Howard W. Sams & Co., Inc.
4300 W. 62nd Street, Indianapolis, Indiana 46268 USA

$12.95/22098 **ISBN: 0-672-22098-9**