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Cromemco

CDOS Operating System

Instruction Manual

Cromemco™

CDOS

INSTRUCTION MANUAL

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This manual was produced on a Cromemco System Three computer utilizing a Cromemco HDD-22 Hard Disk Storage System running under the Cromemco Cromix^{TM} Operating System. The text was edited with the Cromemco Cromix Screen Editor. The edited text was formatted using the Cromemco Word Processing System Formatter II. Final camera-ready copy was printed on a Cromemco 3355A printer.

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INTRODUCTION

CDOS is an acronym for the **C**romemco **D**isk **O**perating **S**ystem.

The primary use of CDOS is to control input from and output to mass storage devices such as floppy and hard disks. It is designed to allow users of Cromemco microcomputer systems to create and manipulate both random and sequential disk files using symbolic names.

CDOSGEN stands for the **C**romemco **D**isk **O**perating **S**ystem **GEN**erator. It is designed to allow CDOS to be tailored to the needs of the user and hardware configuration at hand. It allows standard or custom functions to be called by the function keys of Cromemco terminals.

Most Cromemco software packages are provided with a 64K version of CDOS which may be directly booted up as shipped. CDOSGEN is also provided with most Cromemco software packages.

This manual is designed as both a reference and an instructional manual. Chapter 1 gives an overview of CDOS to the user who is new to operating systems. Chapter 2 describes the structure of CDOS, its memory allocation, disk layout, and file structure. Chapter 3 covers CDOSGEN including the various parameters necessary to use this program. CDOS operation, startup, and command structure are described in Chapter 4. Intrinsic commands and Utility programs are covered in Chapter 5. Chapter 6 is the CDOS Programmer's Manual. This section is designed for the advanced user who wants to gain a deeper understanding of CDOS and its file structure. Chapter 7 contains a list and explanation of the CDOS error messages. Finally, Chapter 8 contains a glossary of terms and symbols as they are used throughout this manual.

The Cromemco Disk Operating System (CDOS*) is an original product designed and written in Z-80 machine code by Cromemco, Inc. for its own line of microcomputers. However, due to the large number of programs currently available to run under the CP/M** operating system, CDOS was designed to be upwards CP/M compatible. This means that many programs written

* CDOS is a Trademark of Cromemco, Inc.
Mountain View, California

** CP/M is a Trademark of Digital Research, Inc.
Pacific Grove, California

for CP/M (versions up to and including 1.3) will run without modification under CDOS. This also means that programs written for CDOS will **not** generally run under CP/M.

Cromemco is licensed by Digital Research, the originator of CP/M, for use of the CP/M data structures and user interface.

There are several advantages to end users which result from this compatibility. First, users of Cromemco machines are able to draw on the large library of existing CP/M and CP/M compatible programs available on the market. Second, users familiar with CP/M can easily move up to CDOS taking advantage of the many additional features available with CDOS.

The enhancements contained in CDOS, but not CP/M, are primarily visible in the system calls. CDOS has added a number of new system calls to allow the user even more flexible means of device and disk I/O. CDOS includes all twenty-seven of the system calls of CP/M version 1.3.

Chapter 1

BEGINNER'S GUIDE

IMPORTANT NOTE

All commands to CDOS must be terminated by pressing the **RETURN** key. If you enter a command and nothing happens, check that you have properly terminated the command (with a **RETURN**).

1.1 INFORMATION ABOUT DISKETTES

There are five significant parts of the diskette that you need to know about.

1. The label on the plastic casing of the diskette which can be used to describe the general contents.

2. The write protect notch on the plastic casing that enables or disables the ability to write to the diskette.

3. The oblong window in the plastic casing through which the disk drive reads from and writes to the inside circular diskette.

4. The circular window in the middle of the diskette. The disk drive clamps onto the inner portion of the circular diskette here and spins it.

5. The index holes which indicate to the operating system if the diskette is single or double sided.

There are several precautions that you need to take with diskettes.

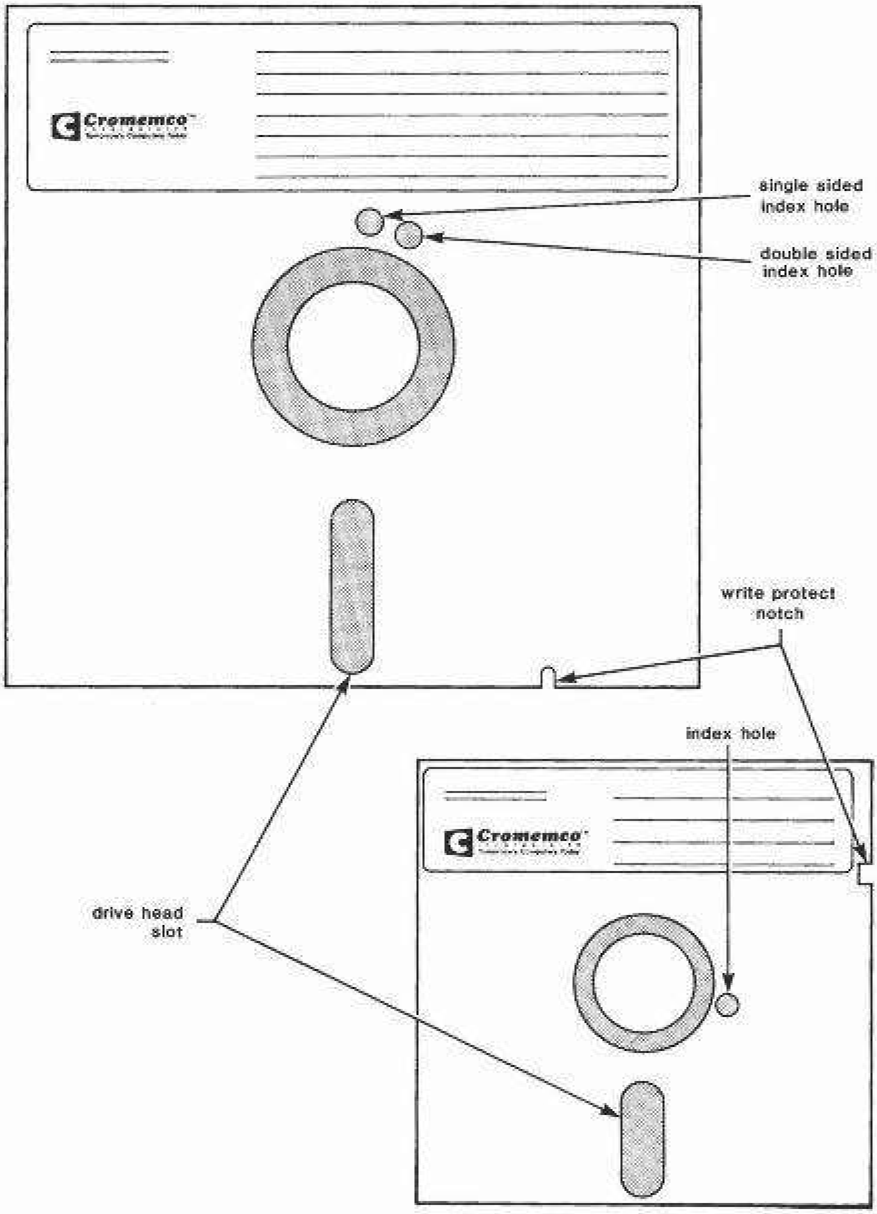
1. Whenever a diskette is not in the computer, make sure that it is in its protective envelope.

2. Never bend a diskette.

3. Never touch the surface of the inner disk of the diskette.

4. Never place a diskette near a source of magnetism.

5. Diskettes cannot tolerate temperature or humidity


Cromemco
single sided
index hole
double sided
index hole
write protect
notch
index hole
Cromemco
drive head
slot

extremes. As a general rule, if you are hot or cold, the diskette is too.

Diskettes are inserted into a drive with the edge nearest the oblong window going in first and with the label on the left. If the drive slot on your computer is horizontal, the label will face up.

If you have a System Three, the drives can be identified by the letters on the white eject buttons beneath each drive slot.

On a System Two or a Z2-H, the drives can be identified by the painted letter below each drive.

1.2 SOME TECHNICAL TERMS EXPLAINED

The **cursor** is the small white rectangle on the screen of your terminal. It indicates the position where text will appear when you type on the keyboard.

An **operating system** is a program which gets information, whether in the form of text or other programs, from your disks, sends printing to your printer, creates places on disk to store information, and also manages that space. This operating system is called CDOS, which stands for the Cromemco Disk Operating System.

A **CDOS prompt** is an indication to the user that the operating system is ready to receive an instruction. The prompt will be in the form of a capital letter followed by a period, e.g., A., D., H., etc. The instruction given in response to the prompt can be an intrinsic operating system function, a program, or one of certain control functions.

The **current drive** is the drive that you are working from. The letter of the CDOS prompt will specify which is the current drive.

A **file** is a collection of related data. A file can be a program, a letter to your mother, an inventory list, or any other group of data that is stored on disk.

Filename is the term for the name of a file with the format that CDOS will accept. There are two parts of a filename that uniquely identify it on a disk. The fundamental name of the file can be up to eight characters long. After this name can be a three letter extension which is generally used to classify what type of file it is. This extension is connected to the name with a period, e.g., cdos.com, payables.bas, primes.z80.

A **disk specifier**, when used by itself, can change the current drive. When it prefaces a filename, it further identifies that file. The disk specifier is composed of a drive letter followed by a colon. When you log on, **A.** is displayed as the CDOS prompt. That means that the drive that you are working on is drive A. If you want to work on drive B, type **B:** and the CDOS prompt **B.** will be displayed on the screen. The current drive is now drive B. It is also useful in accessing a file on another disk drive. If you are doing something on drive A and need to refer to the file **recvabs.led** on drive B, you can specify the file on drive B as **b:recvabs.led.**

Memory refers to the random access memory in your computer, probably a 64KZ board. It is the "work area" of your computer.

Storage refers to the devices which house your programs and data when not in use. These are usually diskettes or hard disks.

RETURN refers to the RETURN key of the terminal.

1.3 UTILITIES AND INTRINSIC COMMANDS

A utility is a program that is related to the operating system and which performs a useful function, but is not a part of the operating system. Utilities are separate programs found in the disk directory, and must be on either the current disk or the master disk (a:) to be executed. DUMP, STATus, and XFER are examples of utility programs. When entering a utility program name, do not type the extension ".com".

An intrinsic command (hereafter referred to as an intrinsic) is a command that is part of the operating system and may be executed wherever the CDOS prompt is displayed. Examples of intrinsics are ATTR, DIR, ERA, and TYPE.

When entering a utility program name or an intrinsic, enter only the portion in capital letters. For instance, if you want to use the STATus utility, type only STAT.

Directory

DIR is the intrinsic that allows you to see what files are on a disk. It is like a table of contents for the disk. DIR is short for directory.

There are several different ways that dir can be used. It can be used by itself, **dir**, to display the filenames and file space used on the current disk. It can be followed by a disk specifier to display the filenames and file space used on a disk in another drive:

```
dir b:
```

You can use it with a single filename to verify the existence or size of that file:

```
dir c:photom.z80
```

Type

TYPE is used to quickly look at files that are composed of alphabetic, numeric, and punctuation characters.

The contents of a file can be displayed by typing **type** followed by a text filename:

```
type thesis.txt
```

TYPE should only be used with text files. Attempting to TYPE nontext files will produce unpredictable results.

Erase

ERA, short for erase, enables you to erase files from the disk. It is also an intrinsic command.

A file can be erased from a disk by typing **era** followed by its filename:

```
era chromatg.rel
```

Disk specifiers can be used with the filename to erase a file which is on a disk in a different drive:

```
     era b:chromatg.rel
```

Attribute

ATTR is used to change the security attributes of a file. With this intrinsic, files can be protected from read, write, or erase operations. ATTR is short for attributes.

There are three different types of protection available for files. They are **E**, which prevents the file from being erased; **R**, which prevents the file from being read; and **W**, which prevents the file from being written to.

A file can be assigned attributes by typing **attr** followed by the name of the file, and the letter(s) corresponding to the desired protections. The file called letter.mom can be erase and write protected by typing:

```
     attr letter.mom ew
```

Attributes can be removed by typing attr, followed by the filename, followed by <u>no</u> attributes.

Rename

REN is the intrinsic that enables you to change the name of a file.

You can change the name of a file by typing **ren**, which is short for rename, followed by the new filename, an equal sign (=), and then the current filename:

```
     ren newname.txt=oldname.txt
```

Renaming a file does not change the data in the file or move the file on the disk. It only changes the name of the file.

Initialize

INIT prepares a disk so that information can be stored on it. This process destroys any data that is already on the disk.

This program should only be run when 1) the disk is new, 2) the disk is unreadable, i.e., the data and formatting of the disk have been magnetically or electrically destroyed, or 3) if you want to store data in double density or single sided format.

All 8" diskettes supplied by Cromemco have already been initialized as double sided disks and must be reinitialized if they are to be used as single sided diskettes.

To initialize a diskette first type **init** and you will be asked several questions concerning the diskette. The characters that appear between the brackets are the default values that can be entered by just pressing the RETURN key. After a diskette has been initialized, STAT/L should be run to label the diskette. The diskette is now ready for use.

Transfer

XFER enables you to copy files to other disks, to the printer, and to your terminal.

A file can be copied to another disk by typing **xfer** followed by the disk specifier of the destination disk, an equal sign (=), and the name of the file:

```
xfer b:=a:source.txt
```

There are four significant options. They are:

/v Verify the copy.

/a Delete the end of file marker (text files only).

/t Expand tabs in source file into spaces in destination file.

/c Compare two files without transfer.

If you want to use one or more of the options, put them immediately after **xfer** with no intervening spaces:

```
xfer/v a:=b:fibonacc.z80
```

copies the file fibonacc.z80 from drive B to drive A and verifies the copy,

```
xfer/t prt:=phi.txt
```

copies the file phi.txt, expanding tabs, from the current drive to the printer.

The /t option should be used when copying a file which contains tabs. If it is not used, tabs will not be displayed on devices incapable of expanding them, such as most printers.

The /v option verifies that the file has been copied correctly.

The /a option is very useful for removing the end of file markers when concatenating files:

```
xfer/a book.txt=chapter1.txt,chapter2.txt,appendix.txt
```

In this example, each successive file is appended to the end of the previous one. This example uses a filename as a destination instead of a disk specifier. Also notice that since no disk specifiers were used all files are on the current drive. Disk specifiers can be used for any of the filenames if they are applicable. The /a option in this example deletes the end of file marker from chapter1.txt and chapter2.txt and leaves the end of file marker from the last file, appendix.txt.

The /c option is used to compare two files. If you suspect that you have two duplicate files when only one is desired, you can resolve your suspicions with the /c option:

```
xfer/c file1.lis=file2.lis
```

No copying is done with this option.

Status

STAT allows you to check and modify various aspects of your system. Following are several of the available options.

/a Displays an alphabetical directory of the files on a disk along with how much space each one takes.

/b Displays a brief description of the space available on a disk.

/d Sets the current date.

/e Allows you to selectively erase files on a disk. These are displayed in alphabetical order.

/l Labels a disk with name, date, and description of the disk.

/t Sets the time of day.

This program is called by typing **stat** immediately followed by the desired option and pressing the RETURN key. You can execute several of STAT's options at one time. The time and date can be set by typing **stat/dt.** STAT with no options displays a comprehensive status description of the current disk and memory.

Batch

@, called **Batch**, enables you to type a group of commands and have them execute sequentially.

Batch jobs can be run two different ways. If the sequence of commands to be executed is not one that is to be run frequently, type **@**. After a few seconds, an exclamation point will appear on the next line. Here, you will enter the first in the sequence of commands. Press the RETURN key and the cursor will move to the beginning of the next line and you can enter the second command. This procedure is repeated for each successive command. When you have entered the entire sequence of commands and are on the beginning of a new line following the last command, press RETURN once more. The commands will begin executing in the order in which you entered them.

If there is a sequence of commands that you want to run frequently, you can create a file containing these commands with one of the Cromemco text editors. This file must contain one command per line. The name of this file must have the extension **cmd:**

```
compile.cmd
```

Enter **@ filename** to execute your BATCH file:

```
@ compile
```

1.4 CONTROL CHARACTERS

Control characters perform console and printer functions. Some useful control characters are:

CNTRL-S Stops printing to the console or the printer. Pressing any key will restart the printing.

CNTRL-V Deletes the current line on the console.

CNTRL-P Sends printing that normally goes to the **console only** to the printer as well. Pressing CNTRL-P again will resume printing to the console only.

Control characters are used by holding down the CNTRL key and pressing another key. CNTRL-V is entered by holding down the CNTRL key and pressing the V key. Users having Cromemco 3102 terminals may use the **CE** function key (clear entry) for CNTRL-V, the **PRINT** function key for CNTRL-P, and the **PAUSE** function key for CNTRL-S. The **PAUSE** key is located between the **EOL** and **PRINT** keys and may not be marked.

1.5 SAFEGUARDING YOUR DATA

It is a wise investment of time and effort to make frequent copies of your work. It is recommended that you make backups at least twice per day, e.g., before lunch and before going home.

Backups are made in different ways depending upon what you are doing. If you are working with the Screen Editor, exiting and updating your file will create a backup. If you are in BASIC, listing or saving your program will create a backup. You should also make a backup copy of your disk using the xfer utility. This should be done daily, or more often depending on the nature of your work.

1.6 THE RESET SWITCH

The reset switch is used to put your computer in a state such that CDOS can be booted. The reset switch is used when you don't like what your computer is doing, i.e., looping forever in a program. Pressing or turning the reset switch will enable you to escape from your program, boot CDOS, and reenter your program to make the necessary changes.

The reset switch on Cromemco computers is found on the back of the computer. On System Three computers, the key switch on the front is also a reset switch. If you do not have a System Three, there is a jack on the back of your computer that will accommodate a remote reset switch.

Pressing reset while the disk is being written to will result in a file that cannot be read.

Chapter 2

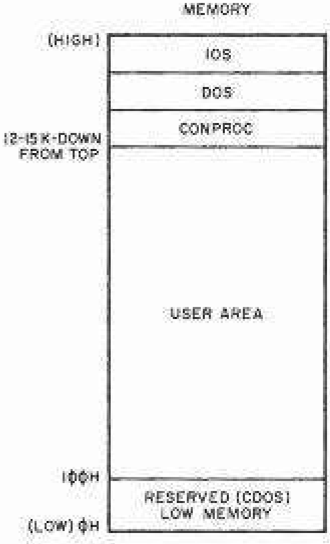
SYSTEM STRUCTURE

2.1 MEMORY ALLOCATION

Under CDOS, memory is divided into two major parts.

The first part is that area of RAM which is reserved for CDOS itself. CDOS occupies memory from locations 0 through 100H (Low Memory) as well as approximately the top 11K to 18K of RAM.

The second part is the User Area of RAM. The user area occupies memory from 100H up to the bottom of CDOS. The size of the user area is determined when CDOSGEN is run and is limited by the amount of memory in the system. It is usually about 48K.



CDOS MEMORY USE MAP

MEMORY USE MAP

The system is described by the total number of bytes it occupies. Most Cromemco software packages are supplied with a CDOS configured for a 64K system.

CDOS is loaded from the System Area of the disk into memory by a bootstrap routine.

By special use of low memory, all user programs call CDOS through a standard sequence which is transparent to the size of CDOS.

Referring to the CDOS Memory Use Map, we see that RAM is divided into the following areas:

High Memory

CDOS contains the basic input/output functions for the console, printer, punch, and reader as well as the disk I/O drivers.

CDOS contains the file management functions which are responsible for managing, creating, opening, reading, and writing disk files. It also is in charge of calling user programs and editing console input.

CDOS also has some internal functions called intrinsic commands.

User Area

This is where programs actually run. The User Area begins at 100H (256 decimal) and extends to the bottom of CDOS. All programs which are not intrinsic to CDOS are run in this area. Intrinsic programs do not run in this area and therefore do not alter it.

The external functions are the utility and user COMmand files which are located on the disk. These files can be identified by the COM filename extension. They are executed by typing the filename without the filename extension (COM is assumed) in response to the CDOS prompt.

Low Memory

Memory below the User Area is reserved by CDOS for the following special purposes:

0- 2H	System warm start vector
3H	I/O byte
5- 7H	System call vector for user requests
8H	Specifies running under CDOS if FFH and under Cromix Operating System if C3H
30-32H	Breakpoints for DEBUG
38-3AH	Jump to **Invalid jump** message
40-5BH	Reserved for system
5C-7BH	Standard user file control blocks
80-FFH	Standard user I/O buffer (disk & command line)

The reader is referred to the CDOS Programmer's Guide for a more detailed discussion on the use of Low Memory.

2.2 DISK ORGANIZATION

Each disk used under CDOS is divided into two general areas. The first area is the **System Area.** It may be accessed by the user only through the WRTSYS utility program or when creating a boot file with CDOSGEN. The contents of this area are not listed by the DIRectory intrinsic command. The System Area occupies the outer tracks of the disk.

The second area is the **File Area.** This is the section where user files (e.g., programs, data, etc.) and the disk directory are stored.

Disk	Tracks in System Area	Approximate File Area
5"SS SD	3	81K
5"DS SD	3	171K
5"SS DD	2	188K
5"DS DD	2	386K
8"SS SD	2	241K
8"DS SD	2	490K
8"SS DD	2	596K
8"DS DD	2	1,208K
Hard-11	1	10,490K

(SS=Single Sided; DS=Double Sided; SD=Single Density; DD=Double Density)

The use of the two areas previously described is not related. Even if the DIRectory command indicates a full disk, a copy of the CDOS boot file may still be written to the System Area using WRTSYS or CDOSGEN. The

DIRectory intrinsic indicates only the user file portion of the File Area which is occupied on the disk. This has no bearing on the System Area.

2.2.1 Disk Specifications

This table shows the number of tracks per disk surface, surfaces, sectors per track, and the sector size for CDOS disks. Numbers not within parentheses are decimal. Numbers within parentheses are hexadecimal.

Disk	Cylinders	Surfaces	Sectors/ Track	Sector Size
8"SD	77(0-4CH)	2	26(1-1AH)	128 bytes
8"DD	77(0-4CH)	2	16(1-10H)	512 bytes
5"SD	40(0-27H)	2	18(1-12H)	128 bytes
5"DD	40(0-27H)	2	10(1-0AH)	512 bytes
HARD	350(0-15DH)	3	20(0-14H)	512 bytes

Note:

The first track (cylinder 0, side 0) of all floppy diskettes is initialized as single density with 128-byte sectors by the INIT program to allow the disk to be booted with 16FDC and 4FDC versions of RDOS.

On hard disks, there are four additional cylinders which are reserved as alternates to be used if other tracks develop hard errors.

2.2.2 Disk Type Specifiers

CDOS determines what type of disk is being used from a special **disk type specifier** stored in the first sector of the disk (sector 1, cylinder 0, side 0 of floppy disks and sector 0, cylinder 0, surface 0 of hard disks). The disk type specifier consists of bytes 121 through 128 of this sector. The specifier is composed of four groups of two bytes each which contain the ASCII values of the characters listed in the following table.

Bytes	Characters	Meaning
121 - 122	LG	CDOS large floppy
	SM	CDOS small floppy
	HD	CDOS hard disk
123 - 124	SS	single sided floppy
	DS	double sided floppy
	11	11-Mbyte hard disk
125 - 126	SD	single density
	DD	double density
127 - 128	reserved for future use	

The System Area of the disk includes all or part of the first 1, 2, or 3 tracks of the disk, depending on the disk type. The space reserved the System Area is always at least 6.5K. On double density floppy disks, part of the system area may be stored on a single density track (cylinder 0, side 0) and part on a double density track (cylinder 0, track 1).

The File Area starts at the beginning of the track following the system area. (CDOS accesses disks by alternating sides or surfaces as it works its way into the disk by increasing cylinder numbers, so the **next track** may be a different surface of the same cylinder.) The directory always begins at the beginning of the file area (i.e., the first 1K of directory space is always on the first track of the file area), but other parts of the directory may be elsewhere on the disk. This information is summarized for each of the various types of CDOS disks in the following table.

Disk Type	System Area	Start of File Area
LG SS SD	c0,s0; c1,s0	c2,s0
LG SS DD	c0,s0; c1,s0	c2,s0
LG DD SD	c0,s0; c0,s1	c1,s0
LG DD DD	c0,s0; c0,s1	c1,s0
SM SS SD	c0,s0; c1,s0; c2,s0	c3,s0
SM SS DD	c0,so; c1,s0	c2,s0
SM DD SD	c0,s0; c0,s1, c1,s0	c1,s1
SM DD DD	c0,s0; c0,s1	c1,s0
HD 11	c0,s0	c0,s1

2.2.3 Write-Protecting Diskettes

8" Diskettes

The 8" (**large**) diskettes are write-protected by a notch on the bottom right side (as the label faces you) of the plastic disk cover. To be able to write on the disk, cover the notch with a silver sticker or a piece of masking tape.

5.25" Diskettes

The 5.25" (**small**) diskettes are write-protected by the presence of the silver write-protect sticker covering the notch. Remove this sticker if you want to write on the disk.

Important Distinction

It is important to note that large disks are write-protected by removing the silver sticker, and small disks are write-protected by placing the silver sticker over the notch.

Files may be write-protected as well as, or instead of, diskettes. This can be done with the ATTR intrinsic. ATTR is a software write-protect only.

2.2.4 Precautions Concerning Diskettes

The following precautions are suggested. They are designed to minimize the chance of damage to files stored on floppy diskettes.

1. While in a program, do not exchange diskettes unless the program provides for it. Terminating execution of the program with CNTRL-C will not close files. Diskettes may be exchanged while in BASIC if the DSK"@" command is used.

2. Execute the STATus Utility program occasionally in order to verify the directory.

3. Diskettes are magnetic media. The following care and attention should be given to them:

   a. Keep them away from all sources of magnetic fields such as power transformers and solenoids.

b. Store a diskette in its dust covers and **never** lay the bare disk down on a dusty surface.

c. Keep them out of direct sunlight as the black plastic heats up rapidly. Normal storage temperature is 50 to 125 degrees Fahrenheit (10 to 52 degrees Celsius).

d. Do not write on the plastic disk jacket with anything but a soft felt tip pen.

e. Do not touch or try to clean the disk surface. Abrasions may cause loss of data.

f. Never bend, fold, or staple the disk.

g. It is suggested that the disk **not be loaded** (i.e., inserted in the drive with the door closed) **while powering up or down.** Under these conditions random data may be written to the disk. In case of power failure it is wise to check the disk for errors following the return of power.

4. As an additional safety precaution, maintain adequate archives of backup disks. Data may occasionally be lost and the additional cost of back up disks is well worth the valuable programs, data, and time which may be saved.

2.3 DATA FILES

Data is information. Some examples of data are: a list of names and addresses, a FORTRAN program, the text of a letter or a manual, etc.

A file is a group of related individual items of information. Some examples of files are: a telephone or address book, a filing cabinet, the paper on which a grocery list is written, etc.

A computer data file (or simply file) is accessed by describing:

1. the storage medium (floppy disk, hard disk, paper tape, etc.),

2. the method of accessing the data (sequential or random), and

3. the code by which the data is translated for storage (ASCII or internal machine representation).

When a file is created, it is given an identifier so that it may be referenced at a later time. This identifier is the filename and optionally the filename extension.

Files may be stored in the same format as data is stored inside the computer. This is referred to as Internal Machine Representation. Files also may be coded, or formatted, according to the American Standard Code for Information Interchange which is usually called ASCII. An ASCII file contains only numbers from the ASCII table. On output, each of these numbers is translated into the character it represents. An ASCII file may be TYPEd while a file stored in internal machine representation must be DUMPed.

Files may be read from or written to a number of devices. The standard devices available under CDOS are:

Device	Data Transfer
Console	Input & Output
Printer	Output
Disk Drive	Input & Output
Paper Tape Reader	Input
Paper Tape Punch	Output

As normally delivered, only the console, printer, and disk are active. The paper tape reader and punch drivers are implemented using the same port assignments as the console. These may be changed by modifying the I/O device drivers.

The primary use of CDOS is to perform I/O with the disk. Any combination of up to four floppy disk drives and up to seven hard disk drives for a total of eight drives may be connected to a Cromemco floppy disk controller and WDI hard disk controller. Unlike some large computer systems, all disk files under CDOS may be accessed in either random or sequential order.

Devices are predefined by CDOS, but disk files are dynamically created, extended, or deleted as required.

2.3.1 Device Names

The following symbolic names may be used when referring to devices accessible by CDOS.

```
Format:  xxx:[#]
```

where:

xxx represents a three character name and # is an optional number from the following table:

Device	Name	Number Range
Console	CON:	0...7
Card Reader	RDR:	0...3
Paper tape Punch	PUN:	0,1
Line Printer	PRT:	0...3
Dummy Device	DUM:	--- (bit bucket/EOF)

2.3.2 Disk File References

The term

file-ref or file reference

is used throughout this manual to describe:

1. a single file reference including a file name and optionally a disk drive specifier and filename extension,

   or

2. an ambiguous file reference if it is specifically stated that the file-ref may include the * and ? replacement characters.

2.3.2.1 Single File Reference

A Single File Reference is a unique reference to a unique file stored on a disk and accessible by CDOS. By default or by specification this type of reference addresses a particular file (filename plus an optional filename extension) on a particular disk drive.

```
Format:  [X:]filename[.ext]
```

where:

X — is an optional disk drive specifier indicating the location of the file being referenced. Appropriate values are the letters A through H.

filename — is a filename composed of up to eight printable ASCII characters except as specified in Note 1 below.

ext — is an optional 1 to 3 character extension to the filename. See Notes 1 and 3.

Notes:

1. A filename or extension may include any printable ASCII character except the following:

   $ * ? = / . , : space

2. Although lower case characters are accepted without modification by most programs, all system functions convert lower case input of filenames to upper case.

3. There are several standard types of filename extensions expected by Cromemco system programs. These are listed below:

BAK	Editor backup file
BAS	BASIC LISTed source file (optional)
CMD	Batch command file
COB	COBOL source file
COM	Executable command program
FOR	FORTRAN source file
HEX	Hex format object file (8080 file)
LIS	BASIC LISTed source file (optional)
PRN	Printer or listing file
REL	Relocatable module (object file)
SAV	BASIC SAVEd source file (optional)
SYS	System image file
TXT	Text Formatter input file (optional)
Z80	Assembler source file

4. When an executable COMmand file is referred to without the optional disk drive specifier, the system will search the current drive for the file. If this search fails, and the current drive is not the master drive, the master drive is then searched for the file. The default master drive is drive A. This procedure is followed only for COM files.

Examples:

A:PROGRAM1.FOR refers to a FORTRAN source file on the disk in drive A named PROGRAM1 with a filename extension of FOR.

C:BASIC.COM refers to an executable COMmand file on the disk in drive C. The filename is BASIC and the filename extension is COM.

PROG.REL refers to a relocatable object file on the disk in the current drive named PROG with a filename extension of REL.

2.3.2.2 Ambiguous File Reference Using Replacement Characters

The asterisk (*), question mark (?), and characters within brackets ([]) may be used as replacement characters in a filename or filename extension to create an ambiguous file reference. The format of the ambiguous file reference is the same as that of the single file reference.

The asterisk replaces any character(s) from the position it occupies, to the right, up to the next delimiter (i.e., period (.), question mark (?), or carriage RETURN).

```
PROG*.* will match  PROGRAM.FOR
                    PROGTEST.Z-80
                    PROG.BAS
                    PROG123.REL
```

The question mark replaces any single character in the exact position it occupies.

```
?OOK.TXT will match COOK.TXT
                    BOOK.TXT
                    LOOK.TXT
                    NOOK.TXT
```

Brackets may be used to indicate that several single characters are to be substituted for that single character position. **Brackets may be used only in the utility programs Xfer and Stat.**

```
TEST[XYA-D].REL will match  TESTX.REL
                            TESTY.REL
                            TESTA.REL
                            TESTB.REL
                            TESTC.REL
                            TESTD.REL
```

Notes:

1. These replacement characters in no way alter the original file reference. They do not become part of the filename or filename extension. The asterisk and question mark serve only to refer to several files at once by creating an ambiguous file reference.

2. These replacement characters may be used only in commands and programs as specified in this manual.

Chapter 3

CDOSGEN

3.1 INTRODUCTION AND FEATURES

CDOSGEN is a very powerful feature of the Cromemco Disk Operating System. It allows CDOS to be built around the user's particular hardware configuration and software needs. As needs and equipment change, CDOS can be reconfigured in a matter of minutes to conform to a new hardware environment.

The ability to program twenty individual console function keys gives CDOS, and all programs run under CDOS, a new flexibility. These programmable keys can be used to facilitate user interaction with programs, any of the many languages offered by Cromemco, and CDOS itself.

CDOS supports up to 64 kilobytes of memory. CDOSGEN will design an operating system around any combination of up to eight disk drives. CDOS can support up to four floppy disk drives and up to seven hard disk drives with drive A being a floppy disk drive.

3.2 GENERATING A NEW CDOS

CDOSGEN is executed by responding to the CDOS prompt by typing **CDOSGEN.** The file CDOSGEN.COM must be located on the current drive or the master drive if a disk drive specifier is not used.

The program will prompt the user with questions concerning the desired system.

3.2.1 Memory Size

After the header, the first prompt CDOSGEN will display is:

```
Memory Size (3FFF through FFFF or 16K through 64) [n] ?
```

where n is the actual amount of memory available. There are three ways in which the user can respond to this. A hexadecimal number in the range from 3FFF to FFFF, or a decimal integer from 16 to 64, followed by a carriage return can be entered. The number entered specifies the highest address available to CDOS. For example, 7FFF or 32 would be entered to specify a 32K system (because this is the highest address of the top RAM card), BFFF or 48 for a 48K system, and FFFF or 64 for a 64K system. Or the user may enter a carriage RETURN which would cause the value n to be entered.

The bottom address of CDOS will always be loaded on an even 100H byte **page** boundary.

3.2.2 Disk Drive Configuration

The following table shows the drive configurations which CDOS will allow.

Drive	Type
A	floppy
B-D	floppy or hard
E-H	hard

After establishing the system size, CDOSGEN will begin querying the user about the disk drive configuration with the prompt:

```
Drive A Type (S=Small, L=Large) ?
```

Enter **S** if drive A is a 5 inch floppy drive or **L** for an 8 inch floppy drive. If the drive is a 5 inch drive, you will be asked:

```
Fast or slow seek [S] ?
```

Enter **S** or a RETURN if the 5 inch drive is the older style having a full width front door; otherwise, enter **F**. For both 5 and 8 inch drives you will be asked:

```
Single or Double Sided [S] ?
```

If the drive is double sided, then type **D** and press

RETURN. If the drive is single sided, press RETURN or type **S** and press RETURN.

```
     Single or Dual Density [S] ?
```

If the drive is dual density, capable of handling either single density or double density disks, type **D** and press RETURN. If the drive is single density, press RETURN or type **S** and press RETURN.

If drive A is designated as a large drive, CDOSGEN will make the assumption that drive B is also a large drive since Cromemco 8 inch floppy disk drives are always adjacent pairs. If drive A is a 5 inch drive and drive B is a large drive, CDOSGEN will assume that drive C is also a large drive.

The next prompt will be:

```
Drive X Type (S=Small, L=Large, H=Hard, N=None, E=End) ?
```

where X is a letter from B to H.

If you do not have a drive X and there are no more drives in your system, enter E for "end of drive specification." If you do not have a drive X and there are more drives in your system, enter N for "no drive assigned to this letter." If drive X is a hard disk, enter H.

3.2.3 Function Key Decoding

The user is then asked to specify the type of function key decoding desired:

```
     Function Key Decoding
     (S=Standard, N=None, U=User, F=File) [S] ?
```

These options are covered in the next sections.

The function key decoding options are supported by Cromemco 3102 and 3101 terminals. Users who have not incorporated either of these terminals into their system should respond to this prompt with an **N**.

3.2.3.1 Standard Function Key Decoding

Responding to the function key decoding prompt with an **S** will cause each of the function keys to issue a predefined standard command. These standard commands are:

F1	A:<RETURN>	F11	SCREEN<space>
F2	B:<RETURN>	F12	XFER/V<space>
F3	C:<RETURN>	F13	DEBUG <RETURN>
F4	D:<RETURN>	F14	C <RETURN>
F5	E:<RETURN>	F15	L$ <RETURN>
F6	F:<RETURN>	F16	G/r$(0) <RETURN>
F7	STAT/A<space>	F17	STAT/DT <RETURN>
F8	*.*<space>	F18	BASIC <RETURN>
F9	STAT <RETURN>	F19	XFER/C<space>
F10	STAT/B <RETURN>	F20	XFER/AT PRT:=<space>

All function keys, except F13 to F16, are designed to be used in response to the CDOS prompt. The commands which are terminated with a carriage RETURN (<RETURN>) are stand-alone functions and will cause CDOS to respond. Those terminated with a <space> will wait for the user to input a file reference followed by a carriage RETURN. Functions 13 through 16 are designed to be used with the Debug program.

3.2.3.2 No Function Key Decoding

Responding to the function key decoding prompt with an **N** will disable the function keys. This will also free some additional space in CDOS for drivers and allow CDOS to occupy less memory after booting.

3.2.3.3 User Defined Function Key Decoding

Responding to the function key decoding prompt with a **U** will cause CDOSGEN to prompt the user for the desired decoding of each function key. In response to each prompt (F1:, F2:, etc.) the user may enter any series of characters not including the ESCape character. In most applications, CNTRL-Z may be substituted for the ESCape character. The ESCape character terminates the current function key definition.

Any command, response, or instruction may be entered as a function. Then, when the function key is depressed, it will repeat the characters which were entered during the definition of the function. Functions keys may be defined for use while in CDOS, the Screen Editor, or any program using CDOS System Calls for console I/O.

Function sequences may contain or be terminated with a carriage RETURN character which, in CDOS, will cause execution of the command. Function sequences may also be terminated with a blank, allowing the user to supply additional information as well as a terminating carriage RETURN.

Function keys may be programmed with a command line which **includes** carriage RETURNs. Thus F1 may be programmed with the sequence:

```
DIR A:<RETURN>
DIR B:<RETURN>
<ESC>
```

When the F1 key is then depressed, the directory of the disk in drive A will be listed followed by the directory of the disk in drive B.

3.2.3.4 File-Defined Function Key Decoding

The file referred to in response to this query must be an assembled file which defines **each** of 20 functions. Each function definition contains the ASCII equivalent of the (command) line to be displayed when the function key is depressed and must be terminated by a -1 (FFH). There **must be** 20 terminators in the file.

Example:

The following file was assembled with the Cromemco Macro Assembler, linked with the Cromemco Linker (link/p:100,filename,filename/n/e), which saves the file on the disk as a COM file to give the standard CDOS function key decoding:

```
;STANDARD FUNCTION KEY DECODING FOR CDOS
;
;THIS FILE MUST CONTAIN 20 EOM'S REGARDLESS
;OF ANY OTHER CHARACTERS IT USES.
;
F1:         DB      'A:',CR,EOM
F2:         DB      'B:',CR,EOM
F3:         DB      'C:',CR,EOM
F4:         DB      'D:',CR,EOM
F5:         DB      'E:',CR,EOM
F6:         DB      'F:',CR,EOM
F7:         DB      'STAT/A ',EOM
F8:         DB      '*.* ',EOM
F9:         DB      'STAT',CR,EOM
F10:        DB      'STAT/B',CR,EOM
F11:        DB      'SCREEN ',EOM
F12:        DB      'XFER/V ',EOM
F13:        DB      'DEBUG',CR,EOM
F14:        DB      'C',CR,EOM
F15:        DB      'L$',CR,EOM
F16:        DB      'G/r$(0)',CR,EOM
F17:        DB      'STAT/DT'CR,EOM
F18:        DB      'BASIC',CR,EOM
F19:        DB      'XFER/CX ',EOM
F20:        DB      'XFER/AT PRT:= ',EOM
;
CR:         EQU     13      ;CARRIAGE RETURN
EOM:        EQU     -1      ;END OF MESSAGE
            END
```

3.2.4 Addresses

Several important addresses will be displayed.

Starting address of CDOS - This is the bottom of CDOS. The bottom of CDOS will always fall on an even 256 (100H) byte or page boundary.

Starting address of I/O drivers - This is the first location of the CDOS I/O drivers.

Last address of CDOS - This is the highest address used by CDOS. Memory between this address and the highest address in the system may be allocated by the user for a particular configuration of CDOS. This is not generally recommended.

Top of memory - This is the amount of memory that the user specified was in the system.

Size of CDOS - This is the Last address minus the Starting address.

Size of the Boot Loader - This is the size of the system area used.

3.2.5 Command File

You will be prompted for the command filename:

```
      Enter command filename [n:CDOS] -
```

where n is the current drive. There are two options here. Either a RETURN can be entered, so that CDOS.COM will be generated on the current drive, or another filename may be entered. The filename can have a different drive specifier only such as B:CDOS or a completely different name such as C:HARDOS. The extension COM will be automatically appended to the filename entered. Note that only the name CDOS.COM will boot the system from RDOS. However, a name such as HARDOS may be used to boot one CDOS from another.

3.2.6 Boot File

You will be prompted as to whether the boot file should be written to the disk:

```
Write system boot to drive n: (Y = Yes, N = No) [Y] ?
```

where drive n is the same as that of the COM file.

If Y is entered in response to the prompt for a boot file, the file will be written to the System Area of the same disk specified in the previous question and will **not** appear in the directory.

In order to bring up the system which was just created, the disk upon which the system was written must be placed in the A drive and then booted up. The user will not be running under the new CDOS until it is brought into memory and this is not done until CDOS is reloaded (booted up).

Chapter 4

CDOS OPERATION

4.1 SYSTEM STARTUP

4.1.1 Loading CDOS

With all the circuit boards installed, the terminal connected, and the switches set as described in the appendix, the following procedure will load CDOS:

1. Turn on the power to the computer, terminal, and disk if an external disk storage device is used.

2. Place the CDOS system diskette in disk drive A.

3. Press the carriage RETURN key up to four times to set the console baud rate. Carriage RETURNs do not need to be sent from a Cromemco 3102 terminal since these characters are automatically sent. If switch 3 of the disk controller board is set to the **ON** position, CDOS will automatically boot up at this point. If switch 3 is set **OFF**, RDOS will respond with a ";" prompt to which the user must respond with **b** and a RETURN to boot up CDOS.

The system is now up and running.

Either of the above procedures is known as a cold bootstrap which includes reading CDOS and the I/O routines from disk. All of CDOS is contained in the file CDOS.COM.

Note:

It is advisable to insert the disks after powering-up and remove them before powering-down the machine. The disks may be left in the drives when resetting the machine.

4.1.2 Warm Start and Drive Selection

When a command is issued, the current disk drive is always referred to unless another drive is specified in the command. The current drive can be changed by entering the disk specifier followed by a colon and a carriage RETURN to terminate.

If drive A is the current drive and it is desired to make drive B the current drive, the user should type:

```
B:<RETURN>
```

and the console will display **B.** indicating that drive B is now the current drive.

If an attempt is made to access a file without entering a disk specifier, CDOS will search the current disk and if it is not found will then search the master disk. If a disk specifier is entered, only the specified disk is searched.

Before a program is executed, the system logs off all drives by clearing the bitmaps. This is called a warm start. After a warm start when a drive is accessed a new bitmap will be obtained. See the Stat utility program for a method of determining whether or not a disk has been written to improperly.

4.2 CONTROL FUNCTIONS

Certain nonprinting characters, called **control characters**, serve to control specific console and printer operations. These characters are described and summarized in the following sections.

4.2.1 Console Control Characters

While typing a command, the standard buffer input mode is active and certain control characters may be used. To type a control character, press the CNTRL key first and hold it in a depressed position while typing the letter. Since a control character is nonprinting, in some applications it will be displayed on the console as the character preceded by an up-arrow (e.g. ^I). Following is a list of control characters and their functions:

^E — Physical carriage return and line feed, go to the next line without terminating.

Backspace
Underscore
RUBout
DELete — any of these will delete the last character entered without echo. These will backspace the cursor on a CRT terminal.

RETURN
^M — Either of these will terminate a command line.

^R — Retype current line (after many corrections).

PAUSE (3102 only)
^S — Pause during device I/O. This is primarily used to stop and restart a listing on the console. Any key may be typed to resume processing, but only ^S can be used to pause.

^U — Delete the current line. Used primarily with hard copy terminals.

CE (3102 only)
^V — Erase the current line.

^X — Delete the last character with echo. This deletes and echoes the character following three backslashes; three forward slashes are generated by resuming typing. Used with hard copy terminals.

4.2.2 Printer Control Characters

There are three control characters which are used to control output to the printer. They are:

^L — CNTRL-L sends a formfeed to the printer.

^N — This character is only for use with Cromemco Printer model 3703. When this character is included in a line which is sent to the printer, it will cause the **entire line** to be printed in double width characters. A line printed in double width characters may contain only half as many characters as a normal line because each double width character takes up twice as much room as a normal character.

PRINT (3102 terminals only)

^P Send all console output to the printer as well as to the terminal. This is a toggle action switch. By entering CNTRL-P output to the console will also be sent to the printer. Output to the printer in this mode can be terminated by entering another CNTRL-P. If a CNTRL-P is inadvertently sent while a printer is either not connected to the system or not enabled, another CNTRL-P will cancel the previous one. CNTRL-P automatically selects 3703 printers.

^T Turn off all output to the printer. This control character can be output by a user program but will have no effect if issued from the console.

^W Send all output to the printer as well as to the console. This control character can be output by a user program but will have no effect if issued from the console.

4.3 AUTOMATIC STARTUP AND PROGRAM EXECUTION

A very powerful feature of CDOS is the ability to enter directly into an application program when powering up the computer. This is done with the Batch file **STARTUP.CMD** which is accessed after booting up the computer or reentering CDOS. The contents of this Batch file will execute automatically. This is especially useful for the inexperienced user as there is no need to deal with any of the commands which are used to load and execute a program.

The following procedure will cause the BASIC user program MULTIPLY.SAV to automatically begin execution when CDOS is entered.

1. Make sure that there is a copy of the batch command file @.COM on disk A.

2. Save the BASIC program you want to RUN in a file (in this example we are using MULTIPLY.SAV). The program must be SAVEd (not LISTed) in order for this to work.

   Our program for this example is:

```
100 Rem This is my application program
110 First = 5
120 Second = 10
130 Print "The answer is "; First*Second
140 End
```

3. Using the Cromemco Screen Editor, create a file named STARTUP.CMD on disk A. This file must be named STARTUP.CMD since this is the filename that CDOS and @ (batch) look for.

   In this example the command file should contain the line:

   ```
   BASIC MULTIPLY.SAV
   ```

   When CDOS is entered, the batch command will call BASIC which will RUN the saved program MULTIPLY.SAV.

4. When the computer is turned on and CDOS is entered (you must depress the carriage return several times if you do not have a Cromemco 3102 terminal), our example will output the following:

   ```
   A.@ STARTUP
   @ (Batch) version ##.##

   A.BASIC MULTIPLY.SAV

   CROMEMCO 32K STRUCTURED BASIC version ##.##
   Copyright (c) 1977, 1979 Cromemco, Inc.

   The answer is 50

   ***140 End***

   >>
   ```

Note:

While the STARTUP.CMD file is controlling the operation of the system, the RETURN key, which is used to terminate a batch command, is disabled. After the STARTUP.CMD file has finished, this function will be returned to its normal mode of operation. The disabling of this function during the startup procedure can be useful in preventing a novice or unskilled user from inadvertently gaining control of the machine.

See the @ (Batch) command for further information.

4.4 COMMAND STRUCTURE AND SYNTAX

When a user enters a command on the console, CDOS processes the command to determine if it is one of the intrinsic commands (those commands which are internal to CDOS and are not saved as disk files). If the command is intrinsic, it is executed. If the command is not recognized as intrinsic, it is assumed to be a COMmand file on the disk and CDOS attempts to locate the file with the COM extension. If no disk is specified, the current disk is searched first, and if the file is not located, the master disk. If the program is found, it is loaded into memory starting at 100H, the remainder of the command line is passed to it as control information and execution is started at 100H. If it is not found, a message to that effect is displayed on the console.

The command line starts with an optional disk drive specifier. If this is omitted, the current disk drive is assumed except as noted previously. This is followed by the command with no extension (COM is assumed). The rest of the line is determined by the function being called. The following conventions are observed:

1. All options are preceded by a slash (/).

2. An assignment command generally follows this format:

   ```
   Destination-file-ref=Source-file-ref
   ```

3. A comma, blank, or equal sign acts as a delimiter to separate filenames.

4. All letters in command lines are translated into upper case upon entry. All filenames appear in upper case only, but may be referenced by any combination of upper and lower case characters.

5. A blank will be ignored except as a delimiter separating filenames.

4.5 RESET SWITCH

Pressing or turning the **reset** switch on your Cromemco computer causes a hardware reset. This causes control to be transferred to the power on jump address selected on the ZPU card. With the switches on the ZPU and disk controller cards set as suggested in the appendix, resetting the computer will cause control to be transferred to RDOS and, if switch 3 on the disk controller is ON, causes CDOS to automatically be reloaded into memory (cold bootstrap).

RESET will interrupt any disk operations in progress, so it is recommended that you not press RESET during a disk write operation.

Note:

If your terminal is not a Cromemco 3102, the RETURN key must be depressed several times after resetting the computer to reestablish the terminal baud rate.

Chapter 5

CDOS I/O DRIVERS

5.1 CROMEMCO PRINTER DRIVERS

CDOS is supplied with a printer driver designed for use with Cromemco dot matrix printers.

If a Cromemco typewriter quality character printer is to be used as the system printer, the special driver which is supplied with the Cromemco model 3355A printer must be used.

After CDOS has been loaded, place the disk containing the file 3355A.COM in the current drive or in the master drive. Type **3355A** followed by a RETURN and a message will be displayed when the driver has been properly loaded. The driver will remain loaded as long as the system is **not** rebooted.

If the typewriter quality character printer is to be used with the Cromemco Formatter II, the @ty command must be used at the beginning of the file which is to be formatted to specify this. This will cause the Formatter program to use an internal 3355A driver which incorporates microspacing to achieve margin justification. Refer to the Cromemco Formatter II Instruction Manual, part number 023-4027, for further information on this command.

5.2 ADDING NEW I/O DEVICE DRIVERS TO CDOS

Device drivers can be changed or added by modifying the source file to the CDOS I/O drivers which is called DRIVERS.Z-80. This may be used in conjunction with the Batch file, DRIVERS.CMD, to easily modify drivers for devices connected to CDOS. These files are available on the Cromemco Z-80 Macro Assembler diskette, model numbers FDA-L or FDA-S.

The ability to change the CDOS I/O drivers has several uses. First, it is a convenient way to remove portions of CDOS in order to make it occupy less machine memory. Second, it allows you to write custom drivers for nonstandard I/O devices and be able to access these through CDOS. Third, it is possible to have the I/O drivers make a decision on which of several devices to access according to the condition of the CDOS I/O Byte.

A programmer attempting to modify the drivers must be familiar with Z-80 assembly language programming, conditional assembly, the Cromemco Z-80 Macro Assembler, and the design of I/O drivers.

The file containing the CDOS I/O drivers is called DRIVERS.Z-80. This file contains switches for conditional assembly and EQUs for port assignments followed by the routines for the various devices.

The following guidelines should be observed when modifying the drivers:

1. The programmer must follow the instructions and notes in the source listing.

2. Tables must not be moved or changed. This applies to those tables which CDOS needs and expects in certain locations.

3. All routines are preceded by a header which specifies entry and/or exit parameters, register contents, etc. These specifications must be observed as CDOS is dependent upon them.

4. If the programmer uses any of the prime registers or the IX or IY registers their value must be preserved (typically on the stack). The nonprime registers need only be preserved to the extent which they are used.

5. The CDOS stack should not be used to a depth greater than ten (approximately).

The following procedure will create a CDOS with the modified I/O drivers as specified in the file MYDRIVER.Z-80. Notice that although the procedure must be followed step by step, the names of the files may be changed as desired. The commands in boldface are given in response to the CDOS prompt and the subsequent text explains the purpose of each.

XFER/V MYDRIVER.Z-80=DRIVERS.Z-80 makes a copy of the file DRIVERS.Z-80 called MYDRIVER.Z-80. This is done so that the original source file will be saved as a reference and backup.

SCREEN MYDRIVER.Z-80 loads the Screen editor and the file MYDRIVER.Z-80 so that the drivers can be changed. Many changes may be performed by merely changing the EQU's at the beginning of the source. For example, if the console to which CDOS is connected is a Model 3101 rather than a Model 3102, the I/O drivers can be changed to reflect this by changing the definition of **C3102** in the source to **FALSE** and **C3101** to **TRUE.** Model 3100 terminals may be selected by changing both **C3102** and **C3101** as for a Model 3101 terminal, as well as changing **FUN.KEYS** to **FALSE.**

ASMB MYDRIVER.@@Z HEX=0 assembles the drivers in HEX format with an ORG of 0H. The filename extension of @@Z will instruct the Assembler that the source file is on the current disk, the object file is to be placed on the current disk, and that no print file is to be produced. The address of 0H must be used.

REN MYD0.HEX=MYDRIVER.HEX renames the resultant HEX file.

ASMB MYDRIVER.@@Z HEX=100 assembles the drivers in HEX format with an ORG of 100H. The address of 100H must be used.

REN MYD100.HEX=MYDRIVER.HEX renames the assembled HEX file. The original source file, MYDRIVER.Z-80, remains unchanged on the current disk.

CDOSGEN MYD0.HEX MYD100.HEX generates a version of CDOS which includes the modified drivers. The two HEX files are used to relocate the drivers to their final location in CDOS. They must appear in the order shown for CDOSGEN to work correctly. All questions in CDOSGEN must be answered as usual. When CDOSGEN has finished writing the CDOS file to the disk, CDOS must be booted up again. To add these drivers to any copies of CDOS you make from now on, simply type this last command:

```
CDOSGEN Myd0.hex Myd100.hex
```

An example of using the I/O Byte to select a device is contained in the file DRIVERS.Z-80. Two printers, both one serial and one parallel may be connected to CDOS by specifying both the labels **C3703** and **S.PRINTER** as **TRUE,** and the label **NO.LST** as **2;** then reassembling and relocating the drivers as already described.

The program STAT (version 02.16 or higher) may then be used to select one of these two printers by one of the following commands:

```
STAT PRT:=0 (or STAT PRT:=PAR:)
STAT PRT:=1 (or STAT PRT:=SER:)
```

If the 3355A driver has been loaded, one of the previous two commands will select another printer in the system. If you wish to access the 3355A again, type:

```
STAT PRT:=2 (or STAT PRT:=TYP:)
```

Other multiple devices may be accessed through CDOS by first changing the the I/O Byte. Note that the standard I/O drivers have the code necessary to access two printers only. Other configurations of multiple devices must be designed and implemented by the user.

The configurations allowed by STAT are as follows:

```
STAT dev:=n:
```

where dev: = CON:, RDR:, PUN:, or PRT: and n = 0-7, 0-3, 0-1, or 0-3, respectively. The actual bit format of the CDOS I/O Byte is:

Bits 0,1,2 are assigned to CONsoles 0 through 7; Bits 3,4 are assigned to ReaDeRs 0 through 3; Bit 5 is assigned to PUNches 0 and 1; Bits 6,7 are assigned to PRinTers 0 through 3.

Chapter 6

CDOS COMMANDS

6.1 INTRINSIC COMMANDS

The intrinsic commands reside in the High Memory that is occupied by CDOS after the system has been loaded. Because these commands are intrinsic to CDOS, their execution does not alter the User Area of memory. All files referred to by intrinsic commands are disk files.

6.1.1 ATTRibutes

ATTR establishes or changes allowable file access modes.

```
Format:  ATTR file-ref [+][p...]
```

where:

file-ref — is a file reference which may include the * and ? replacement characters.

+ — is an optional parameter which indicates that the following ATTRibutes are to be **added** to those already describing the file.

p... — are optional ATTRibute parameters. They are abbreviated by one or more of the following letters:

- E — Erase protect. This file cannot be erased or renamed.
- R — Read protect. The system cannot read from this file. The file may be erased or executed.
- W — Write protect. The system cannot write to this file. The file may be erased or executed.
- S — System file.
- U — User file.

ATTRibutes may be deleted by assigning a new set of ATTRibutes or by giving the ATTR command with only a file reference and no optional parameters. This will cause all user assignable (erase, read, and write protect) ATTRibutes to be deleted. ATTRibutes may be added to those already existing by use of the '+' symbol.

Note:

ATTR is a software protection only against writing, reading, or erasing disk files. If more positive write protection is desired, the use of a write protect sticker is recommended.

The ATTR intrinsic can also be executed by typing ATRIB instead of ATTR.

Examples:

These examples assume that the following directory is on the current disk:

```
PROGRAM1  FOR    7K           PROGRAM2  FOR   18K
PROG             2K           PROGRAM1  REL    2K
PROGRAM2  REL    5K
*** 5 Files, 6 Entries, 34 K Displayed, 207 K Left ***
```

This directory indicates that none of the files have limited access modes (i.e., none of the allowable access modes have been altered by ATTR). If the command:

```
     ATTR *.FOR R
```

is given, then the directory will appear as follows:

```
PROGRAM1  FOR    7K R         PROGRAM2  FOR   18K R
PROG             2K           PROGRAM1  REL    2K
PROGRAM2  REL    5K
*** 5 Files, 6 Entries, 34 K Displayed, 207 K Left ***
```

The command used an ambiguous file reference to refer to all files on the current disk with the extension FOR (*.FOR). The command instructed the ATTR utility to make all the referenced files Read protected (by means of the R parameter). The R following each of two directory entries indicates that PROGRAM1.FOR and PROGRAM2.FOR have been given a Read protect status. If, following this, the command:

```
     ATTR PROGRAM1.FOR +EW
```

is given, then the directory will appear as:

```
PROGRAM1  FOR    7K EWR       PROGRAM2  FOR   18K R
PROG             2K           PROGRAM1  REL    2K
PROGRAM2  REL    5K
*** 5 Files, 6 Entries, 34 K Displayed, 207 K Left ***
```

This time ATTR used a single file reference (PROGRAM1.FOR). The command added (by means of the plus sign) categories of protection to the already existing category. The EWR following the file entry in the resulting directory indicates that the file PROGRAM1.FOR is now Write and Erase protected in addition to its previous status of being Read protected. If the plus sign had been omitted from the parameters specified for this command, the file would no longer be Read protected as the Write and Erase protect would have replaced, not have been added to, this status.

6.1.2 DIRectory

DIR lists disk filenames and sizes followed by a summary of the total disk space used by the files which were listed.

$$\text{Format:}\quad \textbf{DIR}\ [\left\{\begin{array}{l} \texttt{y:} \\ \texttt{file-ref} \end{array}\right\}]$$

where:

y is an optional disk drive specifier. When included in the command line, this parameter will specify the drive whose disk directory is to be examined. When omitted, the DIR command will default to the disk in the current drive. Values acceptable to CDOS are the letters A through H.

file-ref is an optional file reference which may include the * and ? replacement characters. When this parameter is included, only filename(s) which match the file reference will be listed.

Each line of the directory listing (except for the last line) includes:

1. filename,
2. filename extension (if one exists),
3. length of the file in kilobytes,
4. ATTRibute protection of the file.

The last line of the directory is a summary of the listing. This is not always the same as a summary all of the files on the disk. The summary line includes the total number of files, kilobytes, and entries which were listed, as well as the file space remaining on that disk.

For an alphabetized list of filenames and their sizes use Stat/A. An alphabetized list of filenames only is available from Stat/N.

Examples:

Assume that the DIR command, given without any of the optional parameters, will yield the following directory:

```
PROGRAM1  FOR    7K EW        PROGRAM2  FOR   18K EW
PROG             2K           PROGRAM1  REL    2K
PROGRAM2  REL    5K
*** 5 Files, 6 Entries, 34 K Displayed, 207 K Left ***
```

This is a listing of the names of all of the files on the current disk. If the current drive is not drive C, the command:

```
     DIR C:
```

might yield the following directory:

```
FILENAME  BAS   5K            BASIC     COM  19K
*** 2 Files, 3 Entries, 24 K Displayed, 217 K Left ***
```

This is a listing of the names of all the files on the disk in drive C.

The following command would give the user the names of all of the REL files on the current disk:

```
     DIR *.REL
```

The directory would appear as:

```
PROGRAM1  REL    2K           PROGRAM2  REL    5K
*** 2 Files, 2 Entries, 7 K Displayed, 207 K Left ***
```

6.1.3 ERAse

ERA deletes file(s) from a disk directory.

Format: **ERA** file-ref

where:

file-ref — is a file reference which may include the * and ? replacement characters. All file(s) which match the file reference will be deleted from the disk directory. The space on the disk which the erased files had occupied will then be available for other use. Files may also be selectively erased with Stat/E which prompts the user with each filename in alphabetical order.

It is possible to delete a great many files at one time using an ambiguous file reference. Caution is recommended when using replacement characters in the ERAse command file reference. Prior to issuing the ERA command, the DIR command may be given with the same file reference in order to obtain a list of the files which will be deleted by the ERA command. If a file has erase attribute protection, the attribute must be removed before the file can be erased.

Example:

If the current disk drive directory is:

```
PROGRAM1  FOR    7K          PROGRAM2  FOR   18K
PROG             2K          PROGRAM1  REL    2K
PROGRAM2  REL    5K
*** 5 Files, 6 Entries, 34 K Displayed, 207 K Left ***
```

then the command:

```
     ERA PROGRAM1.*
```

would erase the two files referred to by the ambiguous file reference. The resulting directory would appear as:

```
        PROGRAM2  FOR   18K           PROG             2K
        PROGRAM2  REL    5K
        *** 5 Files, 6 Entries, 34 K Displayed, 207 K Left ***
```

6.1.4 **REName**

REN changes the filename and/or filename extension of an existing file.

Format: **REN** new file-ref=old file-ref

where:

new file-ref is a file reference which may include the * and ? replacement characters. This is the file reference which will exist in the disk directory after the execution of the command. **Note:** If replacement characters are used in the new file-ref, they will be replaced by characters from the filename and filename extension referred to by the old file-ref. Replacement characters never appear in an actual filename or filename extension.

old file-ref is a file reference which may include the * and ? replacement characters. This is the file reference which existed in the disk directory before the execution of the command.

Initially, this command verifies that no file exists on the disk which satisfies the new file-ref. If the new file-ref includes a replacement character, any existing file which satisfies the ambiguous file reference will cause the message 'File already exists' to appear and command execution will be aborted. After this initial check, no further file reference checking takes place. It is possible, in a multiple REName command, to create more than one file with the same file reference. It is up to the user to ensure that this does not happen.

Note:

The ambiguous file reference will work only if there is no existing file that matches that reference. For example, if there is a file PROG.REL, then REN *.REL=*.HEX won't work. It will work if PROG.REL isn't there.

Examples:

Assume the directory on the current disk drive appears as follows:

```
PROGRAM1  FOR    7K           PROGRAM2  FOR  18K
PROG             2K           PROGRAM1  REL   2K
PROGRAM2  REL    5K
*** 5 Files, 6 Entries, 34 K Displayed, 207 K Left ***
```

If the files PROGRAM1.FOR and PROGRAM2.FOR are to be used as text files and the user wants to have their extensions reflect this, the following command will change each filename extension of FOR to TXT on the current disk.

```
REN *.TXT=*.FOR
```

If, in addition, the user desired to change the name of the file PROG to PROGRAM.FOR, the following command line would be entered:

```
REN PROGRAM.FOR=PROG
```

After giving these two commands, the directory would appear as:

```
PROGRAM1  TXT    7K           PROGRAM2  TXT   18K
PROGRAM   FOR    2K           PROGRAM1  REL    2K
PROGRAM2  REL    5K
*** 5 Files, 6 Entries, 34 K Displayed, 207 K Left ***
```

6.1.5 **SAVE**

SAVE causes part of the User Area to be saved on disk.

Format: **SAVE** file-ref n

where:

file-ref — will become the name of the SAVEd disk file.

n — is the decimal number of 256 byte pages to be saved.

The SAVE command may be used to save a portion of the User Area, beginning at 100H, in a disk file. For example, if a FORTRAN, COBOL, or Assembler program was linked without the /N option, before beginning execution the SAVE command may be issued to create a COMmand file. A COMmand file may have any filename and must have the filename extension COM.

The number of pages to be saved is displayed by the linker as the last of a series of three exit parameters enclosed in a set of brackets.

It may also be computed by converting the high byte of the highest address to be saved to decimal (e.g., if the user area is to be saved through address 0BFFH, convert 0B to decimal (11) and save 11 pages).

Remember that the user area starts at 100H and that the SAVE command saves from this address on.

6.1.6 **TYPE**

TYPE causes an ASCII file to be output to the console (and optionally to the printer).

Format: **TYPE** file-ref

where:

file-ref is the file to be TYPEd.

Note that only ASCII files may be TYPEd and that an attempt to TYPE a binary (i.e., relocatable or REL or COM) file will yield unpredictable results.

During the execution of this command all of the applicable console control characters will be in effect. CNTRL-S (PAUSE on a 3102) will cause the listing to pause, CNTRL-P (PRINT on a 3102) will cause the listing to go to the printer, and any other character will abort an active listing. Entering any character will restart a listing which has paused in response to a CNTRL-S.

If a CNTRL-W is included in the file to be TYPEd, all output following this character will be sent to the printer as well as the console. Output to the printer may be stopped by using the CNTRL-T character in the file being TYPEd.

6.2 UTILITY PROGRAMS

Utility programs are not part of CDOS but are supplied with most software packages. They reside on the disk as command files which can be called into the user area as desired. As opposed to intrinsic commands, execution of utility programs does alter the user area.

6.2.1 @ (Batch)

The Batch (@) utility allows the user to automatically execute a sequential list of commands from CDOS. In addition, in the immediate mode it allows the user to create a file of commands for one time execution.

```
Format (one time mode):
  [x:]@[/y] <RETURN>

Format (file mode):
  [x:]@[/y] [file-ref] [pl p2...p9]
```

where:

x is an optional disk drive specifier indicating the location of the batch COM file (@.COM). This parameter is required only if the COM file is not located on either the master drive or the current drive. Applicable values are the letters A through H.

y is an optional disk drive specifier indicating the location of the Batch work file, $$$$.CMD.

pl... are optional parameters to be passed to the CMD file.

In file mode, Batch takes its commands sequentially from a file containing all of the commands which are to be executed. In one time mode, Batch will prompt the user with an exclamation mark (!). Valid responses include all legal responses to the CDOS prompt. Execution of the batch command file will commence when a carriage return is entered in response to the prompt. During execution, Batch makes use of its own temporary file, $$$.CMD.

When used in the file mode, the Batch command references an ASCII file containing a list of CDOS commands. This file must have a filename extension of CMD.

The parameters pl through p9 are inserted wherever ^1,...,^9 appear(s) in the CMD file.

Note:

The file-ref (name of the Batch CMD file) may be referenced by using ^0. These are not control characters, but rather are the two separate characters, up-arrow (^) followed by a number.

Parameter 0 stands for the command file reference and with it you may refer to the CMD file reference itself. Parameters 1 through 9 are those in the command line. These parameter numbers may be repeated in a file. The up-arrow itself is represented in the command line by two successive up-arrow characters, only one of which is transmitted.

When the Batch command line is given, each word after the filename is treated as a parameter. More complex parameters may be enclosed in single quotation marks. If too many or too few parameters are given, Batch ignores either the extra parameters or the extra commands, respectively.

Examples:

The one time mode can be used to issue a long string of commands which are to be executed without user intervention. The user might issue the following sequence at the console (the A. is the CDOS prompt while the ! is the Batch one time mode prompt):

```
A.@<RETURN>                         (Batch - one time mode)
!DIR<RETURN>                        (types the DIRectory)
!TYPE PROGRAM1.FOR<RETURN>          (types the file)
!REN TEMP=PROGRAM1.FOR<RETURN>      (renames the file)
!<RETURN>                           (begins execution)
```

Following the null line, Batch immediately begins execution of the three commands issued, giving the command line for each one just prior to execution.

In the file mode Batch allows the user to create a file containing the desired command stream and to execute this file as often as desired. As the following example demonstrates, this can be useful for making a backup CDOS disk. The file used by Batch may be created using the Screen editor and must have an extension of CMD to be found by Batch. In this example, the file used by Batch is called COPY.CMD and contains:

```
XFER/V B:=A:*.COM
DIR B:
```

The user inserts a blank diskette containing only the CDOS resident image into drive B while the master copy of the CDOS.COM files is in drive A and then types the Batch command:

```
@ COPY
```

The system then copies all files with the filename extension COM from the disk in drive A to the disk in drive B. The copy routines are followed by a directory of disk B so the user may verify that all the desired files have been copied.

Suppose the user creates a file called EXAMPL.CMD containing the following:

```
DIR ^1
REN NEWFILE^2
```

The user then types

```
@ EXAMPL OLDFILE '=OLDFILE'
```

which will call the Batch file EXAMPL.CMD and pass it the parameters OLDFILE (for ^1) and '=OLDFILE' (for ^2).

```
DIR OLDFILE1
REN NEWFILE=OLDFILE
```

The system will then type the directory listing OLDFILE and its size followed by renaming OLDFILE. The equal sign (=) was included in the single quotation marks so that it could be passed as part of the second parameter.

The filename "startup.cmd" has special meaning when it is present on the disk that the system is booted from. After CDOS is loaded, it checks the master disk for the file **Startup.cmd.** If it is present, CDOS will execute it first before displaying the CDOS prompt.

6.2.2 DUMP

DUMP is used to display the contents of a file by 128 byte records.

Format: [x:]**DUMP** file-ref

where:

x — is an optional disk drive specifier indicating the location of the DUMP command file. This parameter is required only if the COM file is not located on either the master drive or the current drive. Applicable values are the letters A through H.

file-ref — is the file to be DUMPed.

The file is DUMPed in hexadecimal with the first address of a line displayed along the left margin and the ASCII characters corresponding to the hex displayed as characters on the right margin.

Unlike the TYPE intrinsic, both ASCII and binary files may be DUMPed. The records are numbered starting with 0.

6.2.3 INITialize

INIT is used to initialize large and small floppy diskettes and hard disks. This process records the track, sector, and surface information on the disk to enable the disk controller hardware to address and retrieve data.

Format: [x:]**INIT**

where:

x — is an optional disk drive specifier indicating the location of the INIT COM file. This parameter is required only if the COM file is not located on either the master drive or the current drive. Values acceptable to CDOS are the letters A through H.

All types of disks require initialization at some point after they are manufactured. Many floppy diskettes supplied by Cromemco have already been initialized and contain data. Cromemco hard disks are always initialized at the factory during testing. Therefore, INIT is a program which you may use infrequently or perhaps not at all.

Cromemco 8 inch floppy disks as supplied have been initialized for double sided use according to the IBM 3740 diskette format. It is recommended that the user not reinitialize these disks when new. Diskettes not supplied by Cromemco or diskettes that are to be used in single sided drives must be initialized. Blank 5 inch floppy disks require initialization before use. Occasionally any disk may require reinitialization due to magnetic damage.

Some of its uses are to initialize new, blank floppy diskettes, to reinitialize floppy disks which have developed soft errors through use with a misaligned drive, and to declare alternate tracks on a hard disk.

INIT is executed by typing its name in response to the CDOS prompt. INIT requires a number of parameters which must be supplied by the user in response to questions the program asks.

The first question asks which drive is to be initialized. INIT determines the allowable responses to this question from CDOS; therefore, it is important that

CDOS has been GENerated correctly for the computer system it is currently operating.

The user should supply the correct drive letter in response to this question.

INIT will then prompt the user for the format of the disk. You will be asked whether the disk is single sided or double sided and is single density or double density. Bracketed quantities following these questions are default values which can be entered by pressing the RETURN key. These values are derived from your configuration of CDOS.

The next two questions ask for the first and last cylinders to be initialized. If the entire disk is to be intialized, the RETURN key may be pressed twice to enter the default values. INIT is also capable of initializing any single track or any range of tracks.

The last question asks for the surfaces to be initialized. This question also has a default for all the surfaces on that type of drive (press RETURN to select the default). INIT is capable of initializing any single surface as well.

Following the termination of this question by the RETURN key, the program will begin initializing the appropriate disk according to your instructions. It is possible to abort the initialization in an emergency by pressing the ESCape key at this point.

When initialization is finished and control has returned to CDOS, the disk may be labeled using the program STAT/L.

INITializing a disk will destroy any information which may have been present on the disk.

Switch 4 on the 16FDC or 4FDC board must be off for initialization to take place. Double density initialization is not possible with the 4FDC.

6.2.3.1 Hard Disk Alternate Tracks

The INIT program will not return to CDOS immediately following initialization when INITing hard disks. Instead, it will ask one or two further questions about alternate track declaration. The user should be familiar with the track and sector structure of Cromemco hard disks before attempting to answer these questions.

These two questions ask whether you wish to redeclare the existing alternate tracks and whether you wish to add any new alternate tracks to the table. The usual procedure is to answer no to both these questions.

If you answer yes to either of these questions, you will be further prompted for the hard error track to be declared an alternate. These will automatically be assigned a number from 1 to 12 by the program. The program prohibits any illegal or unreasonable responses during this part, and also inhibits a CNTRL-C program abort. This is because the current alternate track declaration is being held in memory and has not yet been written back to the disk. **It is strongly recommended that you not reset your computer or otherwise prevent the normal operation of INIT in this section of the program.**

Alternate tracks which have been declared at the factory (discovered during testing) should under no circumstances be removed from the alternate track table. Doing so voids any warranties Cromemco makes for that hard disk drive. Cromemco keeps a record of the alternate tracks declared for each drive shipped.

6.2.4 STATus

The program STAT is used to display and change a variety of parameters used by the operating system. Its simplest use is to provide a printout on the console which is a complete summary of all aspects of the computer system. Here is an example of a STAT display:

```
STAT (System Status) version 02.16      9:29:01

SYSTEM MEMORY:                          DEVICE CONFIGURATION:
Operating system version    02.36       CON: = Console 0
Total system memory          64 K       PRT: = Printer 0  (PAR:)
Operating system size        14 K       RDR: = Reader  0
User memory size             49 K       PUN: = Punch   0

DISK MEMORY:                            DISK CONFIGURATION:
Disk label                SYSDISK       Master disk drive          A
Date on disk             03-24-81       Cluster size               2 K
Total disk space           494 K        Sector size              128
Disk space used by directory  4 K       Total directory entries  128
Disk space used by files    426 K       Directory entries used    55
Disk space left              64 K       Directory entries left    73

DRIVE:      Double sided, Single density
DISKETTE:   Double sided, Single density
```

STAT displays with the following information when applicable:

Time and Date: Printed on heading line if previously stored in CDOS.

System Memory: Description of amount and configuration of machine memory.

Device Configuration: Description of device assignment.

Disk Memory: Description of total, used, and available disk space (in kilobytes).

Disk Configuration: Description of total, used, and available disk space (in directory entries). Errors in the directory will be displayed.

Drive: Description of the selected drive.

Diskette: Description of floppy diskette mounted in the selected drive.

STAT, in the /B, /L, or /S modes, runs a validation of the disk directory to see if any cross-linked files have been created or if any clusters have not been allocated. These errors are caused by exchanging diskettes while executing a program that does not provide for this operation.

The general format of the command line for STAT includes a way to request information on any of the disk drives of the system:

```
STAT[/o1][/o2][/on.] [d:][parameters]
```

where the **on** represent one or more of the options described next, **d:** represents one of the disk drive specifiers (A-H), and **parameters** represents any of a number of other parameters which may be required. If the drive specifier is omitted, STAT will default to the current drive. Also note that multiple options may be specified; e.g., STAT/D/T and STAT/DT are both legal expressions.

If there is both a Cromemco 3703 (or 3779) and a 3355A printer in your system, you may use STAT to select the printer to be used. After the 3355A driver has been loaded, the 3355A printer will be selected. To access the dot matrix printer, type:

```
STAT PRT:=0 (or STAT PRT:=PAR:)
```

The 3355A printer may be reselected by typing:

```
STAT PRT:=2 (or STAT PRT:=TYP:)
```

Other devices may be accessed through CDOS by first changing the the I/O Byte. Note that the standard I/O drivers have the code necessary to access two printers only. Other configurations of multiple devices may be designed and implemented by the user.

A Option (Alphabetical directory listing)

This option will produce an alphabetical directory of filenames on the selected disk, along with the space allocated to each one and its system attributes. The format of the command is:

```
STAT/A [x:][file-ref]
```

where **x:** represents a disk specifier (A-H) and **file-ref** represents any single or ambiguous filename on that disk. Normal system status information is not displayed with this option unless the S option is invoked simultaneously. The format of this utility function exactly parallels that of the DIR command.

B Option (Brief system status)

This option allows the user to obtain a quick summary of available disk and machine memory if the normal full system status report is not desired. Upon typing **STAT/B** to select this option, the user is prompted with a display similar to the following:

```
User memory size           49K
Total disk space          243K
Disk space left            34K
Directory entries left    24
```

D Option (set system Date)

This option allows the user to store the current date in CDOS. This date may then be accessed by system or user programs through the Read Date system call (no. 144). The appropriate values will be returned in the A, B, and C registers in binary. Upon typing **STAT/D** to request this option, the user is prompted with

```
(mm/dd/yy):
```

and is expected to respond with the current month, date, and year. STAT will respond by printing the full date along with the day of the week. Subsequent executions of STAT will display the date on the header line if it has been previously set using the D option.

If CDOS is rebooted, the date stored is reset to 00/00/00. The normal printing of system status information is suppressed when the D option is specified. Also note that the date option may be used in conjunction with the time option by typing **STAT/DT.**

Pressing the RETURN key only in response to the date prompt above leaves alone the stored values for date in CDOS. This can be used if the user requested to set the date by means of STAT/D and then found it had been set previously.

E Option (Erase files)

The E option allows the user to erase files from a disk. STAT/E differs from the ERA intrinsic in that the user does not need to type in the filenames which are to be erased. Another difference is that STAT/E displays filenames in alphabetical order whereas ERA does not list filenames at all. Ambiguous file references can be made with STAT/E. When STAT/E is entered

```
     File erase, Query mode (Y=Yes, N=No) [Y] ?
```

will be displayed. If **N** is entered, all files on the disk will be erased. If **Y** or RETURN is pressed, the filenames will be displayed alphabetically and you will be asked if each file should be deleted:

```
     x:filename extension (Y/N) ?
```

If **N** is entered,

```
     x:filename extension (Y/N) ?  No
```

the file will not be erased and the next filename will be displayed. If **Y** is entered,

```
     x:filename extension (Y/N) ?  Yes, deleted
```

the file will be erased and you will then be asked about the next file.

If the file is erase protected,

```
     x:filename extension (Y/N) ?  erase-protected
```

will be displayed and the user will be prompted for the next file.

After the query for the last file,

```
     n files erased
```

will be displayed.

L Option (set Label)

This option is used to label a disk. Disk labels are a feature of Series-2 CDOS, which both allows users to assign a name and a date to their disk, and enables CDOS to obtain certain important information about that disk for file access. All system disks, including hard disks, should be labeled using the L option. A disk must be labeled before any files or data have been stored on it.

The label option is invoked by typing **STAT/L.** STAT/LS is very useful because it displays information about that disk both before and after labeling. Following the normal printout of system status, the user will be prompted for either three or four items of information which comprise the disk label: 1) whether the disk is single- or double sided, 2) the disk name, 3) the date, and 4) the number of directory entries.

All of these questions are supplied with a default quantity printed in brackets, which the user may specify by pressing the RETURN key only. If the disk has been previously labeled, the defaults will be the values stored in the existing label on the disk. If the disk has no label, the defaults will be those supplied by the STAT program; e.g., "Harddisk" and "Userdisk" are the built-in default names for hard disks and floppy disks, respectively. If a user has previously specified a date using the D option and no date is currently stored on the disk, the default date will be the current date.

The label option may be used to change the number of directory entries of a particular disk. The default values are 64 entries for all floppies except double sided 8" disks for which the default is 128, and 512 entries for a hard disk. It is frequently desirable to have more than 64 entries on a floppy disk if a large number of short files are being stored.

There is, however, a trade-off: increasing the allowed number of entries above 64 uses additional disk space for the directory. STAT will allow you to enter any value between 64 and 512 for the number of directory entries, but it will round the entered quantity to the next lower number evenly divisible by 4 (thus, 67 would be rounded to 64). In general, to make most efficient use of the disk, the number you enter for directory entries should be a multiple of 32 times the cluster size.

For example, hard disks have a cluster size of 2 Kbytes and thus should have n*(32*2) directory entries, where n=1,2,3,...,8. You can determine the cluster size for a particular disk from the normal system status display under DISK CONFIGURATION.

If adding or changing a label on a disk necessitates destroying a portion of the present disk directory, STAT will automatically ask whether or not it's OK to do so. Responding **N** to this question cancels the label request and no label is written. Responding **Y** to this question clears the present directory and writes the label. Be aware that this effectively creates a blank disk because, even though data may still be stored on the disk, there will be **no way to retrieve that information** once the directory is cleared.

M Option (select Master drive)

The M option allows the user to select a drive to be searched other than drive A if the file cannot be found on the current disk. This can be done by entering

```
STAT/M drive:
```

N Option (display filenames)

The N option will display the filenames on a disk in alphabetical order without their sizes. This is the fastest, most compact way to obtain an alphabetical list of the filenames in the directory.

S Option (force Status printout)

The S option is used in conjunction with other options to cause the normal system status display to be performed in addition to the other function(s) requested.

Any of the options described in this section may be specified together; e.g., STAT/A/S and STAT/DTS are both legal expressions.

T Option (set system Time)

This option is similar to the date option except that it allows the the user to enter the time. This will also be stored in CDOS, and may be used to set the time of a hardware clock device if the CDOS I/O drivers have been appropriately changed. Users of Series-2 CDOS with 3102 terminals will find that the T option sets the internal clock of the terminal. This may be displayed at any time by pressing CNTRL-1 to view the status line.

The time may be accessed by system or user programs through the Read Time system call (146). Refer to the section on CDOS system calls.

If CDOS is rebooted with the system power on, the time will not be changed. If the system power is turned off, the time stored is reset to 00:00:00. The normal printing of system status information is suppressed when the T option is specified. Also note that the time option may be used in conjunction with the date option by typing **STAT/DT.**

Pressing the RETURN key only in response to the time prompt printed by the T option leaves alone the stored values for time in CDOS. This can be used if the user requested to set the time by means of STAT/T and then found it had been set previously.

Z Option (delete all files on a disk)

The Z option, which must be used in conjunction with the E option, is similar to the E option without the query. The advantage of the Z option is that it may be used in batch mode. Ambiguous file references can be used.

```
STAT/EZ C:
```

will list all of the files in alphabetical order as they are being erased from the disk in drive C.

6.2.5 WRTSYS

WRTSYS is used to write to or read from the CDOS resident image in the system area of a disk.

```
                             { d:         }   { f:         }
Format:  [x:]WRTSYS[/s]      {            } = {            }
                             { file-ref-1 }   { file-ref-2 }
```

where:

x — is an optional disk drive specifier indicating the location of the WRTSYS COM file. This parameter is required only if the COM file is not located on either the master drive or the current drive. Applicable values are the letters A through H.

s — is an optional switch indicating that the system is to be written from one disk to another disk, but that only one disk drive is to be used. The program will prompt the user for insertion of the second disk. This is useful for computers having only one drive.

d — is a disk drive specifier indicating the disk upon which the CDOS resident image is to be written. Using this specifier with a filename in the described format indicates that CDOS is to be written to the system area of the disk.

f — is a disk drive specifier indicating the disk from which the CDOS resident image is to be copied. Using this specifier with a filename in the described format indicates that CDOS is to be copied from the system area of the disk.

file-ref-1 &
file-ref-2 — are each file references indicating the source and destination files respectively. Using a file reference indicates that CDOS is to be copied to or from the file area of the Disk.

The following conventions apply to both the left (destination) and right (source) sides of the equal sign. If only a disk drive specifier is used in the described format, the CDOS resident image is copied to or from the system area of that disk. If a file reference is used, it must have a filename extension of SYS. In this case the system will be written to or from a user file on the disk.

Note:

Using the WRTSYS program to copy any system files does not change the CDOS which is resident in the computer. To change the operating system in use, CDOS must be rebooted.

WRTSYS also preserves the eight byte label for a particular disk. Thus, one can WRTSYS from a double sided disk to a single sided disk, etc.

Examples:

The command

```
WRTSYS B:=A:
```

will copy CDOS from the system area of the disk in drive A to the system area of the disk in drive B. The WRTSYS program will be read from the current disk or, if there is no WRTSYS program on the current disk, from the disk in the master drive.

The command

```
D:WRTSYS A:=B:BOOT.SYS
```

will copy BOOT.SYS from the file area of the disk in drive B to the system area of the disk in drive A. The WRTSYS program will be read from the disk in drive D.

The command:

```
WRTSYS A:SPECIAL.SYS=A:
```

will copy CDOS from the system area of the disk in drive

A to a file called SPECIAL.SYS in the file area of the same disk. The WRTSYS program will be read from the current disk or, if there is no WRTSYS program on the current disk, from the disk in the master drive.

6.2.6 **XFER**

The XFER program transfers files from a disk or other device to another disk or device. It can be used in one of two modes. The repeat mode:

```
     Format:  [x:]XFER<RETURN>
```

will repeatedly prompt the user with an exclamation mark (!). Valid responses to this prompt are the same as the portion of the command line following the switches when XFER is used in the one-time mode. To exit to CDOS, press RETURN.

The one time mode will complete one (set of) transfer(s) per command and can be used with the optional switch(es).

```
     Format:
                      ( d:          )
[x:]XFER[/s1/s2...]  {               } =file-ref-2[,file-ref-3...]
                      ( file-ref-1  )
```

where:

x — is an optional disk drive specifier indicating the location of the XFER COM file. This parameter is required only if the COM file is not located on either the master drive or the current drive. Applicable values are the letters A through H.

s1,s2... — are any number of the following optional switches (each must be preceded by a slash):

A — transfer **ASCII** file. Eliminates end of file marker in all but the last of a group of concatenated files and prints a count of the lines copied.

C — Compare files without transfer. This operation is driven by the source (file-ref-2) file. If file-ref-2 is shorter than file-ref-1, and the two files are identical for the length of file-ref-2, then the two files will compare as the same.

F Filter out illegal ASCII characters (ASCII files only).

R transfer Read protected file.

S Strip all rubouts and nulls from file (ASCII files only).

T expand Tabs (ASCII files only).

V Verify files after transfer.

Z Do not print size statistics at completion of XFER.

d is the destination specifier. If a disk specifier alone is used, the original names and extensions of any files transferred will be preserved. Device specifiers can also be used here, e.g., **prt:**.

file-ref-1 is the destination file reference which may include the * and ? replacement characters. If replacement characters are used, the portion of the destination file reference which is ambiguous will match the source file.

file-ref-2... is (are) the source file reference(s). If only one file reference is used, it may include the * and ? replacement characters. If more than one source file is entered, they will be concatenated.

If more than one single file reference is given as the source, the files will be concatenated. If ASCII files are concatenated, the /A switch must be used to remove the end of file markers from between the files.

An ambiguous transfer with verification will be terminated by a verification error.

Note:

The XFER utility will transfer files only to and from the file area of the disk. The WRTSYS utility must be used to write system files to and from the system area of the disk.

XFER will not transfer random access files. Users who must copy random access or ISAM files will need to write a simple program (in the language that created the file) to transfer these files.

Examples:

The command

```
XFER/V B:=PROGRAM1.FOR
```

will copy and verify PROGRAM1.FOR from the current disk to disk B. The copied file will have the same filename and filename extension as the source file. The XFER program will be read from the current drive or the master drive.

The command

```
XFER B:=A:*.FOR
```

will copy all files with the filename extension FOR from drive A to drive B. Each of the copied files will have the same filename and filename extension as each of the source files. The XFER program will be read from the current drive or the master drive.

The command

```
XFER D:*.TXT=A:*.TYP
```

will copy all files with the filename extension TYP from drive A to drive D. Each of the copied files will have the same filename as each of the source files, but will have the filename extension TXT. The XFER program will be read from the current drive or the master drive.

Sending an ASCII file to the printer can be done in the following manner:

```
XFER/T PRT:=E:SOURCE.COB
```

This will copy the COBOL program SOURCE.COB on drive E to the printer. When sending text files to the printer it is good practice to use the T option so that tabs will be expanded into spaces.

The following command will copy all files from drive A to drive B and then verify these copies:

```
XFER/V B:=A:*.*
```

The XFER program will be read from the current drive or the master drive.

6.3 EDITORS

6.3.1 Cromemco Screen Editor

The Cromemco Screen Editor enables the user to create, edit, and save ASCII text or program files. The user who is not familiar with the CDOS Text Editor is referred to the **Cromemco Screen Editor Instruction Manual** (part number 023-0081). In particular, Chapter 2 will aid the novice user by means of an example of an actual Screen session.

The Cromemco Screen editor displays an entire screen of information during the editing process. A cursor in the display can be readily moved around the screen to add, delete, or change information. Special features of Cromemco CRT terminals such as cursor positioning, blinking fields, and programmable function keys are used to simplify operation to the fullest.

One important feature of the Screen editor is that it prompts the user automatically. This is done by using the top line of the screen display as a "menu" of command choices. By referring to this menu there is less need to refer back to the instruction manual during the routine operation of the editor. Another feature of the editor is that the user is politely notified by a beeping tone if an illegal command has been entered.

6.3.2 Cromemco Text Editor

The Cromemco CDOS Text Editor, also known as **EDIT**, enables the user to create, edit, and save ASCII text or program files. The Text Editor is versatile in that it can be used to manipulate and edit text on a line, word, or character basis. Characters and words can be inserted in, deleted from, or changed within a line of text. The point of change can be chosen to be between any two characters. Insertions and deletions can be made that cover more than one line of text. The Text Editor is not encumbered by line numbers or other extraneous information, and operates using only the text itself as a guideline to changes.

The user who is not familiar with the CDOS Text Editor is referred to the **Cromemco Text Editor Instruction Manual**, part number 023-0040.

Chapter 7

PROGRAMMER'S GUIDE

7.1 INTRODUCTION TO CDOS SYSTEM CALLS

To a programmer, system calls are the single most important feature of CDOS. The user who is writing assembly language programs to run under CDOS should become familiar with their use.

A system call is a call to the operating system which initiates a function, usually involving one of the I/O devices. The most important system calls perform I/O with the disk drives. CDOS also has system calls to perform device I/O with CRTs, printers, punches, and readers. System calls are available to perform such special purpose functions as storing and reading the date or time of day and multiplying and dividing integers.

A system call is executed by loading the **C register** with the number of the call and loading any entry parameters into the specified registers. Upon execution of a Z-80 **CALL 5** instruction, CDOS will perform the desired function. When CDOS has finished, it will return to the user program with a **RET** (return) instruction.

All Z-80 registers will be preserved by system calls except the F (Flag) register and those containing Return Parameters. Programs may safely use the Z-80 set of Primed Registers for temporary storage because system calls which use these registers restore their former values. Entry Parameters are preserved by system calls unless otherwise noted.

All device and disk input and output should be done through the CDOS system calls. This allows user programs to be independent of physical devices or port assignments and assures that the program will be able to run on other Cromemco machines regardless of how I/O devices are connected to those machines. If a change needs to be made in a device driver, it has only to be done once in the system drivers and this change becomes effective in all programs which access that driver through the system calls.

To use one of these routines, the C register must be set to the function number given with the title of each system call. The other registers are set up as the system call requires (for example, the E or DE registers usually contain the entry parameter passed). A CALL 5 instruction is then executed to carry out the function. Remember that CDOS initializes location 5 with a jump instruction. This is done so that the location of CDOS in memory is transparent to a user program. A program using the CDOS system functions does not therefore need to (nor should it) perform a CALL to a particular address in High Memory.

7.2 CDOS MEMORY ALLOCATION

CDOS resides in High Memory. It reserves memory below 100H for its own use. The user is left all memory from 100H to the beginning of CDOS, usually about 48K.

A program with the three-letter filename extension COM can be loaded and executed by typing the program name. The program must have its origin at 100H because that is where CDOS loads and executes it. (Note that when saving files that have been linked using the CROMEMCO Linker, they can be LINKed anywhere using the /P option. This is because LINK automatically puts the correct jump instruction at 100H.) After it is loaded, the program can use any memory at all. Note however that if it alters the CDOS areas, it will have no way of communicating with the disk or returning to CDOS. (CDOS will have to be reloaded by resetting the computer.)

When loaded, CDOS places a jump instruction at bytes 0, 1 and 2. If a jump is made to location 0, the CDOS warm start, control will be returned with the prompt for the current drive (e.g., **A.**). This is the proper method for exiting from a program. Command lines may then be entered from the console keyboard. CDOS places another jump instruction at locations 5, 6 and 7. The normal way to make system requests of CDOS is to call location 5. The address stored at locations 6 and 7 is the address of the beginning of CDOS and thus marks the upper limit of user memory.

The following address map describes the memory area from 0 to 0FFH. All addresses are in hex.

0....2	CDOS reentry
3	I/O byte
4	reserved
5....7	system jump call
8	FFH if running under CDOS, C3H if running under the Cromix CDOS Simulator
30...32	breakpoints for DEBUG
38...3A	jump to "Invalid jump" message
40...59	reserved
5A	flag
5B	flag
5C...6B	default File Control Block 1 (FCB-1)
6C...7B	default File Control Block 2 (FCB-2)
7C...7F	reserved
80...FF	default command line buffer

When a COM program is run by typing the program name on the console, the default command line buffer and default file control blocks are used as follows. FCB-1 will contain the first filename, if any, which was typed after the program name. FCB-2 will contain the second filename, if any. These filenames will be converted to FCB format names, i.e., spaces added. The default buffer will contain the entire command line following the program name. For example, if this command line is typed:

```
PROG FILE1.Z80 FILE2.COM
```

CDOS will place " FILE1   Z80" in FCB-1, " FILE2   COM" in FCB-2, " FILE1.Z80 FILE2.COM" in the command line buffer, and load and execute PROG.COM at 100H. Note that the second FCB starts before the end of the first FCB (FCB-1 is 33 bytes long and there are 16 bytes allotted for it if there is an FCB-2). Before using FCB-1, FCB-2 should be moved. If it is not moved, part of FCB-2 will be destroyed.

The command line which is placed in the default buffer can be used to send more than two filenames to a program, or to start execution of a program with various options specified. For the following command line:

```
PROG FILE1.Z80 FILE2.COM OPTION1 OPTION2
```

the string of ASCII characters " FILE1.Z80 FILE2.COM OPTION1 OPTION2" will be stored beginning at location 81H. The byte at location 80H will contain the length of the string. The byte following the string will contain a null (00). PROG.COM can then look at the command line stored in the default buffer to determine which options were specified.

When a program is loaded, the disk buffer is set to 80H, which is the default command buffer. If the disk is then read to or written from, this buffer will be altered. The program must either reset the disk buffer to another area or move the command line before accessing the disk, if it is desired to save the command line.

7.3 FILE CONTROL BLOCKS

CDOS divides the disk into regions called files. Files are referenced through file control blocks (FCBs). FCBs are 33 bytes long and have the following format:

Byte	Contents
0	**Disk descriptor** before an open (0=current disk, 1 - 8 for drives A - H; the disk number is stored in bits 0 - 3) **Attribute byte** after an open (attributes are stored in bits 4 - 7) bit 7 - write protect 6 - read protect 5 - system file 4 - user file
1 - 8	**filename** (right-filled with blanks)
9 - 11	**File type(extension)** (right-filled with blanks)
12	**File entry or extent** (initially 0; is incremented by one in every new entry of 16 Kbytes)
13 - 14	**Reserved**
15	**Record count** (total number of records in this entry)
16 - 31	**Cluster allocation map** (clusters allocated to this entry)
32	**Next record** (next record to be read or written; has the value 0 through 127)

7.4 DIRECTORY ENTRIES

A directory entry is a description of usage of an extent. It describes the attributes, name, and location of the file, or portion of file, in that extent. The structure of directory entries is similar to that of an FCB.

Byte	Contents
0	special - bit 7 - **erase protected** 6 - **write protected** 5 - **read protected** 4 - **system file attribute** 3 - **user file attribute** 2 - **extended file format** 1 - not used 0 - either **erased file** if the byte value is E5H or **disk label** if the byte value is 81H
1 - 8	**filename**
9 - 11	**filename extension**
12	**extent number**
13	not used
14	**record count in last extent** (for hard disks only)
15	**record count**
16 - 31	**cluster numbers**

Extent number indicates the number of the directory entry for files larger than 16K. The first directory entry number is zero.

Record count indicates how many 128 byte records there are in the entry.

Cluster numbers are either one or two byte pointers as defined in the disk label. One byte pointers allow a range of cluster numbers from 0 to 255 and are used on floppy disks. Two byte pointers are used on hard disks and have a range of 0 to 65535. The cluster itself is either 1K or 2K depending upon the disk format, i.e., double sided single density, double sided double density, hard disk, etc.

If the **extended file format** bit is set in the directory entry this indicates to CDOS that the cluster pointers point to a 2K cluster of directory entries instead of a 2K cluster of file. This is used only on hard disks for files larger than 16K (1 extent).

7.5 DISK LABEL STRUCTURE

The first directory entry is the disk label and its structure is different than that of other directory entries. It includes the name of the disk, the date that the disk was labeled, and disk format information.

Byte	Contents
0	**Label flag** This byte is always 81H
1 - 8	**Label name** (right-filled with blanks)
9 - 11	**Date** Byte 9 = month 10 = day 11 = year (relative to 1900)
12	**Number of records per cluster** CDOS records are 128 bytes long. Since cluster size is either 1K or 2K, this value is either 8 or 16 (10H).
13	**Flags** Bit 7 = 2-byte cluster pointers 6 = extended file format (hard disk only) 5 = bitmap on disk (hard disk only) 4 through 0 are not used
14	**Reserved**
15	**Record count of directory** (total number of 128 byte records)
16 - 31	**Cluster numbers of the directory**

The extended file format bit in the disk label of a hard disk indicates to CDOS that it is necessary to check directory entries to determine if the file is larger than 16K (1 extent).

7.6 INTERRUPTS

During disk I/O operations interrupts are disabled. When a system call is made, interrupts may also be disabled. Registers should be saved on a user stack before an interrupt so that they may be restored after the interrupt and have the desired contents.

7.7 CDOS SYSTEM CALLS

System call:	**program abort** 0 (00H)
Purpose:	This call will abort the current program and return control to CDOS.
Calling parameters:	None
Return parameters:	None

This call has the same effect as jumping to location 0. This is the normal method for exiting from a program.

This call is implemented in the Cromix CDOS Simulator.

System call: **read console** (with echo)
1 (01H)

Purpose: This call is used to retrieve a single character (one byte) from the console keyboard and echo it to the screen.

Calling parameters: None

Return parameters: **A** will contain the byte with the parity bit (Bit 7) reset.

CDOS does not return control to the user program until a character has been read and echoed back to the CRT.

Note that a CNTRL-Z (^Z) character is usually to be considered by a user program as an end of file mark. Also, most other control characters will **not** be echoed back to the CRT and some have special meanings for the operating system. For example, CNTRL-J (LF), CNTRL-M (CR), and CNTRL-G (BEL) are echoed directly, CNTRL-I (TAB) is echoed as expanded spaces (see **write console**), and CNTRL-P will toggle the printer on and off and is not echoed.

This call is implemented in the Cromix CDOS Simulator.

System call:	**write console** 2 (02H)
Purpose:	This call is used to write a single ASCII character (one byte) to the CRT.
Calling parameters:	**E** contains the byte to be written.
Return parameters:	None

CDOS will wait until the console is ready to receive the character and then print it.

After CNTRL-P (^P) is typed while CDOS is outputting characters with this system call, all subsequent characters are sent to both the console and the printer until CNTRL-P is depressed a second time (thus CNTRL-P acts as a toggle switch).

CNTRL-W (^W) also causes subsequent characters to be sent to both the console and the printer but must be encountered in a file to do so. CNTRL-T (^T) in a file cancels the effect of **either** the CNTRL-W or the CNTRL-P and causes characters to be sent only to the console. CNTRL-W and CNTRL-T may be edited into a file so when that file is being typed out on the console, it can stop and start the printer at the appropriate places.

CNTRL-I is the tab character and is converted to spaces as it is typed out so that the cursor is positioned at one of the standard tab stops: column 1, 9, 17, 25, 33, 41, 49, 57, 65, or 73. However, the tab is still stored internally in a file as a single ASCII character (09H).

This call is implemented in the Cromix CDOS Simulator.

System call: **read reader**
3 (03H)

Purpose: This call will read one character from a paper tape or card reader or any device connected in its location in the CDOS I/O drivers.

Calling parameters: None

Return parameters: **A** contains the 8 bits which were read (the parity bit is not stripped).

Since no card or paper tape reader is connected to a standard Cromemco computer system, the port assignments and method of interface (default is serial) for this system call are set up initially with the console as a dummy reader.

Also note that console status is checked during the read for the CNTRL-S (^S) toggle, enabling the user to stop/start the reading process at will. This is useful for pausing during a paper tape jam, for example.

This call is implemented in the Cromix CDOS Simulator.

System call: **write punch**
4 (04H)

Purpose: This call will punch one character on a paper tape punch or any device connected in its location in the CDOS I/O drivers. All 8 bits are punched (including the parity bit).

Calling parameters: **E** contains the byte to be punched.

Return parameters: None

The character is placed in the E register. The system will wait until the punch is turned on and is ready to receive the character.

Since no paper tape punch is connected to a standard Cromemco computer system, the port assignments and method of interface (default is serial) for this system call are set up initially with the console as a dummy punch.

Also note that console status is checked during the read for CNTRL-S (^S), enabling the user to stop/start the punching process. This is useful for pausing during a paper tape jam.

This call is implemented in the Cromix CDOS Simulator.

System call:	**write list** 5 (05H)
Purpose:	This call will print a single character (one byte) on the printer.
Calling parameters:	E contains the byte to be printed.
Return parameters:	None

The character is placed in the E register. The system will wait until the printer is ready to receive the character.

Tabs are not expanded, and control characters which do not have meaning to the printer will be transmitted anyway. Cromemco printers will ignore such control characters. A useful control character for the Cromemco Model 3703 Printer is CNTRL-N (^N), which, when present in a line of printer output, will cause that line to be printed in double width characters.

Also note that console status is checked during the printing for the CNTRL-S (^S) character, enabling the user to stop/start the listing. This is useful for pausing to start a new box of line printer paper.

This call is implemented in the Cromix CDOS Simulator.

System call: **get I/O byte**
7 (07H)

Purpose: Allows for CDOS to interact with additional or different I/O devices.

Calling parameters: None

Return parameters: A will contain the IOBYTE.

The format of the IOBYTE is:

Bit	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Device	**PRT**		**Punch**	**Reader**		**Console**		

I/O Byte

Up to eight devices can be designated, three of which are for paper tape punch and reader, and two for printers. This byte is not used by the standard CDOS I/O drivers. It is, however, used by the 3355A printer driver. The program STAT can modify this byte.

The IOBYTE is stored at location 03H.

This call is implemented in the Cromix CDOS Simulator.

System call:	**set I/O byte** 8 (08H)
Purpose:	This call allows the user program to set the IOBYTE.
Calling parameters:	E contains the IOBYTE.
Return parameters:	None

The format of the IOBYTE is shown in the description of the previous system call.

Up to eight devices can be designated, three of which are for paper tape punch and reader, and two for printers. This byte is not used by the standard CDOS I/O drivers. It is, however, used by the 3355A printer driver. The program STAT can modify this byte.

The IOBYTE is stored at location 03H.

This call is implemented in the Cromix CDOS Simulator.

System call:	**print buffered line** 9 (09H)
Purpose:	This call will print a string of ASCII characters which has been terminated with the dollar sign ($) character.
Calling parameters:	**DE** contains the address of the beginning of the string.
Return parameters:	None

When the line is being output, the following characters will have special meaning:

CNTRL-P (^P)	Toggle printer/console link. When this character is first typed, the link is toggled **on.** All characters will then be sent to the console and the printer. The next time the character is typed, the toggle will be turned off. All characters will then be sent only to the console.
CNTRL-W (^W)	Send all output to the printer as well as to the console.
CNTRL-T (^T)	Turn off all output to the printer.

This call is implemented in the Cromix CDOS Simulator.

System call: **input buffered line**
10 (0AH)

Purpose: This call will read an input line from the console.

Calling parameters: **DE** contains the address of an available buffer.

Return parameters: None

The first byte of the buffer must contain the maximum length of the buffer. On return from this call the second byte of the buffer will contain the actual length entered. The line that is input will be stored beginning at the third byte. If the buffer is not full, the byte at the end of the line will contain a zero.

When the line is being entered, the following characters will have special meaning:

CNTRL-C (^C) Abort. Warm boot back to CDOS.

CNTRL-E (^E) Physical CR-LF. The line is not terminated and nothing is entered into the buffer. This character is used to enter a line longer than can be entered on the console.

CNTRL-P (^P) Toggle printer/console link. When this character is first typed, the link is toggled **on**. All characters will then be sent to the console and the printer. The next time the character is typed, the toggle will be turned off. All characters will then be sent only to the console.

CNTRL-R (^R) Repeat what has been typed so far on the line.

CNTRL-U (^U) Delete the entered line and go back to beginning of buffer for new line.

CNTRL-V (^V) Delete all previous characters on the current line and back up the cursor (used for CRT terminals).

CNTRL-X (^X) Delete the previous character and echo the deleted character (used for hard copy terminals).

RUBout — Delete the previous character and back up the cursor (used for CRT terminals).

DEL — Same as RUBout.

Underscore — Same as RUBout.

Backspace (^H) — Same as RUBout.

This call is implemented in the Cromix CDOS Simulator.

System call: **test for console ready**
11 (0BH)

Purpose: The console is tested to see if a character has been typed.

Calling parameters: None

Return parameters: **A** contains -1 (0FFH) if a character was typed.
A contains 0 if no character was typed.

This call may be used during the running of a program to check the console keyboard to see whether a key has been depressed (i.e., CNTRL-C, ESCape, etc.) without causing a noticeable break in the program.

This call is implemented in the Cromix CDOS Simulator.

System call:	**deselect current disk** 12 (0CH)
Purpose:	Deselects the current disk.
Calling parameters:	None
Return parameters:	None

When a program finishes executing, CDOS logs off the bitmap of all diskettes. This system call logs off the bitmap of the current disk.

Disks should not be changed during program execution unless this call is used because data could be written to an allocated cluster as the bitmap of the old disk is still in memory. The Cromemco Screen Editor uses this call when a disk overflows.

This call is ignored in the Cromix CDOS Simulator.

System call: **reset CDOS parameter area & select master drive**
13 (0DH)

Purpose: CDOS parameters are initialized and the master drive is selected as the current drive.

Calling parameters: None

Return parameters: None

This call resets CDOS by a jump to location 0, logs off all disks, sets the current drive to A, and sets the disk I/O buffer at 80H. Disks will be logged on as soon as they are accessed.

This call is implemented in the Cromix CDOS Simulator.

System call: **select current disk drive**
14 (0EH)

Purpose: The specified disk drive is selected as the current disk.

Calling parameters: E contains a number corresponding to a drive (0 - 7 for drives A - H).

Return parameters: None

This call should be used in conjunction with **search directory for filename** (11H) and **find next directory entry** (12H).

This call is used to change the current disk. CDOS uses this call when you type a disk specifier to change the current disk. BASIC uses this call with the DSK command.

This call is implemented in the Cromix CDOS Simulator.

System call: **open disk file**
15 (0FH)

Purpose: This call opens a file to allow reading or writing to that file.

Calling parameters: **DE** contains the address of the FCB which specifies the filename.

Return parameters: **A** contains the record number if the file is found.
A contains -1 (0FFH) if the file is not found.

CDOS call 86H may be used before this call to set up a valid FCB from a string.

When this call is made the cluster map in the directory entry is loaded into the FCB.

A file does not need to be opened with this call if it has just been created with **create file** (16H).

This call is implemented in the Cromix CDOS Simulator.

System call: **close disk file**
16 (10H)

Purpose: The disk file is closed and the disk directory is updated (i.e., the FCB containing updated cluster information is written to the disk).

Calling parameters: **DE** contains the address of the FCB describing the file to be closed.

Return parameters: **A** contains the directory block number if the file is found.
A contains -1 (0FFH) if the file is not found.

The file described by the FCB should have been previously opened or created. A file to which bytes have just been written **must** be closed using this function or the entire last entry (or extent) will be unable to be read (i.e., no cluster information will be present for this entry in the directory).

This call is implemented in the Cromix CDOS Simulator.

System call: **search directory for filename**
17 (11H)

Purpose: The directory is searched for the first occurrence of the file specified in the FCB.

Calling parameters: **DE** contains the address of the FCB.

Return parameters: **A** contains the block number if the file is found.
A contains -1 (0FFH) if the file is not found.

HL contains the address of the directory entry.

ASCII question mark (? - 3FH) in the FCB matches any character. The current drive will be designated if 3FH appears in the first byte of the FCB and deleted entries will be found as well as valid entries.

An important point to note about this call and the one following (12H) is that they will get the directory entry whether it has been erased or not; i.e., these calls do not check to see if a file has been erased. Files are erased by placing a 0E5H in the first byte of the FCB; the remaining bytes are left unchanged.

This call is implemented in the Cromix CDOS Simulator.

System call: **find next directory entry**
18 (12H)

Purpose: This call is the same as 11H (17) described previously except that it finds the **next** occurrence of the filename in the directory.

Calling parameters: **DE** contains the address of the FCB.

Return parameters: **A** contains the block number if found (see description of directory block numbers in 0FH - Open Disk File described previously).
A contains -1 (0FFH) if the filename is not found.

HL contains the address of the directory entry.

This may be either the next entry of a file occupying several entries (extents), or another filename if the question mark match character (?) is used in the FCB. This call is made after system call 17 and no other disk system function can be executed between these calls.

This call is implemented in the Cromix CDOS Simulator.

System call:	**delete file** 19 (13H)
Purpose:	The ambiguous file specified by the FCB is deleted from the disk directory.
Calling parameters:	**DE** contains the address of the FCB.
Return parameters:	**A** contains the number of deleted directory entries.

ASCII question marks (3FH) which appear in the FCB will match any character in the corresponding position of filenames in the directory. A series of eight questions marks in the filename portion of the FCB corresponds to an asterisk (*) which is a CDOS ambiguous filename replacement character.

This call is implemented in the Cromix CDOS Simulator.

System call: **read next record**
20 (14H)

Purpose: The next record (128 bytes) is read into the current disk buffer.

Calling parameters: **DE** contains the address of the FCB.

Return parameters: **A** will contain one of the following:

0 - read completed
1 - end of file
2 - read attempted on unwritten cluster (random access files only)

The last byte of the FCB is incremented to read the next record.

The default disk buffer at 80H will be used unless CDOS call 26H is made.

This call is implemented in the Cromix CDOS Simulator.

System call: **write next record**
21 (15H)

Purpose: The next record (128 bytes) is written into the file from the current disk buffer.

Calling parameters: **DE** contains the address of the FCB.

Return parameters: **A** contains one of the following:

```
 0 - write completed
 1 - entry error (attempted to close
     an unopened entry)
 2 - out of disk space
-1 - (or FFH) out of directory space
```

The last byte of the FCB is incremented to be ready to write the next record.

The default disk buffer at 80H will be used unless CDOS call 26H is made.

This call is implemented in the Cromix CDOS Simulator.

System call: **create file**
22 (16H)

Purpose: The file specified in the FCB is created on the disk.

Calling parameters: **DE** contains the address of the FCB.

Return parameters: **A** contains the block number of the directory entry (see 0FH - **open disk file**).
A contains -1 (0FFH) if there is no more directory space or the file already exists.

This call is implemented in the Cromix CDOS Simulator.

System call:	**rename file** 23 (17H)
Purpose:	This call will rename a disk file.
Calling parameters:	**DE** contains the address of the FCB.
Return parameters:	**A** contains the number of renamed directory entries.

The old filename and file type are in the first 16 bytes and the new filename and file type are in the second 16 bytes of the FCB. ASCII question mark (?) in the FCB will match with any character.

This call is implemented in the Cromix CDOS Simulator.

System call: **get disk log-in vector**
24 (18H)

Purpose: This call is used to determine which disks are logged in.

Calling parameters: None

Return parameters: **A** contains a byte specifying which disks are logged in.

Each bit represents one disk drive logged in. If the bit is a one, then it is logged in; else it is off-line. The least significant bit is the A drive, next most significant (Bit 1) is drive B, etc.

CDOS call 18H may be used to determine which drives were used in the program up to the time this call was made.

This call is not implemented in the Cromix CDOS Simulator.

System call: **get current disk**
25 (19H)

Purpose: The number of the current disk drive is returned.

Calling parameters: None.

Return parameters: **A** contains a number (0 - 7) corresponding to a drive (A - H).

CDOS uses this call to display the correct CDOS prompt.

CDOS call 19H may be used to get the value of the current drive. This value can be stored so that if the program selects another current drive the program may return to the old current drive.

This call is implemented in the Cromix CDOS Simulator.

System call:	**set disk buffer** 26 (1AH)
Purpose:	This call sets an existing buffer to be used for disk I/O.
Calling parameters:	**DE** contains the address of the disk buffer.
Return parameters:	None

This call sets a disk buffer 128 bytes long.

The default disk buffer at location 80H is used if this call is not made. The user should take care not to overwrite the system area from 0H to 100H and CDOS. The bottom of CDOS can be determined with CDOS call 97H.

This call is implemented in the Cromix CDOS Simulator.

System call:	**get disk cluster allocation map** 27 (1BH)
Purpose:	Returns information about disk storage.
Calling parameters:	None
Return parameters:	**BC** contains the address of a bitmap which corresponds to the allocated clusters on the disk. **DE** contains the number of clusters on the current disk. **HL** contains last address in CDOS. **A** contains the number records per cluster.

This call may be used to determine how much free space there is on a disk. This is done by multiplying the number of bits not set in the bitmap by the number of records on the current disk. The number of bits in the bitmap is the same as the number of clusters on the current disk.

This call is not implemented in the Cromix CDOS Simulator.

System call: **read console (without echo)**
128 (80H)

Purpose: This call is the same as **read console (with echo)** except that it does not echo the character after it is read.

Calling parameters: None

Return parameters: **A** contains the byte read.

CDOS does not return control to the user program until a character has been read.

Note that a CNTRL-Z (^Z) character is usually to be considered by a user program as an end of file mark. CNTRL-P will toggle a printer on and off.

This call is implemented in the Cromix CDOS Simulator.

System call: **get user-register pointer**
129 (81H)

Purpose: This call is provided for expansion of CDOS to a multiprogramming system.

Calling parameters: None

Return parameters: **BC** contains the address of the user register pointers.

This call may be used to access the Standard Device Driver Table.

Example:

```
          LD        C,81H
          CALL      5
          LD        HL,3
          ADD       HL,BC
          LD        E,(HL)
          INC       HL
          LD        E,(HL)
```

DE will now be pointing to the Standard Device Driver Table.

This call is not implemented in the Cromix CDOS Simulator.

System call: **set user CONTROL-C abort**
130 (82H)

Purpose: When CNTRL-C (^C) is typed, the system normally aborts and returns control to CDOS. This call allows the programmer to change the address to which control is transferred when CNTRL-C is typed (i.e., a user may assign a new function to CNTRL-C).

Calling parameters: **DE** contains the address.
If **DE** contains 0, the system abort is reset.
If **DE** contains -1 (0FFH), CNTRL-C will be disabled.

Return parameters: None

Jumping to location 0 at any time causes a return to CDOS as well as restoring CNTRL-C to its original function **unless DE contained -1.** In which case CNTRL-C will be disabled.

If CNTRL-C is disabled, CMD files cannot be aborted by pressing the RETURN key.

This call is implemented in the Cromix CDOS Simulator.

System call: **read logical record**
131 (83H)

Purpose: This system call will read a logical record from the disk without any attention to the files it may contain (i.e., no FCB is specified). A record is defined to be one record of 128 bytes.

Calling parameters: **B** contains the disk number (0 for current drive, 1 - 8 for A - H).

If bit 6 of register B is set to 1, **HLDE** should contain the record number.
If bit 6 of register B is set to 0, **DE** should contain the record number.

If bit 7 of register B is set to 1, the read is interleaved.
If bit 7 of register B is set to 0, the read is noninterleaved.

Return parameters: **A** contains the read status corresponding to one of the following:

0 - OK
1 - I/O error
2 - illegal request
3 - illegal record

Interleaved means the record which is read is found in the order CDOS stores it. Noninterleaved means the record which is read is found in sequential order, the order it is physically stored on the disk.

An example will help to illustrate the use of these parameters. CDOS makes use of 716 sectors on the small single sided single density floppy disks. The record numbers which can legally be loaded into the DE register are 0 through 715 decimal, or 0 through 2CBH. Suppose that DE is loaded with the value 2 and the B register with 0 (current disk, noninterleaved read). Thus, since the sectors are numbered beginning with 1, sector 3 would be read into memory in the disk buffer (located at 80H if it has not been changed). The same read with the B register loaded with 80H (current disk, interleaved read) would read sector 0BH (the third sector when they are read every fifth one).

This call is not implemented in the Cromix CDOS Simulator.

System call: **write logical record**
132 (84H)

Purpose: This system call will write a logical record or sector to the disk without any attention to the file there (no FCB is specified).

Calling parameters: **B** contains the disk number (0 for current drive, 1 - 8 for A - H).

If bit 6 of register B is set to 1, **HLDE** should contain the record number.
If bit 6 of register B is set to 0, **DE** should contain the record number.

If bit 7 of register B is set to 1, the read is interleaved.
If bit 7 of register B is set to 0, the read is noninterleaved.

Return parameters: **A** contains the read status corresponding to one of the following:

0 - OK
1 - I/O error
2 - illegal request
3 - illegal record

This call is not implemented in the Cromix CDOS Simulator.

System call: **format name to file control block**
134 (86H)

Purpose: This system call will build the filename portion of a File Control Block from an input string.

Calling parameters: **HL** contains the address of the start of the input line.

DE contains the address where the FCB is to be built.

Return parameters: **HL** contains the address of the terminator that ended the build operation.

The input line is of the format:

```
d:filename.ext
```

where **d:** represents an optional disk specifier, one of A-H, the filename is up to 8 letters with a 3 letter extension. If a disk specifier is not included, the current drive will be accessed. The FCB is then built from this input line, converting lower case to upper case. The input line is terminated by an ASCII slash (/), equals (=), comma (,), or any character with an ASCII value less than 21H (such as a space or carriage return).

This call formats only the filename portion of the FCB. System call 0FH, **open disk file**, will complete construction of a valid FCB.

The ambiguous replacement character * will be expanded to question marks to fill out the appropriate portion of the input line.

This call is implemented in the Cromix CDOS Simulator.

System call: **update directory entry**
135 (87H)

Purpose: The last disk I/O function called must have been system call 17 or 18, Search Directory or Find Next Entry. The directory entry is then updated on the disk; this means that the entry is written back to the disk without the user having to specify a block.

Calling parameters: **DE** contains the FCB used in the system call 17 or 18.

Return parameters: None

The user merely specifies a filename when calling 17 or 18. This is useful if it is desired to change a directory entry and write it back to the disk.

This call is not implemented in the Cromix CDOS Simulator.

System call: **link to new program**
136 (88H)

Purpose: This enables one command program to call another.

Calling parameters: **DE** contains the address of the FCB of the new program (which must have an extension of COM).

Return parameters: If the new program is **not** found, **A** contains -1 (0FFH). In this case the first 80H bytes (from 100H to 17FH) will be destroyed because this is used in reading the directory.

If the program is found execution begins at 100H, no return is made to the original program.

The default command line buffer and default FCBs for the new program must be set up prior to this call if that program expects to be able to use them.

This call is not implemented in the Cromix CDOS Simulator.

System call: **multiply integers**
137 (89H)

Purpose: This system call provides a 16 bit multiply.

Calling parameters: **HL** and **DE** contain the two 16-bit factors.

Return parameters: **DE** contains the result (i.e., DE = DE*HL).

This call is implemented in the Cromix CDOS Simulator.

System call:	**divide integers** 138 (8AH)
Purpose:	This system call provides a 16-bit divide.
Calling parameters:	**HL** contains the dividend. **DE** contains the divisor.
Return parameters:	**HL** contains the quotient (i.e., HL = HL/DE). **DE** contains the remainder (i.e., DE = remainder).

This call is implemented in the Cromix CDOS Simulator.

System call: **home drive head**
139 (8BH)

Purpose: The disk drive specified is sent a command to **home** the head. The disk drive head will return to track 0.

Calling parameters: **B** contains the number corresponding to the drive to be homed (0 for current drive and 1 - 8 for drives A - H).

Return parameters: None

This call should be used before using **read logical record** or **write logical record** for the first time.

This call is not implemented in the Cromix CDOS Simulator.

System call:	**eject diskette** 140 (8CH)
Purpose:	This call will eject a diskette an 8" floppy disk drive.
Calling parameters:	E contains the number corresponding to the drive with the disk to be ejected (0 for current drive and 1 -8 for drives A - H).
Return parameters:	None

This call will eject a diskette from a Cromemco 8" floppy disk drive with the eject option. Otherwise, the call will have no effect.

This call is not implemented in the Cromix CDOS Simulator.

System call: **get CDOS version and release numbers**
141 (8DH)

Purpose: This call will return the version and release numbers of CDOS.

Calling parameters: None.

Return parameters: **B** contains the CDOS version number Binary Coded Decimal.

C contains the release number in BCD.

A contains a number corresponding to the operating system being used:

0 - CDOS
1 - Multi-User BASIC Operating System
2 - Cromix Operating System

The user's program can make this call and check the version number of CDOS to verify that that operating system is current enough to include all of the necessary system calls for the program to function correctly.

This call is implemented in the Cromix CDOS Simulator. The simulator will return the current version of CDOS.

System call: **set special CRT function**
142 (8EH)

Purpose: This call is used to perform special functions on CRT terminals. The call is designed to be very broad and include as many of the special features available in present-day intelligent terminals as possible. In particular it allows the programmer to take full advantage of the features available in Cromemco Model 3102, 3101, and 3100 CRT terminals.

Calling parameters: **DE** contains parameters as defined in the following chart:

Function	D	E
* address cursor on screen	1-80	1-24
* clear CRT screen	0	0
* home cursor without clearing	1	0
* cursor left one character position	2	0
* cursor right one character position	3	0
* cursor up one line	4	0
* cursor down one line	5	0
* clear to end of line from cursor position	6	0
* clear to end of screen from cursor position	7	0
intensity set to high light	8	0
* intensity set to low-light	9	0
* intensity set to normal-light	10	0
* keyboard enable	11	0
* keyboard disable	12	0
* dynamic function keys	13	0
* static function keys	14	0
* protected field begin	15	0
* protected field end	16	0
* blinking characters begin	17	0
* blinking characters end	18	0
* send from cursor position to end of line	19	0
* send from cursor position to end of screen	20	0
* transmit screen out auxiliary port	21	0
* delete character at present cursor position	22	0
insert character at present cursor position	23	0
delete line at present cursor position	24	0
insert line at present cursor position	25	0
* formatted screen on	26	0
* formatted screen off	27	0
reverse background field begin	28	0
reverse background field end	29	0
underlining characters begin	30	0

underlining characters end	31	0
display message on	32	0
display message off	33	0
CPU message deposit	34	0
HL points to the message which is terminated by 00H.		
insert character off	35	0
graphics mode on	36	0
graphics mode off	37	0
cursor on (3102 toggle)	38	0
cursor off (3102 toggle)	39	0
memory lock on	40	0
memory lock off	41	0
line lock	42	0
A contains the line number.		
line unlock	43	0
A contains the line number.		
read character at cursor	44	0
alarm on	45	0
alarm off	46	0

Return parameters: None except **read character at cursor** returns the character read in the A register.

Those features marked with an asterisk (*) above are all standard features of a Cromemco Model 3101 terminal. The E register is always loaded with 0 to select any special CRT function except cursor addressing.

For cursor addressing the D register should contain the column address (1 through 80 for Cromemco CRTs) and the E register should contain the row address (1 through 24 for Cromemco CRTs) of the desired cursor position. The system call will generate no error if these values are exceeded. Addressing the cursor at a nonexistent location may cause it to disappear from the screen. The location (1,1) is considered to be the upper left-hand corner and the location (80,24) the lower right-hand corner of the screen.

Dynamic function keys enables the preset function key coding. **Static function keys** disables those preset functions and each function key sends a unique control character sequence.

This call is implemented in the Cromix CDOS Simulator.

System call:	**set calendar date** 143 (8FH)
Purpose:	This call is used to store the date (day/mon/yr) in CDOS.
Calling parameters:	**B** contains the day. **D** contains the month. **E** contains the year minus 1900.
Return parameters:	None

The values entered into the registers will be stored in locations in CDOS where they may be accessed by user programs (through system call 144) and thus added to listings or other output.

The operating system makes no check for the correctness or plausibility of the incoming values; thus, it is up to the user to supply this error-checking. Also, the date is not stored on the disk and is thus volatile (will be lost if the user reboots or turns off the power).

The program STAT uses this call to set the current date.

This call is implemented in the Cromix CDOS Simulator.

System call: **read calendar date**
144 (90H)

Purpose: This call is used to retrieve the date (day/mon/yr) stored in CDOS by system call 143.

Calling parameters: None

Return parameters: **A** contains the day.

B contains the month.

C contains the year minus 1900.

No entry parameters are required other than the value in the C register. Note that the C register is changed by this call unlike most other system calls which preserve C.

This is the function which should be used by a program to recover the last previously stored date from the operating system. Note that if **set date** has not yet been used, **read date** will return the values 00/00/00.

The program STAT uses this call to read the current date.

This call is implemented in the Cromix CDOS Simulator.

System call:	**set time of day** 145 (91H)
Purpose:	This call is used to store the time of day (sec/min/hr) in CDOS for use by a hardware clock or user program.
Calling parameters:	**B** contains the seconds. **D** contains the minutes. **E** contains the hours in 24-hour time.
Return parameters:	None

The values in these registers will be stored in locations in CDOS where they may either be accessed and updated by user programs or may in turn be stored in registers of an electronic clock.

The operating system makes no check for the correctness or plausibility of the incoming values. It is up to the user to supply this error checking. Note in the I/O device drivers that a dummy routine is supplied to **start clock.** This dummy routine is called by the operating system during the **set time** function; thus, users may substitute their own routine in the drivers to initialize a hardware clock.

The program STAT uses this call to set the current time. If there is a Cromemco 3102 terminal in the user's system, its clock can be set with STAT/T.

This call is implemented in the Cromix CDOS Simulator.

System call: **read time of day**
146 (92H)

Purpose: This call is used to retrieve the time of day (sec/min/hr) stored in CDOS by system call 145.

Calling parameters: None

Return parameters: **A** contains the seconds.

B contains the minutes.

C contains the hours in 24-hour time.

Note that the C register is changed by this call unlike most other system calls which preserve C.

This is the function which should be used by a program to recover the last previously stored time from the operating system. Note that if Set Time has not yet been used, Read Time will return the values 00/00/00.

The I/O Device Drivers contain a dummy routine to Read Clock. This dummy routine is called by CDOS during the Read Time system call. Thus, users may substitute their own routine in the drivers to read the time from a hardware clock and store it in the time registers also supplied in the drivers.

The program STAT uses this call to display the time.

This call is implemented in the Cromix CDOS Simulator.

System call:	**set program return code** 147 (93H)
Purpose:	Sets return code for the next program.
Calling parameters:	**A** contains the return code for the next program.
Return parameters:	None

The currently running program can use this call as a flag for subsequent programs. When the next program is loaded CDOS will load the program return code in the A register. The A register should be checked as the first operation in the new program, as CDOS will not retain the value of the return code.

The value of the return code is assigned by the user program and has no meaning for CDOS.

This call is implemented in the Cromix CDOS Simulator.

System call:	**set file attributes** 148 (94H)
Purpose:	This call is used to set and/or add file protection flags.
Calling parameters:	**DE** contains the FCB address. **B** contains a byte the bits of which correspond to file attributes.
Return parameters:	None

If the following bits are set to 1 the attributes will be enabled:

Bit set	Attribute
7	Erase protect
6	Write protect
5	Read protect
4	Not currently used
3	Not currently used
2	Not currently used
1	Not currently used
0	Add to current attributes

This call is ignored in the Cromix CDOS Simulator.

System call:	**read disk label** 149 (95H)
Purpose:	This call is used to read the label stored at the beginning of a disk directory for all CDOS disks.
Calling parameters:	**DE** contains the address of the FCB entry.
Return parameters:	**A** is 0 if there was no error. **A** is not 0 if an error occurred.

For hard disks and floppies the label becomes the first entry in the directory. It has roughly the same format as a file FCB, containing both the label name in bytes 2-9 and the cluster numbers allocated to the directory in bytes 16-31. The first byte of the entry will be 81H, which indicates that this is a label.

Be aware that since the label always occupies the first entry of a disk, a disk allowing a total of n directory entries will have only n-1 entries available to files. It is also important to note that directory entries of a hard disk represent the space assigned to that file through secondary directories which are transparent to the user. This means that the number of declared directory entries (minus one for the label) is the actual maximum number of files which may be stored on that hard disk. For floppy disks, however, each directory entry represents a maximum of 16 Kbytes of file space. This means that individual files which are allocated more than 16 Kbytes of disk space will be assigned another directory entry for each additional 16K used.

There is a second part to the CDOS disk label which is written to the last eight bytes of the first sector on the disk (in double sided drives this is cylinder 0, side 0, sector 1). The format of these bytes is:

bytes 1,2: The ASCII characters **LG** for large diskettes; **SM** for small diskettes; **HD** for hard disks.

bytes 3,4: The ASCII characters **SS** for single sided diskettes; **DS** for double sided diskettes; **11** for 11 megabyte hard disks.

bytes 5,6: The ASCII characters **SD** for single density; **DD** for double density.

bytes 7,8: Reserved for future expansion.

If any of bytes 3 through 6 are missing from a diskette (e.g., if all 8 bytes are E5H as on a new diskette), CDOS assumes single sided and/or single density.

Finally, some programmers may find it useful to read and check the disk label from programs to determine whether or not the user has inserted the proper diskette. This may be done through the Read Disk Label system call (no. 149) with the DE register pointing to 32 bytes of free memory where the label name and other information can be stored. The byte pointed to by DE should contain a 0 to read the label of the current disk, and 1-8 to read the label of drives A-H, respectively.

The desired label name will be read into the 8 bytes beginning with the memory location pointed to by DE+1. This will be followed by the last disk date, the cluster numbers assigned to the directory, and other information used by CDOS. Disk labels, unlike filenames, may be both upper and lower case so user programs checking for a particular label should typically translate all characters in the label name to upper case. A label name which is returned as all ASCII periods (2EH) indicates that that disk has not yet been logged on. A label name which is returned as all ASCII spaces (20H) indicates that that disk does not have a label (single sided, single density floppy).

This call is not implemented in the Cromix CDOS Simulator.

System call:	**turn drive motors off** 150 (96H)
Purpose:	This call is used to turn off the disk drive motors.
Calling parameters:	None
Return parameters:	None

No parameters are required on entry or given on return from this call other than the value in the C register.

This call may be used by any program which will perform its primary function in memory over a long period of time during which there will be few disk accesses (e.g., an editor or interpreter).

Note that there is no corollary call to turn the motors on. This will be performed automatically by the operating system the next time any disk operation is attempted. CDOS will also pause for approximately 1 second after turning on the motors and before accessing the disk **only** if the **motor off** call has been issued. This is to allow the motors to come up to speed before the disk is accessed. This call has no affect on hard disks.

This call is ignored in the Cromix CDOS Simulator.

System call: **set bottom of CDOS in RAM**
151 (97H)

Purpose: This call is used to set the bottom address of CDOS to a lower value than the one at which CDOS was originally loaded when it was booted up.

Calling parameters: **E** contains the high byte of the address of the new bottom of CDOS.

Return parameters: None

The high byte of the address of the new bottom is placed into the E register prior to executing the call. The low byte is assumed 0; thus, the bottom of CDOS can never be located on any address other than a 256 byte boundary. If the value is -1 (0FFH) or any other value greater than the high byte of the original bottom when booting up, CDOS will restore this original bottom address.

This function will change the system call jump at locations 5, 6, and 7. Programs using the address at locations 6 and 7 to determine the size of the present User Area will find this area to be reduced in size. A second set of jumps (9 bytes) will be loaded at the new bottom of CDOS which points to the old bottom so that system calls will still execute correctly. Note that CDOS is in no way relocated by this function and will reside in the same memory space as it did previously. The purpose of the call is to make it possible to attach a permanent patch space to CDOS for programs which are to become a permanent part of the operating system for as long as it resides in memory. The only way the patch space may be removed is by a second **set bottom** call.

This call is not implemented in the Cromix CDOS Simulator.

System call: **read current record**
152 (98H)

Purpose: The current record is read into the current disk buffer.

Calling parameters: **DE** contains the FCB address.

Return parameters: **A** will contain one of the following:

0 if OK;
1 if end of file;
2 if tried to read an unwritten record.

This call is the same as **read next record** except that it does not update to the next record. This is useful for random access applications.

The default disk buffer at 80H will be used unless CDOS call 26H is made.

This call is implemented in the Cromix CDOS Simulator.

System call:	**write current record** 153 (99H)
Purpose:	The current record is written into the file from the current disk buffer.
Calling parameters:	**DE** contains the FCB address.
Return parameters:	**A** will contain: 0 if OK; 1 if entry error; 2 if out of disk space; -1 if out of directory space.

This call is the same as **write next record** except that it does not update to the next record. This is useful for random access applications.

This call is implemented in the Cromix CDOS Simulator.

System call:	**check if allocated** 154 (9AH)
Purpose:	Determines if a record is written.
Calling parameters:	**DE** contains the FCB address.
Return parameters:	**A** is 0 if allocated. **A** is -1 (0FFH) if not allocated.

This call may be used in conjunction with random files to determine if a record is unwritten.

This call is implemented in the Cromix CDOS Simulator, but always returns 0 in the A register.

System call:	**list directory** 156 (9CH)
Purpose:	This call lists the directory of a disk.
Calling parameters:	**DE** contains the FCB address of the filename.
Return parameters:	None

Call 86H should be used prior to this call to ensure a valid FCB.

This call is implemented in the Cromix CDOS Simulator.

System call: **set options**
157 (9DH)

Purpose: This call sets I/O and verify options.

Calling parameters: **D** contains the desired options.

E contains the mask.

Return parameters: **A** will contain the old options.

If the following bits are set to **1** the options will be enabled:

The mask should contain a **1** in every bit position to be changed.

0 - CNTRL-P flag
1 - read after write
2 - ESCape key use as carriage RETURN
3 - do not echo carriage RETURN
6 - do not echo

Upon exit from the program options 2, 3, and 6 will be restored to their normal state of **0** and option 1 will be restored to its normal state of **1**. Option 0 will not change state upon exit. It is recommended that the user **not set read after write** because valuable error checking will be lost. Data integrity cannot be assured if there is not a verifying read after the write.

This call is implemented in the Cromix CDOS Simulator.

System call:	**delete extents** 158 (9EH)
Purpose:	Reduces size of file.
Calling parameters:	**DE** contains the FCB address.
Return parameters:	**A** is 0 if not found. **A** is 1 if found and erased.

This call is not implemented in the Cromix CDOS Simulator.

System call:	**get master drive** 159 (9FH)
Purpose:	Determines which drive is the master drive.
Calling parameters:	None.
Return parameters:	**A** will contain the master drive number. **B** will contain the number of the last drive used in the batch command (@).

The master drive is the drive which is searched if a file cannot be found on the current drive. If the master drive is the current drive it will be searched only once.

The master drive is set with the M option of the STAT utility.

This call is not implemented in the Cromix CDOS Simulator.

Summary of CDOS System Calls

The following is a summary table listing all of the system calls implemented in CDOS version 02.17 along with their entry and return parameters. The system calls are listed in numerical order, i.e., by order of the number which is loaded into the C register to achieve the desired function.

Number	Function	Entry Parameters	Return Parameters
0	PROGRAM ABORT	none	none
1	READ CONSOLE (with echo)	none	A = character (parity bit reset)
2	WRITE CONSOLE	E = character	none
3	READ READER	none	A = character
4	WRITE PUNCH	E = character	none
5	WRITE LIST	E = character	none
6	not in use		
7	GET I/O BYTE	none	A = I/O byte
8	SET I/O BYTE	E = I/O byte	none
9	PRINT BUFFERED LINE	DE = buffer address	none
10 (0AH)	INPUT BUFFERED LINE	DE = buffer address	none

11 (0BH)	TEST CONSOLE READY	none	A = -1 (FFH) if ready
			A = 0 if not ready

12 (0CH)	DESELECT CURRENT DISK	none	none
13 (0DH)	RESET CDOS AND SELECT DRIVE A	none	none
14 (0EH)	SELECT CURRENT DISK	E = disk drive no.	none

15 (0FH)	OPEN DISK FILE	DE = FCB address	A = directory block
			A = -1 (FFH) if not found

16 (10H)	CLOSE DISK FILE	DE = FCB address	A = directory block
			A = -1 (FFH) if not found

Number	Function	Entry Parameters	Return Parameters

17 (11H)	SEARCH DIRECTORY FOR FILENAME	DE = FCB address	A = directory block
			A = -1 (FFH) if not found

18 (12H)	FIND NEXT ENTRY IN DIRECTORY	DE = FCB address	A = directory block
			A = -1 (FFH) if not found

19 (13H)	DELETE FILE	DE = FCB address	A = number of entries deleted
20 (14H)	READ NEXT RECORD	DE = FCB address	A = 0 if OK A = 1 if end of file A = 2 if tried to read unwritten records

21 (15H)	WRITE NEXT RECORD	DE = FCB address	A = 0 if OK
			A = 1 if entry error
			A = 2 if out of disk space
			A = -1 (FFH) if out of directory space

22 (16H)	CREATE FILE	DE = FCB address	A = directory block A = -1 (FFH) if out of directory space
23 (17H)	RENAME FILE	DE = FCB address	A = number of entries renamed
24 (18H)	GET DISK LOG IN VECTOR	none	A = those disks currently logged in
25 (19H)	CURRENT DISK	none	A = disk drive number
26 (1AH)	SET DISK BUFFER	DE = buffer address	none

27 (1BH)	DISK CLUSTER ALLOCATION MAP	none	BC = address of bitmap
			DE = number of clusters
			HE = last address of CDOS
			A = records/cluster

128 (80H)	READ CONSOLE (with no echo)	none	A = character
129 (81H)	GET USER REGI-STER POINTER	none	BC = pointer to user register pointers
130 (82H)	SET USER CNTRL-C ABORT	DE = address of ^C handler (0 to reset; -1 to disable)	none

Number	Function	Entry Parameters	Return Parameters

131 (83H)	READ LOGICAL RECORD	DE = block number
		B = drive number
		B top bit = 1 if interleaved
			A = 0 if OK
			A = 1 if I/O error
			A = 2 if illegal request
			A = 3 if illegal block

132 (84H)	WRITE LOGICAL RECORD	DE = block number
		B = drive number
		B top bit = 1 if interleaved
			A = 0 if OK
			A = 1 if I/O error
			A = 2 if illegal request
			A = 3 if illegal block

133 (85H)	not in use		

134 (86H)	FORMAT NAME TO FILE CONTROL BLOCK	HL = address of string
		DE = FCB address
			HL = address of terminator
			DE = FCB address

135 (87H)	UPDATE DIRECTORY ENTRY	DE = FCB address	none
136 (88H)	LINK TO PROGRAM	DE = FCB address	A = -1 (FFH) if error; else execute at 100H

137 (89H)	MULTIPLY INTEGERS	DE = factor 1
		HL = factor 2
			DE = product

138 (8AH)	DIVIDE INTEGERS	HL = dividend
		DE = divisor
			HL = quotient
			DE = remainder

139 (8BH)	HOME DRIVE	B = drive number	none
140 (8CH)	EJECT DISKETTE	E = drive number	none

141 (8DH)	GET VERSION OF OPERATING SYSTEM	none	A = operating system
			B = version-number
			C = release-number

142 (8EH)	SET SPECIAL CRT FUNCTION	D = column address/ special function
		E = row address/0
			none

143 (8FH)	SET DATE	B = day
		D = month
		E = year-1900
			none

144 (90H)	READ DATE	none	A = day
			B = month
			C = year-1900

Number	Function	Entry Parameters	Return Parameters

145 (91H)	SET TIME OF DAY	B = seconds
		D = minutes
		E = hours (24 hr. time)
			none

146 (92H)	READ TIME OF DAY	none	A = seconds
			B = minutes
			C = hours (24 hr. time)

147 (93H)	SET PROGRAM RETURN CODE	A = return code for next program	A = none

148 (94H)	SET FILE ATTRIBUTES	DE = FCB address
		B = new attributes
			none

149 (95H)	READ DISK LABEL	DE = FCB address	none
150 (96H)	TURN MOTORS OFF	none	none
151 (97H)	SET BOTTOM OF CDOS IN RAM	E = high byte of address of bottom of CDOS	none
152 (98H)	READ CURRENT RECORD	DE = FCB address	A = 0 if OK A = 1 if end of file A = 2 if tried to read unwritten records

153 (99H)	WRITE CURRENT RECORD	DE = FCB address	A = 0 if OK
			A = 1 if entry error
			A = 2 if out of disk space
			A = -1 (FFH) if out of directory space

154 (9AH)	CHECK IF ALLOCATED	DE = FCB address	A = 0 if allocated
			A = -1 if not allocated

155 (9BH)	not in use		
156 (9CH)	LIST DIRECTORY	DE = FCB address	none

157 (9DH)	SET OPTIONS	D = desired option
		E = mask
			A = old options

Options

bit 0 = CNTRL-P flag
bit 1 = read after write
bit 2 = ESCape key use as carriage return
bit 3 = do not echo carriage return
bit 6 = do not echo

Number	**Function**	**Entry Parameters**	**Return Parameters**
158 (9EH)	DELETE EXTENTS	DE = FCB address	A = 0 if not found A = 1 if found and erased
159 (9FH)	GET MASTER DRIVE	none	A = master drive B = last drive used in batch (@)

Chapter 8

ERROR MESSAGES

In the event of a system malfunction, CDOS displays a complete error message to the aid in the diagnosis and correction of the problem. The following section describes these messages and their interpretation.

8.1 FLOPPY DISK ACCESS ERROR MESSAGES

When the operating system cannot successfully access a diskette an error message is displayed.

Format:

mode Error, Drive **x**, Cylinder **cc**, Sector **ss**, Status=**ee**

where:

mode — stands for one of the following words:

- Seek — Error occurred in seeking a track on the disk.
- Read — Error occurred during a read from the disk.
- Write — Error occurred during a write to the disk.
- Home — Error occurred in seeking track 0 on the disk.
- Read-after-Write — Error occurred during the Cyclic Redundancy Check.

x — is a letter from A to H which represents the disk drive with the error.

cc — is the cylinder number (in hexadecimal) where the error occurred.

ss — is the sector number (in hexadecimal) where the error occurred.

ee — is the 8 bit status byte displayed in hexadecimal which describes the error and the conditions at the time the error occurred.

The status byte will be a hexadecimal number that will either be one of the hex values in the above table or the combination of two or more of those hex values. The bits which correspond to those hex values will describe the reasons or the error.

Status Bits Set and
Corresponding Hexadecimal Values

Bits	7	6	5	4	3	2	1	0
Hex value	80	40	20	10	8	4	2	1

If the status byte was 0A, the bits set would be 3, 1, and 0 because the only combination of corresponding hexadecimal values that add up to 0A are the ones which correspond to bits 3, 1, and 0.

The following table describes the malfunctions corresponding to the bits set in the status byte.

Status Bits Set	Seek	Read	Write
7	not ready	not ready	not ready
6	write protect*	record type*	write protect
5	head engaged*	record type*	write fault
4	seek error	record not found	record not found
3	crc error	crc error	crc error
2	track 0*	lost data	lost data
1	index*	data request*	data request*
0	busy*	busy*	busy*

Status Bits Set	Home	R-A-W
7	not ready	not ready
6	write protect*	record type*
5	head engaged*	record type*
4	seek error	record not found
3	crc error	crc error
2	track 0*	lost data
1	index*	data request*
0	busy*	busy*

The asterisk (*) in the above table indicates that the condition is not the cause of the error message, but that it was present when the error occurred. For example, if the status byte was 30H during a Seek error, this means that bits 4 and 5 are set (=1). This is a Seek error and the head is engaged. The head is supposed to be engaged during a seek and therefore this condition is not an error and is marked with an asterisk. CRC stands for Cyclic Redundancy Check. It is a verification that is done after a Read or Read-after-Write operation. A CRC error indicates that data was not transferred without error.

There are four possible responses to the error message:

R This will cause the system to retry the disk access which caused the error.

Note:

The error message does not appear until after the disk access instruction has been repeated **ten** times.

I This will cause the system to Ignore the error message and continue. The function which caused the error message is not completed and **no** error code is returned to the calling program.

C This will cause the system to Continue. The function which caused the error message is not completed and an error code **is** returned to the calling program.

CNTRL-C This will abort the program and return control to the CDOS monitor.

Examples:

The following examples use some of the more common status codes:

```
Seek Error, Drive A, Track 17, Sector 1A, Status=36
```

During a Seek operation, status code 36 or B6 indicates that the system expected to find a mini disk drive when there was actually a maxi drive (or vice versa) at the location (specified by A above). CDOSGEN may be run to correct this problem. Be sure that the disk drives are correctly specified as small and large during the system generation.

```
Read Error, Drive B, Track 1C, Sector 10, Status=10
```

During a Read operation, status code 10 or 08 indicate that the data is not readable. This may be caused by bringing the disk close to a magnetic source or by scratching or otherwise mishandling the disk.

8.2 HARD DISK ERROR MESSAGES

If CDOS should encounter an error when accessing a hard disk drive, it will display the error in the following format:

mode Drive **d** Cylinder **cc** Surface **hh** Sector **ss** Status **ffss**

where:

mode	is either Read error, Write error, Read-after-Write error, Home error, or Seek error.
d	is the letter of the drive.
cc	is number of the cylinder in hexadecimal.
hh	is head number.
ss	is the sector number in hex.
ffss	is the error number. The first two digits indicate the fatal error number and the second two digits indicate the system error number.

Hard Disk Fatal Errors

The following error codes are displayed when a fatal disk error occurs:

00 Failed to Seek & Read Header during R/W

An error occurred during an attempt to seek & read header preceding a read/write operation.

01 Failed to Seek - Timeout

The seek did not complete within a specified time. Check the drive electronics.

02 Fault Occurred during Seek

During the seek, a fault error occurred within the drive, as reported by the drive. This may be any of several errors.

03 Failed to Seek to Correct Track

The sector header as read off the disk is not what the drivers expected, thus the current disk location is incorrect.

04 Failed to Read CRC of Header

The CRC for the header as read from the disk is incorrect; it is different than what was expected. Most likely the current disk location is incorrect or the media surface is damaged.

05 Failed to Rezero - Timeout

A rezero command did not complete within a specified time. Check the drive electronics.

06 Fault Occurred after Rezeroing

A fault error occurred within the drive after a rezero command was executed. This may be any of several errors.

07 Drive not Ready

The ready signal from the drive is not active. Make sure the drive is connected properly.

08 Failed to Write - Fault Error

During the write, a fault error occurred within the drive, as reported by the drive. This may be any of several errors.

09 Failed to Verify after Write

After data is written to the disk, it is read back and verified. This error occurs if the data cannot be properly verified.

0A Failed to Read - Fault Error

During the read, a fault error occurred within the drive, as reported by the drive. This may be any of several errors.

0B Failed to Read - CRC Error

The CRC just read from the disk is incorrect; it is different from the expected CRC. This error usually means that the data just read is incorrect.

0C Failed to Read - Cannot Locate Sector

The sector being looked for cannot be found on the current track. This error can occur if the media surface is damaged or if the controller electronics are not functioning properly.

0D Surface is Write Protected

The surface selected for the current write command is write protected and can not be written to.

Hard Disk System Errors

The following error codes are displayed when a system disk error occurs:

00 No Acknowledge Received from Drive

The drive did not acknowledge a command sent to it. Make sure the drive is connected properly.

01 Drive Remains BUSY - Acknowledge Stuck Low

The acknowledge signal from the drive did not go high again after the command strobe went inactive.

02 Timeout Occurred during Rezeroing

A rezero command did not complete within a specified time. Check the drive electronics.

03 Fault Condition Reported by Drive

A fault condition occurred within the drive, as reported by the drive. This may be any of several errors.

04 Failed to Read - CRC Error

The CRC just read from the disk is incorrect; it is different from the expected CRC. This error usually means that the data just read is incorrect.

05 Header Off the Disk Does Not Compare with Expected Header

The sector header as read off the disk is not what the drivers expected, thus the current disk location is incorrect.

06 Failed to Verify after Write Operation

After data is written to the disk, it is read back and verified. This error occurs if the data cannot be properly verified.

8.3 SYSTEM ERROR MESSAGES

Bad directory block dddH

An attempt was made to read the directory block at location **ddd** which was overwritten with inappropriate data.

Bad disk block overwritten

A response of **C** was entered in response to an error which occurred while attempting to SAVE a file.

Cannot read double density diskettes

An attempt was made to access double density diskettes via a CDOS that was configured for single density drives only.

Cannot read double sided diskettes

An attempt was made to access double sided diskettes via a CDOS that was configured for single sided drives only.

CDOS.COM not found

An attempt was made to boot and there was no CDOS.COM file on either the current drive or the master drive.

Drive x write-protected
Diskette in drive x write-protected

The first message will appear if an attempt was made to write to a hard disk that was write protected with the key lock on its rear panel. The second message will appear if an attempt was made to write to either an 8" diskette without a write-enable sticker or a 5" diskette with a write-protect sticker.

Drive not found

An attempt was made to access a drive which was not included in the current CDOS configuration.

Drive not ready

An attempt was made to access a drive which did not have a diskette in it.

File already exists

An attempt was made to rename a file using a name that already exists.

File not found

An attempt was made to access a file which was not on the current disk or the master disk, e.g., REN OLDNAME.TXT=NEWNAME.TXT when OLDNAME.TXT does not exist.

file-ref program too big

An attempt was made to load a program, **file-ref,** which was too big to fit into memory.

Illegal system call cccH at aaaH

An attempt was made to access a CDOS call **ccc** which does not exist. The call was made at location **aaa**H.

Invalid jump to location xxxx

where xxxx is the hexadecimal address to which control was transferred. An instruction was executed which caused control to be transferred to a nonexistent memory location or any memory location containing 0FFH (Restart 38H).

Logical disk error

An attempt was made to access a sector which was not on the disk. This is usually due to an error in the disk directory.

Program not found

An attempt was made to run a program with an extension of COM which was not on the current disk or the master disk.

Appendix A

GLOSSARY OF TERMS AND SYMBOLS

{ }

Braces are used to indicate a choice of items. One of the items enclosed in the braces must be used in the position indicated. An optional choice of items is indicated by braces enclosed in square brackets.

[ ]

Square brackets are used to indicate an optional quantity. The item enclosed in square brackets may be used, in the position indicated, at the user's discretion.

Ambiguous File Reference

This is a file reference which may refer to more than one file by using a replacement character(s).

ASCII

American Standard Code for Information Interchange.

Attribute

The type of protection assigned to a disk file.

Bitmap

A bitmap is a record of the allocation of clusters on a disk. On floppy disks the bitmap is derived from the directory. On hard disks the bitmap is stored on the disk itself.

Cluster

A group of bytes on a disk. CDOS accesses the disk by clusters. A cluster may be 1024 or 2048 bytes depending upon the disk format (single or double density).

Device driver

A program which controls the operation of a peripheral device, such the console, printer, or disk.

Directory

A list of the user files contained on the disk.

Disk Specifier

A disk specifier is one of the letters from A through H followed by a colon. This letter references a disk drive and allows the user to refer to a disk located in the drive. The disk specifier is an optional part of a file reference.

Extent

An area on the disk occupied by a file or a portion of a file, up to 16K bytes long. There is one disk directory entry for each extent occupied by a file.

File Area (disk)

User files are stored on this part of the disk. The contents of this part of the disk are listed by the DIRectory command.

File Control Block (FCB)

One of two areas starting at addresses 5Ch and 6Ch used by CDOS. The FCB contains the information CDOS needs to manipulate a disk file.

Filename

This is a one to eight character label which is used to refer to a file. Several files may have the same filename. These files may be uniquely identified by the use of a disk specifier and/or a filename extension. A filename is a necessary part of a file reference.

Filename Extension

This is a one to three character label which is frequently used to indicate how a file is to be used. A filename extension is an optional part of a file reference.

File or
Data File

A file is a collection of bytes containing related information. This information is addressed by means of a file reference and usually resides on a floppy diskette.

File Reference

A file reference identifies and locates a file.

```
     Format:  [x:]filename[.ext]
```

where:

x	is an optional disk drive specifier.
filename	is a filename up to 8 characters long.
ext	is an optional filename extension up to 3 characters long.

A file reference is a single file reference unless it is specifically stated that it may incorporate replacement characters to form an ambiguous file reference.

Intrinsic

A command in CDOS that is executed from the console, such as DIR or ATTR.

Label

The first entry in each disk directory used by CDOS to identify the disk and to keep information about the directory.

Replacement Character

A replacement character is an asterisk (*) or a question mark (?). These characters may be used where specifically indicated in order to create an ambiguous file reference.

Single File Reference

This is a label specifying **a** unique file. This file reference may **not** include replacement characters.

System Area (disk)

The boot loader of CDOS is stored on this part of the disk. This section is normally accessed only by CDOS. It does not appear in the user area DIRectory.

System Call

A CDOS subroutine that may be accessed by a user program by placing the system call number in the C register, setting up all other registers as required by the call, and executing a CALL 5 instruction.

Text file

A file that consists only of printable ASCII encoded characters and ASCII print control characters.

User Area (RAM)

The User Area is RAM which is available to user programs. This is the part of memory from 100H up to the bottom of CDOS. The size of this area may be determined by executing STAT.

Utility

A program that performs a useful function; specifically one of the program supplied with CDOS, such as STAT or XFER.

Appendix B

SWITCH SETTINGS

16FDC

A brief description of the function of each of the 16FDC switches and their recommended settings follows. For further information on the 16FDC switch settings please refer to the Cromemco 16FDC Disk Controller Manual (part number 023-2004). Switch settings for the 4FDC are identical with those of 16FDC listed here.

Switch 1 is the **RDOS** (PROM Resident Disk Operating System) **DISABLE** switch. When ON, the PROM containing RDOS cannot be accessed. When OFF, the PROM resides from C000H to C3FFH in memory during startup. This switch should be **OFF** for initial system operation.

Switch 2 is the **RDOS DISABLE AFTER BOOT** switch. When ON, RDOS will automatically be disabled from address space following CDOS boot. When OFF, RDOS remains in memory at C000H following CDOS boot. This switch should be **ON** for initial system operation.

Switch 3 is the **BOOT ENABLE** switch. When ON, CDOS boot strap is executed from power-on or a computer reset. When OFF, RDOS comes up when power is applied to the system or when the computer is reset. This switch should be **ON** for initial system operation.

Switch 4 is the **INITIALIZATION INHIBIT** switch. When ON, diskettes cannot be initialized under software control. When OFF, disks may be initialized. This switch may be **ON** or **OFF** for initial system operation.

Note:

When configuring a system with 64 kilobytes of memory, it is important that switch 2 be **ON.** This will disable RDOS after CDOS is booted up so that RDOS and system memory do not overlap at locations C000H to C3FFH.

With switch 2 **ON** the only way RDOS can be reentered after booting CDOS is by resetting the machine. If switch 3 is also **ON,** the user will never be able to access RDOS because CDOS will automatically be booted up any time RDOS is called.

ZPU

The power-on jump should initially be set to C000H, the location of RDOS. To do this, the DIP switch should be set as follows:

```
     #15 = 1 (off)
     #14 = 1 (off)
     #13 = 0 (on)
     #12 = 0 (on)
```

The clock switch should be set to 4MHz.

```
        TITLE   I/O Device Drivers for CDOS
        SUBTTL  Equated Values
        REM
        REM     Copyright (c) 1978, 1980 Cromemco, Inc.
        REM     All Rights Reserved
        REM
        REM
        LIST    NOCOND, NOGEN

TRUE    EQU     -1
FALSE   EQU     0

; At least one of the following three names MUST be TRUE to prevent errors:
C3102   EQU     TRUE         ; Cromemco Model-3102 Terminal
C3101   EQU     FALSE        ; Cromemco Model-3101 Terminal
ADM3A   EQU     FALSE        ; TRUE to include ADM-3A CRT driver

; The state of the following name should match that of C3102 or C3101:
FUN.KEYS EQU    TRUE         ; TRUE to assemble function key decoding routines

; The following two names may be either TRUE or FALSE:
S.READER EQU    FALSE        ; TRUE for serial reader connected to TUART/
                             ;   FALSE for reader driver same as CIN
S.PUNCH  EQU    FALSE        ; TRUE for serial punch connected to TUART/
                             ;   FALSE for punch driver same as COUT

; At least one of the following three names MUST be TRUE to prevent errors:
; (C3703 and C3779 both TRUE counts as only 1 of the printers of NO.LST)
C3703     EQU   TRUE         ; Cromemco Model-3703 Printer
                             ;   (outputs form feeds directly)
C3779     EQU   FALSE        ; Cromemco Model-3779 Printer
                             ;   (outputs form feeds as multiple line feeds)
S.PRINTER EQU   FALSE        ; TRUE to include serial printer driver

; Numbers of devices to be accessed by CDOS:
NO.CON  EQU     1            ; Number of consoles to be accessed (8 maximum)
NO.RDR  EQU     0            ; Number of readers to be accessed (4 maximum)
NO.PUN  EQU     0            ; Number of punches to be accessed (2 maximum)
NO.LST  EQU     1            ; Number of printers to be accessed (4 maximum)

; I/O byte defined values:
IOBYTE  EQU     3            ; I/O byte - used by multiple-device routines
IO.B0   EQU     0            ; I/O byte bit 0 (Console bit 0)
IO.B1   EQU     1            ; I/O byte bit 1 (Console bit 1)
IO.B2   EQU     2            ; I/O byte bit 2 (Console bit 2)
IO.B3   EQU     3            ; I/O byte bit 3 (Reader bit 0)
IO.B4   EQU     4            ; I/O byte bit 4 (Reader bit 1)
IO.B5   EQU     5            ; I/O byte bit 5 (Punch bit)
IO.B6   EQU     6            ; I/O byte bit 6 (Printer bit 0)
IO.B7   EQU     7            ; I/O byte bit 7 (Printer bit 1)

; Miscellaneous defined values:
NULLS    EQU    0            ; Number of nulls transmitted after line feeds
PAGE.SIZ EQU    66           ; Number of lines of text per page for printer
```

```
        SUBTTL  ASCII Character Definitions

;  ASCII characters

CTRLB   EQU     2               ; ASCII control-B character
BACK    EQU     8               ; ASCII back space
LF      EQU     0AH             ; ASCII line feed
VT      EQU     0BH             ; ASCII vertical tab
FORMF   EQU     0CH             ; ASCII form feed
CR      EQU     0DH             ; ASCII carriage return
CTRLN   EQU     0EH             ; ASCII control-N character
CTRLO   EQU     0FH             ; ASCII control-O character
CTRLP   EQU     10H             ; ASCII control-P character
CTRLQ   EQU     11H             ; ASCII control-Q character
CTRLS   EQU     13H             ; ASCII control-S character
CTRLV   EQU     16H             ; ASCII control-V character
CTRLW   EQU     17H             ; ASCII control-W character
CTRLZ   EQU     1AH             ; ASCII control-Z character
ESC     EQU     1BH             ; ASCII escape character
CTRL.RB EQU     1DH             ; ASCII control-] character
CTRL.UP EQU     1EH             ; ASCII control-^ character
SPC     EQU     20H             ; ASCII space character
```

```
        SUBTTL  Device Port Assignments, Status Bits, and Baud Rates

;  I/O device port assignments and status bits

CSTATP  EQU     0               ; Console status port (input)
CDATA   EQU     CSTATP+1        ; Console data port (input/output)
CRDA    EQU     40H             ; Console Receiver-Data-Available mask
CTBE    EQU     80H             ; Console Transmitter-Buffer-Empty mask

RSTATP  EQU     20H             ; Serial reader status port (input)
RBAUD   EQU     RSTATP          ; Serial reader baud rate port (output)
RDATA   EQU     RSTATP+1        ; Serial reader data port (input)
RRDA    EQU     40H             ; Serial reader RDA bit mask

PSTATP  EQU     20H             ; Serial punch status port (input)
PBAUD   EQU     PSTATP          ; Serial punch baud rate port (output)
PDATA   EQU     PSTATP+1        ; Serial punch data port (output)
PTBE    EQU     80H             ; Serial punch TBE bit mask

LSTATP  EQU     54H             ; List device status port (input)
LDATA   EQU     LSTATP          ; List device data port (output)
LRTP    EQU     20H             ; List device Ready-To-Print bit mask
LSTROB  EQU     7               ; List device strobe bit

SSTATP  EQU     50H             ; Serial printer status port (input)
SBAUD   EQU     SSTATP          ; Serial printer baud rate port (output)
SDATA   EQU     SSTATP+1        ; Serial printer data port (output)
STBE    EQU     80H             ; Serial printer TBE bit mask


;  I/O device baud rate assignment table for TUART

;       01H =  110 baud / 2 stop bits
;       82H =  150 baud / 1 stop bit
;       84H =  300 baud / 1 stop bit
;       88H = 1200 baud / 1 stop bit
;       90H = 2400 baud / 1 stop bit
;       A0H = 4800 baud / 1 stop bit
;       C0H = 9600 baud / 1 stop bit
;  (Refer to TUART manual for other rate or stop bit configurations)

;  The following baud rates were chosen from the table above:
RDR.BD.RT EQU   01H      ; Baud rate of serial reader
PUN.BD.RT EQU   01H      ; Baud rate of serial punch
SER.BD.RT EQU   84H      ; Baud rate of serial printer
```

```
        SUBTTL  Device Driver Address Table

;  The following is a table of addresses needed by CDOS
;  to find the starting locations of each of the I/O device
;  routines.  The address values are filled in by CDOSGEN;
;  therefore, this table MUST NOT be removed from the drivers.

CONSOLE:DW      CINIT           ; Console initialize
        DW      CSTAT           ; Console input-status
      IF  FUN.KEYS            ; Conditional #1
        DW      CSPECIN         ; Console input a byte or function key
      ENDIF                   ; End conditional #1
      IF  NOT FUN.KEYS        ; Condition #2
        DW      CIN             ; Console input a byte
      ENDIF                   ; End conditional #2
        DW      CRDY            ; Console output-ready
        DW      COUT            ; Console output a byte
        DW      CSET            ; Console set special command

READER: DW      RINIT           ; Reader initialize
        DW      RSTAT           ; Reader input-status
        DW      RIN             ; Reader input a byte

PUNCH:  DW      PINIT           ; Punch initialize
        DW      PRDY            ; Punch output-ready
        DW      POUT            ; Punch output a byte

PRINTER:DW      LINIT           ; List initialize
        DW      LRDY            ; List output-ready
        DW      LOUT            ; List output a byte

CLOCK:  DW      STRTCLK         ; Start clock
        DW      READCLK         ; Read clock
YEAR:   DB      0               ; Year (-1900) binary storage
MON:    DB      0               ; Month binary storage
DATE:   DB      0               ; Date binary storage
HOUR:   DB      0               ; Hours binary storage
MIN:    DB      0               ; Minutes binary storage
SEC:    DB      0               ; Seconds binary storage
```

```
        SUBTTL  Function Key Address Table and Dummy Return Routine

;  The following is a table of addresses needed by CDOS to
;  locate the pre-programmed value of each of the function
;  keys.  The first 20 address values are filled in by CDOSGEN
;  and MUST NOT be removed from the drivers.

FUNCADDR:
        DW      0       ; Function key F1  (3102 and 3101)
        DW      0       ; Function key F2                /
        DW      0       ; Function key F3               /
        DW      0       ; Function key F4              /
        DW      0       ; Function key F5             /
        DW      0       ; Function key F6            /
        DW      0       ; Function key F7           /
        DW      0       ; Function key F8          /
        DW      0       ; Function key F9         /
        DW      0       ; Function key F10       /
        DW      0       ; Function key F11      /
        DW      0       ; Function key F12     /
        DW      0       ; Function key F13    /
        DW      0       ; Function key F14   /
        DW      0       ; Function key F15  /
        DW      0       ; Function key F16 /
        DW      0       ; Function key F17 (3102 only)
        DW      0       ; Function key F18   /
        DW      0       ; Function key F19  /
        DW      0       ; Function key F20 /
      IF  FUN.KEYS and C3102      ; Conditional #3
        DW      DELLINE ; CE (Clear Entry) function key
        DW      PAUSE   ; PAUSE function key
        DW      PRINT   ; PRINT function key
        DW      HELP    ; HELP function key
      ENDIF           ; End conditional #3


;  Dummy routine to use when returning to caller with no changes

DUMMY:  RET             ; Return to caller with no changes
```

```
        SUBTTL  Console Routines
      IF  C3102               ; Conditional #4

;  Console Initialization Routine for 3102 Terminal

CINIT:  LD      B,'9'           ; Turn-on-function-keys special command to 3102
        JP      SEND.ESC        ; Print escape-dot sequence to console & return
      ENDIF                   ; End conditional #4
      IF  NOT C3102           ; Conditional #5

;  [Dummy] Console Initialization Routine

CINIT   EQU     DUMMY   ; (Console baud rate already set before CDOS booted)
      ENDIF                   ; End conditional #5


;  Get Console Input Status
;  Upon Exit:   A = -1 (FFH) and Z-flag is reset if char. is ready
;               A = 0 and Z-flag is set if character is not ready
;               C-flag is set if function key transmission is in progress

CSTAT:  IN      A,CSTATP        ; Get console-in status
        AND     CRDA            ; Check console RDA flag
      IF  NOT FUN.KEYS        ; Conditional #6
        RET     Z               ; Character not ready
        LD      A,-1            ; Character ready
        RET
      ENDIF                   ; End conditional #6
      IF  FUN.KEYS            ; Conditional #7
        JR      Z,CSTA50        ; Skip to check further if char. not ready
        LD      A,-1            ; Character ready
        RET

CSTA50: LD      A,(FPFLAG)      ; Check whether or not in midst of
        AND     A               ;    function key transmission to CDOS
        RET     Z               ; Return if not with Z and C-flags cleared
        SUB     A               ; Clear A-reg. & set Z-flag for char. not ready
        SCF                     ; Return C-flag set to indicate to CDOS that
        RET                     ;    function key transmission is in progress
      ENDIF                   ; End conditional #7


;  Console Input Routine
;  Upon Exit:   A contains the character read
;               Z-flag is reset to prevent indicating end of file
;                  (Change routine to return Z-flag set ONLY if you wish
;                  to have a particular character indicate end of file.)

CIN:    CALL    CSTAT           ; Get console-in status
        JR      Z,CIN           ; Zero means console busy
        IN      A,CDATA         ; Read the character
        AND     7FH             ; Strip off parity bit
      IF  NOT C3703           ; Conditional #8
        RET                     ; Return with Z-flag reset
      ENDIF                   ; End conditional #8
```

```
IF  C3703               ; Conditional #9
  CP      CTRLP           ; Check for control-P
  RET     NZ              ; Return if any other character
  PUSH    AF              ; Save control-P for a moment,
  LD      A,CTRLQ         ;   get select character, and
  CALL    L1OUT           ;   output it to select the printer
  POP     AF              ; Restore the original control-P for return
  AND     A               ; Reset Z-flag to avoid indicating EOF
  RET
ENDIF                   ; End conditional #9
```

```
      IF  FUN.KEYS              ; Conditional #10
        EJECT

;  Special Console Input Routine Including Function Key Decoding
;  Upon Exit:   A contains the character read, either from the
;               console or as a character in a function key string

CSPECIN:CALL    CSTAT           ; Get console-in status
        JR      NZ,CSIN20       ; Skip to read character if ready now
        LD      A,(FPFLAG)      ; Check whether or not in midst of
        AND     A               ;   function key transmission to CDOS
        JR      NZ,CSIN30       ; Skip if so to finish the transmission
CSIN20: CALL    GETFUNC         ; Get either a single byte or a function key
        JR      Z,CSIN40        ; Skip to process if a function key
        RET                     ; Return if it's a single byte

CSIN30: LD      HL,(FPPTR)      ; Point to next byte to be passed to CDOS
CSIN40: LD      A,-1            ; Non-zero means function-in-progress
        LD      (FPFLAG),A      ; Store the flag
        LD      A,(HL)          ; Get the character being transmitted
        PUSH    AF              ; Save character for a moment
        INC     HL              ; Increment to point to next character
        LD      (FPPTR),HL      ; Store pointer back
        LD      A,(HL)          ; Get subsequent character and check
        SUB     -1              ;   whether it's the end-of-transmission
        JR      NZ,CSIN50       ; Return with character if not
        LD      (FPFLAG),A      ; If end-of-transmission, zero progress flag
CSIN50: POP     AF              ; Restore the character and return
        RET


;  Get either a function key or a single byte from the console
;  Upon Exit:   for a function key:
;                 Z-flag is set and HL points to start of definition
;               for a single byte:
;                 Z-flag is reset and A contains the character read

GETFUNC:CALL    CIN             ; Get a byte from the console
        CP      CTRLB           ; Check for control-B
        RET     NZ              ; Return if any other character
        LD      (FKBUFF),A      ; Save the control-B in sequence buffer
        LD      (FKBUFF+1),A    ;   in first and second positions
        CALL    GETFBYTE        ; Get next byte of function key sequence
        JR      NZ,GTFC30       ; Skip to get other chars. if 3101 function key
        LD      A,CR            ; Set up last byte of 4-byte sequence to make
        LD      (FKBUFF+3),A    ;   3102 func. key look like 3101 func. key
        CALL    ASKFBYTE        ; Get second byte of 3102 func. key sequence
        LD      (FKBUFF+2),A    ;   and save it in sequence buffer
        JR      Z,GTFC20        ; Skip to return if timeout
        CP      CTRLB           ; Check for control-B as second character
        JR      Z,GTFC40        ; Skip to do as block-send (don't echo CTRL-B)
        LD      A,CTRLB         ; Prepare to echo control-B since function key
        CALL    COUT            ; Echo control-B as required by 3102 protocol
        JR      GTFC40          ; Skip to decode the function key

GTFC20: LD      A,CTRLB         ; Return a single control-B since timeout
        AND     A               ; Reset Z-flag to indicate single byte
        RET
        EJECT
GTFC30: CP      CTRLB           ; Check if second byte is control-B for 3101
        RET     NZ              ; Return only that character if not
        CALL    CIN             ; Get byte which determines actual func. key
        LD      (FKBUFF+2),A    ; Save third byte of sequence in buffer
        CALL    CIN             ; Get last byte of sequence
        LD      (FKBUFF+3),A    ;   and save it in buffer
GTFC40: CALL    WAIT30MS        ; Wait 30 msec. to allow for CRT recovery
                                ;   after function key transmission
        LD      A,(FKBUFF+2)    ; Get byte determining function key
        LD      B,A             ;   and put in B-reg. for use later
      IF  C3102               ; Conditional #10A
        LD      HL,BLKSEND      ; Point to block-send sequence to pass on
        CP      CTRLB           ; Check if block-send request instead of
        RET     Z               ;   other function key and return if so
      ENDIF                   ; End conditional #10A
        LD      HL,FKBUFF       ; Point to function key sequence buffer
        LD      A,(CPFLAG)      ; Check whether or not to use CDOS
        AND     A               ;   pre-programmed function keys
        RET     Z               ; Return with address of actual 4 bytes if 0
        LD      HL,FUNCVAL      ; Point to table of function key values
        LD      DE,FUNCADDR     ; Point to addresses of func. key definitions
GTFC60: LD      A,(HL)          ; Get a character from value table
        AND     A               ; Check for end of table
        JR      Z,GETFUNC       ; Skip it func. key not in table to try again
        CP      B               ; Check char. in table to func. byte in B-reg.
        JR      Z,GTFC70        ; Skip if found to get address of definition
        INC     HL              ; Point to next character in value table
        INC     DE              ; Point to next address in definition table
        INC     DE              ; /
        JR      GTFC60          ; Skip to check next byte in value table

GTFC70: EX      DE,HL           ; Swap pointer to address table from DE into HL
        LD      A,(HL)          ; Get the address and put it into HL
        INC     HL              ;   /
        LD      H,(HL)          ;  /
        LD      L,A             ; /
        OR      H               ; If HL=0 (function key is undefined),
        JR      Z,GETFUNC       ;   loop to get another character from console
        SUB     A               ; Set Z-flag to indicate function
        RET                     ;   key transmission and return


;  Variables needed for function key routines

FPFLAG: DB      0               ; Function-transmission-in-progress flag
FPPTR:  DW      0               ; Pointer to current byte of pre-programmed
                                ;   function key transmission to CDOS
FKBUFF: DB      0,0,0,0,-1      ; Buffer for function key sequence
```

```
        EJECT

;  Table of function key values transmitted

;  Note:  When assembled, the number of entries in this table
;  MUST NOT exceed the number of entries in the FUNCADDR table.

FUNCVAL:DB      70H             ; Function key F1  (3102 and 3101)
        DB      71H             ; Function key F2
        DB      72H             ; Function key F3
        DB      73H             ; Function key F4
        DB      74H             ; Function key F5
        DB      75H             ; Function key F6
        DB      76H             ; Function key F7
        DB      77H             ; Function key F8
        DB      78H             ; Function key F9
        DB      79H             ; Function key F10
        DB      7AH             ; Function key F11
        DB      7BH             ; Function key F12
        DB      7CH             ; Function key F13
        DB      7DH             ; Function key F14
        DB      7EH             ; Function key F15
        DB      7FH             ; Function key F16
        DB      6FH             ; Function key F17 (3102 only)
        DB      6EH             ; Function key F18
        DB      6DH             ; Function key F19
        DB      6CH             ; Function key F20
      IF  NOT C3102           ; Conditional #10B
        DB      0               ; End of table
      ENDIF                   ; End conditional #10B
      IF  C3102               ; Conditional #10C
        DB      5EH             ; CE (Clear Entry) function key (3102 only)
        DB      5FH             ; PAUSE function key (3102 only)
        DB      6AH             ; PRINT function key (3102 only)
        DB      6BH             ; HELP function key (3102 only)
        DB      0               ; End of table

;  Character sequences transmitted for special-purpose function keys

DELLINE:DB      CTRLV,-1        ; Delete line (control-V)
PAUSE:  DB      CTRLS,-1        ; Pause console output (control-S)
PRINT:  DB      CTRLP,-1        ; Print console output (control-P)
HELP:   DB      CTRL.UP,-1      ; Help key (control-^)
BLKSEND:DB      CTRLB,CTRLB,-1  ; Block-send sequence
      ENDIF                   ; End conditional #10C
      ENDIF                   ; End conditional #10
      IF  C3102 or FUN.KEYS   ; Conditional #11
        EJECT

;  Ask terminal for a function key byte by sending a control-B (3102 only)
;  Upon Exit:   Z-flag is reset if function key was pressed
;               Z-flag is set if timeout occurred before subsequent char.

ASKFBYTE:
        LD      A,CTRLB         ; Output a control-B to console
        CALL    COUT            ;   to request a function key byte
                                ; Fall through to get function key byte:

;  Get a function key byte
;  Upon Exit:   Z-flag is reset if function key was pressed
;               Z-flag is set if timeout occurred before subsequent char.

GETFBYTE:
        LD      HL,FUNCTIME     ; Get counter for time between characters
GTFB20: CALL    CSTAT           ; Get console-in status
        JP      NZ,CIN          ; Non-zero means char. is ready; get it and
                                ;   return with Z-flag reset (CIN returns
                                ;   flag this way) to indicate function key
        DEC     L               ; If still no character, count down
        JR      NZ,GTFB20       ;   /
        DEC     H               ;  /
        JR      NZ,GTFB20       ; /
        RET                     ; Return with Z-flag set to indicate
                                ;   no character within timeout


;  Delay routine to wait for approx. 30 msec.
;  Registers:   HL registers are not preserved

WAIT30MS:
        LD      HL,8000         ; Load counter for time of 30 msec.
WAIT20: DEC     L               ; Total time approx. = (no. in H) x 1 msec.
        JR      NZ,WAIT20       ;   /
        DEC     H               ;  /
        JR      NZ,WAIT20       ; /
        RET


;  Equate needed for GETFBYTE

FUNCTIME EQU    1400            ; Maximum time allowable between characters
                                ;   of function key sequence (total time is
                                ;   approx. 21 usec. times value shown)
      ENDIF                   ; End conditional #11
```

```
        EJECT

;  Get Console Output Status
;  Upon Exit:   A = -1 (FFH) and Z-flag is reset if ready for char.
;               A = 0 and Z-flag is set if not ready for character

CRDY:   IN      A,CSTATP        ; Get console-out status
        AND     CTBE            ; Check console TBE flag
        RET     Z               ; Console not ready for character
        LD      A,-1            ; Console ready for character
        RET


;  Console Output Routine
;  Upon Entry:  A contains the character to be output

COUT:   PUSH    AF              ; Save character for a moment
COUT30: CALL    CRDY            ; Get console-out status
        JR      Z,COUT30        ; Zero means console busy
        POP     AF              ; Restore character
        OUT     CDATA,A         ; Output the character
      IF  NULLS=0             ; Conditional #12
        RET
      ENDIF                   ; End conditional #12
      IF  NULLS>0             ; Conditional #13
        CP      LF              ; Check for end of line
        RET     NZ              ; Return if not line feed character
        LD      A,NULLS+1       ; If LF, get number of nulls
COUT50: DEC     A               ; Check for 0 nulls at top of loop
        RET     Z               ; Return if all nulls output
        PUSH    AF              ; Save nulls counter
        SUB     A               ; Print a single null
        CALL    COUT            ;   character (recursive)
        POP     AF              ; Restore nulls counter
        JR      COUT50          ; Loop to print next null
      ENDIF                   ; End conditional #13
```

```
        EJECT

;  Set Special Console Command Including Cursor Addressing
;  Upon Entry:  for cursor addressing:
;                  E contains cursor row in the range 1-24
;                  D contains cursor column in the range 1-80
;               for special console command:
;                  E = 0
;                  D contains the special command number
;                  HL contains pointer to string for some commands
;                  A contains additional information for some commands

CSET:   LD      C,A             ; Save the additional information
        LD      A,E             ; Check whether it's a special
        AND     A               ;   or cursor-address command
        JR      Z,CSCOMMD       ; Skip to do special command
      IF  C3102 or C3101      ; Conditional #14
        LD      B,'F'           ; Second special character is "F"
      ENDIF                   ; End conditional #14
      IF  ADM3A               ; Conditional #15
        LD      B,'='           ; Second special character is "="
      ENDIF                   ; End conditional #15
        CALL    SENDESC         ; Send escape-sequence for cursor addressing
        LD      A,1FH           ; Load A-reg. with offset to generate row
        ADD     E               ; Add incoming row number to the offset
        CALL    COUT            ; Output so-created character
        LD      A,1FH           ; Load A-reg. with offset to generate column
        ADD     D               ; Add incoming column number to the offset
        JP      COUT            ; Output so-created character & return

;  Print escape sequence on console
;  Upon Entry:  B contains command character

SENDESC:LD      A,ESC           ; Send an escape character to
        CALL    COUT            ;   console to start sequence
        LD      A,B             ; Retrieve the command character
        JP      COUT            ; Print the command char. & return
      IF  C3102               ; Conditional #16

;  Print escape-dot sequence on console
;  Upon Entry:  B contains command character

SEND.ESC:
        LD      A,ESC           ; Send an escape character to
        CALL    COUT            ;   console to start sequence
        LD      A,'.'           ; Send a dot character to console
        CALL    COUT            ;   as second specifier of sequence
        LD      A,B             ; Retrieve the command character
        JP      COUT            ; Print the command char. & return
      ENDIF                   ; End conditional #16
```

```
        EJECT

;  Set special console command (part of CSET)
;  Upon Entry:  D contains the special command number
;               HL contains pointer to string for some commands
;               C contains additional information for some commands

CSCOMMD:LD      A,D              ; Get number of special command
        CP      SC.MAX           ; Check for illegal special
        RET     NC               ;   command and return if so
        PUSH    HL               ; Save address pointer
        LD      HL,SC.TBL        ; Point to table of special command values
        ADD     L                ; Add offset in A to table address in HL
        LD      L,A              ;    /
        JR      NC,CSCMD30       ;   /
        INC     H                ; /
CSCMD30:LD      A,(HL)           ; Get the command from the table
        POP     HL               ; Restore address pointer
        AND     A                ; Zero means command not implemented
        RET     Z                ; Return if command not implemented
      IF  ADM3A                ; Conditional #17
        JP      COUT             ; Output the special character
      ENDIF                    ; End conditional #17
      IF  C3102 or C3101       ; Conditional #18
        LD      B,A              ; Save the special character
        JP      P,SENDESC        ; Send escape-sequence to console & return
        AND     7FH              ; Strip off top bit
        LD      B,A              ; Multiply by 3
        ADD     B                ;   /
        ADD     B                ; /
        PUSH    HL               ; Save address pointer
        LD      HL,ROUTTBL       ; Point to routine table
        ADD     L                ; Add displacement to HL
        LD      L,A              ;    /
        JR      NC,CSCMD50       ;   /
        INC     H                ; /
CSCMD50:LD      E,(HL)           ; Get routine address into DE-reg.
        INC     HL               ;    /
        LD      D,(HL)           ;   /
        INC     HL               ; /
        LD      A,(HL)           ; Get mask into A-reg.
        POP     HL               ; Get address pointer
        PUSH    DE               ; Put routine address on stack
        RET                      ; Execute routine


CPFLAG: DB      1       ; Cursor pad enable/disable special command flag
                        ;  (1 = CDOS pre-programmed function keys;
                        ;   0 = terminal's actual function key sequence)
      ENDIF                    ; End conditional #18
      IF  C3102 or C3101      ; Conditional #19
        EJECT

;  Special command table for Cromemco 3102 and 3101 terminals

SC.TBL: DB      'E'          ;  0 - Clear screen
        DB      'H'          ;  1 - Home cursor
        DB      'D'          ;  2 - Back space
        DB      'C'          ;  3 - Forward space
        DB      'A'          ;  4 - Move cursor up
        DB      'B'          ;  5 - Move cursor down
        DB      'K'          ;  6 - Clear to EOL
        DB      'J'          ;  7 - Clear to EOS
      IF  C3102            ; Conditional #19A
        DB      84H          ;  8 - High light
        DB      85H          ;  9 - Low light
        DB      86H          ; 10 - Medium light
      ENDIF                ; End conditional #19A
      IF  C3101            ; Conditional #19B
        DB      0            ;  8 - High light
        DB      0            ;  9 - Low light
        DB      0            ; 10 - Medium light
      ENDIF                ; End conditional #19B
        DB      'b'          ; 11 - Enable keyboard
        DB      'c'          ; 12 - Disable keyboard
        DB      80H          ; 13 - Enable cursor pad
        DB      81H          ; 14 - Disable cursor pad
        DB      ']'          ; 15 - Begin protected field
        DB      '['          ; 16 - End protected field
        DB      82H          ; 17 - Begin blinking
        DB      83H          ; 18 - End blinking
        DB      'i'          ; 19 - Line-send
        DB      '1'          ; 20 - Page-send
        DB      'O'          ; 21 - Aux-send
        DB      'P'          ; 22 - Delete character
      IF  C3102            ; Conditional #19C
        DB      'Q'          ; 23 - Insert character
        DB      'M'          ; 24 - Delete line
        DB      'L'          ; 25 - Insert line
      ENDIF                ; End conditional #19C
      IF  C3101            ; Conditional #19D
        DB      0            ; 23 - Insert character on
        DB      0            ; 24 - Delete line
        DB      0            ; 25 - Insert line
      ENDIF                ; End conditional #19D
        DB      'W'          ; 26 - Format on
        DB      'X'          ; 27 - Format off
      IF  C3102            ; Conditional #19E
        DB      87H          ; 28 - Reverse on
        DB      88H          ; 29 - Reverse off
        DB      89H          ; 30 - Underline on
        DB      8AH          ; 31 - Underline off
        DB      '1'          ; 32 - Display message on
        DB      '2'          ; 33 - Display message off
        DB      8BH          ; 34 - CPU message deposit
        DB      '@'          ; 35 - Insert character off
        DB      'R'          ; 36 - Graphics mode on
        DB      'S'          ; 37 - Graphics mode off
```

```
          DB       'Z'              ; 38 - Cursor on (toggle in 3102)
          DB       'z'              ; 39 - Cursor off (toggle in 3102)
          DB       'g'              ; 40 - Memory lock on
          DB       'h'              ; 41 - Memory lock off
          DB       8CH              ; 42 - Line lock
          DB       8DH              ; 43 - Line unlock
          DB       8EH              ; 44 - Read character at cursor
          DB       '8'              ; 45 - Alarm on
          DB       '9'              ; 46 - Alarm off
        ENDIF                     ; End conditional #19E
SC.MAX  EQU        $-SC.TBL         ; Length of table
        ENDIF                     ; End conditional #19
```

```
            IF  ADM3A               ; Conditional #20
              EJECT

;  Special command table for ADM-3A terminals

SC.TBL: DB        CTRLZ           ;  0 - Clear screen
        DB        CTRL.UP         ;  1 - Home cursor
        DB        BACK            ;  2 - Back space
        DB        FORMF           ;  3 - Forward space
        DB        VT              ;  4 - Move cursor up
        DB        LF              ;  5 - Move cursor down
        DB        0               ;  6 - Clear to EOL
        DB        0               ;  7 - Clear to EOS
        DB        0               ;  8 - High light
        DB        0               ;  9 - Low light
        DB        0               ; 10 - Medium light
        DB        CTRLN           ; 11 - Enable keyboard
        DB        CTRLO           ; 12 - Disable keyboard
SC.MAX  EQU       $-SC.TBL        ; Length of table
            ENDIF                 ; End conditional #20
```

```
      IF  C3102 or C3101        ; Conditional #21
        EJECT

;  Routine address table for special console commands

;  Note:  When assembled, the number of entries in this table
;  MUST equal the number of entries in SC.TBL with bit 7 set.

ROUTTBL:DW      CURSPAD          ; 80H - Enable cursor pad
         DB      1
        DW      CURSPAD          ; 81H - Disable cursor pad
         DB      0
        DW      SETATR           ; 82H - Begin blinking
         DB      BLINK
        DW      RESATR           ; 83H - End blinking
         DB      BLINK
      IF  C3102                 ; Conditional #21A
        DW      RESATR           ; 84H - High light (normal)
         DB      HALFINTS
        DW      SETATR           ; 85H - Low light
         DB      HALFINTS
        DW      RESATR           ; 86H - Medium light
         DB      HALFINTS
        DW      SETATR           ; 87H - Reverse on
         DB      REVERSE
        DW      RESATR           ; 88H - Reverse off
         DB      REVERSE
        DW      SETATR           ; 89H - Underline on
         DB      UNDRLINE
        DW      RESATR           ; 8AH - Underline off
         DB      UNDRLINE
        DW      CPUMSG           ; 8BH - CPU message deposit
         DB      0
        DW      LINELOCK         ; 8CH - Line lock
         DB      '<'
        DW      LINELOCK         ; 8DH - Line unlock
         DB      '='
        DW      RDCURS           ; 8EH - Read character at cursor
         DB      'G'
      ENDIF                     ; End conditional #21A

;  Equates and variable needed for 3102 and 3101 special command routines

HALFINTS EQU    ^0               ; Half-intensity attribute bit mask
BLINK    EQU    ^1               ; Blinking-field attribute bit mask
REVERSE  EQU    ^4               ; Reverse-video attribute bit mask
UNDRLINE EQU    ^5               ; Underline attribute bit mask


ATFLAG: DB      0                ; Attributes-set flag byte
```

```
        EJECT

;  Enable/disable function key transmit-through (cursor pad on/off)
;  Upon Entry:  A contains 0 to transmit actual function key sequence and
;                 non-zero to transmit CDOS pre-programmed function keys

CURSPAD:LD      (CPFLAG),A      ; Store value in cursor pad flag & return
        RET


;  Set terminal attribute at present cursor position
;  Upon Entry:  A contains the bit mask for the attribute to be set
;                 (blinking field - 3102 or 3101 terminals)
;                 (half intensity, reverse video, & underline - 3102 only)

SETATR: LD      HL,ATFLAG       ; Point to attributes-set flag byte
        OR      (HL)            ; Combine old attributes with new in A-reg.
        JR      SENDATR         ; Send attributes to the terminal


;  Reset terminal attribute at present cursor position (3102 only)
;  Upon Entry:  A contains the bit mask for the attribute to be set
;                 (blinking field - 3102 or 3101 terminals)
;                 (half intensity, reverse video, & underline - 3102 only)

RESATR: CPL                     ; Invert all incoming bits
        LD      HL,ATFLAG       ; Point to attributes-set flag byte
        AND     (HL)            ; Use mask in A-reg. to turn off old attribute
                                ; Fall through to send attributes to terminal:

;  Send sequence to terminal to finish setting/resetting attributes
;  Upon Entry:  A contains byte with appropriate attribute bits set/reset

SENDATR:LD      (HL),A          ; Save byte specifying attributes set
        LD      B,'m'           ; Normal-video (3102) or end-blinking (3101)
        AND     A               ; Check whether all attributes are reset
        JP      Z,SENDESC       ; Skip if so to send special command & return
        LD      B,'l'           ; Start-blinking special command to 3102 & 3101
      IF  NOT C3102           ; Conditional #21B
        JP      SENDESC         ; Send escape-sequence to console & return
      ENDIF                   ; End conditional #21B
      IF  C3102               ; Conditional #21C
        CP      BLINK           ; Check for blinking-field attribute bit mask
        JP      Z,SENDESC       ; Skip if so to send special command & return
        LD      B,'d'           ; Set-visual-attributes special command to 3102
        CALL    SENDESC         ; Send escape-sequence to console
        LD      A,(ATFLAG)      ; Get flag byte specifying attributes set
        ADD     '@'             ; Convert attributes to appropriate ASCII
        JP      COUT            ; Output so-created character & return
        EJECT

;  Send message to terminal buffer (CPU message deposit for 3102 only)
;  Upon Entry:  HL points to message to be printed terminated in a 0 or a CR

CPUMSG: LD      B,';'           ; CPU-message-deposit special command to 3102
        CALL    SENDESC         ; Send escape-sequence to console
CPUM30: LD      A,(HL)          ; Get a character of the message
        AND     A               ; Check for 0, end of line indicator
        JR      Z,CPUM50        ; Skip if so to give terminating command
        CP      CR              ; Check for CR, end of line indicator
        JR      Z,CPUM50        ; Skip if so to give terminating command
        CALL    COUT            ; Print the message character
        INC     HL              ; Point to next message character
        JR      CPUM30          ; Skip to process next character

CPUM50: LD      A,CTRL.RB       ; Get terminating character for
        JP      COUT            ;   CPU-message-deposit & output it


;  Lock/unlock a display line on terminal (3102 only)
;  Upon Entry:  A contains the command byte to lock/unlock the line
;               C contains line number to be locked/unlocked (in range 1-24)
;                 or
;               C contains number > 24 to unlock all display lines

LINELOCK:
        LD      B,A             ; Line-lock/unlock special command to 3102
        LD      A,C             ; Get line number in C-reg.
        CP      25              ; Check it for outside the range 1-24
        JR      NC,LINL50       ; Skip if so to unlock all lines
        CALL    SENDESC         ; Send escape-sequence to console
        LD      A,1FH           ; Load A-reg. with offset to generate line
        ADD     C               ; Add incoming line number to the offset
        JP      COUT            ; Output so-created character & return

LINL50: LD      B,'?'           ; Unlock-all-lines special command to 3102
        JP      SENDESC         ; Send escape-sequence to console & return


;  Read character at present cursor position (3102 only)
;  Upon Entry:  A contains the command byte to read cursor character
;  Upon Exit:   A contains the character on the screen at the cursor position

RDCURS: LD      B,A             ; Read-cursor-character special command to 3102
        CALL    SENDESC         ; Send escape-sequence to console
        JP      CIN             ; Get the character to be returned
      ENDIF                   ; End conditional #21C
      ENDIF                   ; End conditional #21
```

```
        SUBTTL  Paper Tape or Card Reader Routines
      IF  S.READER or (NO.RDR>0)        ; Conditional #22

;  Reader Initialization Routine

RINIT:  LD      A,RDR.BD.RT     ; Get reader baud rate and
        OUT     RBAUD,A         ;   output to baud rate port
        RET


;  Get Reader Input Status
;  Upon Exit:   A = -1 (FFH) and Z-flag is reset if char. is ready
;               A = 0 and Z-flag is set if character is not ready

RSTAT:  LD      HL,(RD.CTR)     ; Get timeout counter,
        DEC     HL              ;   decrement it,
        LD      (RD.CTR),HL     ;   and store it back
        LD      A,H             ; Check to see whether reader timed
        OR      L               ;   out (zero means timeout)
        JR      Z,RSTA50        ; Return as though character were received
        IN      A,RSTATP        ; Get reader-in status
        AND     RRDA            ; Check reader RDA flag
        RET     Z               ; Character not ready
RSTA50: LD      A,-1            ; Character ready
        AND     A               ; Z-flag reset to show char. ready
        RET


;  Reader Input Routine
;  Upon Exit:   A contains the character read
;               Z-flag is reset if a character was read
;               Z-flag is set if 20 sec. timeout occurred before
;                 character was read (indicating end of file)

RIN:    CALL    RSTAT           ; Get reader-in status
        JR      Z,RIN           ; Zero means reader busy
        LD      HL,(RD.CTR)     ; Get timeout counter
        LD      A,H             ; Check to see whether reader timed
        OR      L               ;   out (zero means timeout)
        LD      A,CTRLZ         ; Return the end-of-file character and
        RET     Z               ;   with Z-flag set to indicate timeout
        LD      HL,READTIME     ; Get value for timeout counter
        LD      (RD.CTR),HL     ; Re-initialize the counter since no timeout
        IN      A,RDATA         ; Read the character
        RET                     ; Return with Z-flag reset to indicate char.


READTIME EQU    65536           ; Timeout value for reader (total time is
                                ;   approx. 300 usec. times value shown)
RD.CTR: DW      READTIME        ; Timeout counter storage
        ELSE                  ; Else conditional #22

RINIT   EQU     DUMMY           ; If no reader is present, use console
RSTAT   EQU     CSTAT           ;   routines and consider it the case of a
RIN     EQU     CIN             ;   teletype with paper tape reader connected
      ENDIF                   ; End conditional #22
```

```
        SUBTTL  Paper Tape Punch Routines
      IF  S.PUNCH or (NO.PUN>0)         ; Conditional #23

;  Punch Initialization Routine

PINIT:  LD      A,PUN.BD.RT     ; Get punch baud rate and
        OUT     PBAUD,A         ;   output to baud rate port
        RET

;  Get Punch Output Status
;  Upon Exit:   A = -1 (FFH) and Z-flag is reset if ready for char.
;               A = 0 and Z-flag is set if not ready for character

PRDY:   IN      A,PSTATP        ; Get punch-out status
        AND     PTBE            ; Check punch TBE flag
        RET     Z               ; Punch not ready for character
        LD      A,-1            ; Punch ready for character
        RET

;  Punch Output Routine
;  Upon Entry:  A contains the character to be output

POUT:   PUSH    AF              ; Save character for a moment
POUT30: CALL    PRDY            ; Get punch-out status
        JR      Z,POUT30        ; Zero means punch busy
        POP     AF              ; Restore character
        OUT     PDATA,A         ; Output the character
        RET
      ELSE                    ; Else conditional #23

PINIT   EQU     DUMMY           ; If no punch is present, use console
PRDY    EQU     CRDY            ;   routines and consider it the case of a
POUT    EQU     COUT            ;   teletype with paper tape punch connected
      ENDIF                   ; End conditional #23
```

```
        SUBTTL  List Device Routines
      IF  C3703 or C3779      ; Conditional #24
        EJECT

;  [Dummy] List Device Initialization Routine

L1INIT  EQU     DUMMY   ; (TUART is already initialized by CDOS upon booting)


;  Get Parallel Printer (List Device) Output Status
;  Upon Exit:   A = -1 (FFH) and Z-flag is reset if ready for char.
;               A = 0 and Z-flag is set if not ready for character

L1RDY:  IN      A,LSTATP        ; Get list-out status
        CPL                     ; Check for negative-logic
        AND     LRTP            ;   printer-ready flag
        RET     Z               ; Printer not ready for character
        LD      A,-1            ; Printer ready for character
        RET


;  Parallel Printer (List Device) Output Routine
;  Upon Entry:  A contains the character to be output

L1OUT:  CP      CTRLQ           ; Check for printer-select character
        JR      Z,L1OT40        ; If yes, skip & don't check for ready
        PUSH    AF              ; Save character for a moment
L1OT30: CALL    L1RDY           ; Get list-out status
        JR      Z,L1OT30        ; Zero means printer busy
        POP     AF              ; Restore character
      IF  C3779               ; Conditional #24A
        AND     7FH             ; Strip off parity bit for comparison
        CP      FORMF           ; Check for form feed character
        LD      HL,LF.CTR       ; Point to line feeds counter before skipping
        JR      Z,L1OT50        ; Skip to process form feed
      ENDIF                   ; End conditional #24A
L1OT40: SET     LSTROB,A        ; Data must be presented with strobe
        OUT     LDATA,A         ;   bit high prior to printing
        RES     LSTROB,A        ; Low-to-high transition of strobe
        OUT     LDATA,A         ;   bit prints the character
        SET     LSTROB,A        ; Strobe is set high upon this
        OUT     LDATA,A         ;   instruction and character is printed
      ENDIF                   ; End conditional #24
      IF  NOT C3779           ; Conditional #25
        RET
      ENDIF                   ; End conditional #25
      IF  C3779               ; Conditional #26
        CP      LF or ^7        ; Check for line feed characters
        RET     NZ              ; Return if not line feed character
        LD      A,(HL)          ; If LF, get number of lines already done
        INC     A               ; Increment counter and
        LD      (HL),A          ;   store it back
        CP      PAGE.SIZ        ; Check for having reached maximum
        RET     NZ              ; Return if still less than a full page
        XOR     A               ; Zero out the line feeds counter
        LD      (HL),A          ;   if a full page of text has been reached
        RET
        EJECT
L1OT50: LD      A,PAGE.SIZ+1    ; Get number of lines to a page
        SUB     (HL)            ; Subtract number of lines already done
L1OT60: DEC     A               ; Check for 0 line feeds first
        RET     Z               ; Return if all line feeds output
        PUSH    AF              ; Save line feeds counter
        LD      A,LF            ; Print a single line feed
        CALL    L1OUT           ;   character (recursive)
        POP     AF              ; Restore line feeds counter
        JR      L1OT60          ; Loop to print next line feed


LF.CTR: DB      0               ; Counter of number of line feeds done
      ENDIF                   ; End conditional #26
      IF  S.PRINTER             ; Conditional #27
        EJECT

;  Serial Printer Initialization Routine

L2INIT: LD      A,SER.BD.RT     ; Get serial printer baud rate
        OUT     SBAUD,A         ;   and output to baud rate port
        RET

;  Get Serial Printer Output Status
;  Upon Exit:   A = -1 (FFH) and Z-flag is reset if ready for char.
;               A = 0 and Z-flag is set if not ready for character

L2RDY:  IN      A,SSTATP        ; Get list-out status
        AND     STBE            ; Check printer TBE flag
        RET     Z               ; Printer not ready for character
        LD      A,-1            ; Printer ready for character
        RET


;  Serial Printer Output Routine
;  Upon Entry:  A contains the character to be output

L2OUT:  PUSH    AF              ; Save character for a moment
L2OT30: CALL    L2RDY           ; Get list-out status
        JR      Z,L2OT30        ; Zero means printer busy
        POP     AF              ; Restore character
        OUT     SDATA,A         ; Output the character
        RET
      ENDIF                     ; End conditional #27
      IF  (C3703 or C3779) and S.PRINTER and (NO.LST>1)    ; Conditional #28
        EJECT

;  Determine List Device Initialization Routine When Two Printers Used

LINIT:  LD      A,(IOBYTE)      ; Get I/O byte to determine which printer
        AND     ^IO.B7 or ^IO.B6  ; Check for bit combination 00 in high 2 bits
        JP      Z,L1INIT        ; If found, use printer-1
        CP      ^IO.B6          ; Check for bit combination 01 in high 2 bits
        JR      Z,L2INIT        ; If found, use printer-2
        RET                     ; All other combinations are ignored


;  Determine List Device Ready Routine When Two Printers Used
;  Upon Exit:   A = -1 (FFH) and Z-flag is reset if ready for char.
;               A = 0 and Z-flag is set if not ready for character

LRDY:   LD      A,(IOBYTE)      ; Get I/O byte to determine which printer
        AND     ^IO.B7 or ^IO.B6  ; Check for bit combination 00 in high 2 bits
        JR      Z,L1RDY         ; If found, use printer-1
        CP      ^IO.B6          ; Check for bit combination 01 in high 2 bits
        JR      Z,L2RDY         ; If found, use printer-2
        LD      A,-1            ; No printer means always ready (Z-flag reset)
        RET                     ; All other combinations are ignored


;  Determine List Device Output Routine When Two Printers Used
;  Upon Entry:  A contains the character to be output

LOUT:   LD      B,A             ; Save character to be output
        LD      A,(IOBYTE)      ; Get I/O byte to determine which printer
        AND     ^IO.B7 or ^IO.B6  ; Check for bit combination 00 in high 2 bits
        LD      C,A             ; Save I/O byte value for a moment
        LD      A,B             ; Restore character to be output
        JR      Z,L1OUT         ; If 00 combination, use printer-1
        LD      A,C             ; Retrieve I/O byte value
        CP      ^IO.B6          ; Check for bit combination 01 in high 2 bits
        LD      A,B             ; Restore character to be output
        JR      Z,L2OUT         ; If found, use printer-2
        RET                     ; All other combinations are ignored
        EJECT
      ENDIF                   ; End conditional #28
      IF  (C3703 or C3779) and (NO.LST=1)      ; Conditional #29
        EJECT

LINIT   EQU     L1INIT          ; Parallel printer initialize
LRDY    EQU     L1RDY           ; Parallel printer output-ready
LOUT    EQU     L1OUT           ; Parallel printer output a byte
      ENDIF                   ; End conditional #29
      IF  S.PRINTER and (NO.LST=1)      ; Conditional #30
        EJECT

LINIT   EQU     L2INIT          ; Serial printer initialize
LRDY    EQU     L2RDY           ; Serial printer output-ready
LOUT    EQU     L2OUT           ; Serial printer output a byte
      ENDIF                   ; End conditional #30
```

```
        SUBTTL  Clock Routines
      IF  C3102                 ; Conditional #31

;  Start-Time Routine for Clock in 3102 Terminal

STRTCLK:LD      B,SPC           ; Set-clock special command to 3102
        CALL    SENDESC         ; Send escape-sequence to console
        LD      A,(HOUR)        ; Get the hours value
        CALL    PRTASC          ; Print hours to console in ASCII
        LD      A,(MIN)         ; Get the minutes value
        CALL    PRTASC          ; Print minutes to console in ASCII
        LD      A,(SEC)         ; Get the seconds value
        JP      PRTASC          ; Print seconds to console in ASCII

;  Read-Time Routine for Clock in 3102 Terminal

READCLK:LD      B,'O'           ; Read-status-line special command to 3102
        CALL    SENDESC         ; Send escape-sequence to console
        CALL    WAIT30MS        ; Give 3102 time to process special function
        CALL    WAIT30MS        ; /
        CALL    GETFBYTE        ; Read first control-B and/or clear UART buffer
        CALL    ASKFBYTE        ; Request the second control-B
        RET     Z               ; Return if timeout; this terminal not a 3102
        CP      CTRLB           ; Check for control-B as second character
        RET     NZ              ; Return if any other character
        LD      B,27            ; Prepare to skip the next 27 characters
RCLK30: CALL    ASKFBYTE        ; Request a function byte by sending a CTRL-B
        RET     Z               ; Return if timeout; unable to read the time
        DJNZ    RCLK30          ; Loop to bit-bucket the next 27 characters
        CALL    GETTWO          ; Read 2 hours digits
        RET     Z               ; Return if timeout; unable to read hours
        LD      (HOUR),A        ; Store the binary value for hours
        CALL    ASKFBYTE        ; Request and bit-bucket the ":" character
        RET     Z               ; Return if timeout
        CALL    GETTWO          ; Read 2 minutes digits
        RET     Z               ; Return if timeout; unable to read minutes
        LD      (MIN),A         ; Store the binary value for minutes
        CALL    ASKFBYTE        ; Request and bit-bucket the ":" character
        RET     Z               ; Return if timeout
        CALL    GETTWO          ; Read 2 seconds digits
        RET     Z               ; Return if timeout; unable to read seconds
        LD      (SEC),A         ; Store the binary value for seconds
        LD      A,CTRLB         ; Acknowledge the last character with
        JP      COUT            ;    final CTRL-B as required by protocol

;  Get two ASCII characters from terminal
;     and combine them into a binary number returned in A-reg.
;  Upon Exit:   A contains the binary byte
;               Z-flag is set if timeout occurs before char.

GETTWO: CALL    ASKFBYTE        ; Request a function byte by sending CTRL-B
        RET     Z               ; Return if timeout occurred before byte
        AND     0FH             ; Strip to value between 0 and 9
        LD      B,A             ; Multiply first digit by 10
        ADD     A               ;    /
        ADD     A               ;   /
        ADD     B               ;  /
        ADD     A               ; /
```

```
LD      B,A             ; Save first digit for a moment
CALL    ASKFBYTE        ; Request a second special function byte
RET     Z               ; Return if timeout occurred before byte
AND     0FH             ; Strip to value between 0 and 9
ADD     B               ; Combine first digit with second digit
LD      B,A             ;   and hold binary value in B-reg.
INC     A               ; Reset Z-flag to indicate no timeout
LD      A,B             ; Retrieve binary value to be returned
RET
```

```
        EJECT

;  Print binary number on console in ASCII
;  Upon Entry:  A contains the binary number to be sent to 3102 terminal

PRTASC: LD      B,'0'-1         ; B-reg. will contain most sig. printable digit
PRTA30: INC     B               ; Increment to next printable digit
        SUB     10              ; Compare value in A-reg. to 10
        JR      NC,PRTA30       ; Loop to increment most sig. digit if A >= 10
        ADD     '0'+10          ; Convert remainder to ASCII if A < 10
        LD      C,A             ; Save second digit for a moment
        LD      A,B             ; Retrieve first digit
        CALL    COUT            ;   and print it on console
        LD      A,C             ; Retrieve second digit
        JP      COUT            ;   and print it also
      ELSE                    ; Else conditional #31

;  [Dummy] Time and Date Routines

STRTCLK EQU     DUMMY           ; If no clock is present, use
READCLK EQU     DUMMY           ;   dummy routine to return
      ENDIF                   ; End conditional #31
```

```
        SUBTTL  Notes

;  Note:  The last assembled byte of this module MUST NOT be a Define
;  Storage (DS or DEFS) pseudo-op to assure proper operation with CDOSGEN

        END
```

```
CROMEMCO Z80 Macro Assembler version 03.07              May 22, 1981  11:23:16                Page 0001
I/O Device Drivers for CDOS
Equated Values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                    0008          LIST    NOCOND, NOGEN
                    0009
      (FFFF)        0010  TRUE     EQU     -1
      (0000)        0011  FALSE    EQU     0
                    0012
                    0013  ;  At least one of the following three names MUST be TRUE to prevent errors:
      (FFFF)        0014  C3102    EQU     TRUE           ; Cromemco Model-3102 Terminal
      (0000)        0015  C3101    EQU     FALSE          ; Cromemco Model-3101 Terminal
      (0000)        0016  ADM3A    EQU     FALSE          ; TRUE to include ADM-3A CRT driver
                    0017
                    0018  ;  The state of the following name should match that of C3102 or C3101:
      (FFFF)        0019  FUN.KEYS EQU     TRUE           ; TRUE to assemble function key decoding routines
                    0020
                    0021  ;  The following two names may be either TRUE or FALSE:
      (0000)        0022  S.READER EQU     FALSE          ; TRUE for serial reader connected to TUART/
                    0023                                  ;   FALSE for reader driver same as CIN
      (0000)        0024  S.PUNCH  EQU     FALSE          ; TRUE for serial punch connected to TUART/
                    0025                                  ;   FALSE for punch driver same as COUT
                    0026
                    0027  ;  At least one of the following three names MUST be TRUE to prevent errors:
                    0028  ;  (C3703 and C3779 both TRUE counts as only 1 of the printers of NO.LST)
      (FFFF)        0029  C3703      EQU   TRUE           ; Cromemco Model-3703 Printer
                    0030                                  ;   (outputs form feeds directly)
      (0000)        0031  C3779      EQU   FALSE          ; Cromemco Model-3779 Printer
                    0032                                  ;   (outputs form feeds as multiple line feeds)
      (0000)        0033  S.PRINTER EQU    FALSE          ; TRUE to include serial printer driver
                    0034
                    0035  ;  Numbers of devices to be accessed by CDOS:
      (0001)        0036  NO.CON   EQU     1              ; Number of consoles to be accessed (8 maximum)
      (0000)        0037  NO.RDR   EQU     0              ; Number of readers to be accessed (4 maximum)
      (0000)        0038  NO.PUN   EQU     0              ; Number of punches to be accessed (2 maximum)
      (0001)        0039  NO.LST   EQU     1              ; Number of printers to be accessed (4 maximum)
                    0040
                    0041  ;  I/O byte defined values:
      (0003)        0042  IOBYTE   EQU     3              ; I/O byte - used by multiple-device routines
      (0000)        0043  IO.B0    EQU     0              ; I/O byte bit 0 (Console bit 0)
      (0001)        0044  IO.B1    EQU     1              ; I/O byte bit 1 (Console bit 1)
      (0002)        0045  IO.B2    EQU     2              ; I/O byte bit 2 (Console bit 2)
      (0003)        0046  IO.B3    EQU     3              ; I/O byte bit 3 (Reader bit 0)
      (0004)        0047  IO.B4    EQU     4              ; I/O byte bit 4 (Reader bit 1)
      (0005)        0048  IO.B5    EQU     5              ; I/O byte bit 5 (Punch bit)
      (0006)        0049  IO.B6    EQU     6              ; I/O byte bit 6 (Printer bit 0)
      (0007)        0050  IO.B7    EQU     7              ; I/O byte bit 7 (Printer bit 1)
                    0051
                    0052  ;  Miscellaneous defined values:
      (0000)        0053  NULLS     EQU    0              ; Number of nulls transmitted after line feeds
      (0042)        0054  PAGE.SIZ EQU     66             ; Number of lines of text per page for printer
```

```
CROMEMCO Z80 Macro Assembler version 03.07             May 22, 1981  11:23:16              Page 0002
I/O Device Drivers for CDOS
ASCII Character Definitions


                    ;  ASCII characters

     (0002)         CTRLB    EQU     2             ; ASCII control-B character
     (0008)         BACK     EQU     8             ; ASCII back space
     (000A)         LF       EQU     0AH           ; ASCII line feed
     (000B)         VT       EQU     0BH           ; ASCII vertical tab
     (000C)         FORMF    EQU     0CH           ; ASCII form feed
     (000D)         CR       EQU     0DH           ; ASCII carriage return
     (000E)         CTRLN    EQU     0EH           ; ASCII control-N character
     (000F)         CTRLO    EQU     0FH           ; ASCII control-O character
     (0010)         CTRLP    EQU     10H           ; ASCII control-P character
     (0011)         CTRLQ    EQU     11H           ; ASCII control-Q character
     (0013)         CTRLS    EQU     13H           ; ASCII control-S character
     (0016)         CTRLV    EQU     16H           ; ASCII control-V character
     (0017)         CTRLW    EQU     17H           ; ASCII control-W character
     (001A)         CTRLZ    EQU     1AH           ; ASCII control-Z character
     (001B)         ESC      EQU     1BH           ; ASCII escape character
     (001D)         CTRL.RB  EQU     1DH           ; ASCII control-] character
     (001E)         CTRL.UP  EQU     1EH           ; ASCII control-^ character
     (0020)         SPC      EQU     20H           ; ASCII space character
```

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I/O Device Drivers for CDOS
Device Port Assignments, Status Bits, and Baud Rates

                    0078
                    0079  ;  I/O device port assignments and status bits
                    0080
      (0000)        0081  CSTATP   EQU     0             ; Console status port (input)
      (0001)        0082  CDATA    EQU     CSTATP+1      ; Console data port (input/output)
      (0040)        0083  CRDA     EQU     40H           ; Console Receiver-Data-Available mask
      (0080)        0084  CTBE     EQU     80H           ; Console Transmitter-Buffer-Empty mask
                    0085
      (0020)        0086  RSTATP   EQU     20H           ; Serial reader status port (input)
      (0020)        0087  RBAUD    EQU     RSTATP        ; Serial reader baud rate port (output)
      (0021)        0088  RDATA    EQU     RSTATP+1      ; Serial reader data port (input)
      (0040)        0089  RRDA     EQU     40H           ; Serial reader RDA bit mask
                    0090
      (0020)        0091  PSTATP   EQU     20H           ; Serial punch status port (input)
      (0020)        0092  PBAUD    EQU     PSTATP        ; Serial punch baud rate port (output)
      (0021)        0093  PDATA    EQU     PSTATP+1      ; Serial punch data port (output)
      (0080)        0094  PTBE     EQU     80H           ; Serial punch TBE bit mask
                    0095
      (0054)        0096  LSTATP   EQU     54H           ; List device status port (input)
      (0054)        0097  LDATA    EQU     LSTATP        ; List device data port (output)
      (0020)        0098  LRTP     EQU     20H           ; List device Ready-To-Print bit mask
      (0007)        0099  LSTROB   EQU     7             ; List device strobe bit
                    0100
      (0050)        0101  SSTATP   EQU     50H           ; Serial printer status port (input)
      (0050)        0102  SBAUD    EQU     SSTATP        ; Serial printer baud rate port (output)
      (0051)        0103  SDATA    EQU     SSTATP+1      ; Serial printer data port (output)
      (0080)        0104  STBE     EQU     80H           ; Serial printer TBE bit mask
                    0105
                    0106
                    0107
                    0108  ;  I/O device baud rate assignment table for TUART
                    0109
                    0110  ;        01H =  110 baud / 2 stop bits
                    0111  ;        82H =  150 baud / 1 stop bit
                    0112  ;        84H =  300 baud / 1 stop bit
                    0113  ;        88H = 1200 baud / 1 stop bit
                    0114  ;        90H = 2400 baud / 1 stop bit
                    0115  ;        A0H = 4800 baud / 1 stop bit
                    0116  ;        C0H = 9600 baud / 1 stop bit
                    0117  ;  (Refer to TUART manual for other rate or stop bit configurations)
                    0118
                    0119  ;  The following baud rates were chosen from the table above:
      (0001)        0120  RDR.BD.RT EQU    01H      ; Baud rate of serial reader
      (0001)        0121  PUN.BD.RT EQU    01H      ; Baud rate of serial punch
      (0084)        0122  SER.BD.RT EQU    84H      ; Baud rate of serial printer
```

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CROMEMCO Z80 Macro Assembler version 03.07          May 22, 1981  11:23:16          Page 0004
I/O Device Drivers for CDOS
Device Driver Address Table


                       ;  The following is a table of addresses needed by CDOS
                       ;  to find the starting locations of each of the I/O device
                       ;  routines.  The address values are filled in by CDOSGEN;
                       ;  therefore, this table MUST NOT be removed from the drivers.

0000' 5900'            CONSOLE:DW       CINIT           ; Console initialize
0002' 5E00'                    DW       CSTAT           ; Console input-status
0004' 8400'                    DW       CSPECIN         ; Console input a byte or function key
0006' 6501'                    DW       CRDY            ; Console output-ready
0008' 6D01'                    DW       COUT            ; Console output a byte
000A' 7701'                    DW       CSET            ; Console set special command

000C' 5800'            READER: DW       RINIT           ; Reader initialize
000E' 5E00'                    DW       RSTAT           ; Reader input-status
0010' 6F00'                    DW       RIN             ; Reader input a byte

0012' 5800'            PUNCH:  DW       PINIT           ; Punch initialize
0014' 6501'                    DW       PRDY            ; Punch output-ready
0016' 6D01'                    DW       POUT            ; Punch output a byte

0018' 5800'            PRINTER:DW       LINIT           ; List initialize
001A' 8A02'                    DW       LRDY            ; List output-ready
001C' 9302'                    DW       LOUT            ; List output a byte

001E' AB02'            CLOCK:  DW       STRTCLK         ; Start clock
0020' C202'                    DW       READCLK         ; Read clock
0022' 00               YEAR:   DB       0               ; Year (-1900) binary storage
0023' 00               MON:    DB       0               ; Month binary storage
0024' 00               DATE:   DB       0               ; Date binary storage
0025' 00               HOUR:   DB       0               ; Hours binary storage
0026' 00               MIN:    DB       0               ; Minutes binary storage
0027' 00               SEC:    DB       0               ; Seconds binary storage
```

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CROMEMCO Z80 Macro Assembler version 03.07          May 22, 1981  11:23:16          Page 0005
I/O Device Drivers for CDOS
Function Key Address Table and Dummy Return Routine

                    0163
                    0164  ;  The following is a table of addresses needed by CDOS to
                    0165  ;  locate the pre-programmed value of each of the function
                    0166  ;  keys.  The first 20 address values are filled in by CDOSGEN
                    0167  ;  and MUST NOT be removed from the drivers.
                    0168
                    0169  FUNCADDR:
0028' 0000          0170          DW      0        ; Function key F1  (3102 and 3101)
002A' 0000          0171          DW      0        ; Function key F2
002C' 0000          0172          DW      0        ; Function key F3
002E' 0000          0173          DW      0        ; Function key F4
0030' 0000          0174          DW      0        ; Function key F5
0032' 0000          0175          DW      0        ; Function key F6
0034' 0000          0176          DW      0        ; Function key F7
0036' 0000          0177          DW      0        ; Function key F8
0038' 0000          0178          DW      0        ; Function key F9
003A' 0000          0179          DW      0        ; Function key F10
003C' 0000          0180          DW      0        ; Function key F11
003E' 0000          0181          DW      0        ; Function key F12
0040' 0000          0182          DW      0        ; Function key F13
0042' 0000          0183          DW      0        ; Function key F14
0044' 0000          0184          DW      0        ; Function key F15
0046' 0000          0185          DW      0        ; Function key F16
0048' 0000          0186          DW      0        ; Function key F17 (3102 only)
004A' 0000          0187          DW      0        ; Function key F18
004C' 0000          0188          DW      0        ; Function key F19
004E' 0000          0189          DW      0        ; Function key F20
0050' 3B01'         0191          DW      DELLINE  ; CE (Clear Entry) function key
0052' 3D01'         0192          DW      PAUSE    ; PAUSE function key
0054' 3F01'         0193          DW      PRINT    ; PRINT function key
0056' 4101'         0194          DW      HELP     ; HELP function key
                    0196
                    0197
                    0198
                    0199  ;  Dummy routine to use when returning to caller with no changes
                    0200
0058' C9            0201  DUMMY:  RET              ; Return to caller with no changes
```

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I/O Device Drivers for CDOS
Console Routines

                   0204
                   0205  ;  Console Initialization Routine for 3102 Terminal
                   0206
0059' 0639         0207  CINIT:  LD      B,'9'           ; Turn-on-function-keys special command to 3102
005B' C39601'      0208          JP      SEND.ESC        ; Print escape-dot sequence to console & return
                   0216
                   0217
                   0218  ;  Get Console Input Status
                   0219  ;  Upon Exit:    A = -1 (FFH) and Z-flag is reset if char. is ready
                   0220  ;               A = 0 and Z-flag is set if character is not ready
                   0221  ;               C-flag is set if function key transmission is in progress
                   0222
005E' DB00         0223  CSTAT:  IN      A,CSTATP        ; Get console-in status
0060' E640         0224          AND     CRDA            ; Check console RDA flag
0062' 2803         0231          JR      Z,CSTA50        ; Skip to check further if char. not ready
0064' 3EFF         0232          LD      A,-1            ; Character ready
0066' C9           0233          RET
                   0234
0067' 3A1A01'      0235  CSTA50: LD      A,(FPFLAG)      ; Check whether or not in midst of
006A' A7           0236          AND     A               ;   function key transmission to CDOS
006B' C8           0237          RET     Z               ; Return if not with Z and C-flags cleared
006C' 97           0238          SUB     A               ; Clear A-reg. & set Z-flag for char. not ready
006D' 37           0239          SCF                     ; Return C-flag set to indicate to CDOS that
006E' C9           0240          RET                     ;   function key transmission is in progress
                   0242
                   0243
                   0244  ;  Console Input Routine
                   0245  ;  Upon Exit:    A contains the character read
                   0246  ;               Z-flag is reset to prevent indicating end of file
                   0247  ;                 (Change routine to return Z-flag set ONLY if you wish
                   0248  ;                 to have a particular character indicate end of file.)
                   0249
006F' CD5E00'      0250  CIN:    CALL    CSTAT           ; Get console-in status
0072' 28FB         0251          JR      Z,CIN           ; Zero means console busy
0074' DB01         0252          IN      A,CDATA         ; Read the character
0076' E67F         0253          AND     7FH             ; Strip off parity bit
0078' FE10         0258          CP      CTRLP           ; Check for control-P
007A' C0           0259          RET     NZ              ; Return if any other character
007B' F5           0260          PUSH    AF              ; Save control-P for a moment,
007C' 3E11         0261          LD      A,CTRLQ         ;   get select character, and
007E' CD9302'      0262          CALL    L1OUT           ;   output it to select the printer
0081' F1           0263          POP     AF              ; Restore the original control-P for return
0082' A7           0264          AND     A               ; Reset Z-flag to avoid indicating EOF
0083' C9           0265          RET
```

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I/O Device Drivers for CDOS
Console Routines


                ;  Special Console Input Routine Including Function Key Decoding
                ;  Upon Exit:   A contains the character read, either from the
                ;               console or as a character in a function key string

0084' CD5B00'   CSPECIN:CALL    CSTAT           ; Get crnsole-in status
0087' 2006              JR      NZ,CSIN20       ; Skip to read character if ready now
0089' 3A1A01'           LD      A,(FPFLAG)      ; Check whether or not in midst of
008C' A7                AND     A               ;   function key transmission to CDOS
008D' 2006              JR      NZ,CSIN30       ; Skip if so to finish the transmission
008F' CDAD00'   CSIN20: CALL    GETFUNC         ; Get either a single byte or a function key
0092' 2804              JR      Z,CSIN40        ; Skip to process if a function key
0094' C9                RET                     ; Return if it's a single byte

0095' 2A1B01'   CSIN30: LD      HL,(FPPTR)      ; Point to next byte to be passed to CDOS
0098' 3EFF      CSIN40: LD      A,-1            ; Non-zero means function-in-progress
009A' 321A01'           LD      (FPFLAG),A      ; Store the flag
009D' 7E                LD      A,(HL)          ; Get the character being transmitted
009E' F5                PUSH    AF              ; Save character for a moment
009F' 23                INC     HL              ; Increment to point to next character
00A0' 221B01'           LD      (FPPTR),HL      ; Store pointer back
00A3' 7E                LD      A,(HL)          ; Get subsequent character and check
00A4' D6FF              SUB     -1              ;   whether it's the end-of-transmission
00A6' 2003              JR      NZ,CSIN50       ; Return with character if not
00A8' 321A01'           LD      (FPFLAG),A      ; If end-of-transmission, zero progress flag
00AB' F1        CSIN50: POP     AF              ; Restore the character and return
00AC' C9                RET


                ;  Get either a function key or a single byte from the console
                ;  Upon Exit:   for a function key:
                ;                 Z-flag is set and HL points to start of definition
                ;               for a single byte:
                ;                 Z-flag is reset and A contains the character read

00AD' CD6F00'   GETFUNC:CALL    CIN             ; Get a byte from the console
00B0' FE02              CP      CTRLB           ; Check for control-B
00B2' C0                RET     NZ              ; Return if any other character
00B3' 321D01'           LD      (FKBUFF),A      ; Save the control-B in sequence buffer
00B6' 321E01'           LD      (FKBUFF+1),A    ;   in first and second positions
00B9' CD4B01'           CALL    GETFBYTE        ; Get next byte of function key sequence
00BC' 201C              JR      NZ,GTFC30       ; Skip to get other chars. if 3101 function key
00BE' 3E0D              LD      A,CR            ; Set up last byte of 4-byte sequence to make
00C0' 322001'           LD      (FKBUFF+3),A    ;   3102 func. key look like 3101 func. key
00C3' CD4601'           CALL    ASKFBYTE        ; Get second byte of 3102 func. key sequence
00C6' 321F01'           LD      (FKBUFF+2),A    ;   and save it in sequence buffer
00C9' 280B              JR      Z,GTFC20        ; Skip to return if timeout
00CB' FE02              CP      CTRLB           ; Check for control-B as second character
00CD' 281A              JR      Z,GTFC40        ; Skip to do as block-send (don't echo CTRL-B)
00CF' 3E02              LD      A,CTRLB         ; Prepare to echo control-B since function key
00D1' CD6D01'           CALL    COUT            ; Echo control-B as required by 3102 protocol
00D4' 1813              JR      GTFC40          ; Skip to decode the function key

00D6' 3E02      GTFC20: LD      A,CTRLB         ; Return a single control-B since timeout
```

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I/O Device Drivers for CDOS
Console Routines

00D8' A7                      AND     A                ; Reset Z-flag to indicate single byte
00D9' C9                      RET
```

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I/O Device Drivers for CDOS
Console Routines

00DA' FE02            GTFC30: CP      CTRLB           ; Check if second byte is control-B for 3101
00DC' C0                      RET     NZ              ; Return only that character if not
00DD' CD6F00'                 CALL    CIN             ; Get byte which determines actual func. key
00E0' 321F01'                 LD      (FKBUFF+2),A    ; Save third byte of sequence in buffer
00E3' CD6F00'                 CALL    CIN             ; Get last byte of sequence
00E6' 322001'                 LD      (FKBUFF+3),A    ;   and save it in buffer
00E9' CD5B01'         GTFC40: CALL    WAIT30MS        ; Wait 30 msec. to allow for CRT recovery
                                                      ;   after function key transmission
00EC' 3A1F01'                 LD      A,(FKBUFF+2)    ; Get byte determining function key
00EF' 47                      LD      B,A             ;   and put in B-reg. for use later
00F0' 214301'                 LD      HL,BLKSEND      ; Point to block-send sequence to pass on
00F3' FE02                    CP      CTRLB           ; Check if block-send request instead of
00F5' C8                      RET     Z               ;   other function key and return if so
00F6' 211D01'                 LD      HL,FKBUFF       ; Point to function key sequence buffer
00F9' 3ACF01'                 LD      A,(CPFLAG)      ; Check whether or not to use CDOS
00FC' A7                      AND     A               ;   pre-programmed function keys
00FD' C8                      RET     Z               ; Return with address of actual 4 bytes if 0
00FE' 212201'                 LD      HL,FUNCVAL      ; Point to table of function key values
0101' 112800'                 LD      DE,FUNCADDR     ; Point to addresses of func. key definitions
0104' 7E              GTFC60: LD      A,(HL)          ; Get a character from value table
0105' A7                      AND     A               ; Check for end of table
0106' 28A5                    JR      Z,GETFUNC       ; Skip if func. key not in table to try again
0108' B8                      CP      B               ; Check char. in table to func. byte in B-reg.
0109' 2805                    JR      Z,GTFC70        ; Skip if found to get address of definition
010B' 23                      INC     HL              ; Point to next character in value table
010C' 13                      INC     DE              ; Point to next address in definition table
010D' 13                      INC     DE              ; /
010E' 18F4                    JR      GTFC60          ; Skip to check next byte in value table

0110' EB              GTFC70: EX      DE,HL           ; Swap pointer to address table from DE into HL
0111' 7E                      LD      A,(HL)          ; Get the address and put it into HL
0112' 23                      INC     HL              ;   /
0113' 66                      LD      H,(HL)          ;  /
0114' 6F                      LD      L,A             ; /
0115' B4                      OR      H               ; If HL=0 (function key is undefined),
0116' 2895                    JR      Z,GETFUNC       ;   loop to get another character from console
0118' 97                      SUB     A               ; Set Z-flag to indicate function
0119' C9                      RET                     ;   key transmission and return



                      ;  Variables needed for function key routines

011A' 00              FPFLAG: DB      0               ; Function-transmission-in-progress flag
011B' 0000            FPPTR:  DW      0               ; Pointer to current byte of pre-programmed
                                                      ;   function key transmission to CDOS
011D' 00000000        FKBUFF: DB      0,0,0,0,-1      ; Buffer for function key sequence
```

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I/O Device Drivers for CDOS
Console Routines

                    0376
                    0377  ;  Table of function key values transmitted
                    0378
                    0379  ;  Note:  When assembled, the number of entries in this table
                    0380  ;  MUST NOT exceed the number of entries in the FUNCADDR table.
                    0381
0122' 70            0382  FUNCVAL:DB      70H             ; Function key F1  (3102 and 3101)
0123' 71            0383          DB      71H             ; Function key F2
0124' 72            0384          DB      72H             ; Function key F3
0125' 73            0385          DB      73H             ; Function key F4
0126' 74            0386          DB      74H             ; Function key F5
0127' 75            0387          DB      75H             ; Function key F6
0128' 76            0388          DB      76H             ; Function key F7
0129' 77            0389          DB      77H             ; Function key F8
012A' 78            0390          DB      78H             ; Function key F9
012B' 79            0391          DB      79H             ; Function key F10
012C' 7A            0392          DB      7AH             ; Function key F11
012D' 7B            0393          DB      7BH             ; Function key F12
012E' 7C            0394          DB      7CH             ; Function key F13
012F' 7D            0395          DB      7DH             ; Function key F14
0130' 7E            0396          DB      7EH             ; Function key F15
0131' 7F            0397          DB      7FH             ; Function key F16
0132' 6F            0398          DB      6FH             ; Function key F17 (3102 only)
0133' 6E            0399          DB      6EH             ; Function key F18
0134' 6D            0400          DB      6DH             ; Function key F19
0135' 6C            0401          DB      6CH             ; Function key F20
0136' 5E            0406          DB      5EH             ; CE (Clear Entry) function key (3102 only)
0137' 5F            0407          DB      5FH             ; PAUSE function key (3102 only)
0138' 6A            0408          DB      6AH             ; PRINT function key (3102 only)
0139' 6B            0409          DB      6BH             ; HELP function key (3102 only)
013A' 00            0410          DB      0               ; End of table
                    0411
                    0412
                    0413  ;  Character sequences transmitted for special-purpose function keys
                    0414
013B' 16FF          0415  DELLINE:DB      CTRLV,-1        ; Delete line (control-V)
013D' 13FF          0416  PAUSE:  DB      CTRLS,-1        ; Pause console output (control-S)
013F' 10FF          0417  PRINT:  DB      CTRLP,-1        ; Print console output (control-P)
0141' 1EFF          0418  HELP:   DB      CTRL.UP,-1      ; Help key (control-^)
0143' 0202FF        0419  BLKSEND:DB      CTRLB,CTRLB,-1  ; Block-send sequence
```

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                  ;  Ask terminal for a function key byte by sending a control-B (3102 only)
                  ;  Upon Exit:    Z-flag is reset if function key was pressed
                  ;                Z-flag is set if timeout occurred before subsequent char.

                  ASKFBYTE:
0146' 3E02                LD      A,CTRLB          ; Output a control-B to console
0148' CD6D01'             CALL    COUT             ;   to request a function key byte
                                                   ; Fall through to get function key byte:

                  ;  Get a function key byte
                  ;  Upon Exit:    Z-flag is reset if function key was pressed
                  ;                Z-flag is set if timeout occurred before subsequent char.

                  GETFBYTE:
014B' 217805              LD      HL,FUNCTIME      ; Get counter for time between characters
014E' CD5E00'     GTFB20: CALL    CSTAT            ; Get console-in status
0151' C26F00'             JP      NZ,CIN           ; Non-zero means char. is ready; get it and
                                                   ;   return with Z-flag reset (CIN returns
                                                   ;   flag this way) to indicate function key
0154' 2D                  DEC     L                ; If still no character, count down
0155' 20F7                JR      NZ,GTFB20        ;    /
0157' 25                  DEC     H                ;   /
0158' 20F4                JR      NZ,GTFB20        ;  /
015A' C9                  RET                      ; Return with Z-flag set to indicate
                                                   ;   no character within timeout


                  ;  Delay routine to wait for approx. 30 msec.
                  ;  Registers:    HL registers are not preserved

                  WAIT30MS:
015B' 21401F              LD      HL,8000          ; Load counter for time of 30 msec.
015E' 2D          WAIT20: DEC     L                ; Total time approx. = (no. in H) x 1 msec.
015F' 20FD                JR      NZ,WAIT20        ;    /
0161' 25                  DEC     H                ;   /
0162' 20FA                JR      NZ,WAIT20        ;  /
0164' C9                  RET



                  ;  Equate needed for GETFBYTE

      (0578)      FUNCTIME EQU    1400             ; Maximum time allowable between characters
                                                   ;   of function key sequence (total time is
                                                   ;   approx. 21 usec. times value shown)
```

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I/O Device Drivers for CDOS
Console Routines


                  ;  Get Console Output Status
                  ;  Upon Exit:   A = -1 (FFH) and Z-flag is reset if ready for char.
                  ;               A = 0 and Z-flag is set if not ready for character

0165' DB00        CRDY:   IN      A,CSTATP          ; Get console-out status
0167' E680                AND     CTBE              ; Check console TBE flag
0169' C8                  RET     Z                 ; Console not ready for character
016A' 3EFF                LD      A,-1              ; Console ready for character
016C' C9                  RET


                  ;  Console Output Routine
                  ;  Upon Entry:  A contains the character to be output

016D' F5          COUT:   PUSH    AF                ; Save character for a moment
016E' CD6501'     COUT30: CALL    CRDY              ; Get console-out status
0171' 28FB                JR      Z,COUT30          ; Zero means console busy
0173' F1                  POP     AF                ; Restore character
0174' D301                OUT     CDATA,A           ; Output the character
0176' C9                  RET
```

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I/O Device Drivers for CDOS
Console Routines


                       ;  Set Special Console Command Including Cursor Addressing
                       ;  Upon Entry:  for cursor addressing:
                       ;                  E contains cursor row in the range 1-24
                       ;                  D contains cursor column in the range 1-80
                       ;               for special console command:
                       ;                  E = 0
                       ;                  D contains the special command number
                       ;                  HL contains pointer to string for some commands
                       ;                  A contains additional information for some commands

0177' 4F               CSET:   LD      C,A             ; Save the additional information
0178' 7B                       LD      A,E             ; Check whether it's a special
0179' A7                       AND     A               ;   or cursor-address command
017A' 2828                     JR      Z,CSCOMMD       ; Skip to do special command
017C' 0646                     LD      B,'F'           ; Second special character is "F"
017E' CD8D01'                  CALL    SENDESC         ; Send escape-sequence for cursor addressing
0181' 3E1F                     LD      A,1FH           ; Load A-reg. with offset to generate row
0183' 83                       ADD     E               ; Add incoming row number to the offset
0184' CD6D01'                  CALL    COUT            ; Output so-created character
0187' 3E1F                     LD      A,1FH           ; Load A-reg. with offset to generate column
0189' 82                       ADD     D               ; Add incoming column number to the offset
018A' C36D01'    R             JP      COUT            ; Output so-created character & return


                       ;  Print escape sequence on console
                       ;  Upon Entry:  B contains command character

018D' 3E1B             SENDESC:LD      A,ESC           ; Send an escape character to
018F' CD6D01'                  CALL    COUT            ;   console to start sequence
0192' 78                       LD      A,B             ; Retrieve the command character
0193' C36D01'    R             JP      COUT            ; Print the command char. & return


                       ;  Print escape-dot sequence on console
                       ;  Upon Entry:  B contains command character

                       SEND.ESC:
0196' 3E1B                     LD      A,ESC           ; Send an escape character to
0198' CD6D01'                  CALL    COUT            ;   console to start sequence
019B' 3E2E                     LD      A,'.'           ; Send a dot character to console
019D' CD6D01'                  CALL    COUT            ;   as second specifier of sequence
01A0' 78                       LD      A,B             ; Retrieve the command character
01A1' C36D01'    R             JP      COUT            ; Print the command char. & return
```

```
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Console Routines


                     ;  Set special console command (part of CSET)
                     ;  Upon Entry:  D contains the special command number
                     ;               HL contains pointer to string for some commands
                     ;               C contains additional information for some commands

01A4' 7A             CSCOMMD:LD      A,D                 ; Get number of special command
01A5' FE2F                   CP      SC.MAX              ; Check for illegal special
01A7' D0                     RET     NC                  ;   command and return if so
01A8' E5                     PUSH    HL                  ; Save address pointer
01A9' 21D001'                LD      HL,SC.TBL           ; Point to table of special command values
01AC' 85                     ADD     L                   ; Add offset in A to table address in HL
01AD' 6F                     LD      L,A                 ;   /
01AE' 3001                   JR      NC,CSCMD30          ;  /
01B0' 24                     INC     H                   ; /
01B1' 7E             CSCMD30:LD      A,(HL)              ; Get the command from the table
01B2' E1                     POP     HL                  ; Restore address pointer
01B3' A7                     AND     A                   ; Zero means command not implemented
01B4' C8                     RET     Z                   ; Return if command not implemented
01B5' 47                     LD      B,A                 ; Save the special character
01B6' F28D01'                JP      P,SENDESC           ; Send escape-sequence to console & return
01B9' E67F                   AND     7FH                 ; Strip off top bit
01BB' 47                     LD      B,A                 ; Multiply by 3
01BC' 80                     ADD     B                   ;  /
01BD' 80                     ADD     B                   ; /
01BE' E5                     PUSH    HL                  ; Save address pointer
01BF' 21FF01'                LD      HL,ROUTTBL          ; Point to routine table
01C2' 85                     ADD     L                   ; Add displacement to HL
01C3' 6F                     LD      L,A                 ;   /
01C4' 3001                   JR      NC,CSCMD50          ;  /
01C6' 24                     INC     H                   ; /
01C7' 5E             CSCMD50:LD      E,(HL)              ; Get routine address into DE-reg.
01C8' 23                     INC     HL                  ;   /
01C9' 56                     LD      D,(HL)              ;  /
01CA' 23                     INC     HL                  ; /
01CB' 7E                     LD      A,(HL)              ; Get mask into A-reg.
01CC' E1                     POP     HL                  ; Get address pointer
01CD' D5                     PUSH    DE                  ; Put routine address on stack
01CE' C9                     RET                         ; Execute routine



01CF' 01             CPFLAG: DB      1          ; Cursor pad enable/disable special command flag
                                                ;  (1 = CDOS pre-programmed function keys;
                                                ;   0 = terminal's actual function key sequence)
```

```
                  0612
                  0613  ;  Special command table for Cromemco 3102 and 3101 terminals
                  0614
01D0' 45          0615  SC.TBL: DB      'E'             ;  0 - Clear screen
01D1' 48          0616          DB      'H'             ;  1 - Home cursor
01D2' 44          0617          DB      'D'             ;  2 - Back space
01D3' 43          0618          DB      'C'             ;  3 - Forward space
01D4' 41          0619          DB      'A'             ;  4 - Move cursor up
01D5' 42          0620          DB      'B'             ;  5 - Move cursor down
01D6' 4B          0621          DB      'K'             ;  6 - Clear to EOL
01D7' 4A          0622          DB      'J'             ;  7 - Clear to EOS
01D8' 84          0624          DB      84H             ;  8 - High light
01D9' 85          0625          DB      85H             ;  9 - Low light
01DA' 86          0626          DB      86H             ; 10 - Medium light
01DB' 62          0633          DB      'b'             ; 11 - Enable keyboard
01DC' 63          0634          DB      'c'             ; 12 - Disable keyboard
01DD' 80          0635          DB      80H             ; 13 - Enable cursor pad
01DE' 81          0636          DB      81H             ; 14 - Disable cursor pad
01DF' 5D          0637          DB      ']'             ; 15 - Begin protected field
01E0' 5B          0638          DB      '['             ; 16 - End protected field
01E1' 82          0639          DB      82H             ; 17 - Begin blinking
01E2' 83          0640          DB      83H             ; 18 - End blinking
01E3' 69          0641          DB      'i'             ; 19 - Line-send
01E4' 49          0642          DB      'I'             ; 20 - Page-send
01E5' 30          0643          DB      '0'             ; 21 - Aux-send
01E6' 50          0644          DB      'P'             ; 22 - Delete character
01E7' 51          0646          DB      'Q'             ; 23 - Insert character
01E8' 4D          0647          DB      'M'             ; 24 - Delete line
01E9' 4C          0648          DB      'L'             ; 25 - Insert line
01EA' 57          0655          DB      'W'             ; 26 - Format on
01EB' 58          0656          DB      'X'             ; 27 - Format off
01EC' 87          0658          DB      87H             ; 28 - Reverse on
01ED' 88          0659          DB      88H             ; 29 - Reverse off
01EE' 89          0660          DB      89H             ; 30 - Underline on
01EF' 8A          0661          DB      8AH             ; 31 - Underline off
01F0' 31          0662          DB      '1'             ; 32 - Display message on
01F1' 32          0663          DB      '2'             ; 33 - Display message off
01F2' 8B          0664          DB      8BH             ; 34 - CPU message deposit
01F3' 40          0665          DB      '@'             ; 35 - Insert character off
01F4' 52          0666          DB      'R'             ; 36 - Graphics mode on
01F5' 53          0667          DB      'S'             ; 37 - Graphics mode off
01F6' 5A          0668          DB      'Z'             ; 38 - Cursor on (toggle in 3102)
01F7' 5A          0669          DB      'Z'             ; 39 - Cursor off (toggle in 3102)
01F8' 67          0670          DB      'g'             ; 40 - Memory lock on
01F9' 68          0671          DB      'h'             ; 41 - Memory lock off
01FA' 8C          0672          DB      8CH             ; 42 - Line lock
01FB' 8D          0673          DB      8DH             ; 43 - Line unlock
01FC' 8E          0674          DB      8EH             ; 44 - Read character at cursor
01FD' 38          0675          DB      '8'             ; 45 - Alarm on
01FE' 39          0676          DB      '9'             ; 46 - Alarm off
      (002F)      0678  SC.MAX  EQU     $-SC.TBL        ; Length of table
```

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Console Routines


                        ;  Routine address table for special console commands

                        ;  Note:  When assembled, the number of entries in this table
                        ;  MUST equal the number of entries in SC.TBL with bit 7 set.

01FF' 2D02'             ROUTTBL:DW      CURSPAD         ; 80H - Enable cursor pad
0201' 01                        DB       1
0202' 2D02'                     DW      CURSPAD         ; 81H - Disable cursor pad
0204' 00                        DB       0
0205' 3102'                     DW      SETATR          ; 82H - Begin blinking
0207' 02                        DB       BLINK
0208' 3702'                     DW      RESATR          ; 83H - End blinking
020A' 02                        DB       BLINK
020B' 3702'                     DW      RESATR          ; 84H - High light (normal)
020D' 01                        DB       HALFINTS
020E' 3102'                     DW      SETATR          ; 85H - Low light
0210' 01                        DB       HALFINTS
0211' 3702'                     DW      RESATR          ; 86H - Medium light
0213' 01                        DB       HALFINTS
0214' 3102'                     DW      SETATR          ; 87H - Reverse on
0216' 10                        DB       REVERSE
0217' 3702'                     DW      RESATR          ; 88H - Reverse off
0219' 10                        DB       REVERSE
021A' 3102'                     DW      SETATR          ; 89H - Underline on
021C' 20                        DB       UNDRLINE
021D' 3702'                     DW      RESATR          ; 8AH - Underline off
021F' 20                        DB       UNDRLINE
0220' 5702'                     DW      CPUMSG          ; 8BH - CPU message deposit
0222' 00                        DB       0
0223' 6F02'                     DW      LINELOCK        ; 8CH - Line lock
0225' 3C                        DB       '<'
0226' 6F02'                     DW      LINELOCK        ; 8DH - Line unlock
0228' 3D                        DB       '='
0229' 8302'                     DW      RDCURS          ; 8EH - Read character at cursor
022B' 47                        DB       'G'



                        ;  Equates and variable needed for 3102 and 3101 special command routines

        (0001)          HALFINTS EQU    ^0              ; Half-intensity attribute bit mask
        (0002)          BLINK    EQU    ^1              ; Blinking-field attribute bit mask
        (0010)          REVERSE  EQU    ^4              ; Reverse-video attribute bit mask
        (0020)          UNDRLINE EQU    ^5              ; Underline attribute bit mask


022C' 00                ATFLAG: DB      0               ; Attributes-set flag byte
```

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Console Routines

                    0752
                    0753  ;  Enable/disable function key transmit-through (cursor pad on/off)
                    0754  ;  Upon Entry:  A contains 0 to transmit actual function key sequence and
                    0755  ;                 non-zero to transmit CDOS pre-programmed function keys
                    0756
022D' 32CF01'       0757  CURSPAD:LD      (CPFLAG),A        ; Store value in cursor pad flag & return
0230' C9            0758          RET
                    0759
                    0760
                    0761  ;  Set terminal attribute at present cursor position
                    0762  ;  Upon Entry:  A contains the bit mask for the attribute to be set
                    0763  ;                 (blinking field - 3102 or 3101 terminals)
                    0764  ;                 (half intensity, reverse video, & underline - 3102 only)
                    0765
0231' 212C02'       0766  SETATR: LD      HL,ATFLAG         ; Point to attributes-set flag byte
0234' B6            0767          OR      (HL)              ; Combine old attributes with new in A-reg.
0235' 1805          0768          JR      SENDATR           ; Send attributes to the terminal
                    0769
                    0770
                    0771  ;  Reset terminal attribute at present cursor position (3102 only)
                    0772  ;  Upon Entry:  A contains the bit mask for the attribute to be set
                    0773  ;                 (blinking field - 3102 or 3101 terminals)
                    0774  ;                 (half intensity, reverse video, & underline - 3102 only)
                    0775
0237' 2F            0776  RESATR: CPL                       ; Invert all incoming bits
0238' 212C02'       0777          LD      HL,ATFLAG         ; Point to attributes-set flag byte
023B' A6            0778          AND     (HL)              ; Use mask in A-reg. to turn off old attribute
                    0779                                    ; Fall through to send attributes to terminal:
                    0780
                    0781  ;  Send sequence to terminal to finish setting/resetting attributes
                    0782  ;  Upon Entry:  A contains byte with appropriate attribute bits set/reset
                    0783
023C' 77            0784  SENDATR:LD      (HL),A            ; Save byte specifying attributes set
023D' 066D          0785          LD      B,'m'             ; Normal-video (3102) or end-blinking (3101)
023F' A7            0786          AND     A                 ; Check whether all attributes are reset
0240' CA8D01'       0787          JP      Z,SENDESC         ; Skip if so to send special command & return
0243' 066C          0788          LD      B,'l'             ; Start-blinking special command to 3102 & 3101
0245' FE02          0793          CP      BLINK             ; Check for blinking-field attribute bit mask
0247' CA8D01'       0794          JP      Z,SENDESC         ; Skip if so to send special command & return
024A' 0664          0795          LD      B,'d'             ; Set-visual-attributes special command to 3102
024C' CD8D01'       0796          CALL    SENDESC           ; Send escape-sequence to console
024F' 3A2C02'       0797          LD      A,(ATFLAG)        ; Get flag byte specifying attributes set
0252' C640          0798          ADD     '@'               ; Convert attributes to appropriate ASCII
0254' C36D01'       0799          JP      COUT              ; Output so-created character & return
```

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I/O Device Drivers for CDOS
Console Routines


                    ;  Send message to terminal buffer (CPU message deposit for 3102 only)
                    ;  Upon Entry:  HL points to message to be printed terminated in a 0 or a CR

0257' 063B          CPUMSG: LD      B,';'           ; CPU-message-deposit special command to 3102
0259' CD8D01'               CALL    SENDESC         ; Send escape-sequence to console
025C' 7E            CPUM30: LD      A,(HL)          ; Get a character of the message
025D' A7                    AND     A               ; Check for 0, end of line indicator
025E' 280A                  JR      Z,CPUM50        ; Skip if so to give terminating command
0260' FE0D                  CP      CR              ; Check for CR, end of line indicator
0262' 2806                  JR      Z,CPUM50        ; Skip if so to give terminating command
0264' CD6D01'               CALL    COUT            ; Print the message character
0267' 23                    INC     HL              ; Point to next message character
0268' 18F2                  JR      CPUM30          ; Skip to process next character

026A' 3E1D          CPUM50: LD      A,CTRL.RB       ; Get terminating character for
026C' C36D01'               JP      COUT            ;   CPU-message-deposit & output it


                    ;  Lock/unlock a display line on terminal (3102 only)
                    ;  Upon Entry:  A contains the command byte to lock/unlock the line
                    ;               C contains line number to be locked/unlocked (in range 1-24)
                    ;                 or
                    ;               C contains number > 24 to unlock all display lines

                    LINELOCK:
026F' 47                    LD      B,A             ; Line-lock/unlock special command to 3102
0270' 79                    LD      A,C             ; Get line number in C-reg.
0271' FE19                  CP      25              ; Check it for outside the range 1-24
0273' 3009                  JR      NC,LINL50       ; Skip if so to unlock all lines
0275' CD8D01'               CALL    SENDESC         ; Send escape-sequence to console
0278' 3E1F                  LD      A,1FH           ; Load A-reg. with offset to generate line
027A' 81                    ADD     C               ; Add incoming line number to the offset
027B' C36D01'               JP      COUT            ; Output so-created character & return

027E' 063F          LINL50: LD      B,'?'           ; Unlock-all-lines special command to 3102
0280' C38D01'               JP      SENDESC         ; Send escape-sequence to console & return


                    ;  Read character at present cursor position (3102 only)
                    ;  Upon Entry:  A contains the command byte to read cursor character
                    ;  Upon Exit:   A contains the character on the screen at the cursor position

0283' 47            RDCURS: LD      B,A             ; Read-cursor-character special command to 3102
0284' CD8D01'               CALL    SENDESC         ; Send escape-sequence to console
0287' C36F00'               JP      CIN             ; Get the character to be returned
```

```
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I/O Device Drivers for CDOS
Paper Tape or Card Reader Routines

                    0900
      (0058')       0901  RINIT    EQU     DUMMY          ; If no reader is present, use console
      (005E')       0902  RSTAT    EQU     CSTAT          ;   routines and consider it the case of a
      (006F')       0903  RIN      EQU     CIN            ;   teletype with paper tape reader connected
```

```
CROMEMCO Z80 Macro Assembler version 03.07              May 22, 1981  11:23:16              Page 0020
I/O Device Drivers for CDOS
Paper Tape Punch Routines

                  0936
      (0058')     0937  PINIT    EQU     DUMMY          ; If no punch is present, use console
      (0165')     0938  PRDY     EQU     CRDY           ;   routines and consider it the case of a
      (016D')     0939  POUT     EQU     COUT           ;   teletype with paper tape punch connected
```

```

                  ;  [Dummy] List Device Initialization Routine

      (0058')     L1INIT  EQU     DUMMY   ; (TUART is already initialized by CDOS upon booting)


                  ;  Get Parallel Printer (List Device) Output Status
                  ;  Upon Exit:   A = -1 (FFH) and Z-flag is reset if ready for char.
                  ;               A = 0 and Z-flag is set if not ready for character

028A' DB54        L1RDY:  IN      A,LSTATP        ; Get list-out status
028C' 2F                  CPL                     ; Check for negative-logic
028D' E620                AND     LRTP            ;   printer-ready flag
028F' C8                  RET     Z               ; Printer not ready for character
0290' 3EFF                LD      A,-1            ; Printer ready for character
0292' C9                  RET


                  ;  Parallel Printer (List Device) Output Routine
                  ;  Upon Entry:  A contains the character to be output

0293' FE11        L1OUT:  CP      CTRLQ           ; Check for printer-select character
0295' 2807                JR      Z,L1OT40        ; If yes, skip & don't check for ready
0297' F5                  PUSH    AF              ; Save character for a moment
0298' CD8A02'     L1OT30: CALL    L1RDY           ; Get list-out status
029B' 28FB                JR      Z,L1OT30        ; Zero means printer busy
029D' F1                  POP     AF              ; Restore character
029E' CBFF        L1OT40: SET     LSTROB,A        ; Data must be presented with strobe
02A0' D354                OUT     LDATA,A         ;   bit high prior to printing
02A2' CBBF                RES     LSTROB,A        ; Low-to-high transition of strobe
02A4' D354                OUT     LDATA,A         ;   bit prints the character
02A6' CBFF                SET     LSTROB,A        ; Strobe is set high upon this
02A8' D354                OUT     LDATA,A         ;   instruction and character is printed
02AA' C9                  RET
```

```
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I/O Device Drivers for CDOS
List Device Routines

                    1087
     (0058')        1088  LINIT    EQU      L1INIT          ; Parallel printer initialize
     (028A')        1089  LRDY     EQU      L1RDY           ; Parallel printer output-ready
     (0293')        1090  LOUT     EQU      L1OUT           ; Parallel printer output a byte
```

```

                  ;  Start-Time Routine for Clock in 3102 Terminal

02AB' 0620          STRTCLK:LD      B,SPC           ; Set-clock special command to 3102
02AD' CD8D01'               CALL    SENDESC         ; Send escape-sequence to console
02B0' 3A2500'               LD      A,(HOUR)        ; Get the hours value
02B3' CD1803'               CALL    PRTASC          ; Print hours to console in ASCII
02B6' 3A2600'               LD      A,(MIN)         ; Get the minutes value
02B9' CD1803'               CALL    PRTASC          ; Print minutes to console in ASCII
02BC' 3A2700'               LD      A,(SEC)         ; Get the seconds value
02BF' C31803'     R         JP      PRTASC          ; Print seconds to console in ASCII


                  ;  Read-Time Routine for Clock in 3102 Terminal

02C2' 064F          READCLK:LD      B,'O'           ; Read-status-line special command to 3102
02C4' CD8D01'               CALL    SENDESC         ; Send escape-sequence to console
02C7' CD5B01'               CALL    WAIT30MS        ; Give 3102 time to process special function
02CA' CD5B01'               CALL    WAIT30MS        ; /
02CD' CD4B01'               CALL    GETFBYTE        ; Read first control-B and/or clear UART buffer
02D0' CD4601'               CALL    ASKFBYTE        ; Request the second control-B
02D3' C8                    RET     Z               ; Return if timeout; this terminal not a 3102
02D4' FE02                  CP      CTRLB           ; Check for control-B as second character
02D6' C0                    RET     NZ              ; Return if any other character
02D7' 061B                  LD      B,27            ; Prepare to skip the next 27 characters
02D9' CD4601'       RCLK30: CALL    ASKFBYTE        ; Request a function byte by sending a CTRL-B
02DC' C8                    RET     Z               ; Return if timeout; unable to read the time
02DD' 10FA                  DJNZ    RCLK30          ; Loop to bit-bucket the next 27 characters
02DF' CD0103'               CALL    GETTWO          ; Read 2 hours digits
02E2' C8                    RET     Z               ; Return if timeout; unable to read hours
02E3' 322500'               LD      (HOUR),A        ; Store the binary value for hours
02E6' CD4601'               CALL    ASKFBYTE        ; Request and bit-bucket the ":" character
02E9' C8                    RET     Z               ; Return if timeout
02EA' CD0103'               CALL    GETTWO          ; Read 2 minutes digits
02ED' C8                    RET     Z               ; Retern if timeout; unable to read minutes
02EE' 322600'               LD      (MIN),A         ; Store the binary value for minutes
02F1' CD4601'               CALL    ASKFBYTE        ; Request and bit-bucket the ":" character
02F4' C8                    RET     Z               ; Return if timeout
02F5' CD0103'               CALL    GETTWO          ; Read 2 seconds digits
02F8' C8                    RET     Z               ; Return if timeout; unable to read seconds
02F9' 322700'               LD      (SEC),A         ; Store the binary value for seconds
02FC' 3E02                  LD      A,CTRLB         ; Acknowledge the last character with
02FE' C36D01'               JP      COUT            ;   final CTRL-B as required by protocol


                  ;  Get two ASCII characters from terminal
                  ;     and combine them into a binary number returned in A-reg.
                  ;  Upon Exit:   A contains the binary byte
                  ;               Z-flag is set if timeout occurs before char.

0301' CD4601'       GETTWO: CALL    ASKFBYTE        ; Request a function byte by sending CTRL-B
0304' C8                    RET     Z               ; Return if timeout occurred before byte
0305' E60F                  AND     0FH             ; Strip to value between 0 and 9
0307' 47                    LD      B,A             ; Multiply first digit by 10
```

```
0308' 87              ADD     A              ;    /
0309' 87              ADD     A              ;   /
030A' 80              ADD     B              ;  /
030B' 87              ADD     A              ; /
030C' 47              LD      B,A            ; Save first digit for a moment
030D' CD4601'         CALL    ASKFBYTE       ; Request a second special function byte
0310' C8              RET     Z              ; Return if timeout occurred before byte
0311' E60F            AND     0FH            ; Strip to value between 0 and 9
0313' 80              ADD     B              ; Combine first digit with second digit
0314' 47              LD      B,A            ;   and hold binary value in B-reg.
0315' 3C              INC     A              ; Reset Z-flag to indicate no timeout
0316' 78              LD      A,B            ; Retrieve binary value to be returned
0317' C9              RET
```

```
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I/O Device Drivers for CDOS
Clock Routines


                     ;  Print binary number on console in ASCII
                     ;  Upon Entry:  A contains the binary number to be sent to 3102 terminal

0318' 062F           PRTASC: LD      B,'0'-1          ; B-reg. will contain most sig. printable digit
031A' 04             PRTA30: INC     B                ; Increment to next printable digit
031B' D60A                   SUB     10               ; Compare value in A-reg. to 10
031D' 30FB                   JR      NC,PRTA30        ; Loop to increment most sig. digit if A >= 10
031F' C63A                   ADD     '0'+10           ; Convert remainder to ASCII if A < 10
0321' 4F                     LD      C,A              ; Save second digit for a moment
0322' 78                     LD      A,B              ; Retrieve first digit
0323' CD6D01'                CALL    COUT             ;   and print it on console
0326' 79                     LD      A,C              ; Retrieve second digit
0327' C36D01'                JP      COUT             ;   and print it also
```

```
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I/O Device Drivers for CDOS
Notes

                     1191
                     1192  ;  Note:  The last assembled byte of this module MUST NOT be a Define
                     1193  ;  Storage (DS or DEFS) pseudo-op to assure proper operation with CDOSGEN
                     1194
032A' (0000)         1195          END

Errors               0
Range Count          4

Program Length  032A (810)
```

```
I/O Device Drivers for CDOS
Symbol      Value  Defn  References

ADM3A       0000   0016  0526 0579 0680
ASKFBYTE    0146'  0429  0313 1121 1126 1132 1137 1151 1160
ATFLAG      022C'  0750  0766 0777 0797
BACK        0008   0060
BLINK       0002   0745  0713 0715 0793
BLKSEND     0143'  0419  0337
C3101       0000   0015  0523 0582 0610 0628 0650 0700
C3102       FFFF   0014  0190 0203 0210 0336 0402 0405 0422 0523 0545 0582 0610 0623 0645 0657 0700 0716
                         0789 0792 1100
C3703       FFFF   0029  0254 0257 0942 1043 1085
C3779       0000   0031  0942 0971 0984 0987 1043 1085
CDATA       0001   0082  0252 0491
CIN         006F'  0250  0251 0304 0328 0330 0441 0846 0903
CINIT       0059'  0207  0130
CLOCK       001E'  0154
CONSOLE     0000'  0130
COUT        016D'  0487  0139 0319 0431 0532 0535 0542 0544 0553 0555 0557 0799 0812 0817 0834 0939 1143
                         1180 1182
COUT30      016E'  0488  0489
CPFLAG      01CF'  0606  0342 0757
CPUM30      025C'  0807  0814
CPUM50      026A'  0816  0809 0811
CPUMSG      0257'  0805  0731
CR          000D   0064  0311 0810
CRDA        0040   0083  0224
CRDY        0165'  0477  0138 0488 0938
CSCMD30     01B1'  0575  0573
CSCMD50     01C7'  0595  0593
CSCOMMD     01A4'  0566  0522
CSET        0177'  0519  0140
CSIN20      008F'  0279  0275
CSIN30      0095'  0283  0278
CSIN40      0098'  0284  0280
CSIN50      00AB'  0294  0292
CSPECIN     0084'  0274  0133
CSTA50      0067'  0235  0231
CSTAT       005E'  0223  0131 0250 0274 0440 0902
CSTATP      0000   0081  0082 0223 0477
CTBE        0080   0084  0478
CTRL.RB     001D   0074  0816
CTRL.UP     001E   0075  0418
CTRLB       0002   0059  0305 0316 0318 0322 0326 0338 0419 0419 0430 1123 1142
CTRLN       000E   0065
CTRLO       000F   0066
CTRLP       0010   0067  0258 0417
CTRLQ       0011   0068  0261 0965
CTRLS       0013   0069  0416
CTRLV       0016   0070  0415
CTRLW       0017   0071
CTRLZ       001A   0072
CURSPAD     022D'  0757  0708 0710
DATE        0024'  0158
DELLINE     013B'  0415  0191
DUMMY       0058'  0201  0901 0937 0947
```

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I/O Device Drivers for CDOS
Symbol      Value  Defn  References

ESC         001B   0073  0541 0552
FALSE       0000   0011  0015 0016 0022 0024 0031 0033
FKBUFF      011D'  0374  0307 0308 0312 0314 0329 0331 0334 0341
FORMF       000C   0063
FPFLAG      011A'  0371  0235 0276 0285 0293
FPPTR       011B'  0372  0283 0289
FUN.KEYS    FFFF   0019  0132 0135 0190 0225 0230 0267 0422
FUNCADDR    0028'  0169  0346
FUNCTIME    0578   0467  0439
FUNCVAL     0122'  0382  0345
GETFBYTE    014B'  0438  0309 1120
GETFUNC     00AD'  0304  0279 0349 0363
GETTWO      0301'  1151  1129 1134 1139
GTFB20      014E'  0440  0445 0447
GTFC20      00D6'  0322  0315
GTFC30      00DA'  0326  0310
GTFC40      00E9'  0332  0317 0320
GTFC60      0104'  0347  0355
GTFC70      0110'  0357  0351
HALFINTS    0001   0744  0718 0720 0722
HELP        0141'  0418  0194
HOUR        0025'  0159  1106 1131
IO.B0       0000   0043
IO.B1       0001   0044
IO.B2       0002   0045
IO.B3       0003   0046
IO.B4       0004   0047
IO.B5       0005   0048
IO.B6       0006   0049
IO.B7       0007   0050
IOBYTE      0003   0042
L1INIT      0058'  0947  1088
L1OT30      0298'  0968  0969
L1OT40      029E'  0977  0966
L1OUT       0293'  0965  0262 1090
L1RDY       028A'  0954  0968 1089
LDATA       0054   0097  0978 0980 0982
LF          000A   0061
LINELOCK    026F'  0826  0733 0735
LINIT       0058'  1088  0150
LINL50      027E'  0836  0830
LOUT        0293'  1090  0152
LRDY        028A'  1089  0151
LRTP        0020   0098  0956
LSTATP      0054   0096  0097 0954
LSTROB      0007   0099  0977 0979 0981
MIN         0026'  0160  1108 1136
MON         0023'  0157
NO.CON      0001   0036
NO.LST      0001   0039  1043 1085 1092
NO.PUN      0000   0038  0906
NO.RDR      0000   0037  0850
NULLS       0000   0053  0492 0495
PAGE.SIZ    0042   0054
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I/O Device Drivers for CDOS
Symbol      Value  Defn  References

PAUSE       013D'  0416  0192
PBAUD       0020   0092
PDATA       0021   0093
PINIT       0058'  0937  0146
POUT        016D'  0939  0148
PRDY        0165'  0938  0147
PRINT       013F'  0417  0193
PRINTER     0018'  0150
PRTA30      031A'  1174  1176
PRTASC      0318'  1173  1107 1109 1111
PSTATP      0020   0091  0092 0093
PTBE        0080   0094
PUN.BD.R    0001   0121
PUNCH       0012'  0146
RBAUD       0020   0087
RCLK30      02D9'  1126  1128
RDATA       0021   0088
RDCURS      0283'  0844  0737
RDR.BD.R    0001   0120
READCLK     02C2'  1116  0155
READER      000C'  0142
RESATR      0237'  0776  0714 0717 0721 0725 0729
REVERSE     0010   0746  0724 0726
RIN         006F'  0903  0144
RINIT       0058'  0901  0142
ROUTTBL     01FF'  0708  0590
RRDA        0040   0089
RSTAT       005E'  0902  0143
RSTATP      0020   0086  0087 0088
S.PRINTE    0000   0033  1012 1043 1092
S.PUNCH     0000   0024  0906
S.READER    0000   0022  0850
SBAUD       0050   0102
SC.MAX      002F   0678  0567
SC.TBL      01D0'  0615  0570 0678
SDATA       0051   0103
SEC         0027'  0161  1110 1141
SEND.ESC    0196'  0551  0208
SENDATR     023C'  0784  0768
SENDESC     018D'  0541  0529 0584 0787 0794 0796 0806 0831 0837 0845 1105 1117
SER.BD.R    0084   0122
SETATR      0231'  0766  0712 0719 0723 0727
SPC         0020   0076  1104
SSTATP      0050   0101  0102 0103
STBE        0080   0104
STRTCLK     02AB'  1104  0154
TRUE        FFFF   0010  0014 0019 0029
UNDRLINE    0020   0747  0728 0730
VT          000B   0062
WAIT20      015E'  0457  0458 0460
WAIT30MS    015B'  0455  0332 1118 1119
YEAR        0022'  0156
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