DISK OPERATING SYSTEM
USER'S MANUAL
(INCLUDING ASSEMBLER AND TEXT EDITOR)

CGC 7900 SERIES
COLOR GRAPHICS COMPUTERS

CHROMATICS

CGC 7900 COLOR GRAPHICS COMPUTER SYSTEM

7900 DOS MANUAL
(with Assembler and Text Editor)

November, 1982

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Document Number 070202
Revision A

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Date of Publication Release: _____ Preliminary?_____

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CONVENTIONS USED IN THIS DOCUMENT

1. Any keys which have labeled caps will be called by their full names, capitalized and underlined. For example, the carriage return key will be denoted by:

   RETURN

2. The modifier keys, CTRL, SHIFT, M1, and M2, must be held down while striking the key they are to modify. Note that these four keys do not generate any characters on their own, but simply modify the character which is struck simultaneously. This process of holding down a modifier key while striking another key will be denoted by the modifier AND the key being underlined together. For example,

   CTRL F

   would indicate that the CTRL key should be held down while striking the F key. If two or more modifiers are needed simultaneously, they will all be underlined together:

   CTRL SHIFT T

   would mean that BOTH modifiers, SHIFT and CTRL, should be held down while striking the T key.

3. Variable parameters will be enclosed in angle brackets, < >. Any items enclosed in these brackets will be explained in full in the text which immediately follows.

4. Optional parameters will be enclosed in square brackets [ ]. Any items which may be repeated will be followed by an ellipsis (three dots).

   Example of (3) and (4):

   <X>, [<Y1>,<Y2>,...]

   The parameter <X> is required. The parameters <Y1>, <Y2>, and so on, are optional. Any number of these may be included. All three types of parameters would be explained immediately beneath the example which contained them.

5. Zeros will be slashed (Ø), alphabetic O will not be slashed.

Preface -- How to Use this Manual

There are several ways to approach CGC DOS, depending on your needs:

If you wish to generate and save pictures, and have no interest in programming, read Sections 1, 2, 3.1 through 3.2.15, and Appendix E.

If you are a programmer, read the entire manual, cover to cover. Skim through Sections 1, 2, and 3; pay special attention to Section 4, and read Section 5 thoroughly if you are unfamiliar with the MC68000 Assembler. Work through the examples listed in the Appendices until you understand what is happening.

When you have become thoroughly acquainted with DOS, Sections 3 and 4 and Appendices B, C, and D will continue to be valuable reference material. Also, read Appendix A from time to time to keep the concepts discussed there in mind.

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Section 1 — Introduction to DOS

1.1 System Requirements

This manual applies to the current release of DOS, version 1.6, released December, 1981. This release is similar to previous releases of DOS, except that some new transients have been added. Transients released with DOS 1.6 are not guaranteed to work with earlier releases of DOS.

To run DOS on a 7900, the system requires a disk controller and dual floppy drives (option #794002 or higher). A hard disk is very useful although not required. Note that a hardware change accompanied the changeover from DOS 1.4 to 1.5. DOS 1.5 and 1.6 require a different disk controller card. If you are upgrading from DOS 1.4 to the current release, a new disk controller will be required, in addition to new PROMs and transients.

1.2 Introduction to DOS

This is the manual for the Chromatics CGC 7900 Disk Operating System (DOS), an optional feature of the 7900 series of color graphics computers. The Disk Operating System uses two double-density flexible disk drives for program and data storage. A fixed disk drive with 10 or 40 megabytes of storage is also available. The DOS option consists of these parts:

Disk drives and controller

PROMs (firmware)

A diskette with system programs

This manual

The disk drives, controller, and PROMs are factory-installed, and should require no attention by you (except that the fixed disk may require special unpacking; instructions for this are attached to your unit if applicable).

The diskette contains programs which provide an interface between the disk drives and your programs or data. Routines are provided to save data on a disk, to retrieve data from a disk, and to manipulate the contents of the disks. This diskette should be handled carefully while you are learning to use DOS. You should make a copy of this diskette as soon as possible. Instructions for copying a diskette are included in this manual (see the FORMAT, COPY and DUPE commands in Section 3).

This manual begins by describing the commands and utility routines available in DOS. In later sections, the Text Editor and MC68000 Resident Assembler are discussed. These two programs allow you to create text files and assembly language programs on the disk, and to generate executable binary machine code for the 68000 processor.

Detailed descriptions of the CGC 7900 special features, such as the color graphics plotting capability, are not provided here. Please refer to your User's Manual for information on other aspects of the CGC 7900.

1.3 Handling Floppy Disks

DOS stores information on the surface of disks, which are coated with a magnetic material. Flexible diskettes, or "floppy disks," are a very reliable and convenient way to store data. A flexible disk will perform well for many hours of use, if a few simple precautions are observed:

HANDLING - DO NOT touch the exposed surface of the diskette, which is visible through a slot on either side of the diskette. DO NOT attempt to remove the circular diskette from its square, dark jacket. Handle the diskette carefully, and do not fold it.

LABELING - A diskette is provided with adhesive labels which should be used to note the contents of the diskette. Write on these labels BEFORE attaching the label to the diskette. If you must write on a label after it has been attached, use a felt-tip pen and press gently. A ball-point pen will crease the disk and may cause permanent damage.

INSERTING - To insert a diskette into a drive, first remove the diskette from its paper sleeve. Hold the diskette gently, with the vendor's label UP, and the arrow on the label aiming toward the drive. Open the drive door by pressing the rectangular button until the door snaps open. GENTLY slide the diskette into the drive until it is completely inside the door (it may seat with a soft "click"). Press the door shut. To remove the diskette, press the rectangular button again.

STORAGE - When a diskette is not in use, it should be removed from the drive and stored in its paper sleeve. Store the diskette away from dust, away from extremely high or low temperatures, away from moisture, and AWAY FROM MAGNETIC FIELDS. Protect the diskette from magnets, motors, transformers, or anything else which could create magnetism.

OPERATION - When a disk drive is in use, the red light in the drive door will light up. It is extremely important that nothing interfere with the disk while this light is on. While a disk is in use, removing the disk, pressing RESET on the keyboard, or turning the power off, may damage the data on a disk.

The fixed disk is a sealed unit, located in the base of the 7900 chassis. It is not subject to many of the restrictions above, since it is hidden away from normal view. But the warning about interrupting a disk operation in progress is still valid: if you have any reason to believe the system is accessing your fixed disk, DO NOT press RESET or otherwise interrupt the process. If you give the system a command to access the fixed disk, be sure the command has been completed before turning the system off or pressing RESET.

WRITE-PROTECTION - A flexible diskette may be protected from accidental destruction by uncovering its write-protect notch. Some diskettes are shipped with the notch covered, and some have it uncovered when you receive them. In either case, the notch must be covered or DOS will not be able to write on the disk. The write-protect notch is a small (1/4") hole on the front edge of the disk.

Section 2 -- DOS Overview

2.1 Entering DOS

The Disk Operating System is entered by pressing the labeled key:

DOS

The DOS log-on message should immediately appear on the screen. If this does not happen, it can be because the state of the system is not what DOS expects to find (for example, if the screen is not connected as the proper output device). You can optionally enter DOS by striking three keys:

RESET CTRL BOOT DOS

This sequence initializes the entire system and will always cause entry into DOS.

The DOS log-on message should now appear:

```
CGC Disk Operating System --- Version 1.6b
Copyright (c) 1981 by CHROMATICS, INC.

ENTER USER PASSWORD =
```

DOS will print its version number. This number should be noted in any communications to Chromatics concerning DOS.

The DOS log-on message will request your User Password. At this point, you may enter a 2-character password and press the RETURN key, or you may simply press RETURN without entering a password. If you do not enter a password, you will only have access to Public files which are not assigned a password. If you do enter a password, you will have access to all Public files, as well as any files whose password matches yours.

Legal characters for a User Password are: digits Ø-9, upper and lower case alphabetic characters, and these special characters:

```
* [ ] ^ _ ` { | } ~
```

Entering any other characters may cause the system to ignore your password and assign you a very strange password. This condition may produce a situation in which existing files are not available.

NOTE:

The User Password system in DOS is not designed to offer a high level of protection. Its main purpose is to help organize files into groups, so that users will see only the files they must work with. This is especially important in the case of the hard disk, where up to two hundred files may exist in the directory.

After completing the log-on procedure, DOS prints a green asterisk (*) as its prompt character. The asterisk means that DOS is ready to accept a command.

Another way to enter DOS is by typing SHIFT DOS. This will skip the password entry feature and assign the user to Public files.

2.2 DOS Command Line

When you are entering commands to DOS, all of the text editing functions labeled on the cursor keypad may be used to edit your input line, except for up and down arrows, INS LINE and DEL LINE. The left and right arrow keys move the cursor around on the input line. The HOME key moves the cursor to the beginning of the input line. The functions labeled in blue are accessed by holding the CTRL modifier and pressing the indicated key: these functions are Insert Character, Delete Character, Clear Line, and Clear EOL. Pressing RECALL brings back a copy of previous lines. RECALL and SHIFT RECALL may be used to retrieve any line from the "Recall Buffer." RECALL works back toward the oldest lines; SHIFT RECALL works forward toward the most recent lines. Once recalled, a previously entered line may be edited with the other functions.

Regardless of where the cursor is on the input line, ALL characters visible on the input line are accepted when the RETURN key is pressed. DOS does nothing with your commands until you press RETURN. If you press DELETE, BREAK, or CTRL C instead of RETURN, DOS ignores the line you typed.

(All of these functions are a part of the Inline Editor, used for DOS, the Monitor, and other 7900 programs. The Inline Editor is discussed in more detail in the 7900 User's Manual, and in Section 4 of this manual.)

Regardless of where the cursor is on the input line, ALL characters visible on the input line are accepted when the RETURN key is pressed. DOS does nothing with your commands until you press RETURN. If you press DELETE, BREAK, or CTRL C instead of RETURN, DOS ignores the line you typed.

Be careful when typing in commands. DOS does not ignore excess spaces in between words. Thus,

```
DIR .*/2
```

is valid, but

```
DIR  .*/2
```

will NOT work!

DOS commands are described in detail in this manual. Most are simple words or abbreviations, such as

DIR (followed by RETURN)

which lists the directory of a disk (the names of the files on that disk).

You may enter several DOS commands on the same line, separating them by a colon (:). For example, the following command would list the disk directories from drives 1 and 2:

```
DIR/1:DIR/2
```

(Do not type a space on either side of the colon.) You may type as many commands as will fit on a single line of the screen. One line contains up to 84 characters and a Carriage Return. If any command causes an error, DOS will not process any following commands on that line.

2.3 Disk File Names

When you type a command to DOS, you are actually entering the name of a disk file. DOS looks for the file, and if the file is found (and is executable), it is loaded into memory and executed.

A file name may have several parts:

a) The primary name, which may be one to eight alphanumeric characters plus the special characters

$ [ ] ^ _ ` { | } ~

b) The secondary name, which is always three alphanumeric characters. The secondary name is separated from the primary name by a period. The secondary name is optional. If it is omitted, DOS will assume a secondary name for the file (depending on what the file name is to be used for).

c) A password, which must match the password assigned to the file. The password is separated from the name by a dollar sign ($). If a password is entered, it must precede the drive number. The password is optional. If it is omitted, it is assumed to be the password under which you logged onto DOS.

d) A drive number, identifying the disk drive on which the file resides. The drive number is separated from the name by a slash (/). The drive number is optional. If it is omitted, the file is assumed to reside on the same drive which responded to the last DOS command (the drive from which the last command was loaded). Thus, the command COPY/2 /1 /3 would leave drive 2 as the default name.

The four parts of a file name (primary name, secondary name, password, drive number) must occur in the order listed. If any of the optional parts are omitted, the remaining parts must occur in the required order.

Examples of legal file names:

```
FILEname

STORY.SRC

PROGRAM/2

USRT29NE$PW

LISTING.OBJ/1

HardLuck.BUF$ED/3
```

Examples of improper file names:

THISISTOOLONG	Too many characters in the primary name -- only the first eight characters would be recognized, so this is equivalent to THISISTO. It would, however, still be accepted.
oops/A	Illegal drive number.
NOWAY!.SYS	Illegal character in primary name.
BADone.GO	Secondary name too short.
Wrong/1.SRC	Incorrect order.

2.4 Disk Drive Numbers

The CGC 7900 supports up to four disk drives: two flexible disks and two hard disks. Many disk commands require specifying the drive number of the disk to which the command refers. The following numbers apply:

Drive 1: the left-hand flexible disk.

Drive 2: the right-hand flexible disk.

Drive 3: the hard disk.

Drive 4: additional hard disk (Remote Fixed Disk).

You may always specify the drive number if you wish. Anytime you do not specify a drive number, DOS assumes you are still using the same drive you used in a previous command.

If a drive number of Ø (zero) is entered, it implies that DOS should search all drives to locate the requested file. The search begins with drive 1. This only works for a DOS command, NOT for other files! Thus, the following command is legal:

```
DIR/Ø .*
```

However, this command is not:

```
DIR FILE/Ø
```

(If a new file is being created, the drive number must be implicitly or explicitly specified, so a drive number of zero is not allowed.)

When you enter DOS, immediately after pressing the DOS key, the system does not know which drive you want to use. The FIRST command you enter to DOS acts as if you had specified a drive number of zero, so DOS will search all drives in your system in an attempt to execute the command. If this search succeeds, DOS now knows which drive you want to use, and it will stay with that drive until you specify a different drive number.

On the other hand, if your first command to DOS fails (as it would if you misspelled a command), DOS will display an error message. Using drive Ø to specify a transient location will only pick up a real drive if no errors occurred. Your next command to DOS will also cause the system to search all drives for the command, assuming you did not give it a specific drive number. This process continues until a command succeeds, at which time DOS "remembers" that drive for future commands.

The feature of "remembering" the current drive applies only to commands. DOS only remembers where the last COMMAND came from, not the last filename. If you type:

```
KILL/2 filename/3
```

The KILL command is coming from drive 2, so DOS remembers drive 2 and will search it for the next command (unless you specify a different drive number).

2.5 Secondary File Names

The following secondary file names are recognized by DOS:

.SYS "System" file. These are executable by DOS, simply by typing the file name as a DOS command. System files are not listed by the DIR command unless specifically requested. They are called "transients" since they are part of the set of DOS commands, but do not reside in memory at all times. System files are listed in the directory in YELLOW.

.KIL "Killed" file. These are files which have been removed from active status by the KILL command. A .KIL file will be removed by COMPRESS; it may be recovered before COMPRESS by using RENAME. Killed files are listed in the directory in RED if requested by the *.KIL or .* commands.

All of the file types below are listed in GREEN in the directory.

.SRC "Source" file. These files contain ASCII text, such as the source code of an assembly program.

.BUF "Create Buffer" files. These files are created by the BUFF command and recalled with DRAW. They contain commands used to draw pictures.

.PIC "Picture" files. These files contain a dump of up to two megabytes of image memory. They are created with PICTURE and recalled with REFRESH.

.RLE "Run-Length Encoded" files. These files contain a compacted version of the data from image memory. They are created with IMPLODE and recalled with EXPLODE.

.ABS "Absolute" binary files. These files contain a dump of bytes from selected areas of memory. They are created with STORE and loaded with FETCH.

2.6 File Name Patterns

DOS allows a "pattern" to be used in place of a file name under many conditions. A pattern permits a single command to affect several files at once, or permits a command to affect any file meeting a set of criteria. Depending on the command, using a pattern will either affect the FIRST file on a disk which matches the pattern, or ALL files which match. Details are given in Section 3.2.

A pattern may consist of any combination of these items:

A primary name.

A secondary name (example: .SYS).

A wild card "*" in either the primary or secondary name.

A password.

A drive number.

The asterisk "*" performs a special function. If the primary name is an asterisk, it will match any file name. If the secondary name is an asterisk, it will match any secondary name. If either field CONTAINS an asterisk (in addition to other characters), the asterisk will match any single character in a file name. If the asterisk is in the last position of a field (in addition to other characters), it will match any set of zero or more characters.

If the primary name is blank, an asterisk is assumed to be inserted in place of the blank. This means that the following two patterns are equivalent:

```
*.SRC

.SRC
```

Either of these patterns would match any file whose secondary name is .SRC (a text file).

If the secondary name is blank, it will match any file EXCEPT a .SYS or a .KIL file. These files are never matched except when specifically asked for, by using a .SYS, .KIL, or .* pattern.

Some examples of patterns:

A*	Matches any file beginning with "A" except .SYS and .KIL files.
A*.*	Same as "A*", but includes .SYS and .KIL files.
AB*D.SRC	Matches files ABCD.SRC, ABFD.SRC, ABED.SRC, etc.
*.BUF	Matches any .BUF file.
.	Matches ANY file.

Patterns can be very convenient, but they should be used with caution. Suppose a program created a set of scratch files, and named them X1, X2, and so on. They could all be removed at once with the command

```
KILL X*
```

but this would also KILL any other files whose names began with the letter X.

Section 3 -- DOS Transients

3.1 General

Transients, or transient programs, are the files which make up the set of commands recognized by DOS. By typing the name of a command, you tell DOS to search the disk for the file with the same name. If the file is found, it is loaded and executed, causing your command to be carried out.

This system of swapping commands in and out of memory as needed gives DOS great flexibility. The entire DOS need never reside in memory at once; only the current command is occupying space in memory. Further, it is simple for you (or Chromatics) to add commands to the set of commands DOS recognizes, by writing assembly language programs to carry out the command. Transients are stored on the disk with a secondary name of ".SYS".

This section discusses the transients (or commands) supplied with DOS. When typing in a command to DOS, the various parts of the command line must be separated by delimiters. Valid delimiters are:

SPACE

comma (,)

Certain control-characters and punctuation marks will also act as delimiters, but they should not be used since it would make the command line difficult to read.

If a command line contains several file names, delimiters must occur between the names. Only a SINGLE delimiter should be used to separate each pair of items on the command line; i.e., you should NOT type a comma followed by a space. This would cause a "Syntax Error" message.

This is the general form of a command line:

<CMD> [args] [;options]

Where:

CMD	is the name of the DOS transient, or command.
args	are the patterns or files used by the command.
;options	are options for modifying the operation of the command. Options are one or more letters long, and may be preceded by a + or -. The transients ASMB and XREF use an arrow (^) instead of the semicolon.

3.2 DOS Transients

The following transients are those currently supported by Chromatics.

3.2.1 APPEND

The APPEND command is similar to DRAW, except that the <file> specified by APPEND is added to the end of the Create Buffer, instead of replacing whatever was previously in the Create Buffer.

Format:

APPEND <file> RETURN

By performing a DRAW followed by one or more APPENDs, several .BUF files may be concatenated. Then the BUFF transient may be used to store the entire series as a single file. DO NOT use APPEND until after you have used DRAW.

Example:

```
DRAW Part1      (load part one of a picture)
APPEND Part2    (add the second part)
APPEND Part3    (and the third part)
BUFF ALLofit    (store the whole thing)
```

See also 3.2.2, "BUFF" and 3.2.8, "DRAW".

3.2.2 BUFF

The BUFF command stores the contents of the Create Buffer into a disk file. The secondary name .BUF is given to the file. If the file name already exists on this disk, the old file is automatically KILLed. BUFF will not allow the user to specify the secondary name.

Format:

BUFF <file> RETURN

Where:

<file> is the name to be given to the file being created by BUFF.

BUFFed files can be called back into the Create Buffer with the DRAW transient.

Examples:

BUFF ANDWAX	Create a file called ANDWAX.
BUFF/1 FUDD/2	In this case the .BUF file is created on a drive other than the drive where the BUFF command resides.

When creating a picture to be stored as a .BUF file, the following hints may be helpful:

1) Turn on CREATE before transmitting any other commands which are necessary to set up the system for your picture. For example, if your picture will be drawn in the Bitmap, your .BUF file should include the "Overlay Off" and "Overlay Transparent" commands. Remember that the best .BUF files can be drawn directly from DOS, requiring no setup by the user.

2) Turn the cursor off at the start of your .BUF file. This makes a picture redraw faster.

3.2.3 COMPRESS

The COMPRESS transient disposes of all files whose secondary name is .KIL (killed files). Delete-protected .KIL files are also wiped out. The space on the disk formerly occupied by these files is now available for use again. The disposed files are NOT recoverable. COMPRESS also reclaims the space formerly occupied by deleted files (see DELETE).

Format:

COMPRESS [$<pw>] [/<d>] [;A] RETURN

Where:

<pw> is the two-character password of the files to be COMPRESSed. If omitted, the password under which you logged onto DOS is assumed.

<d> is the drive number containing the disk to be compressed. If omitted, the disk which contains the transient is compressed.

;A The A-option. If given, ALL files will be compressed regardless of passwords.

If a file is delete-protected, it will not be affected by COMPRESS even if it has been KILLed.

It is advisable to make a backup copy of important files, or of the entire disk, before executing COMPRESS. If COMPRESS is interrupted by pressing Reset, by a power failure, or by removing the diskette during COMPRESS, all data on the disk may be lost.

COMPRESSing a hard disk (drive 3 or drive 4) may take several minutes.

Examples:

COMPRESS	Remove .KIL files.
COMPRESS/2	Compress the disk in drive 2.
COMPRESS/1 /2	Compress the disk in drive 2, using the COMPRESS transient from drive 1.
COMPRESS $AB	Remove .KIL files under password "AB".
COMPRESS ;A	Remove .KIL files under ALL passwords.

NOTE:

Since the directory may not match the current status of the disk file space at any time during the COMPRESSion, the program MUST NOT be interrupted. If the power goes out while the COMPRESS is going on, or the user presses RESET, recovering the data on the disk may be impossible.

3.2.4 COPY

COPY produces a copy of a file, on the original disk or on another disk. The name of the copy may be the same as the original, or different. If a file is copied to the same disk with the same name, the original file is KILLed.

If a pattern is used instead of a file name, all files matching the pattern are copied. This provides an easy way to transfer only .SYS files to a new disk, for example.

Format:

COPY <source> <dest> RETURN

Where:

<source> and <dest> are each file names, or file name patterns. Wild cards are allowed.

Example:

```
COPY/1 HERE.BUF/1 /3
```

NOTES:

If <dest> is located on the same drive as <source>, a wild card is not allowed in the secondary name.

If the secondary names and the drive numbers of <source> and <dest> are identical, only ONE file is copied regardless of any wild cards in the file names. This rule, and the one above, are required to prevent DOS from copying a copy (of a copy of a copy...).

COPY does not recognize .KIL or .SYS files unless specifically requested (see examples).

The new file produced by COPY will have the same password as the old file, unless the command line specifically changes the password (by providing a password on the destination name).

The new file produced by COPY will always have the same status as the old file (execute-only, delete-protected, etc.). See DIR for a discussion of status attributes.

Examples:

COPY AX BX	Make a copy of AX; call it BX, and put it on the same disk with AX.
COPY AX/1 /2	Copy AX from drive 1 to drive 2.
COPY AX/1 BX/2	Copy AX from drive 1 to drive 2, and call the copy BX.
COPY T*/1 /2	Copy all files beginning with the letter T, from drive 1 to drive 2 (except .SYS and .KIL files).
COPY *.SYS/1 /2	Copy all .SYS files from drive 1 to drive 2.
COPY AZ BZ$aa	Make a copy of AZ; call it BZ, and give it password "aa".
COPY AZ$aa $bb	Copy file AZ from password "aa" to password "bb".
COPY .SRC .BUF	Copy all text files into .BUF files. Use your judgement when doing this kind of copy.

The source and destination disks must be formatted on a CGC 7900 before you try to COPY anything onto it (not true for DUPE). Formatting prepares a disk to receive data. (See 3.2.13, "FORMAT," for details.)

If only the drive numbers are specified, and no file name pattern is given, a special full-disk COPY occurs. This copies all data from the source disk to the destination disk, including the disk name and the entire directory. This kind of COPY is normally used to produce a backup copy of an entire disk. A FULL-DISK COPY DESTROYS ALL DATA ON THE DESTINATION DISK.

Example:

```
COPY /1 /2    Copy the entire disk in drive 1
              onto the disk in drive 2.
```

A SPACE must occur between the COPY command and the source drive number. If drive 1 contains the COPY transient, the command above is equivalent to:

```
COPY/1 /1 /2
```

In this case, the drive number of the disk containing the COPY transient is specified. The following command would NOT be legal:

```
COPY/1 /2
```

This command specifies the transient drive and the source drive, but does not specify the destination drive. The result is an "Argument Error" message.

When a diskette (floppy disk) is FORMATted, it is defined to be either single-density or double-density. A single-density diskette can hold up to 256,256 bytes and a double-density diskette can hold up to 509,184 bytes. The 7900 normally uses only double-density diskettes.

If you attempt a full-disk COPY between two disks which have different densities, a warning will be displayed:

```
Density mismatch. Continue (Y/N) ?
```

Press the "Y" key if you want to proceed. If you asked DOS to copy from a single-density diskette to a double-density diskette, the "density mismatch" will not be a problem, since all the data on a single-density diskette can easily fit onto a double-density diskette. If, however, you asked DOS to copy from a double-density diskette onto a single-density diskette, you will get an error after the disk has been halfway copied.

A similar situation arises if you attempt a full-disk COPY between a diskette and the hard disk. The capacity of a diskette is approximately 256K bytes or 512K bytes, depending on the density. The hard disk capacity may be either 10M or 40M bytes. You will see this warning:

Capacity mismatch. Continue (Y/N) ?

If you press the "Y" key, copying will proceed. BEWARE: If you asked DOS to copy a diskette to the hard disk, EVERYTHING on the diskette will be copied and no errors will be displayed. However, the hard disk directory will now be a copy of the diskette directory, and will reflect a disk size of 512K bytes instead of 10 or 40 Mbytes. inaccessable until the hard disk is reformatted.

If you asked DOS to copy the hard disk to a diskette, an error will occur as DOS attempts to write past the end of the diskette. However, individual files can be copied back and forth between floppy disks and hard disks.

3.2.5 DEBUG

DEBUG loads a .SYS file into memory, just as DOS would load a transient for execution. After loading the file, DEBUG jumps to the Monitor. If the file normally expects any arguments to be present on the command line, they may be entered as <args>.

Format:

DEBUG <filename> [<args>] RETURN

Where:

<filename> is the name of a .SYS file to be loaded into memory.

<args> are the arguments expected by the .SYS file.

NOTE:

DEBUG will not load an execute-only file.

To avoid having to use an offset when loading the .SYS file, DEBUG relocates itself to the top of the DOS Transient Program Area before loading <filename>. However, the TPA must be large enough to accomodate both DEBUG and your file. (DEBUG occupies about 512 bytes.) If necessary, the "Thaw" command can be used to change the DOS memory allocation. See the 7900 User's Manual for details.

Example:

```
DEBUG Process

DEBUG Gnats 6 12
```

In the second example, 6 and 12 are arguments to be passed to the program Gnats.

Since the current Monitor (version 1.3) reloads the stack pointer, it will not be possible for your program to execute a normal return to DOS. After using DEBUG to load your program, you may use the Monitor to trace program execution up until the point where your program attempts to return to DOS.

3.2.6 DELETE

DELETE removes a file from the disk directory. This process immediately frees up the disk space formerly occupied by the file. THE CONTENTS OF THE FILE ARE NOT RECOVERABLE.

Format:

DELETE <file> RETURN

Where:

<file> is the name of the file to be deleted.

The DELETE command is different from KILL. KILL simply renames a file with a .KIL secondary name, thus the file still exists. After a file has been deleted, however, the disk directory no longer shows the file's existance.

When DOS creates a new file, it always takes the largest currently available space on the disk. This means that it is not useful to DELETE a small file, since the small space formerly occupied by that file would never be used. DELETE is primarily useful for times when you need to remove a large file (one occupying over 25% of the disk, for example). DELETE allows you to reclaim the disk space without going through the (time-consuming) process of KILLing the file and then COMPRESSing the disk.

A pattern may be used in place of a file name. All files matching the pattern will be DELETEd.

Example:

DELETE OLDdata

The space formerly occupied by deleted files is reclaimed when the disk is COMPRESSed. If you DELETE several small files (going against the advice above), you will have to COMPRESS the disk to make that space available for use again.

If a file is delete-protected, it cannot be deleted.

3.2.7 DIR

The DIR (Directory) command lists the files in the directory of a disk. Several options can be specified to tell the DIR command which files you wish to see.

Format:

DIR [<pattern>] [;<options>] RETURN

Where:

<pattern> is a file name, or a pattern which may contain wild cards.

<options> are as follows:

P List Public Files only, not the files under your password (if you logged in with no password, this is equivalent to listing the normal directory).

L Give Long version of the directory, including the disk name, address of next available space on the disk, address and length of each file, and "attribute" flags pertaining to each file (default case).

S Give Short version of the directory, with file names only. LONG version is default.

A List files stored under ALL passwords.

Typing DIR by itself will give you a list of most files on the disk whose password matches yours. Files with either a .SYS or a .KIL secondary name are not listed when you type DIR.

If <pattern> is included, only files matching the pattern are listed. Some examples of using a pattern with DIR are shown on the following pages.

If you want to examine the files of another user, you may enter that user's password as part of the pattern. It should be separated from the rest of the pattern by a dollar sign ($).

You may use the DIR transient, residing on one disk, to examine the files of another disk. This is normally done only if the second disk does not contain the DIR transient. It is accomplished by specifying the drive number of the disk whose directory is to be listed. This number is preceded by a slash (/).

Examples for DIR are listed on the next page.

In the examples below, and on the following pages, the RETURN key has been omitted, and a space has been used as a delimiter, so that the example will closely resemble what you will see on the 79ØØ screen.

COMMAND	ACTION
DIR	List all except .SYS and .KIL files.
DIR .*	List ALL files (including .SYS and .KIL).
DIR .SYS	List all .SYS files.
DIR *.SYS	List all .SYS files (same as above).
DIR BR*	List all files whose names begin with the letters BR. Possible matches would be BR, BREAK, BROWN, etc.
DIR T*N	List all files whose names are three characters long, begin with T, and end with N (TEN, TON, etc.)
DIR $XY	List files under password "XY".
DIR .*$XY	List all files under password "XY".
DIR/2	List files on drive 2.
DIR/1 /2	List files on drive 2, using the DIR transient from drive 1.
DIR/1 .KIL/2	List all killed files on drive 2, using the DIR transient from drive 1.
DIR ;P	List public files.
DIR .*;P	List all public files.
DIR .*;L	List all files, with details.
DIR/3 .*;LP	List all public files on drive 3, with details.
DIR ;A	List files under all passwords (except .SYS and .KIL files).
DIR .*;A	List files under all passwords, including .SYS and .KIL files.

NOTE:

A SPACE must be present after the command DIR. No space is used between a pattern (if any) and the semicolon. This is illustrated in the examples above.

The disk directory is displayed in this form:

```
DISKNAME              Free Address: $nnnn      Free Length: $xxxxx
-------------------------------------------------------------------
Filename       Status   File     File    File Origin  Last Access
Prefix   Sfx  ........ Address  Length  Date   Time  Date   Time
-------------------------------------------------------------------
Sample12.SRC  w.......  $4000   $200
```

The disk is named "DISKNAME." The first free byte on the disk is byte number $nnnn, and the length of the free space located at that byte is $xxxxx bytes. (All numbers prefixed by the dollar sign are in hexadecimal, base 16.)

One file is listed in this directory. It is write-protected. It is named Sample12, and has .SRC as a secondary name. The file begins at byte $4000 and occupies $200 bytes of the disk.

The "Status" column of a directory may show any of the following characters:

- w The file is write-protected.
- d The file is DELETE-protected (but it can be KILLed and destroyed by COMPRESS).
- e The file is execute-only. Transients marked as such cannot be loaded by DEBUG, FETCH or EDIT.
- o The file is odd length. A file will only occupy exactly the number of bytes it requires, unless it contains an odd number of bytes. In this case, a single extra byte of storage is used by DOS to cause the file to occupy an even number of bytes. This excess byte is transparent to the user when using DOS firmware subroutines such as OPEN, RWBYTE, etc. Note the efficiency of this scheme, in comparison with other disk operating systems which use blocks of 128 or 256 bytes, regardless of the actual file length.
- k The file has been KILLed.

If your system contains the optional Real-Time Clock, DOS will also display time and date information in the directory. The last columns of the directory will show when a file was created, and when it was last accessed. If the system has no Real-Time Clock, these spaces will be left blank.

The "Free Length" entry in the directory always shows the length of the largest free space available on the disk. If this number approaches zero, the disk is getting full and should be COMPRESSed. See section 3.2.3, "COMPRESS" for more details.

3.2.8 DRAW

DRAW takes a file previously created by BUFF and loads it into the Create Buffer. This transient always assumes that the file being referenced has the secondary name of .BUF.

Format:

DRAW <file> RETURN

Where:

<file> is a .BUF file.

After using the DRAW command, pressing the REDRAW key will cause the picture in the Create Buffer to be redrawn. Pressing XMIT will cause the Create Buffer contents to be sent out to Logical Output Device 1, normally the RS-232 serial port.

Examples:

DRAW POKER	The file POKER.BUF is loaded into the Create Buffer.
DRAW/3 Flies/1	The DRAW transient from drive 3 is invoked to call up the file Flies.BUF from drive 1.

NOTE:

For best results, press the TERMINAL key (leaving DOS and entering the Terminal Emulator) before pressing REDRAW. If you do not press TERMINAL before REDRAW, you will find that you are still in DOS after your picture is redrawn, and anything you type may obliterate your picture. To re-enter DOS after the picture finishes redrawing, press SOFT BOOT and DOS. This will leave any picture in the Bitmap intact.

If <file> was created on a CGC 7900 containing a different number of image memory planes, the picture you generate may not look the same as the original picture.

3.2.9 DSKTST

DSKTST is a diagnostic routine which evaluates a disk. This evaluation gives an indication of disk failures or potential problem areas. This test can be run on any of the four drives currently supported by DOS.

Format:

DSKTST /<n> [;options] RETURN

Where:

<n> is the number of the disk drive that is to be evaluated.

;options are described below.

DSKTST can test for two types of errors:

Hard errors — These are caused by some hardware failure in the disk controller, the disk drive, or the disk itself. Errors such as "SERDES hardware failure," "Block not found," or "uncorrectable data found during a read" are examples of hard errors.

Verify errors — Verify errors are caused by discrepancies found during the comparision of the write data with the read data. These errors are generated from sources such as differences in the comparison of the write data and the read data, or a hardware failure in the comparison buffer.

Option may be included in the [;options] field, separated from the rest of the command by a semicolon. Valid options are:

;R Read only test (default).

;W Verify test (read after write).

;Y Proceed without pausing.

With the R option active, the user will see this message:

DISK(ETTE) DIAGNOSTIC - READ TEST:
Test drive #<n> (Y/N)?

This test does not destroy the contents of the specified drive, but checks for hard errors only.

If the W option is selected, the first line will read:

DISK(ETTE) DIAGNOSTIC - WRITE TEST:

THIS TEST DESTROYS THE CONTENTS OF THE SPECIFIED DRIVE. It checks for verify errors as well as hard errors.

Option 'Y' allows the capability to evaluate the specified disk without prompting the user for permission to do so. If option 'Y' is used, evaluation of the specified disk will proceed with no questions asked! Use option 'Y' with caution.

During the evaluation, the console screen will appear as follows:

Maximum byte address of this drive = $<num>

Pass number = $<num> Byte address = $<num> Status = ?

This display gives the current satatus of the disk test. The pass number is equal to the number of times that this test has completed a run. The byte address always shows the current location of the R/W head during the test. The next part of the display give an indication of the current status of the disk under test. The status can have two states: passing or failure.

Disk failures are displayed in RED. Potential hard errors are given four chances to correct themselves before the status is displayed as failure. This information is shown in the following message:

Retry number = $<num> byte address = $<num>

Soft errors are reported as comparison errors as soon as they occur. The <num> indecated how many bytes did not compare in the buffer. The disk address of where this data is located is also shown. This information is shown in the following message:

$<num> Comparison errors occurred at byte address = $<num>

3.2.10 DUPE

DUPE is another method of copying disks. The source can be a CGC 7900 disk or a disk from another system. The source must, however, be an IBM compatible single or double density disk.

Format:

DUPE /<source> /<dest> [;options] RETURN

Where:

<source> is the number of the disk drive for the **source** disk.

<dest> is the number of the disk drive for the **destination** disk.

;options are described below.

DUPE formats the destination disk according the the density of the source disk and then copies the source disk. The format interleave is user definable. Since DUPE requires an intermediate RAM buffer, duplication speed may be enhanced by enlarging "DOSbuffZ" (7FEE is a good number) with THAW (see the CGC 7900 Operator's Manual).

Options may be included in the [;options] field, separated from the rest of the command by a semicolon. Available options are:

;D Format for a DOS disk (default).

;I Format for an Idris disk.

;F<#> Special interleave code. # is a decimal number (1 or 2 digits).

;R Repeat duplication with pause between duplications.

;Y Proceed with duplication without pausing.

With the D option active, the user will see the message:

```
DOS DUPLICATION:
format interleave code = $<num>
Copy from drive #<source> to drive #<destination> (Y/N)?
```

A DOS duplication takes approximately two minutes.

If the desired option is I, the first line will read:

```
IDRIS DUPLICATION:
```

An Idris duplication takes approximately twelve minutes. This is due to the incompatibility of the DOS and Idris interleave codes.

Should the user choose the F option, the first line will read:

```
MISCELLANEOUS DUPLICATION:
```

Interleave factors greater than half the number of sectors per track are illegal. An illegal factor will cause a DOS error to occur.

Option 'R' runs DUPE in a mass production mode. The initial message display will depend on which of the above options was entered in the option field along with the 'R' option. Once the souce disk has been duplicated once, the destination disk is the only disk that needs to be moved. This mode can be terminated by typing N when the prompt appears. After the first duplication, subsequent prompts will be merely "(Y/N)?" without the other text.

The format interleave codes are displayed in hexadecimal for programming convenience.

3.2.11 EXPLODE

EXPLODE is the opposite of IMPLODE. The data produced by IMPLODE will be expanded back into its original form and displayed in Bitmap memory. The Color Lookup Table will be restored to the colors it had at the time the picture was stored by IMPLODE. See the description of IMPLODE in section 3.2.15 for details.

Format:

EXPLODE <file> RETURN

Where:

<file> is the name of a .RLE file to be displayed in Bitmap memory.

EXPLODE, like REFRESH, allows the user to watch the file being sent to the Bitmap. DOS errors will still be visible.

If <file> was created on a CGC 7900 containing a different number of Bitmap memory planes, the image produced by EXPLODE may not look the same as the original image.

Example:

EXPLODE Dynamite

3.2.12 FETCH

FETCH is the opposite of STORE. It may be used to retrieve bytes saved by the STORE transient, or to load a .SYS or .OBJ file into memory.

Format: Fetch <File> .SYS +0

FETCH <file> [<addr>] [+/-<offset>] RETURN

Where:

<file> is the name of the file to be loaded into memory. If no filetype is specified, .OBJ is used.

<addr> is the address where the data from <file> is to be loaded. <addr> is required if the file is NOT a .SYS or .OBJ file.

<offset> is a displacement, to be added to the normal load address of <file>. <offset> is required for a .SYS or .OBJ file, even if the displacement is zero.

NOTE:

FETCH will not load an execute-only file.

If the file read in by FETCH happens to over-write important areas of system memory, the system may hang.

Examples:

FETCH PGM.SYS/2+2000	Load the file PGM from drive 2, at memory addresses 2000 (hex) higher than it occupied when it was STOREd.
FETCH BYTES.ABS 1F000	Load the file BYTES into memory beginning at address 1F000 (hex).

3.2.13 FORMAT

FORMAT initializes a disk, preparing it for data. A new disk must be formatted before it can be used. Formatting destroys all data on a disk. After a disk has been formatted, it contains a blank directory and no files. The blank directory shows only the disk's name, its size, and allows DOS to determine the disk's density (single or double).

Format:

FORMAT [<name>] /<n> [;<opt>] RETURN

Where:

<name> is the name given to the disk being formatted. If omitted, the current revision level of DOS is used to form the disk name.

<n> is the number of the disk drive containing the disk to be formatted. <n> is required.

<opt> is one or more of the following options:

;D double density

;S single density

;Y "Yes," proceed with formatting.

If <name> is specified, the disk is given this name. <name> may be one to eight alphanumeric characters. If <name> is not specified, the disk is named "DOSRevXX" where XX is the version of DOS which initialized the disk. A disk formatted by DOS 1.6 would be named "DOSRev16".

FORMAT prints the message:

Format drive n. Continue (Y/N) ?

where n is the drive number FORMAT will initialize. You are given this chance to abort the process. Press the "Y" key to continue, or any other key to abort. You may also insert a different diskette in the drive before pressing "Y".

When DOS begins formatting the disk, it prints:

Formatting drive n.

If successful, control returns to DOS with no further messages. If an error occurs, such as a bad block detected on the diskette, error messages are printed and the FORMAT should be tried again. If errors continue, the diskette should be discarded.

The default format for diskettes is double density. If desired, a single density diskette may be formatted using the "S" option. A diskette created for single density may be used on any CGC 7900 system.

Option "Y" prevents the system from asking the "Continue?" question above. If option "Y" is used, the disk or diskette will be immediately formatted with no questions asked. However, the "Formatting drive n" message will still be printed. Use option "Y" with caution.

3.2.14 Initializing a New Diskette

Formatting prepares a disk for data, but does not store anything on it. A freshly formatted disk has a blank directory. Here is a sample procedure which might be used to format a brand new diskette:

1) Load a disk containing the FORMAT command, and other transients, into drive 1. Load a blank disk into drive 2.

2) Enter the following:

```
FORMAT/1 NewDisk/2
```

and press RETURN. The FORMAT transient responds:

```
Format drive 2. Continue (Y/N) ?
```

3) Press the "Y" key. The formatting proceeds. When complete, and no error messages have been printed, you can assume the new disk is now formatted properly. It has the name "NewDisk". Now you may wish to copy the DOS transients onto this disk, so that it will be useable without referring to other disks. Enter:

```
COPY/1 *.SYS/1 /2
```

and press RETURN. All system transients (.SYS files) will be copied to the new disk.

NOTE:

If everything on the source disk is to be copied over, DUPE is an easier way to do this. See section 3.2.10.

3.2.15 IMPLODE

IMPLODE stores an image from Bitmap memory, similar to PICTURE. However, IMPLODE uses a data compression technique which can significantly reduce the amount of storage a picture requires. Like PICTURE, IMPLODE also stores the Color Lookup Table. The file produced by IMPLODE has a .RLE secondary name.

Format:

IMPLODE <file> [;<n>] RETURN

Where:

<file> is the name of a file to be created by the IMPLODE command. If a file by that name already exists, the old file is KILLed.

<n> is a hexadecimal number (see below).

The advantage of IMPLODE over PICTURE depends on the complexity of the image, and in extreme cases, IMPLODE can actually use more disk space than PICTURE. IMPLODE will display the number of bytes it stored, and will also display the number of bytes PICTURE would have used. You can then decide whether to try PICTURE instead.

<n> is a hexadecimal number which tells IMPLODE which planes to store. It acts exactly like the optional <n> argument in the PICTURE command. See section 3.2.18 for a description of PICTURE.

Examples:

```
IMPLODE Baseball

IMPLODE CRT;7
```

3.2.16 KILL

The KILL transient changes a file's secondary name to .KIL (except if the file is a .SYS file, which cannot be killed by KILL).

Format:

KILL <filename> RETURN

Where:

<filename> is the file to be KILLed.

KILL is used to remove a file from "active" status, and mark it for eventual destruction with COMPRESS (see below). After a file has been killed, it is still recoverable, but is not recognized unless specifically requested. The DIR command will not display killed files unless the .KIL or .* pattern is included. Most programs will ignore killed files.

Files with the .SYS extension may be killed using the RENAME command, to change their secondary name to .KIL (this should only be done with great care).

After a file has been killed, it is still recoverable until the disk is compressed (see 3.2.3, "COMPRESS"). A .KIL file may be recovered using the RENAME command, to change the secondary name to something other than .KIL (.BUF, .SRC, etc.). After a COMPRESS, the file is NOT recoverable.

If a pattern is used instead of a filename, ALL files matching the pattern are KILLed. Wild cards (*) may be included in the pattern.

Examples:

KILL ANORC	Kill the file named ANORC.
KILL DATA/2	Kill DATA on drive 2.
KILL DATA$XY/2	Kill DATA on drive 2, passworded "XY".
KILL X*	Kill any file beginning with "X".
KILL TEST	Kill any file with primary name TEST.
KILL .SRC	Kill any file with secondary name .SRC (be careful!).

3.2.17 MOVEHEAD

MOVEHEAD positions the R/W head of a disk drive to any valid logical block address (lba). The lba is the contiguous hexadecimal address of a sector on a disk. The first lba is zero.

Format:

MOVEHEAD [/<n>] [;options] RETURN

Where:

<n> is the number of the disk to be positioned. The default value is the drive number specified with the transient name.

;options are described below.

The primary purpose of MOVEHEAD is to prepare a CGC 7900, equipped with a fixed disk drive, for shipment. Two different configurations currently exist for shipping these kinds of units:

1) CGC 7900 with DOS (option 7940-01) and at least one fixed disk drive.

2) CGC 7900 with Idris (option 7965-01).

MOVEHEAD performs this operation by sending the head to the innermost lba on the media. In this manner, should the head bounce on the disk during shipment, damage will be kept to a minimum.

Options may be included in the [;options] field. Allowed options are:

;D Positions R/W head to the innermost lba for DOS (default).

;I Positions head to the outermost lba for Idris.

;A<#> Positions head to lba <#>. This is a hexadecimal number (1-8 digits).

With the D option active, the following message will be displayed:

HEAD PLACEMENT FOR DOS:
R/W head moved to lba = $<num> on drive #<n>

If the I option is selected, the first line will read:

HEAD PLACEMENT FOR IDRIS:

Finally, if the A option is active, the first line will be omitted. If the lba following option A is omitted, a default value of $Ø will be selected.

WARNING:

The protection that this transient offers assumes that the locking mechanisms will be used during shipment. With these mechanisms deactivated, positioning the R/W head will not do any good.

3.2.18 PICTURE

PICTURE stores an image from Bitmap memory into a disk file. This may require up to two megabytes of storage, depending on the number of Image Memory planes installed in your system. The file created by PICTURE has a .PIC secondary name.

Format:

PICTURE <file> [;<n>] RETURN

Where:

<file> is the name of a file to be created by PICTURE. If a file with that name already exists, the old file is KILLed.

<n> is a hex number (see below).

PICTURE also stores the contents of the Color Lookup Table so the current colors on the Bitmap screen can be recreated later.

Example:

PICTURE THIS

NOTE:

If the disk becomes full while PICTURE is storing data, an error occurs and no data is saved on the disk.

The optional argument <n> allows you to specify which planes of Bitmap memory will be stored. You can store the planes which are applicable to your picture, and save disk space by not storing unneeded planes. <n> is a hexadecimal number between Ø and FFFF. Each bit in <n> which is SET corresponds to a plane which will be stored. The least significant bit of <n> corresponds to plane Ø, the most significant bit to plane 15. If you enter more than four hex digits, only the last four are used.

Example:

```
PICTURE FRAME;87
```

The hex number 87 has bits Ø, 1, 2, and 7 set. This command stores the four planes which are normally installed in a four-plane system. If your system contains only four planes, this example is equivalent to using PICTURE without the optional <n>.

NOTE:

Each plane stored by PICTURE occupies 128K bytes of a disk, or $2ØØØØ hex bytes. The "Free Length" entry in the directory must be enough to accommodate this length (plus 1Ø24 bytes for the Color Lookup Table), or PICTURE will generate an error message.

Example:

```
PICTURE BOOK;7
```

This example stores only planes Ø, 1, and 2, a total of 385K bytes. If a picture was drawn on a four-plane system and the blink plane was not in use, this command would store just the information necessary to reproduce the picture. Now this file would fit on a floppy diskette, but if four planes had been stored, it would not fit.

For most applications, BUFF, DRAW and APPEND are much more efficient methods of storing images. See section 3.2.15, "IMPLODE" and 3.2.11, "EXPLODE."

3.2.19 REFRESH

REFRESH is the opposite of PICTURE. REFRESH brings in up to two megabytes of data from the disk and displays them on the screen. The Color Lookup Table is also loaded by REFRESH. See the description of PICTURE for details.

Format:

REFRESH <file> RETURN

Where:

<file> is the name of a .PIC file to be brought in from the disk, and displayed in image memory.

REFRESH modifies the overlay present/future visibility attributes to allow the user to see the .PIC file being transmitted to the Bitmap. DOS errors will still be visible.

If the .PIC file specified in the REFRESH command was created on a CGC 7900 containing a different number of Image Memory planes, the image produced by REFRESH may not look exactly like the original image stored by PICTURE.

Example:

REFRESH Yourself

3.2.20 RENAME

RENAME alters a file's name. The primary name, secondary name, or both, may be altered in the RENAME process. <file2> must not specify a drive number, since the file itself does not move from the disk where it currently resides. If <file2> specifies a drive number, that number is ignored.

Format:

RENAME <file1> [<file2>] [;<opts>] RETURN

Where:

<file1> is the name of an existing file.

<file2> is the new name to be given to the file.

<opts> are one of the following options:

W	Write-protect
-W	Write-enable
D	Delete-protect
-D	Delete-enable
E	Execute-only

RENAME may also be used to change a file's attributes, such as write-protection (see below). If you want to change a file's attributes and leave its name the same, you may omit the <file2> name. It is NOT legal to omit both <file2> and <opts>. At least one of these must be present.

RENAME is not allowed to change a file's password. COPY should be used for this purpose.

If <file1> contains wild cards, any files matching the pattern are renamed. If <file2> contains wild cards, characters are pulled from the name of <file1> to substitute for *'s in <file2>.

If <file1> specifies only a primary name, all files with that name (regardless of their secondary name) are renamed. Likewise, if <file1> specifies only a secondary name, all files with that name are renamed (regardless of their primary name). This can result in more than one file having exactly the same name. If this occurs, you can rename the files again (giving them different names) by specifying the primary AND secondary name of the file to be renamed. If <file1> completely specifies a file name, RENAME will only act on one file.

RENAME will not affect .SYS or .KIL files unless you specify a secondary filename of .SYS, .KIL, or .* in <file1>. RENAME can change a .SYS file to a .KIL, and can revive a .KIL file into its original type. BE CAREFUL.

If no options are specified, the file retains its old attributes.

NOTE:

For security reasons, RENAME will not remove the execute-only status of a file. Once a file has the "e" status, that status may not be altered.

Examples:

RENAME AX BX	Rename file AX to BX, giving it the same attributes AX had.
RENAME AX BX;W	Same as above, but write-protect the file.
RENAME DATA OLDATA;WD	Rename DATA to OLDATA, write-protecting and delete-protecting it.
RENAME ZOO;-W-D	Remove W and D attributes from the file ZOO.
RENAME SECRET;E	Make file SECRET execute-only.
RENAME XX/1 YY/2	File XX on drive 1 is renamed to YY; the "/2" is ignored.
RENAME XX	This produces "Argument Error."
RENAME AB* CD*	Any file beginning with "AB" will now begin with "CD."

RENAME can also change the name of a disk (the name given to the disk when it was FORMATted). Use this form of the command:

```
RENAME /2 Newname
```

The disk in drive 2 will be renamed to "Newname".

3.2.21 STORE

STORE creates a disk file containing all bytes from the range of memory <addr1> through <addr2>, inclusive. The file created by STORE may contain an absolute binary image of memory, or it may be an image in executable form (readable by the DOS loader). STORE decides which type of file to create, based on the secondary name of <file>.

Format:

STORE <file> <addr1> <addr2>
[+/-<offset>] [@<exec>] [;<options>] RETURN

Where:

<file> is the name of the file to be created by STORE.

<addr1> and <addr2> are the starting and ending (hex) addresses of the range to memory to be stored.

<offset> is an address offset (hex) specifying the difference between the address the data was STOREd from and the address it will be loaded into. <offset> must be preceded by a + or - sign. <offset> MUST be specified, even if it is +0. Note that <offset> does not relocate code as a linker would — absolute branches jump to the same address they would have before.

@<exec> is the address at which execution of the data must begin (assuming the data is a program).

;P if included, makes the file "proprietary" (i.e., sets the execute-only flag in the file's attributes).

STORE will allow you to specify any secondary name. If you do not specify a secondary name, the default secondary name of .SYS is used and a load module is generated. If you specify .OBJ as a secondary name, a load module is also generated. Any other secondary name causes an absolute binary image to be stored into the file.

The arguments to STORE are affected by the secondary name of <file>:

1) If the file type is .SYS, the default value for <offset> is zero, and the default value for <exec> is zero.

2) If the file type is .OBJ, the default value for <offset> and <exec> is zero. If the .OBJ file will be renamed to a .SYS file, <exec> must be specified at this time: a .OBJ file whose <exec> is zero cannot be executed.

3) If the file type is neither .SYS nor .OBJ, <offset> and <exec> are not allowed. An absolute binary file is generated which stores data in an unformatted form, storing just the bytes and no addressing information. This type of file may be given any secondary name, although .ABS is recommended.

A file created by STORE may be brought back into memory by FETCH or DEBUG. If STORE is used to create a .SYS file, the file may be executed directly by typing its name as a DOS command.

Examples:

```
STORE/1 HOUSE.ABS/2 4ØØØ 4FFF

STORE Program 14ØØØ 14FFF-1ØØØØ@44ØØ

STORE SECRETS 11C 12AFØ-1ØØØØ;P
```

Note that the + or - sign, and the @ sign, act as delimiters in the command line and should not be preceded by a space.

DOS expects .SYS files to load and execute in the DOS transient program area (TPA). The size of this area is set with the 7900 "Thaw" command, but will normally be at least 16K bytes. The DOS areas begin at memory address $1C3C, and user programs should be arranged to run in this area.

The STORE transient also runs in the DOS area, and would overwrite any data in this area you are trying to STORE. That is the reason for the <offset> parameter. Data to be STOREd can be moved to a higher address with the Monitor "Move Memory" function, then the STORE command with an offset can be used to move the data back to its original addresses in the DOS area.

3.2.22 SUMS

SUMS performs a checksum of all PROMs in the 7900 system. This is normally used as a check on the integrity of a PROM, or to determine which version of firmware is installed in a system.

Format:

SUMS RETURN

SUMS also displays the software revision level of the PROMs in your 7900 system, by searching for the ASCII string "VER#" in each PROM. If your system contains PROMs version 1.1 or higher (DOS version 1.4 or higher), SUMS will display the version number of these programs.

Example:

```
SUMS
```

3.2.23 VERSION

VERSION displays the release date of the transients matching <pattern>. You may use VERSION to see whether you have the latest set of transients from Chromatics, or to indicate the release date of a transient when reporting a expected malfunction to Customer Service.

Format:

VERSION <pattern> RETURN

You must enter at least the disk number as <pattern>. Typing VERSION by itself causes an "Argument Error."

Example:

```
VERSION /2    Display the release date of all
              transients on the disk in drive 2.
```

If VERSION is given a file with a secondary name different than .SYS, the message, "MISSING OR INVALID VERSION RECORD" will be printed.

3.2.24 XREF

XREF is a program designed to be used with the Chromatics MC68ØØØ Assembler (discussed in Section 5 of this manual). XREF produces a cross-reference list of all labels in an MC68ØØØ assembly language source file. The line at which a label is defined is flagged with a pound sign (#).

Format:

XREF [^<options>] <file1> [<file2>...<filen>] RETURN

Where:

<file1>, <file2>, etc. are ASCII files containing an MC68ØØØ assembly language program.

<options> may include any of the following characters:

L	Transmit output to Logical Device Ø (normally the screen).
T	Transmit output to Logical Device 1 (normally the RS-232 serial port, assumed to connect to a printer).
P<n>	Print <n> lines per page (including 4 lines used as a header).
W<m>	Print lines up to <m> characters wide (<m> may range from 81 to 132).
+R	List register usage.
-R	Don't cross-reference registers (AØ, D1, etc.).

If <options> are omitted, the default is ^TP61W132+R. This causes the listing to be directed to the printer, 61 lines per page, 132 columns per line, and registers are included in the XREF listing.

Example:

XREF Program

XREF ^LW85 Program List on the screen, limit lines to 85 characters wide.

A space in the operand field terminates the operand, so that in a statement such as:

```
        DC.W    SYM1,SYM2
```

both SYM1 and SYM2 will be found. However, in this line:

```
        DC.W    SYM1, SYM2
```

SYM2 would not be listed.

Section 4 — DOS Text Editor

4.1 Introduction to the Editor

The Chromatics CGC 7900 Text Editor is a disk-based program used for creating and maintaining text files. It is primarily used in conjunction with the Assembler, for creating programs executable by the MC68000 processor. The editor is also good for working with other types of text files, such as correspondence or documentation. This manual was, in fact, written using a text editor.

The editor executes under DOS, the Disk Operating System, which was described in Sections 1 through 3 of this manual. If the DOS prompt (a green asterisk) is not currently visible, press the DOS key. Enter your password and press RETURN (or simply press RETURN). Make sure that the system contains a disk which has the editor on it, the program EDIT.SYS. Then type:

EDIT RETURN

It may be necessary to specify the number of the disk drive containing the EDIT program, as:

* EDIT/n

Where n is the number of the drive where EDIT.SYS resides. This will only be necessary if another drive, not containing the editor, has been in use.

When the editor expects input, it will prompt you in one of three ways. If the editor expects a command, the prompt is a 4-digit line number followed by a question mark. If it expects a line of text to be inserted into the file, the prompt is a 4-digit line number followed by an "I" and a question mark. If you are in MODIFY mode, the prompt is a number followed by the letter "M" and a question mark.

Examples:

```
0000   ?     Command prompt

0000 I ?     Insert prompt

0000 M ?     Modify prompt
```

The line number is a pointer position within the file. The editor refers to lines by number, and maintains an internal pointer somewhere within the file. Commands are provided which will explicitly move the pointer around, and many commands will implicitly move the pointer. For example, if the pointer is on line 3, and you LIST lines 3 through 20 of the file, the pointer is now on line 20.

NOTE:

When the edit pointer is at the beginning of the file, the line number is displayed as "B". When it is at the end, the line number is displayed as "E".

When you see the command prompt, you may enter any of the legal editor commands described in this manual. The INSERT command will take you out of command mode and put you into insert mode. When you see the insert prompt, anything you type will be inserted into the file at the current pointer position. Hitting the DELETE key will return you from insert mode to command mode.

Each of the commands in this section may be abbreviated to the smallest number of characters which will uniquely identify that command. For example, the OPEN command may be abbreviated as O, since no other command begins with that letter. However,. the command PRINT can only be abbreviated to two characters, PR, so that it won't be confused with the PAGE command (both begin with "P"). In general, it is safe to abbreviate commands to two or three characters.

4.2 INLINE

"INLINE" is the standard subroutine used by the editor for fetching a line of input from the keyboard. This routine is also used by other CGC 7900 programs, such as DOS.

INLINE accepts a line of input, and allows inserting, deleting and replacing characters. When the line is completed to your satisfaction, press RETURN. The cursor can be anywhere on the input line when RETURN is struck, but the entire visible line will always be accepted as input.

The left and right arrow keys move the cursor around within the line currently being typed. The HOME key moves the cursor to the left edge of the current line. The cursor position is used to determine where text will be inserted, or where other commands will take effect.

INLINE supports the editing commands printed in blue on the front of the cursor control keys: INS CHAR, DEL CHAR, CLEAR EOL and RECALL. These blue functions are accessed by holding down the CTRL (control) key and pressing the indicated key. The key printed in white, CLEAR LINE, is also supported.

DEL CHAR (Delete Character) removes one character at the current cursor position. All characters to the right of the cursor move left one position.

CLEAR LINE erases the line currently being typed.

CLEAR EOL (Clear to End Of Line) erases all characters from the current cursor position to the end of the line.

RECALL (Recall Last Line) replaces the line currently being typed with the last complete line that was typed. This function is useful for repeating a command, perhaps altering it slightly with the other functions. Press Recall more than once to bring back earlier lines; this moves backward into the recall buffer. Press SHIFT RECALL to move forward in the recall buffer.

INS CHAR (Insert Character) puts the routine into insert mode. The character under the cursor begins blinking, and any characters typed are now inserted, forcing characters to the right of the cursor to move out of the way. To leave insert mode, use one of the arrow keys to move the cursor. This places the routine in its normal (overstrike) mode, and any characters typed now will simply overwrite existing characters under the cursor.

INLINE is designed to be a general-purpose routine for ALL user input in the CGC 7900. Appendix B describes the calling sequence for INLINE, for users who wish to use it in their own programs. It is STRONGLY SUGGESTED that all programs use INLINE to accept input from the user. This means that all programs will support character editing as described above, and the user will become accustomed to using the same editing sequence for all program input.

4.3 Editor Commands

This section discusses the commands accepted by the editor. Each of these commands may be entered at the command prompt.

In each command, one or more delimiters may be present to separate the various parts of the command. A delimiter may be either a space or a comma. For convenience, we will always use a space in our examples.

If the editor cannot interpret a command, or if for any reason an error occurs during a command, the command line is re-printed on the screen with the cursor positioned over the error. You may then edit the command line, using the INLINE editing functions on the cursor keypad. This avoids retyping the entire input line, and also illustrates exactly where the error occurred.

4.3.1 OPEN

The OPEN command searches for a specified file and returns an error if the file cannot be located. If the file does exist, OPEN simply returns to command mode. Before a file can be edited, it must be OPENed as an input file.

NOTE:
OPEN does not actually cause any text to be read in from the file! See 4.3.2, "GET."

Format:

OPEN <file> RETURN

Where:

<file> is the name of an existing disk file containing ASCII text. <file> is assumed to have the secondary name .SRC, unless a different secondary name is entered.

The file is assumed to contain ASCII text. Each line of the file is terminated by a Carriage Return character, and no Line Feed. The editor will provide a Line Feed after each Return when LISTing or PRINTing the text.

Examples:

OP DOOR

OP WINDOW

OP ThatFile/2

4.3.2 GET

GET reads in text from the currently open input file (the file most recently specified by OPEN). If the GET command is used without an argument, enough text is read in to fill approximately half of the available memory.

Format:

GET RETURN

GET <#> RETURN

Where:

<#> is a decimal number. If <#> is specified, only that many lines are read in. Text is appended to the end of text already in memory.

If the GET command causes the entire file to be read in, the message "End Of Input Data" is printed, and no more text may be read in from the input file.

If the GET command causes memory to be filled with text, the message "Workspace Full" is printed, and no more text is read in. It is now necessary to PUT some text back on disk, to make room for more of the file. See PUT and PAGE for examples.

NOTES:

Use GET without arguments whenever possible, since it will never totally fill the workspace unless several GETs are used.

Examples:

GET

GET 30

4.3.3 LIST

LIST displays lines of text. If no line numbers are entered, LIST begins at the current pointer position. If one line number is given, listing begins at that line and continues through memory. If two line numbers are given, listing begins at the first line number entered and continues through the second line number.

LIST expands tabs in accordance with the tab specification found in the Window #Ø table.

Format:

LIST RETURN

LIST <#1> RETURN

LIST <#1> <#2> RETURN

Where:

<#1> and <#2> are line numbers.

LIST may be paused by typing a CTRL S, and restarted with CTRL Q. LIST may be stopped at any time by pressing DELETE.

The output from LIST is always directed to Logical Output Device Ø, normally the screen or a part of the screen. Each line displayed by LIST is shown with its line number, for reference.

Examples:

LI

LI 2ØØ

4.3.4 PRINT

PRINT performs the same function as LIST, but sends its output to Logical Output Devices Ø and 1. Since Logical Output Device 1 is normally connected to a printer, this produces a hardcopy of the lines listed. Unlike LIST, PRINT does not display line numbers in front of each line. PRINT, however, does expand tab characters like LIST.

Format:

PRINT RETURN

PRINT <#1> RETURN

PRINT <#1> <#2> RETURN

Examples:

PR

PR 1ØØ 19Ø

4.3.5 INSERT

INSERT takes the editor from command mode to insert mode. While in insert mode, the prompt is in the form:

NNNN I ?

The "I" indicates that material is being inserted into text.

Format:

INSERT RETURN

INSERT <#> RETURN

Where:

<#> is a line number.

If <#> is entered with the INSERT command, insertion begins at the line specified. All lines from <#> up will move up in the file to make room for lines being inserted. If <#> is not specified, insertion begins at the current pointer position.

INSERT is the most important command in the editor. It allows you to enter text to create a new file. While in insert mode, any of the INLINE editing features may be used, such as insert and delete character.

Insert mode remains in effect until the DELETE key is struck, at which time the editor returns to command mode.

NOTE:

The INSERT command causes the line numbers of part of the text in memory to be changed, as all lines past the insertion move up in memory. You should LIST the file after leaving insert mode, before performing any operations which are dependent on line numbers.

Examples:

```
IN

IN 15
```

If you enter a Mode code sequence (such as a "Set Color" command) into the input line, the sequence is displayed in compressed form, using special characters. It is not executed until you press the RETURN key. If you enter a tab character (CTRL I) into the line, it too is displayed but not executed. The Mode character resembles a double tilde (~), and the tab character resembles a right-pointing arrow. (These characters are taken from the "A7" character set, described in the CGC 7900 User's Manual.) Pressing RETURN will redisplay the input line with all Mode codes executing as they normally would when printed from a program. Tabs will be executed according to the current tab stop spacing in effect (normally 4 characters apart).

Using the up and down arrow keys or the Delete Line function, you can move from INSERT mode into MODIFY mode. Modify can also be entered by giving the MODIFY command, as discussed next.

4.3.6 MODIFY

MODIFY is the editor's most flexible mode. When you enter MODIFY, the editor's prompt is in the form

NNNN M ?

and is displayed in magenta. The current line is also displayed in magenta.

Format:

MODIFY RETURN

MODIFY <#> RETURN

Where:

<#> is a line number.

MODIFY allows you to use the INLINE editing features on existing text in memory. You can insert or delete characters using the labeled functions on the cursor keypad. When you have finished altering a line, you must press RETURN to store that line in its new form. If you move the cursor up or down using the arrow keys, the line you modified will NOT be stored, but will return to its previous condition.

Using the Insert Line and Delete Line functions, you can move between MODIFY mode and INSERT mode at will. When in MODIFY, the prompt will be displayed in magenta and will be in the form "NNNN M ?" While in INSERT mode, the prompt is in yellow, and is in the form "NNNN I ?"

Pressing DELETE moves you back to command mode.

Examples:

MO

MO 25

When in MODIFY, as in INSERT, a special compressed form is used to display Modes, tabs, and other control-characters. In MODIFY, the line containing the cursor is always displayed in compressed form so that any control-characters in the line will be visible and may be edited. Other lines on the screen during MODIFY are displayed normally; only the line with the cursor is displayed in this special form.

4.3.7 DELETE

DELETE removes a set of lines from the text. If DELETE is entered with no arguments, only the current line is deleted. (The current line is the line whose number is printed in the prompt.)

Format:

DELETE RETURN

DELETE <#1> RETURN

DELETE <#1> <#2> RETURN

If DELETE is entered with one argument <#1>, the single line whose line number is <#1> is deleted. If DELETE is entered with both <#1> and <#2>, all lines within the range <#1> through <#2>, inclusive, are deleted.

NOTE:

The DELETE command causes the line numbers of part of the text to be changed, as all lines past the lines deleted are moved down in memory. After a DELETE, it is advisable to LIST the file before doing any other operations which are dependent on line numbers.

4.3.8 FIND

FIND locates a string. The range of lines to be searched, and the number of searches to perform, are specified in the command.

Format:

FIND \<string>\ RETURN

FIND <#1> \<string>\ RETURN

FIND <#1> <#2> \<string>\ RETURN

FIND <#1> <#2> <N> \<string>\ RETURN

FIND with no arguments other than <string> begins searching at the current pointer position, and reports all occurrences of <string> until the end of the file.

FIND with <#1> is the same as above, but begins searching at line <#1> rather than at the current pointer position.

FIND with <#1> and <#2> searches all lines from <#1> to <#2>, inclusive.

FIND with <#1>, <#2> and <N> begins searching at line <#1>, and terminates when it reaches line <#2> OR if it has found <N> occurrences of <string>.

The backslash character "\" is used as a delimiter to define the search string. Any non-numeric character (except "[") could be used as a delimiter, provided it does not occur in <string>. The terminating delimiter (just before RETURN) is not required.

Examples:

FI \Ø\	Find all zeroes from the current pointer to the end of the file.
FI 1 999\.\	Find all decimal points in the file (through line 999).
FI 1 999 1Ø\the\	Find up to 1Ø occurrences of the word "the", between lines 1 and 999.

During a FIND, you may press CTRL S to pause the display, and then CTRL Q to continue. DELETE returns you to command mode.

4.3.9 SUBSTITUTE

SUBSTITUTE performs a search-and-replace function.

Format:

SUBSTITUTE \<string1>\<string2>\ RETURN

SUBSTITUTE <#1> \<string1>\<string2>\ RETURN

SUBSTITUTE <#1> <#2> \<string1>\<string2>\ RETURN

SUBSTITUTE <#1> <#2> <P> \<string1>\<string2>\ RETURN

SUBSTITUTE <#1> <#2> <P> <F> \<string1>\<string2>\ RETURN

You can enter a number of options to specify exactly how the substitution takes place:

SUBSTITUTE with no arguments affects only the current line, and if <string1> is on that line, it is replaced by <string2>. Only one occurrence of <string1> will be replaced.

SUBSTITUTE with <#1> affects only the line specified, and only one occurrence will be replaced.

SUBSTITUTE with <#1> and <#2> begins at line number <#1> and continues through line number <#2>. If <string1> is found on any line, it is replaced by <string2>, but only the first occurrence of <string1> per line will be affected.

SUBSTITUTE with <#1>, <#2> and <P> affects all lines from <#1> to <#2>, inclusive, and replaces <P> occurrences per line.

SUBSTITUTE with <#1>, <#2>, <P> and <F> affects all lines from <#1> to <#2>, inclusive, replaces <P> occurrences per line, but begins at occurrence <F> on each line.

The backslash "\" is used as a delimiter to define the beginning and end of each string. Any non-numeric character (except "[") could also be used as a delimiter, provided it does not occur in either <string1> or <string2>.

The terminating delimiter (just before the RETURN) is not required.

Examples:

SU /A/B/	Change the first occurance of "A" to "B" on the current line (if any).
SU 54/123/321/	On line 54, change "123" to "321" (one occurance at most).
SU 1ØØ 2ØØ/me/I/	Change "me" to "I" everywhere between lines 1ØØ and 2ØØ (not more than once per line).
SU 1ØØ 2ØØ 99/me/I/	Same as above, but up to 99 times per line (effectively changes all occurrences on each line in the range).
SU 1 1ØØ 1 2/this/the/	Between lines 1 and 1ØØ, change the second occurance "this" to "the" on each line.
SU 1 1ØØ 99 2/this/the/	Same as above, but changes all occurrences EXCEPT the first occurance on each line.
SU 1Ø 55.\./.	Change backslash to slash (using a period as a delimiter), once per line, between lines 1Ø and 55.

SUBSTITUTE displays each line it changes. To abort the SUBSTITUTE process, press the DELETE key. You will return to command mode, and any lines which have not already been displayed by SUBSTITUTE will not be affected.

SUBSTITUTE can be very destructive, if not used carefully. It is good practice to use FIND before SUBSTITUTE, to see exactly what will be affected by SUBSTITUTE. For example,

FI 1 99 1/A/	Find the first occurance of "A" and display the line.
SU /A/B/	Change "A" to "B" at this line

By using the Recall Last Line function, you can repeat these two commands as often as required, examining each occurance of "A" before changing it to "B".

4.3.10 PUT

PUT removes text from memory, and writes it back to the disk.

Format:

PUT RETURN

PUT <#1> RETURN

PUT <#1> <#2> RETURN

If PUT is entered with no arguments, all text in memory is written out to the disk. If only one argument is entered, all lines from the beginning of text through line <#1> are written out to the disk.

If two arguments are entered, only lines between line number <#1> and line number <#2> are written out to the disk.

PUT is primarily useful for dividing up a file into smaller files. By doing a PUT followed by a CLOSE, a new file is created which contains only the lines which were PUT.

NOTE:

PAGE and EXIT are more general-purpose commands for ending an editing session.

Examples:

```
PU

PU 60 90
```

4.3.11 CLOSE

CLOSE enters the output file into the disk directory, and closes the file.

Format:

CLOSE RETURN

CLOSE <filename> RETURN

If CLOSE is entered without a <filename>, the new file has the same name as the old file. The editor will automatically KILL the old file.

If a <filename> is specified, the new file has that name. The file will have .SRC as a secondary name unless you specify a different secondary name.

Once a file has been closed, either by CLOSE or by EXIT, it exists on the disk and can be re-opened by OPEN as an input file.

Examples:

CL

CL MIND

CL NEWFILE

NOTE:

PAGE and EXIT are more general-purpose commands for ending an editing session.

4.3.12 PAGE

The PAGE command is used when editing large files. If a file is too large to fit entirely in memory, you must bring in a portion of the file, edit that portion, then go on to the next. PAGE dumps all of the text in memory back to the disk, then brings in enough text from the input file to fill half of the available memory.

Format:

PAGE RETURN

PAGE is equivalent to doing a PUT of all text in memory, followed by a GET.

Example:

PA

4.3.13 DRIVE

DRIVE causes the editor to create a new output file, on the specified disk.

Format:

DRIVE <#> RETURN

The output from the editor normally goes onto the same disk from which the input file was read. You may alter this with the DRIVE command, forcing the editor's output onto another disk.

Example:

```
DR 2
```

If you have already written some text to the output file, using PAGE or PUT, DRIVE is not allowed until you CLOSE the currently open output file. (If it were allowed, the text you had written to the disk would be lost.)

4.3.14 EXIT

EXIT is the proper way to end an editing session. EXIT first PUTs all text in memory onto the disk. Then it performs a series of GETs and PUTs (if necessary) to insure that the entire input file has been written to the output file. When no text remains in the input file, the output file is closed.

Format:

EXIT RETURN

EXIT <filename> RETURN

If EXIT is entered with no <filename>, the output file has the same name as the input file. The editor then automatically KILLs the old input file.

If EXIT is entered with a <filename>, the output file is given that name. The file will have .SRC as a secondary name unless you specify otherwise.

Example:

EX

EX RAMP

NOTE:

Due to a bug in EXIT, this command cannot be used for new files. When ending a session with a newly created file, type the following three commands:

```
PUT
CLOSE <file>
ABORT
```

4.3.15 ABORT

The ABORT command ends an editing session, but does not close the output file. If any changes had been made in the file, the changes are lost.

Format:

ABORT RETURN

ABORT is used if you decide that you don't want to alter the file after all. If you had been using the editor simply to examine a file (rather than making changes), ABORT would be the logical way to end the session.

Example:

AB

NOTE:

Pressing the DOS, MONITOR, or TERMINAL keys will also result in aborting the editor.

Section 5 — The 68000 Assembler

The Chromatics MC68000 resident assembler is used to produce machine-readable object code from assembly language source files. The assembler executes under the Chromatics Disk Operating System, described in Part 1 of this manual.

The full MC68000 instruction set is supported by the assembler. For this section, you should understand the MC68000 processor architecture, as described in the Motorola MC68000 User's Guide (available from Chromatics). The examples provided in this manual are intended only to demonstrate proper syntax, and do not necessarily show useful programming techniques.

You should also be familiar with the basic operating techniques used in the CGC 7900; if not, consult the CGC 7900 User's Manual before attempting to use the assembler.

5.1 Running the Assembler

The ASMB command invokes the file ASMB.SYS, the Chromatics MC68000 resident assembler. The ASMB command must be entered at the DOS prompt, which is a green asterisk (*).

Format:

ASMB [^<options>] <file1> RETURN

ASMB [^<options>] <file1>
[^<options>] <file2> ... RETURN

Where:

<file1>,<file2>, etc. are the names of source files to be assembled.

<options> are characters which specify assembly options (see below).

The assembler expects its input files to be in ASCII text form. Input files must have the secondary name .SRC.

The assembler produces an output file of type .SYS, which may be directly executed by DOS. If you enter the command line

ASMB PROGRAM

and press the RETURN key, the file PROGRAM.SRC would be assembled and an output file named PROGRAM.SYS would be produced. This .SYS file can be directly executed by typing its name as a DOS command:

PROGRAM

When the assembler closes its output .SYS file, any old .SYS file with the same name is KILLed. Thus, a program can be edited, assembled, re-edited and re-assembled any number of times, but only the most recent version of the source and object code will be active on the disk.

Several options are available to control the assembly and the output listing. The option field is indicated by the "carat" character, ^. The options may be entered in any order.

C Close output file, producing an executable program file as output.

-C Do not close output file.

T Type listing on printer (through Logical Output 1).

-T Display listing on screen (through Logical Output Ø).

Follow LIST/NOLST commands in source file. The listing is on until a NOLST is encountered.

+L Force listing ON regardless of source file commands.

-L Force listing OFF regardless of source file commands.

+S List symbol table.

-S Do not list symbol table.

The default conditions for options are C and L. If no options are specified, the output file will be closed, the listing will be sent to the 7900 screen, and the listing will be controlled by LIST and NOLST commands in the program source file.

If you do not specify any options, you must not enter the carat (^).

All options are valid at the start of the command line, before the first file name <file1>. You may repeat any of the "L" options prior to other files, in order to control listing of the various files individually.

Examples:

ASMB TEST	Assemble the file TEST, close output file, listing on the screen. Output file is named TEST.SYS.
ASMB ^-C TEST	Assemble, list to screen, do not close output file.
ASMB ^-L TEST	Assemble and close, no listing.
ASMB ^T-C+L TEST	Assemble, list on printer, do not close output file, listing ON.
ASMB ^T-L TEST1 ^+L TEST2	

The last example assembles the program which is contained in both files, TEST1 and TEST2. The output file is closed, and is given the name TEST2.SYS. This file is created on the same drive which contained the file TEST2. Listing is suppressed for file TEST1 and is forced on for TEST2. (Options other than the "L" family would not be valid prior to TEST2.)

If a program is contained in more than one file, each file must have its own END statement.

5.2 Source File Format

The text editor is used to create program source files, which are processed by the assembler. Source files have a secondary name of .SRC, and are stored in ASCII text form.

The general form of a line in the source file is:

[<label>] <instr> [<operands>] [<comments>]

The four fields may be separated by spaces or tabs. The MODE character ($1) always begins a comment.

<label> is optional. If included, it must be alphanumeric, from one to twenty-three characters. The first character must be a letter. Other lines of code may refer to this line by referencing <label>.

<instr> is required. It must be a legal instruction mnemonic, as defined in the MC68000 instruction set; or it may be a pseudo-instruction recognized by the assembler. This manual includes descriptions of the pseudo-ops available. Consult Motorola literature for details on the MC68000 instruction set.

<operands> are the arguments to the instruction. Different instructions require different arguments.

<comments> may be included on any line, at the programmer's convenience. It may be useful to use a color-code at the beginning of a comment, to distinguish different sections of a program.

In addition, any line beginning with an asterisk (*) is ignored, and whole-line comments may be included in this way.

The first (or only) source file in a program will generally begin with an ORG statement, to initialize the Internal Program Counter (IPC). Each source file must end with an END statement.

5.3 Labels

Labels always begin in the first column (character position) of a line of code. If the first character in a line is a space or tab, the line does not contain a label.

A label may contain any upper or lower case letter, A-Z or a-z, or digits Ø-9. It may contain up to 23 characters, and all characters are significant. Upper and lower case characters are distinct; that is, the labels AB and Ab are considered different. A label must begin with a letter.

A label is assigned the value of the IPC at the instruction where the label occurs, unless the instruction is EQU or SET (see Pseudo-Instructions).

Certain reserved words have special meanings to the assembler, and may not be used as labels. They are:

DØ	D1	D2	D3	D4	D5	D6	D7
AØ	A1	A2	A3	A4	A5	A6	A7
SP	USP	CCR	SR	IPC			

It is possible, but not wise, to use an instruction mnemonic as a label.

5.4 Instructions

The instruction field is separated from the label by a space or a tab. If a line does not contain a label, the instruction must be preceded by a space or tab to separate it from the beginning of the line.

An instruction will either be a member of the MC68000 instruction set, or an assembler pseudo-instruction.

If an instruction is a legal MC68000 op code, it may have a data size associated with it. Certain MC68000 instructions can operate on different data sizes: Byte (8 bit), Word (16 bit), or Long (32 bit). For these instructions, the desired data size may be specified by appending the characters ".B", ".W" or ".L" to the op code. The default data size of Word (16 bit) is assumed if the data size code is omitted.

If an instruction does not have a variable data size associated with it, the characters B, W or L may NOT be appended.

Examples:

MOVE	D1,D2	Word size is assumed by default.
MOVE.B	D3,D4	Byte size is declared.
LEA	(A1),A2	Long word size is required for this instruction; a data size code would not be permitted here.

5.5 Operands

The operands, if any, follow the instruction. Operands are separated from the instruction by a space or tab. If more than one operand is present, they are separated by commas.

Most instructions have one or two operands. Instructions which use two operands consider the first to be a "source" and the second to be a "destination", as:

```
MOVE.W  D1,D5       Move 16-bit data from D1 to D5.

ANDI.L  #$7F,(A2)   Get 32-bit data from the address
                    pointed to by A2; AND it with
                    immediate data $7F (hex); then put
                    the result back where we got it.

SUB.W   DØ,(A3)+    Subtract DØ from the 16-bit word
                    pointed to by A3; put back the
                    result, then increment A3 by 2.
```

The same terminology of "source" and "destination" is applied to compare operations. Note that the "destination" is compared to the "source", not the other way around:

```
CMP.L   AØ,A1       Is A1 greater than AØ?
BHI     Somewhere   If YES, do the branch.
```

5.6 Comments

Any line may contain a comment field. The comment field is separated from the remainder of the line by a MODE character, which with a "C" and a color code will cause the comment to be displayed in a different color from the instructions. The color change is not necessary in most cases (except as mentioned in the note below), but it will improve the legibility of your programs. The printer driver strips the MODE codes before sending the comments to the printer.

To insert a color-coded comment into a line of program source using the 7900 editor, first separate it from the rest of the line by a tab (CTRL I) or spaces. Then press SET, followed by a color key. When displayed by the editor in response to LIST, the color will be executed as typed. When in MODIFY or INSERT mode, the line containing the cursor is always displayed in compressed form, using special symbols for control-characters. A typical statement might normally appear as:

```
LABEL     EQU     value     This is a comment
```

If a color code had been typed before "This", the comment field would appear in that color. In MODIFY mode, or when entering the line in INSERT mode, the same line would appear as:

```
LABEL→EQU→value→~C6,This is a comment
```

The tab character is abbreviated with a right-arrow symbol, and the Mode character is abbreviated with a double tilde. This example uses color number 6, or yellow, as the comment color. You may wish to define a Function Key to be the equivalent of a "Set Color" command.

NOTE:

Certain op-codes will accept an indefinite number of arguments (Example: Define Constant, DC). In these cases, the assembler will continue to parse arguments from the source line until it reaches a Mode character or a carriage return. If you include a comment in a source line of this type, you MUST delimit the comment with a Mode code, or the comment will be assembled! Note that the END pseudo-op also accepts a variable number of arguments (zero or one expressions). A comment on an END statement should be delimited with a color code.

5.7 Pseudo-Instructions

Pseudo-instructions, or pseudo-ops, are instructions to the assembler. They affect how the assembler generates object code, but do not, in general, generate code themselves. (The DC pseudo-op is an exception, and does generate code.)

5.7.1 ORG (Origin)

ORG is used to set the "origin" of the code generated by the assembler. ORG loads a value into the Internal Program Counter (IPC). When using the (default) ORG form, all absolute addresses are assembled in "absolute short" form, which confines them to values between $0000 and $7FFF, and between $FF8000 and $FFFFFF. This is because the 16-bit number is treated as a two's complement number and sign-extended through 32 bits.

Format:

```
ORG <expression>

ORG.L <expression>
```

In the CGC 7900, the "long" ORG.L is more commonly used. ORG.L forces all absolute addresses to long form, which allows access to the entire 7900 address space ($000000 to $FFFFFF).

(The exception to this rule occurs if a symbol name is suffixed with a ".W" or ".L" specifier. In this case, the specifier is used and the ORG type is overridden.)

Examples:

```
ORG.L PROGSTART

ORG.L $1C3C
```

DOS expects programs to run in the DOS Transient Program Area, which begins at $1C3C. Your programs should normally be ORG'ed at this address.

ORG may be used in several places during a program, if desired.

5.7.2 EQU (Equate)

EQU equates a label to a value. A label is required in this context, for the EQU statement is meaningless without a label. The value may be a constant or another label which has been previously defined in the program.

Format:

<label> EQU <expression>

Examples:

```
HexNum    EQU    $ØAØA

Gold      EQU    Silver+32

HERE      EQU    IPC
```

The last example equates the label "HERE" to the value of the assembler's Internal Program Counter. The IPC always has the value of the address for which code is currenty being generated. Note the equivalence of the following two pieces of code:

```
SUBRT     MOVE.L     D1,D3
```

and,

```
SUBRT     EQU        IPC
          MOVE.L     D1,D3
```

Either of these two sections would generate identical object code if used in the same place in a program.

5.7.3 SET

SET assigns the value of <expression> to <label>. The difference between SET and EQU is that a label defined by SET may be re-defined later in the program by another SET. A label defined by SET may not be defined by EQU, nor may it be used in the label field of a line of code.

Format:

<label> SET <expression>

The rules for <expression> are the same as for EQU.

5.7.4 DC (Define Constant)

The DC pseudo-ops generate bytes, words or long-words of code whose value is equal to <expression>. More than one constant may be defined by a single DC statement, by using a list of expressions.

Format:

```
DC.B <expression> [,<expression>...]

DC.W <expression> [,<expression>...]

DC.L <expression> [,<expression>...]
```

Examples:

```
DC.B 'hi'                          (defines 2 bytes)

DC.B Ø,Ø,1,-5,$A9,$FF              (defines 6 bytes)

DC.W $45Ø4,7ØØØ,-1,'WD'            (defines 4 words)

DC.L $18Ø1A4C9,'LONG'              (defines 2 long words)
```

NOTE:

The DC.B pseudo-op may cause the IPC to end up on an odd address after assembling an odd number of bytes. This will cause instructions following the DC.B to assemble on odd addresses, which is illegal. See DS.L below for a way around this problem.

If the expression does not evaluate to a number within the size range specified (8, 16 or 32 bits), an "S" error occurs.

When entering an ASCII string in a DC.W or DC.L statement, the string is packed into memory as one character per byte. If an odd number of bytes is entered, the last word (or long word) is zero-filled on the right, to the nearest word (or long word) boundary.

Examples:

DC.W 'A' would put 'A',Ø in memory.

DC.W 'ABC' would put 'A','B','C',Ø in memory.

DC.L 'A' would put 'A',Ø,Ø,Ø in memory.

DC.L 'AB' would put 'A','B',Ø,Ø in memory.

5.7.5 DS (Define Storage)

The DS pseudo-op reserves space by advancing the IPC past a number of bytes, words or long words. <expression> determines the number of bytes, words, or long words skipped.

Format:

DS.B <expression>

DS.W <expression>

DS.L <expression>

NOTE:

Storage allocated by the DS pseudo-op is always initially undefined.

Examples:

```
DS.B 14

DS.L 1
```

NOTE:

The DS.B and DC.B pseudo-ops may cause an odd number of bytes to be assembled. This causes the IPC to end up on an odd address, and subsequent instructions will be assembled on odd addresses, which is illegal. To avoid this problem, always follow DC.B and DS.B pseudo-ops with a "DS.L Ø" line. This insures that no machine instructions will begin on odd addresses. DS.L used with an argument of zero bumps the IPC to the nearest even boundary.

Example:

```
DS.B    9       Reserve some space, then

DS.L    Ø       align IPC to a word boundary.
```

5.7.6 END

The END statement tells the assembler that no more lines of source code exist in the file. Each file must end with an END, or the assembler will attempt to read past the end of the file and an error will occur.

Format:

```
END [<addr>]
```

The last (or only) source file in a program may have an address, <addr>, in the argument field of its END statement. <addr> tells DOS where to begin execution of the program, if and when the program is executed as a .SYS file. This is known as the "run address." If <addr> is omitted, the file is NOT executable. Attempting to execute it will cause DOS to print a "No Run Address" error message.

5.7.7 PAGE

The PAGE pseudo-op tells the assembler to output a form-feed during the assembly listing. It may be used to break up a listing into convenient pieces. PAGE has no effect on the object code.

Format:

```
PAGE
```

5.7.8 LLEN

LLEN instructs the assembler that it may print lines containing up to <length> characters. The default value for <length> is 85, corresponding to the width of the CGC Overlay screen. <length> may be set to suit the width of your printer, and must be a number between Ø and 255.

Format:

LLEN <length>

Example:

LLEN 132

5.7.9 NOLST

NOLST turns off the assembly listing. It is typically used in conjunction with LIST, to cause only selected parts of the program to be listed during assembly.

Format:

NOLST

5.7.10 LIST

LIST resumes the assembly listing, following a NOLST. LIST is assumed, unless a NOLST has been encountered.

Format:

LIST

5.8 Addressing Modes

The MC68ØØØ provides a large number of addressing modes, which define the source and/or destination operands in an instruction. This section discusses and provides examples of each of the addressing modes supported by the MC68ØØØ.

5.8.1 Register Direct Mode

This mode operates directly on the contents of a register, DØ through D7 or AØ through A7.

Format:

An or Dn

Where:

n is a number, Ø through 7.

Examples:

MOVE.L	A1,A4	Move the contents of register A1 into register A4 (32 bits).
ADD.W	DØ,D3	Add the lower 16 bits of the contents of DØ to the lower 16 bits of the contents of D3. Put the result into the lower 16 bits of D3.

5.8.2 Address Register Indirect

This mode operates on the memory location whose address is in the specified address register, An.

Format:

(An)

Where:

n is a number, Ø through 7.

Examples:

MOVE.B	(AØ),D1	Move the byte whose address is in AØ, into register D1.
ADD.L	D3,(A5)	Add the contents of register D3 (32 bits) to the long word whose address is in A5.

5.8.3 Address Register Indirect with Postincrement

The operand is pointed to by the specified address register, as it was in Address Register Indirect. After the address is used, the register An is incremented by 1, 2, or 4, depending on whether the operation specifies byte, word, or long word.

Format:

(An)+

Where:

n is a number, Ø through 7.

Examples:

MOVE.B	D4,(A2)+	Move the low byte of D4 to the address in A2, then add 1 to A2.
ADD.L	(A3)+,DØ	Add the long word whose address is in A3, to DØ; then add 4 to A3.

5.8.4 Address Register Indirect with Predecrement

The operand is pointed to by the specified address register, An. Before the address is used, it is decremented by 1, 2, or 4, depending on whether the operation specifies byte, word, or long word.

Format:

-(An)

Where:

n is a number, Ø through 7.

Examples:

MOVE.L	D2,-(A1)	Decrement A1 by 4; then move 32-bit data from D2 to the location whose address is in A1.
CLR.B	-(A5)	Decrement A5 by 1, then clear the byte at that address (set it to zero).

5.8.5 Address Register Indirect with Displacement

The displacement d is added to the contents of register An. This sum provides the address of the operand. d is a used as a sign-extended 16-bit number.

Format:

d(An)

Where:

n is a number, Ø through 7;
d is a 16-bit displacement.

Examples:

MOVE.B D3,TABLE(A3)	Move the low byte of D3 to the address pointed to by the sum of TABLE plus the contents of A3.
CMP.W 2(AØ),D7	Compare the lower word (16 bits) of D7, to the word whose address is two plus the contents of AØ.

5.8.6 Address Register Indirect with Index

The index register (Rn) may be any address or data register. The low word or the entire register may be used as index, depending on whether the suffix ".W" or ".L" is appended to the index register name.

Format:

```
d(An,Rn.W)
d(An,Rn.L)
```

Where:

n is a number, Ø through 7.

d is an 8-bit displacement (range -128 to +127).

The displacement d is used as an 8-bit sign-extended number. If the low word of Rn is specified, its value is also sign-extended.

Examples:

MOVE.L Name(A1,D4.W),D5	Move 32-bit data from the address given by: the contents of A1, plus the 16-bit contents of D4, plus the 8-bit value of Name. Data moves into D5.
AND.B DØ,1(AØ,D7.L)	Logical AND the low byte of DØ, with the byte whose address is given by: AØ plus D7 (32 bits) plus 1. The result is placed in this same memory address. If the displacement is zero, you should specify it.

5.8.7 Absolute Short

The absolute address of the operand is specified. It is used as a sign-extended 16-bit number, which limits this mode to addressing memory between $0000 and $7FFF, and between $FF8000 and $FFFFFF (see section 5.8.1).

NOTE:

If the statement ORG.L is included in the program, this addressing mode will not be used by the assembler. Absolute Long will be substituted (see below).

Example:

```
        JMP       $400C        Jump to address 400C (hex).

MEM     EQU       $120
        MOVE.L    A1,MEM       Move the 32-bit contents of A1
                               to the word called MEM (120 hex).
```

5.8.8 Absolute Long

The absolute address of the operand is specified, and is used as a 32-bit number.

Example:

```
                ADD.W   $1A2BC,D3   Add the 16-bit data from address
                                    1A2BC to register D3, leave the
                                    result in D3.

CHAROUT         EQU     $800008
                JMP     CHAROUT     Jump to CHAROUT (800008 hex).
```

5.8.9 PC with Displacement

The address of the operand is given by adding the sign-extended displacement d to the current value of the program counter.

Format:

```
*+d

*-d
```

Where:

d is a 16-bit expression (-32768 to 32767).

The expression "*" has the value of the EXTENSION word of the code which is generated for this instruction. Therefore, if the instruction has a label NAME, the value of "*" is NAME+2, or NAME+4, depending on the number of words occupied by the instruction.

Examples:

```
BRA       *+$18                    Branch to the address 2Ø hex bytes
                                   (16 words) past this instruction.

LEA       *+LABEL-(IPC+2),AØ

MOVEM.L   *+(expr-(IPC+4)),D4-D5
```

The second example above would be used to generate position-independent code for loading the address of LABEL into AØ. It would be operationally similar to the statement

```
MOVEA.L #LABEL,AØ
```

which would also load AØ with the address of LABEL. However, the LEA statement above takes fewer bytes, and is preferred if LABEL is within the 16-bit displacement range required by this addressing mode.

Note the use of the expressions (IPC+2) and (IPC+4) in examples two and three above. The LEA statement has a length of one word (plus the extension word), so (IPC+2) is equal to "*" for this instruction. Subtracting (IPC+2) from "*" leaves a result of zero, so the value of the arithmetic expression is simply the value of LABEL, the desired result. Similarly, the MOVEM instruction has a length of two words plus extension, so (IPC+4) equals "*" for this instruction.

5.8.10 PC with Index

The address of the operand is given by adding the sign-extended displacement to the 16 or 32-bit contents of register Rn, and to the current value of the program counter.

Format:

*+d(Rn.W) *-d(Rn.L)

Where:

d is an 8-bit expression (range -128 to +127).

Rn is an address or data register.

Examples:

JMP *+OFFSET(D3.L) Jump to the address given by OFFSET plus the 32-bit contents of D3, plus the current Program Counter.

MOVE.W *+(DATA-(IPC+2))(AØ.W),D4

Move a word into D4 from the address which is beyond label DATA by an amount contained in AØ.W (the low 16 bits of AØ).

5.8.11 Immediate

Immediate data is always preceded by the pound sign (#). It is used to specify an absolute number other than absolute addresses.

Format:

#<expression>

The # character tells the assembler to use immediate data, rather than an address. Consider the distinction between these two statements:

```
MOVE.L $400,D0  Move a long word from address $400
                into D0 (getting data from memory
                at address 400 hex).

MOVE.L #$400,D0 Move the hex number $400 into D0.
```

Certain instructions require immediate data; for example, Move Quick:

```
MOVEQ.L #10,D1 Put decimal 10 into D1.
```

5.9 Assembler Errors

The assembler indicates errors as a one-character abbreviation, to the left of the source line listing. Errors are always printed regardless of the NOLST pseudo-opcode or the -L (suppress listing) option.

Error Code	Description
M	Mode error (wrong operand type).
Z	Size error (wrong size operand).
C	Code error (unrecognized opcode).
Ø	Division by zero.
D	Doubly defined label.
U	Undefined label.
A	Argument error in operand.
(	Unbalanced parentheses.
L	Label too long.
E	Expression error.
#	Error in number.
O	Overflow (number out of range).

The following are non-fatal errors:

~	Phasing error (label does not agree with IPC).
S	Storage Error (overflow from a DC instruction).

Phasing errors are the result of other errors earlier in the program, in which a statement did not assemble properly. It is a good practice to fix other errors first, and phasing errors will usually disappear as a result.

Appendix A — Programming Techniques

This section deals with programming techniques applicable to the Chromatics CGC 7900. Two important concepts are discussed, which greatly simplify the process of adding custom features to the CGC 7900: writing modules, and writing transients.

Modules are sub-programs which are loaded into memory (RAM or EPROM). When the system is booted, all modules are "linked" together in a fashion which allows any of them to be executed by ASCII code sequences. All of the features implemented in the 7900 are written as modules: this includes I/O drivers, Plot submodes, Mode, Escape and User codes. Using the information in this section, the user can write modules which perform custom functions, and link them into the CGC 7900 system.

A.1 Modules

A module is a sub-program, written according to a list of guidelines so that it may be linked into the CGC 7900 software. There are seven types of modules:

B: Boot only. This module contains code which is executed at boot time, but not otherwise used by the system.

I: Input device. This is a driver which interfaces a physical input device to the system. Currently defined "I" modules drive the keyboard and serial port.

O: Output device. This is a driver which interfaces a physical output device to the system. Currently defined "O" modules drive the serial ports, windows, and keyboard lights.

Mode: Mode code. This module performs functions which modify the attributes of a window. The window software calls Mode modules when it receives a Mode code sequence.

Plot: Plot submode. This module describes a Plot submode, and is called when a window receives a Plot code sequence.

Escape: Escape code. This module is called by the Escape code processor when an Escape code sequence is received. Escape codes generally alter the status of the entire system.

User: User code. This module is called by the Escape code processor when a User code sequence is received. User codes generally alter the status of the entire system, or cause execution of a controlling program (such as DOS).

Modules may exist in EPROM or in RAM. Most of the EPROM firmware in the 7900 consists of modules. For each Mode, Plot, Escape and User code sequence recognized by the 7900, there is a module in firmware which defines the actions taken by that code sequence. All modules in the system are "linked" whenever: the system is powered-up; CTRL SHIFT RESET is pressed; or when CTRL BOOT is pressed.

The process of "linking" means that the system is scanned for modules, the addresses of all modules are loaded into dispatch tables, and any necessary initialization is performed. Note that this "linking" is done sequentially, through EPROM, then through any RAM modules which may have been loaded by the user. This means that two or more modules may define the same code sequence, and the LAST one linked will be the one in the dispatch table after linking is complete. This makes it easy for a user module to re-define a system function, with the module replacing the firmware module which has the same identifying code at its beginning.

Mode, Plot, Escape and User modules may accept arguments. The required arguments are defined by the module, and the system automatically parses arguments before passing control to the module. This relieves the user from writing argument parsing routines, and insures that all arguments are parsed in a consistent manner.

A module must save any registers it modifies, and restore the registers before exiting. As decribed below, several registers are pre-loaded before the module is executed and provide the module with system status information.

A.2 The Linking Process

The system scans two areas for modules when linking is performed: first, each EPROM pair on the 7900 Raster Processor Board is checked. If a ROM Expander card is installed and its address is consecutive with the Raster Processor, firmware in the ROM Expander will also be checked. If an EPROM pair is installed, and if a valid module is found at the start of the EPROM, linking proceeds through the EPROM. Linking terminates when an invalid length descriptor or an invalid module type code (one not in the set B, I, 0, etc.) is found. Linking then proceeds to the start of the next EPROM pair.

After all EPROM modules have been linked, the system checks for RAM modules. RAM modules, if they exist, must be loaded into system RAM at the address pointed to by RAMMDLE. (RAMMDLE is a pointer in CMOS memory, and its contents may be altered with the "Thaw" command. See the 7900 User's Manual for details.) The default address for RAM modules is $1FØØØ; this allows 4K of space for modules, when a single Buffer Memory card is installed.

If RAM modules exist, they must follow all the rules described in this section, with an additional provision: to indicate the presence of RAM modules, the bytes 'MDLE' must be loaded into RAM at the start of the first RAM module:

```
ORG.L    $1FØØØ        Org where Thaw wants us to be
DC.L     'MDLE'        Indicate RAM modules here
etc.
```

The bytes 'MDLE' must NOT be included if a module is being put into EPROM.

Modules are expected to be "back to back", existing in consecutive words of code through memory. Thus, any tables or other data used by a module must be WITHIN the module, not after it.

The last module should end with the following statement:

```
DC.L -1,-1
```

This indicates to the linker that no more modules follow.

A.3 Module Construction

Each module begins with a length descriptor. The length is used to determine where one module ends, and where the next one begins. The address of each module is determined at boot time during the linking process, and loaded into a dispatch table for future reference.

Next, a module contains one of the characters B, I, O, Mode (Control-A), Plot (Control-B), Escape (Control-[), or User (Control-U), to define the type of module. This is immediately followed by a character which uniquely identifies that module.

The remainder of the module is variable, depending on the type of module you are writing. All of the seven types of modules are discussed in this section, and examples are provided.

A.3.1 Boot Modules

A Boot module is executed upon power-up, when the system RESET key is pressed, or when the system is booted (by pressing CTRL BOOT). A Boot module might be written to initialize a piece of hardware, or to pre-load the Case Table for interfacing to a certain host computer.

The Boot module contains a length descriptor (word), the character 'B' followed by a dummy character, and the code to be executed. It ends with a RTS instruction.

```
            ORG.L  $1FØØØ     Org where Thaw says to Org
            DC.L   'MDLE'     Required for RAM modules

            DC.W   MdleEnd-IPC  This is our length
            DC.B   'B',Ø        Identify a Boot module

*
*   Boot code begins here...
*     .
*     .
*   and ends here.
*

            RTS

MdleEnd     EQU    IPC
            DC.L   -1,-1      Make sure linking ends here
            END
```

A.3.2 Input/Output Modules

I/O modules define the interface between a physical device, such as a printer, and the logical device assignment structure in the 7900. The I or O module must be responsible for handling all transfers to or from the device, checking the status of the device (if applicable), and booting the device (if necessary). Note that the Boot section of an I or O module performs the function of a B module.

The I or O module begins with a length descriptor (word). This is followed by the character 'I' or 'O', defining an input or output module, and a character between A and Z to identify this particular I/O module. This character (A-Z) is used in the "Assign" command to identify the phyical device which is being assigned.

Two words of code must follow the identifying character. These must be either SHORT branches to Boot and Status sections of the module, or RTS instructions. The Status section is used in an 'I' module to see whether a character is ready to be read. The Status code should return the Z flag SET if no character is available, or clear it if a character is available. If the Status code returns Z set, the system will not execute the main code.

In an input module (type I), if input is being buffered, the Status code may return a "snapshot" of the oldest character in the buffer in DØ.B. This feature is used by the STATIN routine in TERMEM, and is called by DOS to check for X-ON and X-OFF commands (to suspend output). Note that the character snapshot must not remove the character from the input buffer; the character should remain in the buffer until read by the main code of the I module.

The Status section is not used in an 'O' module. An 'O' module must not return until it has completed processing a character.

The main body of the module follows, terminated by a RTS. The Boot and Status portions of the module must also terminate with a RTS. The system passes a character to an Output module in register DØ, and expects an Input module to return a character in DØ. The low 8 bits of the register are used.

Note that a single device capable of both input and output requires two modules, one I and one O. (Our device 'Q' below may have an I module and an O module associated with it.)

```
*
*  Sample Input module (type 'I') for a device named Q.
*
         ORG.L     $1FØØØ          Org where Thaw says to Org
         DC.L      'MDLE'          Required for RAM modules

         DC.W      MdleEnd-IPC     Our length
         DC.B      'I','Q'         Input module for device 'Q'

         BRA.S     Qboot
         BRA.S     Qstat

*
*  Main code for inputting a character from device Q.
*

         MOVE.B    Qbuffer,DØ      Get input data
         BSR       Stompbuf        Remove this data from buffer
         RTS


*
*  Code for booting device Q. (Executed at Boot time.)
*

Qboot    MOVE.B    #Ø,QCtrlPort    Initialize device Q.
         MOVE.B    #$FF,QCtrlPort
         MOVE.L    #QISR,Qvector   Load interrupt vector
         RTS

*
*  Code for checking status of Q.
*

Qstat    TST.W     Qbufstat        Check buffer status
         MOVE.B    Qbuffer,DØ      Snapshot oldest character
         RTS

MdleEnd  EQU       IPC
         DC.L      -1,-1           No more modules here
         END
```

A.4 Argument Parsing

The module types discussed below may have arguments associated with them. An argument is a set of characters or numbers which is passed to the module. Mode, Plot, Escape and User modules may accept arguments. The arguments required by a module are defined by that module, and are parsed by the system before the module is called. The module then simply picks up its arguments and processes them.

The system will parse ten types of arguments:

Arg type	Description
ø	No argument, just a placeholder.
1	A single character.
2	A string of characters, delimited by a space, comma, or semicolon.
3	A string of characters, delimited by a semicolon ONLY.
4	A signed 16-bit decimal number (or a number in Binary Coordinate form, if the system is in Binary Mode).
5	A 16-bit hexadecimal number.
6	A decimal number, or the X component of a coordinate defined by the cursor.
7	A decimal number, or the Y component of a coordinate defined by the cursor.
8	An X-Y coordinate pair (combination of 6 and 7; will accept a period for cursor position).
9	Any number of coordinate pairs, delimited by a semicolon.
A	A decimal number, scaled but without translation.

Argument types 6, 7, 8 and 9 are designed to parse coordinate data. Each of these will scale and translate arguments according to the scale factors in use in the window which executed the module.

In defining arguments, the system looks for two words immediately following the module's name. Up to eight argument types may be placed in these words. If no arguments are to be processed, fill both words with zero.

Peculiarities of each type of module are discussed below.

A.5 Mode Modules

A Mode module is executed when a window receives the Mode code sequence identifying that module. Mode modules are expected to affect only the window which called them, although nothing in the system will prevent a Mode module from affecting other windows or other aspects of the system.

A Mode module consists of a length descriptor (word), followed by the Mode character (control-A, decimal 1), and a character which uniquely identifies the module. This character may be any ASCII character above 'Ø' (hex $3Ø).

The next long word in the Mode module defines a list of arguments, to be parsed and passed to the module. Each nybble (4 bits) of the long word specifies one of the ten argument types listed in section A.4.

The argument list in this long word is right-justified, and the least-significant nybble defines the FIRST argument to be parsed. The long word must be left-filled with zeros to indicate the end of the argument list. Up to 8 arguments may be defined in this long word.

Example:

```
DC.W  MdleEnd-IPC    Length Descriptor
DC.B  Mode,'L'       Name of Mode module
DC.L  $ØØØØØ144      Argument list
```

This list would specify that the module requires two decimal numbers, followed by a single character.

Arguments to a Mode module are put onto the "A1 stack." That is, the Mode module may assume that its arguments are waiting for it at the address pointed to by (A1), and successive bytes. The stack may contain up to 16 long words. MODE codes are processed when they reach the screen (or other physical device).

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A.5.1 Example Mode Module

```
*******************************************************
*                                                     *
* This sample Mode module does the same thing as      *
* the TERMEM Fill ON/OFF command (MODE f 1/Ø)         *
*                                                     *
*******************************************************

          ORG.L     $1FØØØ        Org where Thaw says to Org
          DC.L      'MDLE'        Required for RAM modules
          DC.W      FillEnd-IPC   Length descriptor
          DC.B      Mode,'f'      Name of module
Mode      EQU       1             (Mode is Control-A)
Fillon    EQU       8             Bit 8 in D7

          DC.W      $ØØØØ         Our arg list
          DC.W      $ØØØ1         (just one character)

*
*  Code for module "Mode f" begins here.
*
*  The user would type Mode f <n>
*
*  where <n> is either 0 or 1.
*
*

          CMP.B     #'Ø',(A1)     Get the flag

          BEQ.S     FillOff       If it equals zero, kill Fill
          BSET      #Fillon,D7    Else turn it on
          RTS                     Then quit

FillOff   BCLR      #Fillon,D7    Turn off Fill mode
          RTS

FillEnd   EQU       IPC
          DC.L      -1,-1         Only if no more modules
          END
```

Type sequence To change color

A.6 Plot Modules

A Plot module performs a graphics function. All of the plotting features in the 7900 firmware are written as Plot modules. Plot modules generally accept coordinate data as arguments, and perform some plotting function based on this data. The "linking" procedure used for all modules means that you can write your own Plot modules, link them in to add new features to the 7900 firmware, or replace any existing features. PLOT codes, like MODE codes, are processed when they reach the current output device.

Plot modules begin with a length descriptor (word). This is followed by the Plot character (control-B, decimal 2) and a character which identifies the module. The identifier may be any character above ASCII "@" (hex $40).

The next two words specify arguments to be passed to the Plot module. The FIRST time a Plot module is entered, it may need to execute a special sequence of instructions to initialize itself. A status bit tells the module whether it is being entered for the first time, or on subsequent calls.

The second word of the argument list is used to select arguments for the first call. The first word selects arguments for subsequent calls.

Once a Plot code sequence has been entered, execution of the Plot module begins. The module can then be repeatedly called; it will be executed automatically when it has enough arguments.

Example:

```
        DC.W    ModEnd-IPC
        DC.B    Plot, 'Z'

        DC.W    $0011       Two chars for repeated calls
        DC.W    $0008       Coord arg for first call
```

In this example, the Plot module requires a coordinate argument when it is first executed. After the coordinates have been entered, the system will accept two single characters before entering the module (this is the argument scheme used by Incremental Vector).

This process continues until another Plot submode is entered or until the user turns Plot mode off.

On entry to the Plot module (and other modules), certain registers are set up for convenience. One of these is D7, which contains the window status. The "Submode" bit of D7 (bit 17) is set when a Plot module is first entered, to indicate that "this Plot Submode was just entered." If a Plot module cares about whether the submode has just been entered, it must check this bit and perform any necessary initialization if the bit is set. Then, it must clear the "Submode" bit.

If the Plot module does not do anything special when it is first entered, duplicate the argument list in the first and second word:

```
DC.W    ModEnd-IPC
DC.B    Plot,'Z'

DC.W    $0008       A coord for repeated calls
DC.W    $0008       and also for the first call.
```

Note that Plot modules may only parse FOUR arguments before execution begins; Mode modules could have up to eight.

To prevent conflicts between Plot code and Mode code arguments, Plot arguments are stacked on the "A3 Stack" and may be picked up from the addresses pointed to by A3. The module must not alter A3 or any other registers. Up to 32 long words are allocated for Plot module arguments.

Remember that more than one window at a time may be in the same Plot Submode. A Plot module should not store any local data which could interfere with another window calling the Plot module. Local data should be stored in the window table, or otherwise be localized to the window.

A.6.1 Example PLOT Module

```
*
*    An example of how a Plot module should be set up.
*
        ORG.L   $1FØØØ
        DC.L    'MDLE'

        DC.W    ModEnd-IPC
        DC.B    Plot,'Z'
Plot    EQU     2               (Plot is Control-B)

        DC.W    $ØØØ8           One coordinate pair normally,
        DC.W    $ØØ88           Two pairs the first time through.

Submode EQU     17
        BTST    #Submode,D7     Did we just enter the submode?
        BEQ.S   Norm            No, it's a normal entry
*
*    Submode was just entered.  We can set up
*    in this block of code if necessary.
*
        BCLR    #Submode,D7     Prepare for next entry
        RTS

*
*
*    Come here if submode was NOT just entered.
*
*
Norm    MOVEM.L DØ-D2/A3,-(SP)  Save registers
        MOVE.W  (A3)+,DØ        Get X argument into DØ
        MOVE.W  (A3),D1         Get Y argument into D1

*
*    Now, do something with the arguments here....
*    Maybe plot a vector or something.
*
        MOVEM.L (SP)+,DØ-D2/A3  Restore registers
        RTS
```

A.7 Escape and User Modules

Escape and User modules are identical to each other, and are similar to the Mode modules discussed earlier. An Escape or User module begins with a length descriptor (word), followed by the Esc ($1B hex) or User ($15 hex) character, and a single ASCII character which identifies the module. The identifier may be any character above ASCII '@' ($40 hex).

The next two words define an argument list, exactly like a Mode module. All arguments (up to eight) are parsed by the Escape Code Processor and are passed to the Escape or User module. Arguments are found on the A1 stack (pointed to by A1). This does not conflict with the stack of Mode arguments because Escape and User codes are processed by a different routine than Mode codes.

Remember that Escape and User codes have identical priority in the 7900 code processing scheme. Escape and User modules are not specific to a window, so they should be used to implement functions affecting the entire machine. Escape and User codes are trapped and processed by the Escape Code Processor.

A.7.1 Example ESCAPE code Module

```
*
*    A sample Escape code module to play with the
*    lights on the keyboard.  This could also have
*    been written as a User module.
*
         ORG.L   $1FØØØ
         DC.L    'MDLE'          Identify a module is here

         DC.W    MdleEnd-IPC     Length descriptor
         DC.B    Esc,'X'         Escape X is our sequence
Esc      EQU     $1B

         DC.W    $ØØØØ
         DC.W    $ØØØ4           We want one decimal #

         MOVE.W  (A1),Keybrd     Send it to the keyboard
Keybrd   EQU     $FF8Ø8Ø         (Keyboard address)

         RTS

MdleEnd  EQU     IPC
         DC.L    -1,-1

         END
```

A.8 Register Setup for Modules

When a module is executed, several registers are pre-loaded for convenience. The following table defines what each register is used for, when each type of module is entered.

Module	Register Usage
B (boot)	No registers pre-loaded.
I (input)	No registers pre-loaded.
O (output)	No registers pre-loaded.
Mode, Plot	A0: Points to base of Window Table for the window which called the module (see Window Table description). A1: Points to Mode arguments (parsed before module execution begins). A3: Points to Plot arguments (parsed before module execution begins). D7: Contains window status for the window which called the module (see Window Table description).
Escape, User	A0: Points to base of the Window Table for window A (the Master Window). A1: Points to arguments (parsed before module execution begins). D7: Contains window status for window A and Escape code status.

A.9 Window Tables

512 bytes of data are allocated as a Window Table for each active window. These bytes hold the current status of the window, including such items as color, blink, scale, window limits, and most other window attributes. Window attributes are usually set by Mode code sequences, and Mode modules will often want to alter items in a Window Table.

The following chart lists the location of each item in the window table, by giving an offset into the table where each item may be found. An item can be altered by a module by using the listed offset as a displacement from (AØ), since AØ is pre-loaded with the base of the Window Table.

Example:

```
FrgCol  EQU      $8E              Offset in table
                                  for Foreground color

        MOVE.W   FrgCol(AØ),DØ    Get color into DØ
```

In this table, entries are marked with ".B", ".W", or ".L", to indicate the appropriate data size (where possible).

```
$ØØ .L    TVALUE:   Temporary storage area (reserved)
$Ø4 .L    Arglst:   Mode argument list
$Ø8 .L    Parglst:  Plot argument list
$ØC .L    STATUS:   copy of D7 status long word
$1Ø .L    ^Argstk:  pointer to Mode argument stack
$14 .L    Argdsp:   Mode dispatch address
$18 .L    ^Prgstk:  pointer to Plot argument stack
$1C .L    Prgdsp:   Plot dispatch address (submode)

        Window variables are stored beginning here
              and occupy one word each.

$2Ø .W    Window Variable A
$22 .W    Window Variable B
   .
   .
$5C .W    Window Variable _
$5E .W    Window Variable `
```

The following items are also Window Variables but are used for system data as well.

$60	.W	AcursX:	Overlay cursor X position
$62	.W	AcursY:	Overlay cursor Y position
$64	.W	CursX:	Bitmap cursor X position
$66	.W	CursY:	Bitmap cursor Y position
$68	.W	AwindX0:	Overlay window upper left corner X
$6A	.W	AwindY0:	Overlay window upper left corner Y
$6C	.W	AwindX1:	Overlay window lower right corner X
$6E	.W	AwindY1:	Overlay window lower right corner Y
$70	.W	WindX0:	Bitmap window upper left corner X
$72	.W	WindY0:	Bitmap window upper left corner Y
$74	.W	WindX1:	Bitmap window lower right corner X
$76	.W	WindY1:	Bitmap window lower right corner Y
$78	.W	CharXZ:	Character X raster size
$7A	.W	CharYZ:	Character Y raster size
$7C	.W	CharDX:	Character delta X after write
$7E	.W	CharDY:	Character delta Y after write
$80	.W	CharXM:	Character X multiplier
$82	.W	CharYM:	Character Y multiplier
$84	.W	XVmin:	Virtual X minimum value
$86	.W	YVmin:	Virtual Y minimum value
$88	.W	Tabcol:	Tab stop spacing
$8A	.W	Vecwid:	Vector width
$8C	.W	BkgCol:	Background color
$8E	.W	FrgCol:	Foreground color
$90	.W	PlaneE:	Planes enabled
$92	.W	CursCol:	Cursor color (not used, reserved)
$94	.W	OldX:	Rubber band X position
$96	.W	OldY:	Rubber band Y position
$98	.W	XScl:	Virtual X Scale value
$9A	.W	YScl:	Virtual Y Scale value
$9C	.L	Charadr:	Character set base address
$A0	.L	Endbuf:	End of arguments for virtual coordinate
$A4	.L	Plotdot:	Dispatch address for dot plotting
$A8	.L	Plotvect:	Dispatch address for vectors

The following five items are used for raster processor operations in the window.

$AC	.W	WXsrc:	X source raster operating point
$AE	.W	WYsrc:	Y source raster operating point
$B0	.W	WDXsrc:	Delta X for source raster
$B2	.W	WDYsrc:	Delta Y for source raster
$B4	.W	Wctrl:	Control bytes for rasters

$B6-$F5	Curstg:	32 words for cursor pixel storage
$F6-$135	Argstk:	Argument stack for Mode args (32 words)
$136-$1B9	Pargstk:	Argument stack for Plot args (64 words)

The following four bytes contain the current Overlay color, blink and transparency attributes.

$1BA	AentSt:	Transparency
$1BB	AentBC:	Background color
$1BC	AentFC:	Foreground color
$1BD	AentCh:	ASCII character portion

$1BE-$1FF Reserved for future expansion

A.1Ø Window Status and ESCAPE Code Status

As shown before, register D7 is pre-loaded with status information when certain types of modules are executed. The bits in D7 are defined as follows:

Bit		Meaning
Ø	modeF:	Mode flag used by window processor
1	plotF:	Plot flag used by window processor
2	Moredat:	Control bit used by argument scanners
3	Negnum:	Control bit used by argument scanners
4	visctrl:	SET when visible ctrls are on
5	Pltmode:	SET when in a plot submode (not alpha)
6	Overlay:	SET when Overlay on (not Bitmap)
7	Curson:	SET when cursor is on
8	Fillon:	SET when fill is on
9	Blinkon:	SET when blink is on
1Ø	Rollon:	SET when roll is on
11	OvrStrk:	SET when overstrike is on
12	Binmode:	SET when binary mode is on
15	Rubron:	SET when rubber band is on
16	Patton:	SET when patterns are on
17	Submode:	SET when Plot submode just entered
18	Cursin:	SET when Bitmap cursor in screen RAM
19	BinTwo:	Flag for binary coordinate parser
2Ø	VScale:	SET when scaling is on
21	A7on:	SET when A7 character set active
23	Local:	SET in LOCAL mode
24	Full:	SET in FULL duplex
25	Escflg:	Escape code processor flag
26	Usrflg:	Escape code processor flag
27	Create:	SET if Create is on
28	LitPØ:	Escape code processor flag
29	LitP1:	Escape code processor flag
3Ø	Literal:	SET if Literal Create is on
31	Escdone:	Escape code processor flag

Bit Ø is the least significant bit.
Unused bits are reserved.

A.11 Writing Transients

This section describes the procedure for writing a transient program executable under DOS.

A transient must be located in an appropriate area of RAM, usually the DOS Transient Program Area. This begins at address $1C3C (hex). The length of this area is variable depending on your requirements, but will normally be at least 16K bytes.

Any RAM used by a transient should be in this same area of memory, or in the DOS Buffer which immediately follows it. RAM allocations are defined by pointers in system RAM and in CMOS, described earlier. Your transient should be careful not to exceed these allocations or the system may become confused.

When a transient is executed, DOS loads it at whatever address it was assembled (DOS does not check whether this is a legal address!). DOS then begins execution at the start address you defined in your END statement.

On entry to a transient, A1 points past the first character after the name of the transient. If your transient expects to pick up an argument from the command line, such as a file name, A1 will be pointing to that argument.

NOTE:

DOS will only advance A1 past the FIRST delimiter it finds. If the user typed two spaces, commas, etc., A1 will still be pointing to a delimiter.

Your transient now has control of the system. Using routines provided in the jump tables, your transient can pick up arguments from the command line, open and close files, and (See Appendix D in the 7900 User's Manual for information on Traps.)

If the last delimiter found by your program was a colon, assume that another command follows on the command line, and flag this before returning to DOS. This is done by setting D1.B non-zero, and pointing A1 to the first character of the command following the colon. Note that most DOS argument parsing routines automatically bump A1 to the next character after gathering arguments.

Before returning to DOS, your transient must set DØ.B zero if no errors occurred. If you want DOS to report an error, put the error number in DØ.B and DOS will display the error message for you. If an error is reported, DOS will not attempt to process any further commands which were entered on the same command line.

If no errors were reported, and you return to DOS with D1.B non-zero, DOS assumes another command is waiting on the input line to be processed. A1 should be pointing to the first character of the next command. Your transient will have to determine whether a colon existed on the command line by backing up A1 to look for it. (Some DOS routines, such as GETNAM, assist in this process by returning the delimiter character to you).

Here is a summary of registers used by DOS transients:

On entry to a transient:

A0.L points to the current User File Table.

A1.L points to the first unused character in the command line.

On exit from a transient:

D0.B	D1.B	A1	A0	Action
0	0	don't care	don't care	No errors, no further commands.
<>0	don't care	don't care	points to UFT of file	Error, D0 = DOS error number.
0	<>0	points to next cmd.	don't care	No errors, process next command.

```
*********************************************************************
*
*
*   Sample transient: READ
*   Command format:  READ <filename>
*
*
*   This transient demonstrates:
*
*       Parsing a file name as a command line argument
*       Opening a file
*       Reading data from the file
*       Exiting from a transient, returning properly to DOS
*
*
*
*********************************************************************
*
*
*   DOS Equates
*
GETNAM  EQU     $8ØC064         Get file name from input line
RWBYTE  EQU     $8ØC024         Read/Write bytes to disk
OPEN    EQU     $8ØC01Ø         Open existing disk file
PRTMSG  EQU     $8ØC084         Print ASCII string
*
*
*   DOS UFT Equates
*
TUFT1   EQU     $11E2           UFT #1 for transients
U       EQU     Ø               Base of UFT
SLOT    EQU     U               Logical file number
BUFFP   EQU     SLOT+2          Memory pointer for transfer
MBYTES  EQU     BUFFP+4         # of bytes to transfer
CONTRL  EQU     MBYTES+4        various flags
DRIVE   EQU     CONTRL+2        Drive # (LUN)
ERROR   EQU     DRIVE+1         Error # of last operation
BPNTR   EQU     ERROR+1         Current pointer to file on disk
BLNGTH  EQU     BPNTR+4         Current file length
PNAME   EQU     BLNGTH+4        Primary file name
SNAME   EQU     PNAME+8         Secondary file name
REV     EQU     SNAME+3         Revision level (not used)
PSWRD   EQU     REV+1           File password
START   EQU     PSWRD+2         Points to file start on disk
LENGTH  EQU     START+4         Length of file on disk
ORIGIN  EQU     LENGTH+4        Time/Date of file origin
ACCESS  EQU     ORIGIN+4        Time/Date of last access
STATUS  EQU     ACCESS+4        File status
*
```

```
*
*   TERMEM Equates
*
CHAROUT EQU     $800008         Character-out
CHARIN  EQU     $80000C         Character-in
CTRLIN  EQU     $800014         Character-in with Esc processing
CTRLOUT EQU     $800010         Character-out with Esc proc
DOSBUFP EQU     $C3C            Pointer to DOS buffer
DOSBUFZ EQU     $E40116         Size of DOS buffer
*
*
*   ASCII Equates
*
CR      EQU     13              Carriage return
LF      EQU     10              Line feed
DEL     EQU     $7F             Delete
XOFF    EQU     $13             X-off (Control-S)
*
*
*********************************************************************
*
*   The transient begins execution here.
*

        ORG.L   $1C3C           We run in DOS transient area
        LLEN    132             Printer is 132 columns wide

READ    EQU     IPC
        MOVE.L  #TUFT1,A0       Point to UFT to use
        MOVE.L  #DefName,A2     Point to default name: '*.SRC'
        JSR     GETNAM          Get file name into UFT.
        MOVE.L  A1,SaveA1       Save cmd line pointer for DOS
        TST.B   D0
        BNE     READerr         GETNAM found an error.

        CMPI.B  #':',D1         Was command delimiter a colon?
        SEQ     Another         If YES, another command follows.
*
*
*   The UFT now contains a filename, parsed by GETNAM.  (If
*   no filename was entered, the default filename remains
*   in the UFT, *.SRC)
*
*
        JSR     OPEN            Attempt to open the file.
        TST.B   D0
        BNE     READerr         OPEN found an error.
*
```

```
*
*   OPEN has now provided the UFT with details of the file
*   such as its length and disk location.
*
*
READ1   MOVE.L  BLNGTH-U(AØ),D4     D4.L = file length remaining
        BEQ.S   READex              If zero, file is empty now.

        MOVE.L  DOSBUFP,BUFFP-U(AØ)     Put data in DOS buffer
        CLR.L   D5
        MOVE.W  DOSBUFZ,D5              D5.L = size of DOS buffer
*
*   Check if bytes left in file will fit into DOS buffer.
*
        CMP.L   D4,D5           Will it all fit?
        BHI.S   READ2           Yes.
        MOVE.L  D5,D4           NO, so only read what WILL fit.

READ2   MOVE.L  D4,MBYTES-U(AØ) Read this many bytes
        BSET    #Ø,CONTRL-U(AØ) Say READ
        JSR     RWBYTE          Go and read bytes from disk.
        TST.B   DØ
        BNE     READerr         Error from RWBYTE.

*
*   We have read bytes into the DOS buffer.  D4 is the number
*   of bytes.
*
        MOVE.L  DOSBUFP,A2      Point to the data
        SUBQ.L  #1,D4           Decrement count for DBRA below
        CLR.W   D1              Specify Device Ø for CHAROUT
*
*   Display the bytes.
*
READ3   MOVE.B  (A2)+,DØ        Get a byte of data
        JSR     CHAROUT         Display it
        CMP.B   #CR,DØ          Was it a Carriage Return?
        BNE.S   READ4           No
        MOVEQ.L #LF,DØ
        JSR     CHAROUT         Follow Return with Line Feed.
*
*   After printing each character, check if we should pause.
*
READ4   JSR     CHARIN          Check the keyboard.
        BEQ.S   READ5           No key was hit.
        CMP.B   #DEL,DØ         Did he hit DELETE?
        BEQ     READex          Yes.... quit.
        CMP.B   #XOFF,DØ        Did he hit Ctrl-S?
        BNE.S   READ5           No, so ignore the key.
*
```

```
*
*   Control-S was hit, so pause.
*
READp   JSR     CHARIN          Wait for another key
        BEQ.S   READp
        CMP.B   #DEL,DØ         DELETE?
        BEQ     READex          Yes, so quit.
READ5   DBRA    D4,READ3        Go display more data.
        BRA     READ1           Go get more data from disk.

**********************************************************************
*
*   Come here for normal exit from the transient.
*
READex  CLR.B   DØ              Flag NO error and fall into exit.

*
*   Come here to go back to DOS with error message.
*   DØ.B holds the error code.
*   AØ.L points to UFT of offending file.
*
READerr CLR.W   D1              Logical Device Ø for CHAROUT
        MOVE.W  DØ,-(SP)        Save the error flag
        MOVE.B  #LF,DØ          Print a line feed
        JSR     CHAROUT         Or two...
        JSR     CHAROUT
        MOVE.B  Another,D1      Flag if another command existed
        MOVE.L  SaveA1,A1       Restore command line pointer
        MOVE.W  (SP)+,DØ        Restore the error flag
        RTS                     Back to you, DOS!


DefName DC.B    '*      SRC'    Default name for UFT (11 chars)
        DS.L    Ø               Align even addresses after DC.B

SaveA1  DC.L    0               Place to save A1
Another DS.B    1               Flag for colon on command line
        DS.L    Ø               Align even addresses after DS.B
*
*
*
*
        END     READ            Begin execution at label READ
*
*
*
```

Appendix B -- Jump Tables

B.1 TERMEM Jump Tables

This section describes the utilities available in CGC 7900 PROM firmware. Each of these routines may be accessed through a subroutine call (JSR) to the appropriate address. BSR will not work, because the jump tables will be located beyond a 16-bit displacement from your program.

Registers used in each routine are defined in this section. Unless noted, the routine only alters registers as necessary to return values to the caller. The notation "D1.W" means that the low word (16 bits) of D1 are used by the routine, DØ.B means the low byte of DØ, and so on.

Name: CHAROUT

Address: $8ØØØØ8

Entry: DØ.B = character to pass to logical device.
D1.W = logical device number (Ø to 4 are defined).

CHAROUT is the system character-out routine. It passes a character to a logical output device. The system's device assignment structure will then pass the character on to a physical device, if possible. Logical output device Ø is normally used to put characters on the screen, and device 1 is normally connected to the serial port. If the character is part of a Mode or Plot code sequence, it will be processed when it reaches a Window (physical device). Escape and User codes are NOT processed by CHAROUT, but are treated as normal characters. To process Escape and User codes, see CTRLOUT, CTRLIN and ESCPROC below.

Name: CHARIN

Address: $8ØØØØC

Entry: D1.W = logical device number to read from

Exit: Zero flag SET if no character was available. Zero flag CLEAR and character in DØ.B if available

CHARIN is the system character-in routine. It reads a character from a logical input device. Reading from device Ø will get a character from the keyboard (if available), device 1 will be the serial port.

To wait for a character from CHARIN, use a loop on the EQ condition:

```
Loop  JSR     CHARIN    Get a character, if any
      BEQ.S   Loop      No character yet
```

Escape and User codes are not processed by CHARIN, but are treated as normal characters. See CTRLOUT, CTRLIN and ESCPROC below.

Name: CTRLOUT

Address: $800010

Entry: D0.B = character to pass to logical device.
D1.W = logical device number.
Zero flag must NOT be set.

CTRLOUT is like CTRLIN, but processes Escape and User codes before passing the character on to the logical output device. It does this by calling ESCPROC (see below), then calling CHAROUT.

NOTE:

Do not call CTRLOUT if the zero flag is set -- your character will be ignored.

Name: CTRLIN

Address: $800014

Entry: D1.W = logical device number to read from.

Exit: Zero flag SET if no character was available. Zero flag CLEAR and character in D0.B if available.

CTRLIN is like CHARIN, but processes Escape and User codes before returning a character to you. It does this by calling CHARIN and then ESCPROC. If an Escape or User code was entered, it will be "eaten" by ESCPROC and the zero flag will be returned to you, indicating that no character was available.

Name: STATIN

Address: $8ØØØ8C

Entry: D1.W = logical device number to read from.

Exit: DØ.B = snapshot of oldest character (see below). Zero flag CLEAR if character available, SET if not.

STATIN is similar to CHARIN and CTRLIN, in that it returns the status of an input device reflected in the zero flag. STATIN will also return a snapshot of the oldest character in the input buffer (if possible; some devices are not buffered). STATIN does not actually remove a character from a buffer. A character returned by STATIN will be returned again by subsequent calls to STATIN, and will also be returned by a call to CHARIN. Only after CHARIN or CTRLIN have been called, is the character removed from the device's input buffer.

Name: ESCPROC

Address: $8ØØØ18

Entry: DØ.B = character to process. The zero flag must NOT be set.

Exit: Zero flag SET if character was "eaten" by ESCPROC. Zero flag CLEAR if character is still available.

ESCPROC handles Escape and User code processing. It is used by CTRLIN and CTRLOUT, and may also be called directly. ESCPROC detects Escape and User codes, and processes them by setting the zero flag to indicate that the character was processed (and thus should not be considered available). After the Escape or User code is detected, ESCPROC will process subsequent characters to satisfy the argument list of that particular Escape or User function, then execute the function. This will normally be transparent to the user.

Note that ESCPROC also processes the Create Buffer. Characters must flow through ESCPROC (or CTRLIN, or CTRLOUT), or they will not be put into the Create Buffer.

Name: BOOT

Address: $8ØØØ4C

BOOT boots the system. It does not return to the caller. One reason for calling BOOT would be to link in any RAM modules you have loaded into system memory.

Name: TERMEM

Address: $8ØØØ4Ø

TERMEM is the entry point for the Terminal Emulator, the main operating program in the CGC 7900. Programs can jump to this address to terminate execution without returning to DOS. TERMEM does not return to the caller. When entering TERMEM, it remains in the same status it was last in (half duplex, full duplex, or local).

Name: Keystuff

Address: $8ØØØ88

Entry: DØ.W = character to put into keyboard buffer

Keystuff puts 8-bit characters into the keyboard input buffer. These characters will be read from the buffer along with any characters which were actually typed. Keystuff also checks if the M1 and/or M2 keys are active (signified by bits 1Ø and 11 being set), and performs translations if so. To insert a normal 8-bit character into the keyboard buffer using Keystuff, mask off these bits:

```
AND.W   #$FF,DØ     Make 8-bit only
JSR     Keystuff    And put into buffer
```

If the keyboard buffer is full, the character is discarded.

Name: Scankey

Address: $800098

Entry: D0.W = character to be converted and buffered.

Scankey converts an 8-bit code (produced by the upper half of the keyboard) into a stream of 7-bit codes, then stuffs them into the keyboard input buffer. See Keystuff, described above.

Name: NOISE

Address: $800054

Entry: A0 points to tone descriptor block (14 bytes).

Exit: A0 is incremented past block.

NOISE feeds data to the sound generator. 14 bytes are loaded sequentially into the tone chip. These bytes go into registers 0 through 13 of the tone chip (a General Instruments AY-3-8910), and control the following attributes:

Register #	Purpose
0	Fine Tune A (8 bits)
1	Coarse Tune A (4 bits)
2	Fine Tune B (8 bits)
3	Coarse Tune B (4 bits)
4	Fine Tune C (8 bits)
5	Coarse Tune C (4 bits)
6	Noise Period (5 bits)
7	Output Enable
8	A Amplitude (5 bits)
9	B Amplitude (5 bits)
10	C Amplitude (5 bits)
11	Envelope Period Fine (8 bits)
12	Envelope Period Coarse (8 bits)
13	Envelope Shape/Cycle Control (4 bits)

The tone generator has three voices, A, B, and C, each of which can be programmed to produce tone or noise. If a given voice is programmed for both tone and noise, noise will usually dominate. Tone and/or noise are enabled by register 7:

7	6	5	4	3	2	1	Ø
X	X	An	Bn	Cn	At	Bt	Ct

A zero on any of the "n" bits enables noise from that channel, and a zero on any of the "t" bits enables tone from that channel. Unused channels are turned off by writing ones in the desired bits.

Registers 8, 9 and 1Ø control the output amplitudes:

7	6	5	4	3 2 1 Ø
X	X	X	A	manual level ctrl

A one in bit 4 specifies the channel's amplitude to be controlled by the envelope generator (Auto mode). If bit 4 is a zero, the amplitude is fixed by the value in bits Ø-3.

The envelope generator is controlled by register 13:

7	6	5	4	3	2	1	Ø
X	X	X	X	cont	attk	alt	hold

Bits Ø-3 describe the envelope with "continue," "attack," "alternate," and "hold." See General Instruments literature for the envelope waveforms. The 7900 Hardware Reference Manual also has more information on the sound generator.

Name: PRTDEC

Address: $800058

Entry: DØ.W = decimal number to convert to ASCII.
A1.L = pointer to buffer where ASCII goes.

Exit: A1 is incremented past the string.

PRTDEC prints a decimal number as an ASCII string. The string is placed into memory at (A1)+.

Name: SINDØ

Address: $800064

Entry: DØ.W = angle in integer degrees.

Exit: DØ.W = sine of that angle.

SINDØ takes the sine of an angle and returns the value as a 14-bit fraction. The form of the fraction is:

```
-----------------------------------
| S M F F F F F F F F F F F F F F |
-----------------------------------
      ^
      Binary point
```

Where:

S is the sign of the value (1 is negative).

M is the mantissa (zero except if the value is one or negative).

F are the fractional bits.

The following example uses SINDØ to compute Y*SIN(Theta). DØ is the angle Theta, and Y is in the lower word of D1. The value is returned in D1.

```
JSR     SINDØ   Get sine of theta
MULS    DØ,D1   Y=Y*SIN(theta)
ASL.L   #2,D1   Adjust for 14-bit fraction
SWAP    D1
EXT.L   D1      Clear garbage from high word
```

Name: PLRRCT

Address: $800068

Entry: DØ.W = radius
D1.W = angle in integer degrees

Exit: DØ.W = X
D1.W = Y

PLRRCT performs polar to rectangular conversion, using SINDØ and a technique similar to the example above.

Name: READJOY

Address: $8ØØ7Ø

Entry: A1.L = pointer to joystick X, Y or Z axis.

Exit: DØ.W = value read from joystick.

READJOY returns the current value of a joystick axis as a 1Ø-bit number in the range Ø to 1Ø23. A1 must be set to the address of one of the joystick axes, as follows:

X	$FF8ØC6
Y	$FF8ØCA
Z	$FF8ØCC

B.2 Plotting Functions

Many of the plotting primitives in the 7900 may be accessed through jump tables. Plot functions are specific to a window, which means the system must know which window to use for executing the plot routine. Data from the Window Table determines such things as the color of the plotted figure, and whether or not the figure will be filled.

Before calling any of these plot routines, the data to be plotted must be scaled to screen coordinates, between Ø and 1Ø23. Data outside this range will be plotted unpredictably unless clipping is enabled. If clipping is enabled, out-of-range data will not be plotted.

All of the plot routines discussed below need register AØ to point to the base address of the current Window Table. This will be done automatically if your program is linked as a module, but if you are writing a transient, you must load AØ in your program. If plotting in window A is desired, you may set up AØ by this code:

```
BtmGWin  EQU     $C4Ø          Pointer to W table base
         MOVE.L  BtmGWin,AØ    Get pointer
```

Each Window Table occupies 512 bytes. If DØ.L contains the window number (Ø through 7, for windows named A through H), the following code would point AØ to the base of any Window Table:

```
MOVE.L  BtmGWin,AØ     Get pointer
ASL.L   #5,DØ
ASL.L   #4,DØ          DØ=512*DØ
ADD.L   DØ,AØ          Add to base
```

Some of the functions described below require an argument list, which is passed on the "A3 stack." The values passed to the routine are pointed to by (A3), and the words following (A3). An area of the Window Table called Pargstk (Plot Argument Stack) is normally used to pass arguments, or your program can use other RAM for this purpose. To load the Pargstk area with four values for a vector, the following code could be used:

```
Pargstk  EQU     $136                Offset in W table for plot args

         LEA     Pargstk(AØ),A3      Point to Pargstk
         MOVE.W  X1,(A3)
         MOVE.W  Y1,2(A3)            Load XY values on A3 stack
         MOVE.W  X2,4(A3)
         MOVE.W  Y2,6(A3)
         JSR     FVECT               Draw a vector
```

Before calling any of these plot routines, the data to be plotted must be scaled to screen coordinates, between Ø and 1Ø23. Data outside this range will be plotted unpredictably.

Name: PLOTXY

Address: $8ØØØ5C

Entry: DØ.W = X value
D1.W = Y value
AØ.L = pointer to Window Table

PLOTXY plots a single dot in the Overlay or Bitmap, at the XY coordinate specified by DØ and D1. PLOTXY vectors through the Window Table entry called Plotdot, which holds the address of a routine to plot a dot in the Overlay or Bitmap. Plotdot also hold the address of a routine which plots patterns in the Bitmap, if patterns have been enabled. The address in Plotdot is loaded by any of the "Mode O" or "Mode T" commands. The current foreground color of the window is used unless patterns are active.

Name: FVECT

Address: $8ØØØ6Ø

Entry: A3.L = pointer to X1, Y1, X2, Y2 (words)
AØ.L = pointer to Window Table

FVECT plots a vector in the Overlay or Bitmap, from (X1, Y1) to (X2, Y2). FVECT vectors through the Window Table entry called Plotvect, which holds the address of a routine to plot a vector in the Overlay or Bitmap (see the discussion of Plotdot above). The address in Plotvect is loaded by any of the "Mode O" or "Mode T" commands. The current foreground color of the window (stored in the window table) is used unless patterns are active, OR UNLESS THE VECTOR IS HORIZONTAL. If Y1=Y2, a special fast vector routine is used which writes part of the vector through proprietary Color Status hardware. The color produced by Color Status is determined by loading the Color Status Foreground latch, a word at address $E4ØØ16. To use FVECT properly, you must load the Window Table and the Color Status latch with your desired color.

NOTE:

Both FVECT and PLOTXY make use of the optional Hardware Vector Generator, if one is installed in your system.

Name: BVECT (Bold Vectors)

Address: $800074

Entry: A3.L = pointer to X1, Y1, X2, Y2 (words) and 4 scratch words
A0.L = pointer to Window Table
D7.L = Window Table status (see section A.10)

Name: CIRCLE

Address: $800078

Entry: A3.L = pointer to X, Y, radius (words)
A0.L = pointer to Window Table
D7.L = Window Table status

Name: ARC

Address: $80007C

Entry: A3.L = pointer to X, Y, radius, start, delta (words)
A0.L = pointer to Window Table
D7.L = Window Table status

Name: CURVE

Address: $800084

Entry: A3.L = pointer to X1, Y1, X2, Y2, X3, Y3, X4, Y4 (words)
A0.L = pointer to Window Table
D7.L = Window Table status

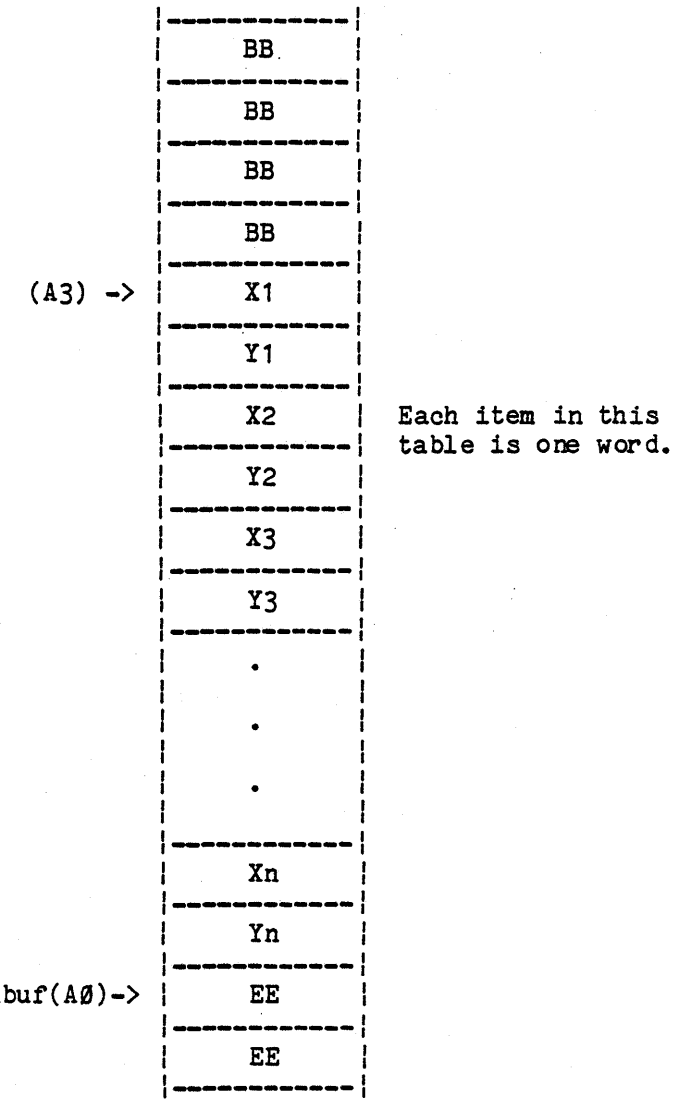
Each of these routines plots a figure according to the attributes of the Window Table pointed to by A0. Plotting will occur in the Overlay or Bitmap, with or without patterns, according to the current status of the window.

Name: POLYG

Address: $800080

Entry: A3.L = pointer to coordinate pairs (words)
A0.L = pointer to Window Table
D7.L = Window Table status

POLYG is similar to the other plot routines described above, except that it can accept a variable-length argument list. The beginning of the list is pointed to by A3.L, and the end of the list is pointed to by an entry in the Window Table named Endbuf. Endbuf is a long word, and it holds the address of the word PAST the last coordinate in the polygon argument list.



Pairs of words before and after the list (marked BB and EE above) are used as scratch areas by POLYG, and your program should allow room for them.

The following code might be used to call POLYG:

```
Pargstk   EQU     $136              Offsets in W table
Endbuf    EQU     $AØ

          LEA     Pargstk(AØ),A3    Point to arg stack
          MOVE.L  A3,-(SP)          Save pointer
          MOVE.W  X1,(A3)+
          MOVE.W  Y1,(A3)+          Load coordinates
          MOVE.W  X2,(A3)+           onto A3 stack
          MOVE.W  Y2,(A3)+
           .
           .
           .
          MOVE.W  Xn,(A3)+          Put last values
          MOVE.W  Yn,(A3)+
          MOVE.L  A3,Endbuf(AØ)     Set up end of list
          MOVE.L  (SP)+,A3          Retrieve pointer to
                                     start of list
          JSR     POLYG             Do polygon
```

B.3 DOS Jump Tables

Name: DOS

Address: $8ØCØØ8

This is the main entry point to DOS. It requests the user's password and begins accepting DOS commands.

Name: EXDOS

Address: $8ØCØØC

Entry: A1.L = pointer to command line.

Exit: A1.L = pointer to next (unprocessed) character in line.
DØ.B = error code (if any), or zero if no error.

EXDOS attempts to execute a transient. The name of the transient should be pointed to (on the command line) by A1. EXDOS calls GETNAM to parse the transient name, OPEN to locate the file on disk, and LOAD to load the file into memory. If successful, execution begins at the transient's start address. The TRANSIENT is responsible for returning A1 and DØ as required above.

Name: OPEN

Address: $8ØCØ1Ø

Entry: AØ.L = pointer to UFT in use. # Apnd C page C-5

Exit: DØ.B = error code (if any), or zero if no error.

OPEN looks up a file on a disk. Before calling OPEN, the UFT (User File Table) should contain the complete filename: primary, secondary, password, and drive. (The UFT is an area of RAM which defines the current status of a file, and includes all of the file's vital statistics. UFT's are discussed later.) See GETNAM for a way to parse the filename. If successful, OPEN will add the following information to the UFT: START, LENGTH, ACCESS, STATUS, BPNTER, BLNGTH, SLOT. If unsuccessful, DØ.B holds the error code.

Name: CLOSE

Address: $8ØCØ14

Entry: AØ.L = pointer to UFT in use.

Exit: DØ.B = error code (if any), or zero if no error.

CLOSE enters a new file into the disk directory. The UFT must be completely built before calling CLOSE. CLOSE is only used on files which have been created by CREATE, not on existing files which have been OPENed. If the file name specified in the UFT already exists, the old file by that name is killed automatically.

Name: CREATE

Address: $8ØCØ18

Entry: AØ.L = pointer to UFT to be used.

Exit: DØ.B = error code (if any), or zero if no error.

CREATE prepares the largest available free space on the disk for writing. Before calling CREATE, the UFT should contain the complete filename: primary, secondary, password, and drive number. CREATE will add SLOT, START, LENGTH, ORIGIN, ACCESS, BPNTER and BLNGTH. These items will reflect the largest currently available disk space.

Name: LOAD

Address: $8ØCØ2Ø

Entry: AØ.L = pointer to UFT in use.

Exit: DØ.B = error code (if any), or zero if no error.

LOAD reads an executable file into memory. The file must be in load module form, as a .SYS file. If the file is loaded successfully, RAM location GOADDR ($11B4) will contain the file's normal execution address. LOAD returns to the caller, who may then jump to the address in GOADDR if desired.

Name: RWBYTE

Address: $8ØCØ24

Entry: AØ.L = pointer to UFT in use.

Exit: DØ.B = error code (if any), or zero if no error.

RWBYTE is the main disk read/write routine. The UFT must contain proper values in BUFFP, MBYTES, DRIVE, CONTROL, BPNTER, BLNGTH, and STATUS. BUFFP is the memory address to/from which data will be moved. MBYTES is the number of bytes. If MBYTES < 128, then data may be transferred to/from an odd memory address. If MBYTES >= 128, data must be transferred to/from even addresses only.

On exit, BUFFP points past the memory location where the last transfer took place. MBYTES will be zero if all requested bytes were transferred, else it will be the number of bytes NOT transferred (due to error). The EOF bit of CONTROL will be set appropriately. BPNTER and BLNGTH will be updated according to the current state of the file.

Name: GETNAM

Address: $8ØCØ64

Entry: AØ.L = pointer to UFT to use.
A1.L = pointer to input buffer (command line).
A2.L = pointer to default filename.

Exit: DØ.B = error code (if any), or zero if no error.
D1.B = last character processed.
A1.L = pointer to first unprocessed character.

GETNAM parses the input buffer and extracts a file name. All parts of the file name are loaded into the UFT. A string of 11 characters to be used as a default name (if no name was entered) must be pointed to by A2. If no password was entered, the current user password is copied into the UFT. If no drive number was entered, the current drive number is copied into the UFT.

GETNAM returns D1.B with the delimiter it found after the file name. This may be a colon, in which case you must flag to DOS that another command exists on the input line. It may also be a semicolon, used to delimit an option field. A1 should be saved for return to DOS, or used as a pointer to further arguments on the command line (if your program expects any).

Name: PRTMSG

Address: $8ØCØ84

Entry: AØ.L = pointer to ASCII string (terminated by zero).
LogDev.W ($13E4) must contain the appropriate logical unit number.

PRTMSG transmits an ASCII string to a logical output device. PRTMSG goes through CTRLOUT to allow Escape and User code processing. BREAK and CTRL S/CTRL Q are active during this routine.

Name: PRTHEX

Address: $8ØCØ94

Entry: DØ.L = data (hex long word).
D1.L = number of hex digits to print (1 to 8).
LogDev.W ($13E4) must contain the appropriate logical unit number.

PRTHEX prints a hex number to a logical output device. The number is preceded by a dollar sign ($). D1 specifies the number of hex digits to print, and these are taken from the least significant digits of DØ. (If D1 = 2, then the low byte of DØ is printed.) The hex number is left-justified, and padded on the right with spaces if necessary, to fill out the number of characters specified by D1. This is the format of hex numbers printed in the disk directory. BREAK and CTRL S/CTRL Q are active during this routine.

Name: GETCLK

Address: $8ØCØ98

Exit: D0.L = packed time and date information from clock.

GETCLK reads the Real Time Clock and encodes time and date information into a long word. If the clock option is not installed, the long word contains zero. This routine is intended for use with CLKBCD (next page).

Name: CLKBCD

Address: $8ØCØAØ

Entry: DØ.L = packed time and date in GETCLK format.
AØ.L = pointer to 19-character buffer.

Exit: Buffer is loaded with ASCII time and date.

CLKBCD unpacks the time and date information produced by GETCLK. The buffer pointed to by AØ will be loaded with month, day, year, hour, and minute information in ASCII form. A zero byte is appended to the ASCII text so that it can be printed by PRTMSG. If DØ contained zero on entry to CLKBCD, the buffer will be loaded with 18 spaces and a zero.

Name: GETARG

Address: $8ØCØA8

Entry: A1.L = pointer to input buffer.

Exit: A1.L = pointer to character past delimiter.
D1.L = hex argument returned.
DØ.B = zero if no error, non-zero if error.

GETARG parses a hex number from an input buffer. The value of the argument is returned in D1. DØ is non-zero if a non-hex character was detected before the delimiter was reached. If DØ is zero, no error was detected. A1 is advanced past the argument.

Name: DOSERR

Address: $8ØCØBC

Entry: AØ.L = pointer to UFT of the file which caused an error.
DØ.B = error code.

DOSERR prints a DOS error message. The drive number of the offending file is printed also. Error codes available in DOSERR are listed in Appendix E. Note that DOS automatically prints error messages if your transient returns to DOS with DØ.B non-zero.

Error messages always go to logical unit Ø.

B.4 Inline Calling Sequences

Name: INLINE

Address: $8ØAØØC

Entry: A1.L = pointer to input buffer to be used (must be at least 84 characters long).
D1.W = Logical Input Device number to read from.
D7.B = control bits (see below).

Exit: Zero flag SET if the user hit DELETE. Zero flag CLEAR if the user hit RETURN.

INLINE is the 7900's general-purpose input routine, used by DOS, the Monitor, and Thaw. It reads a line of up to 83 characters from the user, allowing character editing, Recall Last Line, etc. Bits in D7 control INLINE as follows:

Bit	Meaning if SET
5	Treat line-feeds as logical line separators (newline character).
3	Echo the input line to the screen after RETURN is pressed (in expanded form, Modes and tabs executed normally).
2	Process Escape and User codes as they are entered.
1	Use "A7" character set for control-characters displayed in compressed form.
Ø	Do not display the characters as they are entered (you can't see what you type). The line will NOT be put into the Recall Buffer.

DOS uses D7 equal to $ØE, D1 equal to zero, and A1 pointing to the DOS input buffer in low RAM. The end of the user's input line is indicated by a RETURN character ($ØD) in the buffer. Note that INLINE does not echo a RETURN/LINEFEED when then user enters RETURN.

Name: INLINE1

Address: $80A018

Entry: A1.L = pointer to input buffer to be used.
D1.W = Logical Input Device number to read from.
D2.L = length of input buffer.
D7.B = control bits as described for the INLINE routine.
A4.L = pointer to table of line termination characters.

Exit: Zero flag CLEAR if user hit RETURN; D0.L undefined.

Zero flag SET if the user entered a line delete character sequence. D0.L = index into termination table of characters causing delete (i.e. the instruction MOVE.L 0(A4,D0.L),D0 will put the terminating characters into D0).

INLINE1 is used to read lines of non-standard length. The length of the input buffer is given in D2.L. INLINE1 will read up to **length-1** characters into the buffer, with the end of the line being flagged by the RETURN character ($0D). INLINE1 also provides for changing the list of characters which delete an input line (DELETE, BREAK and CTRL C are the standard line termination characters).

Note that lines longer than 255 characters will not be stored in the Recall Buffer.

As an example, suppose you are writing an editor. You want to be able to edit lines of up to 150 characters. Furthermore, you want the characters CTRL X, INS LINE and DEL LINE to cause INLINE to abort input. The following is a program fragment to accomplish this.

```
*
* define input buffer storage
*

LINELEN     EQU     150+1                   150 characters + CR
INPBUF      DS.B    LINELEN                 Input buffer

*
* define termination table
* (you must ensure that it is on an even boundary!)
*

TRMTBL      DC.L    $18                     CTRL-X
            DC.L    $00013E32               Insert line (MODE > 2)
            DC.L    $00013C32               Delete line (MODE < 2)
            DC.L    0                       End of table marker

*
* read a line
*

            MOVEQ.L #0,D1                   Read from Device 0
            MOVEQ.L #$0E,D7                 Control bits
            LEA     *+(TRMTBL-(IPC+2)),A4   Pointer to termination table
            LEA     *+(INPBUF-(IPC+2)),A1   Pointer to input buffer
            MOVE.L  #LINELEN,D2             Line Length
            JSR     INLINE1                 Read line
            BEQ     trmn8ed                 If LINE DELETE char entered
            BRA     retin                   Return entered
            .
            .
            .

trmn8ed     CMP.L   #4,D0                   See if INSERT LINE entered
            BEQ     ...                     If yes
            CMP.L   #8,D0                   See if DELETE LINE entered
            BEQ     ...                     If yes
```

Name: INLINE2

Address: $80A01C

Entry: Registers as set up by INITINL (routine described below)

Exit: Same as INLINE1

INLINE2 is a low level routine used to get characters from the specified device and preocess them until RETURN or a line termination character is entered. Its use will be demonstrated in the INLINE3 example below.

Name: INLINE3

Address: $80A020

Entry: Registers as set up by INITINL or returned by INLINE3.
D0.B = character to process.

Exit: If D0.B was not a line termination character or RETURN, then D2.L=0; Zero flag is SET. Registers are updated for another character.

If D0.B was RETURN, then D2.L=1, Zero flag CLEAR.

If D0.B was a line termination character, then D2.L=2; Zero flag is CLEAR; D0.L=index into termination table.

Important! Between calls to INLINE3, the only registers that may be altered are D0, A1 and A5. Changing any other registers will most likely crash the system. Also, INLINE3 will destroy D0, A1 and A5.

INLINE3 is the workhorse of the INLINE system. It accepts characters one at a time and processes them, performing all editing functions.

As an example of how these routines tie together, see the program fragment below. It shows how the DOS editor (should) display lines for editing. Assume that A5 points to the line to be edited and that it is terminated by a RETURN. The code on the following page will display the line, then let the user modify it:

```
*
* save pointer to char as INLINE3 eats things
*
          MOVE.L   A5,-(SP)

*
* set up inline for a new line:
*
          MOVEQ.L  #Ø,D1                  Read from device Ø
          MOVEQ.L  #$ØE,D7                Control bits
          LEA      *+(TRMTBL-(IPC+2)),A4  Pointer to termination table
          LEA      *+(INPBUF-(IPC+2)),A1  Pointer to input buffer
          MOVE.L   #LINELEN,D2            Length of input buffer
          JSR      INITINL                Initialize the INLINE system

*
* get characters from EDIT buffer and feed to INLINE
*
X1        MOVE.L   (SP)+,A5               Get pointer to char
          MOVE.B   (A5)+,DØ               Get the character
          CMP.B    #CR,DØ                 End of the line?
          BEQ.S    X2                     If it is....
          MOVE.L   A5,-(SP)               Remember:  INLINE3 munches reg's
          JSR      INLINE3                Feed char to INLINE3
          BRA.S    X1

*
* let user edit the line
*
X2        JSR      INLINE2

*
* INLINE2 returns EQ/NE.  Take appropriate action....
*
```

Name: INITINL

Address: $80A024

Entry: A1.L = pointer to input buffer to be used.
D1.W = Logical Input Device number to read from.
D2.L = length of input buffer.
D7.B = control bits.
A4.L = pointer to table of line termination characters.

Exit: Registers as required by INLINE3.

INITINL is used to initialize all information as required by the INLINE system.

Name: INLHOME

Address: $80A028

Entry: Registers as set up by INITINL.

Exit: Cursor moved to home position of line.

After a line has been output (see INLINE3 example), INLHOME could be used to put the cursor on the first character of the line before allowing the user to edit the line. The Chromatics editors supporting INLINE put the cursor at the end, but it is only a matter of taste.

Appendix C -- Memory Allocation

C.1 CMOS Memory Allocation

4096 bytes of CMOS or static memory are installed on the 7900 CPU card. This memory is used to store Function Key definitions, information for buffer sizes, and other important system pointers. The CMOS memory is optional, and comes with a battery-backed supply so that user-defined parameters will be maintained while the system is turned off. This concept is described in detail in the 7900 User's Manual description of the "Thaw" command. If your system does not contain the CMOS option, you will have static RAM installed at these addresses, but the data in this RAM will still correspond to the following table.

This section describes the allocation of CMOS memory in the current version of firmware, TERMEM 1.3. Allocation may change slightly or greatly in future releases. All CMOS is reserved for system use, and any user programs which occupy CMOS do so at the risk of interfering with future system programs.

The CMOS entries which determine buffer sizes should not be altered except through the Thaw command. If these entries do not agree with actual RAM allocation at all times, the system may crash.

Addresses $E40000 through $E40100 are also used by hardware registers in the 7900 system. Accessing these addresses affects CMOS and the hardware as well.

Where appropriate in the following tables, each entry is marked with ".B", ".W", or ".L", to indicate the data size of the entry.

Address		Use
$E40000	.W	Bitmap roll counter
$E40002	.W	X pan register
$E40004	.W	Y pan register
$E40006	.B	X zoom register
$E40007	.B	Y zoom register
$E40008-$E40009		(Reserved)
$E4000A-$E4000F		Raster processor registers
$E40010	.W	Blink select register
$E40012	.W	Plane select register
$E40014	.W	Plane video switch register
$E40016	.W	Color status foreground register
$E40018	.W	Color status background register
$E4001A	.W	Overlay roll counter
$E4001C-$E4001F		(Reserved)
$E40020-$E4003E		Raster processor registers

Address		Use
$E4ØØ4Ø-$E4Ø1ØB		(Reserved)
$E4Ø1ØC	.L	CMOS verifier long word
$E4Ø11Ø-$E4Ø113		(Reserved)
$E4Ø114	.W	Size of DOS Transient Program Area
$E4Ø116	.W	Size of DOS Buffer
$E4Ø118	.B	Number of active windows
$E4Ø119		(Reserved)
$E4Ø11A	.W	Size of keyboard buffer
$E4Ø11C	.W	Size of Function Key stack (nesting)
$E4Ø11E	.W	Size of RS-232 input buffer
$E4Ø12Ø	.W	Size of RS-232 output buffer
$E4Ø122	.W	Size of RS-449 input buffer
$E4Ø124	.W	Size of RS-449 output buffer
$E4Ø126	.W	Size of Escape code argument stack
$E4Ø128	.W	Size of system stack
$E4Ø12A	.L	Highest RAM address used by system
$E4Ø12E	.L	Pointer to INLINE recall buffer
$E4Ø132	.L	Recall buffer size
$E4Ø136-$E4Ø141		Pointers for INLINE
$E4Ø142	.L	Pointer to start of Function Key buffer
$E4Ø146	.L	Pointer to end of Function Key buffer
$E4Ø14A	.L	Pointer to Case Table
$E4Ø14E-$E4Ø15D		(Reserved)
$E4Ø15E	.L	Address of default program (executed by Boot)
$E4Ø162	.L	Address to search for RAM modules
$E4Ø166-$E4Ø169		TERMEM status flags
$E4Ø16A	.L	Address of Bitmap plot cursor descriptor
$E4Ø16E	.L	Address of Bitmap alpha cursor descriptor
$E4Ø172-$E4Ø179		(Reserved)
$E4Ø17A-$E4Ø17B		INLINE Recall flags
$E4Ø17C-$E4Ø1C7		Default Boot string
$E4Ø1C8-$E4Ø213		Default Reset string
$E4Ø214-$E4Ø21D		Host EOL sequence
$E4Ø21E	.L	Address of vector-drawn character font
$E4Ø222	.B	RS-232 mode command
$E4Ø223-$E4Ø224		(Reserved)
$E4Ø225	.B	RS-232 handshake flags
$E4Ø226-$E4Ø229		(Reserved)
$E4Ø22A	.B	RS-449 mode command
$E4Ø22B-$E4Ø22C		(Reserved)
$E4Ø22D	.B	RS-449 handshake flags
$E4Ø22E-$E4Ø231		(Reserved)
$E4Ø232-$E4Ø7FF		(Reserved)
$E4Ø8ØØ-$E4Ø8FF		Case Table
$E4Ø9ØØ-$E4ØBFF		Function Key buffer
$E4ØCØØ-$E4ØCFF		INLINE Recall buffer
$E4ØDØØ-$E4ØFFF		(Reserved)

C.2 Low RAM Allocation

The area of RAM between addresses $400 and $FFF is used by the 7900 system for pointers and miscellaneous constants. The area between $1000 and $1C3B is used for DOS tables and pointers. As mentioned earlier, areas marked "Reserved" should be left alone, for compatibility with future releases of software.

Address	Use
$400-$463	Monitor input line
$464-$495	Monitor flags and breakpoint storage
$496-$4E5	Monitor pseudo-register storage
$4E6-$509	Monitor register display formats
$50A-$69B	Monitor stack
$69C-$BFF	(Reserved)
$C00 .L	Pointer to base of TERMEM dispatch tables
$C04 .L	Pointer to Keyboard buffer start
$C08 .L	Keyboard input pointer
$C0C .W	Keyboard buffer character count
$C0E .L	Pointer to Keyboard buffer end
$C12 .W	Joystick X center offset
$C14 .W	Joystick Y center offset
$C16 .W	Joystick Z center offset
$C18-$C1B	Light pen argument list
$C1C .L	Function Key stack pointer
$C20 .L	Pointer to Function Key buffer
$C24 .L	Pointer to Function Key stack
$C28 .L	Pointer to RS-232 input buffer
$C2C .L	Pointer to RS-232 output buffer
$C30 .L	Pointer to RS-449 input buffer
$C34 .L	Pointer to RS-449 output buffer
$C38 .L	Pointer to Esc argument stack
$C3C .L	Pointer to DOS buffer
$C40 .L	Pointer to window table base
$C44 .L	Pointer to top (start) of stack
$C48 .L	Pointer to bottom (end) of stack
$C4C .L	Pointer to start of Create Buffer
$C50 .L	Pointer to end of Create Buffer space
$C54 .L	Pointer to DOS transient area
$C58-$C5D	TERMEM storage for keyboard light data
$C5E-$C61	TERMEM storage for HVS calculations
$C62 .W	Active image planes in system
$C64 .W	Copy of interrupt mask register
$C66 .W	Copy of baud rate generator data
$C68-$C7F	Escape code processor storage area
$C80 .L	Pointer to current character in Create Buffer
$C84 .L	Pointer to end of Create Buffer data (EOF+1)
$C88-$C8D	Joystick data storage area
$C8E .L	Warmstart vector (for USER W)

Address	Use
$C92-$C99	RS232 input ring buffer pointers
$C9A-$CA1	RS232 output ring buffer pointers
$CA2-$CA9	RS449 input ring buffer pointers
$CAA-$CB1	RS449 output ring buffer pointers
$CB2-$FFF	(Reserved)

DOS memory allocation begins here....

$1000-$1009	DOS command block for disk controller
$100A-$103F	Default DOS UFT (details below)
$1040-$113F	Directory buffer space
$1140-$1143	Command block variable space
$1144-$118B	DOS input line buffer
$118C-$11B3	DOS variables and pointers
$11B4 .L	GOADDR: Start address for executable files
$11B8-$11C3	DOS pointers
$11C4 .B	REVN: Revision number of file (not used)
$11C5 .B	DRIVEN: Drive from which last transient came
$11C6 .W	USERN: Password of current user (** = public)
$11C8-$11CD	DOS variables
$11CE .W	FLSTAT: File status used by CLOSE
$11D0 .W	SLASH0: Slash/0 mode flag
$11D2-$11E1	Disk controller variables
$11E2-$1217	TUFT1: Transient UFT #1
$1218-$1243	DOS variables
$1244-$1279	TUFT2: Transient UFT #2
$127A-$1389	DOS variables
$138A-$13FF	Reserved for DOS expansion

C.3 The User File Table

DOS maintains a User File Table (UFT) in memory for each file currently being accessed. The UFT contains the file name, password, directory location, size, and various pointers which uniquely identify that file. Whenever DOS reads from or writes to a file, the UFT is updated to show the current file status. The UFT must remain intact as long as a file is in use, or until a new file is closed.

Each UFT occupies 54 bytes; DOS has three UFTs allocated in low RAM. Your program may use these areas to build UFTs, or you may use other RAM.

Each item in the UFT is defined below. If AØ points to the start of a UFT, the item of interest may be accessed with the "Indirect with Displacement" addressing mode; e.g. OFFSET(AØ).

Offset in UFT	Description
$ØØ .W	SLOT: Location of a file in the disk directory.
$Ø2 .L	BUFFP: Memory address to/from which the data transfer will take place on the next read or write.
$Ø6 .L	MBYTES: Number of bytes to transfer on next read or write.
$ØA .W	CONTRL: Defines the next operation to be performed. In this word,

Bit	Meaning
9	1 = End of file
8	1 = Read, Ø=Write
7	1 = Enable retry
6	1 = Enable ECC

$ØC .B	DRIVE: Logical unit number of disk drive: Ø and 1 are floppy disks, 2 is the hard disk.
$ØD .B	ERROR: Error code of last operation.

Offset in UFT	Description
$ØE .L	BPNTER: Pointer to current byte in file.
$12 .L	BLNGTH: Current length of file (goes to zero as file is read in).
$16-$1D	PNAME: 8-character primary filename.
$1E-$2Ø	SNAME: 3-character secondary filename.
$21	(not used)
$22-$23	PSWRD: 2-character password. Public files are given password "***".
$24 .L	START: Starting address of file on disk (bytes).
$28 .L	LENGTH: Length of file on disk (bytes).
$2C .L	ORIGIN: File origin time/date.
$3Ø .L	ACCESS: Time/date of last access.
$34 .W	STATUS: File attributes as follows...

Bit	Meaning if SET
15	Blind file
8	Active slot
7	Write-protected
6	Delete-protected
4	Free (deleted)
3	Execute-only
1	Odd length
Ø	Killed

Appendix D — Custom Cursors and Character Sets

D.1 Custom Character Sets

The 7900 allows user-defined character sets to be used in the Bitmap in place of the two character sets supplied with the system. An entry in each Window Table (Charadr) points to the base of the character set for that window, and the size of the font (X by Y pixels) may also be defined for each window. The character font dimensions may be up to 16 in the X direction, and 256 in the Y direction.

Since the character set address for a window is stored in the Window Table, it will default back to the normal character set whenever Boot or Soft Boot is executed.

The character set for the Overlay is stored in high-speed PROM, and is not alterable through software.

The following program is a module, designed to be linked into the 7900 system software. It will install a custom character set in any window which receives a MODE i command. This program is an example ONLY. It does not include a complete character set definition. The data set which should accompany this program would be too long to fit into the standard 7900 memory, unless you do one of the following: (1) change the ORG address, which requires changing address RAMMDLE with the Thaw command, (2) change the height of the character set to reduce the data required, or (3) install additional memory above address $20000.

```
*
*    Sample module to install a new character set.
*    The set is installed in a window by the command:
*
*        MODE i
*
*    To return to the standard set, use  SOFT BOOT.
*
*


*
*    CGC 79ØØ equates...
*

Mode     EQU    1          MODE is Control-A

CharXZ   EQU    $78        Offset in window table for X raster size
CharYZ   EQU    $7A        Y raster size
CharDX   EQU    $7C        X intercharcter spacing (step)
CharDY   EQU    $7E        Y intercharcter spacing
Charadr  EQU    $9C        Address of font for this window


*
*
*
         ORG.L   $1FØØØ          This is the address called "MDLE"
*                                 as specified by the Thaw command.
*
         DC.L    'MDLE'           This header must be present if
*                                 the module is located in RAM.
*
         DC.W    CharEnd-IPC      This is the length of the
*                                 module (including the
*                                 character set at end)
*
         DC.B    Mode,'i'         We are executed when the user
*                                 types this sequence.
*
         DC.W    $ØØØØ            We require no arguments.
         DC.W    $ØØØØ

*
*    Execution begins here after MODE i is entered.
*    TERMEM preloads AØ with the base of the window table.
*

         MOVE.W    #6,CharXZ(AØ)     Load character size (X)
         MOVE.W    #8,CharYZ(AØ)                         (Y)
         MOVE.W    #6,CharDX(AØ)     Load step size (X)
         MOVE.W    #8,CharDY(AØ)                    (Y)
         MOVE.L    #BASE,Charadr(AØ)    Load address of font
         RTS                            That's all!
```

```
*********************************************************************
*
*    What follows is the character font definition.
*
*    It is arranged as 128 regular characters, followed by 128
*    A7 characters.  All 256 characters should be defined.
*
*    Assume the font is set in a field X by Y.  (Default is
*    X = 6 and Y = 8.)  Then each character requires 8 words
*    of data, one for each Y scan; and 6 bits of each word
*    are used.  The active 6 bits are left-justified in the
*    16-bit word.
*
*
*  . Example: the character "A"
*
*                                    bit #
*
*                                    111111              Hex value
*                                    5432109876543210
*
*                                1   .XXX.............     $7000
*                                2   X...X.............     $8800
*                                3   X...X.............     $8800
*          Word #                4   XXXXX.............     $F800
*      (one per Y scan)          5   X...X.............     $8800
*                                6   X...X.............     $8800
*                                7   X...X.............     $8800
*                                8   ................      $0000
*
*
*    The X by Y field must include any necessary
*    spacing between characters or between lines.
*
*
*    Memory requirements:
*
*    This module will require 256 * Y words, plus 23 words of
*    overhead for the preceding code.  This much memory must
*    exist between address "RAMMDLE" and the physical end of memory.
*    If necessary, use Thaw to alter the address of "RAMMDLE" (be
*    sure to put it where nothing will stomp on it!)
*
*
```

```
*
*
*    This Scale Factor will left-justify a 6-bit number in a
*    16-bit field, by shifting 10 bits.  All of the numbers in
*    this database are 6-bit for convenience, and S justifies
*    them properly.
*

S       EQU     1024

*
*
BASE    EQU     IPC         This is where it all begins.
*
*    This is the regular character set.
*
    DC.W    $24*S,$34*S,$3C*S,$2C*S,$24*S,$04*S,$04*S,$07*S     ^@
    DC.W    $0C*S,$10*S,$08*S,$05*S,$1D*S,$07*S,$05*S,$05*S     ^A
*     .
*     .    etc. for regular set.
*     .
    DC.W    $01*S,$0E*S,$10*S,$00*S,$00*S,$00*S,$00*S,$00*S      ~
    DC.W    $0A*S,$15*S,$0A*S,$15*S,$0A*S,$15*S,$0A*S,$00*S     DL
*
*
*
*
*    Alternate (A7) character set begins here.
*
    DC.W    $1F*S,$15*S,$15*S,$1F*S,$15*S,$15*S,$1F*S,$00*S     ^@
    DC.W    $08*S,$15*S,$02*S,$08*S,$15*S,$02*S,$00*S,$00*S     ^A
*     .
*     .    etc. for A7 set.
*     .
    DC.W    $01*S,$02*S,$02*S,$04*S,$08*S,$10*S,$10*S,$20*S      ~
    DC.W    $00*S,$00*S,$00*S,$00*S,$00*S,$00*S,$00*S,$3F*S     DL
*
*

CharEnd EQU     IPC     This is the end of our module.
        DC.L    -1,-1   No more modules follow this one.

        END
*
*
```

D.2 Installing a New Cursor

The 7900 Bitmap cursors, Plot and Alpha, are each described by a set of data. This set is pointed to by pointers in the CMOS area, one pointer for the Plot cursor and one for the Alpha cursor.

```
Plotcur   EQU   $E4Ø16A
Alphcur   EQU   $E4Ø16E
```

The cursor descriptor data is a list of up to 32 long words. Each long word describes the displacement of one pixel of the cursor, with respect to the center pixel of the cursor. The list is terminated with a zero word. Since this zero word is part of the descriptor, the center pixel of the cursor is always ON.

The displacements are given as addresses in Bitmap memory. Each pixel in Bitmap memory corresponds to a word (two bytes) of memory, so an X displacement of one pixel is produced by an address displacement of two. (Positive X displacement is to the right.) Similarly, a Y displacement of one pixel corresponds to an address change of 2Ø48 bytes (1Ø24 pixels per Y line of the screen, times two bytes per pixel. A positive Y displacement is in the down direction.

A sample cursor might look like this, where X's correspond to pixels included in the cursor:

```
 X
XXX
 X
```

The data list for this cursor would be:

```
   +2  (the pixel to the right of center)
   -2  (the pixel to the left of center)
+2Ø48  (the pixel below center)
-2Ø48  (the pixel above center)
   Ø   (the center pixel, and end of the list)
```

To install a new cursor, first define it in the form above. Store this data in memory. Then, alter the pointer in CMOS (either Plotcur or Alphcur) so that it points to your data. Note that if you store your cursor in RAM other than CMOS, the description will vanish when system power is turned off, but the CMOS pointer will remain! This will cause you to have NO cursor at all. To reload CMOS defaults, use CTRL SHIFT M1 M2 RESET.

```
*************************************************************************
*
*     Sample program PUTCURS
*
*     Installs a new cursor as the Bitmap plot cursor.
*
*     This program stores its cursor descriptor in upper CMOS
*     memory, unused by current 7900 software.  This may not be
*     compatible with future 7900 releases.
*
*
*
         ORG.L   $1C3C          We run in DOS area

PUTCURS  MOVE.L  #HiCMOS,A2     Point to some unused CMOS
         MOVE.L  #Cursor,A3     Point to our new cursor descriptor

PUTloop  MOVE.L  (A3)+,(A2)+    Copy a long word into CMOS
         TST.L   -4(A2)         Was it zero?
         BNE.S   PUTloop        No, continue copying

         MOVE.L  #HiCMOS,Plotcur   Set up pointer to new cursor

         CLR.L   D0             Flag no error occurred
         CLR.L   D1             (We don't check for colon on line)
         RTS                    Return to DOS


HiCMOS   EQU     $E40E00        CMOS area (unused in TERMEM 1.3)
Plotcur  EQU     $E4016A        Plot cursor pointer

Cursor   DC.L    -4*1024        New cursor descriptor
         DC.L    -4*1024+2
         DC.L    -4*1024-2
         DC.L    -2*1024-4
         DC.L    -2*1024+4
         DC.L    -4
         DC.L    +4
         DC.L    +6
         DC.L    +8
         DC.L    -2*1024+8
         DC.L    -2*1024+10
         DC.L    -2*1024+12
         DC.L    -2*1024+14
         DC.L    -4*1024+10
         DC.L    -4*1024+12
         DC.L    -4*1024+14
         DC.L    -4*1024+16
         DC.L    4*1024
```

```
        DC.L    4*1Ø24+2
        DC.L    4*1Ø24-2
        DC.L    2*1Ø24-4
        DC.L    2*1Ø24+4
        DC.L    2*1Ø24+8
        DC.L    2*1Ø24+1Ø
        DC.L    2*1Ø24+12
        DC.L    2*1Ø24+14
        DC.L    4*1Ø24+1Ø
        DC.L    4*1Ø24+12
        DC.L    4*1Ø24+14
        DC.L    4*1Ø24+16
        DC.L    Ø               (end of list)

        END     PUTCURS
```

Appendix E — DOS Error Messages

The following errors may be reported by DOS. To force DOS to print an error message, load the error number into DØ.B before returning to DOS.

Error (hex)	Message
Ø1	No index signal detected
Ø2	No seek complete
Ø3	Write fault
Ø4	Drive not ready
Ø5	Drive not selected
Ø6	No track ØØØ detected
1Ø	ID read error
11	Uncorrectable data error found during a read
12	ID address mark not found
13	Data address mark not found
14	Block not found
15	Seek error
16	No host acknowledgement
17	Diskette write protected
18	Data field error found and corrected
19	Bad track found
1A	Format error
2Ø	Invalid disk controller command
21	Illegal logical block address
22	Illegal function for the specified drive

3Ø	Diagnostic RAM error
4Ø	Disk controller not ready
41	Controller time out error
42	Unable to determine controller error
43	Undefined controller state
44	Controller protocol sequence error
5Ø	Undefined load error state
51	Record count error
52	Checksum error
53	Premature EOF during load
54	DOS buffer too small
55	Transient program size too small
6Ø	End of file reached
61	File is write protected
62	Attempted to read through density barrier
63	Attempted to transfer data on odd address
7Ø	Unable to find requested file
8Ø	Unable to create new file space
9Ø	Unable to close requested file
AØ	Empty slot found
A1	Unable to update the directory

B1	No run address
B2	Unable to find disk name
B3	Argument error
B4	Attempt to access a non-existant drive
B5	Unable to initialize drive 1
B6	Unable to initialize drive 2
B7	Syntax error! Missing argument
CØ	Premature format termination
C1	Error mapping routine not implemented
C2	Unable to fetch this file
C3	File is delete protected
C4	File type error
C5	File is execute only
C6	File is to big to append
C7	Insufficient stack size
C8	/Ø mode is not allowed in argument filenames

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