ATARI GEMDOS
-
REFERENCE MANUAL

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INTRODUCTION

THIS IS A PRELIMINARY DOCUMENT. IT MAY CONTAIN INACCURACIES AND MISINFORMATION. PLEASE REPORT ANY BUGS IN THIS DOCUMENT TO ATARI.

This is the Atari GEMDOS User's Manual. It describes the internals and use of GEMDOS on the Atari ST. This manual is divided into three parts; a tutorial and introduction for beginning users, a reference manual for application writers, and appendices for GEMDOS wizards.

The GEMDOS Tutorial is a gentle introduction to the basics of GEMDOS. Its intention is to get beginning users started as quickly as possible. It gives example programs, designed to exercise most of GEMDOS, which combine into a simple commandline interface, or "shell". The tutorial also covers common pitfalls and useful shortcuts.

The GEMDOS Reference Manual is the application-writer's bible. It covers GEMDOS' calling conventions, file and handle manipulation, process execution, and every GEMDOS call.

The Appendices contain nitty-gritty details and hints for those who have to push GEMDOS to the limit. They are for application writers (and the merely curious) who have "need to know" about obscurities in the system.

To use this manual effectively readers should be familiar with C and 68000 assembly language. Familiarity with MSDOS, Unix[1], and the standard C runtime library will also help.

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[1] Unix ist ein eingetragenes Warenzeichen der Bell Laboratories.

CALLING CONVENTIONS

GEMDOS uses the Alcyon (or Digital Research) C calling conventions. Note that these conventions may differ from other 68000 C compilers. If you are using another C compiler it might not be possible to call GEMDOS directly; please check your compiler's documentation for compatibility.

Arguments are pushed on the stack, in reverse order of their declaration. The GEMDOS function number is pushed last, as a WORD. To do the call to GEMDOS, a 68000 "TRAP #1" instruction is executed. The trap can be made with the 68000 in user or supervisor mode.

NOTE

Applications running in supervisor mode may be forced back into user mode after making a GEM AES call.

Stack Snapshot
(Just Before a GEMDOS Trap)

stack	contents
(sp)	WORD function number
2(sp)	argument 1
X(sp)	argument 2
Y(sp)	argument 3
.	.
.	... and so on ...
.	.

Results are returned in D0. Registers D0-D2 and A0-A2 can be modified; registers D3-D7 and A3-A7 will always be preserved. The caller is responsible for popping the arguments (including the function number) off of the stack after the call.

The Alcyon C compiler does not generate TRAP instructions, so most applications use a small assembly-language binding. It typically looks like:

```
    text
*+
*  GEMDOS binding for Alcyon C
*
*  NOTE:
*    This binding is NOT re-entrant, and cannot
*    be shared by foreground and interrupt code.
*
*-
        .globl  _gemdos
_gemdos:
        move.l  (sp)+,tlsav     ; save ret addr
        trap    #1              ; call GEMDOS
        move.l  tlsav,-(sp)     ; restore ret addr
        rts                     ; do "real" return

    bss
tlsav:  ds.l    1               ; saved ret addr
```

FILENAMES

A filename consists of a drive specification followed by a pathname and a simple filename. A drive specification consists of a single letter, A through P, followed by a colon; if the specification is missing, the default drive is used. A pathname consists of a list of simple filenames separated with backslashes. If the pathname starts with a backslash it is anchored in the root directory, otherwise it is anchored in the current directory. If the pathname is missing, the current directory is used. A simple filename consists of one to eight characters, optionally followed by a period and zero to three more characters.

Legal characters in filenames and pathnames include the alphabet (A-Z), digits (0-9), and most punctuation. Periods, colons, backslashes, slashes, question-marks, asterisks, control characters (including NULs), and characters greater than 0x7f may never appear in filenames. Lowercase letters are converted to uppercase.

A full file specification may not exceed 125 characters.

Legal Characters in Filenames
letters A-Z, a-z numbers 0-9 _ (underscore) ! @ # $ % ^ & ( ) + - = ~ ` ; ' " , < > | [ ] { }

In a pathname, "." refers to the current directory and ".." refers to the current directory's parent directory. Thus, the paths:

```
"..\..\foo"
```

and

```
".\.\.\.\.\.\..\.\.\..\.\foo"
```

refer to the same file two directories up from the current one. (There is no parent directory at the root.)

There are three character devices. Only the calls Fread(), Fwrite() Fopen(), Fcreate(), and Fclose(), and the standard I/O functions work on them:

name	handle	device
CON:, con:	0x0ffff (-1)	system console
AUX:, aux:	0x0fffe (-2)	RS232 port
PRN:, prn:	0x0fffd (-3)	printer port

An Fopen( ) or Fcreate( ) call on one of the character devices will return a character device handle. The handle is WORD negative, but not LONG negative.

FILE OPERATIONS

GEMDOS places no restrictions on what a file may contain. Most applications assume that text files contain lines separated with carriage-return linefeeds, with a control-Z indicating the end of file. The format of executable files is documented in the Appendix.

The GEMDOS calls Fcreate( ) and Fopen( ) return small, positive 16-bit integers, called handles, that refer to open files. A file may be opened for reading only, for writing only, or for reading and writing. Closing the file relinquishes the handle, allowing the handle to be re-used.

There are three kinds of handles. Standard handles range from 0 to 5, and may refer to character devices or files. Non-standard handles start at 6, and refer only to files. Character handles refer only to character devices; the handle numbers range from 0xfffd to 0xffff, which are WORD negative, but not LONG negative.

When a process does a Pexec( ) call the child process inherits the parent's standard handles. Handle 0 is often referred to as "standard input" or "standard output"; normally it is connected to the console, CON:. With Fdup( ) and Fforce( ) calls it is possible to redirect a process's standard I/O to or from a file or another character device.

When a media change occurs, all files open on the disk that was removed are forced closed by GEMDOS.

BUGS

There is no concept of "standard error" output.

PROCESSES

Although GEMDOS does not support multitasking, it is possible to execute processes in a subroutine-like manner. A process may "call" another with Pexec(); the child process will terminate with a WORD return code.

A process owns any files it opens and any memory it allocates. Open files are closed and memory is deallocated when the process terminates.

Before a process is actually terminated GEMDOS will call extended vector 0x102. This allows applications to make a "last ditch" effort to recover from error conditions, or to deinstall themselves.

The memory model used by GEMDOS is similar to MSDOS's. A process runs in the TPA (Transient Program Area). The first 0x100 bytes of the TPA is the process's basepage, which contains process-specific information.

Basepage Structure

offset	name	description
0x00	p_lowtpa	-> base of TPA
0x04	p_hitpa	-> end of TPA
0x08	p_tbase	base of text segment
0x0c	p_tlen	size of text segment
0x10	p_dbase	base of data segment
0x14	p_dlen	size of data segment
0x18	p_bbase	size of BSS segment
0x1c	p_blen	base of BSS segment
0x20	p_dta	Disk Transfer Address (DTA)
0x24	p_parent	-> parent's basepage
0x28	(reserved)	
0x2c	p_env	-> enviroment string
0x80	p_cmdlin	commandline image

`p_lowtpa' points to the basepage (to itself). `p_hitpa' points to the TPA's limit, to the first unusable location. `p_tbase', `p_tlen' and so on contain the starting addresses and sizes of the text, data and BSS segments. `p_parent' points to the process's parent process's basepage. `p_env' points to the enviroment string [see Pexec()].

The first byte of the commandline image contains the number of characters in the commandline. The second through Nth bytes contain the image. The image is not guaranteed to be null-terminated.

An application receives control at the starting address of its text segment. The second longword on the stack, 4(sp), will contain a pointer to the process's basepage. Normally all free memory is allocated to a new process; if the process is going to use Malloc() or Pexec() then it must relocate its stack and call Mshrink() to release memory back to the system. The stack segment starts near the highest TPA location and grows toward the BSS.

EXTENDED VECTORS

The 68000 uses vectors 0x02 through 0xff, corresponding to absolute locations 0x0000 through 0x03fc. GEMDOS adds eight logical vectors, numbered 0x100 through 0x107. The absolute locations of the logical vectors is undefined; it is up to the BIOS to allocate storage for them.

Logical Vector Assignments

vector	use
0x100	timer tick
0x101	critical error handler
0x102	terminate (^C) handler
0x103 - 0x107	reserved for future use

0x100 Timer Tick

This vector is called periodically (at 50hz) by the BIOS to maintain the system's date/time-of-day clock and do housekeeping. The first word on the stack, 4(sp), contains the number of milliseconds from the last timer tick interrupt.

To intercept the timer vector, use the BIOS call to get and set the vector. Each handler should execute its own code first, and then follow the old vector. Interrupt handlers should be short and sweet; dawdling here will affect system performance.

All registers (except SP and USP) are modified by GEMDOS. The BIOS takes responsibility for saving registers D0-D7/A0-A6; therefore handlers chained to this interrupt do not have to save and restore registers.

0x101 Critical Error Handler

The Critical Error Handler is called by the BIOS to handle certain errors (rwabs() disk errors and media change requests.) It allows the application to handle the errors as it sees fit.

The first word on the stack, 4(sp), is an error number. Depending on the error, other arguments may also be on the stack. The critical error handler should preserve registers D3-D7/A3-A6. When the handler returns, D0 contains a result code:

value in D0.L	meaning
0x00010000	retry
0x00000000	pretend there wasn't an error (ignore)
0xffffffXX	abort with an error

The default critical error handler simply returns -1.

0x102 Terminate (^C) Handler

Before a process is actually terminated, GEMDOS calls the terminate vector. If the terminate vector points to an RTS (the default case), the process will be terminated. If the application does not wish to be terminated it should do a longjump (or its equivalent) to an appropriate handler.

ERROR NUMBERS

All error numbers are negative. Two ranges of errors are defined; BIOS errors range from -1 to -31 and GEMDOS errors range from -32 to -127.

BIOS Error Codes

name	number	description
E_OK	0	OK (no error)
ERROR	-1	Error
EDRVNR	-2	Drive not ready
EUNCMD	-3	Unknown command
E_CRC	-4	CRC error
EBADRQ	-5	Bad request
E_SEEK	-6	Seek error
EMEDIA	-7	Unknown media
ESECNF	-8	Sector not found
EPAPER	-9	Out of paper
EWRITF	-10	Write fault
EREADF	-11	Read fault
	-12	(unused)
EWRPRO	-13	Write on write-protected media
E_CHNG	-14	Media change detected
EUNDEV	-15	Unknown device
EBADSF	-16	Bad sectors on format
EOTHER	-17	Insert other disk (request)

`EOTHER' is really a request from the BIOS to insert another disk in drive A:. The "virtual" disk number (0 or 1) is at 6(sp). This feature is used to fake GEMDOS into thinking that a single drive system really has two drives.

GEMDOS Error Codes
(numbers in parenthesis
are MSDOS-equivalent error#s)

name	number	description
EINVFN	-32 (1)	Invalid function number
EFILNF	-33 (2)	File not found
EPTHNF	-34 (3)	Path not found
ENHNDL	-35 (4)	Handle pool exhausted
EACCDN	-36 (5)	Access denied
EIHNDL	-37 (6)	Invalid handle
ENSMEM	-39 (8)	Insufficient memory
EIMBA	-40 (9)	Invalid memory block address
EDRIVE	-46 (15)	Invalid drive specification
ENMFIL	-47 (18)	No more files
ERANGE	-64	Range error
EINTRN	-65	GEMDOS internal error
EPLFMT	-66	Invalid executable file format
EGSBF	-67	Memory block growth failure

GEMDOS FUNCTIONS BY NUMBER
0x00 Pterm0 - Terminate Process
0x01 Cconin - Read character from Standard Input
0x02 Cconout - Write Character to Standard Output
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0x2B Tsetdate - Set Date
0x2C Tgettime - Get Time
0x2D Tsettime - Set Time
0x2F Fgetdta - Get DTA (Disk Transfer Address)
0x30 Sversion - Get Version Number
0x31 Ptermres - Terminate and Stay Resident
0x36 Dfree - Get Drive Free Space
0x39 Dcreate - Create Directory
0x3A Ddelete - Delete Directory
0x3B Dsetpath - Set Current Directory
0x3C Fcreate - Create File
0x3D Fopen - Open File
0x3E Fclose - Close File
0x3F Fread - Read From File
0x40 Fwrite - Write To File
0x41 Fdelete - Delete File
0x42 Fseek - Seek File Pointer
0x43 Fattrib - Get/Set File Attributes
0x45 Fdup - Duplicate File Handle
0x46 Fforce - Force File Handle
0x47 Dgetpath - Get Current Directory
0x48 Malloc - Allocate Memory
0x49 Mfree - Release Memory
0x4A Mshrink - Shrink Size of Allocated Block
0x4B Pexec - Load/Execute Process
0x4C Pterm - Terminate Process
0x4E Fsfirst - Search First
0x4F Fsnext - Search Next
0x56 Frename - Rename File
0x57 Fdatime - Get/Set File Timestamp

GEMDOS FUNCTIONS BY NAME
0x03 Cauxin - Read Character from Standard AUX:
0x12 Cauxis - Check Status of Standard AUX: Input
0x13 Cauxos - Check Status of Standard AUX: Output
0x04 Cauxout - Write Character to Standard AUX:
0x01 Cconin - Read character from Standard Input
0x0B Cconis - Check Status of Standard Input
0x10 Cconos - Check Status of Standard Output
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0x0A Cconrs - Read Edited String from Standard Input
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0x3B Dsetpath - Set Current Directory
0x43 Fattrib - Get/Set File Attributes
0x3E Fclose - Close File
0x3C Fcreate - Create File
0x57 Fdatime - Get/Set File Timestamp
0x41 Fdelete - Delete File
0x45 Fdup - Duplicate File Handle
0x46 Fforce - Force File Handle
0x2F Fgetdta - Get DTA (Disk Transfer Address)
0x3D Fopen - Open File
0x3F Fread - Read From File
0x56 Frename - Rename File
0x42 Fseek - Seek File Pointer
0x1A Fsetdta - Set DTA (Disk Transfer Address)
0x4E Fsfirst - Search First
0x4F Fsnext - Search Next
0x40 Fwrite - Write To File
0x48 Malloc - Allocate Memory
0x49 Mfree - Release Memory
0x4A Mshrink - Shrink Size of Allocated Block
0x4B Pexec - Load/Execute Process
0x4C Pterm - Terminate Process
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0x31 Ptermres - Terminate and Stay Resident
0x20 Super - Get/Set/Inquire Supervisor Mode
0x30 Sversion - Get Version Number
0x2A Tgetdate - Get Date
0x2C Tgettime - Get Time
0x2B Tsetdate - Set Date
0x2D Tsettime - Set Time

0x00 Pterm0 - Terminate Process

void Pterm0( )

Terminate this process, closing all files it opened and releasing any memory it allocated. Return an exit code of 0x0000 to the parent process.

0x01 Cconin - Read character from Standard Input

LONG Cconin( )

Read character from the standard input (handle 0). If the standard input device is the console, the longword returned in D0 contains both the ASCII and the console scancode:

31..24	23..16	15..8	7..0
0x00 or shift bits	scancode or 0x00	0x00	ASCII char

The function keys (F1 through F10, HELP, UNDO, etc.) return the ASCII code 0x00, with appropriate scancode values; see the GEM/VDI manual for keyboard scancode assignments. The ST BIOS is capable of placing the keyboard shift-key status in bits 24..31; see the BIOS Programmer's Guide for further details.

BUGS
Does not return any indication of end of file.
Control-C is not recognized.
There is no way to tell if standard input is a character device or a file.
There should be some way to type all possible 256 codes from the keyboard.

0x02 Cconout - Write Character to Standard Output

```
void Cconout(c)
WORD c;
```

Write the character `c' to the standard output (handle 0). The high eight bits of `c' are reserved and must be zero. Tabs are not expanded.

0x03 Cauxin - Read Character from Standard AUX:

```
WORD Cauxin()
```

Read character from handle 1 (normally the serial port, AUX:).

BUGS
This function causes RS232 flow-control to fail; applications should use the BIOS character device calls to avoid losing received characters.

0x04 Cauxout - Write Character to Standard AUX:

```
void Cauxout(c)
WORD c;
```

Write `c' to standard handle 1 (normally AUX:, the serial port). The high eight bits of `c' are reserved and must be zero. Tabs are not expanded.

BUGS
This function causes RS232 flow-control to fail; applications should use the BIOS character device calls to avoid losing transmitted characters.

0x05 Cprnout - Write Character to Standard PRN:

```
void Cprnout(c)
WORD c;
```

Write `c' to handle 2 (normally PRN:, the printer port). The high eight bits of `c' are reserved and must be zero. Tabs are not expanded

0x06 Crawio - Raw I/O to Standard Input/Output

```
LONG Crawio(w)
WORD w;
```

If `w' is not 0x00FF, write it to the standard output. Tabs are not expanded

Otherwise, if` `w' equals 0x00ff, read a character from the standard input. 0x0000 is returned if no character is available.

BUGS
Because of the way this function is defined, `0xff' cannot be written to the standard output with this function.
Cannot distinguish between 0x00 and the end of the file.

0x07 Crawcin - Raw Input from Standard Input

```
LONG Crawcin( )
```

Read a character from the standard input (handle 0). If the input device is CON: no control character processing is done and the character is not echoed.

BUGS
No end of file indication.

0x08 Cnecin - Read Character from Standard Input, No Echo

```
LONG Cnecin()
```

Read character from the standard input. If the input device is CON:, no echoing is done, although control characters are interpreted.

0x09 Cconws - Write String to Standard Output

```
void Cconws(str)
char *str;
```

Write a null-terminated string, starting at `str', to the standard output.

0x0A Cconrs - Read Edited String from Standard Input

```
void Cconrs(buf)
char *buf;
```

Read string from the standard input, handling common line editing characters. The editing characters are:

Char	Function
<return>, ^J	End the line
^H, <rub>	Kill last character
^U, ^X	Kill entire line
^R	Retype line
^C	Terminate the process

The first character of `buf' indicates the size of the data part of the buffer. On return, the second byte of `buf' is set to the number of characters read, and locations `buf+2' through 'buf+2+buf[1]' contain the characters.

The string is <u>not</u> guaranteed to be null-terminated.

BUGS
Hangs on end-of-file.

0x0B Cconis - Check Status of Standard Input

```
WORD Cconis()
```

Return 0xFFFF if a character is available on the standard input, 0x0000 otherwise.

0x0E Dsetdrv - Set Default Drive

```
LONG Dsetdrv(drv)
WORD drv;
```

Set the default drive to the zero-based drive number `drv' (ranging from 0 to 15, A: to P:). Return a bit-string of known drives (bit 0 = A, bit 1 = B, etc.)

A "known drive" is one on which a directory has been used.

BUGS

GEMDOS only supports 16 drives (bits 0 through 15). Future systems will support 32 drives.

0x10 Cconos - Check Status of Standard Output

```
WORD Cconos()
```

Return 0xFFFF if the console is ready to receive a character. Return 0x0000 if the console is NOT ready.

BUGS

CON: and files are always ready, so why check?

0x11 Cprnos - Check Status of Standard PRN:

```
WORD Cprnos()
```

Return 0xFFFF if PRN: is ready to receive a character, 0x0000 if it isn't.

0x12 Cauxis - Check Status of Standard AUX: Input

```
WORD Cauxis( )
```

Return 0xFFFF if a character is available on AUX: (handle 1), 0x0000 if not.

0x13 Cauxos - Check Status of Standard AUX: Output

```
WORD Cauxos( )
```

Return 0xFFFF if AUX: (standard handle 1) is ready to accept a character, 0x0000 if not.

0x19 Dgetdrv - Get Default Drive

```
WORD Dgetdrv( )
```

Return the current drive number, 0 through 15.

0x1A Fsetdta - Set DTA (Disk Transfer Address)

```
void Fsetdta(addr)
char *addr;
```

Set the DTA to `addr'. (The DTA is used only by the functions Fsfirst( ) and Fsnext( ).)

0x20 Super - Get/Set/Inquire Supervisor Mode

```
LONG Super(stack)
WORD *stack;
```

If `stack' is -1L (0xFFFFFFFF) return 0x0000 if the processor is in user mode, or 0x0001 if the processor is in supervisor mode.

Otherwise, if the processor is in user mode, return with the processor switched to supervisor mode. If `stack' is NULL (0x00000000) then the supervisor stack will be the same as the user stack before the call. Otherwise the supervisor stack will be set to `stack'.

If the processor is in supervisor mode, return with the processor switched back to user mode. `stack' should be the value of the supervisor stack that was returned by the first call to the function.

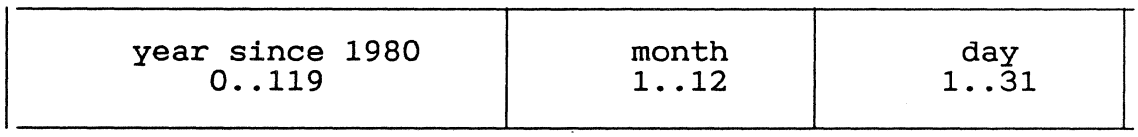
NOTE

The original supervisor stack value MUST be restored before the process terminates. Failure to do so will result in a system crash.

0x2A Tgetdate - Get Date

```
WORD Tgetdate()
```

Return the current date, in DOS format:



RETURNS

Bits:
0..4 contain the day, ranging 1..31.
5..8 contain the month ranging 1..12.
9..15 contain the year (since 1980) ranging 0..119.

0x2B Tsetdate - Set Date

```
WORD Tsetdate(date)
WORD date;
```

Set the current date to `date', which is in the format described in Tgetdate( ).

RETURNS
0 on valid date;
ERROR on an obviously screwed-up date.

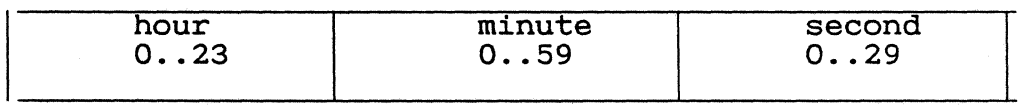
BUGS
GEMDOS is not picky about date parameters; for instance, it likes Feb 31st ....

GEMDOS does NOT let the BIOS know that the date has been changed.

0x2C Tgettime - Get Time

```
WORD Tgettime( )
```

Return the current time in DOS format:



RETURNS
Bits 0..4 contain the second divided by 2, 0..29.
Bits 5..10 contain the minute, 0..59.
Bits 11..15 contain the hour, 0..23.

0x2D Tsettime - Set Time

```
WORD Tsettime(time)
WORD time;
```

Set the current time to `time', which is in the format described in Tgettime().

RETURNS
0 if GEMDOS liked the time;
ERROR if it didn't.

BUGS
GEMDOS does NOT let the BIOS know that the time has been changed.

0x2F Fgetdta - Get DTA (Disk Transfer Address)

```
LONG Fgetdta()
```

Returns the value of the current DTA, a pointer used by the functions Fsfirst() and Fsnext().

0x30 Sversion - Get Version Number

```
WORD Sversion()
```

Return GEMDOS's version number (in byte-reversed format). The high byte contains the minor version number, the low byte contains the major version number.

NOTE
The 5/29/85 (first disk-based) and the 11/20/85 (first ROM-based) release of GEMDOS had the version number 0x1300.

GEMDOS version numbers and TOS versions numbers are not one and the same. See the ST BIOS REFERENCE MANUAL for about TOS version numbers.

0x31 Ptermres - Terminate and Stay Resident

```
void Ptermres(keepcnt, retcode)
LONG keepcnt;
WORD retcode;
```

Terminate the current process, keeping some of it in memory. `keepcnt' is the amount of the memory belonging to the process to keep, including and starting at the 256-byte basepage. `retcode' is the exit code that is returned to the parent process.

Memory the process has allocated (in addition to the TPA) will NOT be released.

Ptermres( ) will never return.

BUGS
Open files are closed as part of termination.

0x36 Dfree - Get Drive Free Space

```
void Dfree(buf, driveno)
LONG *buf;
WORD driveno;
```

Get disk allocation information about the drive `driveno' and store it into four longwords starting at `buf':

buf + 0	# of free clusters
buf + 4	total # of clusters
buf + 8	sector size (in bytes)
buf + 12	cluster size (in sectors)

BUGS
Incredibly slow (5-10 seconds) on a hard disk.

0x39 Dcreate - Create Directory

```
WORD Dcreate(pathname)
char *pathname;
```

Create a directory. `pathname' points to a null-terminated string specifying the pathname of the new directory.

RETURNS
0 on success;
ERROR or appropriate error number on failure.

0x3A Ddelete - Delete Directory

```
WORD Ddelete(pathname)
char *pathname;
```

Delete a directory (it must be empty, except for the special directories "." and ".."). `pathname' points to a null-terminated string specifying the pathname of the directory to remove.

RETURNS
0 on success;
ERROR or appropriate error number on failure.

0x3B Dsetpath - Set Current Directory

```
WORD Dsetpath(path)
char *path;
```

Set the current to `path', a null-terminated string. If the path begins with a drive letter and a colon, set the current directory on the specified drive.

A current directory is kept for each drive in the system.

RETURNS
0 for success;
ERROR or an appropriate error number.

0x3C Fcreate - Create File

```
WORD Fcreate(fname, attribs)
char *fname;
WORD attribs;
```

Create a file `fname' and return a write-only non-standard handle to it. The attribute word is stored in the directory entry; its bit assignments are:

mask	description
0x01	file set to read-only
0x02	file hidden from directory search
0x04	file set to "system"
0x08	file contains 11-byte volume label

RETURNS

a positive number, a handle, or:
ERROR or an appropriate error number.

BUGS

Useless feature department: If the `read-only' bit is set, a write-only handle is returned, and the handle can't be written to.

Ideally, only one volume label is permitted in the volume's root directory. GEMDOS doesn't enforce this, though, which could cause confusion.

0x3D Fopen - Open File

```
WORD Fopen(fname, mode)
char *fname;
WORD mode;
```

Open the `fname' according to `mode', and return a non-standard handle to it. The open mode can be:

mode	description
0	read only
1	write only
2	read or write

RETURNS
a positive number, a handle, or:
a negative error number.

0x3E Fclose - Close File

```
WORD Fclose(handle)
WORD handle;
```

Close the file associated with the handle.

RETURNS
0 on success;
ERROR or an appropriate error number.

0x3F Fread - Read From File

```
LONG Fread(handle, count, buffer)
WORD handle;
LONG count;
char *buffer;
```

Read from a file. From the file referred to by `handle' read `count' bytes into memory starting at `buffer'.

RETURNS
the number of bytes actually read, or:
0 on end of file, or:
a negative error number.

0x40 Fwrite - Write To File

```
LONG Fwrite(handle, count, buffer)
WORD handle;
LONG count;
char *buffer;
```

Write to a file. Write `count' bytes from memory, starting at `buffer', to the file referred to by `handle'.

RETURNS
the number of bytes actually written, or:
a negative error number.

0x41 Fdelete - Delete File

```
WORD Fdelete(fname)
char *fname;
```

Delete the file `fname'.

RETURNS
0, success, or:
a negative error number.

0x42 Fseek - Seek File Pointer

```
LONG Fseek(offset, handle, seekmode)
LONG offset;
WORD handle;
WORD seekmode;
```

Set the current position within the file associated with `handle'. `offset' is a signed number; positive values move toward the end of the file, and negative values move toward its beginning. `seekmode' can be:

seekmode	Moves `offset' bytes ...
0	from beginning of file
1	relative to current position
2	from end of file

RETURNS

The current, absolute position in the file.

0x43 Fattrib - Get/Set File Attributes

```
WORD Fattrib(fname, wflag, attribs)
char *fname;
WORD wflag;
WORD attribs;
```

Get or set a file's attribute bits. `fname' points to a null-terminated pathname. If `wflag' is 1, set the file's attributes from `attribs' (no return value). If `wflag' is 0, return the file's attributes.

The attribute bits are:

mask	description
0x01	file is read-only
0x02	file hidden from directory search
0x04	file set to "system"
0x08	file contains 11-byte volume label
0x10	file is a subdirectory
0x20	file has been written to and closed.

BUGS

The "archive" bit, 0x20, doesn't seem to work as advertised.

0x45 Fdup - Duplicate File Handle

```
WORD Fdup(handle)
WORD handle;
```

The handle `handle' must be a standard handle (0..5); Fdup() returns a non-standard handle (greater than or equal to 6) that refers to the same file.

RETURNS

a handle, or:
EIHNDL - not a standard handle
ENHNDL - no more standard handles available

0x46 Fforce - Force File Handle

```
Fforce(stdh, nonstdh)
WORD stdh;
WORD nonstdh;
```

Force the standard handle `stdh' to point to the same file or device as the non-standard handle `nonstdh.'

RETURNS

OK, or:
EIHNDL - invalid handle

0x47 Dgetpath - Get Current Directory

```
void Dgetpath(buf, driveno)
char *buf;
WORD driveno;
```

The current directory for the specified drive `driveno' is copied into `buf'. The drive number is 1-based: 0 specifies the default drive, 1 specifies A:, and so on.

BUGS

The maximum size of a pathname is not limited by the system; it is up to the application to provide enough buffer space. 128 bytes should be enough for 8 or 9 levels of subdirectories.

0x48 Malloc - Allocate Memory

```
LONG Malloc(amount)
LONG amount;
```

If `amount' is -1L ($FFFFFFFF) return the size of the largest free block in the system.

Otherwise, if `amount' is not -1L, attempt to allocate `amount' bytes for the current process. Return a pointer to the beginning of the block or NULL if there is no free block large enough to meet the request.

BUGS
WARNING
A process may not have, at any time, more than 20 blocks of Malloc()'d memory. Exceeding this limit may cripple GEMDOS. [It is OK to do many Malloc() calls if they are followed by matching Mfree() calls; the limit of 20 is to the number of fragments a process may generate.]

0x49 Mfree - Release Memory

```
WORD Mfree(saddr)
LONG saddr;
```

Free the block of memory starting at `saddr'; the block must be one that was returned by Malloc().

RETURNS
0 if the release was successful, or:
ERROR or an appropriate error number.

0x4A Mshrink - Shrink Size of Allocated Block

```
WORD Mshrink(0, block, newsiz)
(WORD) 0;
LONG block;
LONG newsiz;
```

Shrink the size of an allocated block of memory; `block' points to a process basepage or a piece of memory allocated by Malloc(), `newsiz' is the new size of the block.

The first argument must be a WORD of zero.

RETURNS

0 if the size adjustment was successful, or:
EIMBA - invalid memory block address
EGSBF - setblock failure due to growth restrictions

BUGS

A block can only be shrunk; `newsiz' must be less than or equal to the current block size.

0x4B Pexec - Load/Execute Process

```
WORD Pexec(mode, ptr1, ptr2, ptr3)
WORD mode;
char *ptr1;
char *ptr2;
char *ptr3;
```

This function wears several hats, according to the flag `mode':

mode	ptr1	ptr2	ptr3
0 = load & go	file to exec	command tail	enviroment string
3 = load, no go	file to load	command tail	enviroment string
4 = just go	basepage address	(unused)	(unused)
5 = create basepage	(unused)	command tail	enviroment string

The file to load or exec, `ptr1', and the command tail, `ptr2', are null-terminated pathnames. The enviroment string, `ptr3', is either NULL (0L), or a pointer to a string structure of the form:

```
"string1\0"
"string2\0"
... etc. ...
"stringN\0"
   "\0"
```

The enviroment string is any number of null-terminated strings, with an empty string (a single null) at the end. If `ptr3' is NULL, then the process inherits a copy of the parent's enviroment string.

Load-and-go (mode 0) will load the specified file, set-up its basepage, and execute it. Pexec()'s return value will be the child process's exit code (see Pterm0() and Pterm()).

Load-nogo will load the specified file, setup its basepage, and return a pointer to the basepage; the process is not executed.

Just-go is passed a pointer to a basepage. The process

starts executing at the base of its text segment, as specified in the basepage.

Create-basepage will allocate the largest free block of memory and create most of a basepage for it. (Some entries, most significantly the text/data/bss size and base values, are NOT setup -- the caller is responsible for maintaining them).

A child process inherits the parent's standard file descriptors; effectively doing an Fdup( ) and an Fforce( ) call on handles 0 through 5.

Since system resources are allocated when a basepage is created, the spawned process MUST be terminated in order to release them. This is especially important when using overlays; see the [Pexec cookbook] for details on use of Pexec( ).

0x4C Pterm - Terminate Process

```
void Pterm(retcode)
WORD retcode;
```

Terminate the current process, closing all open files and releasing any allocated memory. Return `retcode' to the parent process.

0x4E Fsfirst - Search First

```
WORD Fsfirst(fspec, attribs)
char *fspec;
WORD attribs;
```

Search for the first occurrence of the file `fspec'. The file specification may contain wildcards (`?' and `*') in the simple filename, but not in the path specification. `attrib' controls which files are returned by Fsfirst; its format is described in the documentation on `Fattrib()'.

If `attrib' is zero, then only normal files are searched for (no volume labels, hidden files, subdirectories or system files are returned). If `attrib' is set for hidden or system files, they are included in the search set. If `attrib' is set for volume labels, only volume labels are returned.

When a file is found, a 44-byte structure is written to the location pointed to by the DTA:

offset	size	contents
0-20		(reserved)
21	byte	file attribute bits
22	word	time stamp
24	word	date stamp
26	long	file size
30	14 bytes	file name + extension

The filename and extension is null-terminated, and contains no spaces.

RETURNS

0, if a file was found, or:
EFILNF - file not found (no matches), or:
an appropriate error number.

0x4F Fsnext - Search Next

```
WORD Fsnext()
```

Search for the next occurrence of a file. (The first occurrence should be searched for with Fsfirst()). Bytes 0-20 of the DTA must remain unmodified from the Fsfirst() call or the most recent Fsnext() call.

RETURNS
0 if a file was found, or:
ENMFIL - no more files were found, or:
an appropriate error number.

0x56 Frename - Rename File

```
WORD Frename(0, oldname, newname)
(WORD) 0;
char *oldname;
char *newname;
```

Rename a file from `oldname' to `newname'. The destination file must not exist. The new file may be in another directory.

The first argument must be a zero WORD.

RETURNS
EACCDN - destination file already exists;
EPTHNF - `oldname' not found;
ENSAME - `newname' not on save drive;
or an appropriate error.

0x57 Fdatime - Get/Set File Timestamp

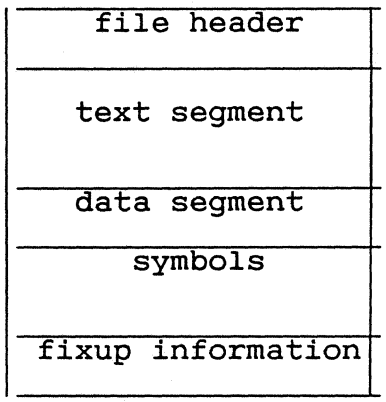
```
void Fdatime(handle, timeptr, wflag)
WORD handle;
LONG timeptr;
WORD wflag;
```

The file is referred to by `handle'. `timeptr' points to two words containing the DOS formatted timestamp (the time word is first, the date word is second). If `wflag' is 1, set the file's timestamp from `timeptr', otherwise read the file's timestamp into `timeptr'.

EXECUTABLE FILES

An executable file consists of a header followed by images for the text and data segments, zero or more symbol table entries, a fixup offset, and zero or more fixup records:

Executable File Parts



The file header contains a "magic" number (a signature to indicate that it is an executable file) and several longwords containing size information:

Executable File Header

Offset	Size	Description
0x00	word	0x601A (magic number)
0x02	long	Size of text segment
0x06	long	Size of data segment
0x0A	long	Size of BSS segment
0x0E	long	Size of symbol table
0x12	long	(reserved)
0x16	long	(reserved)
0x1A	long	(reserved)
0x1E		(start of text segment)

The text and data segment images immediately follow the header. The symbol table, if there is one, follows the data segment.

GEMDOS will "fix up" a longword in the text or data segments by adding the base of the text segment to the value already in the longword. The fixup list specifies which longwords need to be relocated. The first item in the fixup list is a longword specifying the offset of the first fixup;

the longword is NULL (0L) if there are no fixups. Single bytes following the longword specify offsets to more fixups. The longwords must start on word boundaries, or the system will crash.

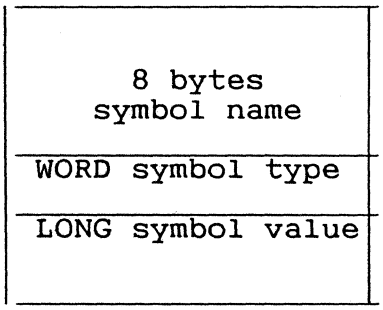
Relocation Bytes

Byte	Description
0	end of relocation information
1	advance 254 bytes, get next byte
2, 4, .. 254	fixup longword at location pointer
3, 5, .. 255	(odd numbers, reserved for future use)

SYMBOL TABLE

The symbol table consists of symbol-table entries, formatted as:

Symbol Table Entry



<<<explain about symbol types here. It's really pretty simple...>>>

Values for Symbol Types

Type	Value
defined	0x8000
equated	0x4000
global	0x2000
equated register	0x1000
external reference	0x0800
data based relocatable	0x0400
text based relocatable	0x0200
BSS based relocatable	0x0100

VOLUME ORGANIZATION

GEMDOS uses the first few sectors of a disk to indicate where files are stored. A volume usually contains five parts; an optional boot sector, two identical FAT tables, a root directory, and a cluster area.

When GEMDOS first accesses a drive (or accesses one after a media change), it makes a `GETBPB' (Get BIOS Parameter Block) BIOS call to determine how big these areas are, and where they are stored on the disk. GETBPB returns a pointer to a nine-word structure. From this structure, GEMDOS can puzzle out where the various parts of the file system are.

BIOS Parameter Block (BPB)

name	value	function
recsiz	512	physical sector size in bytes
clsiz	2	cluster size in sectors
clsizb	1024	cluster size in bytes
rdlen		root directory length in sectors
fsiz		FAT size, in sectors
fatrec		sector# of 1st sector of 2nd FAT
datrec		sector# of 1st data sector
numcl		number of data clusters on disk
bflags		flags

RECSIZ indicates the number of bytes per physical sector; this must be 512 with the current GEMDOS. CLSIZ indicates the number of sectors in a cluster; this must be 2 in the current GEMDOS. CLSIZB is the number of bytes in a cluster, which must be 1024.

RDLEN is the size of the root directory, in sectors. A directory entry uses 32 bytes, so the number of root files available is RDLEN * 512 / 32.

FSIZ is the size of each FAT in sectors. FATREC is the starting sector number of the first sector of the /second/ FAT.

DATREC is the starting sector# of the first cluster. NUMCL is the number of clusters on the device.

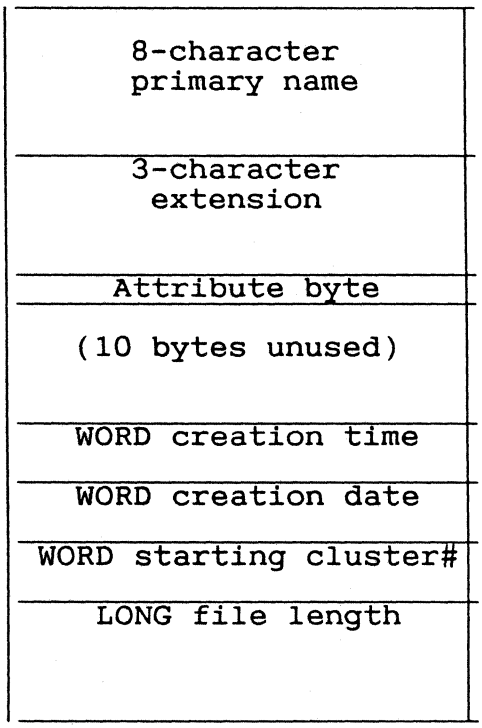
BFLAGS was supposed to be a bit-vector of flags. Currently only bit 0 is being used; when set it indicates that 16-bit FAT entries (instead of 12-bit ones) are to be used.

If there are boot sectors, they occupy logical sectors 0 through FATREC - FSIZ - 1. The second FAT starts at FATREC, and the first FAT starts at FATREC - FSIZ. The root directory starts at FATREC + FSIZ, and the first cluster starts at DATREC. The cluster region is where the data for all files on the volume is kept.

DIRECTORY ENTRIES

A directory entry contains a filename, some flags, the file's creation time and date, the file's size, and the file's starting cluster number. The entry itself is a 32-byte structure that looks like:

Directory Entry



All WORDS and LONGS in the directory entry are in 8086 "byte reversed" format.

When a file is deleted, the first byte of the name field is set to 0xe5.

A subdirectory is a file that contains directory entries. The first two entries in a subdirectory are always the special directories "." and "..".

FAT ENTRIES

The File Allocation Table (FAT) is used to allocate clusters and to link clusters together into files. FAT entries may be 12 or 16 bits. A file's directory entry contains the number of the first cluster in the file. Each cluster's associated FAT entry contains the number of the next cluster in the file, or a number that indicates end-of-file.

12-bit FAT Entries

value	meaning
0x000	free cluster
0x001	(impossible)
0x002 - 0xfef	next cluster number
0xff0 - 0xff7	bad sector
0xff8 - 0xfff	end of file

16-bit FAT Entries

value	meaning
0x0000	free cluster
0x0001	(impossible)
0x0002 - 0x7fff	next cluster number
0x8000 - 0xffef	(impossible)
0xfff0 - 0xfff7	bad sector
0xfff8 - 0xffff	end of file

For a 12-bit FAT, obtain the next cluster in the file, NCL, given the current cluster number, CL, by:

[1] (Multiply by 1.5)
NCL = CL + CL / 2

[2] Set NCL to the 16-bit word in the FAT indexed by NCL (it must be byte-swapped to 68000 format as well.) The word might not be on a 68000 word boundary.

[3] (Extract the correct 12 bits.)
If CL is odd, set NCL = NCL >> 4.

[4] (Mask off incorrect bits.)
Set NCL = NCL & 0x0FFF.
[5] (Interpret the result.)
If NCL is 0x0FF8 or higher, then CL was the last cluster in the file. If NCL is zero or in the range 0x0FF0 to 0x0FF7 then there is a file system problem. Otherwise, NCL is the number of the next cluster in the file.

For a 16-bit FAT, obtain the next cluster in the file, NCL, given the current cluster number, CL, by:
[1] Set NCL to the 16-bit word in the FAT indexed by CL. The word must be byte-swapped into 68000 format.
[2] If NCL is 0xfff8 or higher, then CL was the last cluster in the file. If NCL is 0 or in the range 0x8000 to 0xfff7 then there is a file system problem. Otherwise, NCL is the number of the next cluster in the file.

To convert from a cluster number, CL, to a logical sector number, LSN:
[1] (Adjust for reserved FAT entries.)
LSN = CL - 2
[2] Multiply LSN by the number of sectors per cluster (CLSIZ).
[3] Add the logical sector# of the first cluster to LSN (DATREC).