EXIDY'S CBIOS USERS GUIDE

VERSION 3.0

EXIDY INC.

JANUARY, 1980

COPYRIGHT

DISCLAIMER

Exidy Inc. makes no representations or warranties with respect to the contents hereof and specifically disclaims any implied warranties of merchantibility or fitness for any particular purpose. Further, Exidy Inc. reserves the right to revise this publication and to make changes from time to time in the content hereof without obligation of Exidy Inc. to notify any person of such revision or changes.

TRADEMARKS

CP/M is a registered trademark of Digital Research.

TABLE OF CONTENTS

1. INTRODUCTION

The CBIOS program (Cache Basic Input/Output System) interfaces between CP/M (TM) and the Sorcerer's hardware. The term BIOS was coined by Digital Research, the creators of CP/M. Their term CBIOS stands for Customized Basic Input/Output System, in which the BIOS is customized to the user's hardware. The Exidy program is a CBIOS in this sense. However, the Exidy 'C' stresses the use of disk buffer cache techniques to improve program performance.

Portability is the most valuable attribute of CP/M. The clean separation of logical and physical I/O enables it to run on many 8080/Z80 based systems. Digital Research provides the logical I/O in CP/M's Basic Disk Operating System (BDOS). This routes all physical I/O through a BIOS vector. See the "CP/M System Alteration Guide" for a description of the BIOS vector and its functions.

Each hardware system CP/M is used on requires a separate BIOS program. The Exidy interface is tailored for the Sorcerer and the hardware the Sorcerer supports. Because the disk drive is the most complicated piece of hardware CP/M uses, this document focuses on the CBIOS disk interface for the Display Disk System (DDS) soft-sectred 77 track disk and the Floppy Disk System (FDS) soft-sectored 77 or 40 track disk.

For clarification, a brief explanation of physical and logical units may benefit the user in our discussion. A physical unit is the actual input/output device and its hardware recording medium. A diskette, for example, physically has 77 tracks, each of which has 16 sectors of 256-bytes. However, an interface between the physical hardware and the user may translate or break up this size into any number of combinations. This level, used by the programmer, is the logical level. That is, the very same diskette may be dealt with by the programmer as a different size from the physical size (say, 77 tracks each of which has 32 sectors of 128-bytes) The software interface makes all necessary adjustments for the input to be understood on the differing physical diskette size.

The Digital Research interface of the BDOS to the BIOS defines the logical CP/M diskette with a logical sector size of 128-bytes. The Exidy physical diskette systems, however, have a 256-byte sector. To compensate for this difference, Exidy splits each physical 256-byte sector in half to form two CP/M logical 128-byte sectors. The CBIOS is responsible for mapping 128-byte logical CP/M sectors to the proper half of a 256-byte physical sector. The physical sectors are skewed or interleaved on the diskette to minimize rotational delay. This skewing pattern is described in detail later.

The disk buffer cache improves performance by buffering reads and writes of the disk in a RAM cache storage area. When CP/M requests a 128-byte sector read from a sector not within the cache buffer, a 256-byte sector from disk must be read. Thus, the cache returns the requested sector to the user, keeping track of the other 128-byte sector half within the 256-byte cache buffer. Should a read request be made for that sector at this point, no disk I/O is required because the sector already exists in the memory cache. This same principle applies to cache buffer writing. That is, only one 256-byte physical sector I/O is written for two CP/M 128-byte logical I/O requests on the same physical sector. If there is no room in the cache buffer for a 256-byte sector during a physical I/O, the CBIOS "pages out" the least recently used sector buffer by writing it to the disk, thereby freeing a buffer slot for use by the I/O.

2. CONFIGURATION AND SYSTEM GENERATION

A. Hardware for the DDS and the FDS

The Exidy CBIOS runs on both the Display Disk System (DDS) and the Floppy Disk Subsystem (FDS). A DDS consists of a Sorcerer II Computer (with keyboard), Display Disk Unit containing a video screen, and two soft sectored Micropolis drives. The Exidy CBIOS may actually support three disk drives connected to the soft sectored disk controller. However, a controller and only two drives are supplied with the DDS. The DDS may be augmented by other peripherals such as a printer, cassettes, etc.. The Exidy CBIOS assigns the logical CP/M devices, Punch and Reader, to serial write and serial read respectively. The List device is assigned to the Sorcerer Centronics parallel printer interface.

On cold boot, CP/M on the DDS outputs the following message:

```
CP/M on Exidy Sorcerer for 77 Track Disk
32K CP/M VERS 1.42/3
Copyright (C) 1980 Exidy Inc.


A>
```

There are other Exidy CP/M's for 40 track disks. Exidy's CP/M for the DDS should state 77 tracks.

The Exidy CBIOS also runs on the Floppy Disk System (FDS). An FDS consists of a Sorcerer II Computer (with keyboard), and a Floppy Disk Subsystem containing an MPI floppy disk drive and controller. The Exidy CBIOS may actually support three disk drives connected to the soft sectored disk controller. However, a controller and only one drive are supplied with the standard Floppy Disk Subsystem. The FDS may be augmented by other peripherals such as printers, cassettes, etc.. The Exidy CBIOS assigns the logical CP/M devices Punch and Reader, to serial write and serial read respectively. The List device is assigned to the Sorcerer Centronics parallel printer interface. On cold boot, CP/M on the FDS outputs the following message:

```
CP/M on Exidy Sorcerer for 40 Track Disk
32K CP/M VERS 1.42/3
Copyright (C) 1980 Exidy Inc.

A>
```

There are other Exidy CP/M's for 77 track disks. The FDS user should insure his system says "For 40 Track Disk."

Apart from configuration differences, CBIOS operates the same on both systems, DDS and FDS.

B. System Generation

Two programs, MOVCPM and SYSGEN, either create a new CP/M system or change its location in RAM. The MOVCPM program obtains a CP/M system image sized appropriately, for example, 32K, 48K, etc. and performs system relocation. SYSGEN takes the system output from MOVCPM and writes it to tracks 0 and 1 of the target diskette. The simplest method of doing this is:

```
A> MOVCPM 32 * <carriage return>
EXIDY MOVCPM PROGRAM VERSION 3
CONSTRUCTING 32K CP/M VERS 1.4
READY FOR "SYSGEN" OR
"SAVE 40 CPM32.COM"
A>
```

Notice that "MOVCPM 32 *" is the only user input. At this point MOVCPM has created a 32K CP/M system image in memory and the user may either proceed immediately to SYSGEN or he may save the image on disk as a COM file by typing SAVE 40 CPM32.COM in response to the "A" prompt. The latter procedure provides the user the option of modification with the DDT utility.

With a MOVCPM image in memory, as it is after the last prompt, the user may do a memory image SYSGEN. In the next example, the system is created on drive B. Note the response to the source drive name prompt is a carriage return. This indicates the source system already exists in memory.

```
A>SYSGEN <carriage return>
EXIDY SYSGEN VER 1.4/3

SOURCE DRIVE NAME (OR RETURN TO SKIP)
DESTINATION DRIVE NAME (OR RETURN TO REBOOT)B
DESTINATION ON B, THEN TYPE RETURN <carriage return>
CP/M TO BE CREATED WILL RESIDE IN RAM FROM 6000 TO 7F00
```

The actual disk writing occurs now then this message signs on:

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

At this point the system has been created on disk. The user should do a cold boot on the new diskette (in drive A) to verify this. For more details on MOVCPM and SYSGEN, see "An Introduction to CP/M Features and Facilities."

MOVCPM may also be performed without the second "*" parameter MOVCPM 29. In this case, MOVCPM attempts to create and execute in memory a new system of the specified size. However, the system may be destroyed if the given memory size causes the new target system to use memory in either the executing MOVCPM program or the executing CP/M system. Exidy suggests always specifying the second "*" parameter for MOVCPM and using SYSGEN to create a new disk system.

C. Options

Two options come with the CBIOS: Diagnostic Error Messages and Read After Write Data Verification. The default settings are 1) no Diagnostic Error Messages and 2) Read After Write Verification.

With the Diagnostic Error Message option turned off, only fatal errors are reported to the user and recovered soft errors are not. The user selects this option if he wants all errors reported. A Diagnostic Error message shows for any error encountered.

The Read After Write Verification option allows all data to be reread and compared to the write buffer and CRC after the user has written to a physical disk sector. The user may turn off this option, increasing the speed of disk writes by 50 per cent. This may, however, decrease data reliability. We suggest leaving this option set to the default value to assure disk writes are being done successfully.

Only someone familiar with CP/M programming should attempt changing option values. To make these changes, the user creates a disk file with his CP/M system on it. That is, he does a MOVCPM, followed by a SAVE, as described in Section II. A. of this manual. The user then DDT's the CP/M system into memory, altering the contents of absolute location 1F02 hex to reflect the options he wishes, as shown below:

bit 0 = Read After Write Option (hex 01)
bit 2 = Diagnostic Error Message Option (hex 04)

If the value of the bit is 1, then the option is asserted. A bit of 0 turns off the option. Thus the default value is 01 hex for the Read After Write option without Diagnostic Error Messages.

D. Cache Buffer Allocation

The CBIOS dynamically allocates cache buffers whenever CP/M is cold booted. CBIOS determines the top of memory by calling the Sorcerer Monitor routine GETIY (E1A2H). This returns the address of the Monitor Work Area (MWA), located in high memory. CBIOS subtracts 40 hex (64 decimal) from this address for Sorcerer Monitor stack forming an upper buffer address bound. The area from the end of the CBIOS code area to this bound contains all the CBIOS buffers. The maximum buffers possible is seven. A CBIOS buffer is 262 bytes long. The maximum of seven is chosen to insure that the CBIOS is not so overbuffered that more buffer bookkeeping overhead is performed than I/O.

The first parameter of the MOVCPM function controls the number of buffers in the system. For example, if the user has a 32K memory Sorcerer, he may generate his CP/M system through the usual MOVCPM 32 * command. This allocates the minimum of one cache buffer. A MOVCPM 31* command "lies" to CP/M, telling it the machine is 1K smaller than it actually is. This allocates an extra 1K to CBIOS buffers, allowing 4 extra buffers. Thus a "MOVCPM 31 *" command increases that number of buffers from one to five. A "MOVCPM 30 *" command increases that number to seven. (Analogous numbers hold for a 48K Sorcerer, that is, 48 results in one, 47 results in five, and 46 results in seven buffers. If the cold boot is located at BF00 H, then the largest possible CP/M is 47K, using 4 buffers. A 48K CP/M does not work if the boot is at BF00H.

E. Incompatibilities

All CP/M disk formats, including Exidy's, are incompatible with the Micropolis Disk Operating System (MDOS) and with some other CP/M formats. This incompatiblility, especially evident with MDOS, is a result of different sector skewing arrangements. All Exidy disk-based software products only run on Exidy's CP/M TM.

The Exidy skewing pattern follows for those interested in developing translation programs.

F. Sector Skew Pattern

CP/M logical 128-byte sector	Exidy 256-byte Sector (Physical Sector, first/last half)
1	16, first
2	16, last
3	13, first
4	13, last
5	10, first
6	10, last
7	7, first
8	7, last
9	4, first
10	4, last
11	1,first
12	1, last
13	14, first
14	14, last
15	11, first
16	11, last
17	8, first
18	8, last
19	5, first
20	5, last
21	2, first
22	2, last
23	15, first
24	15, last
25	12, first
26	12, last
27	9, first
28	9, last
29	6, first
30	6, last
31	3, first
32	3, last

Note that Exidy physical sectors are numbered 1 to 16, and are 256 physical bytes long. CP/M logical sectors are numbered 1-32 and are 128-bytes long. Thus, two CP/M sectors fit in one Exidy physical sector.

3. FEATURES

A. Error Recovery

The CBIOS includes extensive automatic error detection, recovery, and reporting facilities. The Read After Write option, active by default, is the only error detection function controlled by the user. When a disk I/O error occurs, recovery is fully automatic in the following steps:

1. CBIOS retries operation up to 5 times until successful.
2. If the error still exists, it steps one track in/out alternately for a total of 6 times and repeats step 1 again.
3. If error still exists, then it deselects/reselects drive and then homes to track 0, up to 2 times, repeating 1 and 2. If error still exists, the error is treated as "permanent" and unrecoverable and the operation is aborted.

These error recovery steps are performed in nested fashion. That is, a separate counter is maintained for each error retry state, 1, 2, and 3. If step 1 fails, (its counter reaching 5), then step 2 is performed and its counter incremented. Meanwhile, the step 1 counter is reset, and its process again performed. If successive errors cause the step 2 counter to reach its maximum, then step 3 is performed, and its counter incremented. Both the first and second counters are reset, and step 1 is reinitiated. Thus a total of sixty (5x6x2) retry steps are performed before the error is declared non-recoverable. This retry process can take up to 75 seconds.

If the error is non-recoverable, the CBIOS issues an error messsage stating:

```
n DRV:  ERR CODE= D
```

n here identifies the drive A, B, or C. Further identification of the error code follows the message.

The CBIOS then returns the error to its caller, the CP/M Basic Disk Operating System (BDOS). BDOS reports the error to the user, in less descriptive terms than the CBIOS in the following message:

```
BDOS ERR ON n: BAD SECTOR
```

The BDOS operation is suspended until the user hits any key except control-C. When any other key is hit, the BDOS retries the I/O. If the user wishes to end error processing, he must hit control-C or reset to the Sorcerer Monitor and perform either a warm boot (GO 0) or a cold boot.

If the user chooses the Diagnostic Error Message option, each error issues an I/O error message even if recovered by the CBIOS. In the event of a nonrecoverable error, the CBIOS prints 60 diagnostic error messages before declaring the error nonrecoverable and issuing the above error message. This procedure slows down recovery considerably. Only technicians diagnosing disk-related hardware errors should use this option.

One peculiar "error" of CP/M systems is the write protect error. The CBIOS shows this error message to the user:

```
n DRV: ERR CODE=B
```

However, the CBIOS doesn't report the error to the BDOS. Thus the BDOS thinks it is writing to a disk, but cannot because it is a write protected disk. The BDOS discovers the error only after it reads back the directory data and it does not agree with what it remembered having "written". This usually results in the following error message:

```
BDOS ERR ON n: R/O
```

The write protect error occurs when CP/M performs "token" directory writes upon reading each new extent of a file. Thus if a PIP (Peripheral Interchange Program) is performed on a large (>16K) file from a write protected diskette to a writable diskette, the token directory writes cause write protect errors on the write protected source diskette. If the CBIOS returned the write protect error to the BDOS, the user could never copy files from a write protected diskette (even though only reads are to be done). These wrtie protect errors on a diskette used only for input can be ignored as a peculiarity in CP/M.

B. CP/M Programming

Cache BIOS does not immediately, upon user request, execute disk writes. At any given moment there may be "dirty" buffers in the cache, that is, buffers which should be written to disk. Writing such buffers to disk is called "flushing the cache". The typical user who interfaces to the CBIOS through the BDOS, that is, does logical file I/O, documented in the "Interface Guide", does not need to be aware of the flushing mechanism. The cache is automatically flushed upon BDOS file closing. Only the user who performs direct CBIOS I/O through the vector needs to be aware of cache flushing. The cache is flushed when:

1. An I/O error occurs
2. A write to the directory track occurs
3. A CBIOS disk select occurs

Programmers using the non-standard CBIOS I/O functions and not the standard BDOS ones should be careful and account for caching processes.

The best guide to CP/M programming is Digital Research's "CP/M Interface Guide." Although the guide is accurate and informative, additional information may help the user overcome any problems he may encounter, as listed below.

1. The address of the last SETDMA call is used as the CP/M directory buffer of the BDOS Open, Close, and Delete commands. These calls destroy the buffer set for the last disk I/O. This feature is visible when the CCP SAVE command destroys the last 128 bytes of memory it writes to disk after closing the file it just saved. THUS MORE THAN ONE SAVE CANNOT BE DONE IN A ROW.

2. The BDOS search commands (function numbers 17 and 18) do not work as indicated in the "CP/M Interface Guide". The following provides accurate information

   a. The Search command (17) does not return a byte pointer. Instead, it returns the index of the found file (within the directory) to register A, or to 255 if a match is not found. The index of the file is within the range of 0 to 127, since the Exidy CP/M contains up to 128 directory entries. Directory entries are 32 bytes per entry, thus there are four entries per sector. The BDOS, searching for the

desired file, reads directory sectors into its DMA buffer, located from 80 to FF hex. These facts provide the basis for the following formula. The File Control Block (FCB) for the found file is located at:

80H + MOD(index,4)*32

The BDOS returns "index" and MOD is the modulus function which returns the remainder of "index" divided by 4.

b. Only after the initial search (17), may search (18) occur. The Interface Guide incorrectly states that an FCB parameter is required. Actually, the FDB from the previous search call (17) is used. The parameter returns in the A register and is a directory index exactly as described above in 2a.

4. ERROR MESSAGES

The following is the error message format with an explanation of the various error codes:

x DRV: ERR CODE=c

where x represents the drive on which the error occurred (A, B, or C) and c represents one of the following:

A - Disk Select Error- The disk selected was not drive "A", "B", or "C".

B - Write Protect Error- The attempt to write to a write protected diskette was not reported to the BDOS as an error. See III. B., CP/M Programming.

C - Disk Track Out of Range- A track number was detected past the end of the disk, indicating that the CP/M is very sick.

D - Non-Recoverable Disk I/O Error- All retries have failed to eliminate a read or write error. A more complete description follows this section.

E - Insufficient Memory for Disk Cache Buffers- At initialization, cache buffers are allocated. This error occurs if there is not sufficient space for one cache buffer, see II. D, Cache Buffer Allocation.

F - Error on Cache Flush- An error occured while the cache was flushed. The last CP/M job or command should be redone.

A non-recoverable disk I/O error (Code D) has a few possible causes, which is one of the following:

(I/O Type):TRK=ttH, SCTR=ssH: STAT=bbH *

Where I/O Type is of the following:

READ ERR - Error occured during read operation

WRITE ERR - Error occured during write operation

RDAFTWR VERIFY ERR - The read after write option was selected, and the verify did not agree. The write however, was done successfully.

Note that track and sector values (tt and ss) are expressed in hexadecimal.

The status value (bb) is eight bits of status flags from the disk controller, expressed in hexadecimal. Only the status flags listed below are used for error indicators.

04H (bit 2) - Lost data (data overrun/underrun)

08H (bit 3) - CRC error

10H (bit 4) - Record Not Found (RNF)

20H (bit 5) - Write Fault for Write command

40H (bit 6) - Write Protect Flag

80H (bit 7) - Not Ready Flag

These codes show up in messages like this:

A DRV: ERR CODE = D

READ ERR: TRK=02, SCTR=05: STAT=10H

This message would tell the user that he has a non-recoverable disk I/O error (ERR CODE = D) on the second track of sector 5 and its status, 10H refers to bit 4, Record Not Found.

ADDITIONAL CONFIGURATIONS SUPPORTED BY THE EXIDY CP/M'S CBIOS

I. INTRODUCTION

The operation of the CP/M CBIOS on the hard-sectored Micropolis Mod II (77 track) and I (38 track) is very similar to its operation on the DDS and the FDS. Therefore, all the information described for those systems is accurate for users with the Micropolis Mods I and II. The only differences are listed here:

II. HARDWARE FOR THE MICROPOLIS MOD I AND II DUAL DISK UNIT WITH S100 AND DDS WITH HARD-SECTORED 77 TRACK DISKS.

The Exidy CBIOS runs on a Sorcerer system with S100 Expansion and Micropolis Dual Disk Units or with the hard-sectored DDS disk. The dual disk is a Micropolis quad density, and the associated disk controller is for hard 16 sector per track diskettes. The CBIOS supports up to 4 drives, allowing the usage of two dual disk units on a system.

Upon cold boot, CP/M should output the following message on the system:

```
CP/M on Exidy Sorcerer
32K CP/M VERS. 1.42/3
Copyright (C) 1979 Exidy Inc.
```

It should be noted that the Mod I has 38 tracks and the Mod II or hard DDS has 77.

II. Options

All three systems (Micropolis Mods I and II and DDS Hard Sectored 77 track disks) have both the options described earlier, Diagnostic Error and Read After Write Data Verification. An additional option, the Pre-Write Read Verification is featured on these systems. By default this third option is set.

The Pre-write Read option verifies that the disk head is located on the proper track before the write operation is performed. This verification is performed by reading the header of a sector on the track and insuring that the number in the header agrees with the requested track. This option causes no performance degradation due to the interleaving sectors on the disk. The user is advised to leave this option set.

The bit designations remain the same for the other two options, with bit 1 (02 hex) assigned to Pre-Write Read Verification Option. If the value of the bit is 1, then the option is asserted. Thus the default value is 03 hex, with Read After Write, Pre-Write Read Verification and no Diagnostic Error Messages options asserted.

III. Error Messages

The status value, expressed in hexidecimal at the conclusion of Error Messages is not the same for any of these three systems. Instead, the lower digit value of STAT in an error code is interpreted as follows (the upper digit has no meaning for the user):

Stat	Message/Explanation
X1	HOME ERR Did 90 step-outs but could not find track 0 status.
X2	SEEK ERROR (Not currently implemented.)
X3	SYNC BYTE NOT OFFH During a read operation, the sync byte was not FF.
X4	HDR BYTE NOT ZERO Header byte with non-zero value (all ten header bytes must be zero).
X5	TS ID MISMATCH Track/sector ID read from diskette do not match track/sector requested.
X6	CKSMS DON'T AGREE Checksum read from a sector does not match the checksum computed from the data read.
X7	DATA COMPARE ERROR Read after write found that data did not agree with the data written.

VERIFY READ ERROR	---	Error occurred while reading the copied data on drive B. See "READ ERROR" above.
HOME ERROR	---	Error occurred while "homing" the heads. Probable drive problem with A or with B.
INCORRECT CP/M VERSIONS	---	COPYDISK only runs on Exidy CP/M version 1.42/3 and any later version.
A DISK ERROR HAS OCCURRED ON DRIVE d ERROR CODE cc	---	This message is displayed for all errors to show the affected drive (d) and the CP/M hardware error code (cc). See the Exidy CP/M User's Guide for details on this code.
WRITE TO WRITE PROTECTED DISKETTE	---	Remove write-protect sticker tab before using the diskette in drive B (make certain the correct diskette is inserted).