Utilities Reference

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April 2003

Contents

1 Utilities

This chapter provides a list, in alphabetical order, of OS-9® utilities. It includes the following sections:

Standard Utility Documentation

For quick reference purposes, the format of the utility information has been standardized. Each utility contains the following headings and corresponding information, if applicable:

- Command Syntax
- Operating System (OS)
- Command Options
- Description of the Utility
- Examples
- See Also

Command Syntax

The Syntax field identifies the rules governing the structure of the utility command line.

- Syntax specified in the command section does not include the shell built-in options (e.g., alternate memory size, I/O redirection, piping, etc.). The shell filters these options out from the command line before processing the program being called.

Operating System (OS)

The OS field identifies Microware operating systems with which the utility is packaged and other operating systems on which the utility is functional. Some utilities function under other operating systems in addition to OS-9 and OS-9 for 68K.

Some path names and code examples may refer to OS-9000. These references pertain to the OS-9 (non-68K) operating system.

Command Options

The Options field lists the available options for each utility.

- Unless otherwise specified, command line option order is insignificant. For example, the following command lines provide the same results:

```
attr -a junk -pw
attr junk -pw -a
attr junk -a -pw
```

- The equal sign (=) used in many utility options and the `k` used in the alternate memory size option are generally optional. For example, you may write `-b=256k as -b256, -b256k,` or `-b=256`. However, the equal sign is mandatory when using `-z=<file>` option.
- Utilities that use the `-z` option expect input of one file name per line. Some utilities do not interpret comments (lines beginning with a `"*"`) in a `-z` file.
- The `-?` option is available although not listed for most utilities. Typing `-?` displays the options, function, and command syntax of the utility. Exceptions are built-in shell commands, such as `chd` and `set`.
- A few utilities offer only the `-?` option. You cannot list other options on the command line. Built-in shell commands, such as `chd` and `set`, do not have options including the `-?` option.

Description of the Utility

The Description field presents a narrative detailing the uses, features, and specific instructions for each utility.

Examples

The Examples field provides one or more illustrations of using the utility.

See Also

The See Also field provides a reference to related utilities that offer additional information.

Formal Syntax Notation

Each command section includes a syntactical description of the command line. These symbolic descriptions use the following notations:

`[ ] =`	Enclosed items are optional.
`{ } =`	Enclosed items may be used 0, 1, or multiple times.
`< > =`	Enclosed item is a description of the parameter to use.

For example:

`<path> =`	A legal path list
`<devname> =`	A legal device name
`<modname> =`	A legal memory module name
`<procID> =`	A process number
`<opts> =`	One or more options specified in the command description
`<arglist> =`	A list of parameters
`<text> =`	A character string ended by end-of-line
`<num> =`	A decimal number, unless otherwise specified
`<file> =`	An existing file
`<string> =`	An alphanumeric string of ASCII characters

List of OS-9 Utilities

Table 1-1 provides a list of OS-9 utilities, including utility name and a brief description. The complete documentation follows.

Table 1-1. OS-9 Utilities

Utility Name	Description
activ	Activates a Process
alias	Sets Device Pathlist Alias
assign	Single Word Command Line Substitutions
attr	Changes/Examines File Security Attributes
backup	Makes a Backup Copy of Disk
bfed	Screen-Oriented Disk Editor
binex	Converts Binary Files to S-Record Format
bootgen	Builds and Links a Bootstrap File
break	Invokes System Level Debugger or Reset System
build	Builds Text File from Standard Input
cfp	Command File Processor
chd	Changes the Current Data Directory
chm	Change the Current Module Directory
chx	Change the Current Execution Directory
chown	Changes the Ownership of a File/Directory
cmp, os9cmp	Compares Two Binary Files
code	Prints the Hex Value of the Input Character
com	Communicates With a Remote System
compress	Compresses ASCII Files
copy	Copies Data from One File to Another
count	Counts Characters, Words, and Lines in File
cudo	Convert text file EOL characters
date	Displays System Date and Time
dcheck	Checks Disk File Structure
debug	Debugs and Tests 68000 Machine Language Programs
deiniz	Detaches Device
del, os9del	Deletes a File
deldir	Deletes All Files in Directory
delmdir	Deletes Existing Module Directories
devs	Displays System's Device Table

Table 1-1. OS-9 Utilities (Continued)

Utility Name	Description
dir	Displays Names of Files in Directory
diskcache	Enables, Disables, or Displays Status of Cache
dosfile	Converts DOS Text to OS-9 and Vise Versa
dpsplit	Splits/Rejoins the DPIO descriptor
dsave	Generates Procedure File to Copy Files
dump, os9dump	Displays Formatted Dump
echo	Echoes Text to Output Path
editmod	Creates, Displays, and Edits Modules
edt	Line-Oriented Text Editor
events	Displays Active System Events
ex	Chains to a Program
exbin	Converts S-Record to Binary
expand	Expands Compressed File
fdisk	Displays/Alters the Partition Table
fixmod	Fixes Module CRC and Parity
format	Initializes Disk Media
free	Displays Free Space Remaining on Mass-Storage Device
frestore	Restores Directory from Backup
fsave	Incremental Directory Backup
grep	Searches File for Pattern
help	On-Line Utility Reference
hist	Command History
ident	Prints OS-9 Module Identification
iniz	Attaches Devices
irqs	Displays System's IRQ Polling Table
kermit	Transfers Sequential Files Over Asynchronous Lines
kill	Aborts Processes
link	Links Previously Loaded Module into Memory
list	Lists Contents of Text File
lmm	Loads Modules At Pathlist
ln	Creates a Hard Link to an Existing File
load	Loads Module(s) from File into Memory
login	Timesharing System Login
logout	Timesharing System Logout

Table 1-1. OS-9 Utilities (Continued)

Utility Name	Description
makdir	Creates Directory File
makmdir	Creates a New Module Directory
maps	Prints Process Memory Usage Information
mdattr	Changes Module Directory Security Permissions
mdir	Displays Module Directory
merge, os9merge	Copies and Combines Files to Standard Output
mfree	Displays Free System RAM
mkdatmod	Packages File into Data Module
moded	Edits OS-9 Modules
mshell	Command Interpreter
mv	Move a File/Directory From One Directory to Another
os9cmp	Compares Two Binary Files
os9del	Deletes a File
os9deldir	Delete files within a directory.
os9dump	Displays Formatted Dump
os9gen	Builds and Links Bootstrap File
os9make	Maintains, Updates, and Regenerates Groups of Programs
os9merge	Copies and Combines Files to Standard Output
p2init	Links and Initializes An OS9P2 Module
padrom	Extends File Size
park	Park Hard Drive Heads
paths	Display Process Paths
partition	Partition OS-9/68k hard disks
pcdcheck	Check specified device for correct FAT file system
pcformat	Creates a FAT File System for use with PCF
pd	Prints Working Directory
pinfo	Partition Table Utility
pr	Prints Files
printenv	Prints Environment Variables
procs	Displays Processes
profile	Reads Commands from File and Return
qsort	In-Memory Quick Sort

Table 1-1. OS-9 Utilities (Continued)

Utility Name	Description
rename	Changes File Name
romsplit	Splits File
save	Saves Memory Module(s) to File
set	Sets Shell Options
setenv	Sets Environment Variables
setime	Activates and Sets System Clock
setpr	Sets Process CPU Priority
shell	Command Interpreter
sleep	Suspends Process for Period of Time
su	Fork a New Shell with a New User ID
suspend	De-activate an Active Process
sysid	Print System Identification
tape	Tape Controller Manipulation
tapegen	Creates a bootable tape
tapestart	Initialize RBF Device from Tape
tar	Tape Archive
tee	Copies Standard Input to Multiple Output Paths
tmode	Changes Terminal Operating Mode
touch, os9touch	Update Last Modification Date of File
tr	Transliterate Characters
tsmon	Supervises Idle Terminals and Initiate Login Command
umacs	Advanced Screen Editor
unassign	Discards Single Word Command Line Substitutions
undel	Retrieves Deleted OS-9 for 68K RBF Files
undel	Retrieves Deleted OS-9 RBF Files
unlink	Unlinks Memory Module
unsetenv	Clears Environment Parameter
w, wait	Waits for One/All Child Process(es) to Terminate
what	Display Version Strings
xmode	Examines or Changes Device Initialization Mode

activ
Activates a Process

Syntax
```
activ {<procID>}
```

OS
OS-9

Description
The `activ` utility activates processes that were stopped by the `suspend` utility.

Type `activ` and the process ID of the process to activate a process. The process ID can be obtained by using the `procs` utility. Suspended processes are identified with a `z` in the `state` status.

Only super users may use this utility.

Example
```
$ procs -e
Id PId Grp.Usr  Prior  MemSiz Sig S    CPU Time Age  Module & I/O
2   0   0.0     128   30.75k   0 w       0.04  0:10 tsmon <>>>term
3   5   0.0     128   11.00k   0 z       7.00  0:01 eatmpu <>>>term
4   0   0.0     128   30.75k   0 s       0.04  0:10 tsmon <>>>t3
5   2   0.0     128    9.00k   0 w       3.09  0:10 shell <>>>term
6   5   0.0     128   35.25k   0 *       0.07  0:00 procs <>>term
>dd
$ activ 3
$ procs -e
Id PId Grp.Usr  Prior  MemSiz Sig S    CPU Time Age  Module & I/O
2   0   0.0     128   30.75k   0 w       0.04  0:10 tsmon <>>>term
3   5   0.0     128   11.00k   0 a      13.73  0:01 eatmpu <>>>term
4   0   0.0     128   30.75k   0 s       0.04  0:10 tsmon <>>>t3
5   2   0.0     128    9.00k   0 w       3.46  0:10 shell <>>>term
6   5   0.0     128   35.25k   0 *       0.05  0:00 procs <>>term >dd
```

See Also
`suspend`

alias

Sets Device Pathlist Alias

Syntax

```
alias <alias name> <actual name>
```

OS

OS-9

Options

`-d`	Deletes the specified alias name.
`-l`	Prints the current list of aliases. `-l` must be used alone.
`-z`	Gets list of aliases from standard input. Cannot be used with `-d`. Lists one pair per line in the form: `<devname> <pathlist>`
`-z[=]<file>`	Gets list of aliases from `<file>`. Cannot be used with `-d`.

Description

The `alias` utility assigns an alternate name to a device pathlist. Pathlist aliases allow you to refer to specific device pathlists with shorter or more convenient names.

Type `alias`, the alternate (alias) name, and the actual pathlist to assign an alternate name to a pathlist. IOMAN expands all alias references into their associated pathlist name.

- The `<actual name>` must exist. OS-9 does not verify the existence of `<actual name>`.
- A real device name as `<alias name>` is discouraged.

Example

```
$ dir /h1
Error #000:221
$ alias /h1 /n0/tony/h0
$ dir /h1
                Directory of /h1 16:00:55
CMDS         DEFS          LIB           SYS           USR
SysBoot      startup
$
```

assign

Single Word Command Line Substitutions

Syntax

```
assign [<name> <definition>]
```

OS

OS-9

Options

The `assign` utility only has zero or two arguments.

Description

The `assign` utility equates a single word to a string for command line substitution.

The substitution occurs when `<name>` appears as the command to execute.

Not all occurrences of `<name>` in the command line are replaced. Only in those occurrences where `<name>` is a command to be executed is the `<name>` replaced.

This command does not appear in the `CMDS` directory as it is a built-in shell command.

Example

```
$ assign ls dir
```

Changes `ls` to `dir`

```
$ assign cd chd
```

Changes `cd` to `chd`

```
$ assign
```

Changes `ls` to `dir` and `cd` to `chd`

```
cd          chd
ls          dir
```

attr
Changes/Examines File Security Attributes

Syntax
```
attr [<opts>] {<path>} {<permissions>}
```

OS
OS-9; OS-9 for 68K

Options

`-a`	Suppresses the printing of attributes. In OS-9, suppresses the warning that appears if group attributes are specified.
`-q`	Quiet mode suppresses "can't open" file error messages.
`-x`	Searches for the specified files in the execution directory. The files must have execute permission to be found using `-x`.
`-z`	Reads the file names from standard input.
`-z=<file>`	Reads the file names from `<file>`.

Description
The `attr` utility examines or changes the security attributes (`<permissions>`) of the specified files.

Type `attr`, followed by the pathlist for the files whose security permissions you want to change or examine. Then, enter a list of permissions to turn on or off.

Permission is granted by specifying the permission code preceded by a hyphen (-).

Permission is withdrawn by specifying the permission code preceded by a hyphen and an `n (-n)`.

Permissions not explicitly named by permission code are unaffected.

If permissions are not specified on the command line, the `attr` utility displays the current file attributes.

Attempts to change permission attributes of a file by a user other than the owner, except super user, is disallowed. A super user can examine or change the attributes of any file in the system.

When using the PCF system, the only two relevant command line options are `-npwngwnw` (which shuts off write permission) and `-pwgww` (which turns on write permission). No other permissions options are relevant because it is impossible to make attribute changes on a directory.

See Also

`deldir`
`makdir`

Examples

```
$ attr myfile
```
Displays the current attributes of `myfile`.

```
$ attr myfile -npr -npw
```
Withdraws public read and public write permissions.

```
$ attr myfile -rweprpwpe
```
Grants both the public and the owner read, write, and execute permissions.

```
$ attr -z
```
Displays the attributes of the file names read from standard input.

```
$ attr -z=file1
```
Displays the attributes of the file names read from `file1`.

```
$ attr -npwpr *
```
Withdraws public write and grant public read for all files in the directory.

```
$ attr *.lp
```

Lists the attributes of all files with names ending in `.lp`.

Table 1-2. Permission Codes

OS-9 for 68K Files	OS-9 Files	OS-9 Directory	Specification
d	d	d	Directory file
s	o	o	Single user file or directory Non-sharable file or directory
r	r	r	Read permission to owner
w	w	w	Write permission to owner
e	e		Execute permission to owner
		s	Search permission to owner
	gr	gr	Read permission to group
	gw	gw	Write permission to group
	ge		Execute permission to group
		gs	Search permission to group
pr	pr	pr	Read permission to public
pw	pw	pw	Write permission to public
pe	pe		Execute permission to public
		ps	Search permission to public

On OS-9 for 68K, the owner is the creator of the file. Owner access is given to any user with the same group ID number as the owner. The public is any user with a different group ID number than the owner. You can determine file ownership with the dir -e command.

Specifying group attributes on OS-9 for 68K gives a non-fatal warning that they are ignored. This warning is suppressed when the `-a` option is used.

backup
Makes a Backup Copy of Disk

Syntax
```
backup [<opts>] [<srcpath> [<destpath>]]
```

OS
OS-9; OS-9 for 68K

Options

`-b[=]<num>`	Allocates `<num>` k bytes of memory for use by the `backup` buffer. `backup` uses a 4K buffer by default. The greater the allocation of memory, the faster `backup` runs.
`-r`	Causes `backup` to continue upon occurrence of a read error.
`-v`	Prevents `backup` from making a verification pass.

Description
The `backup` utility physically copies all data from one device to another.

A physical copy is performed sector by sector without regard to file structures. In most cases, the specified devices must have the same format and must be devoid of defective sectors.

- When an OS-9 bootable floppy is copied using `backup`, you also need to use the `bootgen` utility to make the target floppy bootable.
- This backup utility does not work with PCF.

In the following description, source disk is the disk to back up (from disk) and destination disk is the disk to copy onto (to disk).

Before backing up a disk, you should write protect the source disk with the appropriate write protect mechanism to prevent accidentally confusing the source disk and the destination disk during exchanges.

Single Drive Backup

A single drive backup requires exchanging disks in and out of the disk drive.

To begin the backup procedure, put the source disk in the drive and type `backup/d0`. The system asks if you are ready to backup. Type `y` if you are ready.

Initially, the `backup` utility reads a portion of the source disk into memory. The `backup` utility then prompts you to exchange disks. Remove the source disk from the drive, and insert the destination disk. The `backup` utility writes the previously stored data onto the destination disk. This exchange process continues until all of the data on the source disk is copied to the destination disk. When the backup is finished, an exchange is again requested. This places the source disk back in the drive.

The `-b` option increases the amount of memory the backup procedure uses. This decreases the number of disk exchanges required.

Two Drive Backup

On a two drive system, device names `/d0` and `/d1` are assumed if both device names are omitted on the command line. If the second device name is omitted, a single unit backup is performed on the drive specified.

To begin the backup procedure, put the source disk in the source drive and the destination disk in the destination drive. By default, the source drive is `/d0` and the destination drive is `/d1`. Enter `backup`, the name of the source drive, and the name of the destination drive. The system asks if you are ready to backup. Enter `y` if you are ready. If errors do not occur, the backup procedure is complete.

Errors

The backup procedure includes two passes by default. The first pass reads a portion of the source disk into a buffer in memory and then writes it to the destination disk. The second pass verifies that the data was copied correctly.

If errors occur on the first pass, the source disk or source drive is at fault.

If errors occur in the second pass, the destination disk is at fault. If `backup` fails repeatedly on the second pass, reformat the destination disk and retry the backup.

Examples

```
$ backup /D2 /D3
```

Backs up the disk in `/d2` to the disk in `/d3`.

```
$ backup -v
```

Backs up the disk in `/d0` to the disk in `/d1` without making a verification pass.

```
$ backup -b40 /d0 /d2
```

Allocates 40K of memory to use in backing up `/d0` to `/d2`.

bfed
Screen-Oriented Disk Editor

Syntax
```
bfed [<opts>] <path> [<opts>]
```

OS
OS-9; OS-9 for 68K

Options

`-s[=]<num>`	Reads the block number specified.
`-v`	Opens `<path>` in view mode.

Description
The `bfed` utility, a screen-oriented binary file editor, enables editing of files and disks in binary sector format and moving sectors around on a disk. The `bfed` utility also allows the user to copy sectors from one disk to another to help in recovering accidentally deleted files.

The `bfed` utility operations are oriented to the disk sector buffer which is always displayed and may be filled with data from a file or written to a file. The buffer may also be edited by hand at any time for complete control of the data in a file.

Typically, you might type `bfed myfile` on the command line. The `bfed` utility would then open `myfile` and display the first sector. Alternatively, you can type `bfed` without any command line arguments and use the `c` or `o` commands to create or open, respectively, an edit file. The contents of the current buffered sector are then examined or modified and then optionally written out to the file.

The `bfed` utility allows two edit files to be open at a time. You may display one or the other using the `a` command. You may also move sectors from one edit file to another using the `m` command.

One of the bfed utility's more useful capabilities is its ability to recover a deleted file by writing the "deleted" sectors to a recovery file. It is important that the recovery file be on a different mass storage device than the deleted file to ensure that the sectors of the deleted file are not overwritten.

To recover a deleted file, open the recovery file using the c (create edit file) command. Use the m command to copy sectors to the new file.

Another feature of the bfed utility is the distinction between the buffer sector and the current sector. If the buffer's current contents were read from the edit file, the buffer sector is the location in the file from which the data came. The current sector, which is independent, is the current position in the edit file for reading or writing. Thus, it is possible to read a sector from one location in a file and to copy it to another location.

All numbers that the bfed utility asks for are assumed to be hexadecimal; however, by using a leading # in the number, the bfed utility interprets the number as decimal. To enter 100 in decimal, type #100.

The following commands are available for the bfed utility. Please note that all values are given in hexadecimal.

Table 1-3. bfed Commands

Command	Description
a	Switches the current active file. Most of the bfed utility's commands operate on the active edit file, which is denoted by an * at the start of the status line for that file. The buffer displayed on the screen is the buffer associated with the current active file.
c	Creates a new edit file. This is especially useful when recovering a deleted file, and it is the only way to open a file that does not exist.
e	Ends the edit session for the current active file; that is, it closes the active file. If the buffer has been modified, the bfed utility displays a prompt asking if you want to continue. When answering in the affirmative, the buffer is not discarded but may not be written unless another edit file is opened.

Table 1-3. bfed Commands (Continued)

Command	Description
f<value>	Fills the buffer with an arbitrary, user-supplied value. The value may be a byte, word, or long, with byte size being the default. Size is specified by entering the number in the format nnnn.s where s is b, w, or l. The size is optional with the default being byte.
g	Reads the current sector into the sector buffer.
i	Displays the information from the File Descriptor sector for the active edit file.
l	Accepts a pattern and start and end points in the active file in which to look for the pattern. The pattern may be a number in byte, word or long sizes, or it may be a string of characters by preceding the string with a " (double-quote mark). Thus to search for the string help, you would enter "help when prompted. When entering the start and end points, <CR> defaults to the start and end of the file, respectively.
m<1st sector> <count>	Moves sectors from the active edit file to the other edit file. You may specify the start point and number of sectors from the source (active) file, but the copy uses the current sector in the target as the starting location. When an error is encountered, you are prompted about continuing. If you continue, garbage is written in the target where the error occurred.
n<sector>	Sets the current sector to <sector> number.
o<path>	Opens an edit file. The file must already exist.
p<sector>	Picks and reads a new sector from the active edit file. You are allowed to select a sector that is beyond the end of file.
q	Quits disk editing session.
r	Repaints the screen.
s	Substitutes a byte for a new value. Prompts for location and new value.
v	Toggles view mode on or off for the active edit file. When in view mode you may not alter the edit file in any way, although you may edit the buffer.

Table 1-3. bfed Commands (Continued)

Command	Description
w	Writes the buffer to the current sector in the active edit file. If the buffer is a partial sector (such as the last sector in a file), you are prompted for writing a full sector (and thus changing the file size) or writing only a partial sector.
x	Displays a number in decimal and hexadecimal.
z	Sets the file size of the edit file. The size change is immediate.
<	Steps backward to the previous block.
>	Steps forward to the next block.
+	Steps forward 256 bytes in the file.
-	Steps backward 256 bytes in the file.
<tab>	Steps through command, hexadecimal editing, and ASCII editing modes.
<CR>	Steps forward 256 bytes.

The bfed utility has a feature enabling editing of a sector on the screen in either hexadecimal or ASCII. From the command line, the <tab> command positions the cursor into the hexadecimal display on the screen. Entering hex values replaces the existing ones in the buffer. Changes must be saved by writing to the disk with the w command.

In edit mode, the <tab> key toggles between hexadecimal and ASCII edit modes. In ASCII edit mode, typed characters are placed in the buffer. Note that changes in either edit mode, hexadecimal or ASCII, causes an update of both hexadecimal and ASCII displays to new values. Cursor control in screen edit mode uses the following keystrokes for up, left, right, and down movements respectively:

^P = Up

^B = Left

^F = Right

^N = Down

When in either hexadecimal or ASCII edit mode, return to the command mode is accomplished by pressing the <tab> key. Use the \ key as an escape character in ASCII mode, thus allowing the entry of control keys into the buffer. For example, to enter the value <tab> into the buffer in ASCII mode, type \ then <tab>. The ^P, ^B, ^F, ^N, and <tab> characters are entered in this manner.

Another useful feature is the ability to enter a decimal number in hexadecimal edit mode. Upon pressing #, a prompt is displayed for entry of a decimal number in the form n.b where n is the decimal number and s is the size of b for byte, w for word, or l for long. If size is not specified, the default is byte. It is not necessary to use a leading 0 to specify a decimal number.

Entering data at the end of the sector in edit mode causes display of the following prompt:

```
Do you wish to write the current sector and continue to
the next?
```

Entering data at the end of the sector will work in either hexadecimal or ASCII edit modes.

binex

Converts Binary Files to S-Record Format

Syntax

```
binex {<option(s)>) [<inpath>] [<outpath>] [<opts>]
```

OS

OS-9; OS-9 for 68K; WIN; UNIX

Options

`-a[=]<hex>`	Specifies the load address in hex.
`-b[=]<value>[k]`	Specifies the conversion buffer size to use. The 'k' sub-option converts `<value>` to k bytes.
`-s[=]<num>`	Specifies which type of S-record format binex is to generate. Default is `1`.
`-x`	Gets file from the execution directory. (OS-9 and OS-9 for 68K only)
`-z[[=]<file>]`	Reads the command line arguments and options from `<file>`. Default is `stdin`.

Description

The `binex` utility converts binary files to S-record files.

S-record files are a type of text file containing records that represent binary data in ASCII hexadecimal form. This Motorola-standard format is used by many commercial PROM programmers, emulators, logic analyzers, and similar devices that use the RS-232 interface. It can be useful for transmitting files over data links that can only handle character type data. It can also be used for converting assembler or compiler generated programs to load on non-OS-9 systems.

The `binex` utility converts the binary file specified by `<path1>` to a new file with S-record format. The new file is specified by `<path2>`. S-records have a header record to store the program name for informational purposes and each data record has an absolute memory address. This absolute memory address is meaningless to the operating systems because they use position-independent code.

Table 1-4. S-Record Types Generated

Record	Description
`S1`	Uses a two-byte address field. (Default)
`S2`	Uses a three-byte address field.
`S3`	Uses a four-byte address field.
`S7`	Terminates blocks of S3 records.
`S8`	Terminates blocks of S2 records.
`S9`	Terminates blocks of S1 records.

To specify the type of S-record file to generate, use the `-s=<num>` option. `<num> = 1, 2`, etc., corresponding to S1, S2, etc.

Standard input and output are assumed if both paths are omitted. If the second path is omitted, standard output is assumed.

Examples

The following example downloads a program to `T1`. This type of command downloads programs to devices such as PROM programmers.

```
$ binex scanner.S1 >/T1
```

The next example generates `prog.S1` in S1 format from the binary file, `prog`.

```
$ binex -s1 prog prog.S1
```

See Also

`exbin`

bootgen
Builds and Links a Bootstrap File

Syntax
```
bootgen [<opts>] <devname> {<path>}
```

OS
OS-9

Options

`-b[=]<num>`	Assigns `<num>` k bytes of memory for `bootgen`. Default memory size is 4k.
`-e`	Uses type 41 partition.
`-e1`	Allows the placing of type 41 boots on systems that support booting from type 41 partitions.
`-i[=]<file>`	Sets the logical block offset to 0 for a specified device and then writes the specified file to block 0 of that device. This option is only valid on PCAT versions.
`-l[=]<file>`	Makes a "low level boot" using `<file>`. The name of the generated boot file is `firstboot`.
`-n`	Installs new bootstrap files. This option does not save the old bootstrap files.
`-q`	Sets block zero pointing to `<path>`. (Quick Boot)
`-x`	Searches the execution directory for pathlists.
`-z`	Reads the file names from standard input.
`-z=<file>`	Reads the file names from `<file>`.

Description

The bootgen utility creates and links the sysboot file required on any disk from which OS-9 is to be bootstrapped. The bootgen utility makes a copy of an existing boot file, adds modules to an existing boot file or creates an entirely new boot file for a different system. These are just a few examples.

Type bootgen and the name of the device on which the sysboot file is to be installed. If a sysboot file already exists on the target device, it is renamed. The sysboot file is copied onto the target device. The File Descriptor's starting address is linked in the disk's Identification Block (LSN 0) for use by the OS-9 bootstrap firmware.

If the -z option is used, the bootgen utility first uses the files specified on the command line and then the file names from its standard input, or from the specified pathlist, one pathlist per line. If the names are entered manually, no prompts are given and the end-of-file key (usually <escape>) or a blank line is entered after the line containing the last pathlist. Files included with the -z option can contain comment lines. Comment lines are lines starting with an asterisk (*).

To determine what modules are necessary for your boot file, use ident with the sysboot file that came with your system.

The -el option allows placing type 41 boots on systems that support booting on type 41 partitions. PowerPC PrepSpec includes the ability of systems conforming to the standard to boot devices with type 41 partitions. The fdisk utility must be used to set up the partition as type 41. Once the disk is formatted, a type 41 boot may be placed on the disk.

```
$ chd /h0/MWOS/OS9000/603/PORTS/MVME1603/CMDS/BOOTOBJS/ROM
$ bootgen -el=/hs01fmt coreboot -b400
```

- **For PCAT Users**:

  Place PCAT specific IPL on system.

  ```
  chd /h0/MWOS/OS9000/80386/PORTS/PCAT/CMDS/BOOTOBJS/IPL
  bootgen -i=iplhd /hs01fmt
  ```

  Place first boot on system.

  ```
  chd /h0/MWOS/OS9000/80386/PORTS/PCAT/CMDS/BOOTOBJS/ROM
  ```

  Place OS-9 boot on system.

  ```
  chd /h0/MWOS/OS9000/80386/PORTS/PCAT/CMDS/BOOTOBJS/BOOTFILE
  bootgen /hs01fmt h0_s8xx
  ```

- **For PowerPC Users**:

  Place type 41 boot on system.

  ```
  chd /h0/MWOS/OS9000/603/PORTS/MVME1603/CMDS/BOOTOBJS/ROM
  bootgen -el=coreboot /hs01fmt
  ```

  Place OS-9 boot on system.

  ```
  chd /h0/MWOS/OS9000/603/PORTS/MVME1603/CMDS/BOOTOBJS/BOOTFILE
  bootgen /hs01fmt h0_scsi
  ```

The `-q` option updates information in the disk's Identification Block by directing it to point to a file already contained in the root directory of the specified device.

The `-q` option is useful when restoring the `sysboot.old` file as the valid boot on the disk. `bootgen` renames the specified file to be `sysboot` and saves the current boot as described previously.

Examples

This command manually installs a boot file on device `/d1` which is an exact copy of the `sysboot` file on device `/d0`.

```
$ bootgen /d1 /d0/sysboot
```

The following three methods manually install a boot file on device `/d1`. The bootfile on `/d1` is a copy of the `sysboot` file on device `/d0` with the addition of modules stored in the files `/d0/tape.driver` and `/d2/video.driver`:

Method 1:

```
$ bootgen /d1 /d0/sysboot /d0/tape.driver /d2/video.driver
```

Method 2:

```
$ bootgen /d1 /d0/sysboot -z
/d0/tape.driver
/d2/video.driver
[ESCAPE]
```

Method 3:

```
$ bootgen /d1 -z
/d0/sysboot
/d0/tape.driver
/d2/video.driver
[ESCAPE]
```

You can automatically install a boot file by building a "bootlist" file and using the `-z` option to either redirect `bootgen` standard input or use the specified file as input:

```
$ build /d0/bootlist
```
Create file bootlist

```
? /d0/sysboot
```
Enter first file name

```
? /d0/tape.driver
```
Enter second file name

```
? /d2/video.driver
```
Enter third file name

```
? * V1.2 of video driver
```
Comment line

```
? [RETURN]
```
Terminate build

```
$ bootgen /d1 -z </d0/bootlist
```
Redirect standard input

```
$ bootgen /d1 -z=/d0/bootlist
```
Read input from pathlist

`bootgen` treats any input line preceded by an asterisk (`*`) as a comment.

The following command makes the `TestBoot` file the current boot, but saves the current `SysBoot` file as `SysBoot`:

```
$ bootgen /d1 -q testboot
```

break

Invokes System Level Debugger or Reset System

Syntax

```
break
```

OS

OS-9; OS-9 for 68K

Description

The `break` utility executes an `F$SysDbg` (OS-9), `F_SYSDBG` (OS-9000) system call. This call stops the operating system and all user processes and returns control to the ROM debugger. The debugger's `g[o]` command resumes execution of the operating system.

You should only call the `break` utility from the system's console device, because the debugger only communicates with that device. If the `break` utility is called from another terminal, you must still use the system's console device to communicate with the debugger.

Only super users may use this utility.

The `break` utility is used only for system debugging. It should not be included with or run on a production system.

If there is not a debugger in ROM or if the debugger is disabled, the `break` utility resets the system.

The system clock is not updated when the system is running ROMbug. It is recommended that a `setime` be performed when returning from ROMbug to standard system operation.

Be aware of any open network paths when you use the `break` utility as all timesharing is stopped. Network paths are not serviced while the system is in ROMbug and protocol time-outs may occur.

build
Builds Text File from Standard Input

Syntax
```
build <path>
```

OS
OS-9; OS-9 for 68K

Description
The `build` utility creates a file specified by a given pathlist.

Type `build` and a pathlist. A question mark prompt (`?`) displays. This requests an input line. Each line entered is written to the output file.

To terminate the `build` utility:

- Enter a line consisting of only a carriage return.
- Enter an end-of-file character at the beginning of an input line. The end-of-file character is typically `<escape>`.

Example
```
$ build newfile
? Build should only be used
? in creating short text files.
? [RETURN]
$ list newfile
Build should only be used
in creating short text files.
```

cfp
Command File Processor

Syntax
```
cfp [<opts>] [<path1>] {<path2>}
```

OS
OS-9; OS-9 for 68K

Options

`-b[=]<size>`	Specifies the buffer size in k bytes used by `cfp` for processing the command file.
`-d`	Deletes the temporary file. This is the default.
`-nd`	Does not delete the temporary file.
`-e`	Executes the procedure file. This is the default.
`-ne`	Does not execute the procedure file. Instead, the `cfp` utility lists the procedure file to standard output. If the `-s` option is specified, any path on the command line is treated as a `<path2>` substitution string.
`-s=<str>`	Reads `<str>` instead of a procedure file. If the string contains characters interpreted by the shell, the entire option needs to be enclosed in quotes. It does not make sense to specify both a procedure file and this option.
`-t=<path>`	Creates the temporary file at `<path>` rather than in the current working directory.
`-z`	Reads the file names from standard input substitution strings.
`-z=<file>`	Reads the file names from `<file>` after processing any existing `<path2>`.

Description

The cfp utility creates a temporary procedure file in the current data directory and then invokes the shell to execute it.

Type cfp, the name of the procedure file to execute (<path1>), and the file(s) (<path2>) for the names to substitute when executing the <path1> procedure file and creating a temporary procedure file.

All occurrences of an asterisk (*) in the procedure file (<path1>) are replaced by the given pathlists, <path2>, unless preceded by the tilde character (~). For example, ~* translates to *. The command procedure is not executed until all input files have been read.

For example, if you have a procedure file in your current data directory called copyit that consists of a single command line, copy *, all of your C programs from two directories, PROGMS and MISC.JUNK, are placed in your current data directory by typing:

```
$ cfp copyit ../PROGMS/*.c ../MISC.JUNK/*.c
```

If you use the "-s=<string>" option, you may omit the name of the procedure file, but you must enclose the option and its string in quotes. The -s option causes cfp to use the string instead of a procedure file. For example:

```
$ cfp "-s=copy *" ../PROGMS/*.c ../MISC.JUNK/*.c
```

You must use double quotes to force the shell to send the string -s=copy * as a single parameter to cfp. The quotes also prevent the shell from expanding the asterisk (*) to include all pathlists in the current data directory.

In the above examples, the cfp utility creates a temporary procedure file to copy every file ending in .c in both PROGMS and MISC.JUNK to the current data directory. The procedure file created by the cfp utility is deleted when all the files have been copied.

Using the -s option is convenient because you do not have to edit the procedure file to change the copy procedure. For example, if you are copying large C programs, you may want to increase the memory allocation to speed up the process.

You can allocate the additional memory on the cfp command line:

```
$ cfp "-s=copy -b100 *" ../PROGMS/*.c ../MISC.JUNK/*.c
```

You can use the -z and -z=<file> options to read the file names from either standard input or a file. Use the -z option to read the file names from standard input. For example, if you have a procedure file called count.em that contains the command count -l * and you want to count the lines in each program to see how large the programs are before you copy them, enter the following command line:

```
$ cfp -z count.em
```

The command line prompt does not appear because the cfp utility is waiting for input. Enter the file names on separate command lines. For example

```
$ cfp -z count.em
../PROGMS/*.c
../MISC.JUNK/*.c
```

When you have finished entering the file names, press the carriage return a second time to get the shell prompt.

If you have a file containing a list of the files to copy, enter:

```
$ cfp -z=files "-s=copy *"
```

Example

In this example, test.p is a procedure file that contains the command line list * >/p2. The command cfp test.p file1 file2 file3 produces a procedure file containing the following commands:

```
list file1 >/p2
list file2 >/p2
list file3 >/p2
```

The following command accomplishes the same thing:

```
$ cfp "-s=list * >/p2" file1 file2 file3
```

chd

Changes the Current Data Directory

Refer to chx for details.

chm
Change the Current Module Directory

Refer to chx for details.

chx
Change the Current Execution Directory

Syntax

```
chd [<path>]
chm [<path>]
chx <path>
```

chd/chx OS

OS-9; OS-9 for 68K

chm OS

OS-9

Description

These commands are built-in shell commands used to change the working data directory, working module directory or working execution directory.

Type `chd` and the pathlist of the new data directory to change your data directory.

Type `chx` and the pathlist of the new execution directory to change your execution directory.

On OS-9 (non-68K), type `chm` and the pathlist of the new module directory to change your primary module directory.

In all cases a full or relative pathlist may be used. Relative pathlists used by the `chd`, `chm` and `chx` utilities are relative to the current data, module and execution directory, respectively.

If the `HOME` environment variable is set, the `chd` command with no specified directory changes your data directory to the directory specified by `HOME`.

OS-9: If the `MDHOME` environment variable is set, the `chm` command with no specified directory changes your current module directory to the directory specified by `MDHOME`.

`chm` does not search the alternate pathlist for a module directory if the directory is not found in the current module directory.

These commands do not appear in the `CMDS` directory as they are built in to the shell.

Examples

```
$ chd /d1/PROGRAMS
$ chx ..
$ chx /D0/CMDS; chd /D1
$ chm /usr/tony
$ chm //tony/newproj
```

chown

Changes the Ownership of a File/Directory

Syntax

```
chown [<opts>] <group>.<user> {<file>}
```

OS

OS-9; OS-9 for 68K

Options

`-s`	Does not print details of changes (Silent).
`-z`	Reads file names from standard input.
`-z=<file>`	Reads file names from `<file>`.

Description

The `chown` utility changes the owner ID of a file or directory to the owner ID specified.

You must be a super user to change the ownership of a file.

Examples

```
$ chown 1.1 prog.c
```

Changes the file owner ID to 1.1

cmp, os9cmp
Compares Two Binary Files

Syntax

```
cmp {<option(s)>} <path1> <path2>      OS-9/68K or OS-9
os9cmp {<option(s)>} <path1> <path2>    DOS or UNIX
```

cmp OS
OS-9; OS-9 for 68K

os9cmp OS
WIN; UNIX

Options

`-b[=]<size>`	Assigns `<size>` k bytes of memory for the `cmp` utility to use. The `cmp` utility uses a 4K memory by default.
`-s`	Stops the comparison when the first mismatch occurs and prints an error message (Silent mode).
`-t`	Prints only the byte totals compared and different.
`-x`	Searches the current execution directory for both of the specified files. (`cmp` only)

Description
The `cmp` utility opens two files and performs a comparison of the binary values of the corresponding data bytes of the files. If any differences are encountered, the file offset (address), the hexadecimal value, and the ASCII character for each byte display.

The comparison ends when an end-of-file is encountered on either file. A summary of the number of bytes compared and the number of differences found is displayed.

Type `cmp` and the pathlists of the files to compare.

Examples

The following example uses an 8K buffer to compare `file1` with `file2`.

```
$ cmp file1 file2 -b=8
Differences
          (hex)   (ascii)
byte      #1  #2  #1  #2
========  ==  ==  ==  ==
00000019  72  6e   r   n
0000001a  73  61   s   a
0000001b  74  6c   t   l
Bytes compared:  0000002d
Bytes different: 00000003
file1 is longer
```

The following example compares `file1` with itself.

```
$ cmp file1 file1
Bytes compared:  0000002f
Bytes different: 00000000
```

code

Prints the Hex Value of the Input Character

Syntax

```
code
```

OS

OS-9; OS-9 for 68K

Description

The `code` utility prints the input character followed by the hex value of the input character.

Unprintable characters print as a period (`.`). The keys specified by `tmode quit` and `tmode abort` terminate `code`.

`tmode quit` is normally `<control>E`, and `tmode abort` is normally `<control>C`.

The most common use of `code` is to discover the value of an unknown key on the keyboard or the hex value of an ASCII character.

Examples

```
$ code
ABORT or QUIT characters will terminate CODE
a -> 61
e -> 65
A -> 41
. -> 10
. -> 04
$
```

com
Communicates With a Remote System

Syntax
```
com <devicename> [<functionkeyfile>]
```

OS
OS-9

Description
The com utility allows you to communicate with a remote system using an RS-232 serial port.

<devicename> is the name of the communications I/O port to be used during the session. You must give this name or an error message displays and com aborts.

<functionkeyfile> is the name of a file that specifies up to ten user defined functions keys that transmits text sequences through com.

You must make sure that the I/O port to be used is properly wired to the modem or remote computer and is set to the correct baud rate. If you are connecting two computers using a hard-wired connection, you may need a null modem device. You can use the com utility to help test your connections.

The default configuration of your terminal and the I/O port (as given in device descriptors and displayed by the tmode command) are not important to com because the configuration is automatically set by the com utility to the appropriate values.

Upon entering the com utility you should see the following message:

```
% Com V2.0  Copyright 1986 Microware Systems Corp.
% You are talking to the remote system.  (on line);
metachar: ^Z
```

The % character always begins each com utility generated message. This differentiates com utility messages from the data received from the remote computer.

At this point, your terminal is directly connected to the communications port. This is called *communications mode*. At this time, you should dial the remote system if you are using a modem. If you are using a hard-wired connection, or after the modem connection is made, you may immediately perform any log-in procedure that may be required by the remote system.

In communications mode, all data sent by the remote computer is immediately displayed on your terminal. Anything typed on your keyboard is immediately transmitted to the remote system. Communications in either direction is done on a character-by-character basis.

The usual OS-9 keyboard control keys (such as backspace, line delete, etc.) and your `tmode` settings (such as echo, auto line feed, screen pause, etc.) do not work within the `com` utility. Instead, your terminal responds only to the control characters supported by the remote system.

All control keys (except the meta-character (`<control>-z`) and function keys (see the programmable function keys section below) are passed directly to the remote computer for processing without interference by the `com` utility or OS-9.

Similarly, all data received from the remote system passes directly to your terminal, except for ASCII null (hex 00) and rubout (hex 7F) characters, which are disposed of.

This *transparency* of data transmission eliminates possible conflicts between terminal control functions of OS-9 and the remote computer system.

You can enter `control mode` at any time from communication mode by typing the meta-character (`<control>-z`). While you are in control mode, the data link is kept open. However, it is always wise to halt any output from the remote system before entering control mode to prevent possible data loss. Most computers stop output when they receive an X-OFF character (`<control>-s`) and resume output when an X-ON character (`<control>-q`) is received.

A summary of the control mode commands are shown in Table 1-5. They are followed by a more detailed explanation. These commands are not case sensitive.

Table 1-5. Control Mode Commands

Command	Specification
c	Change directory on host system.
d	Download file from remote system.
e	Echo on/off. The default is off.
l	Lock upper case on/off. The default is off.
m	Change meta-char (^z).
p	Copy communications to print file.
q	Exit to operating system.
r	Return to remote system.
t	Strip parity from data remote on/off. The default is on.
u	Upload to remote system.
x	Send XON to remote system, return on-line.
*	Automatic download on/off. The default is off.
$	OS9 shell command.
<cr>	Display help menu.
.	Automatic download quick mode. Default is disabled.

When you enter control mode, the com utility displays the following:

```
% COM:
```

At the prompt, you can enter any of the above commands. You can use the r command at any time to return to communications mode.

If an error occurs in a control mode command, an error message displays along with the corresponding OS-9 error number.

About System Hardware Configuration:

The communications port and your terminal must be interrupt-driven for the com utility to work, as most OS-9 serial I/O ports are. In addition, your terminal must be able to operate at a baud rate equal to or faster than the communications port baud rate. You may discover a maximum speed at which your OS-9 system can receive data without “dropped characters” or read errors. This depends on CPU clock speed, the type of I/O interface, and the number of active tasks on the system.

Change Directory Command

The `c` command allows you to change your current working directory on the host system. This is useful when uploading and downloading files.

Echo On/Off Command

Most computers automatically echo characters from the terminal keyboard to the display screen. This is referred to as *full duplex* operation. Some systems do not echo characters, so the terminal must echo locally. This is known as *half duplex* operation. The `e` command allows you to turn local echo on or off. The default setting is full duplex (local echo off). If the remote system responds to your input, but does not echo keyboard input to the screen, you should switch the `com` utility to half duplex (local echo on).

Case Lock Command

The `l` command alternately turns the upper case lock on and off. When the case lock is on, all lower case characters received from the remote system are automatically converted to upper case. Characters sent from your keyboard are not converted. The default setting is off.

Set Meta-Character Command

The `m` command allows the meta-character to be changed. The meta-character returns to command mode when you are in communications mode. The default meta-character is `<control>-z`. If it is necessary to send a `<control>-z` to the remote system, changing the meta-character to an unused character allows `<control>-z` to be transmitted. Similarly, if you are talking to a third device or system through a second `com` link, you will want to change the meta-character on the first `com`.

Quit Command

The `q` command closes any open files and terminates `com`. You must log-off the remote system (and hang up the phone line) before using this command.

Strip Parity Command

The t command strips the parity bit on data received from the remote system. By default, this option is ON.

Send XON and Return to Communications Mode

The x command is identical to the r command, except that an XON character is sent to the remote system before returning to communications mode.

OS-9 Shell Command

The $ command can be used to create a shell and return control to the host system. You may execute a single command by typing $ <command line>. After typing $, the prompt changes to the following:

```
% Com: $OS9:
```

By typing $<cr>, you enter the new shell until a subsequent escape (EOF) key is entered. The escape (EOF) key returns you to the com utility.

For example:

```
% Com: $ mfree
Current total free RAM: 4240.00 K-bytes
% Com:
```

Programmable Function Keys

The com utility has a "programmable function key" feature that allows up to ten user-defined text sequences to be stored for transmission upon a simple keyboard command. You can use this feature to eliminate repetitive typing of common keyboard entries such as user ID logins, program names, or auto-dial modem phone numbers. This is a software feature that does not require use of a terminal with special function keys.

Ten function keys are available. Select them by typing <control>-f followed by a number key (0-9). For example, the function key number four is selected by typing:

```
<control>-F4
```

The text associated with each function key is read from a disk file. You must specify the file name on the command line when you start the com utility. For example, if your function key file is called mykeys, start com like this:

```
com /t1 mykeys
```

You can create a personalized text file using a text editor or OS-9's build utility. The file contains up to ten text lines. Each line of the file is used as the string for the associated function key. The first line is function key 0, the second is function key 1, etc. The maximum size of this file is 512 characters.

Each line is transmitted exactly as stored in the file with one exception: a less than character (<) sends a <return> character to the remote system. This permits you to specify whether or not the transmitted function key string should be followed by a <return> character or not. It also allows the transmitted string to be several "lines."

Below is an example function key file:

```
dial 202 555 2626<
user12<
mypassword<
basic myprogram<run<
bye<
dir<
dir
chd
list
basic
```

Because you specify the name of the function key file when you run the com utility, you can create many different function key files for use with different systems.

Uploading And Downloading Files

An important feature of the com utility is its ability to transfer data between the remote computer and files on your OS-9 system. The control mode u and d commands are used for these functions.

"Downloading" refers to copying data from the remote system to a file on your system. The downloaded data can be a text file, the output of a program, S-records or any ASCII character data.

"Uploading" refers to copying data from a file on your system to the remote computer. The data transmitted can be any type of text. Normally, the data file to be transmitted is created with a text editor or generated by a program.

The only restriction on uploading and downloading is that the data must be text. Binary files must be converted to S-record files before being transmitted, otherwise certain bytes would be mistaken for control characters.

Downloading Files

The d command downloads files. When this command is input, the com utility asks you for the name of the file to be created for holding received data. You can then enter the name of any legal OS-9 file name (pathlist). If the file already exists, the com utility returns the following prompt:

```
% File already exists. Rewrite (y/n)?
```

If the com utility can open the file without error, it automatically switches to communications mode and stores all data received from the remote system on the file. If the communications line is operating in full duplex mode, the data stored will include any data typed on your keyboard that was echoed back from the remote system.

To terminate the download, type <control>-z to enter command mode and enter the d command again. You can now enter another filename or press ENTER to return to command mode.

Below is a sample download session:

```
% Com: Download filename: stock.prices
online:
run summary
The Dow-Jones average closed up 7-1/2 points today at
1225 in heavy trading, fueled by Wall Street rumors of
a lower third quarter inflation forecast.
<control>-Z
% Com:
```

Auto-Download

Another way to download files is to use the auto-download option. Auto-download is toggled on and off with the asterisk (`*`) command. The advantage to using auto-download is that the entire transfer can be done in communications mode instead of switching back to command mode. This is especially helpful when downloading more than one file.

After switching to communications mode, an auto-download is started by the character sequence `~>:` (tilde, greater than, colon) followed by the destination file name. If this file already exists on the host system, the `com` utility allows you to overwrite it. Downloading of this file is terminated by the character sequence `~>` (tilde, greater than).

Below is a sample auto-download session (this example assumes the remote computer is an OS-9 system):

```
% Com: *
% Com: *** automatic download mode ***
% Com: R
online: echo \7e\3e\3a; echo stock.prices
Downloading file: stock.prices
run summary
The Dow-Jones average closed up 7-1/2 points today at
1225 in heavy trading, fueled by Wall Street rumors of
a lower third quarter inflation forecast.
echo \7e\3e
file closed
```

If the remote system is an OS-9 system, auto-download procedure may be “automated” by using a `cfp` file. For example:

```
"echo \7E\3E\3A; echo *; list *; echo \7E\3E\0D"
```

Auto-Download Quick Mode

When downloading files, the text being transferred is echoed to your screen. If the dot (.) command is used, the com utility prints dots to show the progress of the transfer instead of echoing the text.

Download Data Buffering

When data is being downloaded, the com utility saves the received text in a 1K memory buffer. When this buffer is full (or when the download is terminated, if earlier) its contents are written to the disk file.

This buffering and XON-XOFF protocol is critical for OS-9 systems that have disk controllers that halt the system while accessing the disk. Otherwise, incoming data could be lost. In order for the com utility to work properly, the remote computer must recognize the XON-XOFF protocol.

In the case (worst case) of an OS-9 system that does not recognize XON-XOFF, with a disk controller that halts the system while talking to a remote system, the maximum file size that can be reliably downloaded corresponds to the size of the com buffer.

Systems with disk controllers that halt the CPU should also not run any other simultaneous task that accesses the disk while the com utility is running.

Uploading Files

The u command uploads files. After this command is input, the com utility asks you for the name of the file to be transmitted. You can then enter any legal OS-9 file name (path list). If the com utility can locate and open the file without error, it automatically switches to communications mode and begins sending the contents of the file to the remote system.

If the communications link is in full duplex mode, you will see the transmitted data echoed back to your terminal. If you want to abort the upload, type <control>-z to enter command mode, type the u command again and type <return> instead of a file name.

Below is a example upload session:

```
% Com: Upload filename: message.to.linc
Dear Lincoln,
I got your message today.  I will be visiting you
on June 12th so we can finalize our plans.  I'm looking
forward to seeing you then.
Regards,
Steve
<control>-Z
% Com:
```

If you want the remote computer to save the uploaded file, you must give the correct command for that system to store a file before starting the upload. You may also have to give the correct command after the upload to tell the remote system to close the file. If the remote system does not have a special upload command, you can often use the system's text editor program or merge-type utilities to receive uploaded files.

You can also use the upload command to send short commonly used commands to the remote system such as log-on sequences.

compress
Compresses ASCII Files

Syntax
```
compress [<opts>] {<path>}
```

OS
OS-9; OS-9 for 68K

Options

`-d`	Deletes the original file. This is inappropriate when no pathlist is specified on the command line and standard input is used.
`-n`	Creates an output file.
`-z`	Reads file names from standard input.
`-z=<file>`	Reads file names from `<file>`.

Description
The `compress` utility reads the specified text file(s), converts it to compressed form, and writes the compressed text file to standard output or to an optional output file.

Type `compress` and the path of the text file to compress. If files are not given, standard input is used.

The `compress` utility replaces multiple occurrences of a character with a three character coded sequence: `aaaaabbbbbccccccccc` would be replaced with `~Ea~Eb~Jc`.

Each compressed input file name is appended with `_comp`. If a file with this name already exists, the old file is overwritten with the new file. Typical files compress about 30% smaller than the original file.

The `compress` utility reduces the size of a file to save disk space. Refer to the `expand` utility for details on how to expand a compressed file.

Only use the `compress` and `expand` utilities on text files.

Examples

In the first example, `file1` is compressed, `file1_comp` is created, and `file1` is deleted.

```
$ compress file1 -dn
```

In this example, `file2` is compressed, `file3` is created from the redirected standard output, and `file2` is deleted.

```
$ compress file2 -d >file3
```

copy
Copies Data from One File to Another

Syntax
```
copy [<opts>] <path1> [<path2><dir>]
```

OS
OS-9; OS-9 for 68K

Options
`-a`

Aborts the `copy` routine if a source file error occurs. This option cancels the `continue (y/n) ?` prompt of the `-w` option.

`-b[=]<num>`

Allocates `<num>` k bytes of memory for buffering by `copy`. The default is 8k.

`-c[=][[<host>]<target]`

Convert ASCII files from `<host>` to `<target>` where:

```
d = MS-DOS(CRLF)
o = OS-9 or OS-9/68K(CR)
u = UNIX(LF)
```

Default `<host>` is ANY and `<target>` is `o`.

`-f`

Rewrites destination files with no write permission.

`-n`

Does not copy original file descriptor information (attributes, etc.) to the destination.

`-p`

Does not print a list of the files copied. This option is only for copying multiple files.

`-r`

Overwrites the existing file.

`-v`
: Verifies the integrity of the new file.

`-w[=]<dir>`
: Copies one or more files to `<dir>`. This option prints the file name after each successful copy. If an error such as no permission to copy occurs, the prompt `Continue (y/n)?` is displayed.

`-x`
: Uses the current execution directory for `<path1>`.

`-z`
: Reads file names from standard input.

`-z=<file>`
: Reads file names from `<file>`.

Description

The `copy` utility copies data from `<path1>` to `<path2>`. If `<path2>` already exists, the contents of `<path1>` overwrites the existing file when the `-r` option is specified. If `<path2>` does not exist, it is created.

If files are not given on the command line and the `-z` option is not specified, an error is returned.

You can copy any type of file. Copied files are not modified in any way unless the `-c` option is specified. The `-c` option should not be used on binary files.

The attributes of `<path1>` are copied exactly.

You must have permission to copy the file.

You must be the owner of the file specified by `<path1>` or have public read permission in order to copy the file.

You must also be able to write to the specified directory.

In any case, if the `copy` procedure is successful, `<path2>` has your group.user number unless you are the super user. If you are the super user, `<path2>` has the same group.user number as `<path1>`.

If <path2> is omitted, the destination file has the same name as the source file. It is copied into the current data directory. Therefore, the following two copy commands have the same effect:

```
$ copy /h0/cmds/file1 file1
$ copy /h0/cmds/file1
```

The copy utility can also copy one or more files to the same directory by using the -w=<dir> option. The following command copies file1 and file2 into the BACKUP directory:

```
$ copy file1 file2 -w=BACKUP
```

If used with wildcards, the -w=<dir> option becomes a selective dsave. The following command copies all files in the current data directory that have names ending with .lp into the LP directory:

```
$ copy *.lp -w=lp
```

Specification of the -w option for a destination directory name is optional. If the last path given to the copy command is an already existing directory name, then the destination directory name will be this path. For instance, to copy all files in the current directory to /r0, type:

```
$ copy * /r0
```

Data is transferred using large block reads and writes until an end-of-file occurs on the input path. Because block transfers are used, normal output processing of data does not occur on character-oriented devices such as terminals, printers, etc. Therefore, the list utility is preferred over the copy utility when a file consisting of text is sent to a terminal or printer.

Any error that occurs while creating or writing a destination file aborts the copy utility.

The copy utility always runs faster if you specify additional memory with the -b option. This allows the copy utility to transfer data with a minimum number of I/O requests

Examples

The following example copies `file1` to `file2`. If `file2` already exists, error #218 is returned.

```
$ copy file1 file2
```

This example copies `file1` to `file2` using a 15K buffer.

```
$ copy file1 file2 -b=15
```

This example copies all files in the current data directory to `MYFILE`.

```
$ copy * -w=MYFILE
```

This example copies all files in the current data directory that have names ending in `.lp`.

```
$ copy *.lp -w=MYFILE
```

This example copies `/d1/joe` and `/d0/jim` to `FILE`.

```
$ copy /d1/joe /d0/jim -w=FILE
```

This example writes `file3` over `file4`.

```
$ copy file3 file4 -r
```

This example copies a set of ASCII files, converting them to several different line termination styles. In the end, the directories `OS9` and `OS9000` will contain identical files.

```
$ copy OS9/*.c -c=d -w=DOS
$ copy DOS/*.c -c=u -w=UNIX
$ copy UNIX/*.c -c=o -w=OS9000
```

count

Counts Characters, Words, and Lines in File

Syntax

```
count [<opts>] {<path>}
```

OS

OS-9; OS-9 for 68K

Options

`-b`	Counts characters and gives a breakdown of their occurrence.
`-c`	Counts characters.
`-d[=]<number>`	Divides the count of lines by the specified number.
`-l`	Counts lines.
`-w`	Counts words.
`-z`	Reads file names from standard input.
`-z=<file>`	Reads file names from `<file>`.

Description

The `count` utility counts the number of lines in a file. Options include character count and word count.

To count the number of lines in a file, enter `count` and the pathlist of the file to examine. If a pathlist is not specified, the `count` utility examines lines from standard input.

The `count` utility recognizes the line feed and form feed characters as line delimiters.

By using `-c`, the `count` utility counts the number of characters in a file.

By using `-w`, the `count` utility counts the number of words in a file. A word is defined as a sequence of non-blank, non-carriage-return characters.

By using `-l`, the number of lines in a file is displayed. A line is defined by zero or more characters ending in a carriage-return.

Example

```
$ list file1
first line
second line
third line

$ count -clw file1
"file1" contains 34 characters
"file1" contains 6 words
"file1" contains 3 lines
```

cudo

Convert text file EOL characters

Syntax

```
cudo [<opts>] [<file name>] [<opts>]
```

OS

OS-9

Options

`-c<to>`

Convert file from any type to type <to>:

`-c<from><to>`

Convert file from type <from> to type <to>:

d	DOS format
o	OS-9 format
u	UNIX format

`-e`

Add a <ctrl Z> to the end of the file

`-q`

Quiet mode

`-r`

Remove any <ctrl Z> from the file

`-z`

Get list of input file names from standard input

`-z=<path>`

Get list of input file names from <path>

Description

This utility converts text file end-of-line (EOL) characters to and from UNIX, DOS, or OS-9 ASCII file formats.

OS-9 has, since its original version for the 6809, considered the ASCII CR (carriage return) to mark the end of a line, whereas Unix uses the ASCII LF (line feed) to mark the end of a line and MS-DOS uses the two-byte sequence CR LF. The cudo utility can be used to convert text files between the three EOL character formats.

For example, if you intend to edit OS-9 hosted text files from a Windows machine via NFS, you need to be aware of the difference in OS-9 end-of-line characters versus that for DOS (vs. that for UNIX). Once a text file with OS-9 end-of-line formatting has been saved using a Windows editor, you will more than likely need to use the cudo utility to convert the EOL characters from the MS-DOS format (CR LF) back to OS-9 (CR).

Examples

```
$ cudo -cdo readme.txt
```

Convert file from MS-DOS EOL format to OS-9.

```
$ cudo -co readme.txt
```

Convert file with unknown EOL format to OS-9.

date
Displays System Date and Time

Syntax
```
date [<opts>]
```

OS
OS-9; OS-9 for 68K

Options
`-j`
Displays the Julian date and time.

`-m`
Displays the military time (24 hour clock) after the date.

Description
The `date` utility displays the current system date and system time. The system date and time are set by the `setime` utility.

Examples
```
$ date
December 18, 1994 Tuesday 2:20:20 pm

$ date -m
December 18, 1994 Tuesday 14:20:24
```

See Also
`setime`

dcheck
Checks Disk File Structure

Syntax
```
dcheck [<opts>] <devname>
```

OS
OS-9; OS-9 for 68K

Options
`-b[=]<low>[:<high>]`
Print file names containing blocks in the given range. (OS-9 only)

`-d[[=]<num>]`
Prints the path to the directory `<num>` deep.

`-r`
Prompts to turn on or off bits in the bit map (Repair mode.)

`-y`
Does not prompt for repair, but answers yes to all prompts (Repair mode). This option may only be used with the `-r` option.

Description
The `dcheck` utility is a diagnostic tool which detects the condition and general integrity of the directory/file linkages of a disk device.

Type `dcheck`, the option(s) desired, and the name of the disk device to check.

The `dcheck` utility first verifies and prints some of the vital file structure parameters. It moves down the tree file system to all directories and files on the disk. As it moves down the tree file system, the `dcheck` utility verifies the integrity of the file descriptor sectors (FDs) and reports any discrepancies in the directory/file linkages.

From the segment list associated with each file, the `dcheck` utility builds a sector allocation map. This map is created in memory.

For OS-9 Users:

- Sectors are called blocks.
- Cluster size is one block.

If any FDs describe a segment with a cluster not within the file structure of the disk, the `dcheck` utility reports the following message:

OS-9 for 68K:

```
*** Bad FD segment (xxxxxx-yyyyyy)
```

OS-9:

```
*** bad fd segment ($xxxxxxxx-$yyyyyyyy)
```

This indicates that a segment starting at sector `xxxxxx` (hexadecimal) and ending at sector `yyyyyy` cannot be used on this disk. The entire FD is probably bad if any of its segment descriptors are bad. Therefore, the allocation map is not updated for bad FDs.

While building the allocation map, the `dcheck` utility ensures that each disk cluster appears only once in the file structure. If a cluster appears more than once, the `dcheck` utility displays a message:

OS-9 for 68K:

```
Sector xxxxxx (byte=nn bit=n) previously allocated
```

OS-9:

```
Block $xxxxxxxx previously allocated
```

For OS-9 for 68K Users:

The above message indicates the cluster at sector `xxxxxx` has been found at least once before in the file structure. `byte=nn bit=n` specifies in which byte of the bitmap this error occurred and in which bit in that byte. The first byte in the bitmap is numbered zero. For the `dcheck` utility's purposes, bits are numbered zero through seven; the most significant bit is numbered zero. The message may be printed more than once if a cluster appears in a segment in more than one file.

Occasionally, sectors on a disk are marked as allocated even though they are not associated with a file or the disk's free space. This is most commonly caused by media defects discovered by `format`. These defective sectors are not included in the free space for the disk. This can also happen if a disk is removed from a drive while files are still open, or if a directory containing files is deleted by a means other than `deldir`.

If all the sectors of a cluster are not used in the file system, the dcheck utility prints a message:

OS-9 for 68K:
```
xxxxxx cluster only partially used
```
OS-9:
```
Block $xxxxxxxx not in file structure
```

The allocation map created by the dcheck utility is then compared to the allocation map stored on the disk. Any differences are reported in messages:

OS-9 for 68K:
```
Sector xxxxxx (byte=nn bit=n) not in file structure
Sector xxxxxx (byte=nn bit=n) not in bit map
```
OS-9:
```
Block $xxxxxxxx not in bitmap
```

On OS-9 for 68K, the first message indicates sector number xxxxxx was not found as part of the file system but is marked as allocated in the disk's allocation map. In addition to the causes previously mentioned, some sectors may have been excluded from the allocation map by the format program because they were defective. They could be the last sectors of the disk, whose sum is too small to comprise a cluster.

The second message indicates that the cluster starting at sector xxxxxx is part of the file structure but is not marked as allocated in the disk's allocation map. This type of disk error could cause problems later. It is possible that this cluster may later be allocated to another file. This would overwrite the current contents of the cluster with data from the newly allocated file. All current data located in this cluster would be lost. Any clusters reported as previously allocated by the dcheck utility have this problem.

Repairing the Bitmap

The dcheck utility can repair two types of disk problems using the -r option. If a cluster was found in the file structure but not in the bitmap, the bit may be turned on in the bitmap to include the cluster. If the cluster was marked in the bitmap but not in the file structure, the bit in the bitmap may be turned off.

Do not use the -r option unless you thoroughly understand what you are doing. The disk errors could be caused by previously mentioned problems and perhaps should not be repaired.

Restrictions

1. Only the super user (user `0.n`) may use this utility.
2. The `dcheck` utility should have exclusive access to the disk being checked. The `dcheck` utility can be fooled if the disk allocation map changes while it is building its bitmap file from the changing file structure.

Example

```
$ dcheck /r0
Volume - 'Ram Disk (Caution: Volatile)' on device /r0
$001000 total sectors on media, 256 bytes per sector
Sector $000001 is start of bitmap
$0200 bytes in allocation map, 1 sector(s) per cluster
Sector $000003 is start of root dir
Building allocation map...
$0003 sectors used for id sector and allocation map
Checking allocation map...

'Ram Disk (Caution: Volatile)' file structure is intact
5 directories, 60 files
580096 of 1048576 bytes (0.55 of 1.00 meg) used on media
```

debug

Debugs and Tests 68000 Machine Language Programs

Syntax

```
debug [<opts> <prog> <prog opts>]
```

OS

OS-9

Options

`-m=<n>`	Increases memory size for program.

Description

The `debug` utility debugs and tests user-state 68000 machine language programs written for the OS-9 for 68000 operating system.

The `debug` utility uses:

- Software techniques to control a process to debug.
- The `F$DFork` and `F$DExec` system calls to create and execute the process to debug. These system calls provide an environment that allows the debugger to control how a process executes without affecting other processes on the system.

  Full access to the 68000 user-mode registers is provided. On 68020/68881-based systems, full access to user-mode 68020 registers and all 68881 floating point registers are provided.

For more information about the debug utility, refer to Chapter 2.

deiniz
Detaches Device

Syntax
```
deiniz [<opts>] {<modname>}
```

OS
OS-9; OS-9 for 68K

Options
`-z`
Reads the module names from standard input.

`-z=<file>`
Reads the module names from `<file>`.

Description
The `deiniz` utility removes the device from the system device table. In addition, the `deiniz` utility uses the `I$Detach` (OS-9 for 68K) or `I_Detach` (OS-9) system call to accomplish this.

Type `deiniz`, followed by the name of the module(s) to detach.

`<modname>` may begin with a slash (`/`). The module names may be read from standard input or from a specified pathlist if the `-z` option is used.

Do not use the `deiniz` utility to detach a module unless you have explicitly initialized it. If you use the `deiniz` utility to detach a device that you have not initialized, you could cause problems for other users who may be using the module.

See Also

`I$Detach`	*OS-9 Technical Manual*
`I_Detach`	*OS-9000 Technical Manual*
`iniz`	

Example

```
$ deiniz t1 t2 t3
```

del, os9del
Deletes a File

Syntax

```
del [<opts>] {<path>}      OS-9 or OS-9/68K
os9del [<opts>] {<path>}    DOS or UNIX
```

del OS

OS-9; OS-9 for 68K

os9del OS

WIN; UNIX

Options

`-d`

Deletes hard link to directories. (OS-9 only)

`-e`

Erases the disk space that the file occupied.

`-f`

Deletes files with no write permission.

`-p`

Prompts for each file to be deleted with the following prompt:

```
delete <filename> ? (y,n,a,q)
y = yes.
n = no.
a = deletes all specified files without further
prompts.
q = quits the deleting process.
```

`-q`

Quiet mode. Suppress File Not Found error messages.

`-x`

Looks for the file in the current execution directory. (`del` only)

`-z`
Reads the file names from standard input.

`-z=<file>`
Reads the file names from `<file>`.

`-@<path>`
Reads the file names from `<file>`. (`os9del` only)

Description

The `del` utility deletes the files specified by the pathlists.

You must have write permission for the files to be deleted. You cannot delete directory files with the `del` utility unless their attribute is changed to non-directory.

Examples

These examples use the following directory structure:

```
$ dir
   Directory of /D1  14:29:46
junk myfile newfile number_five old_test_program
test_program
$ del newfile
```

Delete `newfile`.

```
$ del *_*Delete all files in the current data directory
with an underscore character in their name
```

After executing the preceding two examples, the directory has the following files:

```
$ dir
Directory of /D1  14:30:37
junk            myfile
```

To delete all files in the current directory, type:

```
$ dir -u ! del -z
```

To delete a file that starts with a dash, type:

```
$ del ./-foo
```

See Also

attr
deldir

deldir

Deletes All Files in Directory

Syntax

```
deldir [<opts>] {<path>}
```

OS

OS-9; OS-9 for 68K

Options

`-e`

Erases the disk space that files in the directory occupied.

`-f`

Deletes files regardless of whether write permission is set.

`-l`

Check for hard links to directories.

When `-l` is used, each directory is checked for other hard directory links. If other hard links are detected, the directory contents will not be deleted or will search for other directories to delete. If no hard links are detected, the contents are deleted.

Failure to use `-l` in the presense of hard links leads to the removal of directory contents, though (empty) directories will be left on the disk.

`-q`

Quiet mode. No questions are asked. The directory and its sub-directories are all deleted, if possible.

`-x`

Deletes directories relative to the execution directory.

`-z`

Reads the directory names from standard input.

`-z=<file>`

Reads the directory names from `<file>`.

Description

The `deldir` utility deletes a directory and the files (and subdirectories) it contains.

When the `deldir` utility is run, it prints a prompt message:

```
$ deldir OLDFILES
Deleting directory: OLDFILES
Delete, List, or Quit (d, l, or q) ?
```

Table 1-6. Prompt Response

Response	Action
`d`	Initiate the process to delete the files.
`l`	Cause `dir -e` to run so you can have an opportunity to see the files in the directory before they are deleted.
`q`	Abort the command before action is taken.

After listing the files, the `deldir` utility prompts with:

```
delete ? (y,n)
```

The directory to be deleted may include directory files, which may themselves include directory files. In this case, the `deldir` utility operates recursively (that is, lower-level directories are also deleted). The lower-level directories are processed first.

You must have the correct access permission to delete all files and directories encountered. If not, the `deldir` utility aborts when it encounters the first file for which you do not have write permission.

The `deldir` utility automatically calls `dir` and `attr`, so they must reside in the current execution directory. When the `deldir` utility calls `dir`, it executes a `dir -ea` command to show all files contained in the directory.

Do not delete the current data directory (.).

delmdir
Deletes Existing Module Directories

Syntax
```
delmdir [<opts>] {<module directory>}
```

OS
OS-9

Options

`-z`	Reads the module directory names from standard input.
`-z=<file>`	Reads the module directory names from `<file>`.

Description
The `delmdir` utility deletes existing module directories.

The module directory to delete may contain both modules and module sub-directories. These sub-directories may contain sub-directories, or modules, etc. The `delmdir` utility recursively deletes all sub-directories when the parent directory is deleted.

The `delmdir` utility does not delete the module directory if there are modules located in the directory which are in use or if any of the sub-directories are in use.

The `delmdir` utility does not search the alternate module directories if the directory to be deleted is not located in the current module directory.

You must have the appropriate access permissions to a module directory in order to delete it.

See Also
`makdir`
`chm`
`mdir`

Example

```
$ mdir USR
           Module Directory of USR
proram1              program2            program3
$ delmdir USR
$ mdir USR
$
```

devs
Displays System's Device Table

Syntax
```
devs
```

OS
OS-9; OS-9 for 68K

Options
`-a`
Lists extended information about each device. (OS-9 only)

Description
The `devs` utility displays a list of the system's device table.

The device table contains an entry for each active device known. The `devs` utility does not display information for non-initialized devices.

Under OS-9 for 68K, the `devs` display header lists the system name, the operating system version, and the maximum number of devices allowed in the device table.

Under OS-9, the `devs` display header lists the system hardware architecture, operating system version, and the CPU class.

Each line in the `devs` utility's display contains five fields:

Table 1-7. devs Display Fields

OS-9 for 68K	OS-9	Description
`Device`	`Device`	Name of the device descriptor.
`Driver`	`Driver`	Name of the device driver.
`File Mgr`	`File Mgr`	Name of the file manager.
`Data Ptr`		Address of the device driver's static storage.

Table 1-7. devs Display Fields (Continued)

OS-9 for 68K	OS-9	Description
Links		Device use count. Each time a user executes a chd to an RBF device, the use count of that device increments one. Therefore, the Links field may be artificially high.
	DrvStat	Location of device driver's static storage.
	FMStat	File manager static storage.
	LUStat	Logical unit static storage.
	Users	User count

Example

The following example displays the OS-9 device table for a system named Tazz:

```
$ devs
Tazz_VME147  OS-9/68K V3.0.3  (128 devices max)

  Device     Driver    File Mgr   Data Ptr  Links
---------- ---------- ---------- --------- ------
term       sc8x30     scf        $007fda40      7
h0         rbsccs     rbf        $007fcbe0  31175
d0         rb320      rbf        $007e94a0      1
dd         rbsccs     rbf        $007fcbe0     23
t10        sc335      scf        $006d3a70      5
t11        sc335      scf        $006d3850      5
t12        sc335      scf        $006d3630      5
t13        sc335      scf        $006d3410      5
t20        sc335      scf        $006d31f0      5
t21        sc335      scf        $006d2fd0      5
t22        sc335      scf        $006d2db0      5
t23        sc335      scf        $006d2b90      5
5803       rb320      rbf        $007e94a0     20
3803       rb320      rbf        $007e94a0      1
mt2        sbgiga     sbf        $006d9640      1
n0         n9026      nfm        $006d63a0    372
nil        null       scf        $006d6340     10
socket     sockdvr    sockman    $006c0500      4
lo0        ifloop     ifman      $006c0380      4
```

```
le0         am7990      ifman       $006bed60      1
pipe        null        pipeman     $0068ecc0      3
pk          pkdvr       pkman       $0048dc90      1
pkm00       pkdvr       pkman       $00427b50      1
3807        rb320       rbf         $007e94a0     12
pcd0        rb320       pcf         $007e94a0      3
pks00       pkdvr       scf         $004279b0      2
```

See Also

iniz
deiniz

dir
Displays Names of Files in Directory

Syntax
```
dir [<opts>] {<path>}
```

OS
OS-9; OS-9 for 68K

Options
`-a`
Displays all file names in the directory. This includes file names beginning with a period.

`-b`
Does not display block address in extended listing (OS-9 only)

`-d`
Appends a slash (`/`) to all directory names listed. This does not affect the actual name of the directory.

`-e`
Displays an extended directory listing.

`-e=<opt>`
Displays an extended directory listing. (OS-9 only)† `opt = c, a, m, u,` and `b`

```
a = last access time
b = last backup time
c = creation time
m = last modified time (default)
u = last update time
```

`-f`
Displays the file link count in extended listing (OS-9000 only).

`-h`
Displays the file host number in extended listing (OS-9 only).

`-i`
: Inverts the order of sorted listings (OS-9 only).

`-n`
: Displays directory names without displaying the file names they contain. This option is especially useful with wildcards.

`-o`
: Does not display file owner in extended listing (OS-9000 only).

`-r`
: Recursively displays the directories. †

`-r=<num>`
: Displays the directories recursively up to the `<num>` level below the current directory. †

`-s`
: Displays an unsorted listing. †

`-t`
: Sorts on file date and time instead of name. (OS-9000 only).

`-u`
: Displays an unformatted listing. †

`-x`
: Displays the current execution directory. †

`-z`
: Reads the directory names from standard input.

`-z=<file>`
: Reads the directory names from `<file>`.

† This does not include file names beginning with a period.

Description

The `dir` utility displays a formatted list of file names of the specified directory file on standard output.

Type `dir` and the directory pathlist, if desired.

If parameters are not specified, the current data directory is shown. If you use the `-x` option, the current execution directory is shown. If a pathlist of a directory file is specified, the files of the indicated directory are shown.

Using the `-e` options, you can create your own listing, showing specific items as needed. Valid `<opt>` values are: `c`, `a`, `m`, `u`, or `b`.

`$dir -e=a`	Displays time last append occurred.
`$dir -e=b`	Displays time of last backup.
`$dir -e=c`	Displays creation time.
`$dir -e=m`	Displays time last modified.
`$dir -e=u`	Displays time of last update.

Because the shell does not interpret the `-x` option, wildcards do not work as expected when you use this option.

Unless you use the `-a` option, the `dir` utility does not display file names that begin with a period (`.`).

Unformatted Directory Listing

You can print an unformatted directory listing using the `-u` option. This displays only the names of the entries of a directory. No directory header is displayed. Entries are printed as follows:

```
$ dir -u
DIR1
file1
file2
file3
```

You can send the output of a `dir -u` command through a pipe to another utility or program that can use a pipe. For example:

```
$ dir -u ! attr -z
```

The above command displays the attributes of every entry in the current directory.

You can use the `-e` option to display an extended directory listing without the header by adding the `-u` option.

Examples

The first example displays the current data directory:

```
$ dir
Directory of . 12:12:54
BK          BKII         RELS         ed10.c       ed11.c
ed2.c
```

In the second example, the parent of the working data directory is displayed:

```
$ dir ..
```

This example displays the `NEWSTUFF` directory:

```
$ dir NEWSTUFF
```

The next example displays the entire description of the current data directory:

```
dir -e
                    Directory of . 13:54:44
 Owner    Last modified Attributes Sector Bytecount Name
-------   ------------- ---------- ------ --------- ----
  1.78    90/11/28 0357  d-ewrewr   383C8       160 NOTES
  1.78    90/11/28 0357  d-ewrewr   383E8       608 PROGRAMS
  1.78    90/11/28 0357  d-ewrewr   383D8       160 TEXT
  1.78    90/11/14 0841  ------wr   F4058       438 arrayex.c
  1.78    90/11/12 0859  ------wr   F4068       538 arrayex.r
  1.78    90/11/09 0852  ------wr   F2AB0       312 asciiinfo
  0.0     90/04/27 1719  ----r-wr   71EC8      4626 atari.doc
  1.78    90/11/14 0911  ------wr   B4548       636 bobble.c
  1.78    90/11/14 0910  ------wr   B4AA8       815 bobble.r
  1.78    90/10/18 1259  ------wr   BD418       619 cd.order
  1.78    90/06/06 1009  ---wr-wr    82B8      5420 cdichanges
  1.78    90/11/28 1102  ------wr   E0C68      1478 checks.c
  1.78    90/11/28 1102  ------wr   E1D08      1075 checks.r
  1.78    90/09/07 0848  ------wr   708B8       274 datafile
  0.78    90/04/12 1206  ---wr-wr   70EE8      1065 drvr.a
  1.78    90/11/13 1544  ------wr   B1650       112 exloop
```

To display the execution directory, type:

```
$ dir -x
```

To display the entire description of the execution directory, type:

```
$ dir -xe
```

To display the contents of the current directory and all directories one level below this directory, type:

```
$ dir -r=1
```

The next example displays the entire description of all files within the current directory. This includes files within all subdirectories of the current directory.

```
$ dir -er
```

This example displays all directory and file names that begin with `B`.

```
$ dir -n B*
```

To display all named pipes for device `/pipe`, type:

```
$ dir /pipe
```

diskcache

Enables, Disables, or Displays Status of Cache

OS-9 for 68K Syntax

```
diskcache [<opts>] [<dev>]
```

OS-9 Syntax

```
diskcache [<opts>] {<devname>[=<num>k]}
```

OS

OS-9; OS-9 for 68K

Options

`-c`
: Disables CRC checking of cached sectors. (OS-9 for 68K)

`-d`
: Disables cache for `<dev>`.

`-e`
: Enables cache for `<dev>`.

`-i`
: Disables statistical information. (OS-9 for 68K)

`-l`
: Display the cache status for `<dev>`. (OS-9 for 68K)

`-t=<size>`
: Specifies the size limit of the total cache. (OS-9 for 68K)

`-s`
: Prints cache status information for the specified device. (OS-9)

Description

The `diskcache` utility enables, disables, or displays the status of cache. Caching may be enabled for any type of RBF device, and more than one device may be cached at a time.

OS-9 for 68K Systems: Use the `-t` option to set the total amount of system memory used for caching all enabled drives. If not explicitly defined, `diskcache` automatically selects a reasonable value based on the amount of free system memory.

OS-9 Systems: The following command enables caching on the hard disk (`/h0`) with an 800k cache: `diskcache -e /h0=800k`

Use the -e and -d options to dynamically enable or disable caching on a per drive basis while the system is running.

Statistical information regarding the hit/miss ratios and amount of memory allocated can be inspected on a drive by drive basis using the `-l /(device)` OS-9 for 68K option, or `-s /(device)` OS-9 option.

An example output of this information follows.

```
Current size =  1047552
  Size limit =  1048576
crc enabled, stats enabled

Device:  /h0:1:1
           Requests  Sectors  Hits  Zaps  >2 Xfr   Hit Rate
  Reads:     47592    55436   21874  143    662     39.5%
  Writes:     7723     8065    7342   68
  Dir Reads: 54048    54048   34526  18387<-Sctr Zero  63.9%
Hit compares  =  63399 (  1/hit)
Miss compates =  92685 (  3/miss)
```

The `Device: /h0:1:1` line of information uses the following syntax: `[[<dev>[<bias>:<rebias>]]`. Where `<bias>` is the bias when last used, and `<rebias>` is the bias when last reused. The hit (miss) compares show total number of hits or misses, and average number of compares in cache before each hit or miss).

If caching is to be enabled on drives with different sector sizes, include the device with the largest sector size in the initial cache enabling.

Attempting to add a drive (with a sector size larger than any currently cached drive) to the cache system after initial cache startup results in continuous “misses” for that drive, as the sector size is too large.

dosfile

Converts DOS Text to OS-9 and Vise Versa

Syntax

```
dosfile [<opts>] [<file_name>] [<opts>]
```

OS

OS-9

Options

`-d`

Converts OS-9 text file to DOS format.

`-r`

Rewrites the target file if it exists.

`-b[=]<size>`

Use buffer of `<size>` kilobytes.

Description

The `dosfile` utility converts DOS text tiles to OS-9 format or OS-9 text files to DOS format.

Similar functionality is also implemented in the `copy` command for both OS-9 for 68K and OS-9. This utility may be removed in a future release.

dpsplit

Splits/Rejoins the DPIO descriptor

Syntax

```
dpsplit [<opts>] <desc> [<opts>]
```

OS

OS-9; OS-9 for 68K; WIN; UNIX

Options

`-j`

Joins `<desc>.1` and `<desc>.2` into `<desc>`.

`-s`

Splits `<desc>` into `<desc>.1` and `<desc>.2`.

Description

The `dpsplit` utility was designed to make development of the DPIO descriptors for the OS-9/68000 operating system easier. Because the `editmod` utility cannot handle a fully constructed DPIO descriptor, the descriptor must be split to be edited or listed.

Use the `dpsplit` utility to split the DPIO descriptor, and the `editmod` utility to edit or list the split components, then the `dpsplit` utility again, to rejoin the descriptor.

When creating a DPIO descriptor, the `editmod` utility can be used to create both components and the `dpsplit` utility can be used to join the components.

Example

`dpsplit -s nv0`	Creates `nv0.1` and `nv0.2`
`editmod -l nv0.1`	List contents of the wrapper module

<<< listing not shown >>>

`dpsplit -j nv0`	Join `nv0.1` and `nv0.2` back to `nv0`

dsave

Generates Procedure File to Copy Files

Syntax

```
dsave [<opts>] [<path>]
```

OS

OS-9; OS-9 for 68K

Options

`-a`

Does not copy any file that has a name beginning with a period.

`-b[=]<n>`

Allocates `<n>` k bytes of memory for `copy` and `chm` if needed.

`-c[=][[<host>]<target]`

Convert ASCII files from `<host>` to `<target>` where:

```
d = MS-DOS(CRLF)
o = OS-9 or OS-9/68K(CR)
u = UNIX(LF)
```

Default `<host>` is ANY and `<target>` is `o`.

`-d`

Compares dates with files of the same name and copies files with more recent dates.

`-d=<date>`

Compares the specified date with the date of files with the same name and copies any file with a more recent date than that specified. See format for `<date>` above.

`-e`

Executes the output immediately.

`-f`

Uses `copy`'s `-f` option to force the writing of files.

`-i`

Indents for directory levels.

`-l`

Does not save directories below the current level.

`-m`

Does not include `makdir` commands in the procedure file.

`-n`

Does not load `copy` (`cmp, os9cmp` if `-v` is specified).

`-o`

Uses `os9gen` (OS-9 for 68K), `bootgen` (OS-9), to create a bootfile on the specified destination device if a bootfile exists on the source device. The default name used for the bootfile is `OS9Boot` (OS-9 for 68K), `SysBoot (OS-9)`. This option creates a bootable disk. Merely copying `OS9Boot` or `SysBoot` to a new disk does not make it bootable.

`-o=<name>`

Uses `os9gen` (OS-9 for 68K), `bootgen` (OS-9), to create a bootfile on a new device, using the specified name. This option creates a bootable disk. Merely copying `OS9Boot` or `SysBoot` to a new disk does not make it bootable.

`-r`

Write any source file over a file with the same name in the destination directory. This is the same as using the `copy` utility with the `-r` option.

`-s`

Skip files on error. This turns off the prompt to continue the `dsave` routine when an error occurs.

`-t`

Do not issue `tmode` commands.

`-v`

Verify files with the `cmp, os9cmp` utility.

Description

The dsave utility backs up or copies all files in one or more directories. It generates a procedure file, which is either executed later to actually do the work or is executed immediately using the -e option.

Type dsave and the path of the new directory. The dsave utility writes commands on standard output to copy files from the current data directory to the directory specified by <path>. If <path> is not specified, the copies are directed to the current data directory when the procedure file is executed.

You should direct the dsave utility's standard output to a procedure file that you can later execute or use the -e option to execute the dsave utility's output immediately.

If the dsave utility encounters a directory file, it automatically includes the makdir and chd commands in the output before generating copy commands for files in the subdirectory. The procedure file duplicates all levels of the file system connected downward from the current data directory.

If the current working directory is the disk's root directory, the dsave utility creates a procedure file to backup the entire disk, file by file. This is useful when you need to copy many files from different format disks, or from a floppy disk to a hard disk.

If an error occurs, the dsave utility displays the following prompt:

```
continue (y,n,a,q)?
```

Enter one of the following responses:

Table 1-8. Responses

Response	Description
y	Continue. Ignore the error.
n	Do not continue. Save work to this point.
a	Copy all possible files. Skip all files where an error occurs. Do not display the error or prompt.
q	Quit the dsave procedure.

If for any reason you do not wish to be bothered by this prompt, use the -s option. This skips any file which cannot be copied and continues the dsave utility with no prompt.

The dsave utility helps keep up-to-date directory backups. When you use the -d or -d=<date> options, the dsave utility compares the date of the file to copy with a file of the same name in the directory it is to be copied to.

- -d copies any file with a more recent date.
- -d=<date> copies a file with a date more recent than that specified. The format for the date is as follows:

<year> <delimiter> <month> <delimiter> <day> where:

<year>	is any two digit whole number from 00 to 99
<delimiter>	colon (:), semicolon (;), slash (/), comma (,), or space ( )
<month>	1 to 12
<day>	1 to 31

A common error occurs when using the dsave utility if the destination directory has files with the same name as the source directory. Because a file name must be unique within a directory, this produces an error. Use the -r option to prevent this error.

Examples

The first three examples accomplish the same goal: copying all files in /d0/MYFILES/STUFF to /d1/BACKUP/STUFF. Each example highlights a different method of using the dsave utility.

In the first example, no path is specified in the dsave command and a procedure file is generated. Therefore, you must change data directories before executing the procedure file. If the directory is not changed, an error message occurs:

```
#218--file already exists in this directory under the same name.
```

`$ chd /d0/MYFILES/STUFF`	Selects the directory to copy.
`$ dsave >/d0/makecopy`	Makes the procedure file makecopy.
`$ chd /d1/BACKUP/STUFF`	Select the destination directory for makecopy.
`$ /d0/makecopy`	Runs makecopy.

The second example uses the `/d1/BACKUP/STUFF` path in the `dsave` command. You do not need to change directories before executing the procedure file. This example also allocates 32K of memory for the copy procedure, which saves time.

```
$ chd /d0/MYFILES/STUFF
$ dsave -ib=32  /d1/BACKUP/STUFF >saver
$ saver
```

The third example is like the second, but without a procedure file.

```
$ chd /d0/MYFILES/STUFF
$ dsave -ieb32 /d1/BACKUP/STUFF
```

In the following example, `dir -e` shows the creation dates of the files. This shows the `-d` option of the `dsave` utility.

```
$ dir -e WORKFILES BACKUP
                          Directory of WORKFILES 14:10:03
 Owner    Last modified  Attributes Sector Bytecount Name
-------   -------------  ---------- ------ --------- ----
 30.110   95/05/02 1358   ------wr  1201FC        38 program.c
 30.110   94/05/12 1617   ------wr   10AE0         1 prog.2

                           Directory of BACKUP 14:10:03
 Owner    Last modified  Attributes Sector Bytecount Name
-------   -------------  ---------- ------ --------- ----
 30.110   94/12/20 0947   ------wr   C0378        38 program.c
 30.110   94/05/12 1617   ------wr   C0370         1 prog.2

$ chd WORKFILES
$ dsave -deb32 ../BACKUP
$ cd ..

$ dir -es WORKFILES BACKUP

                        Directory of WORKFILES 14:12:23
 Owner    Last modified  Attributes Sector Bytecount Name
-------   -------------  ---------- ------ --------- ----
 30.110   95/05/02 1358   ------wr  1201FC        38 program.c
 30.110   94/05/12 1617   ------wr   10AE0         1 prog.2

                          Directory of BACKUP 14:12:22
 Owner    Last modified  Attributes Sector Bytecount Name
-------   -------------  ---------- ------ --------- ----
 30.110   95/05/02 1358   ------wr  14025C        38 program.c
 30.110   94/05/12 1617   ------wr   C0370         1 prog.2
```

Here, only `prog2` is copied because the data in `WORKFILE` is current.

dump, os9dump
Displays Formatted Dump

Syntax
```
dump {<option(s)>} [<path> [<starting offset>]]
os9dump {<option(s)>} [<path> [<starting offset>]]
```

dump OS
OS-9; OS-9 for 68K

os9dump OS
WIN; UNIX

Options
`-a`
Interpret path as memory range of either: `<start>[-end]` or `<start>[:size]`.

`-c`
Does not compress duplicate lines.

`-k`
Displays shift-JIS Kanji code in the ASCII format area.

`-m`
Dumps from a memory resident module.

`-s`
Interprets the starting offset as a sector number. This is useful for RBF devices with a sector size not equal to 256.

`-x`
Indicates that `<path>` is an execution directory. You must have execute permission for the pathlist.

Description

The dump utility produces a formatted display of the physical data contents of <path>. <path> may be a mass storage file or any other I/O device. The dump utility is commonly used to examine the contents of non-text files.

Type dump and the pathlist of the file to display. A starting address within a file may also be specified.

If <path> is omitted, the dump utility uses standard input. The output is written to standard output.

When <starting offset> is specified, the contents of the file are displayed starting with the appropriate address. <addr> is must be a hexadecimal number.

The data is displayed 16 bytes per line in both hexadecimal and ASCII character format. Data bytes that have non-displayable values are represented by periods.

The addresses shown in the dump are relative to the load addresses of the memory modules.

Examples

`$ dump`	Display keyboard input in hex.
`$ dump myfile >/P`	Dump `myfile` to printer.
`$ dump shortfile`	Dump `shortfile`.

Sample Output

```
Starting Data bytes in hexadecimal format Data bytes in ASCII
format
Address
Addr 0 1 2 3 4 5 6 7 8 9 A B C D E F 0 2 4 6 8 A C E
-------- ---- ---- ---- ---- ---- ---- ---- ---- ----------------
00000000 6d61 696e 2829 0d7b 0d09 696e 7420 783b main().{..int x;
00000010 0d09 0d09 6765 745f 7465 726d 5f64 6566 ....get_term_def
00000020 7328 293b 0d09 783d 6d65 6e75 2829 3b0d s();..x=menu();.
```

echo
Echoes Text to Output Path

Syntax
```
echo [<opts>] {<text>}
```

OS
OS-9; OS-9 for 68K

Options
`-n`
Separates the text with carriage returns.

`-r`
Does not send a carriage return after `<text>`.

`-z`
Reads the text from standard input.

`-z=<file>`
Reads the text from `<file>`.

Description
The `echo` utility echoes its parameter to the standard output path.

The `echo` utility is used to generate messages in shell procedure files or to send an initialization character sequence to a terminal.

Type `echo` and the text to output. The `echo` utility reads the text until a carriage return is encountered. The input then echoes on the output path.

You can embed a hexadecimal number representing a character in a character string, but you must precede it with a backslash (`\`). The shell removes all but one embedded space from character strings passed to the `echo` utility. Therefore, to allow for more than one blank between characters, you must enclose the string with double quotes. A single backslash (`\`) is echoed by entering two backslashes (`\\`).

Do not include any of the punctuation characters used by the shell in the text unless you enclose the string with double quotes.

Examples

```
$ echo "Here is an important message!"

Here is an important message!
```

```
$ echo \1b >/p1
```

Send an <escape> character to a printer (/p1).

```
$ echo column1       column2        column3

column1 column2 column3

$ echo "column1       column2       column3"

column1       column2       column3
```

editmod
Creates, Displays, and Edits Modules

Syntax
```
editmod [<opts>] [<module>] [<opts>]
```

OS
OS-9; OS-9 for 68K; WIN; UNIX

Options
`-a[=]<dir>`
Specifies an alternative `MWOS` directory structure.

`-b`
Enables verbose debugging messages. Multiple `-b` options increase the amount of output. For example: `editmod -bbb -c test` shows very verbose debugging messages while the module test is being created.

`-c`
Creates a module.

`-d[=]<name>[[=]<value>]`
Defines name for the pre-processor. If the optional `value` is not supplied, the empty string is `name`'s value.

`-e`
Edits the contents of a module.

`-f[=]file`
Specifies the file which contains the named module. If the module being edited or listed is contained in a larger file, use this option. The OS-9 for 68K boot file is an example of this situation. To edit the `init` module within the boot file, the following command line is used:

```
editmod -f=OS9Boot init -e
```
The edited module's size is not constrained by the size of the module prior to editing module.

`-h[=]<struct>`

Emits the symbol `<struct>` as a C structure (or macro, see `-m`) to standard output or to the pathlist specified with `-o`. Multiple `-h` options may be used on a single command line. This option is most commonly used to generate a header file that is included by the device driver.

`-i[=]<file>`

Specifies a non-interactive edit file name (used in conjunction with `-e`). The file specified is read after all other description files. Generally, the file contains `init` blocks as well as symbol redefinitions. These items are processed and the modified module is written to the file.

`-l`

Lists the contents of a module.

`-m[=]<name>=<struct>`

Emits the symbol `struct` as a C pre-processor macro called `name` to standard output or to the pathlist specified with `-o`. Only a single `-m` may be used on a command line. This option generates a header file that is included by the device driver.

`-nc[=]<file>`

Overrides the initial file read in creation mode. Normally, `systype.des` is read when `-c` is used. This option allows you to specify a different file name. For example, to read `testfile.des` instead of `systype.des`:

```
editmod -nc=testfile.des -c -dTEST testmod
```

`-nd[=]<name>`

Renames the driver for a descriptor module. If the descriptor being edited has the same format as a `sc8042` module, but uses a driver with a different name, use this option. For example:

```
editmod -nd=<name> newterm
```

`-nf[=]<name>`

Renames the file manager for a descriptor module. When editing a descriptor module such as the `term` module, the names of the file manager and driver are used to determine what description files to read. If the descriptor being edited has the same format as a `sc8042` module, but uses a file manager with a different name, use this option. For example:

```
editmod -nf=<name> newterm
```

`-nm[=]<name>`

Renames the module. When editing a data or system module such as the `init` module, the module name determines what description file to read. If the module being edited has the same format as the `init` module but is named differently, use this option. For example:

```
editmod -nm=init newinit
```

`-o[=]<file>`

Overrides the output file name when a module is being edited. This option allows you to edit one descriptor but write the edited version to a different file. This option cannot be used when `-f` is used.

`-p`

Prints the pre-processed version of the description files that `editmod` reads. This can be useful when developing the description files to examine what is actually being seen by `editmod` in the presence of conditional code.

`-q[=]<name>[[=]<qvalue>]`

Define name (with optional `qvalue`) for pre-processor `qvalue` will replace with double-quotes on either end.

`-t?`

Displays target OS and CPU options.

`-to[=]<name>`

Specifies the target operating system for the generated module.

name	Target Operating System
`osk`	OS-9 for 68K
`os9000, os9k`	OS-9

`-tp[=]<name>`

Specifies the target processor for the generated module. Refer to the output of -t? for information about valid target processors.

`-v[=]<dir>`

Adds a directory to the list of directories searched for include files.

`-z`

Reads command line arguments from standard input.

`-z[=]<file>`

Reads command line arguments from <file>.

Description

The `editmod` utility creates, displays, and edits modules. It has the following attributes:

For more information about the `editmod` utility, refer to Chapter 3.

- Comprehensive — Use the `editmod` utility for all aspects of module maintenance: creation, examination, and modification. The `editmod` utility supports these actions on device descriptors, system modules, and data modules. You can use it in conjunction with the `os9make` utility to create modules non-interactively. It is not necessary to use the `moded` utility, compilers, assemblers, and linkers.
- Host/Target independent — The `editmod` utility may be used on any host platform to manipulate modules for any target platform.
- Stand-alone — With the exception of supporting description files, the `editmod` utility does not require any other resources to manipulate modules.
- Extensible — End-Users can write the supporting files necessary for the `editmod` utility to understand modules of their own creation.

- Unconstrained — The `editmod` utility does not limit module modifications based on previous module contents. This includes support for variable length lists such as the colored memory list in the `init` module. In addition, a module within a boot file may be modified to any length.
- User interface — The `editmod` utility allows entry of C expressions with additional operand types for hexadecimal constants, binary constants, internet addresses, and ethernet addresses.

Examples

To edit the `cnfgdata` module, first set your `MWOS` environment variable, then type:

```
editmod -e cnfgdata -dc_all
```

edt
Line-Oriented Text Editor

Syntax
```
edt [<opts>] <path>
```

OS
OS-9; OS-9 for 68K

Options
`cc`
Exist, a buffer of the indicated size is assigned for the new file.

Description
The `edt` utility is a line-oriented text editor that allows you to create and edit source files.

Type `edt` and the pathlist desired. If the file is new or cannot be found, the `edt` utility creates and opens it. The `edt` utility then displays a question mark prompt (`?`) and waits for a command. If the file is found, the `edt` utility opens it, displays the last line, and then displays the `?` prompt.

The first character of a line must be a space if text is to be inserted. If any other character is typed in the first character position, the `edt` utility tries to process the character as an `edt` command. The `edt` utility command format is very similar to BASIC's editor.

The `edt` utility determines the size of the file to `edit` and uses the returned size plus 2K as the edit buffer. If the file does not already exist, the edit buffer is initialized to 2K. When the end of the edit buffer is reached, a message is displayed.

edt Commands

All `edt` commands begin in the first character position of a line.

Table 1-9. edt Commands

Command	Description
`<num>`	Moves the cursor to line number `<num>`.
`<esc>`	Closes the file and exits. `q` also does this.
`<cr>`	Moves the cursor down one line (carriage return).
`+[<num>]`	Moves the cursor down `<num>` lines. Default is one.
`-[<num>]`	Moves the cursor up `<num>` lines. Default is one.
`<space>`	Inserts lines.
`c`	Change string in current line.
`d[<num>]`	Deletes `<num>` lines. If `<num>` is not specified, the default value of `<num>` is one.
`l[<num>]`	Lists `<num>` lines. `<num>` may be positive or negative. The default value of `<num>` is one.
`l*`	Lists all lines in the entire file.
`q`	Quits the editing session. Command returns to the program that called the editor or the shell.
`s`	Searches for occurrences of a pattern.

For the following search and replace commands, `<delim>` may be any character. The asterisk (`*`) option indicates that all occurrences of the pattern are searched for and replaced if specified.

Search command: searches for the occurrences of a pattern. For example:

```
s[*]<delim><search string><delim>
```

`s/and/` Finds the first occurrence of `and`.

`s*,Bob,` Finds all occurrences of `Bob`.

Replace command: finds and replaces a given string. For example:

```
c[*]<delim><search string><delim><replace string><delim>
```

`c/Tuesday/Wednesday/`
Replaces the first occurrence of `Tuesday` with `Wednesday`.

`c*"employee"employees"`
Replaces all occurrences of `employee` with `employees`.

events
Displays Active System Events

OS-9 for 68K Syntax
```
events
```

OS-9 Syntax
```
events [<opts>]
```

OS
OS-9; OS-9 for 68K

Options
`-h`
Displays the event values in hexadecimal format.

`-k[=]name`
Kills the event.

Description
The `events` utility displays a list of the active events on the system and information about each event. The `events` utility header line lists the system name and the version number.

Each line in the `events` utility display contains the following fields:

Table 1-10. `events` **Fields**

OS-9 for 68K	OS-9	Description
`event ID`	`Event ID`	Event ID number.
`name`	`Name`	Name of the event.
	`Owner`	Owner of the event. (OS-9 only)
	`Perm`	Event's permission field. For example, 0333 represents an event with all permissions set. Permissions are left to right: reserved, public, group, owner. (OS-9 only)

Table 1-10. `events` **Fields (Continued)**

OS-9 for 68K	OS-9	Description
`value`	`Value`	Current contents of the event variable
`W-inc`	`W-inc`	Wait increment. Assigned when the event is created and does not change.
`S-inc`	`S-inc`	Signal increment. Assigned when the event is created and does not change.
`links`	`Links`	Event use count. When the event is created, `links` is assigned value one. It increments each time a process links to the event.

You cannot delete an event unless the link count is zero.

If there are no active events currently on the system, the `events` utility displays the message "`No active events`."

Example

The following example displays the active system events for an OS-9 for 68K system named `Calvin`:

```
Calvin    OS-9/68K V3.0
event ID      name         value     W-inc  S-inc  links
---------  ------------ ---------- ------ ------ ------
   10000   evtfffe4000           1     -1      1      1
   20001   irqfffe4000           0     -1      1      1
   30002   SysMbuf          121952      0      0      1
   40003   net_input             0     -1     -1      1
   50004   Sur00227750           0      0      0      1
   60005   Str002261f0           0      0      0      1
   70006   Stw002261f0           0      0      0      1
   80007   Str00227380           0      0      0      1
   90008   Stw00227380           0      0      0      1
   a0009   Str00232a50           0      0      0      1
   b000a   Stw00232a50           0      0      0      1
   c000b   Str0020ac30           0      0      0      1
   d000c   Stw0020ac30           0      0      0      1
   e000d   pkm00i                0      0      0      1
   f000e   pkm00o                0      0      0      1
  10000f   teln.1                0     -1     -1      1
  130012   Str0020adf0           0      0      0      1
  140013   Stw0020adf0           0      0      0      1
```

See Also

`F$Event` service request	*OS-9 for 68K Technical Manual*.
`F_Event` system call	*OS-9 Technical Manual*.

ex
Chains to a Program

Syntax
```
ex <path> [<arglist>]
```

OS
OS-9; OS-9 for 68K

Description
The `ex` utility is a built-in shell command that causes the shell to chain to another program. It permits a transition from the shell to another program without creating another process, thus conserving system memory.

The `ex` utility is used when the shell is called from another program to execute a specific program, after which the shell is not needed. For example, applications which use only BASIC need not waste memory space on shell.

The `ex` utility should always be the last command on a shell input line because any command lines following it are never processed.

Because this is a built in shell command, it does not appear in the `CMDS` directory.

Example
```
$ ex BASIC
$ echo "Starting tsmon" ; ex tsmon /t1 /t2 /term
```

exbin
Converts S-Record to Binary

Syntax
```
exbin {<option(s)>} [<inpath>[<outpath>]]
```

OS
OS-9; OS-9 for 68K

Options
`-b[=]<num>[k]`
Specifies the conversion buffer size in bytes to use. The `k` sub-option converts `<num>` to k bytes.

Description
The `exbin` utility converts S-record files to binary.

S-record files are a type of text file containing records that represent binary data in hexadecimal form. This Motorola-standard format is often used by commercial PROM programmers, emulators, logic analyzers, and similar devices that use the RS-232 interface. It can be useful for transmitting files over data links that can only handle character type data. It can also be used for converting assembler or compiler generated programs to load on non-OS-9/OS-9for 68K systems.

`<inpath>` is assumed to be an S-Record format text file which the `exbin` utility converts to pure binary form in a new file, `<outpath>`. The load addresses of each data record must describe contiguous data in ascending order.

The `exbin` utility does not generate or check for the proper module headers or CRC check value required to actually load the binary file. You can use `ident` to check the validity of the modules if they are to be loaded or run. The `exbin` utility converts any of the S-record types mentioned above.

Standard input and output are assumed if both paths are omitted. If the second path is omitted, standard output is assumed.

Examples

The following example generates `CMDS/prog` in binary format from the S1 type file, `prog.S1`.

```
$ exbin prog.S1 cmds/prog
```

See Also

binex

expand
Expands Compressed File

Syntax
```
expand [<opts>] {<path>}
```

OS
OS-9; OS-9 for 68K

Options
`-d`
Deletes the old version of the file. This option should not be used when a pathlist is not specified on the command line and standard input is used.

`-n`
Sends output to a file instead of the standard output. The file has `_exp` appended to it, unless the file name already has a `_comp` suffix. In this case, the `_comp` is removed.

`-z`
Reads the file names from standard input.

`-z=<file>`
Reads the file names from `<file>`.

Description
The `expand` utility restores compressed files to their original form. It is the complement command of the `compress` utility.

Type `expand` and the name of the file to expand.

If file names are not given on the command line, standard input is assumed.

Examples

`$ expand data.a -nd`

Expands and then delete `data.a`, creating `data.a_exp`.

`$ expand file1_comp`

Expands `file1_comp` and displays output on standard output.

`$ expand -nd file2_compfile2_comp`

Expanded and then deleted, creating `file2` with the expanded output.

fdisk

Displays/Alters the Partition Table

Syntax

```
fdisk [<opts>]
```

OS

OS-9

Options

`-a[=]<num>`

Makes partition `<num>` the active partition.

`-d[=]<dev>`

Examines/changes device. Default = `/hc`.

`-c`

Forces terminal mode (curses off).

`-e`

Includes partition information in display mode.

`-i`

Initialize the partition table to zero.

`-s`

Shows partition table.

Description

Although OS-9 may be used without disk partitions of any kind, the use of partitions is strongly recommended, even if only one partition is used.

There are several reasons for using partitions with OS-9.

Hard Disk Booting

Without partitions, you must boot from floppy disk.

Multiple Operating Systems

When disk partitioning is employed, other operating systems may share the same physical disk.

OS-9 is compatible with most Boot Managers, including OS-2 Boot Manager and Linux LILO. If a boot manager is not used, OS-9 includes an IPL (Initial Program Loader) which prompts you for information on where to boot from.

Partition Information

The OS-9 partition for x86 is defined as a primary partition type 0x9.

OS-9 for the Power PC includes extended type41 and 0x41. The RBF file system only understands these two type partitions.

The `fdisk` utility allows a maximum of four primary partitions to be created.

The `fdisk` utility also allows extended partitions to be converted to OS-9 primary partitions.

When converting extended partitions to OS-9, all data on the extended partition is deleted. This includes any logical partitions associated with the extended partition.

Do NOT place OS-9 on a logical drive partition.

You may have to use extended partitions for other operating systems such as DOS, OS/2 and WINDOWS.

Further, with OS-9 “PCF” DOS extended partitions and logical drives may be accessed.

To create or delete a partition, you must enter `fdisk` in the interactive mode:

```
fdisk -d=/hcfmt
```

or

```
fdisk -d=/hcfmt -e
```

The following options display:

```
1. Create OS-9000 partition
2. Set Active Partition
3. Delete partition
4. Display partition information
5. Change extended DOS partition to OS-9000 partition
6. Write master boot record (MBR)
```

Create OS-9 Partition (1)

This option allows the creation of OS-9 partitions. When partitions are created, you are prompted for the size of the partition in terms of cylinders.

Cylinder size is not in megabytes. Although, some cylinders may be 1 MEG in size. Enter the number of cylinders to allocate for the partition, not the number of bytes.

Set Active Partition (2)

This option allows you to specify which partition is bootable. If DOS is set as the active partition, and the system is reset, then DOS loads. To allow OS-9 to boot, you would have to use the DOS version of `fdisk` to set the OS-9 partition to active.

If a boot manager is used, then set the Boot Manager as active.

Delete Partition (3)

Use the delete option with care. Extended partitions may include any logical drives associated with them.

Display Partition Information (4)

This option displays the partition tables. If the `-e` option is used from the command line, additional information about the partition tables displays.

The extended/additional information includes:

`st`
: Start-flag (if 80 drive is startable)

`s_head`
: Start head (byte)

`s_cyl_blk`
: Start Cylinder block (word)

`type`
: Partition type (word)

`e_head`
: End head (byte)

`e_cyl_blk`
: End cylinder block (word)

`s_blk`
: Start block (LBA) (long-word)

`size`
: Size of block (LBA) (long-word)

```
{end}s_blk + size
```

Change Extended DOS Partition to OS-9 Partition (5)

This option converts an extended partition to an OS-9 partition. Use this option with care. Extended partitions may include logical drives.

Write Master Boot Record (MBR) (6)

This option writes the master boot record to disk. The master boot record is required to boot IDE and SCSI devices on x86 platforms.

If the disk is newly formatted or does not appear to boot, this option may correct the problem.

Examples

To modify the partition table for SCSI disk ID 1, type:

```
fdisk -d=/hs1fmt
```

To find out the partition information of a drive, type:

```
fdisk -d=/hs1fmt -s
```

See Also

pinfo

fixmod
Fixes Module CRC and Parity

Syntax
```
fixmod {<option(s)>} {<modname>}
```

OS
OS-9; OS-9 for 68K; WIN; UNIX

Options
`-d[=<path>]`
Locates and dumps all modules in file to separate files (in either the current directory or the specified path).

`-f`
Forces dump of module even if destination filename already exists.

`-j[=<pathname>]`
Skips junk (invalid module data) and continue locating modules in the specified file.

`-l[=]<name>`
Specify module on which to operate.

`-q`
Quiet mode. Does not display status as files are updated.

`-r`
Changes the revision number only.

`-u`
Updates an invalid module CRC or parity.

`-ua[=]<att.rev>`
Changes module's attribute/revision level.

`-ub`
Fixes the `sys/rev` field in BASIC packed subroutine modules.

`-ue[=]<sysedit>`
Changes module's edition to `<sysedit>`.

`-ug`
Updates the corresponding STB module with the new CRC of the module being modified.

`-un[=]<name>`
Changes the name stored in the module header. This option can only be used on files that contain a single module.

`-uo=<grp>.<usr>`
Sets the module owner's group.user number to `<g>.<u>`. Only the super user is allowed to use this option.

`-up=<perm>`
Sets the module access permissions to `<perm>`. `<perm>` must be specified in hexadecimal.

`-us[=]<size>[k]`
Sets the module required stack size to the specified value. The 'k' sub-option converts `<size>` to k bytes.

`-x`
Looks for the module in the execution directory. (OS-9, OS-9 for 68K only)

`-z`
Reads the module names from standard input.

`-z=<file>`
Reads the module names from `<file>`.

Description

The `fixmod` utility verifies and updates module parity and module CRC (cyclic redundancy check). You can also use the `fixmod` utility to set the access permissions and the group.user number of the owner of the module. The `fixmod` utility can process OS-9 for 68K, OS-9/80386, and OS-9/PowerPC modules, regardless of the host operating system.

Use the fixmod utility to update the CRC and parity of a module every time a module is *patched* or modified in any way. OS-9 and OS-9 for 68K cannot recognize a module with an incorrect CRC.

You must have write access to the file in order to use the fixmod utility on it.

Use the -u option to recalculate and update the CRC and parity. Without -u, the fixmod utility only verifies the CRC and parity of the module.

The -up=<perm> option sets the module access permissions to <perm>. <perm> must be specified in hexadecimal. You must be the owner of the module or a super user to set the access permissions.

The permission field of the module header is divided into four sections from right to left:

```
owner permissions
group permissions
public permissions
reserved for future use
```

Each of these sections are divided into four fields from right to left:

```
read attribute
write attribute
execute attribute
reserved for future use
```

The entire module access permissions field is given as a three-digit hexadecimal value. For example, the command fixmod -up=555 specifies the following module access permissions field:

```
-----e-r-e-r-e-r
```

The -uo<grp>.<usr> option allows the super user to change the ownership of a module by setting the module owner's group.user number.

Examples

`$ fixmod dt`	Checks parity and CRC for module dt.
`$ fixmod dt -u`	Checks parity and CRC for module dt and updates them if necessary.

The following example changes the name stored in the module header:

```
$ chd /h0/CMDS

$ copy dir ls

$ fixmod -u -n=ls ls

Module: dir - Fixing header parity - Fixing module CRC
```

See Also

CRC and parity	*OS-9 for 68K Technical Manual* *OS-9 Technical Manual*

`ident`

format
Initializes Disk Media

Syntax
```
format [<opts>] <devname>
```

OS
OS-9; OS-9 for 68K

Options
`-bo=<num>`
Sets the block offset to <num>. (OS-9)

`-c`
Uses the interactive mode. (OS-9)

`-c=<num>`
Specify the number of sectors per cluster. <num> must be decimal and must be a power of 2. The default is 1. (OS-9)

`-dd`
Initializes a double-density (floppy) disk.

`-ds`
Initializes a double-sided (floppy) disk.

`-e`
Displays elapsed verify time. This is useful for checking the sector interleave values. (OS-9 for 68K)

`-h=<num>`
Sets the number of heads to <num>. (OS-9)

`-i=<num>`
Specifies the number for sector interleave offset value. <num> is decimal.

`-m=<num>`
Sets the bitmap address to <num>. (OS-9)

`-nf`
Specifies no fast verify mode. (OS-9 for 68K)

`-np`
Specifies no physical format.

`-nv`
Specifies no physical verification.

`-o`
Performs interleave optimization. (OS-9)

`-r`
Inhibits the ready prompt. This option is ignored if the device is a non-partitioned hard disk under OS-9 for 68K or any hard disk under OS-9.

`-sd`
Initializes a single-density (floppy) disk.

`-ss`
Initializes a single-sided (floppy) disk.

`-s=<num>`
Uses a spiral skew of `<num>`. (OS-9)

`-t=<num>`
Specifies the number of cylinders given in decimal.

`-to=<num>`
Sets the track offset to `<num>`. (OS-9)

`-v=<name>`
Specifies the volume name. This name can be 32 characters maximum. If the name contains blanks, enclose the option and name with quotation marks. For example, `"-v=Name of disk"`.

Description

The `format` utility physically initializes, verifies, and establishes an initial file structure on a disk. You must format all disks before using them on an OS-9 or OS-9 for 68K system.

Type `format`, the name of the device to format, and any options. The `format` utility determines whether the device is:

- Autosize (for example, devices such as SCSI CCS drives).
- Non-autosize (such as standard floppy disks and many hard disks).

An autosize device is one which can be queried to determine the capacity of the device.

The `format` utility checks a bit in `PD_Ctrl` to determine whether or not a device is autosize. If this bit is zero, the device is non-autosize. If one, the media is autosize.

Format on Non-Autosize Devices

If the `format` utility determines that your device is non-autosize, the `format` utility reads a description of the disk from the device descriptor module. The values in the descriptor determine the default values for the number of sides (single or double), number of tracks, sector size, and density. At this time, the default cluster size is set at one.

The `format` utility determines the media capacity by multiplying together the number of:

- Cylinders (`PD_CYL`).
- Tracks (`PD_TKS`).
- Sectors per track (`PD_SCT`, `PD_T0S`).

Because the `format` utility calculates the device capacity using this formula, you can use the `-t=<num>` and `-ss/-ds` options to affect the capacity of the device.

On OS-9 for 68K, the following information is displayed before formatting begins:

```
                Disk Formatter
OS-9/68K V2.4   Delta MVME147 - 68030
------------  Format Data  ------------
Fixed values:
    Physical floppy size: 5 1/4"
                          (Universal Format)
              Sector size: 256
            Sectors/track: 16
     Track zero sect/trk: 16
            Sector offset: 1
             Track offset: 1
               LSN offset: $000000
Total physical cylinders: 80
 Minimum sect allocation: 8
Variables:
        Recording format: MFM all tracks
    Track density in TPI: 96
Number of log. cylinders: 79
      Number of surfaces: 2
Sector interleave offset: 1
Formatting device:  /d0
proceed?
```

You can change the values in the variables section when formatting floppy disks by using command line options or by answering `n` to the prompt. The `format` utility asks for any required options not given on the command line.

When formatting hard disks, answering `n` to the prompt returns control to the shell. You can change hard disk parameters only by command line options or by changing the device descriptor.

You can only change the values in the `Fixed values` section by altering the device descriptor module of the specific unit.

Format on Autosize Devices

If the `format` utility determines that the device has the autosize feature, the `format` utility performs an `SS_DSize` SetStat call to the drive to request the capacity of the device. The driver then queries the actual drive. The value returned to the `format` utility is the capacity of the device. Because the `format` utility performs no calculations when determining the capacity, the `-t` and `-ss/-ds` options do not affect the capacity of the device.

The following information is displayed before formatting commences:

```
                Disk Formatter
OS-9/68K V2.4   Delta MVME147 - 68030
------------  Format Data  ------------
Fixed values:
               Disk type: hard
             Sector size: 512
           Disk capacity: 208936 sectors
                          (106975232 bytes)
           Sector offset: 0
            Track offset: 0
              LSN offset: $000000
 Minimum sect allocation: 8
Variables:
Sector interleave offset: 1
Formatting device:  /h1
proceed?
```

When formatting hard disks, answering `n` to the prompt returns control to the shell. You can only change the sector interleave offset. The `format` utility cannot change the other values.

You can only change the values in the `Fixed values` section by altering the device descriptor module of the specific unit.

Continuing the Format Procedure

The formatting process works as follows:

1. The disk surface is physically initialized and sectored.
2. Each sector is read back and verified. If the sector fails to verify after several attempts, the offending sector is excluded from the initial free space on the disk. As the verification is performed, track numbers are displayed on the standard output device for non-autosize devices; logical sector numbers are displayed for autosize devices.
3. The disk allocation map, root directory, and identification sector are written to the first few sectors of track zero. These sectors cannot be defective.

The `format` utility uses a "fast verify" mode. This means that the `format` utility reads a minimum of 32 sectors. If the cluster size is greater than 32 sectors, one cluster's worth of sectors is read.

- If the cluster size is less than 32 sectors, 32 sectors are read.
- If you want the `format` utility to use the cluster size regardless of the number of sectors per cluster, you *must* use the `-nf` option. For example, if your cluster size has one sector, 32 sectors are read by default, while only one sector would be read if you specify `-nf`.

You must run `os9gen` or `bootgen` to create the bootstrap after the disk has been formatted if you use the disk as a system disk.

Examples

```
$ format /D1 -dsdd -v="database" -t=77
$ format /D1 -sssd -r
```

free

Displays Free Space Remaining on Mass-Storage Device

Syntax

```
free [<opts>] {<devname>}
```

OS

OS-9; OS-9 for 68K

Options

`-b[=]<num>`	Uses the specified buffer size in k bytes.
`-le`	Creates big-endian file system.
`-be`	Creates little-endian file system

Description

The `free` utility displays the number of unused sectors on a device available for new files or for expanding existing files.

The `free` utility also displays the disk's name, creation date, cluster size, and largest free block in bytes.

For OS-9 Users:

- Sectors are called blocks.
- Cluster size is one block. (Cluster information is not used in OS-9).

Type `free` followed by the name of the device to examine. The device name must be the name of a mass-storage, multi-file device.

Data sectors are allocated in groups called *clusters*. The number of sectors per cluster depends on the storage capacity and physical characteristics of the specific device.

For example, a given disk system uses eight sectors per cluster. A `free` command shows the disk has 32 sectors free. Because disk space is allocated in clusters, a maximum of four new files could be created even if each had only one sector.

OS-9 Example

```
$ free /r0

"Ram Disk" created on: Sat Nov 23 18:59:04 1996
Capacity: 32768 blocks, 8.000 Mbytes
Free: 32725 blocks, 7.989 Mbytes
Largest Free Block: 32725 blocks, 7.989 Mbytes

For RAM disk size of 8MEG use the following
Blocks/track = 8192*4                = 32768
Size of block in bytes               =   256
-----------------------------------------
Total size (Blocks/track*BlockSize) = 8388608 (8MEG)
```

OS-9 for 68K Example

```
$ free

"Tazz: /H0 Wren V" created on: Oct 6, 1990
Capacity: 2347860 sectors (256-byte sectors, 8-sector
clusters)
1508424 free sectors, largest block 1380120 sectors
386156544 of 601052160 bytes (368.26 of 573.20 Mb) free
on media (64%)
353310720 bytes (336.94 Mb) in largest free block
```

frestore
Restores Directory from Backup

Syntax
```
frestore [<opts>] [<path>]
```

OS
OS-9; OS-9 for 68K

Options
`-a`
Forces access permission for overwriting an existing file. You must be the owner of the file or a super user (0.n) to use this option. (OS-9 for 68K)

`-a[=]<number>`
Consider media to begin after `<number>` tape marks. (OS-9)

`-b[=]<int>`
Specifies the buffer size in k bytes used to restore the files.

`-c`
Checks the validity of files without the interactive shell.

`-d[=]<path>`
Specifies the source device. The default source device is `/mt0`.

`-e`
Displays the pathlists of all files in the index as the index is read from the source device.

`-f[=]<path>`
Restores from a file.

`-i`

Displays the backup name, creation date, group.user number of the owner of the backup, volume number of the disk or tape, and whether the index is on the volume. This option does not restore any files. The information is displayed, and `frestore` is terminated.

`-j[=]<int>`

Sets the minimum system memory request in k bytes. (OS-9 for 68K)

`-p`

Suppresses the prompt for the first volume.

`-q`

Overwrites already existing files when used with the `-s` option.

`-s`

Forces `frestore` to restore all files from the source device without an interactive shell.

`-t[=]<dirpath>`

Specifies an alternate location for the temporary index file.

`-v`

Displays the backup name, creation date, group.user number of the owner of the backup, and volume number of the disk or tape. This option does not restore any files. The information is displayed, and `frestore` is terminated.

`-x[=]<int>`

Pre-extends a temporary file. `<int>` is specified in kilobytes.

`-z[=]<path>`

Adds pathlists `<path>` to restoration list. Pathlists start from root of tape directory. (OS-9 for 68K)

OS-9 for 68K Users: `-j` allows you to specify the size of the dynamic memory requests made by the `frestore` utility. As the `frestore` utility builds its index structure in memory, it requests additional memory from the system as needed. Since the number of requests allowed is limited, increasing the minimum request size may be needed on systems with very large backups or with fragmented free memory.

Description

The `frestore` utility restores a directory structure from multiple volumes of tape or disk media. Typing `frestore` by itself on the command line attempts to restore a directory structure from the device `/mt0` to the current directory.

Specifying the pathlist of a directory on the command line causes the files to be restored in the specified directory. The `fsave` utility creates the directory structure and an index of the directory structure.

If more than one tape/disk is involved in the `fdisk` utility backup, each tape/disk is considered a different volume. The volume count begins at one (1). When you begin an `frestore` operation, you must use the last volume of the backup first. The last volume of the backup contains the index of the entire backup.

The `frestore` utility first attempts to locate and read in the index of the directory structure from the source device. The device you are restoring from is the source device. It then begins an interactive session with you to determine which files and directories in the backup should be restored to the current directory.

The `-s` option forces the `frestore` utility to restore all files/directories of the backup from the source device without the interactive shell.

The `-d` option allows you to specify a source device other than `/mt0`.

The `-v` option causes the `frestore` utility to identify the name and volume number of the backup mounted on the source device. It also displays the date the backup was made and the group.user number of the person who made the backup. This option does not restore any files. After displaying the appropriate information, the `frestore` utility terminates. This is helpful for locating the last volume of the backup if a mix-up has occurred.

The `-i` option duplicates the `-v` option and also checks to see if the index is on the volume being checked.

The `-e` option echoes each file pathlist as the index is read off the source device.

The `frestore` utility cannot restore a file that requires more than four disks. If the backup index requires more than a single volume, the `frestore` utility fails with a `header block corrupt` error.

Examples

The following command restores files and directories from the source device `/mt0` to the current directory by way of an interactive shell.

```
$ frestore
```

The next command restores files and directories from the source device `/d0` to the current directory using a 32K buffer. As each file is read from the index, the file's pathlist is echoed to the terminal.

```
$ frestore -eb=32 -d=/d0
```

The next command restores all files/directories found on the source device `/mt1` to the directory `BACKUP` without using the interactive shell.

```
$ frestore -d=/mt1 -s BACKUP
```

The following command displays the backup and the volume number:

```
$ frestore -v
Backup: DOCUMENTATION
Made:   11/30/90 10:10
By:     0.0
Volume: 0
```

This command does not restore the backup.

fsave
Incremental Directory Backup

Syntax
```
fsave [<opts>] [<dir>]
```

OS
OS-9; OS-9 for 68K

Options
`-a`
Appends backup data to data already existing on tape. (OS-9)

`-b[=]<int>`
Allocate a `<int>` k byte buffer to read files from source disk.

`-d[=]<dev>`
Specifies the target device to store the backup. The default target device is `/mt0`.

`-e`
Does not echo the file pathlist as it is saved to the target device.

`-f[=]<path>`
Saves to a file.

`-g[=]<int>`
Specifies a backup of files owned by group number `<int>` only.

`-i`
Provides information about backup: the amount of time it took to perform the backup and the number of kilobytes per second. (OS-9)

`-j[=]<num>`
Sets the minimum system memory request in k bytes. (OS-9 for 68K)

`-l[=]<int>`
: Specifies the level of backup to be performed.

`-m[=]<path>`
: Specifies the pathlist of the date backup log file to be used. The default is `/h0/sys/backup_dates`.

`-p`
: Turns off the *mount volume* prompt for the first volume.

`-s`
: Displays the pathlists of all files needing to be saved and the size of the entire backup without actually executing the backup procedure.

`-t[=]<dirpath>`
: Specifies an alternate location for the temporary index file.

`-u[=]<int>`
: Specifies a backup of files owned by user number `<int>` only.

`-v`
: Does not verify the disk volume when mounted.

`-x[=]<int>`
: Pre-extends the temporary file. `<int>` is specified in kilobytes.

OS-9 for 68K Users: `-j` allows you to specify the size of the dynamic memory requests made by the `fsave` utility. As the `fsave` utility builds its index structure in memory, it requests additional memory from the system as needed. Since the number of requests allowed is limited, increasing the minimum request size may be needed on systems with very large backups or with fragmented free memory.

Description

The `fsave` utility performs an incremental backup of a directory structure to tape(s) or disk(s).

Typing `fsave` by itself on the command line makes a level 0 backup of the current directory onto the target device `/mt0`.

Use the -l option to specify different backup levels. A higher level backup only saves files changed since the most recent backup with the next lower number. For example, a level 1 backup saves all files changed since the last level 0 backup.

The backup log file, /h0/sys/backup_dates, is updated each time an fsave command is executed. The backup log keeps track of the name of the backup and the date it was created. More importantly, it keeps track of the level of the backup.

When the fsave utility is executed, this backup log is examined for the specified level of the current backup and the previous backups with the same name. Once the backup is finished, a new entry is entered in the file indicating the date, name, and level of the current backup. The fsave utility does not accept a device name as a directory. For example, if fsave /h0 is entered, error #216 is returned.

Prior to performing the first backup, a log file named backup_dates must be created and must be completely blank (no end of file marks, etc.). To create this blank file, type the following:

```
touch /h0/sys/backup_dates
```

The fsave Procedure

When you start an fsave procedure, the fsave utility first builds the directory structure. You are then prompted to mount the first volume to use:

```
fsave: please mount volume.
(press return when mounted).
```

If you use a disk as the backup medium, the fsave utility verifies the disk and displays the following information:

```
verifying disk
```

The numbers above are used as an example. If you use a tape as the backup medium, the backup begins at this point.

As each file is saved to the backup device, its pathlist is echoed to the terminal. If this is a long backup, use the -e option to turn off the echoing of pathlists.

If the fsave utility receives an error when trying to backup a file, it displays a message and continues the fsave operation.

If the backup requires more than one volume, the fsave utility prompts you to mount the next volume before continuing.

At the end of the backup, the fsave utility prints the following information:

```
fsave: Saving the index structure

Logical backup name:
Date of backup:
Backup made by:
Data bytes written:
Number of files:
Number of volumes:
Index is on volume:
```

By specifying one or more directories on the command line, the fsave utility performs recursive backups for each specified pathlist. You can specify a maximum of 32 directories on the command line.

Use the -d option to specify an alternative target device. The default device is /mt0.

Use the -m option to specify an alternative backup log file. The default pathlist is /h0/sys/backup_dates.

When using disks for backup purposes, be aware that the fsave utility does not use an RBF file structure to save the files on the target disk. It creates its own file structure. This makes the backup disk unusable for purposes other than the fsave and frestore utilities without reformatting.

Any data on the disk before using the fsave utility is destroyed by the backup.

For a full description of the fsave, frestore, and tape utilities, refer to *Making Backups* in *Using OS-9* or *Using OS-9 for 68K*. The information includes work through examples and backup strategies for disk and tape.

Examples

The following command specifies a level 0 backup of the current directory. It assumes the device `/mt0` is to be used. `/h0/SYS/backup_dates` is used as the backup log file.

```
$ fsave
```

This command specifies a level 2 backup of the current directory. The device `/mt1` is used. `/h0/misc/my_dates` is used as the backup log file.

```
$ fsave -l=2 -d=/mt1 -m=/h0/misc/my_dates
```

The next command specifies a level 0 backup of all files owned by the super user in the `CMDS` directory, assuming `CMDS` is in your current directory. `/d2` is the target device used for this backup. The backup log file used is `/h0/sys/backup_dates`. The mount volume prompt is not generated for the first volume, and a 32K buffer reads the files from the `CMDS` directory.

```
$ fsave -pb=32 -g=0 -u=0 -d=/d2 CMDS
```

grep
Searches File for Pattern

Syntax
```
grep [<opts>] [<expression>] {[<path>]}
```

OS
OS-9; OS-9 for 68K

Options
`-c`
Counts the number of matching lines.

`-e=<expr>`
Searches for `<expr>`. This is the same as `<expression>` in the command line.

`-f=<path>`
Reads the list of expressions from `<path>`.

`-g`
Formats output similar to UNIX `grep`.

`-i`
Searches for text, insensitive to upper/lower case.

`-l`
Prints only the names of the files with matching lines.

`-m=<num>`
Prints specified number of lines from each matched occurrence.

`-n`
Prints the relative line number within the file followed by the matched expression.

`-s`
Does not display matching lines. Silent Mode.

`-v`
: Prints all lines except for those that match.

`-z`
: Reads the file names from standard input.

`-z=<path>`
: Reads the file names from `<path>`.

You cannot use `-l` and `-n` at the same time, nor can you use `-n` and `-s` at the same time. You cannot use `-f` when information to `grep` is read from STDIN.

Description

The `grep` utility searches the input pathlists for lines matching `<expression>`.

Type `grep`, the expression to search for, and the pathlist of the file to search. If the `<path>` is not specified, the `grep` utility searches standard input.

If the `grep` utility finds a line that matches `<expression>`, the line is written to the standard output with an optional line number of where it is located within the file. When multiple files are searched, the output has the name of the file preceding the occurrence of the matched expression.

Expressions

An `<expression>` specifies a set of characters. A string which is a member of this set is said to match the expression. To facilitate the creation of expressions, some metacharacters are defined to create complex sets of characters.

Table 1-11. Expression Special Characters

Character	Specification
`.`	**ANY**. The period (`.`) is defined to match any ASCII character except new line.
`~`	**BOL or NEGATE**. The tilde (`~`) is defined to modify a character class as described above when located between square brackets (`[ ]`). At the beginning of an entire expression, it requires the expression to compare and match the string at only the beginning of the line. The *NEGATE* character modifies the character class so it matches any ASCII character not in the given class or newline.

`[ ]`	**CHARACTER CLASS**. The square brackets (`[ ]`) define a group of characters which match any single character in the compare string. The `grep` utility recognizes certain abbreviations to aid the entry of ranges of strings:
	
	`[a-z]` Equivalent to the string `abcdefghijklmnopqrstuvwxyz`
	
	`[m-pa-f]` Equivalent to the string `mnopabcdef`
	
	`[0-7]` Equivalent to the string `01234567`

`*`	**CLOSURE**. The asterisk (`*`) modifies the preceding single character expression, so it matches zero or more occurrences of the single character. If a choice is available, the longest such group is chosen.

Table 1-11. Expression Special Characters (Continued)

Character	Specification
`$`	**EOL**. The dollar sign (`$`) requires the expression to compare and match the string only at end- of-line.
	ESCAPE. The backslash (`\`) removes special significance from special characters. It is followed by a base and a numeric value or a special character. If the base is not specified, the base for the numeric value defaults to hexadecimal. An explicit base of decimal or hexadecimal can be specified by preceding the numeric value with a qualifier of `d` or `x`, respectively. It also allows entry of some non-printing characters such as: `\t`=Tab character `\n`=New-line character `\l`=Line feed character `\b`=Backspace character `\f`=Form feed character

Example Expressions

You can combine any meta-characters and normal characters to create an expression:

Table 1-12. Meta-characters Example Expressions

Expression	Same as
`abcd`	`abcd`
`ab.d`	`abcd, abxd, ab?d, etc.`
`"ab *d"`	`"abd", "ab d", "ab  d", "ab  d", etc.`
`~abcd`	`abcd` (only if very first characters on a line)
`abcd$`	`abcd` (only if very last characters on a line)
`~abcd$`	`abcd` (only if `abcd` is the complete line)
`[Aa]bcd`	`abcd`, `Abcd`
`abcd[0-9a-zA-z]`	`abcd` followed by any alphanumeric character
`bcd[~a-d]`	`bcd` followed by any ASCII char except `a`, `b`, `c`, `d`, or new line

Examples

To write all lines of `myfile` that contain occurrences of `xyz` to standard output, enter:

```
$ grep xyz myfile
```

This example searches `myfile` for expressions input from `words`, counts the number of matches, and gives the line number found with each occurrence:

```
$ grep -f=words myfile -nc
```

help
On-Line Utility Reference

Syntax
```
help [<utility names>]
```

OS
OS-9; OS-9 for 68K

Description
The `help` utility displays information about a specific utility.

Type `help` and the name of the desired utility for information about any utility. The `help` utility displays the function, syntax, and options of the utility. After the information displays, control returns to the shell.

For information about the `help` utility, type `help` by itself. The `help` utility lists the syntax and function of the help utility.

Built-in shell commands do not have help information.

Examples
```
$ help build
$ help attr
```

hist
Command History

Syntax
```
hist
```

OS
OS-9

Description
The `hist` utility is a built-in shell command that displays the commands that you have already entered.

As commands are entered, they are stored in a buffer. This is a *history* of your commands. To see the commands that you have entered, type `hist` on the command line.

Commands residing in a buffer may be executed or retrieved using tildes (~). One tilde followed by a number (`~<num>`) executes the command that `<num>` points to. For example, entering ~4 on the command line causes the shell to execute the fourth command in your history list.

Entering a number after two tildes (`~~<num>`) places the command in the command line buffer, just as if were the last command entered. For example, if you type `~~3`, the command is placed in a buffer as if it had just been executed. By typing `<control>A`, you can retrieve the command line. It is placed after the shell prompt. This allows you to edit the command line before executing it.

A single tilde "~" followed by alphabetic characters specifies the most recent command executed that began with those letters. For example: `~pro` executes the most recent command line that began with the letters "`p`", "`r`", and "`o`".

Examples

```
[5]$ hist
Shell History
-------------
 1) makdir /h0/usr/TMS
 2) chd /h0/usr/tms
 3) build stat
 4) procs
 5) hist
[6]$ ~4

Id PId Grp.Usr Prior  MemSiz Sig S   CPU Time   Age Module & I/O
3  2   6.10   128    5.25k   0 w      5.02 02:34 shell <>>>term
4  3   6.10   128    8.50k   0 *      0.08 00:00 procs <>>term

[7]$ hist
Shell History
-------------
 3) build stat
 4) procs
 5) hist
 6) procs
 7) hist
[8]$ ~~3
[8]$ <control>A
[8]$ build stat
```

ident

Prints OS-9 Module Identification

Syntax

```
ident {<option(s)>} {<modname>}
```

OS

OS-9; OS-9 for 68K; WIN; UNIX

Options

`-c`

Prints the total number of modules and the combined size of those modules in bytes.

`-e`

Displays the edition number of Microware executables (DOS and UNIX hosted executables only).

`-h`

Prints hexadecimal numbers instead of decimal numbers.

`-m`

Searches for the specified modules in memory via `_os_link()`, rather than opening them as files.

`-o`

Displays the offset within the file for located modules. If `-o` is used with `-m`, `ident` displays the memory address of modules.

`-q`

Displays a one line summary of each module. The line contains the module's name, size, owner, edition number, and CRC information.

`-qa`

Displays a one line summary of each module. The line contains the module's name, processor, OS revision, edition number, and CRC information.

`-r`

Displays module information in columns. Columns include offset (if `-o` is used), name, type, size, data size, stack size, edition number and CRC.

`-s`

Silent mode. Like `-q` mode, but only displays information for modules with bad CRCs.

`-x`

Searches for modules in the execution directory (OS-9 and OS-9 for 68K only).

`-z`

Reads the module names from standard input.

`-z=<file>`

Reads the module names from `<file>`.

Description

The `ident` utility displays module header information and the additional information that follows the header for OS-9 for 68K modules.

The `ident` utility also checks for incomplete module headers, incorrectly set header parity words, and incorrectly set module CRCs.

The `ident` utility is capable of identifying modules for any OS-9 platform regardless of host OS.

The `ident` utility displays the following information in this order:

```
actual module name
module size
owner
CRC bytes (with verification)
header parity (with verification)
edition
type/language and attributes/revision words
access permission
```

For relevant modules it also includes:

```
execution offset
data size
```

```
stack size
initialized data offset
offset to the data reference lists
```

The `ident` utility prints the interpretation of the type/language and attribute/revision bytes at the bottom of the display.

The access permissions are divided into four 4-bit sections from right to left:

```
owner permissions
group permissions
public permissions
reserved permissions
```

Each of these sections are divided into four 1-bit fields from right to left:

```
read permission
write permission
execute permission
reserved permission bit
```

If a permission is allowed, the first letter of the permission (`r`, `w`, `e`) is displayed. If a permission is denied, a dash is displayed.

All reserved fields are displayed as dashes unless the fields are turned on. In that case, the fields are represented with question marks. In any case, the kernel ignores these fields as they are reserved for future use.

Owner permissions allow the owner to access the module. Group permissions allow anyone with the same group number as the owner to access the module. Public permissions allow access to the module regardless of the group.user number. The following example allows the owner and the group to read and execute the module, but bars access to the public:

```
Permission:      $055          ---------e-r-e-r
```

Example

```
$ ident -m ident
Header for:      ident
Module size:     $1562       #5474
Owner:           0.0
Module CRC:      $FA8ECA     Good CRC
Header parity:   $2471       Good parity
Edition:         $C          #12
```

```
Ty/La At/Rev:    $101        $C001
Permission:      $555        -----e-r-e-r-e-r
Exec. off:       $4E         #78
Data size:       $15EC       #5612
Stack size:      $C00        #3072
Init. data off:  $1482       #4250
Data ref. off:   $151A       #5402
68000 Prog Mod, Object Code, Sharable, Sticky Module
```

iniz
Attaches Devices

Syntax
```
iniz [<opts>] {<devname>}
```

OS
OS-9; OS-9 for 68K

Options
`-z`
Reads the device names from standard input.

`-z=<file>`
Reads the device names from `<file>`.

Description
The `iniz` utility performs an `I$Attach` (OS-9 for 68K), `I_Attach` (OS-9) system call on each device name passed to it. This initializes and links the device to the system.

Type `iniz` and the name(s) of the device(s) to attach a device to the system. The operating system searches the system module directory using the name of the device to see if the device is already attached.

If the device is not attached, an initialization routine is called to link the device to the system.

If the device is attached, it is not re-initialized but the link count is incremented.

The device names may be listed on the command line, read from standard input, or read from a specified pathlist.

Do not use the `iniz` utility to attach non-sharable device modules as they become "busy" forever.

See Also

`I$Attach` system call — *OS-9 for 68K Technical Manual*.
`I_Attach` system call — *OS-9 Technical Manual*.
`deiniz`

Examples

```
$ iniz h0 term
```
Increments the link counts of modules `h0` and `term`.

```
$ iniz -z
```
Increments the link count of any modules with names read from standard input.

```
$ iniz -z=/h0/file
```
Increments the link count of all modules whose names are supplied in `/h0/file`.

irqs
Displays System's IRQ Polling Table

Syntax
```
irqs [<opts>]
```

OS
OS-9; OS-9 for 68K

Description
The `irqs` utility displays a list of the system's IRQ polling table. The IRQ polling table contains a list of the service routines for each interrupt handler known by the system.

The `irqs` utility display header lists the system name and the OS-9 version number.

For OS-9 for 68K, the `irqs` utility display header lists the system name, the OS-9 for 68K version number, the maximum number of devices allowed in the device table, and the maximum number of entries in the IRQ table.

Each line in the OS-9 `irqs` utility display contains six fields:

Table 1-13. Fields in OS-9 irqs Utility

Name	Description
`vector`	Exception vector number used by the device. The first number is the exception number in decimal and the second number is the exception number in hex format.
`prior`	Software polling priority
`drivstat`	Address of the device driver's static storage
`irq svc`	Interrupt service routine's entry point

Table 1-13. Fields in OS-9 irqs Utility (Continued)

Name	Description
`driver`	Name of the module which contains the interrupt service routine, usually a device driver
`dev list`	If the `drivstat` is also the driver device entry '`dev list`', then the '`dev list`' entry displays, otherwise, '`<na>`' displays. If the '`dev list`' entry displays, then option '`-d`' displays additional information about the device.

Each line in the OS-9 for 68K `irqs` utility display contains seven fields:

Table 1-14. Fields in OS-9 for 68K `irqs` Utility

Name	Description
`vector`	Exception vector number used by the device. A second number, the hardware interrupt level, is displayed for auto-vectored interrupts.
`prior`	Software polling priority.
`port addr`	Base address of the interrupt generating hardware. The operating system does not use this value, but passes to the interrupt service routine.
`data addr`	Address of the device driver's static storage.
`irq svc`	Interrupt service routine's entry point.
`driver`	Name of the module which contains the interrupt service routine, usually a device driver.
`device`	Name of the device descriptor. If a device name is not displayed, then the entries relate to IRQ handlers that support anonymous devices (for example, the clock ticker, DMA devices associated with other peripherals.)

Options

`-?`

Displays the options.

`-d`

Displays extended information about available device list entries. (OS-9)

Example OS-9

The following example displays the IRQ polling table for a system named `Calvin`:

```
$ irqs

PC-AT Compatible 80386  OS-9000 V2.0 for Intel x86

 vector   $     prior   drivstat    irq svc    driver   dev list
------- ----- --------- ---------  ---------  --------- -------
    64  ($40)    10     $00fd3f40  $0005dlb5   tk8253    <na>
    65  ($41)    10     $00ffd080  $00069alc   sc8042   $00ffd080
    66  ($75)    10     $00ff7474  $0007cla8   aha1540   <na>

$ irqs -d

PC-AT Compatible 80386  OS-9000 V2.0 for Intel x86

Vector: 65 ($41) Priority 10  IRQ_SVC $00ffd080
Device: term Driver: sc8042 File MGR: scf
DrvStat: $00ffd080 FMStat: $00ffe3d0 LUStat: $00ffc8d0 Port:
$000b8000
Users: 2 Mode: $2003 Type: 0 Class: 1 Logical Unit: 0 Current
Process: 3
```

Example OS-9 for 68K

```
$ irqs

Calvin   OS-9/68K V2.4     (max devs: 32, max irqs: 32)

vector  prior port addr data addr  irq svc    driver    device
------- ----- --------- ---------  ---------  --------- -------
 68        0  $fffe1800 $00230b90 $00215084  am7990
 69        5  $fffe4000 $003bd560 $00012ad2  scsi147
 70        5  $fffe4000 $003bd560 $00012ad2  scsi147
 72        0  $fffe1000 $00000000 $0000ccda  tk147
 88        5  $fffe3002 $003be3f0 $0000dacc  sc8x30    term
 88        5  $fffe3000 $003bd300 $0000dacc  sc8x30    t1
 89        5  $fffe3800 $002044a0 $0000dacc  sc8x30    t3
 89        5  $fffe3802 $003bbbe0 $0000dacc  sc8x30    t2
 90        5  $ffff1001 $003bc560 $0000e6b6  sc68560   t4
 91        5  $ffff1041 $003bc120 $0000e6b6  sc68560   t5
255        5  $ffff8800 $00245a50 $002458e0  n9026     n0
```

See Also

`_os_irq()`
Ultra C Library Reference Manual

`_os_irq()`
OS-9 Technical Manual

`F$IRQ` system-state service request
OS-9 for 68K Technical Manual

kermit

Transfers Sequential Files Over Asynchronous Lines

Syntax

`kermit <mode>[<options>] <option arg>...`

`kermit c[8le line esc.char]` (connect mode)

`kermit s[dx8ifl line] file ...` (send mode)

`kermit r[dx8iflk line]` (receive mode)

`kermit h[dx8ifl line]` (host server mode)

`kermit g[dx8iflk line] file...` (get file from server)

`kermit q[dx8ifl line]` (quit remote host server)

OS

OS-9; OS-9 for 68K

Options

`d`

Verbose. The states the `kermit` utility goes through are printed along with other traces of its operation. A second, third, and even fourth d flag causes the `kermit` utility to give an even more detailed trace.

`e`

Escape. Allows you to set the first character of the two character escape sequence for connect mode. When you type the escape character, the `kermit` utility holds it and waits for the next character.

If the next character is:

- `c` or `C`

  The `kermit` utility closes the connection with the remote host.

  The same as the escape character, the escape character itself is passed.

- `P` or `p`, or an exclamation point (`!`)

  To accommodate Unix users, the `kermit` utility forks a shell. (Use your EOF character to return to the `kermit` connect mode.)

- `8`

  Toggles the setting of the eighth-bit flag (which, for connect mode, controls whether the most significant bit of characters received from the remote host is masked out before being displayed).

- `0`

  Sends an ASCII NUL to the remote host.

- A question mark (`?`) displays information about these escape sequences. If, in connect mode, you type any character other than those named above after typing the escape character, an ASCII BEL is echoed to the terminal and characters are not passed to the remote host.

- All other typed characters are passed through unchanged. The default escape character is tilde (`~`).

`f`

No filename case conversion. the `kermit` utility does not perform filename case conversions.

`i`

Image. Allows slightly more efficient file transfer between OS-9 for 68K machines. The `kermit` utility typically converts between its host's end-of-line conventions and its internal representation (`CRLF`); image mode bypasses this transformation. It is useful when sending binary data (for which modification of the data could be ruinous).

`k`

Kermit. If you specify `k` on a Receive or Get `kermit`, data received is written to standard output rather than to the specified files. This, along with the "-" pseudo file name, makes the `kermit` utility useful with redirection and pipes.

`l`

Line. Use this when you want to specify the TTY line that the `kermit` utility should use to communicate with the other machine. This is specified as a regular file name (for example, `/t2`).

If you do not specify the `l` option, the `kermit` utility uses standard input and assumes it is running on the remote host (that is, NOT the machine to which your terminal is attached).

If you specify the `l` option, the port name (TTY line) must be the first argument following the options.

`xXON/XOFF`

Flow control. Turn off XON/XOFF flow control. The `kermit` utility protocol does not use any control characters except SOH, CR, and LF, so that the usual XON/XOFF characters (`<control>q` and `<control>s` respectively) can be used for flow control. You may want to turn flow control off to avoid spurious XOFF characters on a noisy line.

8

Eighth-bit quoting. Request eighth-bit quoting. the kermit utility honors requests to do eighth-bit quoting whether this flag appears or not, so you only need to specify it when you send files over a known seven-bit communications line to avoid the overhead of eighth-bit quoting. In connect mode, the 8 flag indicates that the most significant bit of incoming characters should be masked out.

The file arguments are only meaningful to a Send or Get kermit. The receiving the kermit utility attempts to store the file with the same name that was used to send it. The OS-9 for 68K kermit utility, unless the you use the f flag, converts outgoing file names to uppercase and incoming ones to lower case. If a file name contains a slash (/), all outgoing kermit utilities strip off the leading part of the name through the last slash. In the Get command, file names are sent to the remote host as is and the file names sent back are converted as usual for a receiving kermit utility. (Wildcard characters may be expanded on the remote end.) A Send kermit takes a dash (-) file name to mean that you want standard input to be read and sent. In this case, the name STDIN is sent in the send-init packet so that a receiving kermit has a reasonable file name to write to.

Description

The kermit utility is a protocol for transferring sequential files between computers over asynchronous telephone lines. It provides for reliable file transfer and primitive virtual terminal communication between machines.

The kermit utility's protocols and the original implementation were developed at Columbia University.

The kermit utility has been implemented on many different computers. You can transfer files of arbitrary ASCII data (7-bit characters) of any length. The file transfer protocol uses small (96 character) checksum packets, with ACK/NACK responses and time-outs. The OS-9 kermit utility uses a ten-second time-out and ten retries.

The arguments for the kermit utility are a set of flags (no spaces between the flags), three optional arguments (which, if included, must be in the same order as the examples previous), and if this is a Send or Get operation, a list of one or more files.

A sample working implementation of the kermit "kernel" was written in the C language. This kernel was intended to illustrate the protocol and did not include a user interface or features such as server support, 8-bit quoting, file warning, timeouts, etc. Several sites have added the necessary trappings to make this a production version of kermit, usually under the UNIX operating system. Limited server functions have also been added to the OS-9 for 68K version.

Command line options must all be in the same context, "-cl" not "-c -l".

The following does not work for debugging:

```
kermit -d -d -d -cl /t4
```

The following does work for level 3 debugging:

```
kermit -dddcl /t4
```

The escape option must precede the connect option.

The following does *not* work for escape:

```
kermit -cle ^g/t4
```

The following *does* work for escape:

```
kermit -ecl ^g /t4
```

Modes

The kermit utility has six modes. The mode is specified by the first flag. You can only specify one mode.

Table 1-15. Modes

Mode	Specification
c	Connect; virtual terminal connection.
s	Send; transfer files in a non-server mode. Used with a remote kermit server.
r	Receive; transfer files in a non-server mode.
g	Get; used with a remote kermit server.
q	Quit; used with a remote kermit server. q sends a generic finish packet to the remote kermit server.
h	Host; make the OS-9 for 68K system a server. The Host command has not been fully implemented and tested as of this writing.

Example 1

On the OS-9 for 68K target, the kermit, lmm, and shell utilities, and pipe capability must be present.

The following example is for loading a module into memory when it is passed serially to the system. The lmm utility opens the pipe and waits for a module to be placed serially into the pipe. The kermit utility waits to receive a binary file from the current port and places the file into the pipe to be read by the lmm utility.

To initiate the process type the following on the OS-9 for 68K shell:

```
$ lmm /pipe/hello&
$ kermit rik >-/pipe/hello
```

Once this is done, break out of whatever communications software you are running, then use the kermit utility to send the binary file down from the host machine.

Example 2

For the next example, assume two OS-9 for 68K machines. You are logged on OS-9a (the local machine), and want to communicate with OS-9b (the remote machine). There is a modem on /t2. You want to connect to OS-9b, then transfer file1 to that machine.

- Type:

  kermit cl /t2

  The kermit utility answers:

  kermit: connected...
- Dial the remote machine and connect the modem.

  Anything typed on the terminal is sent to the remote machine. Output from that machine is displayed on your terminal.
- Press <return>.

  A login: prompt displays.
- Type your login and press <return>.
- Start the kermit utility on the remote machine so that you can send the file.
- Start the remote (in this case receiving) kermit utility, then the local, (sending) one.

  Remember that you are talking to OS-9b right now.

- Type:

  ```
  kermit r
  ```

  There is now a Receive `kermit` on `OS-9b`.
- Type ~ (the escape character) and the letter `c` to kill the local (Connecting) kermit:

  ```
  ~c
  ```

  The `kermit` utility responds:

  ```
  kermit: disconnected.
  ```
- Type:

  ```
  kermit sl /t2 file1
  ```

  The `kermit` utility responds:

  ```
  Sending file1 as FILE1
  ```

When the transmission is finished, the `kermit` utility responds with either a `Send complete` or a `Send failed` message, depending on the success of the transfer. To transfer a file from `OS-9b` (remote) to `OS-9a` (local), use these commands:

```
kermit cl /t2
(connected to OS-9b)
kermit s file9
~c (talking to OS-9a again)
kermit rl /t2
```

After all the transfers are done, you should connect again, log out of `OS-9b`, kill the Connect `kermit` utility and hang up the phone.

You do not need to exit the connect mode `kermit` as shown above; you can escape to a shell from within it, and from that shell invoke `kermit` in send or receive mode.

Miscellaneous Notes

To maximize throughput and avoid inefficient constructs such as busy wait loops for timing out, the OS-9 for 68K `kermit` utility uses the `SS_RDY` and `SS_SSIG` status requests and reads all pending characters from the communications port. Therefore, it does not work on devices for which `SS_RDY` and `SS_SSIG` are not supported, and does not work efficiently on devices for which the `SS_RDY` does not return a correct count of pending characters. The latter condition is peculiar to extremely old SCF device drivers which would return one rather than the true count of pending input characters.

The kermit utility can interrupt a file transfer. The OS-9 for 68K kermit utility now notices X and Z in ACK packets, and recognizes <control >x and <control>z in local non-server mode.

The kermit utility protocol uses only printing ASCII characters, <control>a, and CRLF. Therefore, he OS-9 for 68K kermit utility leaves the XON/XOFF fields of the path descriptors it uses intact to avoid buffer overruns unless you specify the x option.

Since BREAK is not an ASCII character, the OS-9 for 68K kermit utility cannot send a BREAK to the remote machine. On some systems, a BREAK is read as a NUL.

The OS-9 for 68K kermit utility supports timeouts, so that it is stable when communicating with "dumb" versions of the kermit utility that do not have timeouts. The OS-9 for 68K kermit utility also supports repeat-count encoding and eighth-bit encoding.

Errors

`cannot open device`
: Wrong permissions.

`could not create file`
: A Receive kermit could not create the file being sent to it.

`nothing to connect to`
: A Connect kermit was started without a line argument.

`can't stat`
: Attempting to kermit across a device whose driver does not support the SS_RDY getstat call.

See Also

lmm

kill

Aborts Processes

Syntax

```
kill [<opts>] {<procID list>}
```

OS

OS-9; OS-9 for 68K

Options

`-<num>`

Signal value to send

Description

The `kill` utility is a built-in shell command. It sends a signal to the processes having the specified process ID numbers.

If no signal value is specified, the SIGKILL signal is sent which unconditionally terminates the processes.

Type `kill`, and the ID number(s) of the process(es) to send the signal. The processes must have the same user ID as the user executing the command. Use `procs` to obtain the process ID numbers.

If a process is waiting for I/O, it cannot die until it completes the current I/O operation. Therefore, if you `kill` a process and `procs` shows it still exists, the process is probably waiting for the output buffer to be flushed before it can die.

The command `kill 0` kills all processes owned by the user.

Because `kill` is a built-in shell command, it does not appear in the `CMDS` directory.

Examples

```
$ kill 6 7
$ procs
 Id PId Grp.Usr Prior MemSiz Sig S   CPU Time   Age Module & I/O
  2   1   0.0   128    0.25k   0 w       0.01   ??? sysgo <>>>term
  3   2   0.0   128    4.75k   0 w       4.11 01:13 shell <>>>term
  4   3   0.0     5    4.00k   0 a   12:42.06 00:14 xhog <>>>term
  5   3   0.0   128    8.50k   0 *       0.08 00:00 procs <>>term
  6   0   0.0   128    4.00k   0 s       0.02 01:12 tsmon <>>>t1
  7   0   0.0   128    4.00k   0 s       0.01 01:12 tsmon <>>>t2
$ kill 4
$ procs
 Id PId Grp.Usr Prior MemSiz Sig S   CPU Time   Age Module & I/O
  2   1   0.0   128    0.25k   0 w       0.01   ??? sysgo <>>>term
  3   2   0.0   128    4.75k   0 w       4.11 01:13 shell <>>>term
  4   3   0.0   128    8.50k   0 *       0.08 00:00 procs <>>term
```

To send a signal 3 to processes 28 and 32 type:

```
$ kill -3 28 32
```

link

Links Previously Loaded Module into Memory

Syntax

```
link [<opts>] {<modname>}
```

OS

OS-9; OS-9 for 68K

Options

`-z`

Reads the file names from standard input.

`-z=<file>`

Reads the file names from `<file>`.

Description

The `link` utility `locks` a previously loaded module into memory.

Type `link` and the name(s) of the module(s) to lock into memory.

The link count of the module specified increments by one each time it is linked.

Use `unlink` to unlock the module when it is no longer needed.

Examples

```
$ link prog1 prog2 prog3
```

```
$ link -z=linkfile
```

Links modules from linkfile.

```
$ link -z
```

Links modules from standard input.

list
Lists Contents of Text File

Syntax
```
list [<opts>] {<path>}
```

OS
OS-9; OS-9 for 68K

Options
`-z`
Reads the file names from standard input.

`-z=<file>`
Reads the file names from `<file>`.

Description
The `list` utility displays text lines from the specified path(s) to standard output.

Type `list` and the pathlist.

The `list` utility terminates when it reaches the end-of-file of the last input path. If more than one path is specified, the first path is copied to standard output, the second path is copied next, and so on. Each path is copied to standard output in the order specified on the command line.

The `list` utility is most commonly used to examine or print text files.

Examples

To redirect the listing, `startup`, to the printer and place the entire command in the background, enter:

```
$ list /d0/startup >/P&
```

The following example lists text from files to standard output in the same order as the command line:

```
$ list /D1/user5/document /d0/myfile /d0/Bob/text
```

To list all files in the current data directory, enter:

```
$ list *
```

The following example reads the name(s) of the file(s) to list from `namefile` and lists their contents.

```
$ list -z=namefile
```

The following line lists the contents of the named pipe `staff` while consuming all the data from the pipe.

```
$ list /pipe/staff
```

lmm
Loads Modules At Pathlist

Syntax
```
lmm [<options>] <pathlist>
```

OS
OS-9; OS-9 for 68K

Options
`-q`
Runs in quiet mode; do not exit with error.

`-u`
Do not attempt to unload old module.

Description
The `lmm` utility loads the module at the specified pathlist.

Use `lmm` to initiate a process to load a memory module from a pathlist. The filename of the pathlist must be the same as the module that you wish to load.

The `lmm` utility may be run as a background process (`&`).

The `lmm` utility performs the following steps:

1. Checks the pathlist for existence each second for two minutes until it exists. If after two minutes the pathlist does not appear, then the `lmm` utility exits.
2. Reads a module header from the path.
3. Infers the module name from the pathlist by stripping any preceding pathlist components from the pathlist.

   For example, each of the following pathlists has an inferred module name of `testmod`:

   ```
   /h0/TEST/testmod
   /pipe/testmod
   testmod
   ```

4. Unloads any module with the inferred name from memory.

   If unloading the module fails, the `lmm` utility reads the remaining data from the pathlist and exits with error `EOS_KNWMOD`.
5. Reads the remaining module from the pathlist and loads it into memory.

Example

The following example starts the `lmm` utility in the background and then uses `kermit` to download a module in the foreground. It demonstrates the method that you might use to load a module on a ROM-based system.

```
$ lmm /pipe/testmod &
+118
$ kermit rik >-/pipe/testmod
$ mdir testmod
    Module Directory at 14:05:09
testmod
```

See Also

`kermit`

ln
Creates a Hard Link to an Existing File

Syntax
```
ln <link to create> <file to link to>
```

OS
OS-9

Description
The `ln` utility creates a directory entry as specified as the first argument that refers to the same file descriptor as the second argument.

Type `ln`, the pathlist of the hard link you want to create and the pathlist of the file you want to link to.

Examples
```
ln /h0/DEFS/errno.h /h0/MWOS/OS9000/SRC/DEFS/errno.h
ln /h0/CMDS/ls /h0/CMDS/dir
```

load

Loads Module(s) from File into Memory

Syntax

```
load [<opts>] {<path>}
```

OS

OS-9; OS-9 for 68K

Options

`-c=<color>`
: Specifies a specific memory color in which to load the module.

`-d`
: Loads the file from your current data directory, instead of your current execution directory.

`-d=<path>`
: Specifies path relative to current data directory from which to load the module.

`-i`
: Ignore errors loading modules and keep going.

`-l`
: Prints the pathlist of the file loaded.

`-s`
: Loads “sticky” modules only.

`-w=<moddir>`
: Loads modules into module directory `<moddir>`. (OS-9 only)

`-z`
: Reads the file names from standard input.

`-z=<file>`
: Reads the file names from `<file>`.

Description

The load utility loads one or more modules specified by <path> into memory.

Unless a full pathlist is specified, <path> is relative to your current execution directory. Therefore, if the module to load is in your execution directory, you need only enter its name:

```
load <file>
```

If <file> is not in your execution directory and if the shell environment variable PATH is defined, the load utility searches each directory specified by PATH until <file> is successfully loaded from a directory.

This corresponds to the shell execution search method using the PATH environment variable. By using the -l option, the load utility prints the pathlist of the successfully loaded file.

The module names are added to the module directory. If a module is loaded with the same name as a module already in memory, the module having the highest revision level is kept.

File Security

The file security mechanism enforces certain requirements regarding owner and access permissions when loading modules into the module directory.

You must have file access permission to the file to be loaded. If the file is loaded from an execution directory, the execute permission (e) must be set. If the file is loaded from a directory other than the execution directory and the -d option is specified, only the read permission (r) is required.

Unless the file has public execute and/or public read (OS-9: group execute/group read) permissions, only the owner of the file or a super user can load the file. Use the dir -e command to examine a file's owner and access permissions.

You must have module-access permission to the file being loaded. Do not confuse this with the file-access permission. The module owner and access permissions are stored in the module header; use ident to examine them.

To prevent ordinary users from loading super user programs, the operating system enforces the following restriction: if the module group ID is zero (super group), you can load the module only if the process' group ID and the file's group ID is also zero.

If you are not the owner of a module and not a super user, the public execute and/or read access permissions must be set. The module access permissions are divided into three groups:

- owner
- group
- public

Only the owner of the module or a super user can set the module access permissions.

Example

```
$ mdir
   Module Directory at 14:44:35
kernel      init        p32clk      rbf         p32hd
h0          p32fd       d0          d1          ram
r0          dd          mdir

$ load edit

$ mdir
   Module Directory at 14:44:35
kernel      init        p32clk      rbf         p32hd
h0          p32fd       d0          d1          ram
r0          dd          edit        mdir
```

login
Timesharing System Login

Syntax
```
login [<name>] [,] [<password>]
```

OS
OS-9; OS-9 for 68K

Options
`-n` Verifies a password entry's contents.

If an entry exists for the name and password supplied on the command line, the information (except the password itself) is printed to standard output.

This option operates in a non-interactive mode.

Description
The `login` utility provides login security in timesharing systems.

It is automatically called by the timesharing monitor `tsmon`, or you can explicitly call it after the initial login to change a terminal's user.

The `login` utility requests a user name and password, which is checked against a validation, or password file. If the information is correct, the user's system priority, user ID, and working directories are set up according to information stored in the file. The `login` utility then forks the `pd` utility to acquire the current working and execution directories. The initial program specified in the password file is also executed. This initial program is usually the `shell` utility. The date, time, and process number also display.

If you cannot supply a correct user name and password after three attempts, the login attempt is aborted.

If you do not need the shell from which you called `login`, you may discard it using the `ex` utility to start the `login` command: `ex login`.

To log off, you must terminate the initial program specified in the password file. For most programs, including shell, you can do this by typing an end-of-file character (escape) as the first character on a line.

If the file `motd` exists in the `SYS` directory with the password file, a successful `login` displays the contents of `motd` on your terminal screen.

The Password File

The password file must be present in the `SYS` directory being used: `/h0/SYS`, `/d0/SYS`, etc. The file contains one or more variable-length text entries; one for each user name. These entries are not shell command lines. Each entry has seven fields. Each field is delimited by a comma. The fields are

1. User name

   This field may be up to 32 characters long. It cannot include spaces. The user name may not begin with a number, a period, or an underscore, but these characters may be used elsewhere in the name. If this field is empty, any name matches.

2. Password

   This field may contain up to 32 characters including spaces. If this field is omitted, no password is required for the specified user.

3. Group User ID number

   This field allows 0 to 65535 groups and 0 to 65535 users. 0.n is the super user. The file security system uses this number as the system-wide user ID to identify all processes initiated by the user. The system manager should assign a unique ID to each potential user.

4. Initial Process Priority

   The initial process priority can be from 1 to 65535.

5. Initial Execution Directory Pathlist

   The initial execution directory is usually `/h0/CMDS`. Specifying a period (`.`) for this field defaults the initial execution directory to the `CMDS` file located in the current directory, usually `/h0` or `/d0`.

6. Initial Data Directory Pathlist

   This is the specific user directory. Specifying a period (`.`) for this field defaults to the current directory.

7. Initial Program

   The name and parameters of the program to initially execute. This is usually `shell`.

Sample Password File

```
superuser,secret,0.0,255,.,.,shell -p="@howdy"
brian,open sesame,3.7,128,.,/d1/STEVE,shell
sara,jane,3.10,100,/d0/BUSINESS,/d1/LETTERS,wordprocess
```

-OR-

```
robert,,4.0,128,.,/d1/ROBERT,Basic
mean_joe,midori,12.97,100,Joe,Joe,shell
```

Using password file entries, the `login` utility sets the following shell environment variables. Programs can examine these environment variables to determine various characteristics of the user's environment:

Table 1-16. Environment Variables

Name	Description
`HOME`	Initial data directory pathlist.
`SHELL`	Name of the initial program executed.
`USER`	User name.
`PATH`	Login process' initial execution directory. If a period (`.`) is specified, `PATH` is not set.

Environment variables are case-sensitive.

To show how the `login` utility uses the password file to set up environment variables, examine the previous sample password file. Assume `login`'s data and execution directories are `/h0` and `/h0/CMDS`, respectively, logging in as `mean_joe` executes a shell with the data directory of `/h0/Joe` and the execution directory of `/h0/CMDS/Joe`.

The environment variables passed to the shell are set as follows:

```
HOME=/h0/Joe
SHELL=shell
USER=mean_joe
PATH=/H0/Cmds
```

logout
Timesharing System Logout

Syntax
```
logout
```

OS
OS-9; OS-9 for 68K

Description
The `logout` utility terminates the current shell. If the shell to terminate is the login shell, the `logout` utility executes the `.logout` procedure file before terminating the shell.

Type `logout` and a carriage return to terminate the current shell. This terminates the current shell in the same manner as an end-of-file character, with one exception. If the shell to be terminated is the `login` shell, the `logout` utility executes the procedure file `.logout`.

The `login` shell is the initial shell created by the `login` utility when you log on the system. In order for the `logout` utility to execute the `.logout` file, `.logout` must be located in the directory specified by the `HOME` environment variable. These commands do not appear in the `CMDS` directory as they are built in to the shell.

Example
```
3.lac: list .logout
procs
wait
date
echo "see you later. . ."
3.lac: logout
2.lac: logout
1.lac: logout
 Id PId Grp.Usr Prior MemSiz Sig S   CPU Time   Age Module & I/O
  2   1   0.0   128    0.25k   0 w       0.01   ??? sysgo <>>>term
  3   2   0.0   128    4.75k   0 w       4.11 01:13 shell <>>>term
  4   3   0.0   128    8.50k   0 *       0.08 00:00 procs <>>term
  5   0   0.0   128    4.00k   0 s       0.02 01:12 tsmon <>>>t1
July 7, 1989 11:59 pm
see you later . . .
```

makdir
Creates Directory File

Syntax
```
makdir [<opts>] {<path>}
```

OS
OS-9; OS-9 for 68K

Options
`-p`
Creates all missing components of the specified path.

`-q`
Quiet mode.

`-x`
Creates the directory in the execution directory.

`-z`
Reads the directory names from standard input.

`-z=<file>`
Reads the directory names from `<file>`.

Description
The `makdir` utility creates a new directory file specified by the given pathlist.

Type `makdir` and the pathlist specifying the new directory.

You must have write permission for the new directory's parent directory. The new directory is initialized and does not initially contain files except for the pointers to itself (`.`) and its parent directory (`..`). All access permissions are enabled except single use, or non-sharable.

Examples

```
$ makdir /d1/STEVE/PROJECT
```

Creates directory project in `/d1/STEVE`

```
$ makdir DATAFILES
```

Creates directory `DATAFILES` in current working execution directory.

```
$ makdir ../SAVEFILES
```

Creates directory `SAVEFILES` in parent of current working data directory.

```
$ makdir RED GREEN BLUE ../PURPLE
```

Creates directories `RED`, `GREEN` and `BLUE` in current working data directory and `PURPLE` in parent of current working data directory.

```
$ makdir -p MWOS/SRC/TOOLS/UTILS
```

Creates directory: `MWOS` (if it does not already exist) in current working directory, and `SRC` (if it does not already exist) as a child of `MWOS`, and `TOOLS` (if it does not already exist) as a child of `SRC`. And finally, the `UTILS` directory (if it does not already exist) is created as a child of the tools directory.

makmdir
Creates a New Module Directory

Syntax
```
makmdir [<opts>] {<module directory>}
```

OS
OS-9; OS-9 for 68K

Options
`-z`
Reads the module directory names from standard input.

`-z=<file>`
Reads the module directory names from `<file>`.

Description
The `makmdir` utility creates a new module directory.

Type `makmdir`, the module directory pathlist and any desired options to create a new directory.

You must have write permission for the new directory's parent module directory. The new module directory is created with all of the access permissions enabled. A module directory's access permissions can be changed using the `mdattr` utility.

It is an OS-9 convention to capitalize module directory names.

The `makmdir` utility only searches the current module directory for a specified module when creating a new module directory.

The alternate pathlists specified by the `MDPATH` environment variable are not searched if a specified module is not found in the current module directory.

For example, if `USER` is your current module directory and you want to make a new directory in a directory called `TEST`, OS-9 does not search the alternate module directories for a module directory named `TEST`.

Examples

```
$ makmdir USERS
$ makmdir ../UTILS
$ makmdir -z=/h0/sys/users
```

maps
Prints Process Memory Usage Information

Syntax
```
maps [<opts>]
```

OS
OS-9 for 68K

Options
`-l`
Loops printing process information.

`-m`
Prints map of memory usage.

`-p=<id>`
Prints information for process <ID>.

`-r`
Prints ranges of memory used.

`-w`
Shows write permissions in map.

Description
Prints information about process memory usage.

mbc
Compress or Uncompress Bootfile

Syntax
```
mbc {<file> [<opts>]}
```

OS
Windows

Options
`-o=<file>`
Output file.
```
default compressed = <file>.z
default uncompressed = <file>.uz
```

`-u`
Uncompress.

Description
The `mbc` utility is used to compress an OS-9 bootfile. This utility may also be used to uncompress a compressed bootfile.

Example
```
C:\mbc os9kboot -o=os9kboot
```

mdattr

Changes Module Directory Security Permissions

Syntax

```
mdattr [<opts>] {<module directory> <permissions>}
```

OS

OS-9

Options

`-a`

Suppresses the printing of attributes.

`-z`

Reads the module directory names from standard input.

`-z=<file>`

Reads the module directory names from `<file>`.

Description

The `mdattr` utility changes the security (access) permissions of a module directory.

Type `mdattr`, followed by the module directory name whose security permissions are to be changed or examined. Then enter a list of permissions which are to be turned on or off.

A permission is turned on by giving its abbreviation preceded by a hyphen (`-[abbr]`). It is turned off by preceding its abbreviation with a hyphen followed by the letter n (`-n[abbr]`). Permissions not explicitly named are not changed.

If permissions are not specified on the command line, the module directory attributes display.

You cannot examine or change the attributes of a module directory you do not own unless you are the super user. A super user can examine or change the attributes of any module in the system.

The module directory permission abbreviations are:

`r`	Read permission to owner
`w`	Write permission to owner
`gr`	Read permission to group
`gw`	Write permission to group
`pr`	Read permission to public
`pw`	Write permission to public

The *owner* is the creator of the module directory. Owner access is allowed to any user with the same *user ID number* as the owner.

The *group* is any user with the same *group ID number*. The user ID number and the group ID number are combined to form a *group.user ID number*.

The *public* is any user with a different group.user ID number than the owner.

Module directory ownership can be readily determined with the `mdir -e` command.

Examples

`$ mdattr sc83`

Displays the current attributes of sc83.

`$ mdattr sc83 -npr -npw`

Turns off the public read and public write permissions.

`$ mdattr sc83 -rwprpw`

Turns on both the public and owner read and write permissions.

`$ mdattr -z`

Displays the attributes of the module directory names read from standard input.

See Also

`makmdir`
`mdir`

mdir
Displays Module Directory

Syntax
```
mdir [<opts>] [<modname>]
```

OS
OS-9; OS-9 for 68K

Options
`-a`
Displays the language field instead of the type field in an extended listing.

`-c`
Prints the total number of modules and the combined size of those modules in bytes.

`-e`
Displays the extended module directory.

`-r`
Displays directories recursively. (OS-9)

`-t=<type>`
Displays only the modules of the specified type.

`-u`
Displays an unformatted listing used for piping output.

Description

OS-9 for 68K: The `mdir` utility displays the present module names in the system module directory. The system module directory contains all modules currently resident in memory. By specifying individual module names, only specified modules are displayed (if resident in memory.)

OS-9: The `mdir` utility displays the present module names in the specified module directory. You may use either a full or relative pathlist when specifying a module directory. By specifying individual module names, only specified modules are displayed if resident in memory.

If you use `-e`, the `mdir` utility displays an extended listing of the physical address, size, owner, revision level, user count, and the type of each module.

The module type is listed using the following mnemonics:

Table 1-17. mdir -e option type Mnemonics

Mnemonic	Description
`Prog`	Program Module
`Subr`	Subroutine Module
`Mult`	Multi Module
`Data`	Data Module
`Trap`	Trap Handler Module
`Sys`	System Module
`FMan`	File Manager
`Driv`	Device Driver Module
`Desc`	Device Descriptor Module
`MDir (OS-9)`	Module Directory (not truly a module that consumes memory)

User-defined modules not corresponding with this list are displayed by their number.

By using `-a`, `mdir` displays each module's language instead of the type in an extended listing. The language field uses the following mnemonics:

Table 1-18. mdir Lang Mnemonic

Mnemonic	Description
`Obj`	68000/80386/PowerPC Machine Code
`Bas`	Basic09 I Code

Table 1-18. mdir Lang Mnemonic (Continued)

Mnemonic	Description
Pasc	Pascal I Code
C	C I Code
Cobl	Cobol I Code
Fort	Fortran I Code

If the language field is inappropriate for the module, a blank field is displayed. For example, d0, t1, or init.

Not all modules listed by the mdir utility are executable as processes; always check the module type code to make sure it is executable before executing an unfamiliar module.

Examples

To save space, the following examples are incomplete. Module directories are generally much larger.

```
$ mdir
    Module Directory at 15:32:38

kernel     syscache    ssm    init     tk147   rtclock     rbf
$ mdir -e
Addr        Size     Owner   Perm  Type Revs  Ed #  Lnk  Module name
--------  -------  --------  -----  ----  ----  -----  ----  -------
00006f00   27562     0.0    0555  Sys  a000   83     2   kernel
0000daaa     368     0.0    0555  Sys  a000   10     1   syscache
0000dc1a    1682     0.0    0555  Sys  a000   29     1   ssm
0000e2ac     622     0.0    0555  Sys  8000   20     0   init
0000e51a     322     0.0    0555  Sys  a000    7     1   tk147
0000e65c     494     0.0    0555  Subr a000    8     0   rtclock
0000e84a    8952     0.0    0555  Fman e000   79    26   rbf

$ mdir -ea
Addr      Size     Owner   Perm Lang Revs  Ed #  Lnk  Module name
--------  --------  -------  ----  ----  ----  ----  -----  ----  -------
00006f00   27562     0.0     0555 Obj  a000   83     2   kernel
0000daaa     368     0.0     0555 Obj  a000   10     1   syscache
0000dc1a    1682     0.0     0555 Obj  a000   29     1   ssm
0000e2ac     622     0.0     0555      8000   20     0   init
0000e51a     322     0.0     0555 Obj  a000    7     1   tk147
0000e65c     494     0.0     0555 Obj  a000    8     0   rtclock
0000e84a    8952     0.0     0555 Obj  e000   79    26   rbf
```

merge, os9merge

Copies and Combines Files to Standard Output

Syntax

```
merge {<option(s)>} {<path>}
```

merge OS

OS-9; OS-9 for 68K

os9merge OS

DOS; UNIX

Options

`-a[=]<num>`
: File alignment. Default is 1.

`-b[=]<size>`
: Allocates `<size>` k bytes for use by `merge`. The default memory size is 4K.

`-o[=]<file>`
: Output file. Default is `stdout`.

`-x`
: Searches the current execution directory for files to be merged (`merge` only).

`-z`
: Reads the file names from standard input.

`-z=<file>`
: Reads the file names from `<file>`.

Description

The `merge` utility copies multiple input files specified by `<path>` to standard output.

The `merge` utility is commonly used to combine several files into a single output file.

Data is copied in the order the pathlists are specified on the command line.

The `merge` utility does no output line editing such as automatic line feed.The standard output is generally redirected to a file or device.

Examples

```
$ merge compile.list asm.list >/p
$ merge file1 file2 file3 file4 >combined.file -b=32k
$ merge -x load link copy >Utils1
$ merge -z=/h0/PROGS/file1 >merged_files
```

mfree
Displays Free System RAM

Syntax
```
mfree [<opts>]
```

OS
OS-9; OS-9 for 68K

Options
`-e`
Displays an extended free memory list.

`-s`
Displays system information summary.

Description
The `mfree` utility displays a list of areas in memory not presently in use and available for assignment. The address and size of each free memory block are also displayed.

Examples
```
$ mfree
Current total free RAM: 1392.00 K-bytes
$ mfree -e
Minimum allocation size:       4.00 K-bytes
Number of memory segments:   25
Total RAM at startup:       4095.00 K-bytes
Current total free RAM:     1392.00 K-bytes
Free memory map:
    Segment Address         Size of Segment
   -----------------   -------------------------
       $55000          $7000          28.00 K-bytes
       $6A000          $B000          44.00 K-bytes
       $80000          $8A000        552.00 K-bytes
       $10E000         $1A000        104.00 K-bytes
       $12F000         $1E000        120.00 K-bytes
```

```
$151000         $60000       384.00 K-bytes
$1B5000         $2000          8.00 K-bytes
$1B8000         $E000         56.00 K-bytes
$1DE000         $1000          4.00 K-bytes
$208000         $4000         16.00 K-bytes
$21C000         $5000         20.00 K-bytes
$245000         $1000          4.00 K-bytes
$249000         $1000          4.00 K-bytes
```

mkdatmod

Packages File into Data Module

Syntax

```
mkdatmod -tp=<name> {<option(s)>} <in-file> <out-file>
```

OS

OS-9; OS-9 for 68K; WIN; UNIX

Options

`-b[=]<size>[k|K]`

Specify size of copy buffer. `<size>` is always in K bytes (optional). The default memory size is 32K.

`-n[=]<name>`

Name of data module (default=`<in-file>`

`-r`

Reverse operation (take off module header/footer)

`-to[=]<name>`

Specify target operating system, where `<name>` is target system:

`os9 or osk` (OS-9 for 68K)
`os9000 or os9k` (OS-9)

`-tp[=]<name>`

Specify target processor and options, where `<name>` is target:

`386 or x86` (Intel x86 (386+) family)
`68k` (Motorola 68k family)
`arm` (ARM family)
`mips` (MIPS family)
`ppc` (PowerPC family)
`sh`, `sh3` (Hitachi SH3 family)
`sh4` (Hitachi SH4 family)
`sparc` (SPARC family)

`-z[[=]<file>]`

Read command line arguments from `<file>` (`stdin` if no file).

Description

The mkdatmod utility packages a file into a data module. mkdatmod can also strip the header and footer off an existing data module.

To create a data module, type mkdatmod, the processor type of the destination module (using the -tp option), followed by the source file <in-file> and the destination data module <out-file>. The created data module <out-file> retains <in-file> as the module name unless specified otherwise with -n[=]<name>.

To reverse the operation and strip the header and footer off an existing data module, type mkdatmod -r, followed the by the data module <in-file> and the destination file <out-file>.

mkdatmod automatically calls the fixmod utility during data module creation to set the module parity and CRC (fixmod -u), so fixmod must be accessible on your system.

Examples

```
$ mkdatmod -tp=ppc junk junkmod
Module: junk - Fixing header parity -Fixing module CRC
$ mkdatmod -r junkmod junk
```

See Also

fixmod

moded
Edits OS-9 Modules

Syntax
```
moded [<opts>] [<path>]
```

OS
OS-9 for 68K

Options
`-d[=]<path>`
: Uses `<path>` for the field descriptions (`moded.fields`).

`-e[=]<path>`
: Uses `<path>` for the error message file.

`-f[=]<path>`
: Specifies a file consisting of one or more modules to load into the `moded` buffer.

Description
The `moded` utility edits individual fields of certain types of OS-9 for 68K modules. Currently, you can use the `moded` utility to change the `init` module and any OS-9 for 68K device descriptor module.

The `moded` utility can edit modules which exist in their own files or modules which exist among other modules in a single file such as a bootstrap file. The `moded` utility updates the module's CRC and header parity if changes are made.

Regardless of how you call the `moded` utility, you always enter the editor's command mode. This is designated by the `moded:` prompt.

If parameters are not specified on the `moded` command line, the current module is not loaded into memory.

If a file is specified on the command line, it is assumed to contain a module of the same name. This module is loaded into the editor's buffer and becomes the current module.

If the -f option is used, the specified file is loaded into the editor's memory. If a module of the same name exists in the file, it becomes the current module. If the module does not exist, there is not a current module.

If the -f option is used and a module name is specified on the command line, the specified module becomes the current module.

You can execute the following commands from command mode:

Table 1-19. Commands

Command	Description
e(dit)	Edits the current module.
f(ile)	Opens a file of modules.
l(ist)	Lists the contents of the current module.
m(odule)	Finds a module in a file.
w(rite)	Updates the module CRC and writes to the file.
q(uit)	Returns to the shell.
$	Calls the OS-9 shell.
?	Prints this help message.

Once the moded utility is invoked, it attempts to read the moded.fields file. This file contains module field information for each type of module to edit. Without this file, the moded utility cannot function.

moded searches for moded.fields in the following directories in this order:

1. Device /dd .
2. The default system device, as specified in the init module (M$SysDev). If the init module cannot be linked to, the SYS directory is searched for on the current device.

If the moded utility cannot find moded.fields, it returns an error.

Selecting the Current Module

If you do not specify a module or file on the command line, you may open a module or file from command mode using the `e` or `f` commands, respectively.

- `e` prompts for a file name and a module name if different from the file name. This module then becomes the current module.
- `f` prompts for the name of a file containing one or more modules. If a module in the file has the same name as the file, it becomes the current module by default.
- Use the `m` command to change the current module.

Edit Mode

To edit the current module, use the `e` command. If there is not a current module, the editor prompts for the module name to edit. The editor prints the name of a field, its current value, and prompts for a new value. At this point, you can enter any of the following edit commands:

Table 1-20. Edit Commands

Command	Specification
`<expr>`	A new value for the field.
–	Re-displays the last field.
.	Leaves the edit mode.
?	Prints the edit mode commands.
??	Prints a description of the current field.
`<cr>`	Leaves the current value unchanged.

If the definition of any field is unfamiliar, use the `??` command for a short description of the current field.

Once you have made all necessary changes to the module, exit edit mode by reaching the end of the module or by typing a period.

At this point, the changes made to the module exist only in memory.

To write the changes to the actual file, use the `w` command. This also updates the module header parity and CRC.

Listing Module Fields

To examine the field values of the current module, use the `l` command. This displays a formatted list of the field names and their values.

The Moded.fields File

The `moded.fields` file contains descriptions of specific types of modules. Each module description consists of three parts:

- the module type,
- the field descriptor, and
- the description lines.

Comments may be interspersed throughout the file by preceding the comment line with an asterisk.

For example:

```
* this is a comment line
* it may appear anywhere in the moded.fields file
```

1. The module type

   This is a single line consisting of the module type as specified in `M$Type` in the module header and the device type as specified in `PD_DTP` in the device descriptor. Both values are specified as decimals and are separated from each other by a comma.

   The module type line is the only line which begins with a pound sign (`#`).

   The following example line describes an RBF device descriptor module:

   ```
   #15,1
   ```

   Two module type values are accepted.

Table 1-21. Module Type Values

Value	Specification
`12`	System module (`init` module only)
`15`	Device descriptor module

The device type value is only used when a device descriptor module is being described. The following device type values are accepted.:

Table 1-22. Device Type Values

Value	Specification
0	SCF
1	RBF
2	PIPE
3	SBF
4	NET
6	UCM
7	SOCKET
11	GFM

1. The field descriptor

   This consists of two lines. The first is a textual description of the module field; the baud rate, parity. and descriptor name. The `moded` utility uses this description as a prompt to change this field's value.

   The second line has the following format:

   `<type>,<offset>,<base>,<value>[,<name>]`

   `<type>` specifies the field size in bytes. This is a decimal value.

   The following values are accepted.:

Table 1-23. Type Values

Value	Specification
1	Byte
2	Word
3	3 byte value
4	Long word
5	Long word offset to a string
6	Word offset to a string

`<offset>`

Specifies the offset of the field from the beginning of the module. This is a hexadecimal value.

For device-specific fields (see `<name>`), this offset is the offset of the field within the `DevCon` section of the descriptor (and not the module start).

<base>

specifies the numeric base in which the field value is displayed by the moded utility. The following bases are supported.

Table 1-24. Bases Supported

Value	Specification
0	ASCII
8	Octal
10	Decimal
16	Hexadecimal

<value>

Specifies the default value of the field. This is currently unused; set it to zero.

<name>

Specifies the driver name for this and each field description that follows until a new <name> is specified or a module type line is encountered. This field is optional.

For example, <name> allows descriptors with DevCon sections specific to certain drivers to be edited.

The following lines describe a "descriptor name" field:

descriptor name

5,c,0,0

The field consists of a long-word offset to a string. It is offset 12 bytes from the beginning of the module. The display base is in ASCII.

1. Description lines

   After the Field Descriptor lines, you can use any number of lines to describe the field.

   This description displays when the edit mode command, ??, is used.

   Each description line must begin with an exclamation point (!) to differentiate it from a Field Descriptor. These lines are optional, but they are useful when editing uncertain module fields.

   The following lines might be used to describe the example used for the Field Descriptor:

```
! This field contains the name that the descriptor
! will be known by when in memory.
```

2. Repeated Sequences.

   Braces ({ })can be used to surround a sequence of field descriptor and description lines to imply that the sequence is repeated one or more times.

   The fields are assumed to be repeated within the descriptor until the value of the first field is zero. The offset values used within the repeated sequence determine the format of each structure.

   The first offset specified denotes the offset where the repeated sequences begin. Subsequent offsets specify the format of the repeated sequences. Refer to the supplied `moded.fields` file for an example of repeated sequences.

Example Module Description in Moded.fields:

The following example shows one way to set up a module description:

```
************************************************************
*the following section describes an RBF device descriptor *
************************************************************
#15,1
descriptor name
5,c,0,0
! This field contains the name that the descriptor will
! be known by when in memory.
port address
4,30,16,0
! This is the absolute physical address of the hardware
! controller.
irq vector
1,34,10,0
! This is the irq vector that the device will assert.
! Auto-vectored interrupt devices will use vectors 25-31.
! Vectored interrupt devices will use vectors 64-255.
```

The Provided Moded.fields File:

The provided `moded.fields` file comes with module descriptions for standard RBF, SBF, SCF, PIPE, NETWORK, UCM, and GFM module descriptors. It also includes a description for the init module.

mshell
Command Interpreter

Syntax
```
mshell
```

OS
OS-9; OS-9 for 68K

Description
`MShell` is a command interpreter designed to help you become as productive as possible when working with the OS-9/OS-9 for 68K operating systems. It accomplishes this by providing keyboard shortcuts and a means to automate menial tasks. It is compatible with the current OS-9/OS-9 for 68K shell.

`MShell` started as a port of the OS-9 standard shell to OS-9 for 68K. From that point, enhancements replaced some built-in features of OS-9 and features unique to `MShell` were added. Now, `MShell` contains many of the same features as UNIX shells, as well as some OS-9/OS-9 for 68K specific options.

MShell Features
Refer Chapter 5 for more information.

`MShell` has many features that do not exist in the standard OS-9/OS-9for 68K shell. These features fall into three basic categories:

- Command line interface.
- Procedure files.
- Built-In Commands and Command Line Options.

mv

Move a File/Directory
From One Directory to Another

Syntax

```
mv [<opts>] <srcpath> [<srcpaths>] [<dstpath>]
```

OS

OS-9; OS-9 for 68K

Options

`-f`

Forces move even if the <`srcpath`> is write-protected. (OS-9)

`-r`

Rewrites existing files. (OS-9)

`-w[=]<dir name>`

Moves specified file(s) to `<dir name>`. (OS-9)

`-x`

Gets files from execution directory.

`-z`

Gets file names from standard input.

`-z[=]<file>`

Gets file names from `<file>`.

Description

The `mv` utility moves a file or directory from one directory into another.

You can also use the `mv` utility to do a rename operation although the `rename` utility is better suited for this purpose.

Type `mv`, the pathlist of the file or directory to move, then the pathlist of where it is to be moved. If more than one file is to be moved, type `mv`, the names of the files to be moved separated by spaces. Use the `-w` option to specify the directory where the files are to be moved.

Examples

Move `joe` from `CMDS` to `CMDS/DAVEL`.

```
$ mv CMDS/joe CMDS/DAVEL/joe
```

Move `steve` to current directory.

```
$ mv CMDS/steve
```

Move all the files directories in the current directory.

```
$ mv * -w=/h0/USR/YOU/YOURFILES
```

Move the files listed in `whatfiles`.

```
$ mv -z=whatfiles -w=/h0/USR/YOU/THESEFILES
```

os9cmp
Compares Two Binary Files

Refer to cmp, os9cmp.

os9del
Deletes a File

Refer to del, os9del.

os9deldir
Delete Files within a Directory

Syntax
```
deldir [<opts>] {<path>}
```

os9del OS
WIN

Options
`-e`
Erases the disk space that files in the directory occupied.

`-f`
Deletes files regardless of whether write permission is set.

`-l`
Check for hard links to directories.

When `-l` is used, each directory is checked for other hard directory links. If other hard links are detected, the directory contents will not be deleted or will search for other directories to delete. If no hard links are detected, the contents are deleted.

Failure to use `-l` in the presense of hard links leads to the removal of directory contents, though (empty) directories will be left on the disk.

`-z`
Reads the directory names from standard input.

`-z=<file>`
Reads the directory names from `<file>`.

Description

os9deldir deletes directories and all subdirectories and files from an OS-9 formatted disk from a Windows host.It works similarly to deldir; however, os9deldir does not echo directory names back to the user for confirmation. If it encounters a file for which write permissions are not set, os9deldir will exit.

Example

The following example uses the -f option to delete a directory.

Step 1. At the C:/> prompt, type os9dir /d0. This allows you to view the contents of the OS-9 floppy disk. The following information is displayed:

```
Directory of /d0 16:45:49

CMDS          SYS           firstboot      iplfd
iplhd         iplhdnoq      sysboot
```

Step 2. Type os9deldir /d0/SYS next to delete the SYS directory. The following message should appear:

```
os9deldir.EXE: can't access 'startup' - C:/>
```

This message tells you that you do not have the necessary permissions to delete the file startup; therefore, the SYS directory will still appear when you perform another os9dir/ do command. To delete a file from this directory, regardless of permission, type the following command:

```
os9deldir -f /d0/SYS
```

The file should now be gone.

See Also

del, os9del
deldir

os9dump
Displays Formatted Dump

Refer to dump, os9dump.

os9gen
Builds and Links Bootstrap File

Syntax
```
os9gen [<opts>] <devname> {<path>}
```

OS
OS-9 for 68K

Options
`-b[=]<num>`
Allocates `<num>` k bytes for use by `os9gen`. The default memory size is 64K.

`-e`
Allows you to use large (greater than 64K) and/or non-contiguous files. Extended Boot. *Bootstrap ROMs must support this feature*.

`-q[=]<file>`
Set sector zero pointing to `<file>`. Quick Boot.

`-r`
Removes the pointer to the boot file. This file is not deleted.

`-x`
Searches the execution directory for pathlists.

`-z`
Reads the file names from standard input.

`-z=<file>`
Reads the file names from `<file>`.

Description

The os9gen utility creates and links the OS9Boot file required on any disk from which OS-9 for 68K is to be bootstrapped.

You can use the os9gen utility to:

- Make a copy of an existing boot file.
- Add modules to an existing boot file.
- Create an entirely new boot file for a different system.

Type os9gen and the name of the device on which to install the OS9Boot file.

The os9gen utility creates a working file called TempBoot on the device specified. Each file specified on the command line is opened and copied to the TempBoot file.

Only super users (0.n) may use this utility. Also, you can only use the os9gen utility on format-enabled devices.

After all input files are copied to TempBoot, any existing OS9Boot file on the target device is renamed OldBoot. If an OldBoot file is already present, the os9gen utility deletes it before renaming OS9Boot.

TempBoot is then renamed OS9Boot. Its starting address and size are linked in the disk's Identification Sector (LSN 0) for use by the OS-9 for 68K bootstrap firmware.

If your boot file is non-contiguous or larger than 64K, use the -e option.

Your bootstrap ROMs must support this feature. If they do not, you should not use this option.

If you use the -z option, the os9gen utility first uses the files specified on the command line and then the file names from its standard input, or from the specified pathlist, one pathlist per line. If the names are entered manually, no prompts are given and the end-of-file key (usually <escape>).

To determine what modules are necessary for your boot file, use the ident utility with the OS9Boot file that came with your system.

The -q option updates information in the disk's Identification Sector by directing it to point to a file already contained in the root directory of the specified device.

The -q option is useful when restoring the OldBoot file as the valid boot on the disk. The os9gen utility renames the specified file to be OS9Boot and saves the current boot as described previously.

The -r option removes the pointer to the boot file but does not delete the file. This is useful if you delete the bootfile from your disk (using the del command).

Deleting the bootfile from the file structure *does not* remove the bootfile pointers from the disk's Identification Sector. You can also use it to make a disk non-bootable without deleting the bootfile.

Examples

This command manually installs a boot file on device /d1 which is an exact copy of the OS9Boot file on device /d0.

```
$ os9gen /d1 /d0/os9boot
```

The following three methods manually install a boot file on device /d1. The boot file on /d1 is a copy of the OS9Boot file on device /d0 with the addition of modules stored in the files /d0/tape.driver and /d2/video.driver:

Method 1

```
$ os9gen /d1 /d0/os9boot /d0/tape.driver
/d2/video.driver
```

Method 2

```
$ os9gen /d1 /d0/os9boot -z
/d0/tape.driver
/d2/video.driver
[ESCAPE]
```

Method 3

```
$ os9gen /d1 -z
/d0/os9boot
/d0/tape.driver
/d2/video.driver
[ESCAPE]
```

You can automatically install a boot file by building a *bootlist* file and using the `-z` option to either redirect the `os9gen` utility's standard input or use the specified file as input:

```
$ build /d0/bootlist
```
Create file `bootlist`

```
? /d0/os9boot
```
Enter first file name

```
? /d0/tape.driver
```
Enter second file name

```
? /d2/video.driver
```
Enter third file name

```
? * V1.2 of video driver
```
Comment line

```
? [RETURN]
```
Terminate build

```
$ os9gen /d1 -z </d0/bootlist
```
Redirects standard input

```
$ os9gen /d1 -z=/d0/bootlist
```
Reads input from pathlist

The `os9gen` utility treats any input line preceded by an asterisk (`*`) as a comment.

The following command makes the `OldBoot` file the current boot and saves the current `OS9BOOT` file as `OldBoot`:

```
$ os9gen /d1 -q=oldboot
```

os9make

Maintains, Updates, and Regenerates Groups of Programs

Syntax

```
os9make {<option(s)>} [<target>] {[<target>]}
[<macros>]
```

OS

OS-9; OS-9 for 68K; WIN; UNIX

Options

`-b`

Does not use built-in rules.

`-bo`

Does not use built-in rules for object files.

`-d`

Prints the dates of the files in the makefile (debug mode).

`-dd`

Double debug mode. Very verbose.

`-e`

Imports environment variables as macros in the makefile.

`-ee`

Forces imported environment variables (implies -e flag) to override all other macro definitions. This includes command line definitions unless `-ll` is in effect.

`-f-`

Reads the makefile from standard input.

`-f[=]<path>`

Specifies `<path>` as the makefile. If you do not specify `-f-` or `-f=<path>`, `os9make` looks for a file named `makefile`. If `<path>` is specified as a hyphen (-), `os9make` commands are read from standard input.

`-i`

Ignores errors.

`-l`

Switches the order of precedence to `os9make` later macros override previous definitions. This flag forces `os9make` to behave similar to the order of precedence used by UNIX make.

`-ll`

Forces command line macros to have the highest precedence (cannot be overridden). This flag also turns on the `-l` flag.

`-m`

Ignores undefined macros rather than causing a fatal `os9make` error.

`-mode[=]<mode>`

Sets the mode (`compat`, `ucc`, or `c68`). If used on the command line, this option overrides the environment variable (`MWMAKEOPTS`). If the option is set in the makefile, it overrides both the environment variable and the command line option.

`-n`

Displays commands but do not execute them.

`-nn`

Same as -n but do execute change directories and call sub makes.

`-o`

Dependencies without ROFs (`.r`) will succeed and not give an error. For example:

```
RDIR = rels
make.date: clean
   touch make.date
clean: zfile
   del $(RDIR)/state.r
```

Assumptions abou `.r/.o` are made, however, when no dependencies are provided (for example, clean:).

`-p`

Don't change slash to backslash in makefile lines (`os9make` only).

`-r`
: Views the built-in rules for the current mode. For example, `os9make -rn` lists the current rules without running the makefile.

`-s`
: Silent Mode. Executes commands without echo.

`-t`
: Updates the file dates without executing commands.

`-u`
: Does the make regardless of the file dates.

`-w`
: Why. Print reason for executing command.

`-x`
: Uses the cross-compiler/assembler.

`-z[=<path>]`
: Gets a list of files to make from standard input or `<path>`.

Description

The `os9make` utility determines whether a file needs to be updated. It examines the dates of the target file and the files used to create the target file. If the `os9make` utility determines that the file must be updated, it executes specified commands to recreate the file.

The `os9make` utility has several built-in assumptions specifically designed for compiling high-level language programs; however, you may use `os9make` to maintain any files dependent on updated files.

The `os9make` utility executes commands from a special type of procedure file called a "makefile". The makefile describes the dependent relationships between files used to create the `<target>` file(s). A makefile may describe the commands to create many files.

If the `os9make` utility is called without a target file on the command line, the `os9make` utility attempts to make the first target file described in the makefile. If one or more target file is entered on the command line, the `os9make` utility reads and processes the entire makefile and only attempts to make the appropriate file(s).

os9merge

Copies and Combines Files to Standard Output

Refer to merge, os9merge.

p2init
Links and Initializes An OS9P2 Module

Syntax
```
p2init <module>
```

OS
OS-9; OS-9 for 68K

Description
Use the `p2init` utility to install `OS9P2` modules.

Only the super user may use this utility.

The `p2init` utility initializes an OS9P2 system extension module after the operating system is already up and running. This provides additional functionality which would not be available when the OS9P2 module is initialized as part of the system startup.

You can also use the `p2init` utility to add OS9P2 modules to a running ROM-based system.

For Version 3.0 of OS-9/Atomic OS-9 for 68K, FPU and FPSP math emulation modules may not be installed with the `p2init` utility.

padrom
Extends File Size

Syntax
```
padrom {<option(s)>} <size> <file> [<file>]
```

OS
OS-9; OS-9 for 68K

Options
`-b[=]<num>[k]`

Specifies the buffer size in bytes to use. The 'k' sub-option converts <num> to k bytes. The default is 16k.

Description
Use the padrom utility when making the ROMs for OS-9 Board Support Packages (BSP).

The padrom utility appends bytes with a hex value of FF to the named file, extending the file to the specified <size>.

Examples
The following shows how to use the padrom utility to extend the size of the booter and modules files.

```
$ dir -e booter modules
 Owner     Last modified Attributes Sector Bytecount Name
 -------   ------------- ---------- ------ --------- ----
   0.29    93/11/12 1142  ------wr  1CEB38     12153 booter
   0.29    93/11/12 1143  ------wr  1CEB48       256 modules
```

If you try to pad a file to a size smaller than its current size, the padrom utility displays the following message.

```
$ padrom 0x2000 booter
padrom: file booter already bigger than 8192
```

This example specifies a hex value for <size>.

```
$ padrom 0x8000 booter
```

This example specifies a decimal value for <size>.

```
$ padrom 1024 modules
$ dir -e booter modules
 Owner    Last modified Attributes Sector Bytecount Name
-------   ------------- ---------- ------ --------- ----
  0.29    93/11/12 1144  ------wr  1CEB38     32768 booter
  0.29    93/11/12 1144  ------wr  1CEB48      1024 modules
```

park
Park Hard Drive Heads

Syntax
```
park [<opts>] [<device>] [<opts>]
```

OS
OS-9

Description
The `park` utility parks hard drive heads.

paths
Display Process Paths

Syntax
```
paths [<opts>] [<process id list>]
```

OS
OS-9; OS-9 for 68K

Options
`-e`	Displays all processes of all users.

Description
The `paths` utility displays path information about processes running on the system owned by the user invoking the routine.

Processes can switch states rapidly, usually many times per second. Therefore, the display is a snapshot taken at the instant the command is executed and shows only those processes running at that exact moment.

Display information about specific processes by listing their process IDs in <process id list>.

The `paths` utility with no options displays ten pieces of information for each process:

Table 1-25. Process Information

Name	Specification
`Id`	Process ID
`PId`	Parent process ID
`Grp.usr`	Owner of the process (group and user)
`MemSiz`	Amount of memory the process is using
`Module & I/O`	Process name and I/O paths: If several of the paths point to the same pathlist, the identifiers for the paths are merged.

Examples

```
$ paths -e
 Id PId Grp.Usr   MemSiz Module & I/O
  2   0   0.0      4.00k sysgo <h0:startup >>>term
3)term
  3   2   0.0     52.00k mshell <>>>term
 22   0   0.0     32.00k telnetdc <pks00 4)pkm00 5)nil
6)socket
 30   0   0.0     20.00k routed <>>>nil 3)socket
 31   0   0.0      2.00k ifman
 32   0   0.0      2.00k sockman
 35   0   0.0     24.00k telnetd <>>>nil 3)socket
 36   0   0.0     24.00k ftpd <>>>nil 3)socket
 37  22   0.190   52.00k mshell <>>>pks00
 52  37   0.190   44.00k umacs <>>>pks00
 55   3   0.0     40.00k paths <>>>term
 56   0   0.0     64.00k ftpdc <>socket >>nil
```

partition
Partition OS-9/68k hard disks

Syntax
```
partition [<opts>] <device name> [<descs>] [<opts>]
```

OS
OS-9 for 68K

Options
`-r`
: Replace any existing files.

`-w=<dir>`
: Write partition descriptors to specified directory `<dir>`. Default is current directory.

`-z=<file>`
: Reads names of partition descriptors from `<file>`.

Description
OS-9 for 68K logical disk drives are limited to approximately 4GB in size. The partition utility facilitates breaking a large (greater than 4GB) drive up into a number of smaller logical drives. Using the partition utility, the size of each partition is specified after which a device descriptor is created for each partition. The created device descriptors can then be read in by the partition utility to allow subsequent modification of the partitions.

The partition utility takes the name of the device to be partitioned as follows:

```
partition /h0
```

The first action of `partition` is to create partitions for any space on the device that is not allocated. If descriptors for existing partitions were included on the command line or via the `-z` option, only the space not covered by those descriptors will be allocated. After completing the initial allocation, the following options display:

```
1. create new partition
2. edit existing partition
3. delete existing partition
4. display partition information
5. write device descriptors for partitions
6. format a partition
7. format all partitions
8. exit
```

You enter the number of the action to be performed. For any numerical choice such as a partition number of command number, the letter '`x`' can also be entered to abort the command (or exit the utility in the case of a command number.)

Create New Partition (1)

This option allows the creation of a new partition. You will are prompted for a name for the partition. The default name is the name of the device being partitioned followed by a number representing its partition number. For example, if the device being partitioned is named `h1`, the partition names will be `h11`, `h12`, etc. If the default name is acceptable, simply type the enter key. This is name of the device descriptor generated for the partition.

You are then prompted to enter the partition's size as number of megabytes, number of gigabytes or percent of the total disk capacity. The default is the smaller of the maximum partition size or the amount of space remaining on the device. If the default size is acceptable, simply type the enter key. To specify megabytes enter the number (the number can optionally be followed by `m` and can be a decimal fraction) for example `214` or `214.3m`. To specify gigabytes enter the number as a decimal fraction followed by g, for example `3.4g`. To specify the percentage of the total drive capacity, enter the number followed by the `%` sign, for example `45%`. If there is insufficient space left to allocate the partition, the partition size is set to the amount of space available. If the size specified is larger than the maximum of 4GB, the partition size is set to the maximum.

Edit Partition (2)

This option allows the size and name of a partition to be changed. You will be prompted to enter the partition number after which you will be prompted to enter the name and size of the partition as described above for `Create New Partition (1)`.

Delete Partition (3)

This option deletes a partition. You are prompted to enter the partition number to delete. Use the delete option with care.

Display Partition Information (4)

This option allows you to view the name and size of each existing partition. If there is any disk space un-allocated, that information will also be displayed.

Write Device Descriptors (5)

This option causes the device descriptors for each partition to be generated. For each descriptor, a format enabled version is also created. The format enabled version has the suffix `fmt` appended to the partition name. The device descriptors by default are written to the `BOOTOBJS` directory in the current execution directory by default. This can be overridden using the `-w` option described above. If any of the files to be written already exist, you will be prompted as to whether you want to overwrite them or not. Using the `-r` option causes files to be overwritten without any prompting.

Format a Partition (6)

This option allows a single partition to be formatted. The partition is neither physically or logically formatted since this is not normally needed for SCSI drives.

Format All Partitions (7)

This option allows all the defined partitions to be logically formatted. The user is prompted before each partition is formatted to ensure that none are accidentally overwritten. The partitions are neither physically or logically formatted since this is not normally needed for SCSI drives.

Exit (8)

This option exits the partition utility. If partition sizes have changed since the partitions were formatted, the user is prompted as to whether a format should be done. If the answer is yes, the `Format All Partitions (7)` option is invoked. If partition information has changed since the last time the device descriptors were written, you are prompted as to whether or not the descriptors should be written before exiting.

pcdcheck
Check Specified Device for Correct FAT File System

Syntax
```
pcdcheck [<opts>] {<devname>} [<opts>]
```

OS
OS-9

Options
`-n`
Answer "no" to all repair prompts.

`-q`
Quiet mode. (Only display error messages.)

`-r`
Read-only mode. (Do not modify filesystem.)

`-v`
Verbose mode.

`-y`
Answer "yes" to all repair prompts.

Description
The `pcdcheck` utility may be used to check for a valid PCF (FAT12 / FAT16 / FAT32) format on a device.

Example
```
$ pcdcheck -v /mhc1

/mhc1@: Phase 1 -- Checking boot sector area

/mhc1@: 62880 blocks, size 512 bytes (30.70 Mbytes)

/mhc1@: FAT_start=1 FAT_sects=62 dir_start=125
data_start=157
```

```
/mhc1@: format=FAT16 clusters=15690 label="NO NAME"

/mhc1@: Phase 2 -- Checking directory structure

/mhc1@: 27 directories containing 386 files

/mhc1@: Phase 3 -- Checking File Allocation Table
(FAT16)

/mhc1@:   8 free clusters (16.00 Kbytes)
```

See Also

dcheck

pcformat

Creates a FAT File System for use with PCF

Syntax

```
pcformat [<opts>] {<devname>}
```

OS

OS-9

Options

`-N`
Do not create file system; just print out parameters

`-B <path>`
Get bootstrap from file

`-F  <type>`
FAT type (12, 16, or 32)

`-I <value>`
Volume ID

`-L <str>`
Volume label (up to 11 chars)

`-O <str>`
OEM string

`-S <count>`
Bytes/sector

`-a <count>`
Sectors/FAT

`-b <count>`
Block size

`-c <count>`
Sectors/cluster

`-e <count>`
Root directory entries

`-f <count>`
Standard format (sectors per track)

`-h <count>`
Drive heads

`-i <sec>`
File system info sector

`-k <sec>`
Backup boot sector

`-m <type>`
Media descriptor (`0xf0`, etc.)

`-n <count>`
Number of FATs

`-o <count>`
Hidden sectors

`-q`
Quiet (no prompt, just format)

`-r <count>`
Reserved sectors

`-s <count>`
File system size (sectors)

`-u <count>`
Sectors/track

`-?`
Displays the options

Description

The `pcformat` utility creates a PC file system on a low-level formatted random access device under PCF. It does not do low-level formatting or sector integrity checking. Instead, `pcformat` uses information in the device descriptor to create an empty PC file system that can then be used with PCF.

For many removable media devices, it is important to verify that the media being formatted has been low-level formatted and is free from errors. The low-level formatting and error checking should be done using the `format` utility.

The `pcformat` utility can format FAT12, FAT16 and FAT32 file systems with a variety of options.

PCF and `pcformat` support FAT12, FAT16, and FAT32 file formats. Although PCF and `pcformat` have been tested to interoperate well, some FAT32 file system configurations are not supported by Windows®. It is recommended that FAT32 be used only on partitions 2GB and larger.

When formatting, `pcformat` will attempt to determine the size of the drive directly from the driver as well as the information in the device descriptor.

The `pcformat` utility supports the following standard floppy formats: 160, 180, 320, 360, 720, 1200, 1440, 2880. You can force a particular floppy format on any floppy device by using the `-f` option followed by the desired format.

```
pcformat /md0_3 -f 360
```

pd
Prints Working Directory

Syntax
```
pd [<opts>]
```

OS
OS-9; OS-9 for 68K

Options
`-a`
Displays all directory paths.

`-d`
Displays the current data directory.

`-m`
Displays the current and alternate module directory paths. (OS-9)

`-x`
Displays the path to the current execution directory.

Description
The `pd` utility displays a pathlist showing the path from the root directory to your current data directory.

Programs can use the `pd` utility to discover the actual physical location of files or by users to find their whereabouts in the file system.

The command `pd -x` displays the pathlist from the root directory to the current execution directory.

Examples

```
$ chd /D1/STEVE/TEXTFILES/MANUALS

$ pd
/d1/STEVE/TEXTFILES/MANUALS

$ chd ..

$ pd
/d1/STEVE/TEXTFILES

$ chd ..

$ pd
/d1/STEVE

$ pd -x
/d0/CMDS
```

pinfo
Partition Table Utility

Syntax
```
pinfo <device name>
```

OS
OS-9

Description
Although OS-9 only supports the use of four primary partitions it is possible to use DOS extended partitions with the PCF file manager.

To use DOS extended partitions device descriptors must be created which include the 'logical sector offset' to the partition desired. Further, the 'logical unit number' must match the extended partition primary entry.

To aid in creation of PCF DOS extended descriptors for OS-9, the `pinfo` utility may be used.

The `pinfo` utility displays the value of the 'logical unit number' and 'logical sector offset' required to create the new descriptor. Also, the "FMGR" section shows if the given partition is supported by PCF.

The `pinfo` utility displays information related to the way your hard disk is currently partitioned. If the partitions are changed new descriptors for the extended partitions are required.

The `pinfo` utility expects one argument, the device name. The device name should be the name of the RAW device descriptor and not a descriptor based on a partition.

IDE: `/hcfmt` or `/hdfmt`

SCSI: `/hs0fmt`, `/hs1fmt` through `/hs7fmt`

Examples

The following example of a DOS formatted hard disk contains one DOS primary partition, one DOS extended partition and ten DOS logical partitions.

```
$ pinfo /hcfmt

Primary  Partitions
Partition   LUN  LSNOFFS     Par_Type                  FMGR
-----------------------------------------------------------
01           01  0x00000000  DOS 16-bit FAT >=32M      PCF
02           02  0x00000000  DOS Extended              NA
03           03  0x00000000  EMPTY                     NA
04           04  0x00000000  EMPTY                     NA

================ Extended Partitions ====================

Partition   LUN  LSNOFFS     Par_Type                  FMGR
-----------------------------------------------------------
01           01  0x00064680  DOS 16-bit FAT >=32M      PCF
02           01  0x000c8d00  DOS 16-bit FAT >=32M      PCF
03           01  0x00191a00  DOS 16-bit FAT >=32M      PCF
04           01  0x001c3d40  DOS 16-bit FAT >=32M      PCF
05           01  0x001f6080  DOS 16-bit FAT >=32M      PCF
06           01  0x002283c0  DOS 16-bit FAT >=32M      PCF
07           01  0x0025a700  DOS 16-bit FAT >=32M      PCF
08           01  0x0028ca40  DOS 16-bit FAT >=32M      PCF
09           01  0x002bed80  DOS 16-bit FAT >=32M      PCF
10           01  0x002f10c0  DOS 16-bit FAT >=32M      PCF
```

Creating New Descriptors

Use `editmod` to create new descriptors for the DOS logical drives. There are three ways to do this.

Step 1. Create descriptor information in `systype.h` and create new makefiles. This is done the same way as stock descriptors are created.

Step 2. Cloning. This is the quickest method. If you are cloning an IDE PCF based descriptor, enter the following:

```
$ chd /h0/mwos/os9000/80386/ports/pcat/cmds/bootobjs/desc/rb1003
$ copy mhc1 mhc5
$ editmod -dPORT -e mhc5
   1. module header
   2. Device descriptor data definitions
   3. PCF path options
   4. PCF Logical Unit Static Storage

   Which? [?/1-4/p/t/a/w/q] 1
   1. module owner's group number             : 0
   2. module owner's user number              : 0
   3. module name                             : "mhc1"
   4. access permissions                      : 0x555
   5. type/lang                               : 0xf01
   6. rev/attr                                : 0x8000
   7. edition                                 : 1

   Which? [?/1-7/p/t/a/w/q] 3
   module name                              : "mhc1"
   New string: mhc5

   1. module owner's group number             : 0
   2. module owner's user number              : 0
   3. module name                             : "mhc5"
   4. access permissions                      : 0x555
   5. type/lang                               : 0xf01
   6. rev/attr                                : 0x8000
   7. edition                                 : 1

   Which? [?/1-7/p/t/a/w/q] p
   1. module header
   2. Device descriptor data definitions
   3. PCF path options
   4. PCF Logical Unit Static Storage
```

```
Which? [?/1-4/p/t/a/w/q] p
1. module header
2. Device descriptor data definitions
3. PCF path options
4. PCF Logical Unit Static Storage

Which? [?/1-4/p/t/a/w/q] 3
 1. number of surfaces                        : 5
 2. verify disk writes (0=verify)             : 1
 3. device format                             : 0x8003
 4. number of cylinders                       : 930
 5. default blocks/track                     : 17
 6. default blocks/track for trk0            : 17
 7. segment allocation size                   : 1
 8. block interleave offset                   : 1
 9. track base offset                         : 0
10. block base offset                         : 0
11. # tries                                   : 7
12. size of block in bytes                    : 512
13. control word                              : 0x7
14. first write precomp cylinder              : 128
15. first reduced write current cylinder      : 930
16. park cylinder for hard disks              : 0
17. lsn offset for partition                  : 0
18. max transfer size in terms of bytes       : 0x10000

Which? [?/1-18/p/t/a/w/q] 17
    lsn offset for partition                  : 0
    New value: 0x00064680
 1. number of surfaces                        : 5
 2. verify disk writes (0=verify)             : 1
 3. device format                             : 0x8003
 4. number of cylinders                       : 930
 5. default blocks/track                     : 17
 6. default blocks/track for trk0            : 17
 7. segment allocation size                   : 1
 8. block interleave offset                   : 1
 9. track base offset                         : 0
10. block base offset                         : 0
11. # tries                                   : 7
12. size of block in bytes                    : 512
13. control word                              : 0x7
14. first write precomp cylinder              : 128
15. first reduced write current cylinder      : 930
16. park cylinder for hard disks              : 0
17. lsn offset for partition                  : 411264
18. max transfer size in terms of bytes       : 0x10000
```

```
   Which? [?/1-18/p/t/a/w/q] p
    1. module header
    2. Device descriptor data definitions
    3. PCF path options
    4. PCF Logical Unit Static Storage

   Which? [?/1-4/p/t/a/w/q] p
    1. module header
    2. Device descriptor data definitions
    3. PCF path options
    4. PCF Logical Unit Static Storage

   Which? [?/1-4/p/t/a/w/q] 2
    1. device port address                    : 0x1f0
    2. logical unit number                    : 1
    3. path descriptor size                   : 0x168
    4. device type                            : 10
    5. device mode capabilities               : 0xffff
    6. file manager name                      : "pcf"
    7. driver name                            : "rb1003"
    8. sequential or random                   : 2

   Which? [?/1-8/p/t/a/w/q] 2
   logical unit number                    : 1
   New value: 1
    1. device port address                    : 0x1f0
    2. logical unit number                    : 1
    3. path descriptor size                   : 0x168
    4. device type                            : 10
    5. device mode capabilities               : 0xffff
    6. file manager name                      : "pcf"
    7. driver name                            : "rb1003"
    8. sequential or random                   : 2

   Which? [?/1-8/p/t/a/w/q] w
   Which? [?/1-8/p/t/a/w/q] q
$ editmod -dPORT -l mhc5

   module owner's group number            : 0
   module owner's user number             : 0
   module name                            : "mhc5"
   access permissions                     : 0x555
   type/lang                              : 0xf01
   rev/attr                               : 0x8000
   edition                                : 1
   device port address                    : 0x1f0
   logical unit number                    : 1
   path descriptor size                   : 0x168
   device type                            : 10
```

```
device mode capabilities                : 0xffff
file manager name                       : "pcf"
driver name                             : "rb1003"
sequential or random                    : 2
number of surfaces                      : 5
verify disk writes (0=verify)           : 1
device format                           : 0x8003
number of cylinders                     : 930
default blocks/track                   : 17
default blocks/track for trk0          : 17
segment allocation size                 : 1
block interleave offset                 : 1
track base offset                       : 0
block base offset                       : 0
# tries                                 : 7
size of block in bytes                  : 512
control word                            : 0x7
first write precomp cylinder            : 128
first reduced write current cylinder    : 930
park cylinder for hard disks            : 0
lsn offset for partition                : 411264
max transfer size in terms of bytes     : 0x10000
drive initialized flag                  : 0x0
interrupt vector                        : 0x4e
interrupt level                         : 6
interrupt priority                      : 10
step rate                               : 2
DMA transfer mode                       : 0
drive logical unit number               : 0
controller id                           : 0
total number of cylinders               : 930
```

Step 3. To automate the procedure for Method 2, create script file.

```
-nx -t
copy mhc1 mhc5 -rf
editmod -e -dPORTS mhc5 >>>/nil
1
3
mhc5
p
p
3
17
0x00064680
p
p
2
2
1
w
q
```

pr
Prints Files

Syntax
```
pr [<opts>] {<path>}
```

OS
OS-9; OS-9 for 68K

Options
An equal sign (=) specifies the additional parameters are optional.

`-c[=]<char>`
: Uses `<char>` as the specified column separator. A `<space>` is the default column separator.

`-d[=]<num>`
: Specifies the actual page depth in lines (default is 66).

`-f`
: Pads the page using a series of `\n` (new line), instead of a `\f` (form feed).

`-h[=]<num>`
: Sets the number of blank lines after title line. The default is 5.

`-k[=]<num>`
: Sets the `<num>` columns that the output file prints for multi-column output.

`-l[=]<num>`
: Sets the left margin to `<num>`. The default is 0.

`-m`
: Prints files simultaneously, one file per column. If three files are given on the command line, each file is printed in its own column on the page.

`-n[=]<num>`
: Specifies the line numbering increment: `<num>`. The default is 1.

`-o`
: Truncates lines longer than the right margin. By default, long lines are wrapped around to the next line.

`-p[=]<num>`
: Specifies the number of lines per page: `<num>`. The default is 61.

`-r[=]<num>`
: Sets the right margin to `<num>`. The default is 79.

`-t`
: Does not print the title.

`-u[=]<title>`
: Use specified title instead of file name. `<title>` may not be longer than 48 characters.

`-x[=]<num>`
: Sets the starting page number to `<num>`. The default is 1.

`-z`
: Reads the file names from standard input.

`-z=<file>`
: Reads the file names from `<file>`.

Description

The `pr` utility produces a formatted listing of one or more files to the standard output.

Type `pr` and the pathlist(s) of the files to list. The listing is separated into pages. Each page has the page number, the name of the listing, and the date and time printed at the top.

The `pr` utility can produce multi-column output. When printing multiple output columns with the `-m` option, if an output line exceeds the column width, the output line is truncated.

The `pr` utility can also print files simultaneously, one per column.

If files are not specified on the command line and the `-z` option is used, standard input is assumed to be a list of file names, one file name per input line, to print out.

If files are not specified on the command line and the `-z` option is not used, standard input is displayed on standard output.

Files and options may be intermixed.

A typical page of output consists of 66 lines of output. Therefore, the `pr` utility uses the following default parameters: 61 lines of output with 5 blank lines as a trailer. The 61 lines of output contain one line for the title, 5 blank lines for a header, and 55 lines of text. The trailer can be reduced or eliminated by expanding the number of lines per page.

Examples

The following example prints `file1` using the default values of 55 lines of text per page, one line for the title, and 5 lines each for the header and trailer:

```
$ pr file1 >/p1
```

The following example prints `file1` with no title. This uses 56 lines of text per page:

```
$ pr file1 -t >/p1
```

The following example prints `file1` using 90 lines per page. Pagination begins with page 10:

```
$ pr file1 -x=10 p=90 >/p1
```

To display a numbered, unformatted listing of the data directory, type:

```
$ dir -u ! pr -n
```

printenv
Prints Environment Variables

Syntax
```
printenv
```

OS
OS-9; OS-9 for 68K

Description
The `printenv` utility prints any defined environment variables to standard output.

Example
```
$ printenv
NAME=andy
TERM=abm85
LIST=/p1
As_long_as_you_want=long_value
```

See Also
`setenv`
`unsetenv`

procs
Displays Processes

Syntax
```
procs [<opts>][<process id list>]
```

OS
OS-9; OS-9 for 68K

Options
`-a`
Displays alternate information.

`-b`
Displays regular and alternate `procs` information.

`-e`
Displays all processes of all users.

`-t`
Displays thread information (OS-9 only; not valid for OS-9 for 68K systems).

`-x`
Displays an extended process descriptor listing (OS-9 only; not valid for OS-9 for 68K systems).

Description
The `procs` utility displays a list of processes running on the system owned by the user invoking the routine.

Processes can switch states rapidly, usually many times per second. Therefore, the display is a snapshot taken at the instant the command is executed and shows only those processes running at that exact moment.

Display information about specific processes by listing their process IDs in `<process id list>`.

The `procs` utility displays the following information for each process:

Table 1-26. Process Information

Name	Specification
`Id`	Process ID
`PId`	Parent process ID
`Thd`	Thread count (OS-9 only)
`Grp.usr`	Owner of the process (group and user)
`Prior`	Initial priority of the process
`MemSiz`	Amount of memory the process is using
`Sig`	Last pending signal value for the process/exit status for dead process
`CPU Time`	Amount of CPU time the process has used
`Age`	Elapsed time since the process started
`S`	State of the process **Currently in CPU**. Process is currently in the CPU. This will always be the procs command since it has to be running when it takes the snapshot of the process table. **Active**. Process must wait; another process is in the CPU. **Debug Mode**. Process is currently being debugged. **Waiting on Event**. Process is blocked, waiting on an event. **Waiting on a Semaphore**. Process is blocked, waiting on a semaphore. **Waiting on a Child**. Process is blocked, waiting on a child process to terminate. **Suspended**. Process blocked by special kernel system call. **Zombie**. Process has been terminated, but the parent has not performed a wait to read the exit status.
`Module & I/O`	Process name and standard I/O paths: < Standard input > Standard output >> Standard error output If several of the paths point to the same pathlist, the identifiers for the paths are merged.

The command `procs -a` displays the following information:

- the process ID
- the parent process ID
- the process name, and
- standard I/O paths and
- six new pieces of information

Extended Process Descriptor Listing

The `-x` option displays an extended process descriptor listing of OS-9 values. To view this list, type the following command from a shell prompt:

```
procs -x <process ID number>
```

Below is an example of the output you will receive.

```
$ procs -x 2
 2  mshell      Owner:   0.0
    Parent ID: 0        Thread Child Count: 0
    Child Count: 1 (3)
    System SP: $8ffe8e74   User SP: $0c2714f8   Exception SP:
$8ffe8f7c
    Static Storage: $0c26c000   Static Size: $5770
    Priority: 128   Age: 128
    Queue: Sleeping
    Status: $600  ()
    Main module directory: /  Alt module directory: /
    Current memory usage:   40.00k      Number of segments: 3
    Ticks: 87       CPU Time:  0.87  Age:    ???
    F_Calls:1377  I_Calls:7090  Last:F_SLEEP  Input:50016
Output:2933
    Sched Constant: 7ffef73a  SS Preemptable: No   Deadlock Chain:
0
    Deadlock Chain: 0   Primary Data Size: 22384
    Signal intercept routine installed.
    Signal level: 0  flag: 0  mask: 0  count: 0
    Signal Recursion: 0   Max Signals: 32
    No trap handlers installed.
```

Subroutine Libraries: csl

The following table defines the fields from the code above. The values for these fields will vary depending on your system and process ID.

Table 1-27. Extended Process Descriptor Listing (-x Option)

Name	Specification
`2`	Process ID.
`mshell`	Program name.
`Owner`	Owner of the process (`Grp.usr`).
`Parent ID`	Parent process ID (`PId`).
`Child Count`	Thread count.
`System SP`	System stack pointer.
`User SP`	User stack pointer.
`Exception SP`	Exception stack pointer.
`Static Storage`	Address of static storage.
`Static Size`	Size of static storage.
`Priority`	Initial priority of the process.
`Age`	Elapsed time since the process started.

Table 1-27. Extended Process Descriptor Listing (-x Option)

Name	Specification
`Queue`	State of the process (`S`). `*CPU` = Process is currently in CPU. This will always be the procs command since it has to be running when it takes the snapshot of the process table. `a` = Active. Process must wait because another process is in the CPU currently. `d` = Debug. Process is currently being debugged. `e` = Event. Process is blocked waiting on an event. `p` = Semaphore. Process is blocked waiting on a semaphore. `s` = Sleeping. Process is blocked waiting on a signal or time value to elapse. `w` = Waiting. Process is blocked waiting on a child process to terminate. `z` = Suspended. Process is blocked by a special kernel system call. `-` = Zombie. Process has been terminated, but parent has not performed a wait to read exit status.

Table 1-27. Extended Process Descriptor Listing (-x Option)

Name	Specification
`Status`	Possible Values: `FpuProc`: Process is using the FPU. `RthProc`: Representative thread process. `DbgProc`: Process is being debugged. `SupStat`: Process is executing in system-state. `TimSlep`: Process is in a timed sleep. `TimOut`: Process's time slice has expired. When it returns to user-state, it will give up its time slice. `ImgChg`: SPU/MMU memory map has changed. `SigPend`: Process has a signal pending. `TraceBT`: Trace this process; when returning to user state, suspend and wait for it to be debugged. `Condemn`: Process terminated by kernel. `DeadPrc`: Process has terminated. The process is waiting for the exit status to be read. In system state, the process is required to terminate itself.
`Main module directory`	Main directory from which the system will attempt to execute modules.
`Alt module directory`	If the module is not found on the main module directory, it will be chosen from the list of alternative directories, if any.
`Current Memory Usage`	Amount of memory currently being used.
`Number of segments`	Number of sections in memory.
`Ticks`	Number of clock ticks the process has executed.
`CPU Time`	Amount of CPU time the process has used.
`Age`	Elapsed time since the process started.
`F_Calls`	Number of service request calls made.
`I_Calls`	Number of I/O requests made.
`Last`	Last system call made.

Table 1-27. Extended Process Descriptor Listing (-x Option)

Name	Specification
`Input`	Number of bytes read.
`Output`	Number of bytes written.
`Sched Constant`	Number used to determine the relative age between processes in the active queue.
`Preemptable`	Declares whether or not the program can be interrupted.
`Deadlock chain`	Process ID of the next process in a deadlock chain. This is 0 if the process is not in a deadlock chain.
`Primary Data Size`	Size of the primary data.
`Signal Interrupt`	Declares whether or not a signal interrupt handler has been installed.
`Signal Level`	The process' signal mask level. This is the count of nested signal masks that are currently in place.
`Signal Flag`	A flag used in system-state to avoid race conditions related to signal arrival and signal handling.
`Signal Mask`	This value is reserved and should always be 0.
`Signal Count`	The number of unhandled signals currently pending
`Signal Recursion`	The number of times that a signal has been received by the process and the process has not called `_os_rte()` to return from the signal handler. `_os_siglngj()` takes advantage of the difference between non-recursive and recursive signal handling.
`Maximum Signals`	Maximum number of signals the process can store.
`Trap Handlers`	Provides a list of installed trap handlers.
`Subroutine Libraries`	Provides a list of installed subroutine libraries.

Table 1-28. Additional Process Information

Name	Specification
`Aging`	Age of the process based on the initial priority and how long it has waited for processing.
`F$calls`	Number of service request calls made.
`I$calls`	Number of I/O requests made.
`Last`	Last system call made.

Table 1-28. Additional Process Information

Name	Specification
`Read`	Number of bytes read.
`Written`	Number of bytes written.

The `-b` option displays both sets of information.

The `-e` option displays information for all processes in the system.

Detailed explanation of all information displayed by the `procs` utility is available in the *OS-9 Technical Manual* or the *OS-9 for 68K Technical Manual*.

Examples

```
$ procs
Id PId Grp.Usr Prior MemSiz Sig S   CPU Time   Age Module & I/O
 2   1   0.0   128    0.25k   0 w       0.01   ??? sysgo <>>>term
 3   2   0.0   128    4.75k   0 w       4.11 01:13 shell <>>>term
 4   3   0.0     5    4.00k   0 a   12:42.06 00:14 xhog <>>>term
 5   3   0.0   128    8.50k   0 *       0.08 00:00 procs <>>term
 6   0   0.0   128    4.00k   0 s       0.02 01:12 tsmon <>>>t1
 7   0   0.0   128    4.00k   0 s       0.01 01:12 tsmon  <>>>t2

$ procs -a
Id PId  Aging  F$calls I$calls Last   Read Written Module & I/O
 2   1   129         5       1 Wait       0       0 sysgo <>>>term
 3   2   132       116     127 Wait     282     129 shell <>>>term
 4   3    11         1       0 TLink      0       0 xhog  <>>>term
 5   3   128         7       4 GPrDsc     0       0 procs <>>>term
 6   0   130         2       7 ReadLn     0       0 tsmon <>>>t1
 7   0   129         2       7 ReadLn     0       0 tsmon <>>>t2

$ procs 1
Id Pld Grp. Usr Prior MemSiz Sig S CPU Time  Age  Module & I/O
1   0  0.0  65535     0.00k   0 86:42:07.19 90.58 Kernel <>>>term
```

profile
Reads Commands from File and Return

Syntax
```
profile <path>
```

OS
OS-9; OS-9 for 68K

Description
The `profile` utility causes the current shell to read its input from the named file and then return to its original input source which is usually the keyboard.

The file specified in `<path>` may contain any utility or shell commands, including those to set or un-set environment variables or to change directories. These changes remain in effect after the command executes. This is in contrast to calling a normal procedure file by name only, which a child shell would then execute. This would not affect the environment of the calling shell.

You can nest `profile` commands. That is, the file itself may contain a `profile` command for another file. When the latter `profile` command completes, the first one resumes.

A particularly useful application for `profile` files is within the `.login` and `.logout` files of a system's users. For example, if each user includes the following line in their `.login` file, system-wide commands (such as common environments and news bulletins) can be included in the file `/dd/SYS/login_sys`:

```
profile /dd/SYS/login_sys
```

You can use a similar technique for `.logout` files.

Because this is a built-in shell command, it does not appear in the `CMDS` directory.

qsort
In-Memory Quick Sort

Syntax
```
qsort [<opts>] {<path>}
```

OS
OS-9; OS-9 for 68K

Options
`-c[=]<char>`
Specifies the field separation character. If an asterisk (`*`), question mark (`?`), or comma (`,`) are used as field separation characters, You must enclose the option and the character by quotation marks.

`-f[=]<num>`
Specifies the sort field. Only one `-f` field is allowed on a command line.

`-z`
Reads the file names from standard input.

`-z=<file>`
Reads the file names from `<file>`.

Description
The `qsort` utility is a quick sort algorithm that sorts any number of lines up to the maximum capacity of memory.

Type `qsort` and the pathlist(s) of the file(s) to sort.

The `qsort` utility sorts the file(s) by a user-specified field or field one by default.

The field separation character defaults to a space if the separation character is not specified.

If the file names are not given on the command line, standard input is assumed.

Multiple separation characters in a row are counted as a single field separator. For example, if a comma is specified as the field separation character, three commas in a row (`,,,`) signify only one field separator. To create two null fields, you must insert a space between each comma (`, , ,`).

Examples

```
$ qsort file1 file2 file3
```
Individually sorts the files and displays.

```
$ list file1 file2 file3 ! qsort
```
Sorts the files together and displays.

```
$ dir -ue ! qsort -f=2
```
Sorts extended directory listing by entry date, field 2.

```
$ qsort file -f=2 "-c=*"
```
Sorts file by field 2 using an asterisk (`*`) as the field separation character.

```
$ qsort file -f=2 "-c=,"
```
Sorts file by field 2 using a comma (`,`) as the field separation character.

```
$ qsort -z
```
Reads file names from standard input.

rename
Changes File Name

Syntax
```
rename [<opts>] <path> <new name>
```

OS
OS-9; OS-9 for 68K

Options
`-f`
: Forces rename even if the file is write-protected (OS-9 only).

`-x`
: Indicates that `<path>` starts at the current execution directory. You must have execute permission for the specified file.

Description
The `rename` utility assigns a new name to the mass storage file specified in the pathlist.

Type `rename`, followed by the name of the file to rename, followed by the new name.

You must have write permission for the file to change its name.

You cannot use the names "`.`" or "`..`" for `<path>`.

Examples
```
$ dir
   Directory of .  16:22:53
blue            myfile
$ rename blue purple
$ dir
   Directory of .  16:23:22
myfile          purple
$ rename /h0/HARRY/test1 test2
$ rename -x screenclear clearscreen
```

romsplit
Splits File

Syntax
```
romsplit {<optopn(s)>} {<path>}
```

OS
OS-9; OS-9 for 68K; WIN; UNIX

Options
`-b[=]<size>`
: Specifies the buffer size in k bytes. Defaults to 16k.

`-q`
: Splits the input file into four files.

`-x`
: Reads the input file from execution directory (OS-9, OS-9 for 68K only).

Description
The `romsplit` utility splits the input file specified by `<path>` into two or four files.

The `romsplit` utility converts a ROM object image into an 8-bit wide file. This is useful when a PROM programmer cannot burn more than one PROM at a time and the system has the ROMs addressed as 16-bit or 32-bit wide memory.

If the `-q` option is not specified, the `romsplit` utility copies the even bytes of data to a new file with the same name with a `.0` extension. The odd bytes are copied to a new file with the same name with a `.1` extension.

If the `-q` option is specified, the following copying scheme is used:

Table 1-29. Copying Data

Byte Number	Destination File
`0, 4, 8, 12` etc.	`<path>.0`
`1, 5, 9, 13 etc.`	`<path>.1`
`2, 6, 10, 14 etc.`	`<path>.2`
`3, 7, 11, 15 etc.`	`<path>.3`

save
Saves Memory Module(s) to File

Syntax
```
save [<opts>] {<modname>}
```

OS
OS-9; OS-9 for 68K

Options
`-f[=]<path>`
Saves all specified modules to `<path>`.

`-r`
Rewrites existing files.

`-x`
Saves modules into the current execution directory.

`-z`
Reads the module names from standard input.

`-z=<file>`
Reads the module names from `<file>`.

Description
The `save` utility copies the specified module(s) from memory into your current data directory. The file(s) created in your directory have the same name(s) as the specified module(s).

Type `save`, followed by the name(s) of the module(s) to save. `<modname>` must exist in the module directory when saved.

The new file is given access permissions for all modes except public write.

If you specify more than one module, each module is stored in a separate file, unless you use the `-f` option. In that case, all modules listed are saved in the specified file.

To save a module, the module must have read access permission for either your group or user ID.

The `save` utility uses the current data directory as the default directory. You should generally save executable modules in the default execution directory.

Examples

```
$ save -x dir copy
$ save -f=/d1/math_pack add sub mul div
```

Saving separate module directories in OS-9 requires that you either use `chm` to change the module directory or create a directory of the same name as the module directory to save.

```
$ makmdir MYMODS
```
create module directory

```
$ makdir MYMODS
```
create directory of same name

```
$ load -dw=MYMODS modules
```
load modules into module directory

```
$ mdir -u ! save -z
```
save modules back to disk

```
$ mdir -u ! save -z -f=memmods
```
save modules to a single file

set
Sets Shell Options

Syntax
```
set [<opts>]
```

OS
OS-9; OS-9 for 68K

Options
Refer to your shell documentation for available options.

Description
The `set` utility changes shell options for the individual shell in which they are declared.

To change the options for your current shell, enter `set` and the desired shell options. This command is the equivalent of typing the options directly after the shell prompt on the command line. This is the preferred method of changing shell parameters within procedure files because of its clarity.

The hyphen that usually proceeds declared options is unnecessary when using the `set` command.

The options specified by the `set` utility change the shell parameters only in the shell in which they are declared. All descendant shells have the default parameters unless changed within the new shell.

`set` is a built-in shell command. Therefore, it is not in the `CMDS` directory.

`MShell` allows the `set` command to be used to examine the current value of all options. Entering the command line `set<cr>` displays all shell options. See `mshell` for more information.

Examples

All commands on the same line have the same effect:

```
$ set x  $ set -x  $ -x
$ set xp="JOE"  $ set -xp="JOE"   $ -xp="JOE"
```

setenv
Sets Environment Variables

Syntax
```
setenv <name> <evalue>
```

OS
OS-9; OS-9 for 68K

Description
The `setenv` utility sets environment variables within a shell for use by the individual shell's child processes.

`<name>` and `<evalue>` are strings stored in the environment list by shell. These variables are known to the shell in which they are defined and are passed on to descendent processes from that shell.

Do not confuse `setenv` with the shell `set` command. It has a completely different function. The `setenv` command is a built-in shell command. Therefore, it is not in the `CMDS` directory.

Examples
```
$ setenv PATH ../h0/CMDS:/d0/CMDS:/dd/CMDS
$ setenv TERM abm85
$ setenv _sh 0
$ setenv As_long_as_you_want long_value
```

setime
Activates and Sets System Clock

Syntax
```
setime [<opts>] [y m d h m s [am|pm]]
```

OS
OS-9; OS-9 for 68K

Options
`-d`
Does not echo date/time when set.

`-s`
Reads time from battery backed up clock.

`-q`
Specifies that `setime` should not enter interactive mode for any reason. (`setime` typically enters into interactive mode when no command line arguments have been specified or when any illegal command line arguments are specified.)

Description
The `setime` utility sets the system date and time. Once set, it activates the system interrupt clock.

Type `setime`, and enter the year, month, day, hour, minute, second, and am or pm as parameters on the command line.

The `setime` utility does not require field delimiters, but allows you to use the following delimiters between the year, month, day, etc.:

colon (`:`), semicolon (`;`), slash (`/`), comma (`,`), or space ( )

If semicolons are used as field delimiters, the date and time string must be enclosed by quotes so that the semicolons are not interpreted by the shell. For Example

```
$ setime "91;1;15;1;25;30;pm"
```

If parameters are not given, the setime utility issues the prompt:

```
$ setime
        yy/mm/dd hh:mm:ss [am/pm]
Time:
```

The yy field in the setime utility works as follows: for each yy value from 70 to 99, the corresponding year value is 1970 through 1999. For each yy value from 00 to 69, the corresponding year value is 2000 through 2069.

When no am|pm field is specified, the system time uses the 24 hour clock. For example, 15:20 is 3:20 pm. Midnight is specified as 00:00. Noon is specified as 12:00. Using the am|pm field allows you to use the 12 hour clock. If a conflict exists between the time and the am|pm field (such as 15:20 pm) the system ignores the am/pm designation.

The setime utility uses the date utility to echo the date and time after it is set.

The system ticker is required to be running so setime time sharing operation can commence. The OS-9 kernel automatically starts the system ticker during system cold start unless the init module's M$Compat flag (B_NoClock) is set. If the system has a battery-backed clock, this command also sets the system's date and time.

If this system does not have a battery-backed clock, (or the init module flag is set), you should run this utility to set the system date and time for the file system.

Systems with Battery Backed Up Clocks

The setime utility should still be run to start timeslicing, but you only need to give the -s. The date and time are read from the clock.

See Also

The date utility.

Examples

```
$ setime 91 01 13 15 45Set to:
    January 13, 1991, 3:45 PM

$ setime 910113 154500Set to:
```

January 13, 1991, 3:45 PM

```
$ setime 91/01/13/3/45/pmSet to:
```

January 13, 1991, 3:45 PM

```
$ setime -s
```

For systems with a battery-backup clock sets time to the value of the battery-backed clock.

If no parameters are specified, the user is prompted:

```
$ setime
      yy/mm/dd hh:mm:ss [am/pm]
Time: 91 01 13 15 45
January 13, 1991 Sunday 3:45:00 pm
```

setpr
Sets Process CPU Priority

Syntax
```
setpr <procID> <priority>
```

OS
OS-9; OS-9 for 68K

Description
The `setpr` utility changes the CPU priority of a process.

Type `setpr`, the process ID, and the new priority value of the process to change.

The `setpr` utility may only be used with a process having your ID. Use `procs` to obtain the ID number and present priority of any current process.

The priority number is a decimal number in the range of 1 (lowest) to 65535 (hex FFFF).

This command does not appear in the CMDS directory as it is a built-in shell command.

Example
```
$ setpr 8 250
```
Change the priority of process number 8 to 250

shell
Command Interpreter

Syntax
```
shell [[set] <arglist>]
```

OS
OS-9; OS-9 for 68K

Options
`-a`
Echoes command line if altered after entry. (OS-9)

`-na`
Does not echo altered command line. (OS-9)

`-c=<num>`
Specifies the number of previously executed commands the shell should "remember." This provides a history of your commands. If `<num>` is not specified, the default is 40. (OS-9)

`-nc`
Does not keep a command line history. (OS-9)

`-e`
Prints error messages from `/dd/SYS/errmsg`.

`-e=<file>`
Prints error messages from `<file>`.

`-ne`
Does not print error messages, only error numbers. This is the default.

`-h`
Displays the command's history number in front of the command line prompt. This is the default option. (OS-9)

`-nh`
Does not display the command's history number. (OS-9)

`-l`
Requires the `logout` command to terminate the `login` shell. End-of-File `<eof>` does not terminate the shell.

`-nl`
Terminates the `login` shell when using end-of-file `<eof>`. The `<Esc>` key normally sends an `<eof>` to the shell.

`-p`
Displays prompt. The default prompt is `$` (dollar sign).

`-p=<string>`
Sets current shell prompt equal to `<string>`.

`-np`
Does not display prompt.

`-q`
Passes "`assign`"s from shell to shell. (OS-9)

`-nq`
Does not pass "`assign`"s from shell to shell. (OS-9)

`-s`
Saves your command history from one login session to the next. The command history is saved in a `.history` file in your home directory. (OS-9)

`-ns`
Does not save your command history from one login session to the next. This is the default. (OS-9)

`-t`
Echoes input lines.

`-nt`
Does not echo input lines. This is the default.

`-v`

Displays a message using verbose mode for each directory searched when executing a command.

`-nv`

Turns off verbose mode.

`-x`

Aborts process upon error. This is the `default`.

`-nx`

Does not abort on error.

Description

The `shell` utility is the operating system's command interpreter program. It reads data from its standard input which is usually the keyboard or a file and interprets the data as a sequence of commands.

The basic function of the `shell` utility is to initiate and control execution of other programs.

See Also

For more information about using the `shell` utility, refer to Chapter 6.

sleep
Suspends Process for Period of Time

Syntax
```
sleep [<opts>] <num>
```

OS
OS-9; OS-9 for 68K

Options
`-s`
Changes count representation to seconds.

Description
The `sleep` utility puts your process to sleep for a number of ticks or seconds.

This utility is generally used to generate time delays in procedure files.

Type `sleep`, followed by the number of ticks you want the process to sleep.

A tick count of one causes the process to give up its current time slice and return immediately.

A tick count of zero causes the process to sleep indefinitely, usually until awakened by a signal.

The duration of a tick is system-dependent.

Only one number may be used on the command line. If none is specified, `<num>` defaults to zero.

Examples
```
$ sleep 25
```
Sleep for 25 ticks.

```
$ sleep -s 1000
```
Sleep for 1000 seconds.

su
Fork a New Shell with a New User ID

Syntax
```
su <name> [<,>] <password>
```

OS
OS-9; OS-9 for 68K

Options
`-p`
: Do not change prompt.

Description
The `su` utility allows you to start a new shell with a different user ID. This allows you to change user ID's without logging off and logging back on to the system. The system's password file is searched for the name and password given. If a matching entry is found in the password file, a new shell is forked with the associated user ID specified in the password file entry.

suspend
De-activate an Active Process

Syntax
```
suspend <process id>
```

OS
OS-9

Description
The `suspend` utility de-activates or suspends an active process.

Type `suspend` and the process ID of the process you wish to suspend. Obtain the process ID from the `procs` utility.

The `suspend` utility uses the `_os_suspend` system call to remove the process from the system's active queue. It places the process in a limbo state. While it is in this limbo state, it is not a member of any system queue.

The queue identifier for suspended processes is a `z`. This indicates an inactive state.

You must be extremely careful not to suspend a process that currently owns a device. If a process is suspended while using a device, the device is inaccessible until the process is activated.

Only super users may suspend an active process of another user.

Example

```
$ procs -e
Id PId Grp.Usr  Prior  MemSiz Sig S    CPU Time   Age Module & I/O
2   0   0.0     128   30.75k   0 w       0.04  0:10 tsmon <>>>term
3   5   0.0     128   11.00k   0 a       7.00  0:01 eatmpu <>>>term
4   0   0.0     128   30.75k   0 s       0.04  0:10 tsmon <>>>t3
5   2   0.0     128    9.00k   0 w       3.09  0:10 shell <>>>term
6   5   0.0     128   35.25k   0 *       0.07  0:00 procs <>>term
>dd
$ suspend 3

$ procs -e
Id PId Grp.Usr  Prior  MemSiz Sig S    CPU Time   Age Module & I/O
2   0   0.0     128   30.75k   0 w       0.04  0:10 tsmon <>>>term
3   5   0.0     128   11.00k   0 z       8.73  0:01 eatmpu <>>>term
4   0   0.0     128   30.75k   0 s       0.04  0:10 tsmon <>>>t3
5   2   0.0     128    9.00k   0 w       3.46  0:10 shell <>>>term
6   5   0.0     128   35.25k   0 *       0.05  0:00 procs <>>term
>dd

$ procs -e
Id PId Grp.Usr  Prior  MemSiz Sig S    CPU Time   Age Module & I/O
2   0   0.0     128   30.75k   0 w       0.04  0:10 tsmon <>>>term
3   5   0.0     128   11.00k   0 z       8.73  0:01 eatmpu <>>>term
4   0   0.0     128   30.75k   0 s       0.04  0:10 tsmon <>>>t3
5   2   0.0     128    9.00k   0 w       3.47  0:10 shell <>>>term
6   5   0.0     128   35.25k   0 *       0.05  0:00 procs <>>term
>dd
```

See Also

activ

sysid
Print System Identification

Syntax
```
sysid [<opts>]
```

OS
OS-9

Options
`-a`
: Prints reserved string.

Description
The `sysid` utility prints out the identification information of the system. This information includes the OEM number, serial number, specific processor number, processor type, floating point processor, time zone, and the system copyright message.

tape
Tape Controller Manipulation

Syntax
```
tape {<opts>} [<dev>]
```

OS
OS-9; OS-9 for 68K

Options
`-b[=<num>]`
Skips the specified number of blocks. The default is one block. If `<num>` is negative, the tape skips backward.

`-e=<num>`
Erases a specified number of blocks of tape. (`*` is to end of tape.)

`-f[=<num>]`
Skips the specified number of tapemarks. The default is one tapemark. If `<num>` is negative, the tape skips backward.

`-o`
Puts tape off-line.

`-r`
Rewinds the tape.

`-s`
Determines the block size of the device.

`-t`
Retains the tape.

`-w[=<num>]`
Writes a specified number of tapemarks. The default is one tapemark.

`-z`
: Reads a list of device names from standard input. The default device is `/mt0`.

`-z=<file>`
: Reads a list of device names from `<file>`.

If you specify more than one option, the `tape` utility executes each option function in a specific order. Therefore, you can skip ahead a specified number of blocks, erase, and then rewind the tape all with the same command.

Description

The `tape` utility provides a means to access a tape controller from a terminal. The `tape` utility can rewind, erase, skip forwards and backwards, and write tapemarks to a tape.

If the tape device `<dev>` is not specified on the command line and the `-z` option is not used, `tape` uses the default device `/mt0`.

The order of option execution is as follows:

1. Get device name(s) from the `-z` option.
2. Skip the number of tapemarks specified by the `-f` option.
3. Skip the number of blocks specified by the `-b` option.
4. Write a specified number of tapemarks.
5. Erase a specified number of blocks of tape.
6. Rewind the tape.
7. Put the tape off-line.

Examples

`$ tape /mt0 -r`
: Rewind tape on device `/mt0`.

`$ tape -f=5 -e=2 -r`
: Skip forward five files on device /mt0, erase the next two blocks, and then rewind the tape.

tapegen
Creates a bootable tape

Syntax OS-9 for 68K
```
tapegen [<opts>] <filename> <filename>
```

Syntax OS-9
```
tapegen [<opts>] <devnam> [<filename>] [<opts>]
```

OS
OS-9; OS-9 for 68K

Options
`-b=<bootfile>`
: Installs an OS-9 for 68K boot file. (OS-9 for 68K)

`-b[=]<num>`
: Use buffer of `<num>` kilobytes. (OS-9)

`-bz`
: Reads boot module names from standard input. (OS-9 for 68K)

`-bz=<bootlist>`
: Reads boot module names from the specified bootlist file. (OS-9 for 68K)

`-c`
: Checks and displays header information. (OS-9 for 68K)

`-d[=]<dev>`
: Specifies the tape device name. The default is `/mt0`. (OS-9 for 68K)

`-i[=]<file>`
: Installs an initialized data file on the tape. This is usually a RAM disk image. (OS-9 for 68K)

`-o`
Takes the tape drive off-line when finished. (OS-9 for 68K)

`-s`
Swaps bytes in tape header. (OS-9)

`-t[=]<target>`
Specifies the name of the target system. (OS-9 for 68K)

`-v[=]<volume>`
Specifies the name of the tape volume. (OS-9 for 68K)

`-x`
Searches execution directory for files. (OS-9)

`-z`
Reads list of files from standard input.

`-z=<file>`
Reads file names from the specified file.

Description

The `tapegen` utility creates the "bootable" tape.

The `tapegen` utility performs a function similar to the `os9gen` utility. Both utilities place the bootstrap file on the media and mark the media identification block with information regarding the bootstrap file. In addition, the `tapegen` utility can add an initialized data on the tape, for application-specific purposes.

Type `tapegen` followed by any desired options.

OS-9 for 68K Examples

The following example makes a bootable tape. The disk image is derived from the `/dd` device.

```
$ tapegen -b=OS9Boot.tape -i=/dd@ "-v=OS-9/68K Boot Tape" -
t=MySystem
```

This example makes a bootable tape with no initialized data file. The "header" information is displayed after writing the tape.

```
$ tapegen -b=OS9Boot.h0 -c
```

OS-9 Example

```
$ chd /h0/MWOS/OS9000/603/PORTS/MVME1603/CMDS/BOOTOBJS/BOOTFILE

$ tapegen /mt0 h0_scsi -b400

$ chd /h0/MWOS/OS9000/603/PORTS/MVME1603

$ tapegen /mt0 -b400 -z=BOOTLIST/h0_scsi.bl
```

tapestart
Initialize RBF Device from Tape

Syntax
```
tapestart [<opts>] [<device name>] [<opts>]
```

OS
OS-9 for 68K

Options
`<device name>`
RBF device to initialize (defaults to whatever is specified in the `init` module).

`-d=<tdevname>S`
pecifies the tape device (default is '`/mt0`').

`-o`
Forces the tape drive "offline" when finished.

On some drives the `-o` option ejects the tape.

Description
This utility is used to initialize the ram disk when booting off tape.

tar
Tape Archive

Syntax
```
tar <options> <file or directory names>
```

OS
OS-9; OS-9 for 68K

Options
`-b N`
Specifies blocking factor N (block size = Nx512 bytes).

`-B`
Re-blocks as we read.

`-c`
Creates an archive.

`-D`
Dumps record number within archive with each message.

`-e`
Swaps bytes within 16-bit hunks.

`-f F`
Reads/writes archive from file or device F.

`-i`
Ignores blocks of zeros in the archive, which normally mean EOF.

`-k`
Keeps existing files, does not overwrite them from the archive.

`-m`
Does not extract file modified time.

`-o`
Writes an old V7 format archive, rather than P1003 format.

`-p`
: Extracts protection information.

`-s`
: Sorts list of names to extract to match the archive.

`-t`
: Lists a table of contents of an archive.

`-T F`
: Gets names to extract or create from file F.

`-v`
: Lists (verbosely) what files we process.

`-x`
: Extracts files from an archive.

Description

The `tar` utility archives multiple files or directories onto a magnetic tape or file, lists a table of contents of an archive, or restores (extracts) multiple files or directories from a tape to another media maintaining integrity of attributes as archived.

The `tar` utility's action is controlled by the first option indicating exactly one function from the set -c, -t, or -x. Other arguments to the `tar` utility are file or directory names that specify which files to archive, list, or extract. In all cases, the appearance of a directory name refers recursively to the files and subdirectories of that directory.

Example

```
$ tar cvf tarfile *.output
dos.output
dosexxp.output
expr.output
$ tar tvf tarfile
-rw------- 110/30 21056 Jun 27 14:29 1994 dos.output
-rw------- 110/30     9 Jul 11 11:48 1994 dosexp.output
-rw------- 110/30     9 Jul 11 12:46 1994 expr.output
$ tar xvf tarfile
-rw------- 110/30 21056 Jun 27 14:49 1994 dos.output
-rw------- 110/30     9 Jul 11 11:48 1994 dosexp.output
-rw------- 110/30     9 Jul 11 12:46 1994 expr.output
```

tee
Copies Standard Input to Multiple Output Paths

Syntax
```
tee {<path>}
```

OS
OS-9; OS-9 for 68K

Description
The `tee` utility is a filter that copies all text lines from its standard input to its standard output and any other additional pathlists given as parameters.

Type `tee` and the pathlist(s) to which standard input is to be redirected. This utility is generally used with input redirected through a pipe.

Examples
The example below uses a pipeline and the `tee` utility to simultaneously send the output listing of `dir` to the terminal, printer, and a disk file:

```
$ dir -e ! tee /printer /d0/dir.listing
```

This example sends the output of an assembler listing to a disk file and the printer:

```
$ asm pgm.src l ! tee pgm.list >/printer
```

This example broadcasts a message to three terminals:

```
$ echo WARNING System down in 10 minutes ! tee /t1 /t2
/t3
```

tmode
Changes Terminal Operating Mode

Syntax
```
tmode [<opts>] [<arglist>]
```

OS
OS-9; OS-9 for 68K

Options
`-a`
Prints input mapping table values in ASCII format. (OS-9)

`-c`
Prints input mapping table values as control characters. (OS-9)

`-h`
Prints input mapping table values in hexadecimal format. (OS-9)

`-v`
Displays all mapped control characters including those passed through. (OS-9)

`-w=<path#>`
Changes the path number `<path#>` affected.

Description

The tmode utility displays or changes the operating parameters for a path. It accomplishes this by getting and optionally setting a path's options.

The changes made by the tmode utility only last as long as the path that it modifies lasts. That is, if the modified path is closed the modifications are lost. This differs from the xmode utility in that it modifies the default options used to create paths so any changes made with it are permanent, but largely do not effect any open paths. See your technical reference manual for more information on paths and the xmode utility documentation for more information on permanently changing path and device options.

You can only use tmode on paths to SCF, GFM, or UCM devices.

To change the operating parameters of the path to your terminal, type tmode and any parameters you want changed. If parameters are not given, the tmode utility displays the present value for the each path option. Otherwise, the tmode utility processes the parameter(s) given on the command line.

Parameters are given in a variety of ways. If the parameter to be changed is either enabled or disabled (such as pause or echo) then the option is enabled by just specifying the name of the option.

`tmode pause`	Enables the pause option.
`tmode echo`	Enables the echo option.

To disable these types of options, the option name is specified prefixed with the word "no".

tmode nopause noecho Disables the pause and echo options.

If the parameter has a name and a value then these are specified together, separated by an equal sign. Generally, the value 0 disables an option. For example, to disable xon and xoff processing for a path use the command line.

`tmode xon=0 xoff=0`	Disables XON and XOFF processing options

For OS-9 for 68K, the value is the hex number for the option (0x is implied). For OS-9, the value is either the hex value (preceded by 0x), the "control character" (caret [^] followed by the character), or the ASCII mnemonic for the character.

To return one of these type values to its default, use the name of the option without the equal sign and value.

`tmode xon xoff`	Re-enables `XON` and `XOFF` options with default values

For OS-9, setting the character mapping table is accomplished by either specifying the character to be mapped and the behavior or the behavior followed by the character to be mapped. The character can be expressed by either the hex value (preceded by `0x`), the "control character" (caret [`^`] followed by the character), or the ASCII mnemonic for the character. For example, to add `^Y` with IGNORE mapping you could use any of these command line arguments:

```
^Y=IGNORE
IGNORE=^Y
0x19=IGNORE
IGNORE=0x19
EM=IGNORE
IGNORE=EM
```

Use the `-w=<path#>` option to specify which path number to affect. If none is given, standard input is affected.

If you use the `tmode` utility in a shell procedure file, you must use `-w=<path#>` to specify one of the standard paths other than standard input (1 or 2) to change the terminal's operating characteristics.

The change remains in affect until the path is closed. For a permanent change to a device characteristic, you must change the device's initial operating parameters using `xmode`. See the `xmode` utility for more information.

OS-9 for 68K Users:Two of the options that are displayed by `tmode` effect all paths open to the device: type and baud. baud is the baud rate for the device and type contains bit-fields for the word size, stop bits, and parity. Baud is set by setting the baud option. The bit-fields for the word size, stop bits, and parity portions of the type option are set by using the `cs`, `stop`, and `par` options.

Table 1-30. `tmode` **Parameter Names**

OS-9 for 68K Name	OS-9 Name	Specification
`abort=h`	(See xmode.)	Aborts character (normally `<control>C`, default = 03). For OS-9 for 68K, numeric value of character in hexadecimal. For OS-9, numeric value of character in hexadecimal if prefixed with `0x`, "control character" when prefixed with caret (^), or ASCII mnemonic.

`baud=n`	(See xmode.)	Baud rate: The baud rate may currently be set to the following values:
		
		`n = 50 300 2400 19200 57600`
		`75 600 3600 38400 115200`
		`110 1200 4800 56000 midi`
		`124.5 1800 7200 64000 extern`
		`150 2000 9600 31250`

`bell=h`	`bell=h`	Sets bell (alert) output character (default = 07). For OS-9 for 68K, numeric value of character in hexadecimal. For OS-9, numeric value of character in hexadecimal if prefixed with `0x`, "control character" when prefixed with caret (^), or ASCII mnemonic.
`bsb`	`bsb`	Erases on backspace. Backspace characters are echoed as a backspace-space-backspace sequence. Default.

Table 1-30. `tmode` **Parameter Names (Continued)**

OS-9 for 68K Name	OS-9 Name	Specification
`bse=h`		Sets output backspace character (default = 08). For OS-9 for 68K, numeric value of character in hexadecimal.
`bsl`	`del`	Backspaces over line. Lines are deleted by sending backspace-space-backspace sequences to erase the line. Default.
`bsp=h`	`bsp=h`	OS-9 for 68K: Sets the backspace input and output character (normally, control-H, default = 08). OS-9: Sets the backspace output character. For OS-9 for 68K, numeric value of character in hexadecimal. For OS-9, numeric value of character in hexadecimal if prefixed with `0x`, "control character" when prefixed with caret (`^`), or ASCII mnemonic.
`cs=n`	(See `xmode`.	Sets character length using one of the following values: `n = 8, 7, 6 or 5 (bits)` Changing character length changes the type value.
`del=h`	(See Table 1-30.)	Sets input delete line character (normally `<control>X`, default = 18). For OS-9 for 68K, numeric value of character in hexadecimal.
`dup=h`	(See Table 1-30.)	Sets the duplicate last input line character (normally `<control>A`, default = 01). For OS-9 for 68K, numeric value of character in hexadecimal.

Table 1-30. `tmode` **Parameter Names (Continued)**

OS-9 for 68K Name	OS-9 Name	Specification
`echo`	`echo`	Inputs characters echoed back to terminal. Default.
`eof=h`	`eof=h`	For OS-9 for 68K, sets end-of-file input character (normally `<esc>`, default = 1B) that causes an `EOS_EOF` to be returned when entered as the first character of a read or readln system call. Numeric value of character in hexadecimal. For OS-9, it sets the character that will appear in the input buffer when a character mapped to endofile is entered as the non-first character of a read or readln system call. Numeric value of character in hexadecimal if prefixed with `0x`, "control character" when prefixed with caret (`^`), or ASCII mnemonic.
`eor=h`	`eor=h`	Sets end-of-record input character (normally `<cr>`, default = 0D). For OS-9 for 68K, numeric value of character in hexadecimal. For OS-9, numeric value of character in hexadecimal if prefixed with `0x`, "control character" when prefixed with caret (`^`), or ASCII mnemonic.
`lf`	`lf`	Auto line feed on. Line feeds are automatically echoed to terminal on input and output carriage returns. Default.
`nobsb`	`nobsb`	No erase on backspace. Echoes single backspace only.
`nobsl`	`nodel`	No backspace over line. Lines are deleted by printing a new line sequence for hard-copy terminals.
`noecho`	`noecho`	No echo.
`nolf`	`nolf`	Auto line feed off.
`nopause`	`nopause`	Screen pause mode off.

Table 1-30. `tmode` Parameter Names (Continued)

OS-9 for 68K Name	OS-9 Name	Specification
`normal`	`normal`	Sets the terminal back to its default characteristics. This does not affect the following values: type, baud rate, parity, character length, and stop bits.
`null=n`	`nulls=n`	Sets null count. Number of null (`$00`) characters transmitted after carriage returns for return delay. The number is decimal. The default null count is 0.
`noupc`	`noupc`	Upper and lower case characters permitted. Default.
`pag=n`	(See `xmode`.)	Sets video display page length to `n` lines, where `n` is in decimal. Used for `pause` mode, see previous.
`par=s`	(See `xmode`.)	Shows parity using one of the following strings: odd, even, or none. Changing parity affects the `type` value.
`pause`	`pause`	Screen pause on. Output suspended upon full screen. See `pag` parameter for definition of screen size. Output can be resumed by typing any key.
`psc=h`	(See `xmode`.)	Sets pause character (normally `<control>W`, default = 17). For OS-9 for 68K, numeric value of character in hexadecimal.
`quit=h`	(See `xmode`.)	Quits character (normally `<control>E`, default = 05). For OS-9 for 68K, numeric value of character in hexadecimal.
`reprint=h`	(See Table 1-30.)	Sets reprint line character (normally `<control>D`, default = 04). For OS-9 for 68K, numeric value of character in hexadecimal.

Table 1-30. `tmode` Parameter Names (Continued)

OS-9 for 68K Name	OS-9 Name	Specification
`stop=n`	(See `xmode`.)	Sets the number of stop bits used: `n = 1, 1.5 or 2` Changing the stop bit value affects the type value.
`tabc=h`	`tab=h`	Tabs character (normally `<control>I`, default = 09). For OS-9 for 68K, numeric value of character in hexadecimal. For OS-9, numeric value of character in hexadecimal if prefixed with `0x`, "control character" when prefixed with caret (`^`), or ASCII mnemonic.
`tabs=n`	`tabsiz=n`	Number of characters between tab stops. The number is in decimal. The default is 4 characters between tab stops.
	`time=h`	Sets the timeout value in 256th's of a second for unblocked `I_READ` and `I_READLN` operations. If the number of characters requested is not satisfied within the duration of ticks specified, the I/O operation returns with the number of characters available. If `time=1` the I/O operation does not wait. Instead, the number of characters available are returned.
`type=h`	(See `xmode`.)	ACIA initialization value: shows parity, character size, and number of stop bits. Value in hexadecimal. This value is affected by changing the individual `par`(ity), `cs` (character length), and `stop` (stop bits) values.
`upc`	`upc`	Upper case only. Lower case characters are converted automatically to upper case.

Table 1-30. `tmode` Parameter Names (Continued)

OS-9 for 68K Name	OS-9 Name	Specification
`xon=h`	(See `xmode`.)	Resumes output input character (normally `<control>Q`, default = 11). For OS-9 for 68K, numeric value of character in hexadecimal. For OS-9, numeric value of character in hexadecimal if prefixed with `0x`, "control character" when prefixed with caret (`^`), or ASCII mnemonic.
`xoff=h`	(See `xmode`.)	Suspends output input character (normally `<control>S`, default = 13). For OS-9 for 68K, numeric value of character in hexadecimal. For OS-9, numeric value of character in hexadecimal if prefixed with `0x`, "control character" when prefixed with caret (`^`), or ASCII mnemonic.

For OS-9, numeric value of character in hexadecimal if prefixed with `0x`, "control character" when prefixed with caret (`^`), or ASCII mnemonic.

Table 1-31. `tmode` Parameter Names (OS-9)

Name	Description
`delchrl=h`	Sets input backspace character (delete character-left). (Normal `^H`).
`delchru=h`	Sets the "delete character under the cursor" character. (Normal `^D`).
`deline=h`	Sets input delete line character (normally `<control>X`).
`delwrdl=h`	Sets the delete word left character. (Normal `^L`). Numeric value of character is hexadecimal by default.

Table 1-31. `tmode` Parameter Names (OS-9) (Continued)

Name	Description
`delwrdr=h`	Sets the delete word right character. (Normal `^R`). Numeric value of character is hexadecimal by default.
`endofile=h`	Sets the end-of-file character. (Normal `<esc>`). Numeric value of character is hexadecimal by default.
`endorec=h`	Sets the end-of-record character. (Normal `<cr>`). Numeric value of character is hexadecimal by default.
`insrtmode=h`	Sets the enter insert mode character. (Normal `^I`). Numeric value of character is hexadecimal by default.
`movebeg=h`	Sets the move cursor to the beginning of the line character. (Normal `^Z`). Numeric value of character is hexadecimal by default.
`moveend=h`	Sets move to the end-of-line character (normally `^A`).
`moveleft=h`	Sets the move cursor left character. (Normal `^B`). Numeric value of character is hexadecimal by default.
`moveright=h`	Sets the move cursor right character. (Normal `^F`). Numeric value of character is hexadecimal by default.
`reprint=h`	Sets reprint line character (Normal `^P`).
`truncate=h`	Sets the truncate to end-of-line character. (Normal `^K`). Numeric value of character is hexadecimal by default.

OS-9 for 68K Example:

`tmode noupc nopause`	Disable upper-case lock and page pause
`tmode reprint=10`	Change reprint character to `<control>P`
`tmode xon=0 xoff=0`	Disable `XON` and `XOFF` processing

OS-9 Example:

`tmode noupc nopause`	Disable upper-case lock and page pause
`tmode REPRINT=0x04`	Change reprint character to `<control>D`
`tmode pause page=65`	Enable page pause and set page size to 65

touch, os9touch
Update Last Modification Date of File

Syntax

`touch {<option(s)>) {<path>}` OS-9 for 68K or OS-9
`os9touch {<option(s)>) {<path>}` DOS or UNIX

touch OS

OS-9; OS-9 for 68K

os9touch OS

WIN

Options

`-c`
Does not create a file if not found.

`-q`
Does not quit if an error occurs.

`-x`
Searches the execution directory for the file.

`-z`
Reads the file names from standard input.

`-z=<path>`
Reads the file names from `<path>`.

Description

The `touch` utility updates the last modification date of a file. Usually, this command is used with a `os9make` command's `makefile`.

Associated with every file is the date the file was last modified. The `touch` utility opens a file and updates the modification date to the current date and closes it.

Type `touch` and the pathlist of the file to update. The `touch` utility searches the current data directory for the file to update if another directory or the `-x` option is not specified.

If the specified file is not found, `touch` creates a file with a current modification date.

Examples

```
$ touch -c /h0/sys/motd
```

Do not create file if it does not exist.

```
$ dir -u ! touch -z
```

Update all files in current directory.

tr
Transliterate Characters

Syntax

```
tr [<opts>] <str1> [<str2>] [<path1>] [<path2>]
```

OS

OS-9; OS-9 for 68K

Options

`-c`
: Transliterates all ASCII characters (1 through $7F) to `<str2>`, except for the set of characters in `<str1>`.

`-d`
: Deletes all matching input characters and expressions.

`-s`
: Squeezes all repeated output characters or expressions in `<str2>` to single characters or expressions.

`-v`
: Same as `-c`.

`-z`
: Reads standard input for list of file names.

`-z=<path>`
: Reads the file names from `<path>`.

Description

The tr utility transliterates characters from <str1> into a corresponding character from <str2>.

If <str1> contains more characters than <str2>, the final character in <str2> is used for each excess character in <str1>.

Type tr and the characters to search for (<str1>), and optionally, the replacement characters (<str2>), the input file's pathlist (<path2>) and the output file's pathlist (<path2>).

<str1> is required.

If <str2> is missing, all characters in <str1> are deleted from the output.

If <path1> and <path2> are missing, standard input and output are assumed.

If only one path is specified, it is used as the input file pathlist.

You can generally give options anywhere on the command line. If you wish to use the pathlists but not <str2>, you must specify the -d option prior to the pathlists.

Similarly, if you use the -z option to read pathlists from standard input, the -z must precede <path2>.

The -s option does not differentiate between characters originally in <str2> and transliterated characters. It always returns a string with no consecutively repeated characters. For example, the command tr -s abcde x transliterates the string exasperate into xspxrxtx.

The -s and -d options are mutually exclusive.

If you use the -c option to change all but a certain sequence of characters, it also changes carriage returns and newlines unless they are specified in the sequence of characters.

tr always deletes ASCII nul ($00).

<str1> and <str2> are interpreted as character classes. To facilitate creating character classes, use the following meta-characters:

Table 1-32. Meta-characters

Char	Specification
-	RANGE The hyphen (-) is defined as representing all characters lexicographically greater than the preceding character and less than the following character. For Example `[a-z]` is equivalent to the string `abcdefghijklmnopqrstuvwxyz`. `[m-pa-f]` is equivalent to the string `mnopabcdef`. `[0-7]` is equivalent to the string `01234567`. Refer to Appendix A, ASCII Conversion Chart for character values.
\	ESCAPE The backslash (\) removes special significance from special characters. It is followed by a base and a numeric value or a special character. If the base is not specified, the base for the numeric value defaults to hexadecimal. An explicit base of decimal or hexadecimal can be specified by preceding the numeric value with a qualifier of `d` or `x`, respectively. It also allows entry of some non-printing characters such as: `\t`=Tab character `\n`=Newline character `\l`=Line feed character `\b`=Backspace character `\f`=Form feed character

Examples

The following examples use standard input for the input to the `tr` utility. The output is sent to standard output. Thus, the first line following each command line is the standard input, and the second line is the standard output.

```
$ tr abcd jklm
aabdc_efg
jjkml_efg
```

Transliterates standard input, converting each `a`, `b`, `c`, and `d` to `j`.

```
$ tr abcd j
abcd_efgh
jjjj_efgh
```

Transliterates standard input, converting each `a`, `b`, `c`, and `d` to `j`.

```
$ tr a-d k
abc_abcd-efgh
kkk_kkkk-efgh
```

Transliterates standard input, converting each character contained in the expression `abcd` to `k`.

```
$ tr abcd
abcd_efgh
_efgh
```

Transliterates standard input, deleting each `a`, `b`, `c`, and `d`.

```
$ tr -d abcd
abcdefg
efg
```

Transliterates standard input, deleting each `a`, `b`, `c`, and `d`.

```
$ tr -s dcba eocd
edenbcada
encoded
```

Transliterates standard input converting d to `e`, `c` to `o`, `b` to `c`, and `a` to `d`. Consecutively repeated output characters, the matching `eocd`, are squeezed into a single character.

```
$ tr -c a-zA-Z \n
one word per line
one
word
per
line
```

Transliterates standard input, converting all non-alphabetic characters to newline characters.

tsmon

Supervises Idle Terminals and Initiate Login Command

Syntax

```
tsmon [<opts>] {/<dev>}
```

OS

OS-9; OS-9 for 68K

Options

`-d`

Displays statistics when a `^\` character (control-backslash or hex $1C) is typed on a monitored terminal.

`-l=<prog>`

Forks `<prog>`, an alternate login program.

`-p`

Displays an "online" prompt to each timesharing terminal being monitored by the `tsmon` utility.

`-r=<prog>`

Forks an alternate shell program for remote commands.

`-z`

Reads the device names from standard input.

`-z=<path>`

Reads the device names from `<path>`.

Description

The tsmon utility supervises idle terminals and starts the login utility in a timesharing application.

Typically, the tsmon utility is executed as part of the start-up procedure when the system is first brought up and remains active until the system shuts down.

/<dev> specifies a terminal to monitor. This is generally an SCF device.

You can specify up to 28 device name pathlists for the tsmon utility to monitor.

When you type a carriage return on any of the specified paths, the tsmon utility automatically forks login, with standard I/O paths opened to the device. If login fails because you could not supply a valid user name or password, control returns to the tsmon utility.

Most programs terminate when an end-of-file character (normally <escape>) is entered as the first character on a command line. This logs you off the system and returns control to the tsmon utility. The tsmon utility prints a message when you log off:

```
Logout after 11 minutes, 30 seconds.  Total time 3:57:46.
```

The Total time figure is the total amount of time that the terminal has accumulated on-line since the tsmon utility was started.

The tsmon utility is normally used to monitor I/O devices capable of bi-directional communication, such as CRT terminals. However, you may use the tsmon utility to monitor a named pipe. If this is done, the tsmon utility creates the named pipe, and then waits for data to be written to it by some other process.

When data arrives, the tsmon utility starts a shell with its input redirected to the pipe file. This is useful for starting remote processes in a networked environment.

You can run several tsmon utility processes concurrently, each one watching a different group of devices. This must be done when more than 28 terminals are monitored, but is sometimes useful for other reasons, such as if you want to keep modems or terminals suspected of hardware trouble isolated from other devices in the system.

The tsmon utility forks login with the PORT environment variable set to the SCF device name and all other environment variables cleared.

Examples

This command starts timesharing on `term` and `t1`, printing a welcome message to each. A similar command might be used as the last line of a system `startup` file.

```
tsmon -dp /term /t1&

2 devices online      (confirmation by tsmon)
```

The `-d` option causes the `tsmon` utility to print various statistics about the devices being monitored whenever control-backslash (`^\`) is typed on either terminal. The statistics might look something like this:

```
tsmon started 12-11-90 20:38:15 with 2 devices
0:36:06
 /term     quiet at  0:08:07   cumulative time  3:29:30
logins: 1/9
*/t1       quiet at  0:36:03   cumulative time  3:57:46
logins: 2/4
```

The standard input device shown for the `tsmon` utility by the `procs` utility always indicates the last device to gain the `tsmon` utility's attention.

You must implement the `SS_SSig I$SetStat` (OS-9 for 68K), `I_SETSTAT` (OS-9) function (send signal on data ready) on any device to be monitored by the `tsmon` utility. Because this function is used (for example, instead of `I$ReadLn or I_READLN`), it is possible to output data to a terminal that is not logged in without having to wait for someone to press a key.

umacs
Advanced Screen Editor

Syntax
```
umacs [<opts>] {<files>}
```

OS
OS-9; OS-9 for 68K

Description
µMACS is a screen-oriented text editor you can use to create and modify text files. µMACS can maintain multiple buffers so you can work with several files and/or portions of the same file at once.

See Also
For more information about the µMACS Utility, refer to Chapter 7.

unassign
Discards Single Word Command Line Substitutions

Syntax
```
unassign <name> {<name>}
```

OS
OS-9

Description
Discards relationships assigned with the assign command.

This command does not appear in the `CMDS` directory as it is a built-in shell command.

Example
```
$ assign
cd    chd
h     hist
l     list
ls    dir
printenv prenv

$ unassign cd
$ assign
h     hist
l     list
ls    dir
printenv prenv
```

undel

Retrieves Deleted OS-9 for 68K RBF Files

Syntax

```
undel [<opts>] <path> [<dstpath>]
```

OS

OS-9 for 68K

Options

`-o[=]<dev>`	Specify alternate device.

Description

The OS-9 for 68K `undel` utility provides a way to possibly recover an undeleted file. The `undel` utility allows you to copy the data of the deleted file to a new file on another device.

The OS-9 for 68K `undel` utility is only capable of restoring one file at a time.

If the `-o` option is not selected, the OS-9 for 68K `undel` selects the destination device as follows:

Source	Attempted Destinations
/h0	`/r0`, `/d0`
/d0	`/r0`, `/h0`
/r0	`/h0`, `/d0`
<other>	`/r0`, `/d0`

The file can be recovered if none of the disk storage formerly being used by the deleted file is allocated to some other file on the disk.

OS-9 for 68K RBF marks files as deleted by placing a null in the first byte of the filename in the directory entry. For that reason, the OS-9 for 68K `undel` cannot tell the difference between the names of files that were deleted that only differ by the first character. For instance, the file `boo`, `foo`, and `zoo` would all look the same. `undel` select the first name that matches all but the first character of the indicated filename. The OS-9 `undel` does not have this problem.

Examples

The following command line attempts to recover the file `procs`, from the current directory, by copying it to `/r0/procs`.

```
$ undel procs
```

The following command line attempts to recover the file `procs`, from the current directory, by copying it to `/h1/procs`.

```
$ undel procs -o=/h1
```

The following example demonstrates that you don't always get what you want (see Note).

```
$ build foo
? foo
?
$ build boo
? boo
?
$ del foo boo
$ undel boo
$ list /r0/boo
foo
```

undel

Retrieves Deleted OS-9 RBF Files

Syntax

```
undel [<opts>] <srcpath> [<dstpath>]
```

OS

OS-9

Options

`-b[=]<num>`

Allocates `<num>` k bytes of memory to be used as a buffer for `undel`. `undel` uses 4K by default.

`-r`

Overwrites the existing file(s).

`-w[=]<dir>`

Restores one or more files to `<dir>`. This option prints a message as to which file is being restored.

`-x`

Uses the current execution directory for `<srcpath>`.

`-z`

Reads file names from standard input.

`-z=<file>`

Reads file names from `<file>`.

Description

When OS-9 RBF deletes a file, the file can be recovered if none of the disk storage formerly being used by the deleted file is allocated to some other file on the disk.

The OS-9 `undel` utility provides a way to possibly recover an undeleted file. The `undel` utility allows you to copy the data of the deleted file to a new file on another device.

The under utility copies the data of the deleted file <srcport> to <dstpath>. <dstpath> must not be on the same device as <srcpath>.

If <dstpath> already exists, the contents of <srcpath> overwrite the existing file if the -r option is used.

The undel utility is capable of restoring multiple files to the same destination directory. If more than two command line parameters are specified, the last parameter is assumed to be the destination directory unless the -w option was also specified.

If the -w option was specified, all path names given on the command line are treated as source path names.

The wildcard characters asterisk (*) and question mark (?) can be used with the undel utility; however, they must be placed in quotes to prevent the shell from attempting to expand them.

Examples

The following command line attempts to recover the file /h0/CMDS/procs by copying it to /r0/procs.

```
undel /h0/cmds/procs /r0/procs
```

The following command line attempts to recover all files ending in .c by copying them to the directory /r0/MYSOURCE. A message displays telling you which files are being undeleted.

```
undel "*.c" -w=/r0/MYSOURCE
```

The following command line attempts to recover the main.c and funcs.c files by copying them to the directory /r0/MYSOURCE:

```
undel main.c funcs.c /r0/MYSOURCE
```

The following command line attempts to recover main.c by overwriting the existing file in the directory /r0/MYSOURCE:

```
undel main.c /r0/MYSOURCE/main.c -r
```

unlink
Unlinks Memory Module

Syntax
```
unlink [<opts>] {<modnames>}
```

OS
OS-9; OS-9 for 68K

Options
`-f`

Forces a module (if not in use) to be purged from the module directory.

The -f option does not work on modules present in the boot. This prevents accidental unlinking of core components (such as the kernel).

The -f option does not work on sticky modules. For more information, refer to the *Using OS-9* manual.

`-z`

Reads the module names from standard input.

`-z=<file>`

Reads the module names from `<file>`.

Description
The `unlink` utility tells the operating system that you no longer need the memory module(s) named. Type `unlink` and the name(s) of the module(s) to unlink. The link count decrements by one. If the link count becomes zero, the module directory entry is deleted and the memory is de-allocated.

The `-f` option can be slow on OS-9 for 68K because of retries. Unlike OS-9, the OS-9 for 68K `_os_unload()` does not return an error code in some cases when it fails to unlink the module. It is a good practice to `unlink` modules whenever possible to make most efficient use of available memory resources.

See Also

link
load.

Examples

```
$ unlink pgm pm5 pgm9
```

Unlinks pgm, pgm5, and pgm9 and lowers the link count of each module by one.

```
$ dir -u ! unlink -z
```

Pipes an unsorted listing of the current data directory to unlink. This unlinks all modules contained in the directory, lowering the link count of each module by one.

```
$ mdir -u ! unlink -f -z
```

Pipes the current module directory listing to the unlink which then flushes all modules (which are currently not in use) from the system. Under OS-9 for 68K this may take awhile because of the number of retries.

```
$ unlink -z=namefile
```

Unlinks each module listed in namefile and lowers the link count of each module by one.

```
$ mdir
   Module Directory at 14:44:35
kernel      init        p32clk      rbf         p32hd
h0          d0          r0          edit        mdir
$ unlink edit
$ mdir
   Module Directory at 14:44:35
kernel      init        p32clk      rbf         p32hd
h0          d0          r0          mdir
```

unsetenv
Clears Environment Parameter

Syntax
```
unsetenv <name>
```

OS
OS-9; OS-9 for 68K

Description
The `unsetenv` utility deletes the specified environment variable from the environment list.

Type `unsetenv`, followed by the environment parameter to delete. This removes the variable from the environment list.

If the specified variable has not been previously defined, the `unsetenv` utility has no effect and it gives you no message.

These commands do not appear in the `CMDS` directory as they are built-in to the shell.

Examples
```
$ unsetenv _sh
$ unsetenv TERM
```

See Also
`setenv`
`printenv`

w, wait

Waits for One/All Child Process(es) to Terminate

Syntax

```
w
wait
```

OS

OS-9; OS-9 for 68K

Description

The `w` utility causes the shell to wait for the termination of one child process before returning with a prompt.

The `wait` causes the shell to wait for all child processes to terminate before returning with a prompt.

Type `w` or `wait` and a carriage return. When the shell prompt is displayed, the child process(es) have terminated.

This command does not appear in the `CMDS` directory as it is a built-in shell command.

Examples

```
$ list file1 >/p1&
$ list file2.temp ! filter >file2&
$ wait
$ list file2 >/p1
```

In this example, the prompt returns when the first of these three processes (one, two, or three) terminates:

```
$ one&
$ two&
$ three&
$ w
$
```

what
Display Version Strings

Syntax
```
what [<opts>] <file names> [<opts>]
```

OS
OS-9; OS-9 for 68K; DOS

Options
`-s`
: Stop searching after the first occurrence of the pattern.

Description
The `what` utility searches each filename for occurrences of the pattern `@(#)` and prints what follows up to a ", >, or null character.

This utility is useful for finding embedded version stings that exist in some modules.

Examples
```
$ what OS9/68000/CMDS/maui
```

xmode

Examines or Changes Device Initialization Mode

Syntax

```
xmode [<opts>] <devname> [<arglist>] {<devname>}
```

OS

OS-9; OS-9 for 68K

Options

`-a`
Prints input mapping table values in ASCII format. (OS-9)

`-c`
Prints input mapping table values as control characters. (OS-9)

`-h`
Prints input mapping table values in hexadecimal format. (OS-9)

`-v`
Displays all mapped control characters including those passed through. (OS-9)

`-z`
Reads device names from standard input.

`-z=<file>`
Reads device names from `<file>`.

Description

The `xmode` utility displays or changes the default operating parameters for a device. It accomplishes this by getting and optionally setting a device's default options.

For OS-9, the changes made by the `xmode` utility last as long as the device that it modifies is initialized (see `iniz`, `devs`). That is, if the modified device is de-initialized the modifications are lost.

For OS-9 for 68K, the changes made by the xmode utility last as long as the device descriptor for the device remains in memory (generally until the machine is rebooted). This differs from the tmode utility in that it modifies only an open path's options.

See your technical reference manual for more information on paths and the tmode utility documentation for more information on temporarily changing path and device options.

You can only use xmode for SCF, GFM and UCM devices.

OS-9 for 68K Users: On SSM systems, the module header permissions of the module must allow the appropriate write permission; otherwise an access error occurs. The typical default for modules is write-protected, this means you need to use fixmod on the module before it is loaded into memory.

Generally, changes made with using the xmode utility should be made prior to iniz-ing the device as changes made after the device is initialized will only affect paths opened after the changes have been made. For Example Assuming that device t1 is not initialized, the following command sequence opens all paths to t1 without the pause option.

`xmode /t1 nopause`sets the `nopause` option
`iniz /t1`initializes `t1`

The exceptions are the five parameters type, par, cs, stop, and baud. Any change to these options affects all currently open paths as well as any paths opened to the device in the future.

To change the operating parameters of a terminal device, type xmode, the name of the device, and any parameters you want changed. If parameters are not given, the xmode utility displays the present value for the each device option. Otherwise, the xmode utility processes the parameter(s) given on the command line.

For OS-9, the device name is optional, the xmode utility assumes the device that is open on standard input is to be displayed/modified.

Parameters are given in a variety of ways. If the parameters to be changed is either enabled or disabled (such as pause or echo) then the option is enabled by just specifying the name of the option.

```
xmode /term pause
```
Enables the pause option.

```
xmode /term echo
```
Enables the echo option.

To disable these types of options the option name is specified prefixed with the word "no".

```
xmode /term nopause noecho
```
Disables the pause and echo options.

If the parameter has a name and a value then these are specified together, separated by an equal sign. Generally, the value 0 disables an option. For example, to disable `xon` and `xoff` processing for a path use the command line.

```
xmode /term xon=0 xoff=0
```
Disables `XON` and `XOFF` processing options.

For OS-9 for 68K, the value is the hex number for the option (`0x` is implied).

For OS-9, the value is either the hex value (preceded by `0x`), the "control character" (caret [^] followed by the character), or the ASCII mnemonic for the character.

On OS-9 for 68K, to return one of these type values to its default, use the name of the option without the equal sign and value.

```
xmode /term xon xoff
```
Enables `XON` and `XOFF` options with default values.

For OS-9, setting the character mapping table is accomplished by either specifying the character to be mapped and the behavior or the behavior followed by the character to be mapped. The character can be expressed by either the hex value (preceded by 0x), the "control character" (caret [^] followed by the character), or the ASCII mnemonic for the character. For example, to add ^Y with IGNORE mapping you could use any of these command line arguments:

```
^Y=IGNORE
IGNORE=^Y
0x19=IGNORE
IGNORE=0x19
EM=IGNORE
IGNORE=EM
```

For OS-9, xmode sets two different I/O system items: the default path options and the logical unit options. Changes to the path options will only take effect when new paths are opened. Changes to the logical unit options take effect immediately to all paths already open to the device as well as paths that are opened in the future.

For OS-9, numeric value of character in hexadecimal if prefixed with 0x, "control character" when prefixed with caret (^), or ASCII mnemonic.

Table 1-33. xmode Parameter Names

OS-9 for 68K Name	OS-9 Name	Specification
abort=h	abort=h	Aborts character (normally <control>C, default = 03). For OS-9 for 68K, numeric value of character in hexadecimal.
baud=n	baud=n	Baud rate. The baud rate may currently be set to the following values: n = 50 300 2400 19200 57600 75 600 3600 38400 115200 110 1200 4800 56000 midi 124.5 1800 7200 64000 extern 150 2000 9600 31250 This value is not affected by xmode normal.

Table 1-33. `xmode` Parameter Names (Continued)

OS-9 for 68K Name	OS-9 Name	Specification
`bell=h`	`bell=h`	Sets bell (alert) output character (default = 07). For OS-9 for 68K, numeric value of character in hexadecimal.
`bsb`	`bsb`	Erases on backspace. Backspace characters are echoed as a backspace-space-backspace sequence. Default.
`bse=h`	`bsp=h`	Sets output backspace character (normally `<control>H`, default = 08). For OS-9 for 68K, numeric value of character in hexadecimal.
`bsl`	`del`	Backspaces over line. Lines are deleted by sending backspace-space-backspace sequences to erase the line. Default.
`bsp=h`	`bsp=h`	Sets the backspace input character (normally `<control>H`, default=08). For OS-9, sets the backspace output character. For OS-9 for 68K, numeric value of character in hexadecimal.
`cs=n`	`wordsize = n`	Sets the character length using one of the following values: n = 8, 7, 6 or 5 (bits) Setting character length changes the type value. This value is not affected by `xmode normal`.
`del=h`	See `Table 1-34`.	Sets input delete line character (normally `<control>X`, default = 18). For OS-9 for 68K, numeric value of character in hexadecimal.
`echo`	`echo`	Inputs characters echoed back to terminal. Default.

Table 1-33. `xmode` Parameter Names (Continued)

OS-9 for 68K Name	OS-9 Name	Specification
`eof=h`	`eof=h`	For OS-9 for 68K, sets end-of-file input character (normally `<esc>`, default = 1B) that causes an EOS_EOF to be returned when entered as the first character of a read or readln system call. Numeric value of character in hexadecimal. For OS-9, it sets the character that will appear in the input buffer when a character mapped to endofile is entered as the non-first character of a read or readln system call.
`eor=h`	`eor=h`	Sets end-of-record input character (normally `<cr>`, default = 0D). For OS-9 for 68K, numeric value of character in hexadecimal.
`dup=h`	See Table 1-34.	Sets duplicate last input line character (normally `<control>A`, default = 01). For OS-9 for 68K, numeric value of character in hexadecimal.
`lf`	`lf`	Auto line feed on. Line feeds are automatically echoed to terminal on input and output carriage returns. Default.
`nobsb`	`nobsb`	No erase on backspace. Echoes single backspace only.
`nobsl`	`nodel`	No backspace over line. Lines are deleted by printing a new line sequence.
`noecho`	`noecho`	No echo.
`nolf`	`nolf`	Auto line feed off.
`nopause`	`nopause`	Screen pause mode off.
`normal`		Sets the terminal back to its default characteristics. This does not affect the following values: type, baud rate, parity, character length, and stop bits.
`noupc`	`noupc`	Upper and lower case characters are permitted. Default.

Table 1-33. `xmode` Parameter Names (Continued)

OS-9 for 68K Name	OS-9 Name	Specification
`null=n`	`null=n`	Sets null count. Number of null ($00) characters transmitted after carriage returns for return delay. The number is decimal. By default, the null count is set to zero.
`pag=n`	`page=n`	Sets video display page length to `n` lines. `n` is a decimal number. Used for `pause` mode.
`par=s`		Sets parity using one of the following strings: odd, even, or none. Setting parity affects the `type` value. This value is not affected by `xmode normal`.
	`parity=s`	Sets parity using one of the following strings: odd, even, or none.
`pause`	`pause`	Screen pause on. Output suspended upon full screen. See `pag` parameter for definition of screen size. Output can be resumed by typing any key.
`psc=h`	`psc=h`	Sets pause character (normally `<control>W`, default = 17). For OS-9 for 68K, numeric value of character in hexadecimal.
`quit=h`	`quit=h`	Quits character (normally `<control>E`, default = 05). For OS-9 for 68K, numeric value of character in hexadecimal.
`reprint=h`	(See Table 1-34.)	Sets reprint line character (normally `<control>D`, default = 04). For OS-9 for 68K, numeric value of character in hexadecimal.
	`stopbits=n`	Sets the number of stop bits used: `n = 1, 1.5, or 2 (stop bits)`

Table 1-33. `xmode` Parameter Names (Continued)

OS-9 for 68K Name	OS-9 Name	Specification
`stop=n`		Sets the number of stop bits used: `n = 1, 1.5 or 2 (stop bits)` Setting the stop bit value affects the type value. This value is not affected by `xmode normal`.
`tabc=h`	`tab=h`	Tab character (normally `<control>I`, default = 09). For OS-9 for 68K, numeric value of character in hexadecimal.
`tabs=n`	`tabsiz=n`	Number of characters between tab stops. The number is in decimal. By default, there are four characters between tab stops.
	`time=n`	Sets the timeout value in 256ths of a second for unblocked `I_READ` and `I_READLN` operations. If the number of characters requested is not satisfied within the duration of ticks specified, the I/O operation returns with the number of characters available. If `time=1` the I/O operation does not wait. Instead, the number of characters available are returned.
`type=h`		ACIA initialization value. Sets parity, character size, and number of stop bits. Value in hexadecimal. This value is affected by changing the individual `par`(ity), `cs` (character length), and `stop` (stop bits) values. This value is not affected by the `xmode normal` command.
`upc`	`upc`	Upper case only. Lower case characters are converted automatically to upper case.

Table 1-33. `xmode` Parameter Names (Continued)

OS-9 for 68K Name	OS-9 Name	Specification
`xon=h`	`xon=h`	Resumes output input character (normally `<control>Q`, default = 11). For OS-9 for 68K, numeric value of character in hexadecimal.
`xoff=h`	`xoff=h`	Suspends output input character (normally `<control>S`, default = 13). For OS-9 for 68K, numeric value of character in hexadecimal.

For OS-9, numeric value of character in hexadecimal if prefixed with `0x`, "control character" when prefixed with caret (`^`), or ASCII mnemonic.

Table 1-34. OS-9 Control Keys that Affect the Input Line

Name	Description
`delchrl=h`	Sets input backspace character (delete character-left). (Normal `^H`.)
`delchru=h`	Sets the "delete character under the cursor" character. (Normal `^D`.)
`deline=h`	Sets input delete line character (normally `<control>X`).
`delwrdl=h`	Sets the delete word left character. (Normal `^L`). Numeric value of character is hexadecimal by default.
`delwrdr=h`	Sets the delete word right character. (Normal `^R`). Numeric value of character is hexadecimal by default.
`endofile=h`	Sets the end-of-file character. (Normal `<esc>`). Numeric value of character is hexadecimal by default.
`endorec=h`	Sets the end-of-record character. (Normal `<cr>`). Numeric value of character is hexadecimal by default.
`insrtmode=h`	Sets the enter insert mode character. (Normal `^I`). Numeric value of character is hexadecimal by default.

Table 1-34. OS-9 Control Keys that Affect the Input Line (Continued)

Name	Description
`movebeg=h`	Sets the move cursor to the beginning of the line character. (Normal `^Z`). Numeric value of character is hexadecimal by default.
`moveend=h`	Sets move to the end-of-line character (normally `<control>A`).
`moveleft=h`	Sets the move cursor left character. (Normal `^B`). Numeric value of character is hexadecimal by default.
`moveright=h`	Sets the move cursor right character. (Normal `^F`). Numeric value of character is hexadecimal by default.
`reprint=h`	Sets reprint line character (Normal `^P`).
`truncate=h`	Sets the truncate to end-of-line character. (Normal `^K`). Numeric value of character is hexadecimal by default.

OS-9 for 68K Examples

`xmode /term noupc nopause`

Disables upper-case lock and page pause.

`tmode /term reprint=1`

Changes reprint character to `<control>P`.

`tmode /term xon=0 xoff=0`

Disables `XON` and `XOFF` processing.

OS-9 Examples

`tmode /term noupc nopause`

Disables upper-case lock and page pause.

`tmode /term REPRINT=0x04`

Changes reprint character to `<control>D`.

`tmode /term pause page=65`

Enables page pause and set page size to 65.

2 Using the debug Utility

The `debug` utility is a software tool for debugging and testing user-state 68000 machine language programs written for the OS-9 for 68000 operating system.

`debug` uses:

- Software techniques to control a process to debug.
- The `F$DFork` and `F$DExec` system calls to create and execute the process to debug. These system calls provide an environment that allows the debugger to control how a process executes without affecting other processes on the system.

Full access to the 68000 user-mode registers is provided. On 68020/68881-based systems, full access to user-mode 68020 registers and all 68881 floating point registers are provided.

Symbolic Debugging

The OS-9 linker (`l68`) produces a symbol module for a program if you specify the `l68 -g` option when the program is linked. This option places global data and code symbols in a data module. `debug` automatically loads the symbol table data (`STB`) module when the debugging session begins.

This method of separating symbolic debugging information from the executable program module provides a number of advantages. The symbol information is not loaded into memory until the program is actually debugged. No `production` linkage or symbol stripping is required to remove the symbols from the code. You can keep the `STB` module for possible future debugging of the production code. The CRC of the program module is stored in the `STB` module and validated by the debugger to ensure that the symbol module matches the version of the program being debugged.

Starting debug

Type `debug` at the shell prompt. The `debug` utility then waits for a command with the prompt: `dbg:`

The `f` command is the first command entered in a `debug` session. This creates a process to execute the program to debug.

If any parameters are specified on the shell command line, they are assumed to be arguments for the `f` command.

If any parameters are specified, the `f` command is implicitly executed upon startup.

If redirection, priority specification, and stack size (`<`, `>`, `^`, `#`) are given, be sure to enclose the arguments in quotes to protect them from interpretation by the shell.

The `f` command can pass up to 64 arguments to the process.

A full explanation of entering `debug` via the shell command line and the `f` command appear in later sections of this chapter.

Exiting the Debugger

Use the `q` command to exit the debugger. The process being debugged is terminated and all its resources returned to the system. Any module linked by the `l` command is unlinked as well as any symbol modules in use.

Relocation Registers

The debugger maintains eight relocation registers. These registers are used for storing memory base addresses for later use in commands and expressions.

The registers are referenced by the names `r0` through `r7`. The `r0` register is hard-wired to zero.

When an address is specified, the default relocation register is added to the address automatically. Setting the default relocation register to zero disables this action.

The default relocation register is not added if a symbolic address or an expression is specified.

The following commands deal with the relocation registers.

Table 2-1. Relocation Register Commands

Command	Specification
`@`	Prints the default relocation register.
`@<num>`	Sets the default relocation register to `<num>`. `<num>` = 0 to 7.
`.r`	Displays the relocation registers.
`.r<num> <val>`	Sets specified relocation register to `<val>`.

Examples

```
dbg: @
the default relocation register is .r0 00000000
dbg: .r4 1fe00
dbg: @
the default relocation register is .r4 0001fe00
dgb: .r
rn: 00000000 00000000  00000000 0001fe00  00000000
00000000  00000000 00000000
```

Breakpoints

The debugger sets up to 16 simultaneous breakpoint addresses. Breakpoints can only be set at even-byte addresses.

The debugger supports two distinct types of breakpoints: *soft* breakpoints and *hard* breakpoints. Each is used in a different manner.

A soft breakpoint is not actually placed in the code, but is *emulated* by the `F$DExec` system call. This allows you to set breakpoints in ROM code or code that another process is currently executing. Because the soft breakpoint facility is implemented in software, the program runs much slower than normal in this mode.

A hard breakpoint is an illegal instruction placed in the code that causes an illegal instruction exception. Because of this, you cannot use a hard breakpoint in ROM code. If another process is executing the code being debugged, it will most likely exit with an illegal instruction error when the breakpoint instruction is reached. The program runs at full speed when using hard breakpoints.

By default, the debugger uses soft breakpoints. To continue the program at full speed using hard breakpoints, use the `x -1` command. For more information, see the execution commands section in this chapter.

The following commands deal with breakpoints:

Table 2-2. Breakpoint Commands

Command	Specification
`b`	Displays the breakpoint list.
`b<addr>`	Sets the breakpoint at `<addr>`.
`k <addr>`	Kills breakpoints at `<addr>`.
`k *`	Kills all breakpoints.

Examples

```
dbg: b
breakpoint count = 0
dbg: b main
dbg: b
breakpoint count = 1
main                (00162f40)
dbg: b main+1f0
dbg: b
breakpoint count = 2
main                (00162f40)
main+1f0            (00163130)
dbg: k main+1f0
dbg: k
clear all breakpoints? y
dbg: k *
```

debug Commands

To get a brief synopsis of debugger commands, type `?` at the prompt.

Execution Commands

The `debug` utility provides a number of commands to initiate and control program execution:

Table 2-3. Execution Commands

Command	Specification
`i`	*Instruction count* Displays the number of instructions the program executed. This count does not include instructions executed in system state or during the `x -1` command.
`g`	*Go* Runs the program until a breakpoint, exception, or the `F$Exit` system call is encountered.
`g <addr>`	*Go from address* Runs the program starting execution at `<addr>`, until a breakpoint, exception, or the `F$Exit` system call is encountered.

Table 2-3. Execution Commands (Continued)

Command	Specification
`gs`	*Go and stop* Executes the program until the next instruction is encountered. This is the same as the `Go` command, but it sets a breakpoint at the next instruction. The breakpoint is automatically removed when the debugger regains control.
`gs <addr>`	*Go and stop at address* Executes the program starting at the address in the PC register up to the specified `<addr>`. This is the same as the `Go` command, but it sets a breakpoint at `<addr>`. The breakpoint is automatically removed when the debugger regains control.
`t`	*Trace* Executes one instruction and re-displays the machine registers.
`t <count>`	*Trace instructions* Executes `<count>` instructions and re-displays the machine registers. Each instruction is displayed as it is executed. Breakpoints are ignored while tracing.
`x <count>`	*Execute instructions* Executes `<count>` instructions and re-displays the machine registers. Breakpoints are in effect and no instruction trace is displayed. If `<count>` is -1, hard breakpoints are set in the program allowing full-speed debugging. If `<count>` is positive, soft breakpoints are used and control returns after `<count>` instructions have been executed.

All code executed in system state (including system calls) is considered a single instruction. If a system call or exception transfers control to a user handler, tracing continues at the first instruction of the user handler.

The `F$TLink` system call executes the initialization routine of a user trap handler in user state. When tracing a program that has issued an `F$STrap` system call to handle an exception, control is transferred immediately to the exception handler code when the exception occurs.

The gs command is useful when stopped at a bsr or db instruction. The program runs until control is returned from the subroutine or the decrement loop terminates.

The program may stop before the next instruction breakpoint is reached if another breakpoint, exception or F$Exit is reached first.

The x and t commands cause the debugger to enter a repeat command mode. If <cr> is entered at the exe: or tra: prompt, the last t or x command respectively, is performed again. Even though <cr> has a special meaning at this point, any other command may be given.

For example:

```
dbg: i
instructions executed = 16 (0x10)
dbg: x10
dn: 00000001 00000000 00000082 00000003 00000000 00000076 00001020
00000020
an: 0001B2FE 00000020 00000000 001809C0 0001B306 0001B298 000222F0
0001B298
pc: 00180A5C cc: 00 (-----)
_cstart+0x4E >670C beq.b _cstart+0x5C
exe: <cr> entered; repeat x10 command
dn: 00000001 00000000 00000084 00000003 00000000 00000076 00001020
0000000B
an: 0001B2F6 0000000B 00000000 001809C0 0001B306 0001B298 000222F0
0001B298
pc: 00180A5C cc: 00 (-----)
<68881 in Null state>
_cstart+0x4E >670C beq.b _cstart+0x5C
exe: <cr> entered; repeat x10 command again
dn: 00000001 00000000 00000086 00000003 00000000 00000076 00001020
00000000
an: 0001B2EE 00000000 00000000 001809C0 0001B306 0001B298 000222F0
0001B298
pc: 00180A5C cc: 04 (--Z--)
<68881 in Null state>
_cstart+0x4E >670C beq.b _cstart+0x5C->
exe: i
instructions executed = 64 (0x40)
dbg:
```

A program can cause the kernel to transfer control to specific code within the program by issuing an `F$STrap` system call. Given in the call are a list of exception vector offsets and handler addresses for each exception that the program wishes to handle. Any exceptions not explicitly handled by the program cause the process to abort when the exception occurs. If a given exception occurs while tracing the program, control is immediately transferred to the handler. The debugger cannot tell that the exception occurred other than through the transfer of control.

If the program causes an exception and does not have an exception handler installed, control transfers to the debugger, the appropriate error number/message is printed, and for bus and address exceptions the following information is displayed:

```
execution error - class=0161 violation address=00555553 inst =
5988
Error #000:102 bus trap
dn: 0000000C 000C0064 00000080 00000003 00000000 000000A2 00001050
00000000
an: 00555555 0001EB50 00000000 0015B610 00000000 0001EAAC 00025B00
0001EAAC
pc: 0015B678 cc: 04 (--Z--)
_cstart+0x1A >4A68FFFE tst.w -2(a0)
tra:
```

`class` is the stack frame special status word on the 68010/68020; for the 68000 this is the first word of the exception frame. `violation address` is the access address that caused the exception. `inst` is the instruction input buffer for the 68000/68010; for the 68020 this is the instruction pipe stage `B` word. On the 68010, the PC shown by the debugger may be advanced up to five words due to instruction pipeline buffering.

Stack Traceback Command

You can examine the flow of execution with the stack `traceback` command. When you use this command, the debugger displays the functions on the call stack and their absolute addresses. The following syntax is used for this command:

Table 2-4. Stack Traceback Command

Command	Description
`w[<n>]`	Linkstack traceback via (`a5`). `<n>` = depth of traceback. If `<n>` is not specified, a complete traceback is displayed.

Example

```
dbg: gs printf
dn: 001972BE 00000000 00000001 00000003 00000001
0008434A 00004380 000000
an: 001972BE 00000000 00084342 00084338 00084334
00084218 00088000 000841
pc: 00197506 cc: 00 (-----)
<FPCP in Null state>
printf >4E550000 link.w a5,#0
dbg: t
dn: 001972BE 00000000 00000001 00000003 00000001
0008434A 00004380 000000
an: 001972BE 00000000 00084342 00084338 00084334
000841D4 00088000 000841
pc: 0019750A cc: 00 (-----)
<FPCP in Null state>
printf+0x4 >48E7C080 movem.l d0-d1/a0,-(a7)
tra: w
Stack traceback via (a5):
printf+0x4 (0019750A)
main+0xA4 (00196F04)
_cstart+0xE4 (00196D24)
```

Memory Change Commands

You can examine and change memory with the debugger memory change command. When you use this command, the debugger automatically enters the *memory change mode*. There are three forms of this command:

Table 2-5. Memory Change Command

Command	Specification
`c<addr>`	Change byte values.
`cw<addr>`	Change word values.
`cl<addr>`	Change longword values.

Addresses specified by the word and longword change commands must be even for non-68020 processors. The debugger displays the address and the values at the address and prompt for the new value:

```
dbg: d1 .d0                Display memory

0x1EF7E - 6A626364 65660000 00000000 00000000
jbcdef.........

dis: c .d0                 Enter change mode

0x1EF7E :6A 'a             Store the character a

0x1EF7F :62 20             Store a blank

0x1EF80 :63 -              Back up

0x1EF7F :20 #20            Different base (use 10)

0x1EF80 :63 -              Back up

0x1EF7F :14 +              Advance

0x1EF80 :63 .              Exit change mode

dbg: d1 .d0                Display memory

0x1EF7E - 61146364 65660000 00000000 00000000  a.cdef.........
```

Changing longword values is similar:

```
tra: d1 i_                  Display memory
i_ - 00000000 00000000 00000000 00000000  ................
dis: cl i_                  Enter longword change mode
i_ :00000000 #10000         New value
j_ :00000000 #44            New value
k_ :00000000 .              Exit change mode
dbg: d1 i_                  Display memory
i_ - 00002710 0000002C 00000000 00000000  ..'....,........
```

The change values may also be given all at once with no intermediate memory display:

```
tra: d1 i_
i_  - 00000000 00000000 00000000 00000000  ................

dis: cl i_ #10000 #44 .  Enter change mode, store 2 values, exit
                           change
dbg: d1 i_
i_  - 00002710 0000002C 00000000 00000000  ..'....H........
```

Memory Commands

Memory is displayed using the memory display command: `d`. This command allows interpretation of memory in a number of ways. The general form of the display memory command is:

```
d[M][N] <addr> [<len>]
```

Table 2-6. Memory Display Parameters

Parameter	Specification
`[M]`	Optional format indicator.
`[N]`	Number of lines (0-9) of dump to display. This value is used only if `<len>` is not given.

Table 2-6. Memory Display Parameters (Continued)

Parameter	Specification
<addr>	Starting address for the memory display. This value must be even for instruction disassembly and floating point display.
<len>	Number of bytes to display. If not given, the default is 256 for hex/ASCII display, 16 for instruction disassembly, and 12, 8, and 4 for X, D, and F floating point formats, respectively. <len> is rounded so that a full line is always displayed. For example, if 1 is specified, 16 bytes are actually displayed.

If not present, the memory dump is displayed in the normal hexadecimal/ASCII dump format. You can specify one of the following codes to cause the dump to interpret a memory as follows:

Table 2-7. Dump Memory Interpretation Codes

Code	Specification
I	Instruction disassembly.
F	Single precision floating point.
D	Double precision floating point.
X	Extended precision floating point (only if 68881 is available).

Hex/ASCII Dump Memory Display

In the ASCII field of the hex/ASCII dump, bytes in the range of $20 - $7E are displayed as the ASCII character equivalent. All other values are displayed as a period (.)

```
dbg: d _cstart                Use hex/ASCII dump format (256 bytes)

_cstart - 2D468010 2D468014 3D438018 4A85671E -F..-F..=C..J.g.
_cstart+0x10 - 08050000 661441F5 58004A68 FFFE660A
....f.AuX.Jh.~f.
_cstart+0x20 - 598849E8 FFFC7001 60204235 58FF204D Y.Ih.|p.B5X. M
_cstart+0x30 - D7EB000C 42A72F0B 74016100 10186076
Wk..B'/.t.a...`v
_cstart+0x40 - 43E80004 2D4984E8 74002260 2E09670C Ch..-I.ht.".g.
_cstart+0x50 - D3CD4229 FFFF2089 528260EE 538067E0 SMB)..
.R.S.g~pc
_cstart+0x60 - 4A826610 4A68FFFE 670A4228 FFFF2448
J.f.Jh.~g.B(..$H
_cstart+0x70 - 58886006 208D2448 52825282 4A946718 X. .$HR.R.J.g.
```

```
_cstart+0x80 - 28544A1C 66FCB5CC 631E0C1C 00FC6618
(TJ.f|5Lc....|f.
_cstart+0x90 - 528C2654 D7CD6014 0C2D00FC 00026608 R.&TWM.-.|..f.
_cstart+0xA0 - 266D0004 D7CD6004 D7EB000C 210B2F08 &m..WMWk..!./.
_cstart+0xB0 - 4228FFFF 2F026100 0E7E6500 01086114
B(../.a..~e...a.
_cstart+0xC0 - 4CDF0003 9BCD2F2E 84E86100 01367000
L_...M/..ha..6p.
_cstart+0xD0 - 61001340 207CFFFF 8572D1CE 2D488004 a..@ |...rQN-
H..
_cstart+0xE0 - 2D4F8000 2D4F8008 203CFFFF FF042F08 -O..-O..
<..../.
_stkchec+0x2 - 41F70800 B1EE8008 640AB1EE 80046508
Aw..1n..d.1n..e.
dis: d _cstart 44 Same as before but at 44 bytes
_cstart - 2D468010 2D468014 3D438018 4A85671E -F..-F..=C..J.g.
_cstart+0x10 - 08050000 661441F5 58004A68 FFFE660A
....f.AuX.Jh.~f.
_cstart+0x20 - 598849E8 FFFC7001 60204235 58FF204D Y.Ih.|p.B5X. M
_cstart+0x30 - D7EB000C 42A72F0B 74016100 10186076 Wk..B'/.t.a...
_cstart+0x40 - 43E80004 2D4984E8 74002260 2E09670C Ch..-I.ht.".g.
dis: d5 _cstart Five line display
_cstart - 2D468010 2D468014 3D438018 4A85671E -F..-F..=C..J.g.
_cstart+0x10 - 08050000 661441F5 58004A68 FFFE660A
....f.AuX.Jh.~f.
_cstart+0x20 - 598849E8 FFFC7001 60204235 58FF204D Y.Ih.|p.B5X. M
_cstart+0x30 - D7EB000C 42A72F0B 74016100 10186076 Wk..B'/.t.a...
_cstart+0x40 - 43E80004 2D4984E8 74002260 2E09670C Ch..-I.ht.".g.
dis: d1 _cstart One line display
_cstart - 2D468010 2D468014 3D438018 4A85671E -F..-F..=C..J.g.
dis: d _cstart 1 Same as above
_cstart - 2D468010 2D468014 3D438018 4A85671E -F..-F..=C..J.g.
```

Instruction Disassembly Memory Display

In the instruction disassembly display format, conditional instructions may be followed with a hyphen, followed by a right angle bracket (->) indicator. If -> is present, the instruction performs its `TRUE` operation; otherwise, the instruction performs the `FALSE` operation. The appropriate condition code register is examined to determine which case the processor performs. The following conditional instruction categories use this feature:

Table 2-8. Conditional Instructions

Instruction	Description
`Bcc`	Branch on condition.
`DBcc`	Decrement and branch on condition.

Table 2-8. Conditional Instructions

Instruction	Description
Scc	Set according to condition.
TRAPcc	Trap on condition.
FBcc	Branch on floating condition.
FScc	Set according to floating condition.
FDBcc	Decrement and branch on floating condition.
FTRAPcc	Trap on floating condition.

Example

```
dis: di _cstart                          Instruction disassembly
_cstart           >2D468010     move.l d6,_totmem(a6)
_cstart+0x4       >2D468014     move.l d6,_sbsize(a6)
_cstart+0x8       >3D438018     move.w d3,_pathcnt(a6)
_cstart+0xC       >4A85         tst.l d5
_cstart+0xE       >671E         beq.b _cstart+0x2E
_cstart+0x10      >08050000     btst.b #0,d5
_cstart+0x14      >6614         bne.b _cstart+0x2A->
_cstart+0x16      >41F55800     lea.l 0(a5,d5.l),a0
_cstart+0x1A      >4A68FFFE     tst.w -2(a0)
_cstart+0x1E      >660A         bne.b _cstart+0x2A->
_cstart+0x20      >5988         subq.l #4,a0
_cstart+0x22      >49E8FFFC     lea.l -4(a0),a4
_cstart+0x26      >7001         moveq.l #1,d0
_cstart+0x28      >6020         bra.b _cstart+0x4A
_cstart+0x2A      >423558FF     clr.b -1(a5,d5.l)
_cstart+0x2E      >204D         movea.l a5,a0
dis: di _cstart 5              Disassemble 5 instructions
_cstart           >2D468010     move.l d6,_totmem(a6)
_cstart+0x4       >2D468014     move.l d6,_sbsize(a6)
_cstart+0x8       >3D438018     move.w d3,_pathcnt(a6)
_cstart+0xC       >4A85         tst.l d5
_cstart+0xE       >671E         beq.b _cstart+0x2E
```

Floating Point Memory Displays

Floating point conditional instructions use the condition portion of the 68881 FPSR register, the others use the processor CC register. During memory disassembly display, the -> indicator appears based on the static value of the condition register value when the disassembly occurred. The following are examples of floating point memory displays:

```
dis: d1 f_              Display in hex/ASCII format

f_      - 3F2AAAAB 00000000 00000000 00000000
?**+............

dis: df f_              Display in single-precision decimal

f_      - 3F2AAAAB 0.6666666865348816

dis: d1 a_              Display in hex/ASCII format

a_      - 3FE55555 55555555 3F2AAAAB 00000000
?eUUUUUU?**+....

dis: dd a_              Display in double-precision decimal

a_      - 3FE5555555555555 0.6666666666666666
```

To display a floating point number in machine registers, give the name of the register preceded by an ampersand (&). Normal expression evaluation uses the value in the register as a pointer to the desired value. Using ampersand (&) syntax, the value in the register is used.

```
dn: 3FE55555 55555555 00000001 00000003 00000000
000000A6 00001210 00000000
an: 0001DB78 00000000 0001E7EE 0001E7E2 0001E7DE 00000000 00025610
0001E758
pc: 0010CD40 cc: 00 (-----)
<68881 in Null state>
main+0x2C 2F2E801E move.l a_+0x4(a6),-(a7)
dbg: dd &.d0 Display double precision value in register
[reg] - 3FE5555555555555 0.6666666666666666
dn: 3F2AAAAB 55555555 00000001 00000003 00000000 000000A6 00001210
00000000
an: 0001DB78 00000000 0001E7EE 0001E7E2 0001E7DE 00000000 00025610
0001E750
pc: 0010CD4C cc: 00 (-----)
<68881 in Null state>
main+0x38 61001750 bsr.w _T$FtoD
```

```
dbg: gs
dn: 3FE55555 60000000 00000001 00000003 00000000 000000A6 00001210
00000000
an: 0001DB78 00000000 0001E7EE 0001E7E2 0001E7DE 00000000 00025610
0001E750
pc: 0010CD50 cc: 00 (-----)
<68881 in Null state>
main+0x3C 2F01 move.l d1,-(a7)
tra: df f_ Display single precision float
f_ - 3F2AAAAB 0.6666666865348816
dis: dd f_ Display using wrong format
f_ - 3F2AAAAB00000000 0.0002034505596384406 Garbage value
dis: dd .d0 Uses .d0 as a pointer (wrong)
0x3F2AAAAB bus error.
dis: dd &.d0 Uses value in .d0 (correct)
[reg] - 3F2AAAAB55555555 0.0002034505984435479
dis: df &.d0
[reg] - 3F2AAAAB 0.6666666865348816
```

Displaying values in the 68881 floating point registers is similar.

```
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dn: 3FE55555 60000000 00000001 00000003 00000000 000000A6 00001210
00000000
an: 0001DB78 00000000 0001E7EE 0001E7E2 0001E7DE 00000000 00025610
0001E750
pc: 0010DDB0 cc: 00 (-----)
fp0:3FFE0000 AAAAAB00 00000000 fp4:7FFF0000 FFFFFFFF FFFFFFFF
fpcr: 0000 XN
fp1:7FFF0000 FFFFFFFF FFFFFFFF fp5:7FFF0000 FFFFFFFF FFFFFFFF
fpiar: 00000000
fp2:7FFF0000 FFFFFFFF FFFFFFFF fp6:7FFF0000 FFFFFFFF FFFFFFFF
fpsr: 00000000
fp3:7FFF0000 FFFFFFFF FFFFFFFF fp7:7FFF0000 FFFFFFFF FFFFFFFF (---
- 0)
main+0x3C 2F01 move.l d1,-(a7)
dbg: dd .fp0 Uses .fp0 as a pointer (wrong)
0x3FFE0000 bus error.
dbg: dd &.fp0 Uses value in .fp0 (correct, wrong format)
[reg] - 3FFE0000AAAAAB00 1.875000635782897
dis: dx .fp0
0x3FFE0000 bus error.
dbg: dx &.fp0 Uses value in .fp0 (correct format - 'X')
[reg] - 3FFE0000AAAAAB0000000000 0.6666666865348816
```

Display/Change Machine Registers

Use the period (.) command to display and change the machine registers:

Table 2-9. Display/Change Machine Register Commands

Command	Specification
.	Display machine registers.
.<reg> <val>	Change machine register.

The register display appears as follows:

```
dn: 0000000C 000C0064 00000080 00000003 00000000
000000A6 00001210 00000000
an: 00000000 0001E820 00000000 0010CAC0 00000000
0001E778 00025610 0001E778
pc: 0010CB12 cc: 00 (-----)
<68881 in Null state>
_cstart> 2D468010 move.l d6,_totmem(a6)
```

The first two lines of the display show the data and address registers from D0 - D7 and A0 - A7 respectively. The third line shows the program counter and status register. Only the user byte (containing the processor condition code values) is available. The condition code bits are interpreted and displayed after the condition code register hex value in parentheses.

The bit interpretation is:

```
(XNZVC)
```

C = Carry

V = Overflow

Z = Zero

N = Negative

X = Extend

The following discussion of the 68881 coprocessor registers applies only to OS-9 systems running on a 68020 processor with the 68881 installed as a coprocessor.

If the display 68881 registers option is set, the next line(s) indicate the state of the 68881 coprocessor. If the coprocessor is not present on the system, the following message appears:

```
<No 68881 available>
```

If the process has yet to access the 68881, the following message appears:

```
<68881 in Null state>
```

When the process accesses the 68881, a floating point register dump appears. If the setting of the debugger decimal register display option indicates hex display, the 68881 coprocessor registers appear as such:

```
fp0:40010000 D5555555 55555200 fp4:7FFF0000 FFFFFFFF FFFFFFFF
fpcr: 0000 XN
fp1:7FFF0000 FFFFFFFF FFFFFFFF fp5:7FFF0000 FFFFFFFF FFFFFFFF
fpiar: 00000000
fp2:7FFF0000 FFFFFFFF FFFFFFFF fp6:7FFF0000 FFFFFFFF FFFFFFFF
fpsr: 00000208
fp3:7FFF0000 FFFFFFFF FFFFFFFF fp7:7FFF0000 FFFFFFFF FFFFFFFF (---
- 0)
```

If a decimal display is indicated, the registers appear in the following format:

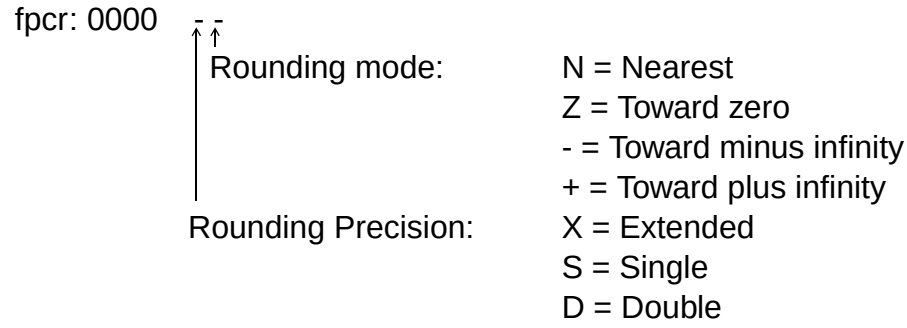
```
fp0:6.666666666666666 fp4:<NaN> fpcr: 0000 XN
fp1:<NaN> fp5:<NaN> fpiar: 00000000
fp2:<NaN> fp6:<NaN> fpsr: 00000208
fp3:<NaN> fp7:<NaN> (---- 0)
```

The value of the registers are printed in decimal using scientific notation when the value becomes very large or very small. IEEE not-a-number values are printed as `<NaN>`, plus and minus infinity values are printed as `<+Inf>` and `<-Inf>`, respectively. The extended precision values are converted to double precision before printing, so conversion overflow may result. The hexadecimal format display can be used to determine the exact values in the registers.

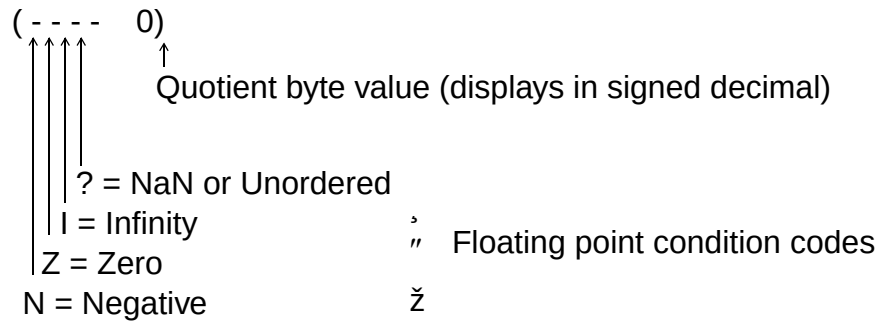
The eight 68881 floating point registers are displayed in either hexadecimal or decimal form depending on the floating point register display option setting. The 68881 status registers appear to the far right of the display:

```
fpcr: 0000 --      68881 control register
fpiar: 00000000     68881instruction address register
fpsr: 00000000     68881 status register
(----     0)       FPSR interpretation bits
```

The -- field next to the FPCR register displays an interpretation of the 68881 rounding mode and precision. These fields are interpreted as follows:



The FPSR condition code byte and the quotient byte are displayed as follows:



Immediately following the main floating register display, the debugger interprets the exception enable byte of the control register and the exception status and accrued exception bytes of the status register. If all bits in the byte are zero, nothing is printed. Otherwise, the bits are displayed as follows:

`XE:(BSUN,SNAN,OPERR,OVFL,UNFL,DZ,INEX2,INEX1)` *FPCR exception enable*

`AX:(IOP,OVFL,UNFL,DZ,INEX,???,???,???)` *FPSR accrued exception*

`XS:(BSUN,SNAN,OPERR,OVFL,UNFL,DZ,INEX2,INEX1)` *FPSR exception status*

A full register display example follows:

```
dn: 00000000 00000000 00000001 00000003 00000000
000000A2 00001050 00000000
an: 000152D2 00000000 00015F4E 00015F46 00015F42
00000000 0001CF30 00015ED4
pc: 00139364 cc: 04 (--Z--)
fp0:40010000 C0000000 00000000 fp4:7FFF0000 FFFFFFFF
FFFFFFFF fpcr: 0000 XN
fp1:7FFF0000 FFFFFFFF FFFFFFFF fp5:7FFF0000 FFFFFFFF
FFFFFFFF fpiar: 00000000
fp2:7FFF0000 FFFFFFFF FFFFFFFF fp6:7FFF0000 FFFFFFFF
FFFFFFFF fpsr: 00000008
fp3:7FFF0000 FFFFFFFF FFFFFFFF fp7:7FFF0000 FFFFFFFF
FFFFFFFF (---- 0)
AX:(INEX)
_exit+0x6 >DEADDEAD add.l -8531(a5),d7
```

You can change processor registers with the period (.) command. Any processor register or coprocessor control register can be changed with this command:

```
.<regname> <expr>
```

Valid register names are:

```
.d0 - .d7
.a0 - .a7
.sp, .pc, .cc
.fpsr, .fpcr, .fpiar (for 68881 only)
```

Example

```
dn: 00000000 00000000 00000001 00000003 00000000
000000A6 00001210 00000000
an: 0001DB78 00000000 0001E7EE 0001E7E2 0001E7DE
00000000 00025610 0001E770
pc: 000F8FA8 cc: 04 (--Z--)
_exit+0x6 DEADDEAD add.l -8531(a5),d7
dbg: .d4 100 Set D4 to 100
dbg: . Display registers
dn: 00000000 00000000 00000001 00000003 00000100
000000A6 00001210 00000000
an: 0001DB78 00000000 0001E7EE 0001E7E2 0001E7DE
```

```
00000000 00025610 0001E770
pc: 000F8FA8 cc: 04 (--Z--)
dbg: .d4 .d2+.a6 Set D4 using an expression
dbg: . Display registers
dn: 00000000 00000000 00000001 00000003 00025611
000000A6 00001210 00000000
an: 0001DB78 00000000 0001E7EE 0001E7E2 0001E7DE
00000000 00025610 0001E770
pc: 000F8FA8 cc: 04 (--Z--)
dbg: .d4 No <value> means zero
dbg: .
dn: 00000000 00000000 00000001 00000003 00000000
000000A6 00001210 00000000
an: 0001DB78 00000000 0001E7EE 0001E7E2 0001E7DE
00000000 00025610 0001E770
pc: 000F8FA8 cc: 04 (--Z--)
```

The floating point register change command allows the change value to be either a double precision decimal constant or a left-justified hexadecimal value:

```
.fp<n> <float-decimal constant> or
.fp<n> <96-bit left-justified hex constant> or
.fp<n> .fp<n>
```

`<n>` is one of 0 - 7 representing the desired 68881 general floating point register.

The syntax for `<float-decimal constant>` is:

```
[+/-]digits[.digits][Ee[+/-]integer]
```

The syntax for `<96-bit left-justified hex constant>` is:

```
0xh
```

h represents up to 12 hexadecimal digits. If less than 12 digits are given, the value is padded on the right with zeroes. Remember that bits 68 through 80 of an extended precision value in IEEE are always zero.

```
dbg: .fp0 4          Set FP0 to 4.0
dbg: .
dn: 00000000 00000000  00000001 00000003   00000000
000000A6  00001210 00000000
an: 0001DB78 00000000  0001E7EE 0001E7E2   0001E7DE
00000000  00025610 0001E770
pc: 000F8FA8  cc: 04 (--Z--)
fp0:40010000 80000000 00000000  fp4:7FFF0000 FFFFFFFF
FFFFFFFF   fpcr: 0000 XN
fp1:7FFF0000 FFFFFFFF FFFFFFFF  fp5:7FFF0000 FFFFFFFF
FFFFFFFF  fpiar: 00000000
fp2:7FFF0000 FFFFFFFF FFFFFFFF  fp6:7FFF0000 FFFFFFFF
FFFFFFFF   fpsr: 00000208
fp3:7FFF0000 FFFFFFFF FFFFFFFF  fp7:7FFF0000 FFFFFFFF
FFFFFFFF   (----    0)
AX:(INEX) XS:(INEX2)
_exit+0x6          >DEADDEAD         add.l -8531(a5),d7
dbg: .fp0 0x4        Set FP0 with hex value (left
justified)
dbg: .
dn: 00000000 00000000  00000001 00000003   00000000
000000A6  00001210 00000000
an: 0001DB78 00000000  0001E7EE 0001E7E2   0001E7DE
00000000  00025610 0001E770
pc: 000F8FA8  cc: 04 (--Z--)
fp0:40000000 00000000 00000000  fp4:7FFF0000 FFFFFFFF
FFFFFFFF   fpcr: 0000 XN
fp1:7FFF0000 FFFFFFFF FFFFFFFF  fp5:7FFF0000 FFFFFFFF
FFFFFFFF  fpiar: 00000000
fp2:7FFF0000 FFFFFFFF FFFFFFFF  fp6:7FFF0000 FFFFFFFF
FFFFFFFF   fpsr: 00000208
fp3:7FFF0000 FFFFFFFF FFFFFFFF  fp7:7FFF0000 FFFFFFFF
FFFFFFFF   (----    0)
AX:(INEX) XS:(INEX2)
_exit+0x6            >DEADDEAD        add.l -
8531(a5),d7
dis: .fp0 0x40200000aef5       Another hex value
```

Memory Fill

Use the `mf` command to fill memory with a given pattern:

```
mf[S][N] <start> <end> <value>
```

Table 2-10. Memory Fill Parameters

Parameter	Specification
`[S]`	Specifies the size of the fill. If `[S]` is not given, byte length is assumed. Three values are allowed for the `[S]` parameter: `b`, `w`, or `l` for byte, word, or longword, respectively.
`[N]`	Indicates that the fill is to be performed without regard to word/longword boundaries (for example, word and longword fills are done on a byte for byte basis). Fills of word and longword size must begin on an even address on a non-68020 processor unless the `[N]` parameter is given.
`<start> and <end>*`	Starting and ending addresses for the memory fill.
`<value>`	Pattern used to fill the memory range.

* If the length of the fill determined from `<start>` and `<end>` is not an even word or longword multiple (for a word and longword fill), the length is trimmed to the next lowest respective multiple.

There are two special types of memory fill when using the byte fill size:

1. `<value>` may start with a double quote character (`""`) in which case all remaining characters are used as a fill string.
2. `<value>` can be multiple byte values in which case each successive value is used as fill characters.

In both cases, the pattern is reused from the beginning if the fill count has not been exhausted.

Example

```
d3 70000 Display memory
0x00070000 - FEEDC0DE FEEDC0DE FEEDC0DE FEEDC0DE ~m@^~m@^~m@^~m@^
0x00070010 - FEEDC0DE FEEDC0DE FEEDC0DE FEEDC0DE ~m@^~m@^~m@^~m@^
0x00070020 - FEEDC0DE FEEDC0DE FEEDC0DE FEEDC0DE ~m@^~m@^~m@^~m@^
dis: mfb 70000 70003 a1 Fill with byte
dbg: d2 70000
0x00070000 - A1A1A1A1 FEEDC0DE FEEDC0DE FEEDC0DE !!!!~m@^~m@^~m@^
0x00070010 - FEEDC0DE FEEDC0DE FEEDC0DE FEEDC0DE ~m@^~m@^~m@^~m@^
dis: mfw 70000 7000f 5252 Fill with word
dbg: d2 70000
0x00070000 - 52525252 52525252 52525252 52525252 RRRRRRRRRRRRRRRR
0x00070010 - FEEDC0DE FEEDC0DE FEEDC0DE FEEDC0DE ~m@^~m@^~m@^~m@^
dis: mfl 70000 70002 81186226 Fill with longword
dbg: d3 70000
0x00070000 - 81186226 81186226 81186226 81186226 ..b&..b&..b&..b&
0x00070010 - FEEDC0DE FEEDC0DE FEEDC0DE FEEDC0DE ~m@^~m@^~m@^~m@^
0x00070020 - FEEDC0DE FEEDC0DE FEEDC0DE FEEDC0DE ~m@^~m@^~m@^~m@^
dis: mfwn 70001 70007 0102 Non-aligned fill word
dbg: d3 70000
0x00070000 - 81010201 02010201 81186226 81186226 ..........b&..b&
0x00070010 - FEEDC0DE FEEDC0DE FEEDC0DE FEEDC0DE ~m@^~m@^~m@^~m@^
0x00070020 - FEEDC0DE FEEDC0DE FEEDC0DE FEEDC0DE ~m@^~m@^~m@^~m@^
dbg: mfb 70000 7000f "shazam! Fill with a string
dbg: d4 70000
0x00070000 - 7368617A 616D2173 68617A61 6D217368 shazam!shazam!sh
0x00070010 - FEEDC0DE FEEDC0DE FEEDC0DE FEEDC0DE ~m@^~m@^~m@^~m@^
0x00070020 - FEEDC0DE FEEDC0DE FEEDC0DE FEEDC0DE ~m@^~m@^~m@^~m@^
0x00070030 - FEEDC0DE FEEDC0DE FEEDC0DE FEEDC0DE ~m@^~m@^~m@^~m@^
0x00070040 - FEEDC0DE FEEDC0DE FEEDC0DE FEEDC0DE ~m@^~m@^~m@^~m@^
0x00070050 - FEEDC0DE FEEDC0DE FEEDC0DE FEEDC0DE ~m@^~m@^~m@^~m@^
0x00070060 - FEEDC0DE FEEDC0DE FEEDC0DE FEEDC0DE ~m@^~m@^~m@^~m@^
0x00070070 - FEEDC0DE FEEDC0DE FEEDC0DE FEEDC0DE ~m@^~m@^~m@^~m@^
dis: mf 70000 70010 1 2 3 4 3+2 Fill with multiple byte values
dbg: d4 70000
0x00070000 - 01020304 05010203 04050102 03040501 ................
0x00070010 - 02EDC0DE FEEDC0DE FEEDC0DE FEEDC0DE .m@^~m@^~m@^~m@^
0x00070020 - FEEDC0DE FEEDC0DE FEEDC0DE FEEDC0DE ~m@^~m@^~m@^~m@^
0x00070030 - FEEDC0DE FEEDC0DE FEEDC0DE FEEDC0DE ~m@^~m@^~m@^~m@^
```

Memory Search

Use the ms command to search memory for a given pattern:

```
ms[S][N] <start> <end> [:<mask>] <value>
```

Table 2-11. Memory Search Parameters and Specifications

Parameter	Specification
[S]	Specifies the size of the search. If [S] is not given, byte length is assumed. Three values are allowed for the [S] parameter: b, w, or l for byte, word, or longword, respectively.
[N]	Indicates that the search is to be performed without regard to word/longword boundaries (for example, word and longword searches are done on a byte for byte basis). Fills of word and longword size must begin on an even address on a non-68020 processor unless the [N] parameter is given.
<start> and <end>*	Starting and ending addresses for the memory search.
<value>	Pattern used to search the memory range.

* If the length of the search determined from <start> and <end> is not an even word or longword multiple (for a word and longword search), the length is trimmed to the next lowest respective multiple.

There are two special types of memory search when using the byte search size:

- <value> may start with a double quote character (") in which case all remaining characters are used as a search string.
- <value> can be multiple byte values in which case each successive value is used as a search pattern.

A <mask> may be specified to limit the comparison to only those bits set in the mask. If <mask> is not specified, the mask used is -1 (all bits set). <mask> is ignored for multiple character patterns.

Example

```
dbg: d1 btext
btext     - 4AFC0001 0000259E 000C0064 00000048  J|....%....d...H
dis: msw  btext btext+259e 1 Search for word-aligned 0001
btext+0x2      - 00010000 259E000C 00640000 00480555
....%....d...H.U
sprintf+0x1C0  - 0001206F 000C58AF 000C2008 56802200  .. o..X/..
.V.".
putc+0x42      - 000141EF 00072208 306A000E 2008206A  ..Ao..".0j..
. j
fclose+0x20    - 0001670E 200A6126 28006006 4A6A000C  ..g.
.a&(.`.Jj..
fseek+0xB8     - 000167BC 0CAF0000 00010020 6608202A  ..g<./.....
f. *
fseek+0xC0     - 00010020 6608202A 00089092 988024AA  ... f.
*......$*
ftell+0x2E     - 00017200 306A000E 20086100 057C588F  ..r.0j..
.a..|X.
_setbase+0x2A  - 00016606 303C0080 60027040 48C0816A
..f.0<..`.p@H@.j
_setbase+0xC8  - 00010012 603E306A 00122008 22000CAE  ....`>0j..
."...
_iobinit+0x16  - 00018182 3D7C0002 819C3D7C 0002819E
....=|....=|....
_T$LDiv+0x14   - 00016122 E20A6402 4480E20A 64024481
..a"b.d.D.b.d.D.
getstat+0x     - 0001672E 0C010006 673A0C01 00026710
..g.....g:....g.
getstat+0x2    - 00016000 03044E40 008D6500 02FC206F
..`...N@..e..| o
lseek+0xC      - 00016716 0C010002 670672CB 6000013C
..g.....g.rK`..<
_utinit+0x2    - 00014E75 4E752F05 7A004A80 6A047A08
..NuNu/.z.J.j.z.
Tens16+0xA6    - 00013C67 0EF54646 D4973C9C D2B297D8
..<g.uFFT.<.R2.X
_T$DInt+0x3A   - 00015247 E288E291 51CEFFF2 64125281
..RGb.b.QN.rd.R.
_T$DMul+0x18E  - 000108C0 001F6030 0C828000 00006604
...@..`0......f.
PackD+0x58     - 00010101 01010101 01011111 01111101
.................
PackD+0xE0     - 000104E8 00000000 00000001 04E40000
...h.........d..
PackD+0xEA     - 000104E4 00000000 0085230F 0D74000F
...d......#..t..

dbg: msw  btext btext+259e 4e40 Search for system calls
_stkchec+0x30  - 4E40008C 321F4E75 202E8000 90AE8008  N@..2.Nu
.......
```

```
trapinit+0x1A  - 4E400021 64066100 12CE6564 2F490014
N@.!d.a..Ned/I..
trapinit+0xBA  - 4E400006 4E400006 12D866FC 4E7548E7
N@..N@...Xf|NuHg
trapinit+0xBE  - 4E400006 12D866FC 4E7548E7 C080203C
N@...Xf|NuHg@. <
getstat+0x2C   - 4E40008D 650002FC 206F0010 20826000  N@..e..| o..
.`.
getstat+0x3E   - 4E40008D 650002EA 20016000 02E2206F  N@..e..j
.`..b o
getstat+0x50   - 4E40008D 600002D6 48E76080 C1414A81
N@..`..VHg`.AAJ.
setstat+0x1E   - 4E40008E 600002B0 48E76080 20403001  N@..`..0Hg`.
@0.
access+0x8     - 4E400084 650002A2 4E40008F 60000294
N@..e.."N@..`...
access+0x10    - 4E40008F 60000294 48E76080 20403001  N@..`...Hg`.
@0.
open+0xA       - 4E400084 60000286 48E76080 4E40008F
N@..`...Hg`.N@..
close+0x4      - 4E40008F 6000027A 48E76080 20403001  N@..`..zHg`.
@0.
mknod+0xA      - 4E400085 6500026A 60000260 48E76080
N@..e..j`..`Hg`.
create+0x10    - 4E400083 6000023A 48E76080 2F092040
N@..`..:Hg`./. @
creat+0x16     - 4E400083 2049225F 64000218 0C0100DA  N@..
I"_d......Z
creat+0x36     - 4E400084 650001FE 74007202 4E40008E
N@..e..~t.r.N@..
creat+0x42     - 4E40008E 640001F0 34014E40 008F3202
N@..d..p4.N@..2.
creat+0x4C     - 4E40008F 32026000 01E648E7 60802040
N@..2.`..fHg`. @
unlinkx+0x8    - 4E400087 650001D6 600001CC 48E76080
N@..e..V`..LHg`.
unlink+0x8     - 4E400087 650001C2 600001B8 48E76080
N@..e..B`..8Hg`.

dup+0x4        - 4E400082 600001B0 48E76080 2041222F  N@..`..0Hg`.
A"/
read+0xA       - 4E400089 65062001 6000019A 0C4100D3  N@..e.
.`....A.S
readln+0xA     - 4E40008B 60DC48E7 60802041 222F0010  N@..`\Hg`.
A"/..
write+0xA      - 4E40008A 6500016E 20016000 016648E7  N@..e..n
.`..fHg
writeln+0xA    - 4E40008C 60E648E7 6080122F 00136726
N@..`fHg`../..g&
lseek+0x1E     - 4E40008D 640E60F2 72054E40 008D6404
N@..d.`rr.N@..d.
```

```
lseek+0x28      - 4E40008D 640460E8 7400D497 22024E40
N@..d.‘ht.T.".N@
lseek+0x36      - 4E400088 65DC2001 60000114 48E76080  N@..e\
.‘...Hg‘.
ebrk+0x42       - 4E400028 204A245F 650000C8 2D4884D8  N@.(
J$_e..H-H.X
sbrk+0x14       - 4E400007 64000008 225F6000 00642D40
N@..d..."_‘..d-@
_srqmem+0x2     - 4E400028 650A2D40 84E0200A 245F4E75  N@.(e.-@.‘
.$_Nu
_srtmem+0x8     - 4E400029 245F6000 000691C8 C1886406
N@.)$_‘....HA.d.
_exit+0x2       - 4E400006 DEADDEAD 003C0001 4E754E75  N@..^-^-
.<..NuNu

dbg: msl  btext btext+259e :ffffff80 4e400000Only non-I/O calls
sbrk+0x14       - 4E400007 64000008 225F6000 00642D40
N@..d..."_‘..d-@
_srqmem+0x2     - 4E400028 650A2D40 84E0200A 245F4E75  N@.(e.-@.‘
.$_Nu
_srtmem+0x8     - 4E400029 245F6000 000691C8 C1886406
N@.)$_‘....HA.d.
_exit+0x2       - 4E400006 DEADDEAD 003C0001 4E754E75  N@..^-^-
.<..NuNu

dbg: msln btext btext+259e :ffffff80 4e400000   Non-longword
boundary search
trapinit+0x1A   - 4E400021 64066100 12CE6564 2F490014
N@.!d.a..Ned/I..
trapinit+0xBA   - 4E400006 4E400006 12D866FC 4E7548E7
N@..N@...Xf|NuHg
trapinit+0xBE   - 4E400006 12D866FC 4E7548E7 C080203C
N@...Xf|NuHg@. <
ebrk+0x42       - 4E400028 204A245F 650000C8 2D4884D8  N@.(
J$_e..H-H.X
sbrk+0x14       - 4E400007 64000008 225F6000 00642D40
N@..d..."_‘..d-@
_srqmem+0x2     - 4E400028 650A2D40 84E0200A 245F4E75  N@.(e.-@.‘
.$_Nu
_srtmem+0x8     - 4E400029 245F6000 000691C8 C1886406
N@.)$_‘....HA.d.
_exit+0x2       - 4E400006 DEADDEAD 003C0001 4E754E75  N@..^-^-
.<..NuNu

dbg: ms   btext btext+259e "math String search
trapinit+0x7B   - 6D617468 00000000 00223C00 0000402F
math.....”<...@/

dis: ms   btext  btext+259e "*String search
trapinit+0x34   - 2A2A2A2A 20537461 636B204F 76657266  **** Stack
Overf
```

```
trapinit+0x35  - 2A2A2A20 53746163 6B204F76 6572666C  *** Stack
Overfl
trapinit+0x36  - 2A2A2053 7461636B 204F7665 72666C6F  ** Stack
Overflo
trapinit+0x37  - 2A205374 61636B20 4F766572 666C6F77  * Stack
Overflow
trapinit+0x48  - 2A2A2A2A 0D002A2A 2A2A2043 616E2774  ****..****
Can't
trapinit+0x49  - 2A2A2A0D 002A2A2A 2A204361 6E277420  ***..****
Can't
trapinit+0x4A  - 2A2A0D00 2A2A2A2A 2043616E 27742069  **..****
Can't i
_T$DMul+0x150  - 2A04CA81 84852A04 4685C285 C8808284
*.J...*.F.B.H...
_T$DMul+0x156  - 2A044685 C285C880 8284C085 4A826A3C
*.F.B.H...@.J.j<
_T$DDiv+0x64   - 2A3C0000 07FF2801 C885B981 80842803
*<....(.H.9...(.
NormD+0x66     - 2A044685 C285C882 82846022 E8B9E8B8
*.F.B.H...`"h9h8

dbg: ms  btext  btext+259e 2a 00Same as above but null terminated
sprintf+0x3B8  - 2A0047EE 803E2004 720FC081 2C002200  *.Gn.>
.r.@.,.".
putc+0x7       - 2A000C48 C0028000 0080220C 80000080
*..H@.....".....
putc+0x1B      - 2A000C48 C07222C0 810C8000 00000266
*..H@r"@.......f
putc+0x35      - 2A000C48 C0080000 02672A48 78000141
*..H@....g*Hx..A
putc+0x6B      - 2A000C48 C0080000 08660620 0A610001  *..H@....f.
.a..
putc+0x8D      - 2A000C48 C0080000 0766160C 97000000
*..H@....f......
fclose+0xD     - 2A000C48 C0080000 0F671430 2A000C48
*..H@....g.0*..H
fclose+0x19    - 2A000C48 C0080000 01670E20 0A612628  *..H@....g.
.a&(
_setbase+0x4B  - 2A000C48 C0080000 07670E41 FA049E25
*..H@....g.Az..%
_setbase+0x75  - 2A000C48 C0720CC0 81660000 9E4A6A00
*..H@r.@.f...Jj.
_setbase+0x89  - 2A000C48 C0080000 07670835 7C020000
*..H@....g.5|...
_setbase+0xFB  - 2A001248 C0D1AE81 54700848 C0816A00
*..H@Q..Tp.H@.j.
_setbase+0x10D - 2A000432 2A001248 C1D08125 40000824
*..2*..HAP.%@..$
_setbase+0x111 - 2A001248 C1D08125 40000824 80588F4C
*..HAP.%@..$.X.L
dbg:
```

Linking to a Module

Use the `l` command to link to a memory module. If the named module is not in memory, `debug` tries to load a file (in the execution directory) of the given name. The module's address is placed in the `.r7` relocation register. Subsequent `l` commands unlink the previously linked module and link to the new module. The module is automatically unlinked when the debugger terminates.

Table 2-12. Link Memory Module Command

Command	Specification
`l <name>`	Link debugger to the module specified by `<name>`.

Example

```
dbg: l term      Link to the module named TERM
dbg: @7          Set default relocation register to
dbg: .r          Display relocation registers
Rn: 00000000 00000000  00000000 0001FE00   00000000
00000000  00000000 000230C
dbg: d8 0        Display memory
0x00000000+r7 - 4AFC0001 0000007A 00000000 00000070
J|.....z.......p
0x00000010+r7 - FFFF0F00 80000004 00000000 00000000
................
0x00000020+r7 - 00000000 00000000 00000000 0000C5F3
..............Es
0x00000030+r7 - 00FF8080 1B030123 00640068 00000000
.......#.d.h....
0x00000040+r7 - 00000000 0000001C 00000100 01010001
................
0x00000050+r7 - 1808180D 1B040117 03050807 000F0070
..............p
0x00000060+r7 - 11130904 53636600 73633638 36383100
....Scf.sc68681.
0x00000070+r7 - 7465726D 00000022 24014AFC 00010000
term..."$.J|....
dis:
```

Symbolic Debugging

The debugger's symbolic debugging facility allows easy debugging without linkage maps or address tables for reference. The `-g` option of the linker (`l68`) writes symbol information into an OS-9 data module. The linker places the symbols associated with global code and data offsets into the symbol table. If a symbol module is available for the code module being debugged, symbolic addresses can be used in most debugger commands.

The linker's `-g` option creates a symbol module in the execution directory. The name of the module is that of the code module with `.stb` appended. If a directory named `STB` exists in the execution directory, the linker places the symbol module in that directory. This is helpful to reduce the number of entries in the execution directory.

Upon successful creation of a process to execute a program module (see the `f` command), the debugger searches the execution directory for the symbol module. If not found in the execution directory, the `STB` directory in the execution directory is searched. If the `STB` directory does not exist or the symbol module was not found, the debugger begins the same search sequence using directories given in the `PATH` environment variable. This search sequence is the same as the shell uses.

If the symbol module cannot be located, the following message is reported:

```
- can't find 'prog.stb'.  Error #000:216  file not found
```

When the symbol module is successfully loaded, it is examined to verify that it matches the code module being debugged. The module CRC of the program module is stored in the symbol module. If this CRC value does not match that of the code module, the following message is reported:

```
- symbol module 'c68.stb' is obsolete.
```

This message indicates one of three problems:

- The symbol module does not match the code module.
- The code module does not match the symbol module.
- The debugger does not recognize the format of the symbol module.

The cause of this error is usually that an old version of the symbol module and/or code module is already in memory. Be sure that the program has been properly linked by the linker and that old versions of the program are removed from memory.

If the debugger cannot locate a symbol module, the program can still be debugged but the symbolic facilities are not available. Because the program's symbols are kept in a separate module, a program need not have a final production compilation to remove the symbol information. You can keep the symbol modules of production programs in case additional debugging is required.

The debugger maintains a table of symbol modules containing an entry for each program module being debugged. Normally, this consists of a primary program module and any trap handler module symbol tables. The debugger automatically locates and uses the proper symbol module when that point in the program is reached.

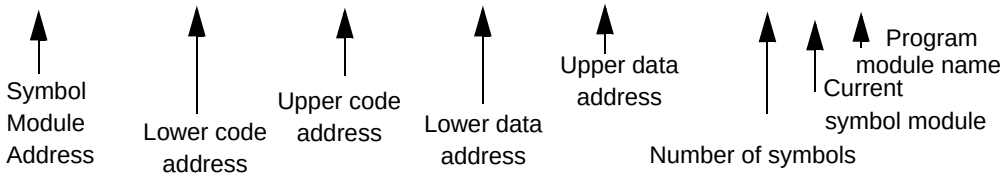
The following commands deal with the symbol table features:

Table 2-13. Symbol Table Commands and Specifications

Command	Specification
`s`	Display all symbols in all symbol modules.
`s [mod:]<symb>`	Display a single symbol from the current symbol module or symbol module [`mod:`]. The asterisk (`*`) and question mark (`?`) wildcard symbols may be used in the symbol name.
`sm`	Display symbol module table.
`ss`	Set current symbol module to the module containing the current PC.
`ss <addr>`	Set current symbol module to the module containing `<addr>`.
`ss <name>:`	Set current symbol module to the symbol module specified by `<name>`.
`sd <name>`	Display data symbols only for the specified symbol module.
`sc <name>`	Display code symbols only for the specified symbol module.

Examples

```
dbg: f progx Create process running progx
default symbols belong to 'progx' Current symbol module
set to progx
dn: 0000000A 000C0064 00000080 00000003 00000000
000000A2 00001050 00000000
an: 00000000 0001B660 00000000 0016F030 00000000
0001B5BC 00022610 0001B5BC
pc: 0016F07E cc: 00 (-----)
<68881 in Null state>
_cstart >2D468010 move.l d6,_totmem(a6)
dbg: sm Display known symbol modules
Mod Addr  Code Lo  Code Hi  Data Lo  Data Hi Count Name
0016e850 0016f030 0016f51e 0001a610 0001a9bc    83
*progx
```



`Code Lo` and `Code Hi` are the base and end addresses of the program module. `Data Lo` and `Data Hi` are the lower and upper addresses of the initial process data area when the process was forked. Note that the data addresses have the (a6)+32768 bias removed.

```
dbg: gs main
Installed symbol module for trap handler 'cio'
dn: 00000001 0001B62E  0001A62A 0001B636   00000000
000000A2  00001050 00000000
an: 0001A9BE 001F214A  0001B62E 0001B626   0001B622
00000000  00022610 0001B5B4
pc: 0016F280  cc: 00 (-----)
<68881 in Null state>
main              >48E7F080        movem.l d0-d3/a0,-
(a7)
```

When control is returned to `debug`, the debugger checks to see if the process has called a trap handler module (via the `F$TLink` system call) to install a trap handler. If so, `debug` attempts to locate a symbol table module for the trap handler. If found, the symbol module is entered into the symbol module table. You can then reference code and data addresses in the trap handler by symbol name.

The asterisk (`*`) before the symbol module name indicates the current symbol module. Symbols without a symbol module qualifier are assumed to be in this symbol module. Symbols in other symbol modules are accessed by preceding the symbol name with a colon-terminated symbol module name.

```
dbg: sm
Mod Addr   Code Lo  Code Hi  Data Lo  Data Hi Count  Name
0016c5d0  001f20c0 001f4b48 0016cd70 0016d7dc   109  cio
0016e850  0016f030 0016f51e 0001a610 0001a9bc    83 *progx
dis: gs main+1c
dn: 4042C28F 5C28F5C3  40040000 00000000   00000000 000000A2
00001050 00000000
an: 0001A9BE 001F214A  0001B62E 0001B626   0001B622 00000000
00022610 0001B5A0
pc: 0016F29C  cc: 00 (-----)
<68881 in Null state>
main+0x1C           >4E4F0012         tcall T$Math,T$DMul
dbg: gs
Installed symbol module for trap handler 'math'
dn: 40577333 33333334  02080000 00000000   00000000 000000A2
00001050 00000000
an: 0001A9BE 001F214A  0001B62E 0001B626   0001B622 00000000
00022610 0001B5A0
pc: 0016F2A0  cc: 00 (-----)
fp0:40050000 BB999999 99999E00  fp4:7FFF0000 FFFFFFFF FFFFFFFF
fpcr: 0000 XN
fp1:7FFF0000 FFFFFFFF FFFFFFFF  fp5:7FFF0000 FFFFFFFF FFFFFFFF
fpiar: 00000000
fp2:7FFF0000 FFFFFFFF FFFFFFFF  fp6:7FFF0000 FFFFFFFF FFFFFFFF
fpsr: 00000208
fp3:7FFF0000 FFFFFFFF FFFFFFFF  fp7:7FFF0000 FFFFFFFF FFFFFFFF
(----    0)
AX:(INEX) XS:(INEX2)
main+0x20           >48EE000383A2     movem.l d0-d1,varx(a6)
dbg: sm
Mod Addr   Code Lo  Code Hi  Data Lo  Data Hi Count  Name
0016c5d0  001f20c0 001f4b48 0016cd70 0016d7dc   109  cio
0016e850  0016f030 0016f51e 0001a610 0001a9bc    83 *progx
00181b80  001109c0 001114ca 0001a610 0001a60e    75  math
```

The `ss` command with no parameter sets the current symbol module to the module containing the current program counter address:

```
dbg: ss
default symbols belong to 'progx'
```

The `s` command with no parameter displays all symbols in all symbol modules in the following format: the symbol name, a type code (`D` = data symbol, `C` = code symbol) and the absolute address of the symbol.

```
dbg: s
math:_jmptbl     D 00022610     math:end         D 00022610
math:btext       C 001109C0     math:MathEnt     C 00110A10
math:EntErr      C 00110A36     math:TermEnt     C 00110A40
math:InitEnt     C 00110A40     math:_T$LtoA     C 00110ABA
math:_T$UtoA     C 00110AD0     math:_T$FtoA     C 00110B14
math:_T$DtoA     C 00110B22     math:ASCNUM      C 00110CB2
math:OVRFLO      C 00110D1E     math:NXTDIG      C 00110D3E
     . . .
math:_T$FInt     C 00111472     math:_T$DInt     C 00111480
math:_T$FtoD     C 00111496     math:_T$DtoF     C 001114A4
math:bname       C 001114B2    _mtop             D 00022614
_stbot           D 00022618     errno            D 0002261C
_totmem          D 00022620     _sbsize          D 00022624
_pathcnt         D 00022628     _iob             D 0002262A
     . . .
getenv           C 0016F442     _initarg         C 0016F446
etext            C 0016F49C     exit             C 0016F4CA
abort            C 0016F4D6     _exit            C 0016F4D8
_utinit          C 0016F4E2     _dumprof         C 0016F4E8
cio:errnoptr     D 00174D70     cio:freturn      D 00174D74
cio:fstorage     D 00174D78     cio:errno        D 00174D7C
cio:_mtop        D 00174D80     cio:_mend        D 00174D84
cio:_fcbs        D 00174D88     cio:_caller      D 00174D8C
cio:ememptr      D 00174D90     cio:ememcnt      D 00174D94
cio:environ      D 00174D98     cio:_chcodes     D 00175751
     . . .
cio:munload      C 001F4A78     cio:_sysret0     C 001F4A88
cio:_sysret      C 001F4A8C     cio:_os9err      C 001F4A8E
cio:bname        C 001F4A9A
```

A symbol can be given as the parameter to the `s` command. Each symbol module is searched for the symbol and displayed if present. Symbols in symbol modules, other than the current symbol module, are prefixed by the name of the containing module:

```
dbg: s printfFind symbol in any module
printf          C 000FC60E   cio:printf     C 001F2C96
dbg: s btextFind symbol in any module
math:btext      C 001109C0   btext          C 000F52A0
cio:btext       C 001F20C0
dbg: s cio:printf  Find symbol in given module
cio:printf      C 001F2C96
dbg: s p*Wildcard: all symbols starting with p
printf          C 000FC60E   puts           C 000FC61E
putc            C 000FC626   putw           C 000FC62A
cio:puts        C 001F2B3A   cio:printf     C 001F2C96
cio:putc        C 001F3C66   cio:putw       C 001F3D1E
dbg: ssSet current module to where PC is pointing
default symbols belong to 'cio'
dbg: sm
Mod Addr   Code Lo  Code Hi  Data Lo  Data Hi Count  Name
0016c5d0  001f20c0 001f4b48 0016cd70 0016d7dc   109 *cio
0016e850  0016f030 0016f51e 0001a610 0001a9bc    83  progx
00181b80  001109c0 001114ca 0001a610 0001a60e    75  math
dbg:
dbg:ss progxSet symbol module to progx
dbg:sm Show symbol modules
Mod Addr   Code Lo  Code Hi  Data Lo  Data Hi Count  Name
000f2f30  001f20c0 001f4b48 000f36d0 000f413c   109  cio
000f51b0  00181690 00181b7e 00014f30 000152dc    83 *progx
00181b80  001109c0 001114ca 00014f30 00014f2e    75  math
```

`dbg: sd`Show all data symbols

```
math:_jmptbl     D 0001CF30     math:end     D 0001CF30
_mtop            D 0001CF34     _stbot       D 0001CF38
errno            D 0001CF3C     _totmem      D 0001CF40
_sbsize          D 0001CF44     _pathcnt     D 0001CF48
_iob             D 0001CF4A     _fcbs        D 0001D2CA
environ          D 0001D2CE     varx         D 0001D2D2
_jmptbl          D 0001D2DE     end          D 0001D2DE
cio:errnoptr     D 000FB6D0     cio:freturn  D 000FB6D4
cio:fstorage     D 000FB6D8     cio:errno    D 000FB6DC
cio:_mtop        D 000FB6E0     cio:_mend    D 000FB6E4
cio:_fcbs        D 000FB6E8     cio:_caller  D 000FB6EC
cio:ememptr      D 000FB6F0     cio:ememcnt  D 000FB6F4
cio:environ      D 000FB6F8     cio:_chcodes D 000FC0B1
cio:_jmptbl      D 000FC13E     cio:end      D 000FC13E
```

`dbg: sd progx`: Show data symbols in `progx`

```
_mtop            D 0001CF34     _stbot       D 0001CF38
errno            D 0001CF3C     _totmem      D 0001CF40
_sbsize          D 0001CF44     _pathcnt     D 0001CF48
_iob             D 0001CF4A     _fcbs        D 0001D2CA
environ          D 0001D2CE     varx         D 0001D2D2
_jmptbl          D 0001D2DE     end          D 0001D2DE

dbg: sc progx:Show code symbols in progx
btext            C 00181690     bname        C 001816D8
_cstart          C 001816DE     _stkcheck    C 001817CC
_stkchec         C 001817CC     stacksiz     C 00181804
freemem          C 0018180E     trapinit     C 00181818
main             C 001818E0     _iobinit     C 00181934
fopen            C 001819CE     fdopen       C 001819D2
freopen          C 001819D6     setbuf       C 001819DA
     . . .
os9exec          C 00181A96     _prgname     C 00181A9A
modloadp         C 00181A9E     getenv       C 00181AA2
_initarg         C 00181AA6     etext        C 00181AFC
exit             C 00181B2A     abort        C 00181B36
_exit            C 00181B38     _utinit      C 00181B42
_dumprof         C 00181B48
```

Creating a Process to Debug

The `f` command creates a process to debug. The parameters accepted are similar to those accepted by the `shell`:

```
f <prog> [#mem] [^prior] [<stdin] [>stdout] [args]
```

The program module `<prog>` is forked with the special `F$DFork` system call. This action provides a controlled process environment for the debugger. The program module is located in a similar fashion as the shell; the `PATH` environment variable is used as a list of alternate search directories to search if the command is not found in the execution directory.

The shell pipe (`!`) and concurrent (`&`) features are not supported. You cannot redirect the standard error path as this is the path that the debugger uses for command input and display output. Shell filename wildcards cannot be used on the `f` command but can be given when `debug` is run directly from the shell.

You can use the `f` command at anytime during the debugging session. If a process was already being debugged, that process is terminated before the new process is created.

After the new process is created, control is returned to the debugger immediately. The debugger displays the first instruction to be executed in the program:

```
dbg: f progx -eCreate process running progx with argument -e
   default symbols belong to 'progx'
dn: 0000000C 000C0064  00000080 00000003   00000000
000000AA  00001060 00000000
an: 00000000 00015F90  00000000 000F52A0   00000000
00015EE4  0001CF30 00015EE4
pc: 000F52EE  cc: 00 (-----)
<68881 in Null state>
_cstart      >2D468010    move.l d6,_totmem(a6)
dbg: q
```

Starting the Debugger from the Shell Command Line

You can start the debugger from the shell command line. Any arguments given to `debug` are processed as if the `f` command was given. Any metacharacters recognized by the shell must be quoted if intended for `debug`. Metacharacters seen by the shell affect `debug` itself rather than the program being debugged.

For example:

```
shell: debug progx -e h1 h2
```

This command is the equivalent to the `f` command issued in the debugger:

```
dbg: f progx -e h1 h2
```

To pass a memory override to the `progx` process, the following two commands are equivalent:

```
shell: debug progx "#32k" -e h1 h2
dbg: fprogx #32k -e h1 h2
```

The debugger uses the standard error path to determine the console device on which the debugger is running. The debugger opens a separate path to this device so as not to interfere with the debugged process' standard error path. This action is useful to debug programs that run as filters:

```
shell: qsort data.file ! debug datafilter ! datamerge
```

In this case, the pipes are set up by the shell and the *datafilter* process runs within the pipeline but under control of the debugger.

If shell filename wildcard processing is desired, run the debugger from the shell command line as normal:

```
shell: debug progx -f *.c
```

The wildcards are expanded and passed to `debug`, which in turn passes the filenames to `progx`.

Setting and Displaying debug Options

The `o` command displays and changes debugger options. To display available options use `o?`:

Table 2-14. debug Options

Option	Description
`b<n>`	Numeric input base radix.
`d`	Toggle 68881 decimal register display.
`f`	Toggle 68881 register display.
`x`	Toggle disassembly hex output format.
`?`	Display options help.

The `o` command displays the current option settings:

```
dbg: o
Hexformat = 0x, Input radix = 16
Show 68881 registers ON in hex
```

The `ob` option controls the number input radix. You can use this option to change the input radix between 16 and 10. The initial input radix is 16. To avoid confusion, the value given as the parameter of the `ob` command is assumed to be decimal.

Examples

```
dbg: v 10Display 10
     0x00000010 (16) 0x00000010
dbg: ob 10Change radix to base 10
     Hexformat = 0x, Input radix = 10
   Show 68881 registers ON in
dbg: v 10Display 10
     0x0000000A (10) 0x0000000A
dbg: od
     Hexformat = 0x, Input radix = 10Show 68881
registers ON in hex
```

The `od` option toggles the 68881 register display between decimal and hexadecimal

```
dbg: .
dn: 00000000 00000000  00000001 00000003   00000000
000000A2  00001050 00000000
an: 000152D2 00000000  00015F4E 00015F46   00015F42
00000000  0001CF30 00015ED4
pc: 00139364  cc: 04 (--Z--)
fp0:40010000 C0000000 00000000  fp4:7FFF0000 FFFFFFFF
FFFFFFFF   fpcr: 0000 XN
fp1:7FFF0000 FFFFFFFF FFFFFFFF  fp5:7FFF0000 FFFFFFFF
FFFFFFFF  fpiar: 00000000
fp2:7FFF0000 FFFFFFFF FFFFFFFF  fp6:7FFF0000 FFFFFFFF
FFFFFFFF   fpsr: 00000008
fp3:7FFF0000 FFFFFFFF FFFFFFFF  fp7:7FFF0000 FFFFFFFF
FFFFFFFF   (----    0)
AX:(INEX)
_exit+0x6    DEADDEAD add.l -8531(a5),d7
dbg: od
Hexformat = 0x, Input radix = 10
Show 68881 registers ON in decimal
dbg: .
dn: 00000000 00000000  00000001 00000003   00000000
000000A2  00001050 00000000
an: 000152D2 00000000  00015F4E 00015F46   00015F42
00000000  0001CF30 00015ED4
pc: 00139364  cc: 04 (--Z--)
fp0:6                      fp4:<NaN>
fpcr: 0000 XN
```

```
fp1:<NaN>                    fp5:<NaN>
fpiar: 00000000
fp2:<NaN>                   fp6:<NaN>
fpsr: 00000008
fp3:<NaN>                   fp7:<NaN>
(----    0)
AX:(INEX)
_exit+0x6   DEADDEAD add.l -8531(a5),d7
```

The `of` option toggles the 68881 register display on and off.

```
dbg: .
dn: 00000000 00000000  00000001 00000003  00000000
000000A2  00001050 00000000
an: 000152D2 00000000  00015F4E 00015F46  00015F42
00000000  0001CF30 00015ED4
pc: 00139364  cc: 04 (--Z--)
fp0:6                        fp4:<NaN>
fpcr: 0000 XN
fp1:<NaN>                     fp5:<NaN>
fpiar: 00000000
fp2:<NaN>                    fp6:<NaN>
>fpsr: 00000008
fp3:<NaN>                    fp7:<NaN>
(----    0)
AX:(INEX)
_exit+0x6     DEADDEAD add.l -8531(a5),d7
dbg: of
Hexformat = 0x, Input radix = 10
Show 68881 registers OFF
dbg: .
dn: 00000000 00000000  00000001 00000003  00000000
000000A2  00001050 00000000
an: 000152D2 00000000  00015F4E 00015F46  00015F42
00000000  0001CF30 00015ED4
pc: 00139364  cc: 04 (--Z--)
_exit+0x6     DEADDEAD add.l -8531(a5),d7
dbg:
```

The ox option toggles the hex number indicator between $ (for assembler programmers) and 0x (for C programmers):

```
dbg:di .pc
_cstart         >2D468010     move.l d6,_totmem(a6)
_cstart+0x4     >2D468014     move.l d6,_sbsize(a6)
_cstart+0x8     >3D438018     move.w d3,_pathcnt(a6)
_cstart+0xC     >4A85         tst.l d5
_cstart+0xE     >671E         beq.b _cstart+0x2E
_cstart+0x10    >08050000     btst.b #0,d5
_cstart+0x14    >6614         bne.b _cstart+0x2A->
dis: ox
Hexformat = $, Input radix = 16
Show 68881 registers ON in hex
dbg: di .pc
_cstart         >2D468010     move.l d6,_totmem(a6)
_cstart+$4      >2D468014     move.l d6,_sbsize(a6)
_cstart+$8      >3D438018     move.w d3,_pathcnt(a6)_
cstart+$C      >4A85         tst.l d5
_cstart+$E      >671E         beq.b _cstart+$2E
_cstart+$10     >08050000     btst.b #0,d5
_cstart+$14     >6614         bne.b _cstart+$2A->
```

Expressions and the V Command

Any debugger command accepting an address or numeric value can also accept an expression. An expression operands are shown in <links>Table 2-15. Expression Operands.

Table 2-15. Expression Operands

Operand	Specification
<symbol>	Code or data symbol. Data symbols are automatically biased by -32767 before use.
<num>	<num> is interpreted as a number in the default radix.
#<num>	<num> is a valid decimal (base 10) number.
$<num>	<num> is a valid hexadecimal (base 16) number.
0x<num>	<num> is a valid hexadecimal (base 16) number.

Table 2-15. Expression Operands (Continued)

Operand	Specification
'char>	The ASCII value of <char> is sign extended to a number.
.d0 - .d7	The value of the given data register.
.a0 - .a7	The value of the given address register.
.sp	The value of the .a7 register.
.pc	The value of the program counter.
.cc	The value of the condition code register.
.fpsr	The value of the 68881 FPSR register.
.fpcr	The value of the 68881 FPCR register.
.fpiar	The value of the 68881 FPIAR register.

An expression may contain any of the following operators.

In the following tables, e1 and e2 represent any legal expression.

Binary Operations (operate on the left and right operand)

Binary operations are shown in <links>Table 2-16. Binary Operations.

Table 2-16. Binary Operations

Operator	Function
e1 + e2	Add e2 to e1.
e1 - e2	Subtract e2 from e1.
e1 * e2	Multiply e1 by e2.
e1 / e2	Divide e1 by e2.
e1 > e2	Bitwise right shift e1 by e2 bits.
e1 < e2	Bitwise left shift e1 by e2 bits.
e1 & e2	Bitwise AND of e1 and e2.
e1 | e2	Bitwise OR of e1 and e2.
e1 ^ e2	Bitwise Exclusive OR of e1 and e2.

Unary Operators (operate on the right operand)

Unary operators are shown in <links>Table 2-17. Unary Operators.

Table 2-17. Unary Operators

Operator	Function
`- e1`	Negate `e1`.
`~ e1`	Complements `e1`.

Indirect Operators

Indirect operators are shown in <links>Table 2-18. Indirect Operators.

Table 2-18. Indirect Operators

Operator	Function
`[e1]`	The expression `e1` is used as the address of a long value for this term.
`[e1]l`	The expression `e1` is used as the address of a long value for this term.
`[e1]w`	The expression `e1` is used as the address of a word value which is sign-extended to 32-bits and used as the value for this term.
`[e1]b`	The expression `e1` is used as the address of a byte value which is sign-extended to 32-bits and used as the value for this term.

All expression evaluation is performed using 32-bit two's complement arithmetic. Traditional operator precedence is not observed; evaluation is simply left to right. Parentheses may be used to force evaluation order. Most commands requiring a count accept an asterisk (`*`) to mean infinity.

The `v` command evaluates an expression and prints the value in decimal, hexadecimal, and as a symbolic address.

```
dn: 0000000C 000C0064 00000080 00000003 00000000
000000A2 00001050 00000000
an: 00000000 00015F80 00000000 000F32A0 00000000
00015EDC 0001CF30 00015EDC
pc: 000F32EE cc: 00 (-----)
<68881 in Null state>
_cstart >2D468010 move.l d6,_totmem(a6)
dbg: v .d1
```

```
0x000C0064 (786532) 0xC0064
dbg: v .pc
0x000F32EE (996078) _cstart
dbg: v .pc+10
0x000F32FE (996094) _cstart+0x10
dbg: v .pc+400
0x000F36EE (997102) _initarg+0x38
dbg: v .d1
0x000C0064 (786532) 0xC0064
dbg: v .d5
0x000000A2 (162) 0xA2
dbg: v .d5>4
0x0000000A (10) 0xA
dbg: v .sp+8
0x00015EE4 (89828) 0x15EE4
dbg: gs main
Installed symbol module for trap handler 'cio'
dn: 00000001 00015F4E 00014F4A 00015F56 00000000
000000A2 00001050 00000000
an: 000152DE 001F214A 00015F4E 00015F46 00015F42
00000000 0001CF30 00015ED4
pc: 000F34F0 cc: 00 (-----)
<68881 in Null state>
main >48E7F080 movem.l d0-d3/a0,-(a7)
dbg: v .a1
0x001F214A (2040138) cio:CIOTrap
dbg: v .d1
0x00015F4E (89934) 0x15F4E
dbg: v [.d1]
0x00015F46 (89926) 0x15F46
dbg: d1 [.d1]
0x15F46 - 70726F67 78000000 00015F46 00000000
progx....._F....
```

More expression examples:

```
dn: 00000000 00012345 00000000 0000004A 00000000 0000FA08 00000000
00000000
an: 00008164 00000000 00000045 00000000 00000000 00000000 00002044
00000000
pc: 00000000 cc: 00 (-----)
<68881 in Null state>
dis: v .d1
0x00012345 (74565) 0x00012345
dbg: v .d5>3
0x00001F41 (8001) 0x00001F41
dbg: v 11+69
0x0000007A (122) 0x0000007A
dbg: v #11+#69 Explicit decimal numbers
0x00000050 (80) 0x00000050
Utilities Manual 2-45
dbg: v fe61*2 Some hex values confuse debug
Symbol 'fe61*2' not found
dbg: v 0xfe61*2 Use 0x for clarity
0x0001FCC2 (130242) 0x0001FCC2
dbg: v .a0-24
0x00008140 (33088) 0x00008140
dbg: v .a0&fff
0x00000164 (356) 0x00000164
dbg: v .d5-5*.a2
0x004362CF (4416207) 0x004362CF
dbg: v .d5-(5*.a2)
0x0000F8AF (63663) 0x0000F8AF
dbg: v .a2^.d3
0x0000000F (15) 0x0000000F
dbg: d1 .a6
0x00002044 - 001FEF70 001FF4F4 00156440 000023E4 ..op..tt..d@..#d
dis: v [.a6] Memory indirection
0x001FEF70 (2092912) 0x001FEF70
dbg: v [.a6]+10
0x001FEF80 (2092928) 0x001FEF80
dbg: v [.a6]w
0x0000001F (31) 0x0000001F
dbg: v [.a6]w+1
0x00000020 (32) 0x00000020
dbg: v [.a6]b
0x00000000 (0) 0x00000000
```

Command Summary

<links>Table 2-19. debug Utility Command Summary shows a list of all debug commands and a brief description.

Table 2-19. debug Utility Command Summary

Command	Description
b	Displays breakpoint list.
b<addr>	Sets breakpoint at <addr>.
c<addr>	Changes byte values.
cw<addr>	Changes word values.
cl<addr>	Changes longword values.
d[M][N] <addr> [<len>]	Memory display. [M] is an optional format indicator. If not present, the memory dump is displayed in the normal hexadecimal ASCII dump format. One of the following codes can be given to cause the dump to interpret a memory as follows: I: Instruction disassembly. F: Single precision floating point. D: Double precision floating point. X: Extended precision floating point (if 68881 is available).
f <prog> <params>	Creates the process to execute the specified program. <params> may be one of the following: #<mem> ^<prior> <<path> ><path> <args> Pipes and standard error redirection are not allowed.
g	Go: Runs the program until a breakpoint, exception, or the F$Exit system call is encountered.

Table 2-19. debug Utility Command Summary (Continued)

Command	Description
`g <addr>`	`Go from address:` Runs the program starting execution at `<addr>`, until a breakpoint, exception, or the `F$Exit` system call is encounter
`gs`	`Go and stop:` Executes the program until the next instruction is encountered. This is the same as the `Go` command, but it sets a breakpoint at the next instruction. The breakpoint is automatically removed when the debugger regains control.
`gs <addr>`	`Go and stop at address:` Executes program up to the specified `<addr>`. This is the same as the `Go` command, but it sets a breakpoint at `<addr>`. The breakpoint is automatically removed when the debugger regains control.
`i`	Displays the number of instructions executed by the program. This count does not include instructions executed in system state or during the `x -1` command.
`k <addr>`	Kills breakpoints at `<addr>`.
`k *`	Kills all breakpoints.
`l <name>`	Links debugger to the module specified by `<name>`.
`mf[S][N] <st> <end> <val>`	Memory fill. `[S]` designates the size of the fill. If `[N]` is specified, the fill is not required to be on even word/longword boundaries. `<st>` and `<end>` designate the starting and ending addresses of the fill. `<val>` designates the fill pattern.
`ms[S][N] <st> <end> [:<m>] <val>`	Memory search. `[S]` designates the size of the search. If `[N]` is specified, the search is not required to be on even word/longword boundaries. `<st>` and `<end>` designate the starting and ending addresses of the search. `<val>` designates the search pattern. `<m>` is a mask used to limit the search to the bits set in `<m>`.

Table 2-19. debug Utility Command Summary (Continued)

Command	Description
`o<opt>`	Displays and changes debugger options. To display available options use `o?`: `b<n>` Numeric input base radix. `d` Toggle 68881 decimal register display. `f` Toggle 68881 register display. `x` Toggle disassembly hex output format. `?` Display options; help.
`q`	Exits the debugger. The process being debugged is terminated and all its resources returned to the system. Any module linked by the `l` command is unlinked as well as any symbol modules in use.
`s`	Displays all symbols in all symbol modules
`s [mod:]<symb>`	Displays a single symbol from the current symbol module or symbol module `[mod:]`. The asterisk (`*`) and question mark (`?`) wildcard symbols may be used in the symbol name.
`sm`	Displays symbol module table.
`ss`	Sets current symbol module to the module containing the current PC.
`ss <addr>`	Sets current symbol module to the module containing `<addr>`.
`ss <name>:`	Sets current symbol module to the symbol module specified by `<name>`.
`sd <name>`	Displays data symbols only for the specified symbol module.
`sc <name>`	Displays code symbols only for the specified symbol module.
`t`	`Trace:` The debugger executes one instruction and re-displays the machine registers.

Table 2-19. debug Utility Command Summary (Continued)

Command	Description
`t <count>`	`Trace instructions`: The debugger executes `<count>` instructions and re-displays the machine registers. Each instruction is displayed as it is executed. Breakpoints are ignored while tracing.
`v <expr>`	Prints the value of expression in hexadecimal and decimal
`w [<n>]`	Linkstack traceback via (`a5`). `<n>` = depth of traceback. If `<n>` is not specified, a complete traceback is displayed.
`x <count>`	`Execute instructions`. The debugger executes `<count>` instructions and re-displays the machine registers. Breakpoints are in effect and no instruction trace is displayed. If `<count>` is -1, hard breakpoints are set in the program allowing full-speed debugging. If `<count>` is positive, soft breakpoints are used and control returns after `<count>` instructions have been executed.
`@`	Prints the default relocation register.
`@<num>`	Sets default relocation register to `<num>`. `<num>` = 0 to 7.
`.r`	Displays the relocation registers.
`.r<num> <val>`	Sets the specified relocation register to `<val>`.
`?`	Displays debugger commands.

3 Using the editmod Utility

`editmod` creates, displays, and edits OS-9 and OS-9 for 68K modules. In addition, it can also generate header files for inclusion in code that deals with these modules. It has the following attributes:

- *Comprehensive* — Use `editmod` for all aspects of module maintenance: creation, examination, and modification. `editmod` supports these actions on device descriptors, system modules, and data modules. You can use it in conjunction with the `make` utility to create modules non-interactively. It is no longer necessary to use the `moded` utility, compilers, assemblers, and linkers.
- *Host/Target independent* — `editmod` may be used on any host platform to manipulate modules for any target platform.
- *Stand-alone* — With the exception of supporting description files, `editmod` does not require any other resources to manipulate modules.
- *Extensible* — End users can write the supporting files necessary for `editmod` to understand modules of their own creation.
- *Unconstrained* — `editmod` does not limit module modifications based on previous module contents. This includes support for variable length lists such as the colored memory list in the `init` module. In addition, a module within a boot file may be modified to any length.
- *User interface* — `editmod` allows entry of C expressions with additional operand types for hexadecimal constants, binary constants, internet addresses, and ethernet addresses.

This section contain a basic guide to using `editmod` and a technical programmer's guide for creating modules.

Use Instructions

Creating Modules

The -c option is used to create modules. For example, the following command line creates a device descriptor called term:

```
editmod -c term -dTERM
```

- `-c` specifies the creation mode.
- `term` is the name of the output file.
- `-dTERM` defines the identifier `TERM`.

Refer to the programmer's guide for more information about creating modules.

Listing Modules

The contents of a module are displayed using the `-l` option. For example, the following command line lists the contents of the `init` module.

```
editmod -l init
```

- `-l` selects the view mode.
- `init` is the file name of the module to list

Editing Modules

The contents of a module can be edited by using the `-e` option. A series of navigable menus access all the editable fields in the module. The following is a sample annotated editing session.

To start editing a module, use the following command line:

```
editmod -e init
```

- `-e` selects the edit mode
- `init` is the file name of the module to edit

After the descriptions and module have been read, the following menu is presented:

```
 1. Module header information
 2. Init module information

Which? [?/1-2/p/t/a/w/q]
```

The valid responses appear in the table below:

Table 3-1. Valid Responses to Which?

Response	Description
?	Prints help about the valid responses
1 or *2*	Selects a portion of the module to edit
p	Returns to the previous menu. Since this menu has no previous menu, entering *p* would cause it to be re-displayed.
t	Returns to top menu. Using *t* at a sub-menu would return you to this menu. Since this is the top menu, entering *t* would cause it to be re-displayed.
a	Aborts module editing without writing the module. If the module has been modified, you are asked if losing the changes is desired.
w	Writes the current version of the module into the output file.
q	Writes the modified module to the output file and exits.

Entering `1` transfers you to the following menu:

```
 1. Group number                  : 0x1
 2. User number                   : 0x0
 3. Module name                   : "init"
 4. Module access permissions     : 0x555
 5. Module language               : 0x0
 6. Module type                   : 0xc
 7. Module revision               : 0x0
 8. Module attributes             : 0x80
 9. Module edition                : 0x1

Which? [?/1-9/p/t/a/w/q]
```

There are nine editable items in the menu. Entering `1` displays the prompt:

```
Group number                      : 0x1
New value:
At this point, any of the following may be entered: ?,
<CR>, or a C expression.
```

? prints help on the semantics of the item. For example:

```
New value: ?

This is the group number of the owner of the module.

New value:
```

Pressing <CR> leaves the item at its present value.

A C expression may also be entered. This expression may contain pre-processor identifiers, operators, and constants. Assuming a `#define SUPER_GROUP 0` had appeared in the description files, you might enter:

```
New value: SUPER_GROUP
```

The menu is re-displayed below. Notice the change in the first line.

```
 1. Group number                 : 0x0
 2. User number                  : 0x0
 3. Module name                  : "init"
 4. Module access permissions    : 0x555
 5. Module language              : 0x0
 6. Module type                  : 0xc
 7. Module revision              : 0x0
 8. Module attributes            : 0x80
 9. Module edition               : 0x1

Which? [?/1-9/p/t/a/w/q]
```

This example is trivial because you are editing an integer field. Module editing may involve the editing of arrays, strings, or variable length lists.

Editing an Array

The array is displayed and you are asked which item in the array you want to edit:

```
Which array
0x01, 0x02, 0x03

Which element? (0 - 2)
```

At this prompt, a C expression may be entered specifying which item in the array to edit or `?` may be used to get help on the semantics of the array elements.

Entering `1` yields:

```
Old value = 0x2
New value =
```

Again, a C expression for the new value may be entered or `?` may be used to get semantics help.

Editing a String

Changing a string is as simple as entering a new one. The old string value is displayed and new one is prompted for.

```
Module name                    : "init"
New string:
```

At this point, one of three things may be entered:

- `?` provides help on the semantics of the string.
- `<CR>` results in no change to the string.
- A new string to replace the current one. The new string may contain C-style character escapes (`\n`, `\012`, etc.).

To change the string to the "NULL" string, enter `NULL` in response to the `New string:` prompt.

Editing a Variable Length List

Some items in modules are not a constant size. For example, some `init` modules contain a list of colored memory structures terminated with an entry with type zero. This is shown in the following menu:

```
 1. Memory list nodes [0]
 2. Memory list nodes [1]
 3. Memory list nodes [2]
 4. Memory list nodes [3]
 5. Add additional item to list
 6. Delete item from list

Which? [?/1-5/p/t/a/w/q]
```

This indicates that there are currently four nodes in the list (numbered zero through three).

Selecting menu item six allows any of the four memory list nodes to be deleted.

Selecting menu option five adds one to this list and re-displays the menu as follows. Note the change in item 5.

```
 1. Memory list nodes [0]
 2. Memory list nodes [1]
 3. Memory list nodes [2]
 4. Memory list nodes [3]
 5. Memory list nodes [4]
 6. Add additional item to list
 7. Delete item from list
Which? [?/1-5/p/t/a/w/q]
```

The items in the list are edited using the procedures described above.

Expressions

`editmod` contains an user input expression interpreter. When editing fields within the editor, you may enter expressions that contain the following elements:

Constants	character, hexadecimal, octal, decimal (See below for additional constant types)
Operators	all the non-assignment operators are supported
Preprocessor macros	any preprocessor macros entered are replaced with their appropriate values

The expression interpreter has been extended for use within `editmod` to include additional constant types.

$ prefix

The '`$`' can be used as the prefix for hexadecimal constants. For example, `$555` is the same as `0x555`.

@ prefix

The '@' can be used as the prefix for binary constants. For example, @011101110111 is the same as 0x777.

Internet address

Internet addresses may be used. They appear as a dot(.) separated four item sequence of decimal numbers in the range zero to 255. For example: 190.20.0.45.

Ethernet address

Ethernet addresses may be used. They appear as a colon(:) separated six item sequence of hexadecimal numbers in the range zero to 255(0xff). The 0x or $ prefix is not valid. For example, 6f:ab:0:65:6:4.

DPIO Descriptors

editmod contains some support for OS-9 Dual Ported Input/Output (DPIO) descriptors. editmod assumes an OS-9 system-state program module is a DPIO "secondary" descriptor and that, in creation mode, OS-9 system-state programs may have initialized data.

A utility called DPSplit is also provided to separate and join "primary" and "secondary" descriptors. To edit a DPIO descriptor, use the following process:

Step 1. Use DPSplit to split the file into the individual modules.

Step 2. Edit either modsule.

Step 3. Use DPSplit to join the individual modules back into a single DPIO descriptor.

To create a DPIO module, use the following process:

Step 1. Use `editmod` to create the "primary" module.

Step 2. Use `editmod` to create the "secondary" module.

Step 3. Use `DPSplit` to join the individual modules into a single DPIO descriptor.

Programming Guide

If you create a new driver, file manager or system module, you need to know how to create the description files necessary for `editmod` to understand the format of your descriptors or modules.

Generally, you define the structure of all the sections of the module and the format of the module itself. With this information, `editmod` has what it needs to create a module from scratch, display the contents of an existing module, edit the contents of an existing module, or generate C structure definitions suitable for inclusion in code that manipulates the modules.

The remainder of this section describes some basic aspects of `editmod`'s source language, shows the syntax of the language used to describe the module contents, gives some ground rules that must be followed when creating module descriptions, and details how to use the `editmod` utility.

Features

The description files have the following features:

C-like pre-processor — `editmod` features a C-like pre-processor that should be familiar to C programmers. The additions and omissions are outlined in a following section.

C-like syntax — `editmod`'s description files are written much like C structure definitions and assignment statements. The extensions to the expression interpreter were outlined in a preceding section.

The description language has the following features:

Structures	definition of a sequence of possibly non-identically typed data items. A structure may contain other structures or pointers to other data items.
Arrays	definition of a sequence of identically typed data items.
Pointer arrays	definition of a sequence of pointers to data items.
Strings	definition of a NIL terminated sequence of ASCII characters.
Repeat structures	definition of a series of structures that repeats until a certain condition is met.
Module layout	definition of the exact layout of the module. This technique is superior to relying on a compiler to preserve the programmer's ordering from the source file.
Help text	ASCII descriptions of the various data items that `editmod` uses when interfacing with the user.

Pre-Processor

`editmod` has a built-in pre-processor that is very much like a C pre-processor. The following sections give more specific information.

Exclusions

The following items are not included in `editmod`'s pre-processor:

Macros	`editmod` does not support the definition of macros with arguments. The following is not valid: #define field(x, y) x->y
Identifier catenation	The `##syntax` used by ANSI compilers is not supported in `editmod`.

Pre-processor directive line extension

The '\' at the end of a pre-processor directive line to include the following line is not supported by editmod.

Additions

The following additional pre-processor directive is supported by editmod.

```
#cinclude <filename> or #cinclude "filename"
```

- The #cinclude directive tells editmod to include filename as a C header file. This syntax is used to allowed editmod to extract all the non-macro #define's from a C header file. Any header files included by a header file included with #cinclude are considered to be a C include file. With this technique, description writers can include system header files and use symbolic names in help text to aid the user while editing. For example, if modes.h was included, S_IREAD could be used when entering device mode capabilities.
- All symbol names are available to the pre-processor during pre-processor expressions. That is, one can test for the definition of data structures with #ifdef, #ifndef, or #if defined(). This can be useful for determining of a given structure has already been defined by a previously processed .des file.

For example,

```
#if !defined(devcon)
    struct devcon
    {
        u_int32 empty = 0;
    };
#endif
```

Macro Definitions

_editmod is defined automatically to indicate that the editmod utility is currently being used. For example,

- _editmod indicates that the editmod utility is being used. This might be useful for C header files that are included via #cinclude in description files.

- `_editmod_HM` indicates that `editmod` is reading a description file while in header mode. See the `emit` keyword for an example of where this may be useful.
- `_DPIO` indicates that the module being edited or listed is a `DPIO` OS-9 system state program.
- `M_EDIT` is set to the edition of the module being edited or listed. This may be used to allow editmod to handle multiple formats for the same module.

The remainder of the automatically defined macros are operating system or processor specific.

Table 3-2. Target operating system macros

Operating System	Macro
OS-9/68000	`_OSK`
OS-9	`_OS9000`

Table 3-3. Target processor macros

Processor Family	Macros
68000	`_MPF68K, _BIG_END`
x86/Pentium™	`_MPF386, _LIL_END`
PowerPC™	`_MPFPOWERPC, _BIG_END`

Expressions

The description file contains expressions in various contexts. `editmod` has an extended expression interpreter that includes additional constant types and operations on non-integer constants. The following are the basic features:

Constants — character, hexadecimal, octal, decimal (See below for additional constant types).

Operators — all non-assignment based operators are included.

`sizeof()` operation

Variables — members of other structures can be referenced within expressions.

The following additional features are provided:

Additional constant types
: Refer to the <links> Use Instructions section on expressions.

`numof()` *operation*
: provided to determine the number of items in a repeat structure.

Operations on Internet and ethernet addresses
: The following six operators are allowed on addresses: +, -, |, &, ==, and !=. These integer operations are applied to each addresses respective fields. That is:

```
3:4:5:10:11:12 + 6:2:2:3:4:4 = 9:6:7:13:15:16
192.60.2.10 & 255.255.255.0 = 192.60.2.0
192.60.2.10 == 0.0.0.0 = 0 (False)
```

Search Directories

The list of search directories is built of the following components in the order listed:

1. User-specified directories.

   Any directories specified on the command line with `-v` are added to the list.

2. Directories dictated by the module (see options `-nd`, `-nf`, and `-nm`).

   The directories that relate to the module being edited/listed are added. If creation mode is being used, no additional directories are added at this point.

   For all types of modules the directory:

   `MWOS/SRC/DESC`

   is added to the list. This is where description files for non-descriptor modules that are not operating system specific are located.

   For non-descriptor modules, the configuration file is examined for an entry indicating that the current module being edited needs a specific directory added (refer to the section on the configuration file for more information). If so, that directory is added to the list.

For all types of modules the directory

`MWOS/os/SRC/DESC`

where `os` is the name of the target operating system is added to the list. This is the directory that holds operating system specific description files.

If the module being edited/listed is a descriptor, the file manager specific directory

`MWOS/os/SRC/IO/fm/DESC`

where `os` is the name of the operating system and `fm` is the name of the file manager. If the configuration file has an entry for the file manager, the specified directory is added in place of the file manager specific directory.

If the module being edited/listed is a descriptor, the device driver specific directory

`MWOS/os/SRC/IO/fm/DRVR/driver`

where `os` is the name of the operating system and `driver` is the name of the device driver. If the configuration file has an entry for the device driver, the specified directory is added in place of the device driver specific directory.

A complete list of directories for an OS-9 descriptor module added by step #2 might be:

`MWOS/SRC/DESC`	added for all modules
`MWOS/OS9/SRC/DESC`	added for all OS-9 modules
`MWOS/OS9/SRC/IO/SCF/DESC`	it is an SCF descriptor
`MWOS/OS9/SRC/IO/SCF/DRVR/SC68681`	the device driver is sc68681

A complete list of directories for an OS-9 non-descriptor module added by step #2 might be:

`MWOS/SRC/DESC`	added for all modules
`MWOS/OS9000/SRC/DESC`	added for all OS-9 modules

The location of `MWOS` and the pathlist separators varies among hosts.

OS/processor specific `#include` file directories.

The C include file directories are added to the list.

Table 3-4. `#include` file directories

Target OS	#include File Directories
OS-9/68000	`MWOS/SRC/DEFS` `MWOS/OS9/SRC/DEFS`

OS-9/80386	`MWOS/SRC/DEFS`
	`MWOS/OS9000/SRC/DEFS`
	`MWOS/OS9000/80386/SRC/DEFS`

OS-9/PPC	`MWOS/SRC/DEFS`
	`MWOS/OS9000/SRC/DEFS`
	`MWOS/OS9000/PPC/SRC/DEFS`

Configuration File

A configuration file is read to augment the search directories shown in the preceding section. The configuration file can be found at `MWOS/SRC/DESC/editmod.cfg`. It contains lines with the format:

```
name,os,directory
```

where `name` is the module, file manager, or device driver name whose description files reside in a nonstandard directory, `os` is the operating system that this particular override applies (OS9 or OS9000), and `directory` is the directory to used in place of the standard pathlist.

The directory parameter can be either an absolute or relative pathlist. If the pathlist is relative, it is relative to the root of the host system's `MWOS` directory structure.

For example, if you were developing a new file manager and driver for OS-9 in sub-directories in your `HOME` directory, you would add the following lines to the configuration file:

```
new_fm,os9000,/h0/USR/WARREN/NEWFM
new_driver,os9000,/h0/USR/WARREN/NEWDRVR
```

If you were working on a new OS-9 for 68K system module called `init2`, you would add the following line to the configuration file:

```
init2,os9,OS9/SRC/SYSMODS/INIT2
```

The items specified in the configuration file are only considered when modules are being edited or listed. During module creation, the directories for the description files are provided by using the `-v` option.

Help Text

Various parts of a description file may have help text associated with them. This is the ASCII text that `editmod` uses to communicate with the user as well as for emitting comments in the generated header files. There is more information detailing where help text is used in the following sections. The basic format of the help text is:

```
"name:semantics_help"
```

`name` is a short (generally less than 30 characters) name for the field. This part of the help text is used when displaying the field for the user or as the comment associated with the item in the generated header file.

`semantics_help` is the description the user sees when they ask for help on entering a new value for the field.

As in ANSI C the help text does not have to be, nor is it allowed to be, all in a single double-quoted string. `editmod` concatenates multiple double-quoted strings in a row. The following example illustrates how a help text appears in the description file, assuming `module.h` had been included in the description files.

```
"Module permissions:"
"The module permissions enable/disable various classes
of users from accessing a\n"
"module. The following values can be used to set the
bits:\n"
"    MP_OWNER_READ  (0x0001)\n"
"    MP_OWNER_WRITE (0x0002)\n"
"    MP_OWNER_EXEC  (0x0004)\n"
"    MP_GROUP_READ  (0x0010)\n"
"    MP_GROUP_WRITE (0x0020)\n"
"    MP_GROUP_EXEC  (0x0040)\n"
"    MP_WORLD_READ  (0x0100)\n"
"    MP_WORLD_WRITE (0x0200)\n"
"    MP_WORLD_EXEC  (0x0400)\n"
```

If an item has help text it implies that the member is editable. Many fields are not editable, yet they should have comments in the emitted header file. Use dot(`.`) as the first character of the help text to indicate an non-editable field that should have a comment if emitted in a header file. For example:

```
u_int32 v_lun, ".Logical Unit Number";
```

This would define a non editable unsigned 32-bit integer item called `v_lun` that would appear as

```
u_int32 v_lun; /* Logical Unit Number */
```

in a generated header file.

Refer to the following data structure specific section for information concerning what style of help text is valid in what context.

Module Creation

When the `-c` option of `editmod` is used to create a module, `editmod` begins the task by reading a single description file. It searches the current directory for `systype.des`. If `systype.des` is not found, it searches for `config.des`. However, you can use the `-nc` option to override these searches and specify the initial description file. The initial description file generally contains mutually exclusive sections that contain the initialization information for various modules. For example:

```
#if defined(INIT)
   /* init module specific information */
#endif

#if defined(TERM)
   /* /term descriptor specific information */
#endif
```

You must also define a pre-processor identifier (`TERM` or `INIT` in the example above) to specify which module is being created.

A sample command line to create a module is as follows:

```
editmod -c term -dTERM
```

- `-c` specifies the creation mode.
- `term` is the name of the output file.
- `-dTERM` defines the pre-processor identifier `TERM` to the empty string.

Description Files

Description files are text files that describe the format of modules. They reside in directories shown in the following section. The description files read by `editmod` vary depending on `editmod`'s operational mode.

`editmod`'s creation mode reads, by default, a single description file called `systype.des`. Generally, this description file `#include`'s the appropriate description files to generate a module. Again, the locations of these included files is described in the following section.

`editmod`'s display and edit modes read description files based on the module's contents. If the module is a non-descriptor module, the module name is used to construct a file name in the form `module_name.des`. This description file and those that are `#include`'s are read to determine the format of the module. For descriptor modules, two description files with names based on the file manager and driver names are read in sequence: a file named `driver_name.des` then a file named `file_manager_name.des`. These description files together define the format of the module.

File names generated by `editmod` are limited to the MS-DOS™ file name format of a maximum of eight characters followed by an optional dot and three character maximum extension. Since the extension is always `.des`, the file's base name is limited to eight characters. Therefore, if a module's name, file manager, or driver has a name greater than eight characters, it is truncated to be exactly eight. For example, if the driver was `scp68681lc`, the description file would be named `scp68681.des`.

Description files contain three basic elements:

- Definition Blocks
- Initialization Block
- Module Block

Definition Blocks

Definition blocks are the most basic elements of the definition file. They define the structure and relationships of the various module parts. In C, this is very similar to declaring global variables and defining data structures.

Four types of objects can be defined in a definition block:

- Structures
- Repeat Structures
- Arrays
- Strings

Notes on syntaxes shown:

- `This font` indicates an item that would appear in the description file exactly as shown.
- This font indicates an item that can have various values that are explained following the syntax diagram.
- `Underlined` items in the syntax diagrams indicate items that are optional.

Structures

Structures define all the information related to a set of members. The C struct is very similar in syntax to a structure definition.

```
location struct tag {
   members
}, helptext;
```

- `location` is the section of the module that the structure is to be placed. The keywords that are valid here are *code* or *data*. If a location is not specified, the code area is assumed. Refer to the section on module blocks for more information about putting structures into position within the module.
- `tag` is the name that is associated with the structure. The importance of the name will be seen later.
- `members` define the layout of data within the structure. The following section describes the syntax of the members.

- `helptext` is a double-quoted string that is used when communicating with the user during module display and editing. The current user interface in `editmod` does not use the semantics portion of the help text on structure definitions.

Each member of the structure may be either a:

- Numerical Member
- Pointer to Another Definition Block
- Sub-Structure

Numerical Member

A numerical member definition is in the form:

```
type name = expr , helptext;
```

`type` specifies the type of the numerical member. The valid types and their general size and alignments are listed in the table below.

Table 3-5. Types and their characteristics

type	Size	Alignment	Display
`char`	1	1	'<val>'
`u_char`	1	1	hexadecimal
`int8`	1	1	decimal
`u_int8`	1	1	hexadecimal
`int16`	2	2	decimal
`u_int16`	2	2	hexadecimal
`int32`	4	2	decimal
`u_int32`	4	2	hexadecimal
`in_addr`	4	2	internet address
`et_addr`	6	1	ethernet address

The alignment shown in the table above is the most likely alignment for the object with the exception of `et_addr` which has the same size and alignment on all processors. Some target processors may have different alignment characteristics.

See the section on header generation for information about type aliases.

- `name` is the name of the member. This name is referenced by initialization blocks.
- `expr` is an optional initialization expression. A numerical member that does not have an initialization expression has a default value of zero.
- `helptext` is a double-quoted string that is used when communicating with the user during module display and editing.

Pointer to Another Definition Block

The syntax for a structure member that is a pointer to another definition block is:

```
pointer type name = tag + expr, helptext;
```

type is one of the types from Table 1-23 on page 218. This determines the width of the pointer. For example,

```
pointer u_int16 fm_name = fm_string;
```

declares a structure member named `fm_name` that is a 16-bit wide pointer to `fm_string`.

- name is the name to be given to the pointer member. This name can be referenced from initialization blocks.
- tag is the name of the data structure that is pointed to by the pointer. The destination data structure may be any type: string, structure, array, pointer array, or repeat structure.
- `expr` is an offset within the data structure that `name` is to point to.

Pointer members may have "dot" helptext that will be used when header files are generated. Otherwise, the item pointed at determines if the member is editable.

Sub-Structure

A member of a structure may also be a sub-structure. The syntax for defining such a member is:

```
struct name tag, helptext;
```

- name is the tag for the structure that is to be in the structure being defined.
- `tag` is an optional name for the included structure. When `editmod` is operating in header generation mode the tag field is not optional so it is best to always include a tag field.
- `helptext` is the text emitted as a comment in a generated header file. It must being with a dot(.). This text is not used to communicate with the user; instead, the help text for the structure being named is used.

A given structure can only be named as the sub-structure of only one structure. Otherwise, it would be impossible to initialize sub-structures because the name would be ambiguous.

Repeat Structures

Repeat structures define an item that is a list of structures that terminate on some condition. The definition is very similar to that of a structure.

```
location repeat name [times]{
    members
} until (expr), helptext;
```

- `location` is where the repeat structure is to be placed. It may be either *data* or *code*. If a location is not specified, the code area is assumed.
- `name` identifies the repeat structure. It is most likely referenced by a pointer member.
- `times` is an optional expression that determines the number of times that the repeat must terminate. Use this field to indicate that the termination condition must be met multiple times before the repeat stops.

- `members` are the list of items contained in a single list node for the repeat. The members define a "template" for the format of a single list node. For example, if a member if a pointer member to a string symbol all members of all list nodes in that same position are pointers to string symbols. The structure of the individual list nodes does not vary from one to another. The example shows the usage of a repeat structure.
- `expr` specifies condition that terminates the list of nodes. This is used when reading the nodes from the disk file. The number of nodes in the list is determined by the corresponding `init` blocks (discussed later) in the creation case.
- `helptext` is a double-quoted string used when communicating with the user during module display and editing. The current user interface in `editmod` does not use the semantics portion of the help text on repeat definitions.

An example repeat structure might be:

```
code repeat rep_struct {
   u_int32 is_last = 0;
   u_int32 mem_start;
   u_int32 mem_end;
} until (rep_struct.is_last), "Example repeat
structure";
```

Arrays

Array definitions define a block of identically typed objects. The syntax for defining an array is:

`location array` *`type name`* `[` *`expr`* `] = { data } , helptext;`

- `location` is where the array is to be placed. It may be either *data* or *code*. If a location is not specified, the code area is assumed.
- `type` specifies the type of each element of the array.
- `name` is the name of the array. It may be referenced by pointer structure members.
- `expr` is an expression for the size of the array. The array size may be dependent on members of structures.
- `data` is a comma-separated list of expressions that initialize the array. The array can be uninitialized. This is indicated by not providing any initialization expressions.

- `helptext` is the text used to communicate with the user regarding the array.

An example array might be:

```
code array int16 example_array[10] = {
   1, 3, 5, 7, 9, -2, -4, -6, -8, 0
}, "An example array of numbers";
```

Pointer Arrays

Pointer array definitions define an array of pointers to other data structures. The syntax is as follows:

`location pointer array` *`type name`* `[` *`expr`* `] = {` *`names`* `}, helptext;`

- `location` is where the pointer array is to be placed. It may be either `data` or `code`. If a location is not specified, the code area is assumed.
- `type` specifies the width of each element of the array.
- `name` is the name of the array. It may be referenced by pointer structure members.
- `expr` is an expression for the size of the array. The array size may be dependent on members of structures.
- `names` is a comma-separated list of identifiers that the elements of the array point to. There must be enough to satisfy the size of the array. All pointer arrays are initialized.
- `helptext` is the text that is used to communicate with the user regarding the pointer array.

An example pointer array might be:

```
data pointer array int32 ptr_array[3] = {
   larry_string, moe_string, curly_string
}, "The most famous trio";
```

Strings

A string definition defines a NIL terminated list of characters. The syntax is:

```
location string name = value , helptext;
```

- `location` is where the string is to be placed. It may be either *data* or *code*. If a location is not specified, the code area is assumed.
- `name` is the name for the string. It may be referenced by pointer arrays or pointer structure members.
- `value` is a double quoted string that defines the value for the string data structure.
- `helptext` is the text used to communicate with the user regarding the string.

An example string might be:

```
data string larry_string = "Larry", "Example string";
```

Initialization Block

Initialization blocks set values in data structures. They are used by `editmod` when a module is being created from scratch. The syntax is:

```
init name[index] {
   inits
};
```

- `name` specifies the name of the structure/repeat that is to be initialized.
- `index` is the index into the variable length list of a repeat structure. Although index is an expression, it must resolve to a positive integer. If the item to be initialized is a structure, then ***index*** is omitted.
- `inits` is a series of assignments in the form:

  ```
  name = expr;
  ```

- `name` is the member of the struct/repeat member that is to be initialized.
- `expr` is the expression that the member is to be initialized with.

The following example demonstrates an initialization block:

```
struct example {
   u_int16 mem1 = 0x10;
   u_int32 mem2;
   char mem3 = '\0';
};

init example {
   mem1 = 0x11;
   mem2 = -5;
   mem3 = 'R';
};
```

The `init` block shown overrides the initialization of `mem1` and `mem3` and initializes `mem2`. See the example at the end of this section for an example of a repeat initializer.

When editing or displaying a module, `init` blocks are ignored.

Module Block

The *module block* defines the format for the entire module. Each valid set of description files has a single module block. The syntax for a module blocks is:

```
module { names };
```

`names` is a comma-separated list of names of data structures that are part of the module.

Assuming two code area data structures (`mod_head` and `code_info`) and a data area structure (`data_info`) had been defined, the following is an example module block:

```
module {
   mod_head,
   code_info,
   data_info
};
```

This defines the module to be `mod_head` followed by `code_info` in the code area and data info in the data area. More information about module blocks is presented in the full example at the end of this section.

Header Generation

editmod has the ability to generate C header files for inclusion in code that deals with modules. The information related to this capability has been gathered in this section for easy reference.

A header is generated by giving editmod the name of the description file containing the symbol and the name of the symbol(s) to be emitted. A number of features can be used within the description file to generate an appropriate header file.

Type Aliases

Any basic type may have a type alias associated with it. The type alias is the string to be emitted for the symbol when editmod is operating in header file generation mode. The syntax is

<basic type> ("*<type alias>*")

The <type alias> string may include the printf-like format escape %s that is replaced by editmod with the name of the symbol. Use of the %s escape is not required. If the type alias is an empty string ("") then editmod does not emit any information for that symbol. For example, if the type desired for the header file is "char os9rev[4]", that array might be represented in editmod's language as:

```
int8 ("char os9rev[4];") os9level;
int8 ("") os9release;
int8 ("") os9major;
int8 ("") os9minor;
```

This would generate a header file containing

```
char os9rev[4];
```

and would allow editing of the individual fields of the four byte array.

Comments

The "short description" portion of the help text is used as comments in emitted header files. For example,

```
u_int32 v_lun, "Logical Unit Number:This is the logical unit
number.";
```

would be emitted as:

```
u_int32 v_lun; /* Logical Unit Number */
```

emit <string>;

This syntax allows text to added to the emitted header file. It may only be used within a `struct` or repeat. If `editmod` is not in header mode, these lines are ignored. The following is an example of its use:

```
#if defined(DEV_SPECIFIC)
emit "#if defined(DEV_SPECIFIC)";
   struct dev_specific v_devspec;
emit "#endif";
#endif
```

would appear as:

```
#if defined(DEV_SPECIFIC)
   struct dev_specific v_devspec;
#endif
```

`emit` is useful for inserting pre-processing information into a header file.

_editmod_HM macro

The pre-processor macro `EM_HEADER_MODE` is defined when `editmod` is operating in header mode. This is useful for allowing `editmod` to see an entire structure even when certain defines aren't present. From the previous example, if one were to generate a header file for the `.des` file containing the text above with a command line like:

```
editmod pcf.des -h=pcf_lu_stat
```

One would not get any of the text shown above because `DEV_SPECIFIC` would not be defined so the pre-processor would skip all the text between the `#if/#endif`.

The example shown above should be written:

```
#if defined(DEV_SPECIFIC) || defined(EM_HEADER_MODE)
emit "#if defined(DEV_SPECIFIC)";
   struct dev_specific v_devspec;
emit "#endif";
#endif
```

This causes the expected result while generating headers.

General Rules

- Symbol definitions are seen in the order of their declaration with later redefinitions overriding previous declarations.
- A symbol redefinition without help text inherits the original symbol definition's help text, if it had any.
- The basic principles of modules may not be violated (parity, size, data, `m_exec`, `idata`, `irefs`, CRC, etc.). `editmod` fills in all appropriate fields to generate a legal module.
- All "pointer" type items must be initialized.
- Only two pointers types may be NULL. A NULL string pointer is defined as a pointer to a string that was never given a value. A NULL repeat pointer is defined as a pointers to a repeat structure that was not given any members by `init` blocks. All other pointers are not NULL.
- Data area pointers must be 32 bits wide.
- Repeat structures must at least have one item.
- A structure may be named as a sub-structure by only one other structure.
- Each set of description files must contain exactly one *module* block.
- Symbols named in module block may not be variable sized. Strings and repeat structures, for example, are not permitted.
- Pointers may not point from an item in the code area to an item in the data area.

Example

The following example shows how to build, display, and edit a data module. There are a number of steps involved:

Step 1. Design the Data Module.

Step 2. Create the Description File.

Step 3. Create the Module with editmod.

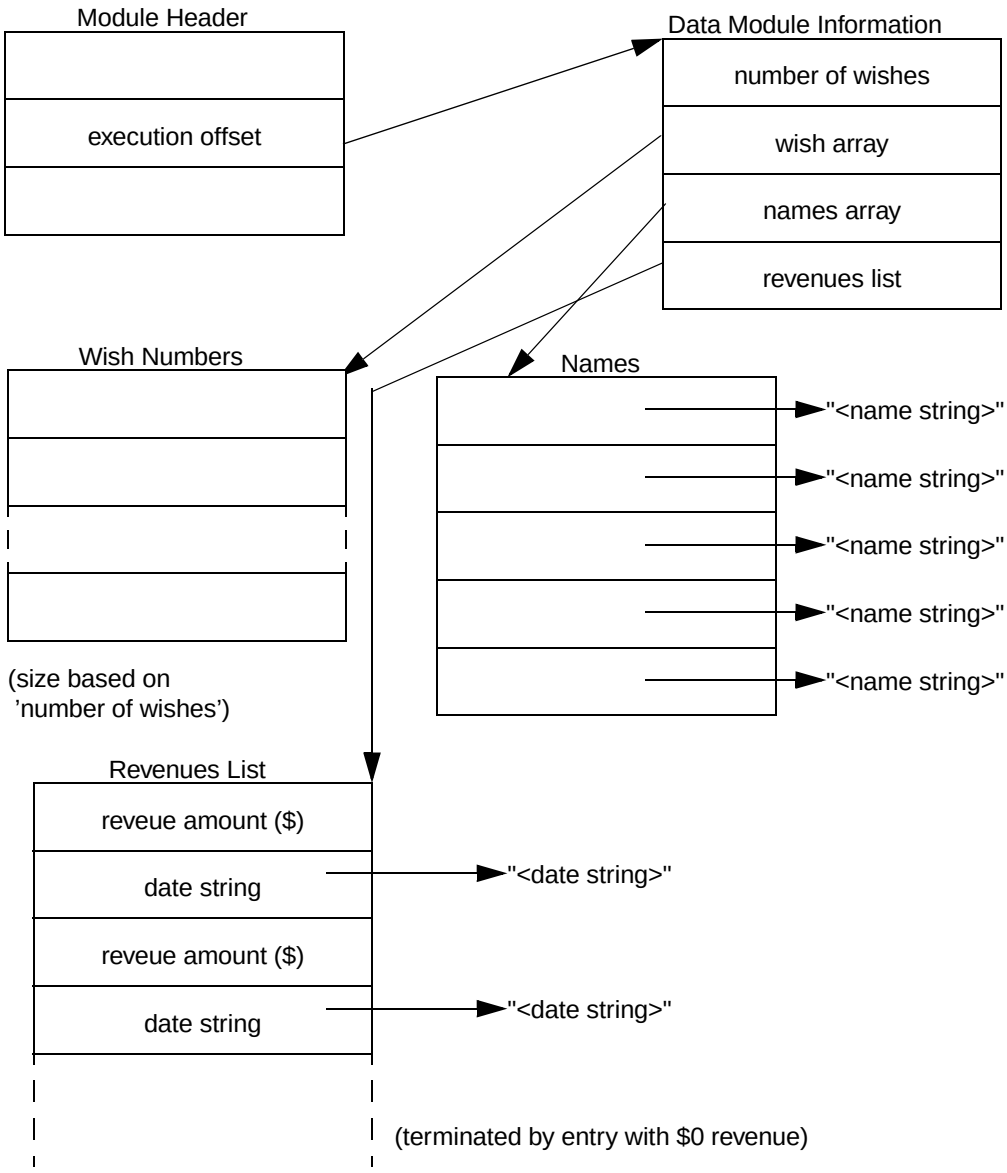
Step 4. Display the Contents of the Module with editmod.

Step 5. Edit the Module.

Design the Data Module

This example uses the OS-9/x86 operating system.

The steps in this example create the following:



Create the Description File

Given the information from the design stage, a description file may be:

```
1  struct mh_com
    {
2     u_int16 m_sync;
3     u_int16 m_sysrev = 1;
4     u_int32 m_size;
5     u_int16 m_group = 0, "Group number";
6     u_int16 m_user = 0, "User number";
7     pointer u_int32 m_name = mod_name;
8     u_int16 m_access = 0x555, "Module access
permissions";
9     u_int8  m_lang = 0x00, "Module language";
10    u_int8  m_type, "Module type";
11    u_int8  m_rev = 0x00, "Module revision";
12    u_int8  m_attr = 0x80, "Module attributes";
13    u_int16 m_edit = 1, "Module edition";
14    u_int32 m_needs;
15    u_int32 m_usage;
16    u_int32 m_symbol;
17    pointer u_int32 m_exec = mod_body;
18    u_int32 m_excpt;
19    u_int32 m_data;
20    u_int32 m_stack;
21    u_int32 m_idata;
22    u_int32 m_idref;
23    u_int32 m_init;
24    u_int32 m_term;
25    u_int16 m_ident;
26    u_int32 m_spare1;
27    u_int32 m_spare2;
28    u_int16 m_parity;
29 }, "Module header information";
30
31 string mod_name, "Module name";
32
33 struct mod_body
    {
34    u_int32 num_wishes = 3, "Number of wishes";
```

```
35   pointer u_int16 (“u_int16 %s”) wishes =
wish_array,
       “.Offset to wish_array”;
36   pointer u_int32 (“u_int32 %s”) names = name_array,
       “.Offset to name_array”;
37   pointer u_int16 (“u_int16 %s”) revs = revenues,
       “.Offset to revenues”;
38 }, "Module Data";
39
40 array u_int8 wish_array[mod_body.num_wishes] =
   {
41   1, 2, 3
42 }, "Wish numbers";
43
44 pointer array u_int32 name_array[5] =
   {
45   al_string, ge_string, ja_string, ia_string,
jas_string
46 }, "Character names";
47
48 string al_string = "Aladdin", "Main character";
49 string ge_string = "Genie", "Magic character";
50 string ja_string = "Jafar", "Evil character";
51 string ia_string = "Iago", "Animal character";
52 string jas_string = "Jasmine", "Female character";
53
54 string mod_name = "data";
55
56 repeat revenues
   {
57   int32 amount,"Revenue amount:This is the amount of
revenue"
58        " realized on the given date";
59   pointer u_int16 date = date_string;
60 } until (revenues.amount == 0), "Revenue List";
61
62 string date_string, "Revenue date:The date the
revenue was
realized";
53
```

```
64 init mh_com
   {
65   m_type = 4;
66   m_edit = 7;
67 };
68
69 init revenues[0]
   {
70   amount = 10000000;
71   date = date1_string;
72 };
73 string date1_string = "93/06/04";
74
75 init revenues[1]
   {
76   amount = 0; /* terminate the revenues list (for
now) */
77 };
78
79 module
   {
80   mh_com,
81   mod_body
82 };
```

Table 3-6. Annotations for Module Description

Line(s)	Description
1-29	Defines the module header structure. This information would normally be supplied by Microware. The fields that have help text associated with them are editable by the user.
31	Here we define the string that eventually holds the name of the module. The actual name is not specified until line 54. This demonstrates the ability to re-define symbols and keep the help text.
33 - 38	This structure is the module's data. In the module, it is pointed to by the `m_exec` field in the module header. Three of its members, wishes, names, and revs are pointers to other data structures.

Table 3-6. Annotations for Module Description (Continued)

Line(s)	Description
40 - 42	Defines the array `wish_array`. The size is an expression related to the `num_wishes` field in the `mod_body` structure. Its members are 8-bit unsigned numbers initialized to 1, 2, and 3.
44 - 46	Defines the pointer array `name_array`. Each of the elements is a reference to another data structure (strings in this case).
48 - 52	Definitions of the strings referred to in `name_array`.
54	Re-definition of the string `mod_name`. Since this version does not have help text, it adopts the help text from the previous `mod_name` definition.
56 - 60	Definition of the repeat structure revenues that defines a list of structures containing an integer and a pointer to a string. The list is terminated by a node where amount is zero.
62	The template for the date strings pointed to by the date entry of the repeat structure. The help text supplied here is inherited by each node in the revenues list.
64 - 67	This init block initializes the `m_type` and `m_edit` fields of the module. The `m_type` field is initialized with four to indicate that we are constructing a data module.
69 - 72	This init block creates the first node in the revenues list. The amount is set to `10,000,000` and the string is redirected to point to `date1_string`.
73	Definition of `date1_string`. This string is referenced by the init block above it.
75 - 77	This init block creates a second node in the revenues list. The amount is set to zero to satisfy the termination condition of the repeat structure.
79 - 82	The module block describes the format of the module. It begins with `mh_com` in the code area followed by `mod_body` in the code area.

Create the Module with editmod

Assuming the description file shown above is in a file called `systype.des`, the following command line would create the data module from scratch:

```
editmod -c data
```

The following annotated hex dump shows the module follows the chosen format:

```
  Addr     0 1  2 3  4 5  6 7  8 9  A B  C D  E F 0 2 4
6 8 A C E
--------  ---- ---- ---- ---- ---- ---- ---- ---- ----
------------
00000000  fc4a 0100 b400 0000 0000 0000 a600 0000
|J..4.......&...
00000010  5505 0004 0080 0700 0000 0000 0000 0000
U...............
00000020  0000 0000 5000 0000 0000 0000 0000 0000
....P...........
00000030  0000 0000 0000 0000 0000 0000 0000 0000
................
00000040  0000 0000 0000 0000 0000 0000 0000 1234
...............4
00000050  0300 0000 ab00 5c00 0000 7000 8d00 0000
....+.\...p.....
00000060  9b00 0000 9500 0000 a100 0000 8500 0000
........!.......
00000070  8096 9800 7c00 0000 0000 0000 3933 2f30
....|.......93/0
00000080  362f 3034 004a 6173 6d69 6e65 0041 6c61
6/04.Jasmine.Ala
00000090  6464 696e 004a 6166 6172 0047 656e 6965
ddin.Jafar.Genie
000000a0  0049 6167 6f00 6461 7461 0001 0203 0000
.Iago.data......
000000b0  00dd c420                              .]D
```

The following table illustrates the annotations for hex dump:

Table 3-7. Annotations for hex dump of module

Addr (hex)	Description
0 - 4f	`mh_com` structure — The type (byte 0x13) is four for data module and the edition number (bytes 6 and 7) is seven. These numbers were installed by the `init` block for `mh_com`.
50 - 5b	`mod_body` structure — Pointers are stored in the module as offsets from the base of the module.
5c - 6f	`name_array` array — Five two-byte pointers to strings in a row.
70 - 75	revenues' first node
76 - 7b	revenues' last node
7c - aa	strings — Various strings pointed to by various data structures.
ab - ad	`wish_array` — The three byte array holding the values one, two, and three.
ae - af	padding — Two bytes of padding to round the module size up to a four byte boundary.
b0 - b3	CRC — The modules CRC value is recorded in the last four bytes.

Display the Contents of the Module with editmod

Use the `-l` option to list the contents of a module.

```
editmod -l data
```

The following output was generated by listing the data module created in Step #3:

```
$ editmod -l data
Group number                    : 0x0
User number                     : 0x0
Module name                     : "data"
Module access permissions       : 0x555
Module language                 : 0x0
Module type                     : 0x4
Module revision                 : 0x0
Module attributes               : 0x80
Module edition                  : 0x7
```

```
Number of wishes              : 0x3
Wish numbers:
0x01, 0x02, 0x03
Character names:
Main character                : "Aladdin"
Magic character               : "Genie"
Evil character                : "Black Bart"
Animal character              : "Spot"
Female character              : "Jeannie"
Revenue List [0]
Revenue amount                : 10000000
Revenue date                  : "93/06/04"
Revenue List [1]
Revenue amount                : 0
```

The editor can also be used to interactively examine the module's contents.

Edit the Module

The following is a sample editing session. The user's input is denoted by the magenta font.

```
$ editmod -e data

 1. Module header information
 2. Module Data

Which? [?/1-2/p/t/a/w/q] 2  select the module data to edit

 1. Number of wishes              : 0x3
 2. Wish numbers
 3. Character names
 4. Revenue List
Which? [?/1-4/p/t/a/w/q] 4  select the revenue list to edit

 1. Revenue List [0]
 2. Revenue List [1]
 3. Add additional item to list

Which? [?/1-3/p/t/a/w/q] 3  add another revenue node to the list
```

```
 1. Revenue List [0]
 2. Revenue List [1]
 3. Revenue List [2]
 4. Add additional item to list

Which? [?/1-4/p/t/a/w/q] 2
```
edit the second one (used to be terminating entry)
```
 1. Revenue amount                : 0
 2. Revenue date                  : NULL

Which? [?/1-2/p/t/a/w/q] 1
```
change the amount field
```
Revenue amount                    : 0
New value: 50000000
```
enter the $50,000,000 revenue
```
 1. Revenue amount                : 50000000
 2. Revenue date                  : NULL

Which? [?/1-2/p/t/a/w/q] 2
```
set the date of realization
```
Revenue date                      : NULL
New string: 94/01/01
```
first day of 1994
```
 1. Revenue amount                : 50000000
 2. Revenue date                  : "94/01/01"

Which? [?/1-2/p/t/a/w/q] p
```
move to previous menu
```
 1. Revenue List [0]
 2. Revenue List [1]
 3. Revenue List [2]
 4. Add additional item to list

Which? [?/1-4/p/t/a/w/q] 3
```
check the last entry in the list to verify that amount is zero
```
 1. Revenue amount                : 0
 2. Revenue date                  : NULL

Which? [?/1-2/p/t/a/w/q] q
```
write the module and exit

The following is a listing of the module after the changes were made:

```
$ editmod -l data
Group number                    : 0x0
User number                     : 0x0
Module name                     : "data"
Module access permissions       : 0x555
Module language                 : 0x0
Module type                     : 0x4
Module revision                 : 0x0
Module attributes               : 0x80
Module edition                  : 0x7
Number of wishes                : 0x3
Wish numbers:
0x01, 0x02, 0x03
Character names:
Main character                  : "Aladdin"
Magic character                 : "Genie"
Evil character                  : "Black Bart"
Animal character                : "Spot"
Female character                : "Jeannie"
Revenue List [0]
Revenue amount                  : 10000000
Revenue date                    : "93/06/04"
Revenue List [1]  note the new revenue list entry
Revenue amount                  : 50000000
Revenue date                    : "94/01/01"
Revenue List [2] note the new terminating revenue list entry
Revenue amount                  : 0
Revenue date                    : NULL
```

To generate the header file for the `mod_body` structure we might use a command line like:

```
editmod data.des -h=mod_body
```

This generates the following header file:

```
#if !defined(_TYPES_H)
#include <types.h>
#endif
/* Module Data */
struct mod_body
{
    u_int32 num_wishes/* Number of wishes */
    u_int16 wishes; /* Offset to wish_array */
    u_int32 names; /* Offset to name_array */
    u_int16 revs; /* Offset to revenues */
};
```

4 Using the os9make Utility

This chapter provides an in-depth description of the `os9make` utility. It includes the following sections:

Overview

The os9make utility analyzes files and determines whether they must be updated. The utility compares the dates of a specific target file with the dates of the file(s) used to create it (called dependencies). In general, if os9make determines that a target file is older than at least one of its dependencies, it executes specified commands to recreate the target file.

The os9make utility has several built-in assumptions specifically designed for compiling high-level language programs; however, os9make can be used to maintain any files dependent on updated files.

os9make Operation

The os9make utility starts by reading the entire makefile and setting up a table of dependencies exactly as listed in the makefile. When the os9make utility encounters a name on the left side of a colon, it first checks to see if it has encountered the name before. If it has, the os9make utility connects the lists and continues.

After reading the makefile, os9make determines the target file(s). The target file is the main file to be made on the list. It then makes a second pass through the dependency table.

During the second pass, the os9make utility looks for object files with no relocatable files in their dependency lists and for relocatable files with no source files in their dependency lists. This facilitates program compilation. If the os9make utility needs to find any source files or relocatable files to complete the dependency lists, it looks for them in the specified data directory, unless a macro is specified.

The os9make utility does a third pass through the list to get the file dates and compare them. When the os9make utility finds a file in a dependency list that is newer than its target file, it executes the specified command(s). If a command entry is not specified, a command is generated based on the assumptions given in the next section. Some operating systems only store the time down to the closest minute. The os9make utility remakes a file if its date matches one of its dependents.

When a command is executed, it is echoed to standard output unless the -s, or silent, option is used or the command line starts with an "at" sign (@). When the -n option is used, the command is echoed to standard output but is not actually executed.

The os9make utility normally stops if an error code is returned when a command line is executed. Errors are ignored if the -i option is used or a command line begins with a hyphen.

Use the -d option to see the file dependencies and the dates associated with each of the files in the list. The -d option turns on the os9make utility debugger and gives a complete listing of the macro definitions, a listing of the files as it checks the dependency list, and all the file modification dates. If it cannot find a file to examine its date, it assumes a date of -1/00/00 00:00, indicating the necessity to update the file.

To update the date on a file without remaking it, use the -t option. The os9make utility opens the file for update and then closes it, updating the date to the current date.

If you are quite explicit about your makefile dependencies and do not want the os9make utility to assume anything, use the -b option to turn off the built-in rules governing implicit file dependencies.

Implicit Rules, Definitions, and Assumptions

Any time a command line is generated, the os9make utility assumes the target file is a program to compile. Therefore, if the target file is not a program to compile, the command entries must be included for each dependency list. The os9make utility uses the following definitions and rules when forced to create a command line.

Table 4-1. os9make Utility Definitions and Rules

Files	Definition/Rule
Object	Files with no suffix. An object file is made from a relocatable file and linked when it needs to be made.
Relocatable	Files appended by either the .r suffix (compat and ucc modes) or the .o suffix (c89 mode). Relocatable files are made from source files and assembled or compiled if they need to be made.
Source	Files with one of the following suffixes: ucc mode: .a .o .i .pp .c .f compat mode: .a .c .f c89 mode: .s .be .ic .i .c .f

Table 4-2. Default Modes

Description	Default
Compiler	`cc`
Assembler	`r68`, `a386`, or a `ppc`
Linker	`cc`
Mode	`ucc`
Directory for all files	The current data directory (`.`)

Only use the default linker with programs that use `cstart.r`.

UCC Rule Modes

To make an executable from a "`.cpp`":

```
$(CC) $(CFLAGS) $(SDIR)/$*.cpp -f=$(ODIR)/$*
```

To make an executable from a "`.cxx`":

```
$(CC) $(CFLAGS) $(SDIR)/$*.cxx -f=$(ODIR)/$*
```

To make a "`.r`" from a "`.cpp`":

```
$(CC) $(CFLAGS) $(SDIR)/$*.cpp -eas=$(RDIR)
```

To make a "`.r`" from a "`.cxx`":

```
$(CC) $(CFLAGS) $(SDIR)/$*.cxx -eas=$(RDIR)
```

To make a "`.a`" from a "`.cpp`":

```
$(CC) $(CFLAGS) $(SDIR)/$*.cpp -eao=$(SDIR)
```

To make a "`.a`" from a "`.cxx`":

```
$(CC) $(CFLAGS) $(SDIR)/$*.cxx -eao=$(SDIR)
```

To make a "`.o`" from a "`.cpp`":

```
$(CC) $(CFLAGS) $(SDIR)/$*.cpp -ebe=$(SDIR)
```

To make a "`.o`" from a "`.cxx`":

```
$(CC) $(CFLAGS) $(SDIR)/$*.cxx -ebe=$(SDIR)
```

To make a ".i" from a ".cpp":

```
$(CC) $(CFLAGS) $(SDIR)/$*.cpp -efe=$(IDIR)
```

To make a ".i" from a ".cxx":

```
$(CC) $(CFLAGS) $(SDIR)/$*.cxx -efe=$(IDIR)
```

Modes

The following modes are built into the os9make utility.

Table 4-3. os9make Utility Modes

Mode	Specification
compat	The compat files reflect the compat mode of the Ultra C executive. This is also the mode to use with the V3.2 C Compiler.
c89	The c89 rules reflect the c89 mode of the Ultra C executive.
ucc	The ucc rules reflect the ucc mode of the Ultra C executive

Refer to the *Using Ultra C/C++* manual, the Using the Executive chapter for more information about Ultra C/C++ modes.

The following methods instruct os9make to use a particular mode:

1. Set the MWMAKEOPTS environment variable to the desired mode. For example:

   ```
   setenv MWMAKEOPTS -mode=c89
   ```

2. Use the -mode=<mode> option on the command line. This method overrides the environment variable. For example:

   ```
   os9make -mode=compat
   ```

3. Use the -mode=<mode> option within your makefile. This overrides both the environment variable and command line option.

Special Macros

Special macros can be defined and used in the makefile for greater flexibility in os9make. The os9make utility uses these macros when assumptions must be made in generating command lines or searching for unspecified files. For example, if a source file is not specified for program.r, os9make searches the specified directory, SDIR, or ".", for program.a (or .c, .p, .f).

The os9make utility recognizes the following special macros.

Table 4-4. Special Macros Recognized by os9make

Macro	Description
IDIR=<path>	The os9make utility searches the directory specified by path for all I-code files not specified by a full path list. If IDIR is not defined in the makefile, the os9make utility searches the current directory by default.
ODIR=<path>	The os9make utility searches the directory specified by <path> for all files that have no suffix or relative pathlist. If ODIR is not defined in the makefile, the os9make utility searches the current directory by default.
SDIR=<path>	The os9make utility searches the directory specified by <path> for all source files not specified by a full pathlist. If SDIR is not defined in the makefile, the os9make utility searches the current directory by default.
RDIR=<path>	The os9make utility searches the directory specified by <path> for all relocatable files not specified by a full pathlist. If RDIR is not defined, the os9make utility searches the current directory by default.
CFLAGS=<opts>	These compiler options are used in any necessary compiler command lines.
RFLAGS=<opts>	These assembler options are used in any necessary assembler command lines.
LFLAGS=<opts>	These linker options are used in any necessary linker command lines.
CC=<comp>	The os9make utility uses this compiler when generating command lines. The default compiler is cc.
RC=<asm>	The os9make utility uses this assembler when generating command lines. The default assembler is r68.
LC=<link>	The os9make utility uses this linker when generating command lines. The default linker is cc.

os9make Generated Command Lines

The os9make utility can generate the following types of command lines:

1. Compiler Command Lines
   These are generated if a source file with a suffix of .c, .f, or .p must be recompiled. The os9make utility generates a compiler command line with the following syntax:

   compat and ucc mode:

   ```
   $(CC) $(CFLAGS) $(SDIR)/<file> -f=$(ODIR)/<file>
   ```

   c89 mode:

   ```
   $(CC) $(CFLAGS) $(SDIR)/<file> -f $(ODIR)/<file>
   ```

2. Assembler Command Lines
   These are generated if an assembly language source file needs to be reassembled. The os9make utility generates the assembler command line with the following syntax:

   compat and ucc mode:

   ```
   $(RC) $(RFLAGS) $(SDIR)/<file>.a -o=$(RDIR)/<file>.r
   ```

   c89 mode:

   ```
   $(RC) $(RFLAGS) $(SDIR)/<file>.s -o=$(RDIR)/<file>.o
   ```

3. Linker Command Lines
   These are generated if an object file must be relinked in order to remake the program module. The os9make utility generates the linker command line with the following syntax:

   ucc and compat mode:

   ```
   $(LC)  $(LFLAGS)  $(RDIR)/<file>.r -f=$(ODIR)/<file>
   ```

   c89 mode:

   ```
   $(LC)  $(LFLAGS)  $(RDIR)/<file>.o -f $(ODIR)/<file>
   ```

When the os9make utility is generating a command line for the linker, it looks at its list and uses the first relocatable file that it finds, but only the first one. For example:

```
prog: x.r y.r z.r
```

Generates:

cc x.r, not cc x.r y.r z.r or cc prog.r

You can include options on the command line when running the os9make utility or in the makefile for convenience.

The os9make utility language is highly specific. Therefore, use caution when using dummy files with names like print.

The os9make utility is always case-dependent with respect to directory names and file names.

Unless a file is specifically an object file or the -b option is used to turn off the implicit rules, use a suffix for your dummy files. For example, use print.file and xxx.h for your header files.

os9make Command Line Options

Below is the syntax for using the os9make utility on the command line:

```
os9make {[<-opts>] [< target file >] [< macros >]}
```

Command line parameters override the MWMAKEOPTS environment variable.

Table 4-5. os9make Comand Line Options

Option	Description
-b	Do not use built-in rules.
-bo	Do not use built-in rules for object files.
-c	ignore DOS command line length.
-cl[=]<length>	Specify DOS command line length.
-d	Debug mode: print file dates in makefile.
-dd	Double debug mode: verbose.
-e	Import environment variables as macros.
-ee	Imported environment variables override others. (-e is implied.)
-f[=]<xxx>	Use <xxx> as the makefile (default: makefile).
-f-	Read the makefile from stdin.
-i	ignore errors on commands and keep going.
-l	Make later macros override previous definitions.
-ll	Command line macros cannot be overridden. (-l is implied.)
-mode[=]<mode>	Rule mode (c89, compat, and ucc).
-m	Undefined macros are treated as empty strings.
-n	Do not execute commands; print them instead.
-nn	Same as -n; however, change directories and call sub makes with -nn.

Table 4-5. os9make Comand Line Options

Option	Description
-o	Do not assume object files need ROF files.
-p	Do not change slash to backslash in makefile lines.
-r	Show built-in rules for current mode.
-s	Silent mode: execute commands without echoing them.
-t	Update the dates without executing the commands.
-u	Perform the make whether or not it is needed.
-w	Print the reason for executing the command.
-x	Use the cross compiler.
-z[=<path>]	Get list of files to make from stdin or path.

Makefile Entries

The os9make utility executes commands from a special type of procedure file called a makefile. The makefile describes the dependent relationships between files used to create the target file(s).

A makefile may describe the commands to create many files. If the os9make utility is called without a target file on the command line, the os9make utility attempts to make the first target file described in the makefile.

If one or more target file's are entered on the command line, the os9make utility reads and processes the entire makefile and only attempts to make the appropriate file(s).

A makefile contains the following types of entries:

- Dependencies
- Commands
- Comments
- Includes
- Macros
- Conditionals
- Looping

Dependencies

This entry specifies the relationship of a target file and its dependencies. The entry has the following syntax:

```
<target>: [<dependent>] {[<dependent>]}
```

The list of files following the target file is known as the *dependency list*.

The following rules are used to determine if a target file must be rebuilt:

- Not found - If any `<dependent>` is not found, execute the command entry.
- Found - If any `<dependent>` is newer than the `<target>`, execute the command entry.
- Period/Dot rule - If a period (`.`) is specified, always execute the command entry.
- Blank rule and file `<target>` - If the *dependency list is blank and the* `<target>` is a file, execute the command entry.
- Blank rule and directory `<target>` - If the *dependency list is blank and the* `<target>` is a directory, execute the command entry if and only if the directory does not exist.

Commands

This entry specifies the command to execute when updating a particular target file.

If instructions for update are not provided, the `os9make` utility attempts to create a command entry to perform the operation (unless `-b` or `-bo` is specified).

The `os9make` utility recognizes a command entry by a line beginning with one or more spaces or tabs. Any legal command line is acceptable.

You can list more than one command entry for any dependency. Each command is forked separately unless continued from the previous command with a backslash (`\`).

For example:

```
<target>:[[<file>],<file>]
   [<command prefix>]<OS command line>
   [<command prefix>]<OS command line> \
    <extended command>
```

Command lines can be prefixed with the following modifiers:

`@`	Silent operation. Do not echo this command line to the screen.
`-`	Ignore errors. Do not exit if this command gets an error.

Comments

This entry consists of any line beginning with an asterisk (`*`) or pound sign (`#`).

In addition, in a Command entry, all characters following a pound sign (`#`) are treated as comments. The one exception to this is a digit following a pound sign, which is considered part of a command entry. This is because the OS-9 resident shell uses `#<num>` to increase stack space.

An asterisk (`*`) in a Command entry is treated as a wildcard character, not a comment.

All blank lines are ignored.

Following is an example:

```
-b
# comment example
* comment line
all:
    # example command
    echo hello # first command

    echo world # second command
Outputs:
echo hello
hello
echo world
world
```

Includes

A makefile `include` entry tells the `os9make` utility to use a file that has entries common to more than one makefile. The `os9make` utility processes the lines of the "included" file as if they were in the current makefile. This makes it easier to change information because you can

change it in one common file rather than each individual makefile. For example:

```
include <pathname>
```

`include` opens the specified file `<pathname>` and processes the lines from that file as if they appeared in the current makefile. You can nest included makefiles up to seven times. For example:

```
include ../../../makesub.com
```

Macros

Syntax

The `os9make` utility recognizes a macro by the dollar sign (`$`) character in front of the name. If a macro name is longer than a single character, the entire name must be surrounded by parentheses. For example:

- `R` refers to the macro `R`.
- `$(PFLAGS)` refers to the macro `PFLAGS`.
- `$(B)` and `$B` refer to the macro `B`.
- `$BR` is interpreted as the value for the macro `B` followed by the character `R`.

You can place macros in the makefile for convenience or on the command line for flexibility. Everywhere the macro name appears, the expansion is substituted for it.

If a macro is defined in your makefile and then redefined on the command line, the command line definition overrides the definition in the makefile. This feature is useful for compiling with special options.

Macro assignments take one of the following forms:

`<name>`	`=`		Define but don't assign a value.
`<name>`	`=`	`<value>`	Assign a value if not already specified. In `-l` mode reassign.
`<name>`	`+=`	`<value>`	Append another value.
`<name>`	`?=`	`<value>`	Reassign a value. In `-l` mode assign if not previously assigned.
`<name>`	`@=`	`<value]`	Set an environment variable for commands.

<value> can contain references to other previously defined macros.

User defined macro names can contain any combination of normal characters (A-Z, a-z) and numbers (0-9).

Other special characters that work in the current version of os9make could change in future versions.

A macro does not require a value specified in the makefile. For example:

```
LOPTS =
```

is a valid line for a makefile. This type of macro is often used when a command line definition of a macro is expected.

The fundamental difference (in terms of compatibility) between os9make and most other make programs, is that by default os9make uses the first assignment of a macro, not the last.

Use the -l option to force os9make to use the last assignment of a macro instead of the first.

os9make -l creates macro assignments in UNIX style.

A macro definition can be appended with the following syntax:

```
<name> += <value>
```

This appends <value> to the existing macro value, separated by a single space. If <name> is not yet defined, it is defined with <value>.

Unless the append syntax is used, the redefinition of a macro name already used has no effect. This allows a macro definition from the os9make command line to override macro definitions within the makefile.

The following macro override syntax:

```
<name> ?= <value>
```

forces the assignment of a macro even when previously defined. In -l mode, this assigns the macro only when not previously assigned. Therefore, in the following example,

```
MACRO = first
MACRO ?= second
```

If MACRO were later expanded by os9make, it would provide a string of second. If os9make were in -l mode, it would provide a string of first.

Sometimes environment variables must be set directly from a makefile. To set environment variables use the following syntax:

```
<name> @= <value>
```

Do not confuse environment variable assignments with traditional macro assignment. For example, in the following makefile both a MWOS macro and a MWOS environment variable are defined as follows:

```
-b
MWOS = foo   # set the MWOS macro
MWOS @= bar  # set the MWOS environment variable
all:
   echo $(MWOS)
   set MWOS
```

outputs:

```
echo foo
foo
set MWOS
MWOS=bar
```

The -l mode has no effect on @= assignments.

Line Continuation

To continue entries on the next line, insert a space followed by a backslash (\) at the end of each line. If a command line is continued, a space or tab must be the first character in the continued line. With non-command lines, leading spaces and tabs are ignored on continuation lines.

Entries longer than 256 characters must be continued on the next line. For example:

```
FILES = aaa.r bbb.r ccc.r ddd.r eee.r fff.r ggg.r \
        hhh.r iii.r jjj.r
```

Macro Substitution

Macro substitution syntax can greatly simplify makefiles. In general, macro substitution takes the form:

```
$(<name>:<op>%<os>=<np>%<ns>)
```

where <op> is the old prefix and <os> is the old suffix, <np> and <ns> are the new prefix and new suffix, respectively, and the pattern matched by % (a string of zero or more characters), is carried forward from the value being replaced. For example, before os9make supported macro substitution, makefiles required that both a RELS line and an IRELS line (if both types of object are being generated) be specified. Now it is possible to specify a single SRCS line and let generic make rules handle the redundant lines.

For example, the macros can be rewritten as shown in Figure 4-1 using macro substitution.

Figure 4-1. Using Macro Substitution

No Macro Substitution

```
RFILES = $(RDIR)/dodate.r $(RDIR)/doname.r
$(RDIR)/domake.r \
         $(RDIR)/domac.r $(RDIR)/data.r
$(RDIR)/misc.r \
         $(RDIR)/rule.r
IFILES = $(IDIR)/dodate.i $(IDIR)/doname.i
$(IDIR)/domake.i \
         $(IDIR)/domac.i $(IDIR)/data.i
$(IDIR)/misc.i \
         $(IDIR)/rule.i
```

Macro Substitution

```
CFILES = dodate.c doname.c domake.c domac.c data.c \
         misc.c rule.c
RFILES = $(CFILES:%.c=$(RDIR)/%.r)
IFILES = $(CFILES:%.c=$(IDIR)/%.i)
```

Combining macro substitution with the for loop eliminates almost all redundant lines of a makefile. This results in a smaller, easier to read, and easier to maintain makefile.

In addition to the % = % modifier, there are other new substitution functions for performing useful operations on the source macro.

For example, to select just the last component of a file path, use the T function as follows:

```
$(CFILES:T)
```

The result is as follows:

```
dodate.r doname.r domake.r domac.r data.r misc.r rule.r
```

Multiple modifiers can be specified and are processed in order.

Macros can be used anywhere within the modifier format strings. For instance:

```
RFILES = $(IFILES:$(IDIR)/%.i=$(RDIR)/%.r)
```

Table 4-6 shows the list of macro modifiers.

Table 4-6. Macro Modifiers

Macro	Description/Example		
E	Replace each word with its suffix		
	TEST/test.c	:E	c
H	Replace each word with everything but the last component		
	TEST/test.c	:H	TEST
L	Lowercase each word		
	ARMv4 Mc68000	:L	armv4 mc68000
M	Select words matching a pattern		
	t1.c t1.h t2.c	:M*.c	t1.c t2.c
N	Select words not matching a pattern		
	t1.c t1.h t2.c	:N*.c	t1.h
R	Remove suffix from all words		
	TEST/test.c t1 t2.c	:R	TEST/test t2
S	Substitute old string for new string (UNIX-like sed syntax)		
	testing the rest	:S/t/T/g	TesTing The resT
	testing the rest	:S/t/T/1	Testing The resT
	testing the rest	:S/t/T/	Testing The resT
	testing the rest	:S/est$/EST/	testing the rEST
	testing the rest	:S/^est/EST/	testing the rest
	testing the rest	:S/^t/T/	Testing The rest
T	Select just the last component of each file path		
	DIR/t1.c t2.c	:T	t1.c t2.c

Table 4-6. Macro Modifiers (Continued)

Macro	Description/Example
U	Uppercase each word
	armv4 Mc6800 :u ARMV4 MC68000
%=%	UNIX prefix/suffix syntax (percent is the wildcard pattern character which is left intact on the rewrite)
	t1.c t1.h t2.c :%.c=%.r t1.r t2.h t3.r
	DIR1/t1.c t2.c :DIR1/%.c=%.r t1.r t2.c
	t1.c t2.c RDIR/t2.r :%.c=RDIR/%.r RDIR/t1.r

for Loop

Combining macro substitution with `for` loop processing results in a very efficient makefile.

In the generic case, only the CFILES line must be modified. Standard rules apply to the rest of the makefile.

For example, the example in Figure 4-1 can be rewritten using a for loop as shown in Figure 4-2.

Figure 4-2. Macro Substitution with for Loop

```
CFILES = dodate.c doname.c domake.c domac.c data.c \
         misc.c rule.c
RFILES = $(CFILES:%.c=$(RDIR)/%.r)
IFILES = $(CFILES:%.c=$(IDIR)/%.i)

for SRC in $(CFILES)
$(SRC:%.c=$(RDIR)/%.r): $(SRC)
        $(RCOMPILE) $(SRC)
$(SRC:%.c=$(IDIR)/%.i): $(SRC)
        $(ICOMPILE) $(SRC)
endfor
```

This example demonstrates how a bulky makefile is reduced to a few lines. To add or delete files from the makefile requires only that the `CFILES` declaration to be modified.

Target Dependent Macros

os9make supports several target dependent macros whose value depends on the context of their use.

Table 4-7. Target Dependent Macros

Macro	Description/Example
$@	The current target, including its full path and any suffix. `RDIR/test.r: new.c old.c  $@ = RDIR/test.r`
$*	The base name of the target. That is, the target name minus any pathlist or extension. `RDIR/test.r: new.c old.c  $* = test`
$?	The list of files that were found to be newer than the target on a given dependency line. `RDIR/test.r: new.c old.c  $? = new.c`
$<	Enumerate all the files upon which an object depends `RDIR/test.r: new.c old.c  $< = new.c old.c`

The operation shown in Figure 4-1 can be made easier by using the $* macro. $* takes the current object being built and strips off the directory path and suffix. Any characters following the asterisk are then appended to the new string.

Therefore, $*.c on RDIR/test.r results in test.c. The $@ macro represents the current object being built, and $< expands to what $@ depends on.

For example, the macros can be rewritten as shown in Figure 4-3.

Figure 4-3. Using `$*` Macro Substitution

No Macro Substitution

```
$(RDIR)/dodate.r: dodate.c
        $(RCOMPILE) dodate.c -fd=$(RDIR)/dodate.r
$(IDIR)/dodate.i: dodate.c
        $(ICOMPILE) dodate.c -fd=$(IDIR)/dodate.i
$(RDIR)/doname.r: doname.c
        $(RCOMPILE) doname.c -fd=$(RDIR)/doname.r
$(IDIR)/doname.i: doname.c
        $(ICOMPILE) doname.c -fd=$(IDIR)/doname.i
$(RDIR)/domake.r: domake.c
        $(RCOMPILE) domake.c -fd=$(RDIR)/domake.r
$(IDIR)/domake.i: domake.c
        $(ICOMPILE) domake.c -fd=$(IDIR)/domake.i
$(RDIR)/domac.r: domac.c
        $(RCOMPILE) domac.c -fd=$(RDIR)/domac.r
$(IDIR)/domac.i: domac.c
        $(ICOMPILE) domac.c -fd=$(IDIR)/domac.i
$(RDIR)/data.r: data.c
        $(RCOMPILE) data.c -fd=$(RDIR)/data.r
$(IDIR)/data.i: data.c
        $(ICOMPILE) data.c -fd=$(IDIR)/data.i
$(RDIR)/misc.r: misc.c
        $(RCOMPILE) misc.c -fd=$(RDIR)/misc.r
$(IDIR)/misc.i: misc.c
        $(ICOMPILE) misc.c -fd=$(IDIR)/misc.i
$(RDIR)/rule.r: rule.c
        $(RCOMPILE) rule.c -fd=$(RDIR)/rule.r
$(IDIR)/rule.i: rule.c
        $(ICOMPILE) rule.c -fd=$(IDIR)/rule.i
```

Macro Substitution

```
FILES  = dodate doname domake domac data \
         misc rule
$(FILES:%=$(RDIR)/%.r): $*.c
        $(RCOMPILE) $< -fd=$@
$(FILES:%=$(IDIR)/%.i): $*.c
        $(ICOMPILE) $< -fd=$@
```

Conditionals

Conditional entries enable the conditional parsing of the makefile.

Syntax

Conditionals always start in the first column and have the following syntax:

```
if <boolean expression>
{lines}
endif
```

Entries may be extended using `elif` and/or `else` as follows:

```
if <boolean expression>
{line(s)}
elif <boolean expression> #Note: not "else if"
{line(s)}
else
{line(s)}
endif
```

Do not indent the contents of `if` statements because they must appear in the first column. For this reason, `else if` does not work. `elif` is the correct syntax. Standard make indentation rules still apply for the body of the conditionals.

Conditionals can be nested to a maximum depth of 30 and can occur anywhere (excluding within a comment).

Boolean Expressions

The following boolean expressions are valid:

- `make`

  The syntax for a `make` boolean expression is `make(<target>)`, and is TRUE if `<target>` has been specified. For example, assume `make` is invoked from the command line, specifying `ppc` as the target as follows:

  ```
  $ os9make ppc
  ```

  The result is that the following `make` expression is TRUE:

  ```
  if make(ppc)
  {line(s)}
  endif
  ```

You can also test for not `make` as follows:

```
if !make(ppc)
{line(s)}
endif
```

The following variations are also supported:

```
ifmake ppc
ifnmake ppc
elif make(ppc)
elif !make(ppc)
elifmake ppc
elifnmake ppc
```

- `defined`

  The syntax for a `defined` boolean expression is `defined(<macro>)`, and is TRUE if `<macro>` is defined. For example, if `TRGTS` is defined, then the following `defined` expression is TRUE:

  ```
  TRGTS   =   SunOS
  if defined(TRGTS)
  {line(s)}
  endif
  ```

  Test for undefined macros use as follows:

  ```
  if !defined(TRGTS)
  {line(s)}
  endif
  ```

  The following variations are also supported:

  ```
  ifdef TRGTS
  ifndef TRGTS
  elif defined(TRGTS)
  elif !defined(TRGTS)
  elifdef TRGTS
  elifndef TRGTS
  ```

- `exists`

  The syntax for an `exists` boolean expression is `exists(<filename>)`, and is TRUE if `<filename>` exists. If no path is specified, the current directory is assumed. For example, if the following file exists at the specified path, then the `exists` expression is TRUE:

```
MWOS    =   ../../../../../..
if exists($MWOS/target.lst)
{line(s)}
endif
```

  Test for non existent files use as follows:

```
if !exists($MWOS/target.lst)
{line(s)}
endif
```

  The following variations are also supported:

```
ifexists $MWOS/target.lst
ifnexists $MWOS/target.lst
elif exists($MWOS/target.lst)
elif !exists($MWOS/target.lst)
elifexists $MWOS/target.lst
elifnexists $MWOS/target.lst
```

Operators

Boolean expressions can take advantage of the standard C boolean operators `&&`, `||`, and `!`, and the standard relational operators ==, `!=`, >, >=, < and <=. The relational operators == and `!=` are overloaded, allowing string comparison capability. These operators are defined as follows:

Table 4-8. os9make Utility Operators

Operator	Description
!	Logical Not
==	Equal
!=	Not Equal
<	Less Than
<=	Less Than or Equal
>	Greater Than
>=	Greater Than or Equal

Table 4-8. os9make Utility Operators (Continued)

Operator	Description
&&	Logical AND
||	Logical OR

Arithmetic and string operators can only be used to test the value of a variable. The left-hand side must contain the variable expansion, while the right-hand side can contain either a string enclosed in double quotes or a numeric value. Standard C numeric conventions (except for specifying an octal number) apply to both sides. Examples include the following:

```
if $(REVISION) == 87

if $(TARGET) == "403GAEVB"

if defined(LOAD_ADDR) && $(LOAD_ADDR) >= 0x10
```

Precedence

Arithmetic and string operators take precedence over &&, || and !. The ! operator takes precedence over &&, which has precedence over ||. Parentheses may be used for further prioritization.

Abbreviations

Abbreviations combining `if` with `defined`, `exists`, or `make` are described in <Bold><links>Table 4-9.

Table 4-9. Abbreviations

Abbreviations	Equivalent
ifdef	if defined
elifdef	else if defined
ifndef	if !defined
elifndef	else if !defined
ifexists	if exists
elifexists	else if exists
ifnexists	if !exists

Table 4-9. Abbreviations (Continued)

Abbreviations	Equivalent
`elifnexists`	`else` `if !exists`
`ifmake`	`if make`
`elifmake`	`else` `if make`
`ifnmake`	`if !make`
`elifnmake`	`else` `if !make`

Looping

Looping entries enable iteration to reduce the size of makefiles. Currently the only looping entry supported is the `for` command.

for Syntax

The `for` command iterates on the members of a macro. It defines a new macro and generates the lines between the `for` and `endfor` commands for each member of an existing macro.

```
for <new macro> in $(existing macro)
{line(s)}
endfor
```

For example:

```
TRGTS = gfx1 gfx2 gfx3
_purge: .
for NAME in $(TRGTS)
        -$(CODO) $(NAME)
        -$(DEL)  $(NAME)
        -$(CODO) $(NAME).stb
        -$(DEL)  $(NAME).stb
        -$(CODO) $(NAME).dbg
        -$(DEL)  $(NAME).dbg
endfor
```

The `for` command can also be nested. For example:

```
TRGTS = gfx1 gfx2 gfx3
_purge: .
for NAME in $(TRGTS)
for SUBNAME in $(NAME) $(NAME).stb $(NAME).dbg
          -$(CODO) $(SUBNAME)
          -$(DEL)  $(SUBNAME)
endfor
endfor
```

Do not indent the contents of `if` statements. Standard make indentation rules still apply.

5 Using the mshell Utility

The `mshell` utility is a command interpreter that helps you become as productive as possible when working with the OS-9/OS-9 for 68K operating systems. It accomplishes this by providing keyboard shortcuts and a means to automate menial tasks. It is compatible with the current OS-9/OS-9000 shell.

The `mshell` utility started as a port of OS-9's standard shell to OS-9 for 68K. From that point, enhancements replaced some built-in features of OS-9 and features unique to the `mshell` utility were added. Now, the `mshell` utility contains many of the same features as UNIX shells, as well as some OS-9/OS-9 for 68K specific options.

The `mshell` utility is a superset of the `shell` utility; the `shell` utility's command line options, syntax, built-in commands, and behavior are not documented here.

The `mshell` utility has many features that do not exist in the standard OS-9/OS-9 for 68K shell. These features fall into three basic categories:

- Command line interface
- Procedure files
- Built-In Commands and Command Line Options

Automatic mshell Login

To automatically execute the `mshell` utility when you log in, you must change your password file to include `mshell` as the initial program to execute. Also, you should load the `mshell` utility when the system starts so that it is in memory when the `login` utility runs. `login` requires that the initial process be in memory or in the user's personal execution directory. Place a line like the following in your start-up file to load `mshell` from the disk into memory:

```
load mshell
```

Refer to the *Using OS-9* or *Using OS-9 for 68K* manual for information about the `login` utility and system start-up file.

Command Line Editing

The `mshell` utility's command line interface is similar to the standard shell's. Therefore, it is easy to learn and use. Please learn to use the features in the order in which they are presented. Each feature mastered will increase your productivity.

Command line interface options include:

- Command line editing, including an option to change the default command line editing keys
- History buffer options and history buffer compression
- Command and pathlist completion options
- Command line aliases (assigns)
- Enhanced piping facilities
- Command line batchfiles

In addition to the standard OS-9/OS-9 for 68K control keys, `mshell` provides control keys which allow you to modify the text on the current command line. You can press the `<control>` key (`^`) and the appropriate letter key before you press `<return>` to add, delete, or modify characters in the command line. The following are `mshell`'s default editing control characters. Most of these are self explanatory.

Table 5-1. mshell Editing Control Characters

Key	Description
`^p`	Previous line (see the `History Buffer` section)*
`^n`	Next line (see the `History Buffer` section)*

Table 5-1. mshell Editing Control Characters (Continued)

Key	Description
^b	Cursor back (non-destructive)
^f	Cursor forward
^d	Delete character under the cursor
^z	Go to visible ends of line**
^k	Kill to end of line
^i	Toggle insert mode

** The first time you press ^z, the cursor goes to the beginning of the line, the next time it goes to the end of the visible line, in effect toggling back and forth between the beginning and end of the line.

* When you use ^p or ^n, insert mode returns to its default value. Refer to the -m command line option for information about the insert mode.

You can press <return> when the cursor is at any point in the command line. mshell processes the entire command.

Insert mode remains in its current state until a new command line is displayed. The command line editing keys that work on the current command line (for example, ^b) do not reset the insert mode to its default. Keys that replace the entire command line (^p or ^n) cause the insert mode flag to return to its default.

When changing text in the middle of a command line, use ^z instead of ^a. ^a displays and goes to the end of the *previous* command line. ^z allows you to edit the *current* command line.

Change Default Command Line Editing Keys

If you want to change the default command line editing keys, set the _EDKEYS environment variable. _EDKEYS contains one character for each of the control characters listed above. _EDKEYS has the following form:

```
<PrevLine><NextLine><PrevChar><NextChar><Insert><Del><Ends> <Kill>
```

For example, the following command sets the editing control keys to their defaults listed above.

```
$ setenv _EDKEYS pnBFIDZK
```

The string which sets `_EDKEYS`:

- Must be exactly eight characters long (extra characters are ignored).
- Is not case sensitive.
- May not contain any characters that cannot be translated to control characters.

Setting more than one key to the same value causes undefined behavior. Remove the `_EDKEYS` environment variable to return `mshell` to the default editing control characters.

The control characters from the path descriptor take precedence over your command line editing keys. Use the `tmode` utility to check your path descriptor. If any of the SCF control characters clash with `mshell`'s editing characters, you should either choose a new character for the `mshell` editing key or change your path descriptor. For example, to override the reprint line (`^d`) character in your path descriptor, put a `tmode reprint=0` command in your `.login` file. Then, you can use `^d` to delete characters.

History Buffer

`mshell` maintains a variable sized history buffer for each of its shells. The history buffer contains a record of each command line that you enter. You can use this buffer to duplicate and/or edit previously entered commands. By default, `mshell` preserves as many as 40 command lines in the history buffer.

The built-in `hist` command allows you to view your history buffer. Key in `hist` to display the history of commands and corresponding buffer index numbers.

Refer to the Built-in Commands section, and the mshell Command Line Options section to learn how to change the size of the history buffer.

To duplicate and immediately execute a command from your history, use ~<num>, where <num> is the index number of the corresponding command in the history buffer. If you want to duplicate and edit a command before executing it, use ~~<num> to bring the history entry into your ^a buffer. Press ^a to display the history entry and use the mshell control keys to make changes to the line as needed. Press <return> to execute the command.

The ~<num> and ~<word> syntaxes are forms of history substitution that you can do anywhere on the command line. If your eighth history entry was procs, your ninth entry was dir, and you entered ~8 -e; ~di -e mshell would execute procs -e ; dir -e.

For instance, to re-execute a command in a slightly different form, you might enter ~~8, type ^a, then use the editing control keys to edit it.

By default, you can use ^p to scroll backward and ^n to scroll forward through the history buffer from anywhere on the command line. For example:

```
$ * line 1<cr>
$ * line 2<cr>
$ ^p   At this point, the command line is replaced
       with * line 2
$ ^p   At this point, the command line is replaced
       with * line 1
```

You may also use ~<word> or ~~<word> to access the most recent command in your history that begins with <word>, where <word> is a sequence of characters in the range 0-9, a-z, or A-Z.

History Substitution

To re-execute a command from history:

```
~<num> or <word>
```

To place history entry into the ^A buffer for editing:

```
~~<num> or ~~<word>
```

View History

To display the history buffer:

```
hist
```

Use the `-r` option to pass your history from `mshell` to `mshell`. That is, you could accumulate some history, use `µmacs`, fork a shell out, and still retain your history. Of course, upon exit any history created in the child shell of µmacs would not be available to the parent of `µmacs`.

Use the `-s` option to save your history across login sessions. The `-s` option saves your history into a temporary file when you log out, and reads from that same file when you log in the next time.

Refer to the Built-in Commands section, and the mshell Command Line Options section for details about the `-r` and `-s` command line options.

If you enter the same command line twice in succession, `mshell` does not increment your history counter. This keeps the history buffer from filling up with duplicate commands, and allows as many unique command lines as possible.

History Compression

The `-h` option enables history compression. `-h` causes the `mshell` utility to search the entire current history for a matching command before adding a new history entry. When the `-h` option is in effect, the history index numbers can be misleading.

Refer to the Built-in Commands section, and the mshell Command Line Options section for details about the `-h` command line option.

The following example illustrates the effect of history compression:

```
[1]$ -h
[2]$ sleep 100
[3]$ sleep 200
[4]$ sleep 100
[4]$ hist
    -h
     sleep 200
     sleep 100
     hist
[5]$ logout
```

Notice that the current history index number did not increase when the second sleep 100 was entered, and that it appears only once in the command line history.

Command Completion

The `mshell` utility's command completion feature allows you to complete an entire command line with a single keystroke. Enter the first few characters of a command line from your history and press the escape key (`<esc>`). `mshell` replaces the current command line with the most recent command line that begins with the typed characters. Press `<esc>` again before entering any other characters. `mshell` replaces the command with the second most recent command which begins with the same few characters, and so on. When there are no more matching command lines a bell sounds. This is a convenient way to access your history without needing to know the number of a particular command.

Press `<esc>` after entering a few characters and `mshell` searches your history buffer for a matching replacement command. If the command line contains spaces or tabs before the cursor, press `<esc>` to use `mshell`'s pathlist completion feature.

Assume that your history buffer contains the following commands:

```
make
make -f=make.debug iopt.386
srcdbg iopt -d test.i
umacs dfa.c Most recent command
```

If you enter `ma` on the command line and press `<esc>`, `mshell` replaces the command line with the most recent occurrence of `ma`:

```
make -f=make.debug iopt.386
```

Now, if you press `<esc>`, `mshell` finds the next most recent occurrence of `ma` and replaces the command line with:

```
make
```

As an environment variable, CMDC also controls mshell's behaviors as mshell performs command completion. There are twelve different possible values for command completion. These values are shown below:

`<not set> or histbell`
: when `the history commands that match the pattern are exhausted, the terminal bell rings and the last matching entry remains`

`histloop`
: when `<esc>` is hit after the last matching entry, the list of matching entries starts over from the beginning

`histbounce`
: when `<esc>` is hit after the last matching entry, mshell begins moving backward through the list

`histpartial`
: when all of the history entries that match the pattern on the command line are examined, the command line is replaced with the longest common substring of all entries. More characters can be typed to disambiguate the entries and `<esc>` used again to finish command completion.

`pathbell`
: the characters on the command line are used as a way in which to find all executable commands and each `<esc>` advances alphabetically through the list of commands. When the list is exhausted, the terminal bell rings and the last matching entry remains.

`pathloop`
: when `<esc>` is hit after the last matching executable, the list of matching executables starts over from the beginning

`pathbounc`
: when `<esc>` is hit after the last matching executable, mshell begins to move backward through the list of executables

`histpartial`
: when all of the executables that match the pattern on the command line are examined, the command line is replaced with the longest common substring of all the entries. More characters can be typed to disambiguate the executables and `<esc>` used again to finish command completion.

`bothbell`
: the characters on the command line are used as a way in which to find all of the matching history entries and executable commands and each <esc> advances through the list. When the list is exhausted, the terminal bell rings and the last matching entry remains.

`bothloop`
: when `<esc>` is hit after the last matching history entry or executable, the list of matches starts over from the beginning

`bothbounce`
: when `<esc>` is hit after the last matching history entry or executable, mshell begins to move backward through the list

`bothpartial`
: when all of the history entries and executables that match the pattern on the command line are examined, the command line is replaced with the longest common substring of all the items. More characters may be typed to disambiguate the item and `<esc>` may be used again to finish the command completion.

In any of these modes, `^\` (control backslash) can be used examining the complete list of matches. This can be especially useful when disambiguating partial completions.

Pathlist Completion

You enter a partial file name in the command line and `mshell` completes it. `mshell` does a wildcard match on the partial pathlist and displays the matching file name on the command line.

For example, in a directory with the files `test1.c`, `file`, `file2`, and `file3`, if you enter:

```
del fi<esc>
```

mshell replaces your command line with the matching file name and places the cursor at the end of the line:

```
$ del file
```

You are free to backspace over the file name if it is not the one you are looking for. Press <esc> again before typing any other characters; mshell displays the next file (in alphabetical order) in the directory that begins with fi (file2), and so forth. A bell sounds when there are no more files that match the pattern.

mshell's file name completion feature is intelligent; it knows the structure of file names. When you enter make -f=make and press <esc>, mshell knows that you are looking for a file that begins with make, not -f=make.

As an environment variable, FILEC is also available to control how mshell behaves when performing command completion. There are four different possible values for command completion. These values are shown below:

<not set> or histbell
: when the pathlists that match the pattern are exhausted, the terminal bell rings and the last matching entry remains

loop
: when <esc> is hit after the last matching entry, the list of matching entries starts over again from the beginning

bounce
: when <esc> is hit after the last matching entry, mshell moves backward through the list

partial
: when all of the pathlists that match the pattern on the command line are examined, the pathlist is replaced with the longest common substring of all the entries. More characters may be typed to disambiguate the entries and <esc> used again to finish the pathlist completion.

In any of these modes, ^\ (control backslash) can be used to examine the complete list of matches. This can be especially useful when disambiguating partial completions or examining the contents of a directory.

Command Name Aliases (Assigns)

Command name aliases make it simple to enter commonly used or repetitive commands. Use the `assign` command to assign an alias to a word which acts as a substitute for a specified string. For example, if you prefer to use the UNIX `cd` command (change directories) rather than the OS-9/OS-9000 `chd` command, you could create an `assign` as follows:

```
assign cd chd
```

From that point forward, every `cd` command you issue automatically changes to `chd`. Characteristics of `assign` include:

- `mshell` only performs the substitution on the command itself, it does not affect the rest of the command line.
- Assigns are case sensitive. `Cd` is not the same as `cd`.
- If there are spaces in the string, you must place quotation marks at the beginning and end of the string. For example:

Refer to the Built-in Commands section, and the mshell Command Line Options section for the `mshell` command line options (`-q`), details about changing the default.

```
$ assign pd "print("%s\n", $(PWD:q))"create a quicker pd
```

- Assigns are always passed to procedure files, so be cautious when executing other people's procedure files with your own assigns set.
- You can keep assigns in the environment to follow you from `mshell` to `mshell`. For example, if you have a number of assigns, fork µmacs, and shell out, your assigns travel with you.

`mshell` has a built-in command, `noassign` you can use to prevent access to the assign list for a given command. For example:

```
$ assign pd "print("%s\n", $(PWD:q))"create a quicker pd
$ pd execute the "assigned" pd
/h0/usr/ric/c/mshell
$ noassign pd execute the "real" pd
/h0/USR/RIC/C/MSHELL
```

Assign

To view all of your current aliases, enter `assign` with no arguments.

Unassign

Use the `unassign` command to remove assigns. `unassign` takes any number of arguments and does not report errors when unassigning words that are not assigned.

Enhanced Piping Facilities

`mshell` allows you to pipe standard output and/or standard error from one process to another. You may use this to capture all output and error messages of a process. Use the following command separators:

Table 5-2. mshell Command Separators

Separator	Description
`!`	Standard output
`!!`	Standard error
`!!!`	Both standard output and standard error

For example, to pipe both the normal and error output of `cc` to `pr`:

```
cc -g -td=/r0 testprog.c !!! pr
```

Command Line Batchfiles

With `mshell`, you can create temporary batchfiles directly from the command line. With this facility, you can use interpreter characteristics without an editor. `mshell` writes your sequence of command lines into a file and by default executes it as a profiled procedure file.

You may choose to have your batchfiles run as normal (non-profile) procedure files by using the `-np` option.

Refer to the Built-in Commands section, and the mshell Command Line Options section for information on `-np`.

To start the batchfile process, enter the first line of the batchfile on the command line, but put a backslash (`\`) character at the end. This tells `mshell` that you want to create a batchfile. `mshell` then begins prompting with a question mark (`?`). Carriage return (`<cr>`) on a blank line terminates the batchfile creation and starts the execution. Press `<esc>` as the first character on any line to terminate the creation of the batchfile and return to the normal shell prompt.

The question mark (?) prompt is treated like any other prompt. `mshell` provides file name completion and history access via `<esc>`.

The following is an example batchfile creation session to copy all `*.c` files to `BACKUP/*.bak`:

```
$ while (next_file(fn,"*.c")) \
? copy -rb=32 %fn BACKUP/%(fn:r).bak
? endwhile
? <cr>
```

You can set the environment variable `_BATCHDEV` to the device that you want `mshell` to use for the temporary batchfile. For example, the following line causes the command line batchfile facility to use the RAM disk for its temporary file:

```
$ setenv _BATCHDEV /r0
```

Set Matching Wildcards

In addition to the standard `*` and `?` wildcards support by OS-9, mshell also supports character set matching. Character sets are specified within square brackets (`[]`). Within the brackets, sets of characters are specified that match a single character in a file name. The set is specified by either individual characters or ranges of characters (two characters separated by a dash). The sense of the match is inverted if the first character of the set is dash. That is, the wildcard will match anything but the specified set of characters.

For example, assume you are in a directory containing the following files:

```
file_a.c file_a.h file_b.c file_b.h file_c.c file_c.h
file_d.c file_d.h
```

You would see the following if you executed these command lines:

```
$ echo file_*.?
file_a.c file_a.h file_b.c file_b.h file_c.c file_c.h file_d.c
file_d.h
$ echo file_[ac].h
file_a.h file_c.h
$ echo file_[b-d].c
file_b.c file_c.c file_d.c
$ echo file_[-abd].h
file_c.h
```

Procedure File Programming Language

mshell procedure files are handled quite differently than OS-9/OS-9 for 68K procedure files. To perform some tasks in OS-9/OS-9 for 68K, the only choice is a quick BASIC or C program. With mshell you can use procedure files. The following describes the mshell procedure file features:

- Parameter Passing to Procedure Files
- Environment Variable Substitution
- Programming Variable Substitution
- Command Output Substitution
- Variable Substitution Modifiers
- Procedure File Line Concatenation
- Procedure File Debugging Facilities

To ensure that you write effective procedure files, master the basics, then progress to their more complex aspects.

mshell includes a full programming language interpreter. The language represents a hybrid of both C and BASIC. The features presented here are related to procedure files. You can use them along with the programming language.

Parameter Passing to Procedure Files

A procedure file may take any number of parameters. To pass parameters to a procedure file, enter them as if you were passing parameters to a program. They are accessed from within the procedure file via environment variables in the form P<num>, where num ranges from 0 to 1 less than the number of parameters passed.

Refer to the mshell Command Line Options section for more information about the PN argument.

There are two additional variables passed to procedure files; P* and PN. P* is the concatenation of all the parameters separated with a space. P* is useful for procedure files that take a variable number of arguments. PN is set to be the number of arguments passed to the procedure file. PN is useful when processing the arguments one-by-one in an interpreted procedure file.

For example:

```
$ procfile param0 param1 param2
```

The line above calls a procedure file with the following environment variables set:

```
P0=param0
P1=param1
P2=param2
P*=param0 param1 param2
PN=3
```

Environment Variable Substitution

`mshell` provides a facility to perform environment variable substitution on the command line. `mshell` replaces the specified environment variable with its actual value. This feature is useful for using the parameters passed to a procedure file or to reduce the amount of typing required.

The following syntax brings environment variables into the command line, where `<name>` is the name of the environment variable desired.

```
$(<name>)
```

For example, the following command line causes `mshell` to substitute the actual name of the terminal type (`kt7`) for the specified environment variable (`TERM`). This command:

```
$ echo "My terminal type is" $(TERM)
```

Yields:

```
My terminal type is kt7
```

Parameter passing makes procedure files more portable in that you can use environment variables within procedure files.

Refer to the sections Command Output Substitution and Variable Substitution Modifiers for information on those topics.

For instance, use the following line to fork `mmacs` from within a procedure file:

```
umacs $(HOME)/tempfile <>>>$(PORT)
```

This allows you access to any terminal that contains a `HOME` directory.

Programming Variable Substitution

`mshell` has shell variables that you can place into the command line, similar to environment variable substitution. The syntax is `%<name>` or `%(<name>)`, where `<name>` is the name of the variable that is desired.

Refer to the Variable Substitution Modifiers section of this chapter for more information about variables.

For example:

```
$ let  a = "hello there"
$ echo %a      or      echo %(a)
hello there
```

Programming variable substitution is performed after environment variable substitution.

Command Output Substitution

`mshell`'s command output substitution feature allows you to place the output of a command within that same command line. In other words, the output which is the result of executing the specified command becomes an argument in the command line.

Use the following syntax (within a command line) to paste the output of a command directly into that same command line:

```
$("command"{:modifiers})
```

`mshell` executes the specified command and substitutes the output for the above syntax. If the output of `command` contains more than one line, each line is separated by a space and added to the command line.

For example, to make up for the shell's lack of wildcards for the module directory, you could use `mdir -u` to execute `unlink` on all modules containing `ric`:

```
unlink $("mdir -u "*ric*"")
```

This facility can also be very useful in interpreted procedure files. The following command line assigns the output of the date utility to the variable `d`:

```
let d = $("date":q)
```

Variable Substitution Modifiers

Programming variable, environment variable, and command output substitution specifiers may also have modifiers. Most of the modifiers accomplish frequent file name type manipulations on the replacement value. These modifiers do not actually change the variable's value. They simply alter its appearance. You may use this option to temporarily mask certain characteristics of a variable. The variable, however, retains its actual value.

You must specify modifiers after the variable name and separate them from the variable name by a colon (for example, `$(HOME:q)` or `%(filename:rq)`. The modifiers are applied in the order in which they appear and may be separated by any number of colons (:).

The following is a list of variable substitution modifiers and a description of the operation that they perform:

Table 5-3. mshell Variable Substitution Modifiers

Modifier	Description
`h`	Strip the file name and slash (`/`) (if applicable) from the variable, leaving the directory that contains the file name.
`r`	Remove the suffix (all characters from the last period (`.`) forward) from the variable.
`e`	Remove the entire pathlist and file name, leaving only the suffix portion of the variable.
`t`	Remove any pathlist components, resulting in a file name only.
`q`	Surround the replacement variable with double quotes ("). `q` is very useful to ensure that the replacement of a variable is interpreted as one argument. For instance, if you want to do a `setenv` with the value of a variable, you might use the following command to ensure that `setenv` received only two parameters. `setenv PATH %(pathvar:q)`

The following examples show the modifier applied and the resulting value if the variable has the value at the top of the column:

Table 5-4. mshell Modifier Examples

Modifier	test.c	/h0/USR/RIC/test.c	TESTDIR
h	.	/h0/USR/RIC	.
r	test	/h0/USR/RIC/test	TESTDIR
e	c	c	(empty string)
t	test.c	test.c	TESTDIR
q	"test.c"	"/h0/USR/RIC/test.c"	"TESTDIR"

The `h` modifier returns a period when there is no pathlist because the pathlist `./` is implied. This enables you to write generic code, regardless of the existence of a pathlist. The following example procedure file makes a backup copy of all .c files:

```
*** For each file in the directory matching "*.c"
while (next_file(fn,"*.c"))
   *** make a copy with a different extension
   copy -rb=32 %(fn) %(fn:r).bak
endwhile
```

Procedure File Line Concatenation

For the convenience of the procedure file programmer, logical lines may span many physical lines. During procedure file execution, if `mshell` encounters a line that ends with a backslash (\) character, the next line is read and added to the current line. This process continues until `mshell` finds a line that does not end with a backslash.

The line following a backslash line is inserted starting at the position of the backslash. The current implementation of this feature allows the break to occur anywhere (within quoted strings, between items that would normally be considered a single token). For example:

```
if (strcmp(%answer,"yes") == 0) || \
    strcmp(%answer,"YES") == 0) || \
    strcmp(%answer,"Yes") == 0))
print("This is a \
very strange place to break a line into two\n");
echo I \
just \
can't \
get \
"enough!"
```

Procedure File Debugging Facilities

`mshell` provides two simple mechanisms for debugging procedure files:

- Command monitoring
- Debugging message logging

The `mshell -d` option turns on command monitoring. When `-d` is enabled, before `mshell` forks a process it prompts you for permission. This allows you to skip or monitor the "dangerous" or time consuming parts of your procedure file (`del`, `deldir`, `cc`, `make`). This option is most useful while debugging a procedure file, but you could use it when experimenting with variable replacement modifiers or history replacement escapes.

Refer to the Built-in Commands and mshell Command Line Options sections for a complete description of `-d`.

The following is a sample of command monitoring:

```
$ -d
$ umacs $(HOME)/.login
Execute: "umacs /h0/USR/RIC/.login"? (y, n, a, or q)
```

At this point, you can enter one of the following:

- `y` to execute the command
- `n` or `<Return>` to skip the command
- `a` to execute the command and turn off the debugging option
- `q` to exit the `mshell` (`q` is not useful here, but is very useful when debugging a real procedure file)

The `-u` option turns on the debugging message log. This feature prints useful information about interpreter variables, functions, and directives.

Messages appear for a variety of reasons. Using `-t` in conjunction with `-u` is very helpful. Put a `-ut` before an area where a bug is suspected and a `-ntnu` after the area. This limits the debugging messages to the area in question.

Built-in Commands

`mshell` has a number of built-in commands and command line options. The built-in commands include:

- profile Command
- UNIX-like Data Directory Commands
- prenv Built-in Command
- set Command
- which Command

Command line options include:

- Options that control various `mshell` features
- Customized prompt string
- Parameter passing among `mshell`s
- An alert message compatible command line

To change a command line option:

You can change a command line option at any time with the dash (–) or `set` command.

profile Command

The built-in `profile` command allows you to execute a procedure file without forking a child shell. This can be useful for changing directories and setting the environment from within a procedure file. A `profile` procedure file can take arguments just like a normal procedure file. The syntax is:

```
profile <procfile> [<param> ...]
```

`procfile` is the name of the procedure file to execute.

`param` is any number of parameters that are to be passed to the procedure file. For example, if you had a procedure file (`newuser`) containing:

```
setenv USER $(P0)
setenv HOME /h0/usr/$(P0)
chd $(HOME)
```

You could execute it with:

```
$ profile newuser robb
```

USER would be set to robb, HOME would be /h0/usr/robb, and your current data directory would be /h0/usr/robb.

During the execution of a profile procedure file, stdin is not redirected from that file to mshell, so mmacs on a line by itself works without any additional redirection.

UNIX-like Data Directory Commands

mshell has three built-in commands that you can use to maintain a stack of working directories. They behave exactly like the UNIX built-ins dirs, pushd, and popd. If you are unfamiliar with the UNIX commands, here is a brief explanation of each command and its parameters (each command prints the stack after the operation is complete).

Table 5-5. mshell Data Directory Commands

Command	Description
dirs	Print the current directory stack.
pushd	Reverse the order of the top two items on the stack and chd to the top item. This is very useful when you need to work in two directories at once.
pushd <dir>	Push the current working directory and do a chd to the directory (dir)
pushd -<num>	Take stack item number num, put it on the top of the stack, and chd you to that directory.
pushd -h	Push the HOME directory onto the directory stack.
pushd -x	Push the current execution directory onto the stack.
popd	Pop the top off the stack and chd to the new top item.
popd -<num>	Discard item number num from your directory stack.

Below is an example of using `pushd` with the `-h` and `-x` options.

```
$ dirs
0. /h0/MWOS/SRC/DEFS
$ pushd -h
0. /h0/USR/RIC
1. /h0/MWOS/SRC/DEFS
$ pushd -x
0. /h0/CMDS/RIC
1. /h0/USR/RIC
2. /h0/MWOS/SRC/DEFS
```

In addition to these commands, the current data directory is maintained in the environment variable `PWD`. These commands use `PWD` to determine the current data directory. `PWD` may not be changed manually.

prenv Built-in Command

`prenv` is a built-in `mshell` command. Its function is much like that of `printenv` in that it displays the environment variables. `prenv`, however, provides a condensed version of `printenv`, omitting environment variables which `mshell` uses to pass history and assign information to other `mshell`s. The list is much shorter and displays only the environment variables that are of the most interest. Specify a dash (-) as an argument to `prenv` to display all environment variables.

You can also use prenv to display specific environment variables. For example, to examine the variables HOME and frog you use:

```
$ prenv HOME frog
```

Resulting in the following output:

```
HOME=/h0/USR/RIC
frog is undefined
```

set Command

Use the built-in `set` command to examine the current `mshell` options. Enter `set` on the command line to display all of the current options and any strings associated with them. You can also use `set` to examine the current command line editing keys. The following is sample output of the `set` command:

```
                              Current Shell Options
                                Prompt = ON (@%(nBugg_$ )
                         Error Messages = OFF
                  Invocation Initialization = OFF
                                     Echo = OFF
                                  Verbose = OFF
                                Debug Mode = OFF
                           Debug Message Log = OFF
                          Profile Batchfiles = ON
                                 Auto Logout = ON
                              Abort on Error = OFF
                                Fancy ReadLn = ON
                          Default Insert Mode = OFF
                                   Alter-Echo = ON
                                      History = OFF
                            History Save/Load = OFF
                              History Passing = ON
                          History Compression = ON
                                Alias Passing = ON
Shell Line Editing Chars:
PvLine=^P  NxLine=^N  PvChar=^B  NxChar=^F  Ins=^I
Del=^D  Ends=^Z  Kill=^K
```

which Command

The `which` built-in command displays where to find a module or file of the given name and the nature of the files (module or procedure file). For example:

```
$ which procs
procs - in-memory module
/h0/CMDS/procs - module - on PATH
$ which procfile
procfile - procedure file - current data directory
relative
$ which cd
cd - aliased to 'chd'
$ which chd
chd - built-in mshell command
```

mshell Command Line Options

`mshell` features include a number of options that control them. All of these options follow the basic form of a shell option.

Table 5-6. Enabling mshell Command Line Options

Enable Option	Disable Option
-<char>	-n<char>

The following is a list of options and their effect on `mshell`.

Table 5-7. mshell Command Line Options

Option	Description
`-a`	Alter-echo When this option is enabled, all lines that are changed between the time they are entered and when the process is ready to be forked are echoed. Changes might include environment variable, interpreter variable, or history substitution. Command name alias substitution does not cause the line to be echoed. The default is `-a`.
`-b`	Profile batchfiles This option determines the execution method of batchfiles created from the command line. If you use `-b`, batchfiles are executed as profiled procedure files. Otherwise, batchfiles are executed as procedure files under a different `mshell`. The default is `-b`.
`-c`	History buffer This option sets the size of the history buffer, turns on the default history buffer, or turns the history buffer off. It may take a size argument: the number of command lines saved. For example: `-c`: Turns on the default 40 command line history buffer. `-c=10`: Turns on a ten command line history buffer. `-nc`: turns off the command line history buffer. The default is `-c=40`.
`-d`	Debug mode This option enables/disables the debugging mode built into `mshell`. When `-d` is enabled, processes are forked under user control. The default is `-nd`.
`-e`	Print error explanations. The default is to not print.

Table 5-7. mshell Command Line Options

Option	Description
-f	Fancy readln Fancy-readln controls the routine mshell uses to read from the user on an SCF device. -f enables command and pathlist completion, editing control characters, and a non-blocking readln command line. This mode has two drawbacks: • I/O can be done to the device between characters. • When running mshell over the network, it can cause excessive traffic. -nf causes mshell to use the standard SCF readln. The default is -f.
-h	History compression -h, when enabled, causes mshell to search the current command line history after each command is entered. If a matching command line is found, no new history entry is created. This prevents repetition of matching command lines. The default is -nh.
-i	Invoke initialization script This option controls whether or not the file $(HOME)/.shellrc is executed each time an mshell begins execution. (Refer to the "Invoking the Initialization File" section.) The default is -ni.
-l	Require "logout" to logout.

Table 5-7. mshell Command Line Options

Option	Description
`-m`	Insert mode When you enable `-m`, the default editing mode is `insert`. If you back into the command line's text (with `^b`) and type, the characters are inserted into the command line rather than overwriting existing characters. The default is `-nm`, `overwrite` mode. The insert mode remains in its current state until a new command line is displayed. The command line editing keys that work on the current command line (for example, `^b`) do not reset the insert mode to its default. Keys that replace the entire command line (for example, `^p`) cause the insert mode flag to return to its default.
`-o`	Time-out The `-o` option allows you to specify the number of minutes to allow an `mshell` sit at an empty command line prompt before timing out. The default is `-nf` (no time-out). The syntax to enable `-o` is: `-o[[=]<n>]` n is the number of minutes to sit before timing out. The default for n is 480 minutes (eight hours).
`-q`	Alias passing This option controls whether or not your assigns are kept in the environment. Regardless of this option, assigns are passed to all procedure files executed. Refer to the Command Line Interface chapter for information on assigns.) The default is `-q`.
`-r`	History passing This option controls whether or not your history is passed from `mshell` to `mshell`. The default is `-nr`.

Table 5-7. mshell Command Line Options

Option	Description
`-s`	History saving This option determines if your history is saved when you log out and read when you log in. Without `-s`, you start each login session with an empty command line history. The default is `-ns`.
`-t`	Echo input lines.
`-u`	Procedure file debugging log This option causes the shell to output debugging messages. It is most effectively used by preceding code where a problem is encountered with a `-u`, and using `-nu` to disable the debugging output after the code. The default is `-nu`.
`-v`	Print attempts to execute command.
`-x`	Exit on error.

Parameter Passing among mshells

`mshell` keeps the `_SHELLPARAMS` environment variable which contains the current settings of some `mshell` options. This allows `mshell` to pass its current options to all other `mshell`s that are forked below it. Some options are not passed because they are changed when procedure files are executed, and would therefore affect any `mshell`s forked from procedure files.

`_SHELLPARAMS` is scanned before the initial command line is parsed, so any option changes on a command line works properly.

You can remove `_SHELLPARAMS` from the environment, but you cannot set it into the environment manually.

Invoking the Initialization File

Each time mshell starts, it searches for the .shellrc file in your HOME directory. You can use the .shellrc file to set shell options which are not passed in the _SHELLPARAMS environment variable. If the file is found, it is executed in the same manner as the .login file is executed when you log in. This feature is controlled by the -i option (see the mshell Command Line Options section). In the case of the "login shell" it is executed after the .login script file. Therefore, any options set in the .login file can be changed in the .shellrc file. It is not considered fatal if there is no .shellrc file, but if it does not, it is more efficient to use the -ni option (default) to keep it from being checked each time.

For example, the -c option is not passed in the _SHELLPARAMS variable. You can create a one line procedure file named .shellrc in your HOME directory containing the -c=50 command. Then, as long as the -i option is in effect, each forked mshell automatically has a 50-entry history buffer.

To use the -i option effectively, you must understand the order of certain mshell operations. When you run mshell, it:

1. Processes the .login file (login shell only)
2. If the -i option is enabled, processes .shellrc
3. Processes the initial command line specified as arguments to mshell
4. Prompts you for further command lines

Note that the .shellrc file processing is done before the initial command line to mshell. This means that a password file line such as the following does not behave as expected:

```
joe,user,1.0,128,/h0/CMDS/JOE,/h0/USR/JOE,
mshell -ip="Joe: "
```

mshell enables the -i option after the check to see if -i is enabled. It is better to place the -i option in the .login file. Also, the following command line does not behave as you might expect:

```
$ mshell -i
```

Again, `mshell` checks to see if *-i* is enabled before the option is actually enabled. The following might be a better sequence. If you are:

Running `mshell`:

```
$ -i; mshell
```

Not running `mshell`:

```
$ mshell -ip="MS: "
MS: profile $(HOME)/.shellrc ; * only necessary once
```

Prompt Format String

`mshell` allows the prompt text to contain `printf`-like format escapes. You can customize your prompt format string with this feature. You may want to include the shell level as part of the prompt, as well as other items. The following are the escapes allowed (`<d>` is the optional delimiter character):

Table 5-8. Allowed Escapes in mshell

Escape	Replacement
`@`	Current shell level and a dot. `@` must be the first character in the prompt. (This is included for compatibility with the standard OS-9/OS-9000 shell.)
`%<d>s`	Current shell level (may appear anywhere in the prompt). `%s` only displays a value if the environment value `_sh` is set to a non-zero value.
`%<d>h`	Current command number in the history buffer
`%p`	Current data directory
`%<d>n`	Number of directories currently on the stack
`%u`	Current user ID of the shell
`%g`	Current group number of the shell
`%l`	Login name of the user (USER environment variable)

Table 5-8. Allowed Escapes in mshell (Continued)

Escape	Replacement
%d	Current date. The default format is yy/mm/dd. You can change this by setting the environment variable _DATEFMT with the following replace escapes permitted: dd = day of month (1-31) ddd = day of week (Sun-Sat) mm = month of year (1-12) mmm = name of month (Jan-Dec) yy = two digit year number yyyy = four digit year number Any other character sequences are copied directly to the prompt. For example: $ setenv _DATEFMT "mmm dd-mm-yyyy" yields a date format such as: Aug 30-08-1993
%t	Current time. The default format is hh:mm:ss am/pm. You can change this by setting the environment variable _TIMEFMT with the following replace escapes permitted: tt Tick ss Second mm Minute hh Hour 24 Military hour ap a.m. or p.m. Any other character sequences are copied directly to the prompt. For example: $ setenv _TIMEFMT "24:mm:ss.tt ap" yields a time format such as: 18:27:15.77 pm For example: $ -p="@[%h]<%p>Vite_$ " causes a prompt which might look like: 3.[216]</h0/usr/ric>Vite_$

%h, %n, and %s may have any of the following optional delimiter characters specified:

Table 5-9. Optional Delimiter Characters in mshell

[	Left bracket	{	Left brace
<	Less than sign	(	Left parenthesis

These characters and their matching close characters delimit the value if the value is non-zero. If the value is zero, no characters appear for the format escape. For example:

```
$ -p="[%h]Test%(n: "    set the prompt
[31]Test: pushd ..      push a directory
0. /h0/usr              the directory stack
1. /h0/usr/ric
[32]Test(2): -nc        turn off the history buffer
[0]Test(2):             notice the [0] is there because
                        no delimiter character was used
                        with the %h
```

Any unrecognized escapes are simply left in the prompt text. For example:

```
-p="%xHello: "
```

yields a prompt of %xHello:. To include a percent sign (%) in a prompt use %%.

Non-blocking ReadLn

mshell, when located at the prompt, allows output to the terminal. Output is allowed when the cursor is sitting at the first position and there are no characters on the command line (after ^x). When -f is enabled, mshell uses a non-blocking readln routine to read from SCF devices. When the command line is empty, other processes can do output to the device. This allows you to see the output of background processes if it arrives when you are sitting at an empty prompt.

This feature causes read errors for background processes that read from the same port as an mshell.

mshell Directives

`mshell` has a built-in procedure file interpreter which represents a hybrid of both C and BASIC. It is implemented using built-in commands called directives. The following sections describe the five basic elements of the language:

- `mshell` Directives
- Operators
- Variables
- Function Calls
- Constants

Directives are built-in commands which control program flow, display text, or assign variables new values. You use directives in the same way that you might use `list` or `dir`. Directives, however, are handled as a special case by `mshell`. Once it is determined that the command is a directive, the remainder of the line is treated as the sole expression argument to the directive. Therefore, apply the following rules when writing shell scripts for `mshell`:

- Use only one directive per line.
- The directive must be the first item on the line:

  ```
  if (%a == %b)
  ```
- Unconditional branch
- Conditional branch
- Procedure file function
- Variables
- Miscellaneous

The statement above is a conditional branch which starts an `if` construct.

Refer to the Directive Descriptions section for information about each directive.

You may follow directive lines with an optional semi-colon (;) and any other text. The following lines are valid:

```
do execute(strcat("del ", %fn))
do execute(strcat("del ", %fn));
do execute(strcat("del ", %fn)); This is a comment
do execute(strcat("del ", %fn))  ;* This is a comment
```

Directives take expressions as their argument. Expressions may contain any of the following four elements:

- Operators
- Variables
- Function Calls
- Constants

Operators

Expressions are formed from operands separated by operators. The operands may be any combination of variables, functions, and constants. See the following table for a list of operators and their precedence.

Table 5-10. Valid Operators

Operators	Class	Precedence
`(<expr>)`	Grouping	High
`~, -, +`	Unary	
`*, /, %, &, ^`	Arithmetic/Bit	
`+, -, |`	Arithmetic/Bit	
`<<, >>, >>>`	Arithmetic/Bit	
`<, <=, >, >=, ==, !=`	Relational	
`&&, ||`	Logical	Low

All operators associate left to right.

Variables

When you reference a variable in an `mshell` procedure file, you can specify either the variable's `name` or its `value`. To assign a new value to a variable, refer to the name of the variable. To use the value of a variable, precede the variable name with a percent character (`%`). For example, the following command assigns a value to `x` (by referring to the name `x` only), and refers to the value in `var` (by preceding the name `var` with a percent character (`%`).

```
let x = %var
```

The name of a variable must follow the rules defined for an identifier constant (see the `Identifier Constants` section). The case of the

letters is significant, that is, AbC is not the same as aBc. The name may be any length.

`mshell` has both *global* and *local* variables.

Global variables are given values by the `let` directive and `assign()` function. They may be assigned in or out of procedure file functions (PFFs).

Local variables are assigned values inside of PFFs via the `llet` directive or the `lassign()` function.

For each variable reference, the locals are searched first (if applicable), then the globals are searched. This causes local variables to take precedence over globals of the same name. See the `function` and `return` directives for more information on PFFs.

%status Variable

`%status` is a global shell variable that is set to the error number of the most recently completed command. A value of zero indicates success; non-zero is an error number.

The built-in commands listed below set `%status`. The remainder do not modify the value in any way:

`chd`	`chx`
`profile`	`prenv`
`pushd`	`popd`
`dirs`	`assign`
`unassign`	`set`
`chm (OS-9 only)`	`kill`
`setenv`	`unsetenv`
`which`	`setpr`

The following example script demonstrates the usage of `%status`:

```
-nx ;* don't terminate script on error
merge -z=filelist -o=bootfile
if (%status != 0)
  print("merge terminated with error %s\n", %status);
endif
```

Functions

mshell has a number of built-in subroutines (functions) which you can call from within expressions. A function may take as many as three expressions as parameters (which may, in turn, have functions in them). The number of parameters for each function varies.

Refer to the mshell functions and their parameters.

Example:

```
let a = len(%b)
```

The statement above places the length of the string held by %b into the variable a.

Constants

There are four types of constants:

- Quoted String Constants
- Integer Constants
- Logical Constants
- Identifier Constants

Quoted String Constants

Quoted string constants begin and end with a double-quote character ("). The string is examined for escape characters. Quoted string constants may contain C-like escape characters in the form `\char`, where `char` is one of the following.

Table 5-11. Quoted String Constants in `mshell`

Escape Character	Replacement
`b`	Backspace (0x08)
`e`	Escape character (0x1b)
`l`	Line feed
`n`	Carriage return
`r`	Carriage return
`t`	Tab
`\`	Backslash
"	Double-quote character
other	Any character other than those above (for example, \h == h)

Integer Constants

Integer constants begin with a digit and continue until the first non-digit character is reached. All integers are stored as signed 32-bit values and may not have values that would require more storage.

Hex constants, a type of integer constant, have a 0x prefix and consist of a sequence of upper or lower case hexadecimal characters. The `hex()` function is available for use on hex constants that do not have the 0x prefix.

Logical Constants

Logical constants are `TRUE`, `FALSE`, `READ`, `WRITE`, and `UPDATE`. They appear in expressions as strings of characters without the double-quote characters. As in C, `TRUE` is equal to 1 and `FALSE` is equal to 0. `READ`, `WRITE`, and `UPDATE` are explained in more detail in the section on I/O functions.

Identifier Constants

An identifier consists of a string of characters beginning with an alphabetic (A-Z, a-z) or underscore (_) character, followed by any number of alphanumeric characters and underscores.

Examples

In the examples that follow, constants are shown in italics.

Quoted string:

```
let a = "This is a test."
if (strcmp(%a, "HELLO") == 0)
     print("%s\n", "Something is very wrong here!")
endif
```

Integer:

```
let a = 127
if (%a >= 256)
     print("Something is very wrong here! %s >= 256\n",
            %a)
endif
```

Logical:

```
let a = TRUE
if (%a == FALSE)
     print("%s\n", "Something is very wrong here!")
endif
```

Identifier:

```
let a = 127
label infinite_loop
     echo "Stop me!"
goto infinite_loop
```

The representation of items within the interpreter is strings of characters. Conversion to integer is done when necessary, but only for computations. The end result of all expressions is a string.

The following statement contains an error. The variable `b` would be assigned the value backslash (`/`) and an error would occur; extra tokens starting at `h0`. White space and punctuation breaks up unquoted strings into separate tokens.

```
let b = /h0/usr/ric
```

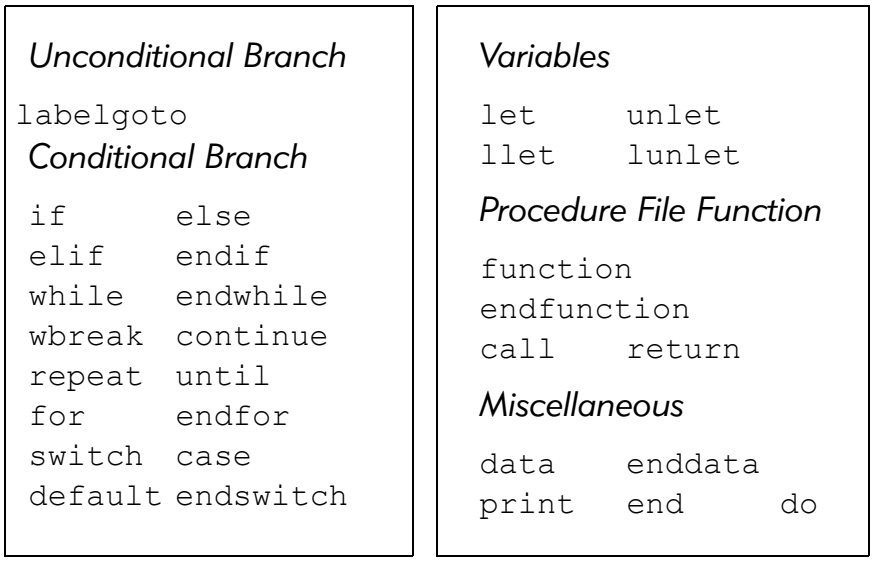
Both of the following statements are equivalent. Double-quoting strings of digits does not make a difference, since the internal representation of values is a string of characters.

```
let c = 912          or          let c = "912"
```

Directive Descriptions

Directives tell `mshell` how to execute a particular procedure file. There are directives which support unconditional and conditional branching, looping, variable assignment, functions, and the printing of expressions. This chapter contains the syntax and descriptions of all `mshell` directives. Unless otherwise noted, directives may only appear in procedure files; you may not enter them directly from the command line (with the exception of batch file creation as described in the Command Line Batchfiles section.)

Figure 5-1. mshell Directives



Syntax

Throughout the directive descriptions, certain conventions are used to describe directive syntax:

Table 5-12. Conventions

Convention	Description
[ ]	Optional
< >	Description of an item

Table 5-12. Conventions

Convention	Description
`{ }`	May be repeated or omitted
`...`	Previous <item> may be repeated

The following tables lists the unconditional directives.

Table 5-13. Unconditional Branch Directives

Command	Description
`goto <expr>`	Transfer Control to a Label `goto` allows the unconditional transfer of control in a procedure file. Execution continues from the line just after the specified label. `expr` is an expression and may contain function calls. The expression, however, must result in a string of identifier type. Notes: The `goto` directive works without regard for constructs. That is, if you use a `goto` to move into the middle of a `while` loop, the `endwhile` causes an error.
`label <name>`	Declare a Label `label` declares a label. `name` is the name of the label, and refers to the next line in the procedure file. Label names have the same construction as identifiers. Control passes to a label name via the `goto` directive. `Notes:` Label and procedure file function names may not clash.

The following table lists the conditional directives.

Table 5-14. Conditional Branch Directives

Command	Description
`case (<expr>) [:]`	Specify a Test Value in a Switch Construct `case` is used within a switch construct to specify the different expressions that should be tested against the `switch` expression. If the case expression (`expr`) and the `switch` expression are the same, execution resumes at the line after the `case`. You must put a `wbreak` at the end of the code to force a break from the switch construct, otherwise code from other cases could be executed. For an example, see the `endswitch` directive.
`continue`	Restart a Construct `continue` transfers control back to the start of a construct (`while`/`endwhile`, `for`/`endfor`, `repeat`/`until`). Generally, the looping expression is re-evaluated to determine if looping should continue. Note: `continue` causes an error if it is not encountered inside one of the constructs listed above.
`default [:]`	Specify Code to Execute if a Matching Case is not Found `default` is used within a switch construct to specify the code to execute if a `case` expression is not found to match the `switch` expression. A `switch` construct need not have a default directive. The default directive can be placed anywhere within the cases, but is not executed until all the cases have been checked. A `wbreak` must be used to break out of the switch construct. See `endswitch` for an example.

Table 5-14. Conditional Branch Directives (Continued)

Command	Description
`elif (<expr>)`	Conditional False Execution Point for an if or elif Directive `elif`, when used in conjunction with an `if` directive, marks the place where execution should be conditionally transferred `if` the expression on the `if` evaluates to FALSE. If this is the case and an `elif` is encountered, the expression (`expr`) on the `elif` is evaluated. If this expression is TRUE, execution begins on the line following the `elif` directive. Otherwise, execution is transferred to one of three possible locations: • Conditionally to the next `elif` directive • To the next `else` directive • To the line following the `endif` (if no further `elif` or `else` directives are found).
`else`	False Execution Point for an if or elif Directive `else`, when used in conjunction with the `if` directive, marks the place where execution should be transferred if the expression on the `if` directive evaluates to FALSE. `else` is optional. For a full example see the description of the `endif` directive.

Table 5-14. Conditional Branch Directives (Continued)

Command	Description

`endfor`	End of FOR Loop Construct
	
	`endfor` causes execution to branch back to the associated `for` directive. At that point, loop termination is considered based on the index variable value and loop limits.
	
	Examples:
	
	`for i = 1 to 10 by 2`
	`  print("%s is an odd number\n",`
	`  %i);`
	`endfor`
	`for j = 10 to 2 by -2`
	`  print("%s is an even number\n",`
	`  %j);`
	`endfor`

`endif`	Terminate an if Construct
	
	`endif` marks the end of an `if` construct. Every `if` directive must have a matching `endif` directive.
	
	Example: The following code segment illustrates how to use an `if` with `elif`'s like a switch statement in C:
	
	`if (assign(val, %a + %b * %c) == 8)`
	`  print("The value is 8!\n")`
	`elif (%val == 4)`
	`  print("The value is 4!\n")`
	`else`
	`  print("The value is neither 8 nor 4!\n")`
	`endif`

Table 5-14. Conditional Branch Directives (Continued)

Command	Description

`endswitch`	Mark the End of a Switch Construct
	
	`endswitch` marks the end of a `switch` construct. When it is encountered and no case's code has been executed, the default code is executed (if a default case was specified). If a `wbreak` is encountered within a `switch` construct, execution resumes at the line following the `endswitch`.
	
	Example: The following is an example `switch` construct:
	
	`1 print("Please type a character: ");`
	`2 let c = input1(); read 1 char from the user`
	`3 switch (%c); switch it over these possibilities`
	`4  case "\n":`
	`5    print("You pressed return!\n");`
	`6    wbreak     ; leave switch construct`
	`7  case " ":               ; space?`
	`8  case "\t":              ; tab?`
	`9    print("You entered some white-space\n");`
	`10   wbreak;`
	`11  default:     ; some other character`
	`12    print("You entered '%s'\n", %c);`
	`13    wbreak;`
	`14  case chr(27):`
	`15    print("<esc> entered!\n");`
	`16  case "\b":`
	`17    print("<esc> or backspace entered!\n");`
	`18    wbreak     ;wbreak for both "\e" and "\b"`
	`19 endswitch`

Table 5-14. Conditional Branch Directives (Continued)

Command	Description
	The above example demonstrates several features of switch constructs: Lines 4-6: Standard `case`, code, and `wbreak` sequence Lines 7-10: Two `cases` can apply to the same code, if either one matches, the code is executed. Lines 11-13: Default `case` to handle other non-special characters, not executed until all other cases are checked Line 14: `case` expression does not have to be a string constant. Lines 14-18: `case` code does not automatically break out of the `switch` construct when another `case` is encountered, it continues to execute (skipping other `cases`) until it encounters a `wbreak`.

`endwhile`	Mark the End of a While Loop Construct
	
	`endwhile` causes control to be transferred back to its corresponding `while` directive. If the expression on the `while` is still TRUE, the loop executes again. Otherwise, execution continues with the statement following the `endwhile` directive.
	
	See Also:
	
	: `endwhile`
	
	Example: The following example code segment prints all file names in the current data directory matching the pattern `*.*`:
	
	`while (next_file(fn,"*.*"))`
	`  print("%s\n", %fn)`
	`endwhile`

Table 5-14. Conditional Branch Directives (Continued)

Command	Description
`for <var> = <expr1> to <expr2> [by <expr3>]`	Beginning of FOR Loop `for` starts a traditional `for` loop. `var` is the index variable name. `var` is assumed to be local if it is within a procedure file function. Otherwise, it is a global variable. `expr1` is the initial value for `var`. `expr2` is the boundary expression of the `for` loop. The optional `expr3` is the increment applied to `var` each time around the loop. If the `by` syntax is not used, `mshell` assumes the increment is +1. `expr1` and `expr3` are evaluated only once. `expr2` is evaluated each time around the loop. `continue` and `wbreak` may be used within a `for` loop. See `endfor` for an example.
`if (<expr>)`	Beginning of Conditional Execution Construct `if` starts the head of conditionally executed code. expr is the expression to evaluate. If `expr` evaluates to non-zero (TRUE), the code directly following the `if` directive line executes. If it is zero (FALSE), execution is transferred to one of three possible locations: • After the next `else` directive. • Conditionally after the next `elif` directive. • After the next `endif` directive (if there is no `else` or `elif` present). For a full example see the description of the `endif` directive.
`repeat`	Mark Beginning of Repeat/Until Construct `repeat` marks the start of a `repeat/until` loop. Execution continues with the next line.

Table 5-14. Conditional Branch Directives (Continued)

Command	Description
`switch (<expr>)`	Beginning of Switch Construct `switch` starts a switch construct. This construct allows you to test the expression (`expr`) for several values and execute code for each possibility. See `endswitch` for an example.
`until (<expr>)`	End of Repeat/Until Construct `until` marks the end of a `repeat`/`until` loop. If the expression (`expr`) evaluates to FALSE (0), execution is transferred to the line after the associated repeat directive. If the expression is TRUE (non-zero), execution continues with the next line.
`wbreak`	Exit Construct `wbreak` causes control to be transferred to the line following the current construct (`while`/`endwhile`, `repeat`/`until`, `switch`/`endswitch`, `for`/`endfor`). For example, you can use it to exit a `for` loop before the looping conditions have been met. `Note: wbreak` causes an error if it is not encountered within one of the previously listed constructs.
`while (<expr>)`	Beginning of a While Loop Construct `while` marks the start of a `while` loop. The loop continues to execute until the expression (`expr`) evaluates to FALSE. See `endwhile` for an example.

Table 5-15. Variable Directives

Command	Description

`let <id> = <expr>`	Assign a Value to a Global Variable
	
	`let` evaluates the expression (`expr`) and assigns the result to a global variable `(id).id` may or may not have been defined earlier. `expr`, though, may not involve any identifiers that are undefined.
	
	The `let` directive, without any argument, prints all defined global variables and their values.
	
	Examples: The following line assigns `fn` with the first file in the current directory that matches the pattern `*.c`.
	
	`$ let fn = filematch("*.c")`
	
	This line prints all the defined variables:
	
	`$ let`
	`fn=dues.c`
	
	Note: You may use `let` directly on the command line.

Table 5-15. Variable Directives (Continued)

Command	Description

`llet [<id> = <expr>]`	Assign a Value to a Local Variable
	
	`llet` evaluates an expression (`expr`) and assigns the result to a local variable `(id).id` may or may not have been defined earlier. `expr`, however, may not involve any undefined identifiers.
	
	The `llet` directive, without any arguments, prints all defined local variables and their values.
	
	Examples: The following line assigns `fn` with the name of the first file in the current directory which matches the pattern `*.c`.
	
	`llet fn = filematch("*.c")`
	
	The following lines print all the defined local variables.
	
	`llet`
	`fn=dues.c`
	
	Note: `llet` is allowed only in procedure file functions.

Table 5-15. Variable Directives (Continued)

Command	Description
`unlet {<id>}`	Remove Global Variables from Memory `unlet` removes global variable(s) (`id`) and their values from memory. Since each reference to a variable causes a tree search, it can be beneficial to remove unnecessary variables from the tree. You can specify any number of variable names. If one of the identifiers specified is an asterisk (*), then all variables are removed from the tree. Note: You may use `unlet` directly on the command line.
`lunlet {<id>}`	Remove a Local Variable from Memory `lunlet` removes local variable(s) (`id`) and their values from memory. Since each reference to a variable causes a tree search, it can be beneficial to remove unnecessary variables from the tree. If one of the identifiers specified is an asterisk (`*`), then all local variables are removed from the tree. Note: `lunlet` is allowed only in procedure file functions.

Table 5-16. Procedure File Functions

Command	Description
`call <id>([<expr>]{ ,<expr>}`	Execute a Procedure File Function `call` passes control to a procedure file function. `id` is the name of the function. Any number of parameters may be passed to the function. Parameters are passed by putting the expressions (`expr`) in the parenthesis following the name. Each expression is separated by a comma (,). A function may return a value. `mshell` stores the return value of a function in a global variable called `%ret`. Be sure to save its value if other functions are called. See `return` for an example of this directive.
`endfunction`	End of Function `endfunction` indicates the end of a procedure file function. Every function directive must have a matching `endfunction` directive. It is used primarily to find the end of the function when `mshell` encounters a function that was not explicitly called.

Table 5-16. Procedure File Functions (Continued)

Command	Description
`function <id>([<pid>]{, <pid>})`	Declare the Location of a Function `function` declares the location of a procedure file function. `id` is the function name. The function begins with the line following the function directive. A number of parameters (`pid`) may be named as well. These are the local names of the expressions passed to the function by the `call` directive. If a function is encountered that is not explicitly called, `mshell` remembers its location and skips its code. See `return` for an example of this directive. Note: If the number of parameters passed varies, leave the parameter name area blank and refer to the parameters by their positional names, `p0` through `p<n>`. That is, the first parameter is named `p0`, the second is `p1`, and so on.

`return [<expr>]`	Return from a Procedure File Function
	
	`return` passes control back to the caller from within procedure file functions. The global variable `%ret` is set to the value of `expr` (if one was specified, otherwise `%ret` is set to the empty string) and execution continues with the line directly following the call directive.
	
	Example: The following is a simple use of a procedure file function:
	
	`function func(param1)`
	`  print("Param #1 = %s\n", %param1)`
	`    return 0`
	`endfunction`
	`call func(8 + 2)`
	
	Executing this procedure file results in the following output:
	
	`Param #1 = 10`

Table 5-17. Miscellaneous Directives

Command	Description

`data [reset]`
`enddata`
	Include BASIC-like Data Statement in Script
	The `data` directive allows you to include BASIC-like data statements in `mshell` scripts. It is ended with the `enddata` directive.
	
	The following is an example of its use:
	
	`data`
	`file.c`
	`file2.c`
	`test.c`
	`test2.c`
	`enddata`
	
	The interpreter function `get_data(<var_name>)` sequentially reads lines of data and puts their contents into the variable named `<var_name>`. `get_data()` returns TRUE if a data item was read into the variable and FALSE if the data list is exhausted (with the variable being set to an empty string).
	
	You can also use the data directive to restore the "data pointer" to the beginning of the data by passing the keyword reset to a data directive. The following example uses the above data set:

	`while (get_data(fn))`
	`  print("I'm about to rename %s\n", %fn);`
	`endwhile`
	`**** restart at the beginning of the data`
	`data reset`
	`while (get_data(fn))`
	`  rename %fn %(fn:r).bak`
	`endwhile`
	
	Any number of data/enddata sets may appear in a procedure file. You can use a backslash (\) to continue the data lines on the next physical line.

Table 5-17. Miscellaneous Directives (Continued)

Command	Description
`do <expr>`	Process an Expression `do` evaluates the expression (`expr`) without regard for the result. This is most useful when you use an expression function that results in no useful return value (for example, `close()`).
`end`	Terminate Procedure File `end` terminates a procedure file. If the procedure file is being run via `profile`, it terminates and `mshell` issues a prompt.

`print (<format> {, <arg>})`	Print a Format String with its Arguments
	
	`print` allows `printf`-like statements to appear in procedure files. The first argument is the format string (`format`), which can contain up to eight format escapes in the form `%s`. There must be enough arguments (`arg`) to satisfy the number of escapes in the format string.
	
	Example: The print directive:
	
	`let a = 10`
	`let b = "hello"`
	`print("a is %s and b is '%s'.\n", %a, %b)`
	
	Prints a line:
	
	`a is 10 and b is 'hello'.`
	
	Note: You may use `print` directly on the command line.

mshell Functions

This section contains descriptions of `mshell` functions. Each function takes from zero to three expressions as arguments. Each expression may involve other functions. The function arguments start with an open parenthesis, are separated by a comma, and end with a close parenthesis. For example:

```
let dot = left(%filename, strchr(%filename, "."))
```

The functions are listed in alphabetical order. The following tables list the functions by type.

Table 5-18. I/O Functions

Function	Description
chdir()	Change the Current Data Directory Path
chmdir()	Change the Current Module Directory
chxdir()	Change the Current Module Directory
close()	Close an Open Path
create()	Create a File
dir()	Check if Name is a Directory or File
dup()	Increment Use Count on a Path
exist()	Determine if a File Exists
filematch()	Scan List of Files for Pattern Match
input()	Read a Line of Input from the User
input1()	Read One Character from User
modate()	Return the File Modification Date
next_file()	Scan Files Matching a Pattern
open()	Open a Path
read()	Read Data from a Path
readln()	Read a Line from a Path
seek()	Seek to a File Position
size()	Determine the Size of a File
tell()	Return the Current File Position
write()	Write Data to a Path
writeln()	Write a Line of Data to a Path

Table 5-19. String Functions

Function	Description
asc()	Return the ASCII Code for the First Character in a String
chr()	Return a One Character String of an ASCII Code
cmpnam()	Compare a String to a Pattern
findstr()	Find a Substring Within a String
tohex()	Convert Decimal Value to Hexadecimal

Table 5-19. String Functions (Continued)

Function	Description
index()	Return the Position of a Character within a String
left()	Return the Left Substring
len()	Return the Length of a String
lower()	Change a String to Lower Case
mid()	Return the Midsection Substring of a String
right()	Return the Right Substring
rindex()	Return the Position of a Character within a String
strcat()	Return the Concatenation of Two Strings
strchr()	Return the Position of a Character within a String
strcmp()	Compare Two Strings for Equality
strlen()	Return the Length of a String
strpbrk()	Scan a String for Delimiters
strrchr()	Return the Position of a Character within a String
strstr()	Find a substring within a string
upper()	Change a String to Upper Case
var_rep()	Perform Variable Replacement on a String

Table 5-20. Miscellaneous Functions

Function	Description
abs()	Arithmetic Absolute Value
assign()	Perform a Global Assignment
env()	Return the Value of an Environment Variable
execute()	Execute a String
getdata()	Read Data Item
getuid()	Get the Current Group and User ID Number

Table 5-20. Miscellaneous Functions (Continued)

Function	Description
`hex()`	Convert Hexadecimal Constant String to Decimal
`lassign()`	Perform a Local Assignment
`param()`	Return a Procedure Parameter
`uns()`	Convert Decimal to Unsigned Representation

abs()
Arithmetic Absolute Value

Syntax

```
abs(<num>)
```

Description

`abs()` returns the absolute value of `num`.

assign()
Perform a Global Assignment

Syntax

```
assign(<var>, <expr>)
```

Description

`assign()` assigns the result of `expr` to the global variable `var`. The result of the function is the value that was assigned into the variable. You can use `assign()` to reduce the number of let directives in your code.

Example

```
let fn = filematch("*.c")
while (len(%fn))
   echo %fn
   let fn = filematch("*.c")
endwhile
```

You could replace the code above with:

```
while (len(assign(fn, filematch("*.c"))))
   echo %fn
endwhile
```

asc()

Return the ASCII Code for the First Character in a String

Syntax

```
asc(<string>)
```

Description

`asc()` returns the integer ASCII value for the first character in string.

See Also

`chr()`

chdir()

Change the Current Data Directory Path

Syntax

```
chdir (<string>)
```

Description

Change the current data directory path.

If an error occurs, `chdir` returns the error number and sets the global value errno. If no error occurs, it returns 0.

Example

```
if (chdir( "/h0/foo" ) == 0)
echo path found
else
echo path not found
endif
```

chmdir()

Change the Current Module Directory

Syntax

```
chmdir(<string>)
```

Description

Change the current module directory.

If an error occurs, `chmdir` returns the error number and sets the global value errno. If no error occurs, it returns 0.

Example

```
if (chdir( "/h0/foo" ) == 0)
echo path found
else
echo path not found
endif
```

chr()
Return a One Character String of an ASCII Code

Syntax

```
chr(<val>)
```

Description

`chr()` returns a one character long string containing the character with the given ASCII code (val).

Example

To make sure a character does not have its high bit set:

```
if (asc(%char) >= 128)
   let char = chr(asc(%char) & 127);
endif
```

See Also

`asc()`

chxdir()
Change the Current Module Directory

Syntax
```
chxdir (<string>)
```

Description
Change the current module directory.

If an error occurs, `chxdir` returns the error number and sets the global value errno. If no error occurs, it returns 0.

Example
```
if (chdir( "/h0/foo" ) == 0)
echo path found
else
echo path not found
endif
```

close()
Close an Open Path

Syntax

```
close(<path>)
```

Description

`close()` closes the file open on path. The path may have been returned from either `open()`, `dup()`, or `create()`.

If an error occurs, `close()` returns -1 and fills the variable `errno` with the error number that occurred. If there is no error, `close()` does not return anything useful.

See Also

`create()`
`dup()`
`open()`

cmpnam()

Compare a String to a Pattern

Syntax

```
cmpnam(<string>, <pattern>)
```

Description

The specified string is compared to the specified pattern. The pattern can contain mshell wildcard characters (e.g. `*`, `?`, `[a-d]`). `cmpnam()` returns TRUE if the string and pattern match, otherwise it returns FALSE.

create()
Create a File

Syntax

```
create(<name>, <mode>)
```

Description

`create()` creates a file on a disk device. `name` specifies the pathlist of the file. `mode` specifies the type of I/O to perform. The meaning of `mode` is described in Table 5-21.

Table 5-21. mode

True Value	Logical Constant	Mode
1	`READ`	Read Only
2	`WRITE`	Write Only
3	`UPDATE`	Read and Write

The file is created with owner read and owner write attributes regardless of the mode specified. If different attributes are desired, use the attr utility to change them.

create() returns a path number to be used by other functions. Generally, a procedure file may not create or open more than 28 files at a time.

If an error occurs, create() returns -1 and fills the variable errno with the error number that occurred.

See Also

`open()`

dir()

Check if Name is a Directory or File

Syntax

```
dir(<name>)
```

Description

`dir()` determines if `name` is a directory or a simple file. It returns logical TRUE (1) if it is a directory, otherwise it returns logical FALSE (0).

`dir()` returns FALSE if called for a file or directory name that does not exist.

See Also

`exist()`

dup()
Increment Use Count on a Path

Syntax

```
dup(<path>)
```

Description

`dup()` increments the use count on the specified path. `dup()` returns a new synonymous path number or -1 if the Operating System `dup` call fails. The mshell variable `errno` will be set to the error number.

env()

Return the Value of an Environment Variable

Syntax

```
env(<name>)
```

Description

`env()` returns the value of the environment variable name. This method is provided as an alternative to the `$(name:q)` syntax. `env()` has the advantage that if `name` is not defined, no error is generated. A string of length 0 is returned from the function instead.

execute()
Execute a String

Syntax

```
execute(<string>)
```

Description

`execute()` executes the command line string under a different mshell. The result of `execute()` is the exit status of the spawned mshell.

See Also

`var_rep()`

exist()
Determine if a File Exists

Syntax

```
exist(<name>)
```

Description

`exist()` returns TRUE if a file (name) exists. It returns FALSE if it does not exist or is not accessible by the procedure file. `exist()` is valid on both directories and files.

findstr()
Find a Substring Within a String

Syntax

```
findstr(<string>, <substring>)
```

Description

`findstr()` returns the index of the first character in `substring` within `string`. If `substring` does not appear in `string`, 0 is returned. If `substring` is the empty `string`, 1 is returned.

See Also

`strstr()`

filematch()

Scan List of Files for Pattern Match

Syntax

```
filematch(<pattern>)
```

Description

`filematch()` moves through a directory sequentially, returning all the file names that match `pattern`. `pattern` may contain the asterisk (*) and question mark (?) wildcard characters. When the list of matching files has been exhausted, a string of length zero is returned.

`filematch()` keeps track of its position in the directory between calls. It continues to move forward through the directory until the requested pattern changes. Therefore, if you intend to scan through the same directory twice for the same pattern, call `filematch()` with an empty string between the scans. For example, filematch("").

See Also

`modate()`

getdata()
Read Data Item

Syntax

```
getdata(<id>)
```

Description

`get_data()` reads the next item from the data section of a script file into the variable `<id>`. `get_data()` returns TRUE if it finds data. `<id>` is set to an empty string and `get_data()` returns FALSE when there is no more data.

Refer to the mshell Directives section (data/enddata directive) for more information and an example.

getuid()

Get the Current Group and User ID Number

Syntax

```
getuid
```

Description

`getuid()` returns a string in the form `gid.uid`, where `gid` is the current group ID of mshell and `uid` is the current user ID of mshell. This is useful in a procedure file for determining the caller's ID.

Example

The following code segment checks the user ID of the user executing the script file, and prints a message and exits if they are not classified as a super user:

```
if (strcmp(getuid(), "0.0") != 0)
   print("Must be super user to use this script
file!\n")
   end
endif
```

hex()

Convert Hexadecimal Constant String to Decimal

Syntax

```
hex(<string>)
```

Description

`hex()` converts a hexadecimal constant string to its decimal representation. The string should be a sequence of upper or lower case hexadecimal digits. The optional 0x prefix is ignored. Any failure to convert the digits results in a return value of 0.

See Also

`tohex()`

index()

Return the Position of a Character within a String

Syntax

```
index(<string>, <char>)
```

Description

`index()` searches from the start of `string` for the character `char`. It returns 0 if `char` is not present in `string`. Otherwise, it returns the offset from the beginning of the string to `char`. The `index()` search is case sensitive.

Since mshell has no "character" constants, the first character of the second argument is assumed to be the character desired. For example the following returns 11 (first t in test):

```
index ("This is a test","type")
```

See Also

`rindex()`

input()
Read a Line of Input from the User

Syntax

```
input()
```

Description

`input()` reads a line of input from the device specified by the environment variable `PORT`. `input()` returns the line entered. mshell eliminates the `<cr>` typed to terminate the line. `<cr>` alone results in a string of length 0. `<esc>` as the first character results in the string "`\e`".

If the `PORT` environment variable is not defined or an error occurs, the procedure file execution is aborted.

See Also

`input1()`

input1()
Read One Character from User

Syntax

```
input1()
```

Description

`input1()` reads exactly one character of input from the device specified by the environment variable `PORT`. It returns the character read (in a string of length 1). `<cr>` results in the string "`\n`". `<esc>` results in the string "`\e`". `input1()` is very useful for menu or yes/no input.

If the `PORT` environment variable is not defined or an error occurs, the procedure file is aborted.

See Also

`input()`

lassign()
Perform a Local Assignment

Syntax

```
lassign(<var>, <expr>)
```

Description

`lassign()` assigns the result of `expr` to the local variable `var`. The result of the function is the value that was assigned into the variable. You can use `lassign()` to reduce the number of `llet` directives used.

Refer to `assign()` for an example.

left()
Return the Left Substring

Syntax

```
left(<string>, <num>)
```

Description

`left()` returns the left-hand number of characters (`num`) in the substring of `string`.

Example

The following function returns the string `This`.

```
left("This is a test", 4)
```

If there are not enough characters to satisfy the request, or the requested number is less than or equal to 0, `left()` returns a string of size 0.

See Also

`mid()`
`right()`

len()
Return the Length of a String

Syntax

```
len(<string>)
```

Description

`len()` returns the string length, in characters.

lower()

Change a String to Lower Case

Syntax

```
lower(<string>)
```

Description

`lower()` changes each alphabetic character in `string` to its lower-case counterpart. It does not affect white space or punctuation.

See Also

`upper()`

mid()

Return the Midsection Substring of a String

Syntax

```
mid(<string>, <start>, <end>)
```

Description

`mid()` allows you to extract middle parts of a string. It returns the characters from position `start` to position `end` of `string`, where the first character's position is 1.

If the string does not have enough characters to satisfy the requested start and end positions, `mid()` returns a string of length 0.

See Also

`left()`
`right()`

modate()
Return the File Modification Date

Syntax

```
modate(<filename>)
```

Description

`modate()` returns a scalar value for the last modification date of a file (`filename`). This number is only useful when compared with the return value of `modate()` on a different file. If the specified file does not exist, the return value is 0 (thus implying a very old file).

Using `modate()` on a directory results in 0.

Example

- Using `filematch`:

```
let fn = filematch("*.c")
while (len(%fn))
   let rel = var_rep("RELS/%(fn:r).r")
   if (modate(%fn) >= modate(%rel))
      cc -gixt=/r0 %fn -r=RELS
   endif
   let fn = filematch("*.c")
endwhile
```

- Using `next_file`:

```
while (next_file(fn, "*.c"))
   let rel = var_rep("RELS/%(fn:r).r")
   if (modate(%fn) >= modate(%rel))
      cc -gixt=/r0 %fn -r=RELS
   endif
endwhile
```

See Also

`dir()`
`exist()`

next_file()
Scan Files Matching a Pattern

Syntax

```
next_file(<variable>, <pattern>)
```

Description

`next_file()` scans sequentially through a directory, and returns files that match `pattern`. `pattern` can contain the asterisk (`*`) and question mark (`?`) wildcard characters. `next_file()` returns TRUE if it finds a matching file, and places the file's name in `variable`. If no matching files are found, `next_file()` returns FALSE and sets `variable` to an empty string. You can use `next_file()` with the while directive to perform a function on each file matching a pattern.

Refer to `modate()` for an example of `next_file()`.

`next_file()` uses `filematch()` to scan the directory. The result of using `filematch()` and `next_file()` within the same construct is undefined. `next_file()` maintains its position in the directory between calls. It continues to move forward through a directory until the requested pattern changes. Therefore, if you intend to scan the same directory twice with the same pattern, call `next_file()` with an empty string between the scans. That is, `next_file(fn, "")`.

See Also

`modate()`

open()
Open a Path

Syntax

```
open(<name>, <mode>)
```

Description

`open()` opens a path in the mode specified. The name of the device or file is passed in the `name` parameter. The I/O mode to use for the path is passed in the `mode` parameter. Values in `mode` have the following meanings:

Table 5-22. mode Values

True Value	Logical Constant	Mode
1	`READ`	Read Only
2	`WRITE`	Write Only
3	`UPDATE`	Read and Write

`open()` returns a path number to use in future I/O calls for the same file or device.

If an error occurs, `open()` returns -1 and places the error number into the variable `errno`.

See Also

`create()`
`dir()`
`exist()`

param()
Return a Procedure Parameter

Syntax

`param(<num>)`

Description

`param()` allows quick access to the parameters passed into a procedure file. `param()` builds a string in the form `P<num>` and gets the environment variable associated with that name. If `num` is out of range or the environment variable `P<num>` does not have a value, `param()` returns a string of length 0.

read()
Read Data from a Path

Syntax

```
read(<path>, <var>, <count>)
```

Description

`read()` reads data from the open path. The data is read into the variable `var`. A buffer of size `count` bytes is allocated for the `read()` operation. This buffer is then assigned to the variable `var`. Be sure that the path was opened or created in either `READ` or `UPDATE` mode, otherwise reading is not allowed.

`read()` returns the number of bytes actually read from the path.

If an error occurs, `read()` returns -1 and fills the variable `errno` with the error number that occurred.

mshell variables hold NULL terminated strings. If the data read from the file contains a byte with the value 0, the string is truncated at that point. For this reason, the string that ends up in the variable may be shorter than the requested number of bytes.

If this function is called from within a procedure file function, the variable named is assumed to be local.

See Also

`readln()`
`write()`
`writeln()`

readln()
Read a Line from a Path

Syntax

```
readln(<path>, <var>)
```

Description

`readln()` reads one line of data from the open path.

The data is read into the variable `var`. At most, 512 characters are read. Be sure that the path was opened or created in either `READ` or `UPDATE` mode, otherwise reading is not allowed.

`readln()` returns the number of bytes read. The `<cr>` that terminates the line remains intact, but could easily be removed with the string functions provided.

If an error occurs, `readln()` returns -1 and fills the variable `errno` with the error number that occurred.

If this function is called from within a procedure file function, the variable named is assumed to be local.

See Also

`read()`
`write()`
`writeln()`

right()
Return the Right Substring

Syntax

```
right(<string>, <num>)
```

Description

`right()` returns the right-hand `num` character substring of `string`.

Example

The following function returns the string `test`.

```
right("This is a test", 4)
```

If there are not enough characters to satisfy the request, or the requested number is less than or equal to 0, then `right()` returns string of size 0.

See Also

`left()`
`mid()`

rindex()

Return the Position of a Character within a String

Syntax

```
rindex(<string>, <char>)
```

Description

`rindex()` searches backwards from the end of string for the character `char`. 0 is returned if `char` is not present in `string`, otherwise the position of the character is returned.

Since mshell has no "character" constants, the first character of the second argument is assumed to be the character desired. For example, the following function returns 14 (the last t in test).

```
rindex ("This is a test", "type")
```

See Also

`index()`

seek()
Seek to a File Position

Syntax

```
seek(<path>, <pos>)
```

Description

`seek()` moves the file pointer to `pos` in the file open on `path`. The next I/O operation starts at that position, relative to the beginning of the file. `seek()` returns nothing useful if it successful.

If an error occurs, `seek()` returns -1 and fills the variable `errno` with the error number that occurred.

See Also

`tell()`

size()
Determine the Size of a File

Syntax

```
size(<filename>)
```

Description

`size()` returns the size of a file (`filename`) in bytes. `size()` is not valid on directories. If the file specified in `filename` cannot be opened, a size of 0 is returned.

strcat()

Return the Concatenation of Two Strings

Syntax

```
strcat(<string1>, <string2>)
```

Description

`strcat()` returns the result of appending `string2` to `string1`. Both source strings are left intact.

strchr()

Return the Position of a Character within a String

Syntax

```
strchr(<string>, <char>)
```

Description

`strchr()` searches from the start of `string` for the character `char`. It returns 0 if `char` is not present in `string`. Otherwise, it returns the offset from the beginning of the string to `char`. The `strchr()` search is case sensitive.

Since mshell has no "character" constants, the first character of the second argument is assumed to be the character desired. For example the following returns 11 (first t in test):

```
strchr ("This is a test","type")
```

See Also

`index()`
`rindex()`

strcmp()
Compare Two Strings for Equality

Syntax

```
strcmp(<string1>, <string2>)
```

Description

`strcmp()` compares `string1` to `string2` and returns an integer less than zero, zero, or greater than zero if `string1` is less than, equal to, or greater than `string2`, respectively.

strlen()
Return the Length of a String

Syntax
```
strlen(<string>)
```

Description
`strlen()` returns the string length, in characters.

See Also
`len()`

strpbrk()
Scan a String for Delimiters

Syntax

```
strpbrk(<string>, <delim>)
```

Description

`strpbrk()` locates the first occurrence in `string` of any character from `delim`. `string` is a string in which to search for any character from `delim`. `delim` is a string containing characters to locate in `src`. `strpbrk()` returns the index of the first character from `delim` or 0 if no characters from `delim` appear in `string`. If `delim` is the empty string, 0 is returned.

strrchr()

Return the Position of a Character within a String

Syntax

```
strrchr(<string>, <char>)
```

Description

`strrchr()` searches backwards from the end of `string` for the character `char`. 0 is returned if `char` is not present in `string`, otherwise the position of the character is returned.

Since mshell has no "character" constants, the first character of the second argument is assumed to be the character desired. For example, the following function returns 14 (the last t in test).

```
strrchr ("This is a test", "type")
```

See Also

`index()`
`rindex()`

strstr()

Find a substring within a string

Syntax

```
strstr(<string>, <substring>)
```

Description

`strstr()` returns the index of the first character in `substring` within `string`. If `substring` does not appear in `string`, 0 is returned. If `substring` is the empty `string`, 1 is returned.

See Also

`findstr()`

tell()
Return the Current File Position

Syntax

```
tell(<path>)
```

Description

`tell()` returns the current file position in the file open on `path`. The next I/O operation starts at the file position returned by `tell()`.

If an error occurs, `tell()` returns -1 and fills the variable `errno` with the error number that occurred.

See Also

`seek()`

tohex()

Convert Decimal Value to Hexadecimal

Syntax

`tohex(<value>)`

Description

`tohex()` converts the decimal value `<value>` to its hexadecimal representation. The hex representation exists in the form 0xhhhhhhhh (where "h" is a hexadecimal digit (lower-case)). The string is always 10 characters long: two for the "0" and the "x", and eight for the lower-case hexadecimal digits. If you do not want the 0x, use `right()` to remove it from the result.

See Also

`hex()`

uns()

Convert Decimal to Unsigned Representation

Syntax

```
uns(<value>)
```

Description

`unx()` converts the specified decimal value to its unsigned representation.

Most operators return signed 32-bit values, regardless of the representation of their arguments.

Example:

```
$ let x = uns(-1)
$ let y = 1
$ let z = %x * %y
$ let
x=4294967295
y=1
z=-1
```

Note that z is -1, not 4294967295. `uns()` must be used with z to get the unsigned result of the multiplication.

upper()
Change a String to Upper Case

Syntax

```
upper(<string>)
```

Description

`upper()` changes each alphabetic character in string to its upper-case counterpart. It does not affect white space or punctuation.

See Also

`lower()`

var_rep()
Perform Variable Replacement on a String

Syntax

```
var_rep(<string>)
```

Description

`var_rep()` passes `string` through the variable replacements: `environment`, `interpreter`, and `command` output. `var_rep()` is very useful in conjunction with execute.

Example

```
let rels = RELS
let cflags = "-gqt=/r0"
setenv NAME test.c
let line = var_rep("cc %cflags $(NAME) -r=%(rels)")
print("Executing: %s\n", %line)
%line
```

write()
Write Data to a Path

Syntax

```
write(<path>, <data>, <count>)
```

Description

`write()` writes count bytes from `data` to the open path. If the length of `data` is less than `count` bytes, garbage fills the remaining bytes (the difference between the length of the data and `count`).

`write()` returns the number of bytes written.

If an error occurs, `write()` returns -1 and fills the variable `errno` with the error number that occurred.

See Also

`read()`
`readln()`
`writeln()`

writeln()
Write a Line of Data to a Path

Syntax

```
writeln(<path>, <data>)
```

Description

`writeln()` writes a line of data to a file open on `path`. It passes the data to be written in the parameter `data`. `data` can be any length. That is, a `writeln` system call is performed with a length equal to the length of the data.

`writeln()` returns the number of bytes written.

If an error occurs, `writeln()` returns -1 and fills the variable `errno` with the error number that occurred.

See Also

`read()`
`readln()`
`write()`

Example Programs

This example script file plays a "guess a number" game (`rand` = program that outputs a random number between 1 and 1000):

```
let num = $("rand");      get the random number
let done = FALSE;         user's not done yet
let guesses = 0;          they haven't guessed yet
while (!%done)
     print("\nGuess a number: ");
     let guess = input(); get the guess from the user
     let guesses = %guesses + 1;
     if (%guess == %num)
          print("Correct in %s guesses!\n", %guesses);
          let done = TRUE;
     elif (%guess < %num); too low?
          print("Higher!\n");   must be too high?
     else
          print("Lower!\n");
     endif
endwhile
```

This program segment asks the user for a new `TERM` environment variable, allowing `<cr>` or `<esc>` to accept default:

```
setenv TERM kt7
print("TERM = (%s) ", env("TERM"));  print the prompt
let ans = input();                   get some input
* if they typed something and it wasn't escape
if (len(%ans) && asc(%ans) != 27)
     setenv TERM %(ans:q);          * set a new TERM
endif
```

6 Using the shell Utility

The `shell` utility is the operating system's command interpreter program. This chapter describes how to use the shell utility.

Overview of shell Utility

The shell utility reads data from its standard input which is usually the keyboard or a file and interprets the data as a sequence of commands. The basic function of the shell utility is to initiate and control execution of other programs.

Usually you enter the shell utility automatically when you log into the system. The shell utility displays a dollar sign (`$`) prompt to show that it is ready and waiting for a command line. You can create a new shell by typing `shell` optionally followed by a command line.

The shell utility reads and interprets one text line at a time from standard input. After interpreting each line, the shell utility reads another line until an end-of-file condition occurs, at which time it terminates itself.

The `shell` utility may also be given a command in its argument list. In this case, the shell utility processes the specified command as if it was typed on a shell command line. Control returns to the calling program after the single command line is processed. If a command is not specified (`shell<cr>`) or the command is a shell utility option or built-in command (such as `chd` and `chx`), more lines are read from standard input and processed as normal. This continues until an end-of-file condition or the `logout` command is executed.

The shell's `ex` command does not recognize utility options unless they are separated from the utility name with a space. For example, `ex procs -e` works properly, but `ex procs-e` does not.

The shell utility uses special characters for various purposes. Special characters consist of the following:

Table 6-1. Special Characters in shell Utility

Type	Character	Purpose
Modifiers	#	Memory allocation
	^	Process priority modification
	>	Standard output redirection
	<	Standard input redirection
	>>	Standard error output redirection
Separators	;	Sequential execution
	&	Concurrent execution
	!	Pipe: interprocess communication

Table 6-1. Special Characters in shell Utility

Type	Character	Purpose
	+	OS-9: concurrent execution
Wildcards	*	Stands for any string of characters
	?	Stands for any single character

To send one of these characters to a utility program, you must use a method called *quoting* to prevent the shell utility from interpreting the special character. Quoting consists of enclosing the sequence of characters to be passed to a routine in single or double quotes. For example, `'<char>'` or `"<char>"`.

The following command line prints the indicated string:

```
$ echo "Hello; goodbye"
Hello; goodbye
```

However, the following command displays the string `Hello` on your terminal screen and then attempts to execute a program called `goodbye`.

```
$ echo Hello; goodbye
```

The shell expands the two wildcards to build pathlists. The question mark (`?`) wildcard matches any single character. The asterisk (`*`) wildcard matches any string of characters.

`dir ????` displays the names of files in the current directory that are four characters long. `dir s*` displays all names of files in the current directory that begin with `s`.

Any command that uses a pathlist on the command line accepts a pathlist specified with wildcards. When the shell utility expands the wildcards, if an explicit directory is not given, the files in the current data directory are searched for the matched expansion. If an explicit directory name is given in the pathlist, the specified directory is searched. If a command uses an option to search for a file in the current execution directory, wildcards may produce unexpected results.

The `shell` utility reads the current data directory or the given relative pathlist containing a wildcard and passes these file names to the command. If the command then tries to find the files relative to the execution directory, the search fails.

Setting shell Options

There are two methods of setting shell utility options:

1. Type the option on the command line or after the command, `shell`. For example:

   `$ -np` Turn off the shell prompt.

   `$ shell -np` Create a new shell that does not prompt.

2. Use the special shell command, `set`. To set shell options, type `set`, followed by the options desired. When using `set`, a hyphen (-) is unnecessary before the letter option. For example:

   `$ set np` Turn off the shell prompt.

   `$ shell set np` Create a new shell that does not prompt.

The two methods accomplish the same function.

The Shell Environment

For each user on a system, the `shell` utility maintains a unique list of *environment* variables. These variables affect the operation of the shell utility or other programs subsequently executed. They are *programmable defaults* that you can set to meet your individual needs.

All environment variables can be accessed by any process called by the environment shell or descendent shells. This allows you to use the environment variables as *global* variables.

If a subsequent shell redefines an environment variable, the variable is only redefined for that sub-shell and its descendents.

Environment variables are case-sensitive.

Several special environment variables are automatically set up when you log on a time-sharing system:

Table 6-2. shell Special Environment Variables

Name	Specification
PORT	This specifies the name of the terminal. This is automatically set up by tsmon. /t1 is an example of a legal PORT name.
HOME	This specifies your *home* directory. The home directory is the directory specified in your password file entry. This is also the directory used when the command chd with no parameters is executed.
SHELL	This is the process that is first executed upon logging on to the system.
USER	This is the user name you type when prompted by login.

Several other important environment variables are available:

Table 6-3. shell Environment Variables

Name	Specification
PATH	This specifies any number of directories. Each directory must be separated by a colon (:). The shell utility uses this as a list of commands directories to search when executing a command. If the *default* commands directory does not include the file/module to execute, each directory specified by PATH is searched until the file/module is found or until the list is exhausted.
PROMPT	This specifies the current prompt. By specifying an "at" sign (@) as the first character of your prompt, you may easily keep track of how many shells you personally have running under each other. The @ is used as a replaceable macro for the shell level number. The environment variable _sh sets the base level.

Table 6-3. shell Environment Variables (Continued)

Name	Specification

_sh	This specifies the base level for counting the number of shell levels. For example, set the shell prompt to "@howdy: " and _sh to 0:
	
	`$ setenv _sh 0`
	`$ -p="@howdy: "`
	`howdy: shell`
	`1.howdy: shell`
	`2.howdy: eof`
	`1.howdy: eof`
	`howdy:`

TERM	This specifies the specific terminal being used. This allows word processors, screen editors, and other screen dependent programs to know what type of terminal configuration to use.
MDHOME (OS-9000)	This specifies your home module directory. This is the module directory used when the command chm with no parameters is executed.
MDPATH (OS-9000)	This specifies any number of module directories to search. Module directory paths must be separated by a colon (:). The shell uses MDPATH as a list of module directories to search when executing a command.

The Environment Utilities

Three utilities are available to manipulate environment variables:

- setenv declares the variable, sets its value. The variable is placed in an environment storage area accessed by the shell. For example:

```
$ setenv PATH ..:/h0/cmds:/d0/cmds:/dd/cmds
$ setenv _sh 0
```

- unsetenv clears the value of the variable and removes it from storage. For example:

```
$ unsetenv PATH
$ unsetenv _sh
```

- printenv prints the variables and their values to standard output. For example:

```
$ printenv
PATH=..:/h0/cmds:/d0/cmds:/dd/cmds
PROMPT=howdy
_sh=0
```

Using Environment Variables as Command Line Parameters

The following section applies to OS-9 systems only (does not apply to OS-9 for 68K systems).

When the following syntax is used, the shell utility replaces the environment variable with the value of the environment variable:

```
$(<env var>)
```

For example, if `HOME` is set to `/h0/USR/ROB` and the command `dir $(HOME)` is entered, the shell utility executes the command `dir /h0/USR/ROB`.

This substitution is useful for entire command lines. By using `setenv`, a command line can be assigned to an environment variable:

```
setenv PR "procs -ea"
```

The shell utility automatically substitutes `procs -ea` any time `$(PR)` appears in the command line.

Using Parameters with Procedure Files

The following section applies to OS-9 systems only (does not apply to OS-9 for 68K systems).

The shell utility allows parameters to be passed to procedure files. These parameters are entered on the command line and take the place of variables located within the procedure file.

For example, if you have the following procedure file, `files`, you can list the first parameter and delete the second parameter:

```
$ list files
list $(P0)
del $(P1)
```

When you enter `files` and two filenames, the first filename replaces `$(P0)` and the second replaces `$(P1)`:

```
files starter update
```

This command lists the file `starter` to your terminal screen and deletes `update`.

If you add a third filename to the command line, it is ignored unless the variable `$(P2)` is added to the procedure file. If there is a variable `$(P2)`, the third parameter is recognized and used.

The `$(P*)` variable is a concatenation of all the parameters given to the procedure file. The following example shows a procedure file that uses the `$(P*)` variable and prints out the environment within the `shell`.

```
[7]POS: build listfil
? list $(P*)
? printenv
?
[8]POS: listfil data1 data2 data3
This is the first file          Contents of data1
This is the second file         Contents of data2
This is the third file          Contents of data3
PORT=/pks01
HOME=/h0/USR/ROBB
SHELL=shell
USER=robb
PATH=/h0/cmds
TERM=kt7
_sh=1
PROMPT=@POS:
P0=data1                        First parameter
P1=data2                        Second parameter
P2=data3                        Third parameter
P*=data1 data2 data3            Value of variable P*
PN=3                            Number of parameters passed to listfil
```

The `shell` utility keeps track of the number of parameters passed to any given procedure file with the `PN` variable.

When the procedure file has finished executing, the `shell` utility environment returns to its previous state. The variables `P0`, `P1`, etc. are not passed from the procedure file back to the `shell` utility.

Microware suggests that you not use `setenv` to set variables such as `P0`, `P1`, etc. as they are not passed between the shell and the procedure file.

The profile Command

Usually when a procedure file is executed, a new shell is forked to process the procedure file. Any changes affecting the shell (such as changing any of the current directories or changing the shell environment) made from within a procedure file will not affect the environment of the shell from which the procedure file was called.

The `profile` built-in shell command executes a procedure file without forking a child shell. This makes it possible to change current directories and environment variables from within a procedure file.

For example, if you frequently work on a project located in directory `/h0/usr/proj/myproj` and you want the environment variable `FRAME` to equal `pickone` whenever you work on your project, you could create a procedure file similar to the following:

```
$ list myproject
chd /h0/usr/proj/myproj
setenv FRAME pickone
```

When you want to work on your project, type:

```
profile myproject
```

Your current data directory is `/h0/usr/proj/myproj` and `FRAME` is set to `pickone`. Parameters may still be passed to procedure files when `profile` is used.

The `profile` utility's commands may be nested. That is, the file itself may contain a `profile` command for another file. When the latter `profile` command completes, the first one resumes.

A particularly useful application for `profile` files is within a user's `.login` and `.logout` files. For example, if each user includes the following line in the `.login` file, system-wide commands (such as common environments and news bulletins) can be included in the file `/dd/SYS/login_sys`.

```
profile /dd/SYS/login_sys
```

You can use a similar technique for `.logout` files.

The login shell, .login, and .logout

The *login shell* is the initial shell created by the `login` program to process the user input commands after logging in.

Two special procedure files are extremely useful for personalizing the shell environment:

- `.login`
- `.logout`

To use these files, they must be located in your home directory. The `.login` and `.logout` files provide a way to execute desired commands when logging on to and leaving the system.

The login shell processes `.login` as a command file immediately after successful login. This allows you to run a number of initializing commands without remembering each and every command. After processing all commands in the `.login` file, the shell prompts you for more commands.

The main difference in handling the `.login` file is that the login shell itself actually executes the commands rather than creating another shell to execute the commands.

You can issue such commands as `set` and `setenv` within the `.login` file and have them affect the login shell. This is especially useful for setting up the environment variables `PATH`, `PROMPT`, `TERM`, `_sh`, and for OS-9 (non-68K), `MDHOME` and `MDPATH`.

The following is an example `.login` file:

```
setenv PATH ..:/h0/cmds:/d0/cmds:/dd/cmds:/h0/doc/
   spex
setenv PROMPT "@what next: "
setenv _sh 0
setenv TERM abm85h
querymail
date
dir
```

`.logout` is executed when `logout` is executed to exit the login shell and leave the system. The `.logout` file is executed before the login shell terminates. Use this to execute any cleaning up procedures that are done on a regular schedule. This might be anything from instigating a backup procedure of some sort to printing a reminder of things to do.

The following is an example `.logout` file:

```
procs
wait
echo "all processes terminated"
* basic program to instigate backup if necessary *
disk_backup
echo "backup complete"
```

shell Command Line Syntax

The shell command line consists of a *keyword* and any of the parts listed below. The keyword appears first on a command line. The order

of the optional parts depends on the nature of the command and the desired effect. The command line consists of:

Table 6-4. shell Command Line

Command Line Unit	Description
`Keyword`	A name of a program or procedure file, a pathlist, or built-in shell command. The built-in commands are: `assign` OS-9 for 68K: Assigns commands and strings to a word for command line substitutions. `chd` Changes your data directory. `chm` OS-9: Changes your module directory. `chx` Changes your execution directory. `ex` Executes a process as overlay. `hist` OS-9: Displays your command history. `kill` Aborts a specified process. `logout` Terminates current shell and executes the .logout procedure file if the login shell is terminated. `profile` Executes a procedure file without forking a child shell. `set` Sets shell options. `setenv` Sets environment variables. `setpr` Sets process priority. `unassign` OS-9 for 68K: Unassigns assignments made with `assign`. `unsetenv` Clears environment variables. `w, wait` Waits for process to finish/ Waits for all immediate child processes to finish.
`Parameter`	File or directory names, values, variables, constants, options, etc. to pass to the program. Wildcards may be used to identify parameter names. The recognized wildcards are: `*` Match any character. `?` Match any single character.

Table 6-4. shell Command Line (Continued)

Command Line Unit	Description
`Execution Modifiers`	These modify a program's execution by redirecting I/O or changing the priority or memory allocation of a process: `#<mem size>` Allocate specified additional memory to a process. `^<priority>` Set the priority of the process. `<` Redirect standard input. `>[- or +]` Redirect standard output. `>>[- or +]` Redirect standard error output. The hyphen (-) following the modifiers signify to write over a specified file. The plus (+) appends the file with the redirected output.
`Separators`	Separators connect command lines together in the same command line. They specify to the shell how they are to be executed. The separators are: `;` Indicate sequential execution. `&` Indicate concurrent execution. `!` Create a communication *pipe* between processes. Pipes connect the standard output of one process to the standard input of another. + *OS-9000*: Indicates the concurrent execution of a process to be orphaned.

Command Line Execution

The shell command line syntax indicates that a keyword may be a program name, procedure file name, a pathlist, or built-in shell command. Built-in commands are executed immediately by the shell; no directory searching is required, nor is a process created to execute the command. If the specified command is not a built-in command, the shell must locate the program to execute from a number of possible locations.

The following procedure describes the actions of the shell when processing a command:

Step 1. Get command line.

Step 2. Prepare command:

- OS-9 only (non-68K): Insert into history buffer
- OS-9 only (non-68K): Replace variables
- Validate syntax.
- Isolate keyword, parameters, and execution modifiers.
- Expand wildcard names if given.

Step 3. If the keyword is a built-in command, execute the command. Otherwise, search the following directories until the command is found or the directory search is exhausted:

- The module directory.
- *OS-9 only (non-68K):* Search alternate module directory and module directories in `MDPATH`.
- The execution directory.
- Each directory specified by the `PATH` environment variable.

Step 4. If the command could not be found in the above directories, return error: `can't find command`.

Step 5. If the command is found, load the command into the module directory.

Step 6. If the load fails, execute `shell command` (`command` is assumed to be a procedure file for the shell)

Step 7. If the load succeeds and the module is executable object code, execute `command`.

Step 8. If the load succeeds and the module is BASIC I-code, execute `Runb command`. `Command` is an argument for `RunB`.

Step 9. If either of the above command execution fails, return error: `can't execute command`.

Commands and procedure files in the current execution directory must have the `execute`, `group execute` *(OS-9 only—non68K)*, `and/or public execute` file attribute set or the file will not be found.

If the `PATH` environment variable is set, its value is interpreted as a list of directories to search if the initial search of the execution directory fails. If an absolute pathlist, a path beginning with a slash (`/`) is given as the command, the shell does not perform the `PATH` directory search. The following are examples of setting up the `PATH` variable:

```
setenv PATH /d0
setenv PATH /h0/cmds:/n0/jack/h0/cmds:/n0/jill/h0/cmds
setenv PATH kim:../kim:.../cmds
```

Each directory name is separated by a colon (`:`). The shell utility isolates the directory name and appends the command name and uses this pathlist to load the command. If the load fails, the next directory given is used until the command is successfully loaded or all directories are tried.

Regardless of the error encountered, the shell utility continues with the next directory. If a directory given is a relative pathlist, the pathlist is relative to the execution directory. To assist in determining the directory from which a command was loaded or not loaded, turn on the `-v` option to display the shell's progress while searching the directories.

The `login` program automatically sets the `PATH` variable to the execution directory from which `login` itself was loaded if the password entry gives an execution directory other than "`.`". The period (`.`) tells the shell to use the login's execution directory.

Example Command Lines

The following example displays a numbered listing of the data directory. `dir` is a keyword indicating the `dir` utility. `-u` is a parameter for `dir`.

The exclamation point (`!`) is a pipe that redirects the unformatted output of `dir` to the standard input of `pr`.

`pr` is a keyword indicating the `pr` utility. `-n` is a parameter for `pr`.

```
dir -u ! pr -n
```

The following command line lists all files in the current data directory that have names beginning with `s`. `list` is the keyword. `s*` identifies the parameters.

```
list s*
```

`update` uses `master` as standard input in this next example. The output from `update` is used as input for `sort`. The output from `sort` is redirected to the printer.

```
update <master ! sort >/p1
```

7 Using the uMacs Utility

The µMACS utility is a screen-oriented text editor you can use to create and modify text files. The µMACS utility maintains multiple buffers so you can work with several files and/or portions of the same file at once.

The following sections are included in this chapter:

uMACS Overview

The µMACS utility features an extensive command set. You can *bind* a command name to a key or key combination. When a command is bound to a key or key combination, instead of typing the command name, you can press the key(s) to execute it. By binding and unbinding keys to commands, you can personalize µMACS to your own configuration.

For an alphabetized list of commands, refer to uMACS Command Summary section.

All key sequences have one or two characters. All two character key sequences begin with a <control>x or an <escape> character.

To simplify personalizing commands, use µMACS to build macros. The macro command can consist of any sequence of commands that are bound to keys.

Terminal Capabilities

The termcap file contains information about terminal capabilities. µMACS looks for the termcap file in the /dd/SYS directory (/dd is the default device for your system). If it is not found, µMACS looks in /h0/SYS and then /d0/SYS.

Refer to the section titled: The Termcap File, for information about the termcap file and basic terminal capabilities required by µMACS.

Cursor Positioning

You can move the cursor to any place in any buffer and change buffers at will.

Use µMACS cursor positioning commands to move:

- To the right or left by characters or words.
- To the beginning or end of a line.
- Forward or backward through the text by line, paragraph, or screen.

Search and Replace

µMACS can search forward or backward for any pattern of characters, including `newline` and `control` sequences. Two "replace string" commands facilitate the search commands.

Cut and Paste

µMACS provides features to cut any region of text from a file and paste it elsewhere. You can duplicate the "cut buffer" repeatedly or delete it when you no longer need it. Other commands change all text to upper or lower case within the marked region.

Format Commands

Extensive formatting commands allow you to reformat paragraphs with new user-defined margins, transpose characters, capitalize words, and change words or sections into upper or lower case. Tab handling features allow µMACS to work with most existing text files.

Buffers

µMACS holds as many buffers as memory permits. If buffers contain µMACS commands, you can execute them like procedure files. At all times, µMACS keeps a precise account of where you are in each buffer. This allows easy access and easy editing between buffers.

Command Basics

Before exploring the µMACS features, it is important to understand some details about the command set. You can execute µMACS commands in either of two ways:

- By name.
- By keystroke sequence.

Each command has a name. For example, the command to move the cursor one character to the right is named `forward-character`. This name is bound to a keystroke sequence. The default key binding is `^f`.

All keystroke sequences begin with one of the following:

- `<escape>` key.
- A `control` character.

To enter a control character, press the <control> key and the character key simultaneously. The <esc> key must be pressed and released, then press the character key.

In this manual, references to control characters use the circumflex (^) notation unless specifically referring to the <control> key or a command that uses the circumflex.

Execute Commands

To execute any command by name, type <esc> x. This is the execute-named-command command. It moves the cursor to the bottom of the terminal screen. Type the name of the command and press <return>. µMACS tries to execute a command by that name. If the specified command does not exist or is incorrectly spelled, µMACS returns the error message [No such function].

Refer to uMACS Command Summary for an alphabetized list of µMACS commands and key sequences. Refer to The uMACS Command Set for command details.

Some commands prompt for another command (for example, execute-named-command). When you are prompted for a command, you can type a partial command followed by a space; µMACS tries to complete the command for you.

For example, when prompted for a command:

Step 1. Type se<space>. µMACS completes the command as far as it can: search-.

Step 2. If you type f<space>, µMACS finishes the command: search-forward.

This is useful as a short cut or when you are uncertain of the spelling or full name of the command.

Key Bindings

Most commands are bound to keys. All key bindings consist of one or two characters. All two character bindings begin with the `<escape>` character or `^x`. Use the following commands to change the default key bindings.

Do not bind commands to either of the following keystroke combinations:

Table 7-1. Keystroke Bindings

Command Name	Binding
bind-to-key	`<esc> k`
unbind-key	`<esc> ^k`

These commands allow you to personalize the keystroke commands.

- `^q`
- `^s`

These are used for serial control on most Microware systems.The `bind-to-key` command prompts with:

```
: bind-to-key
```

At the prompt, type:

1. The name of the command.
2. A space.
3. A keystroke combination.

Remember, two stroke commands must begin with `<escape>` or `^x`. You can bind more than one key combination to the same command. For example, the `set-mark` command is, by default, bound to both `<esc>`. and `<esc> <space>`.

Change Key Bindings

To change the binding on a key, use the `unbind-key` command. The `unbind-key` command prompts for the keystroke combination to unbind. This unbinds that keystroke combination regardless of the named command.

Find Current Key Bindings

To view a list of the current key bindings, use the `execute-named-command` command (`<esc> x`) with the `describe-bindings` command. The `describe-bindings` command is by default unbound. It opens a buffer on the screen and displays an alphabetical list of the command names and their associated key bindings.

To assure that a specific key has no binding, or to find out which command is bound to that key, use the `describe-key` command (`^x ?`). This prompts for the key or key sequence. The name of the command bound to that key or key sequence is displayed. If a command is not bound to the key(s), it returns the message `Not bound`.

The Help Command

The `help` display is another method of receiving information about commands.

Refer to Start uMACS and Exit uMACS for mode descriptions.

Step 1. Type the `help` command (`<esc> ?`).

Step 2. A window is opened on the top half of the screen and a text file is displayed in `VIEW` mode. The cursor is placed in this buffer and all cursor movement commands, including search commands, are available.

Step 3. To return to the previously edited buffer, use the `previous-buffer` command (`^xp`).

Step 4. To close the help window, use the `delete-other-windows (^x1)`.

Repeat Commands

You can use an argument buffer to execute a command a specified number of times. To specify an argument buffer, press <esc> and type <n>, where <n> is the number of times to execute the command. You can use a positive or negative number. If you use a negative number, the normal direction of the command is reversed.

For example:

- <esc>-10^f
  Move the cursor back ten characters.
- <esc>10^f
  Move the cursor forward ten characters.

Abort Command

You can abort commands that have not begun moving the cursor or formatting or editing text. This is useful when aborting commands that require input.

To abort a command, press ^g.

Macro Commands

µMACS allows you to create macro commands. To do this, use the following commands:

Step 1. Start the macro command with the name begin-macro or the begin-macro key sequence:
^x(

Step 2. Enter commands and text.

Step 3. End the macro with the end-macro command or the end-macro key sequence: ^x)

All commands and text entered between the execution of these two commands make up the macro command.

To execute the macro, use the execute-macro command or the key sequence ^x e. This executes all commands and enters all text that makes up the macro. The commands are executed in entry order.

For example, the following series of commands or key sequences would move the cursor to the beginning of the line, insert a tab and move the cursor to the beginning of the next line..

Table 7-2. Macro Commands and Key Sequences

Example MacroCommands	Key sequences
begin-macro	^x(
begining-of-line	^a
handle-tab	^i
next-line	^n
begining-of-line	^a
end-macro	^x)

The Execute-File Command

After you are familiar with the µMACS command set and decide on the key bindings and macros that you want to use, use files and the `execute-file` command to automatically change key bindings and build macros.

The `execute-file` command prompts for the name of the file to execute. µMACS tries to execute the file as a series of µMACS commands; one command per line.

Each line in the executed file must consist of the name of the command to execute. If the command name is misspelled or the file is not executable for any other reason, µMACS returns an error message. If only part of the file is non-executable, µMACS executes each line until it encounters a non-executable line and returns an error message.

If a command requires user input, you must anticipate it and supply quotation marks after the command. For example:

```
search-forward "begin"
```

The .umacsrc File

Each time you execute µMACS, it looks for the `.umacsrc` file in your home directory. The home directory is the directory specified by the `HOME` environment variable. `µMACS` opens `.umacsrc` and executes each line as a `µMACS` command. You can use the `.umacsrc` file to set up your own key-bindings. These key bindings are used each time you enter `µMACS`.

To bind a key to a command, use the `bind-to-key` command. For example, a `.umacsrc` file might look like this `(M- = <esc>)`:

```
bind-to-key describe-bindings ^X?
bind-to-key execute-named-command M-!
```

If a binding specified in `.umacsrc` is bound by default to a different command, the `.umacsrc` binding takes precedence and the previously bound command is unbound. The `.umacsrc` file binds the specified commands to the given bindings before loading any files into µMACS. Any other µMACS commands in this file are also executed at this time (for example, macro definitions).

Command Summary: key and help

The following table summarizes the `key` and `help` commands.

Refer to The uMACS Command Set for command details.

Table 7-3. Key and Help Commands

Command Name	Binding	Description
bind-to-key	`<esc> k`	Bind a named command to a key sequence.
unbind-key	`<esc> ^k`	Unbind a key sequence from all commands.
execute-named-command	`<esc> x`	Execute a specified named command.
describe-bindings	`unbound`	Display key binding help file in window.
describe-key	`^x?`	Display named command (if any) bound to key.
help	`<esc> ?`	Display full help file in window.
abort	`^g`	Abort any incomplete command.
execute-file	`unbound`	Execute a specified file.

Introduction to Windows and Buffers

This section acquaints you with µMACS window and buffer handling. This will help you understand many of the related commands and how µMACS is organized.

Refer to The uMACS Command Set for command details.

µMACS can display multiple buffers on the screen through split screen windows. A window may be as small as one line of text and a status line or it may fill the entire screen. At the bottom of each window is a status line. At the bottom of the entire screen is a single blank line that µMACS uses to display prompts and error messages for the current window.

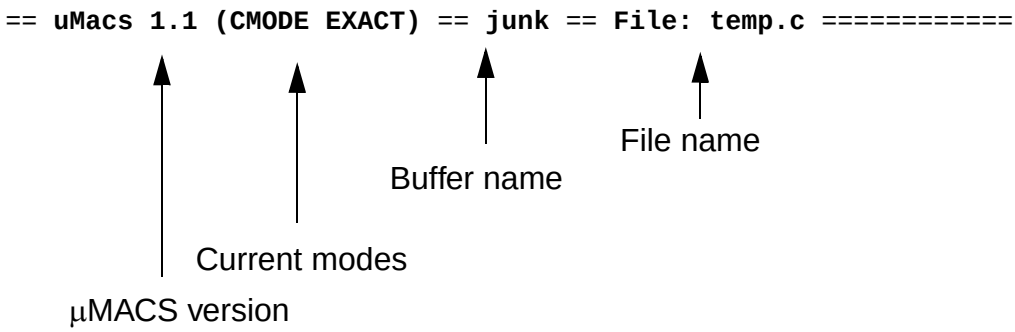
The Status Line

Each window is associated with a named buffer. The status line for each window specifies:

Refer to Start uMACS and Exit uMACS for mode descriptions.

- The µMACS edition.
- The editing mode(s) for that window.
- The buffer's name and the name of the file (if any) in the buffer.

Figure 7-1. Window Status Line



Switching Windows

µMACS supports many commands that allow you to move the cursor between windows. To move to another window, do one of the following:

- Specify a buffer by name.
- Specify the next or previous buffer.
- Specify the next or previous window.

µMACS uses a global buffer to copy text, thus allowing you to move text from one buffer to another.

Start uMACS

To start µMACS, do one of the following:

- Specify µMACS and one or more files to be edited.
- Type `umacs` to edit a new file.

The syntax is as follows:

```
umacs [<opt>] {<filename>}
```

µMACS has two options:

Table 7-4. µMACS Options

Option	Description
`-e`	All files following the -e option are opened in `EDIT` mode. This is the default.
`-v`	All files on the command line following the -v option are opened in `VIEW` mode.

Refer to the *uMACS Editing Modes* section of this chapter for information about changing modes.

Refer to the Input/Output Command or Exit uMACS section of this chapter for information about saving files.

Opening a file in `VIEW` mode allows you to look at the file; you cannot edit it. To edit the file, you must change the mode.

When you execute the `umacs` command, if the file(s) are found, µMACS:

- Reads and displays the first file specified on the command line.
- Tells you how many lines the first file contains.

- Names empty buffers for all other files specified on the command line. The files are read and loaded into the corresponding buffer when that buffer is entered.

  If a file does not exist, µMACS assumes that it is new and opens an empty buffer for editing.

  If you do not specify a file name, µMACS opens an unnamed buffer. You can name and save this buffer.

Input/Output Command

µMACS allows you to load files into existing or new buffers. With two exceptions, all files are read into buffers unchanged.

- All unprintable characters, with the exception of tabs and carriage returns, are displayed as control characters. For example, a form feed is displayed as ^L.
- All lines with more than 255 characters have a carriage return inserted after the 255th character, regardless of word breaks. µMACS alerts you to this with a message at the bottom of the screen. This limitation only affects loading files. Once loaded, a file may have lines of any length.

The following summarizes the commands used to access files and the shell.

Table 7-5. File Access and Shell Commands

Command Name	Binding	Description
insert-file	^x ^i	Inserts a file at the current cursor position.
read-file	^x ^r	Reads a file into the current buffer (overwrites current text).
find-file	^x ^f	Reads a file into a new buffer.
change-file-name	^x n	Names or renames as file in the current buffer.
save-file	^x s	Saves a changed file.
write-file	^x ^w	Writes a file to the specified name.
i-shell	^x c	Forks a shell. Control remains in the shell until you press <escape>.
shell-command	^x !	Forks a shell and execute the specified command. Control returns to µMACS.
view-file	^x^v	Opens a file in view mode.

Insert File

The `insert-file` command (`^x ^i`) prompts you for a file to insert. If the file is found, it is inserted directly before the cursor.

Read File

The `read-file` command (`^x ^r`) prompts you for a file to read into the current buffer. If the file is found and you have edited any portion of the file currently in the buffer, µMACS asks if you wish to save the changes in the file. If you do, the new file is not read.

If you do not wish to save the existing file, the new file is read into the active buffer. In this case, saving the file removes the currently existing file from the µMACS work space, not from your directory. It also changes the filename associated with the buffer.

Find File

The f`ind-file` command (`^x ^f`) prompts you for the name of a file to read into a new buffer. The new buffer is given the name of the file, unless a buffer with that name already exists. In this case, µMACS prompts for a new buffer name.

View File

The `view-file` command (`^x ^v`) is similar to the `find-file` command. It also prompts you for the name of a file to display. Unlike `find-file`, in which the buffer is opened in `EDIT` mode, view-file opens the file in `VIEW` mode. If a new buffer is opened, it is given the name of the specified file, unless there is an existing buffer with that name. In this case, µMACS prompts for a new buffer name.

In all cases, if you specify a file that exists in the µMACS buffer list, that file is used instead of reading a file from your directory. If this is done, µMACS displays a message at the bottom of the screen.

Change File Name

The `change-file-name` command (`^x n`) either names a new file or renames an existing file. This name exists only in µMACS until you save the file. This does not affect the name of the corresponding file in your directory. There can be multiple files of the same name in different buffers. However, each buffer must have a unique name.

Saving Files

There are two ways to save files.

- Use the `save-file` command (`^x s`) to save the file in the current window. µMACS only saves files that were changed in µMACS. If changes were not made to a file, the `save-file` command has no effect. If the file is changed, µMACS looks for a file in your directory with the same name. If the file is found, µMACS rewrites it.
- Use the `write-file` command (`^x ^w`). This command prompts for a file name. It writes the current buffer to the specified file name. If the file name already exists, the file is rewritten. If the file name does not exist, µMACS creates a new file with the specified name.

When saving or writing files, µMACS rewrites any file with the same name. It does not create a backup file, as do some editors.

Execute Operating System Commands

To execute operating system commands while in µMACS:

- Use the `i-shell` command (`^x c`). This command forks a shell from µMACS. Control remains in this shell until you press the `<esc>` key.
- Use the `shell-command` command (`^x !`). This prompts you for a shell command line. µMACS:
- Forks a shell.
- Executes the command line.
- Returns control to µMACS.

You might use `shell-command` to check the files in your directory.

uMACS Editing Modes

All files read into µMACS are by default in EDIT mode, unless you specify the VIEW mode. µMACS has six modes of operation.

You can run any of these modes simultaneously, although some combinations do not make sense. For example, EXACT mode is often used in combination with any other mode. The VIEW mode, however, takes precedence when any other mode is on and does not allow you to overwrite or insert any character. Unless you specify VIEW mode, all modes are by default EDIT modes. This means that all unbound characters are inserted into the text at the cursor position.

Table 7-6. µMACS Modes

Mode	Description
EDIT	All unbound characters are inserted into the text as entered from the keyboard.
OVER	The overwrite mode allows characters entered from the keyboard to replace the text, instead of being inserted.
EXACT	All searching is done with exact case matching. The default searching method is not case sensitive.
WRAP	When a line exceeds the right-hand margin, the line is wrapped to the following line and a carriage return is inserted.
CMODE	Lines ending with a left bracket ({) cause the next line to be indented an extra tab. Lines beginning with a right bracket (}) are indented one less tab than the previous line. A pound sign (#) with only preceding tabs or blanks causes all tabs and blanks to be deleted on that line. This causes all lines beginning with a # to be formatted at the left margin. This is used to identify preprocessor commands. Adding tabs, brackets, or pound signs does not change the rest of the file. CMODE is automatically turned on for any buffer-name ending in .c or .h.
VIEW	Viewing mode allows you to look at a file or buffer; you cannot edit it.

The following is a summary of the commands you can use to add and delete modes.

Table 7-7. Add and Delete Modes

Command Name	Binding	Description
add-mode	^x m	Add the specified mode to the current buffer.
delete-mode	^x ^m	Delete the specified mode from the buffer.
add-global-mode	<esc> m	Add the specified mode to all new buffers.
delete-global-mode	<esc> ^m	Do not add the specified mode to all new buffers.

Add or Delete a Mode

To turn on a mode of operation, use the add-mode command (^x m). You are prompted for the name of the mode to add.

To delete a mode, use the delete-mode command (^x ^m). This also prompts you for the name of the mode.

Refer to the Buffer Commands, Display Current Buffers section for information about determining what mode(s) are active for a buffer.

The add-global-mode command (<esc> m) turns on the specified modes for any newly read buffers. Use this when you know that every file you are going to edit will have the same modes of operation.

For example, if you are editing a number of C programs and searching for specific variable names, you may wish all buffers to have both CMODE and EXACT modes specified. To avoid adding these modes every time you enter a new buffer, use the add-global-buffer command. It prompts you for the mode to add. The prompt only adds one mode at a time. If you type more than one mode, no modes are added. add-global-mode does not affect any previously opened buffer.

The delete-global-mode command (<esc> ^m) deletes any mode specified as global. This will not affect any previously opened buffer. For example, if you open a buffer in CMODE and EXACT modes, and use the delete-global-mode command to delete the EXACT mode, the buffer is still in EXACT mode.

Exit uMACS

There are two ways to exit µMACS.

Table 7-8. µMACS Exit Commands

Command	Binding	Description
exit-emacs	^x ^c	Before exiting, µMACS asks if you want to exit even though you changed files. Choose y to exit, n to stay in µMACS.
quick-exit	<esc> z	Save all changed files and exit.

Save or write your files, one at a time, using the save-file command (^x s) or the write-file command (^x ^w). Then, use the exit-emacs command (^x ^c). This alerts you if there are any unsaved files that have been changed. If there are no changed, unsaved files, you exit µMACS. If there are changed, unsaved files, you must answer a y/n (yes/no) prompt to stay in µMACS or exit without saving the files.

The quick-exit command (<esc> z) automatically saves all files that you changed in µMACS and exits.

The uMACS Command Set

This chapter contains details about µMACS commands. The commands are grouped as follows:

- **Cursor Positioning**

  Use cursor positioning commands to move the cursor forward, backward, up, and down.
- **Insert**

  Use insert commands to insert a space, non-printable characters, new lines, tabs, and files.

Refer to uMACS Command Summary for an alphabetized list of µMACS commands and default key bindings.

- **Delete**

  Use delete commands to delete a character, a word, lines, regions, and blank lines. You can place text in a kill buffer and insert text from the kill buffer to the position before the cursor.
- **Search and Replace**

  Use search and replace commands to find and replace strings.

- **Region Commands**

  Use region commands to mark region boundaries, copy and delete a region, change all letters within a region to upper or lower case, and paste the kill buffer at the cursor position.

- **Format**

  Use format commands to format text. For example, you can change a word's character case, reformat paragraph margins, and transpose characters.

- **Buffer Commands**

  Use buffer commands to list information about buffers and change file and buffer names.

- **Window Commands**

  Use window commands to open new windows, duplicate a window, scroll to another window, and delete, move, shrink, or enlarge windows.

Cursor Positioning Commands

This section discusses µMACS cursor positioning commands.

Table 7-9. µMACS Cursor Positioning Commands

Command Name	Binding	Moves the cursor:
backward-character	^b	One character to the left.
forward-character	^f	One character to the right.
next-word	<esc> f	One word to the right.
previous-word	<esc> b	One word to the left.
next-line	^n	Down the window one line.
previous-line	^p	Up the window one line.
next-paragraph	<esc> n	Ahead to the next paragraph.
previous-paragraph	<esc> p	Back to the last paragraph.
next-page	^v	Ahead one window.
previous-page	^z	Back one window.
beginning-of-line	^a	To the beginning of the line.
end-of-line	^e	To the end of the line.
beginning-of-file	<esc> <	To the beginning of the file.

Table 7-9. μMACS Cursor Positioning Commands (Continued)

Command Name	Binding	Moves the cursor:
end-of-file	<esc> >	To the end of the file.
goto-line	<esc> <line#> <esc> g	To the specified line.

The commands above use the eight-character substring beginning rather than the nine-character substring beginning.

Next or Previous Word, Line, or Paragraph

The next-word command (<esc> f) moves the cursor to the first character of the next word. The previous-word command (<esc> b) moves the cursor to the last character of the previous word.

A word is defined by any character(s) enclosed by either space, tab, and/or newline characters.

The beginning of a paragraph is defined as text that follows any of the character combinations listed below. The end of a paragraph is defined as text that ends with any of these combinations:

- <newline><newline>
- <newline><tab>
- <newline><space>

The next-line command (^n) positions the cursor on the next line in the text. If possible, μMACS keeps the same cursor position in the next line.

The previous-line command (^p) positions the cursor on the line before the current line. All cursor movement wraps to the previous or next line.

If you are at the top of the window and use the previous-line command (^p), the window is redrawn and the cursor is placed on the desired line. That line is positioned in the middle of the window.

The next-paragraph command (<esc> n) places the cursor at the end of the paragraph. The previous-paragraph command (<esc> p) places the cursor at the beginning of a paragraph.

Next or Previous Page

The `next-page` command redraws the window with the bottom two lines on the present page becoming the top two lines on the next page. This allows for some continuity when editing.

The `previous-page` command redraws the window with the top two lines of the present page becoming the bottom two lines on the previous page.

Go To Beginning or End of Line/File

Use the `beginning-of-line` (`^a`) and `end-of-line` (`^e`) commands to move the cursor to the beginning or end of the current line.

The `end-of-file` command (`<esc> >`) moves the cursor to the last character of the file. The `beginning-of-file` command (`<esc> <`) moves the cursor to the first character of the file.

Go to a Specified Line

The `go-to-line` command (`<esc> g`) moves the cursor to the first character of the specified line. The `<esc> g` command needs a line number argument before the command.

To find the current line number, use the `buffer-position` command (`^x =`). The correct syntax is thus changed to `<esc> <line#><esc> g`

Insert Text

This section discusses how to insert text into a buffer.

Table 7-10. Insert Text

Command Name	Binding	Description
insert-space	`^c`	Insert a space character before the cursor.
quote-character	`<esc> q`	Allow a control character to be inserted.
newline	`^m`	The same as a carriage return.
open-line	`^o`	Insert a newline character after the cursor.

Table 7-10. Insert Text (Continued)

Command Name	Binding	Description
new-line-and-indent	^j or <lf>	Insert a newline character and indent the line equal to the previous line.
handle-tab	^i	Redefine and/or insert a tab character.
insert-file	^x ^i	Insert a file from the directory before the cursor.

Refer to the Cursor Positioning section of this chapter for information about moving the cursor.

When you enter µMACS, you are placed in a buffer.

- If you specified a file on the command line, you are in a buffer by that name.
- If you specified more than one file, you are in a buffer with the name of the first file on the command line.
- If you did not specify a file, you are in an unnamed, empty buffer.

To enter text into this buffer:

Step 1. Use any of the cursor positioning commands to move the cursor and type any unbound key.

Step 2. The character is inserted into the text at the cursor position. Any unbound key always inserts text unless you have specified VIEW mode for that buffer.

In OVER mode, the character replaces any character under the cursor. In all other modes, with the exception of VIEW, the character is inserted before the character under the cursor.

Insert a Non-Printable Character

The quote-character command (<esc> q) tells µMACS to insert the next character regardless of whether it is a non-printable character. This allows you to insert control characters into the text. The only exception to this is the carriage return character. It is always entered as a carriage return.

New Lines

The `newline` command has exactly the same effect as entering a carriage return.

The `open-line` command (`^o`) inserts a newline character to create a blank line directly after the cursor.

The `newline-and-indent` command (`^j` or `<linefeed>`) inserts a newline character, then inserts the same number of tabs or spaces as the previous line. This indents the character under the cursor on a new line. This could be useful when splitting lines or indenting text.

Insert a Tab

The `handle-tab` command (`^i`) inserts a tab before the cursor position. If you specify a numeric argument (`<esc> <num> ^i`), the tab character is redefined to the specified number of spaces.

Insert a File

The `insert-file` command (`^x ^i`) prompts for a file name. If the file is found in your directory, it is loaded into the buffer at the cursor position.

Delete Text

This section discusses deleting text, placing it in the kill buffer, and inserting text from the kill buffer to another location.

Table 7-11. Delete Text

Command Name	Binding	Description
delete-next-character	`^d`	Delete the character under the cursor.
delete-previous-character	`^h` or `<bs>` `<del>`	Delete the character before the cursor.
delete-next-word	`<esc> ^d`	Delete from the cursor to the end of word.
delete-previous-word	`<esc> ^h` `<esc> <bs>`	Delete the word up to the cursor.
delete-blank-lines	`^x^o`	Delete the blank lines between text.

Table 7-11. Delete Text (Continued)

Command Name	Binding	Description
kill-paragraph	`<esc> ^w`	Delete the paragraph under the cursor.
kill-region	`^w`	Delete the marked region.
kill-to-end-of-line	`^k`	Delete the line starting at the cursor position.
yank	`^y`	Insert the kill buffer contents at the cursor position.

The Kill Buffer

With two exceptions, all deleted or killed text is put in a buffer called the *kill buffer*. The `delete-next-character` (`^d`) and the `delete-previous-character` (`^h`) command do not place the deleted character in the kill buffer.

Use the `yank` command (`^y`) to insert the kill buffer into the text. This allows you to reconsider deleting or killing an item in the text.

The `kill-to-end-of-line` command (`^k`) puts all characters after the cursor into the kill buffer. The `kill-paragraph` command (`<esc> ^w`) puts all characters in the paragraph containing the cursor into the kill buffer.

Both of these commands replace whatever was previously in the buffer unless two conditions are met:

1. A previous command that puts text in the kill buffer occurred directly before the current command.
2. The cursor has not changed positions between the previous command and the current command.

This allows you to append to the kill buffer if you need to move more than a single line or paragraph.

Delete Word/Blank Lines

There are no exceptions to the following three commands. This allows you to pick and choose the text added to the kill buffer.

The `delete-next-word` command (`<esc> d`) appends all characters from the cursor position to the end of the word, including the character under the cursor, into the kill buffer. For example, if the cursor was on the first `f` in `buffer` and the `delete-next-word` command was executed, the letters `ffer` are appended to the kill buffer.

If the cursor is on a space, tab, or newline character, all spaces, tabs, and newlines up to the beginning of the next word are appended to the kill buffer.

The `delete-previous-word` command (`<esc> ^h`) appends all characters from the beginning of the word to the cursor position into the kill buffer. This does not include the character under the cursor.

For example, if the cursor is on the first `f` in `buffer` and the `delete-previous-word` command is executed, the letters `bu` are appended to the kill buffer. If the cursor is on a space, tab or newline character, all spaces, tabs, newlines, and the previous word are appended to the kill buffer.

A blank line is defined as a line consisting of a single newline character.

The `delete-blank-lines` command (`^x ^o`) deletes all blank lines that exist between two non-blank lines. The cursor must be on a newline character between the two non-blank lines to execute this command. All newline characters deleted from the text are appended to the kill buffer.

Place a Region of Text Into the Kill Buffer

The `kill-region` command (`^w`) replaces the contents of the kill buffer with a region of text. You mark a region with the `set-mark` command (`<esc> <space>` or `<esc> .`). You then move the cursor to another position. The text between the mark and the cursor is the *region*. This includes the character under the mark but not the cursor.

Insert Kill Buffer Contents

Use the `yank` command (`^y`) to insert the kill buffer directly before the cursor position. For example, if you use the `kill-paragraph` command (`<esc>  ^w`) and decide that you still need the paragraph, use the `yank` command to insert the paragraph directly before the cursor position.

Search and Replace

There are six commands you can use to search for and replace strings. Each of these commands requires a *search string*. Once set, this string is used by any search or replace command, until you replace it with another search string.

Table 7-12. Search and Replace Commands

Command	Binding	Description
search-forward	`<esc> s`	Move the cursor forward to the first occurrence of the specified search string.
search-reverse	`<esc> r`	Move the cursor backward to the first occurrence of the specified search string before the original cursor position.
hunt-forward	`<no binding>`	Move the cursor forward to the first occurrence of the current search string.
hunt-backward	`<no binding>`	Move the cursor backward to the first occurrence of the current search string before the original cursor position.
replace-string	`^r`	Substitute all occurrences of the specified search string with the specified replacement string.
query-replace-string	`<esc> ^r`	Prompt to substitute each occurrence of the specified search string with the specified replacement string.

Search Forward and Backward

The search-forward command (<esc> s) and the search-reverse command (<esc> r) display the current search string and prompt for a new search string. For example, if the current search string is delete, µMACS displays the following prompt:

```
Search [delete]<ESC>:
```

If you want a new search string, type the string and press the <esc> key. If you want to use the current search string, press the <esc> key. The <esc> key denotes the end of the search string. You can include newlines and tabs in search strings.

For example, if the current search string is a period (.) followed by a newline, followed by a tab, the prompt is:

```
Search [.  <NL>^I]<ESC>:
```

Refer to the uMACS Editing Modes section for information about changing modes.

Both search-forward and search-reverse look for the next occurrence of the search string. The case of the search string is not significant unless you are in EXACT mode. If a match is found, the cursor is moved to the first character after the matching string. If a match is not found, a Not found message is displayed.

When you want to continue searching for the next occurrence of the search string, use the hunt-forward and hunt-backward commands. By default, these commands are not bound.

To execute the hunt-forward and hunt-backward commands, use the execute-named-command or bind the command(s) to a user-defined binding. They work in the same manner as the search commands, except that they do not prompt for a search string. If a search string is not set at the beginning of an editing session, µMACS displays the No pattern set message.

Replace

The `replace-string` command (`^r`) prompts for the search string and a replacement string. The prompt is given in the same format as the search commands: the current search string is displayed. You have the option of accepting the current string (press the `<esc>` key) or changing the string (type the new string):

```
Replace [delete]<esc>:
```

After you press <esc> or type the new string, you are prompted for the replacement string:

```
With [kill]<esc>:
```

The replacement string is also saved between execution of replace commands. The example above used `kill` as the current replacement string.

All matching strings that occur after the cursor are replaced by the replacement string. The cursor is positioned one character after the last occurrence of a matching string. The number of substitutions made is displayed after the final substitution. If substitutions are not made, `0 substitutions` is displayed and the cursor is not moved.

The `query-replace-string` command (`<esc> ^r`) allows you to control which occurrences of the search string to replace. After the search and replacement strings are determined, for every matching occurrence, you are prompted:

```
Replace 'delete' with 'kill'?
```

Use one of the following one-character responses:

Table 7-13. Responses

Response	Description
`y`	Yes.
`n`	No.
`!`	Continue to substitute all matches without prompting.
`^g`	Abort the command and leave the cursor at its present position.

Table 7-13. Responses (Continued)

Response	Description
.	The period (.) response aborts the command and returns the cursor to its original position before the command began executing.
?	The help (?) response displays the acceptable responses for the command.

Region Commands

A *region* is the text between the cursor and a previously specified point in the buffer. Regions are used in µMACS to cut, paste, delete, or format sections of text.

Table 7-14. Region Commands

Command Name	Binding	Description
set-mark	<esc> . or <esc> <space>	Set a region's marked boundary.
exchange-point-and-mark	^x ^x	Exchange the region's marked boundary with the cursor position.
copy-region	<esc> w	Copy the marked region to the kill buffer.
kill-region	^w	Delete the marked region.
case-region-upper	^x ^u	Change all letters in the region to upper case.
case-region-lower	^x ^l	Change all letters in the region to lower case.
yank	^y	Paste the kill buffer at the cursor position.

Mark Region Boundaries

Regions are bound on one side by a mark in the buffer. To set this mark, use the `set-mark` command (`<esc> <space>` or `<esc> .`). This mark remains in place until you set a new mark. All region commands are relative to this mark.

The mark includes the character on which the mark is set. The other boundary of the region is the cursor. You may interchange the two bounds of the region with the `exchange-point-and-mark` commands (`^x ^x`). This places your cursor where the mark was and places the mark where your cursor was.

Copy or Move a Region

After you set a mark, you can use the `copy-region` command (`<esc> w`) to place a copy of the region in the kill buffer. This leaves the region in its original place in the text. The `copy-region` command writes over the kill buffer, deleting anything that was previously there.

To move a region to another section of text, use the `kill-region` command (`^w`). This deletes the region from the text and places it in the kill buffer. Use the `yank` command to paste it elsewhere. The `kill-region` command writes over the current kill buffer.

Paste

To paste the kill buffer contents elsewhere in the file, use the `yank` command (`^y`).

When pasting the kill buffer into a file, place the cursor at the end of the pasted section. Often, when editing a program or text file, you need to move some code or a section of text to another area of the file and then return to the original point to continue editing. Use the `exchange-point-and-mark` command to do this.

We recommend that you update your mark after executing this command to avoid creating a large region and accidentally editing it.

Change a Region's Character Case

Two commands change the character case of an entire region:

- `case-region-upper` (`^x ^u`)
- `case-region-lower` (`^x ^l`)

These change the entire region to upper or lower case, respectively.

Format Commands

Several text formatting commands are supported by µMACS. These are quite helpful to both programmers and text editors.

Table 7-15. Format Commands

Command Name	Binding	Description
case-word-upper	`<esc> u`	Change all letters from the cursor to the end of the word to upper case.
case-word-lower	`<esc> l`	Change all letters from the cursor to the end of the word to lower case.
case-word-capitalize	`<esc> c`	Change the letter under the cursor to upper case.
set-fill-column	`^x f`	Set right margin using `<esc> <number>^x f`.
fill-paragraph	`<esc> o`	Reformat paragraph using the fill-column.
transpose-characters	`^t`	Transpose the character under the cursor with the character before the cursor.

Change Character Case

Like the region commands, there are format commands you can use to change the character case. Each of these commands moves the cursor to the space, tab, or newline that ends the word.

- `case-word-upper (<esc> u)` changes all letters from the cursor to the end of a word to upper case. This includes the letter under the cursor.
- `case-word-lower (<esc> l)` changes all letters from the cursor to the end of a word to lower case. This includes the letter under the cursor.
- `case-word-capitalize (<esc> c)` capitalizes the letter under the cursor.

  If the word begins with a character that cannot be changed to upper case, the cursor is still moved to the end of the word. For example, if the cursor is on the space before the word, `#include`, and the `<esc> c` command is executed, the word remains the same and the cursor is moved to the end of the word.

Reformat Paragraph Margins

Two commands reformat the margins of paragraphs. These commands must be used together.

- `set-fill-column (^x f)` sets the new margin for the paragraph. `^x f` requires an argument to specify the fill column. Once set, the fill column number remains in effect until it is set to a new margin.

  To set the fill column, the syntax becomes: `<esc> <number>^x f`.

  The new margin has no effect on newly entered text unless in `WRAP` mode. In `WRAP` mode, newline characters are automatically inserted at the end of lines exceeding the fill column (right margin).
- `fill-paragraph (<esc> o)` reformats the paragraph to the new margins specified by the fill column. This replaces all newlines within the paragraph with spaces, and replaces spaces at the end of the new line breaks with newlines.

  `<esc>` o also makes sure that all periods that end words are followed by two spaces. This ensures that previous line endings conform to standard sentence formatting.

A paragraph is defined as any text that begins and ends with a `newline-newline`, `newline-space`, or `newline-tab`.

`fill-paragraph` affects only the paragraph that includes the cursor.

`fill-paragraph` (`<esc> o`) has one or two drawbacks. For example, two spaces are inserted after initials in names. If a real number is indicated in the text by a number followed by a period with no decimal, two spaces are also inserted.

Transpose Characters

You can use µMACS to transpose characters. The `transpose-characters` command (`^t`) transposes the character under the cursor with the character before the cursor. This is an easy way to handle some typographical errors.

Buffer Commands

µMACS sets up a separate buffer for each file specified by the command line. Each of these buffers has the name of the file it contains.

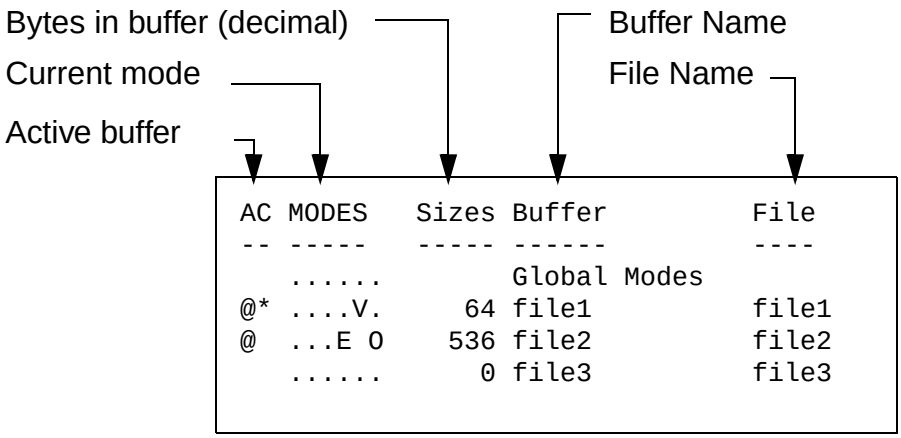
Table 7-16. Buffer Commands

Command Name	Binding	Description
list-buffers	`^x ^b`	List the buffers to be used by µMACS.
select-buffer	`^x b`	Select the buffer to edit.
next-buffer	`^x x`	Select the next buffer in the buffer list to edit.
name-buffer	`<esc> ^n`	Change the name of the buffer currently being edited.
buffer-position	`^x =`	Display status line giving the current buffer position in relation to the entire file.
delete buffer	`^x k`	Delete the specified buffer.
execute-buffer	`<unbound>`	Execute the buffer as a µMACS procedure file.

Display Current Buffers

The `list-buffer` (`^x ^b`) command displays a formatted list of the buffers currently present in µMACS. Press the space bar to remove the list from your display.

Figure 7-2. Buffer List



`@` = Buffer has been entered at least once.

`@*` = Buffer is currently being edited.

Change Buffer or File Name

A buffer always has a name. The file within the buffer may be unnamed, however, you must name the file if you want to save it. The buffer name and the file name do not necessarily have to be the same.

The following are commands you can use to change buffer and file names.

Table 7-17. Change Buffer and File Names

Command Name	Binding	Description
name-buffer	`<esc> ^n`	Prompts for a new buffer name.
change-file-name	`^x n`	Prompts for a new file name.

Edit a Buffer

Once you are aware of the buffers currently available (see the `list-buffer` Display Current Buffers command), you can use the `select-buffer` command (`^x b`) to edit a buffer.

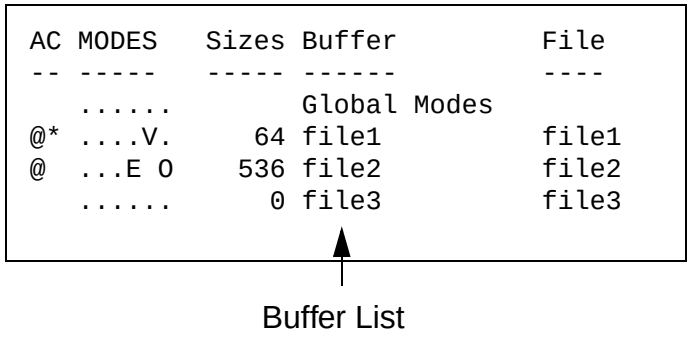
`select-buffer` prompts for the name of the buffer you wish to edit. If you name an existing buffer that has not yet been edited, µMACS:

- Reads the file.
- Displays the number of lines in the file.
- Places the cursor at the beginning of the file.

Open a New Buffer

To open a new buffer, type a name that is not listed in the buffer list. An empty buffer with that name is opened and the cursor is placed at its beginning.

Figure 7-3. Buffer List



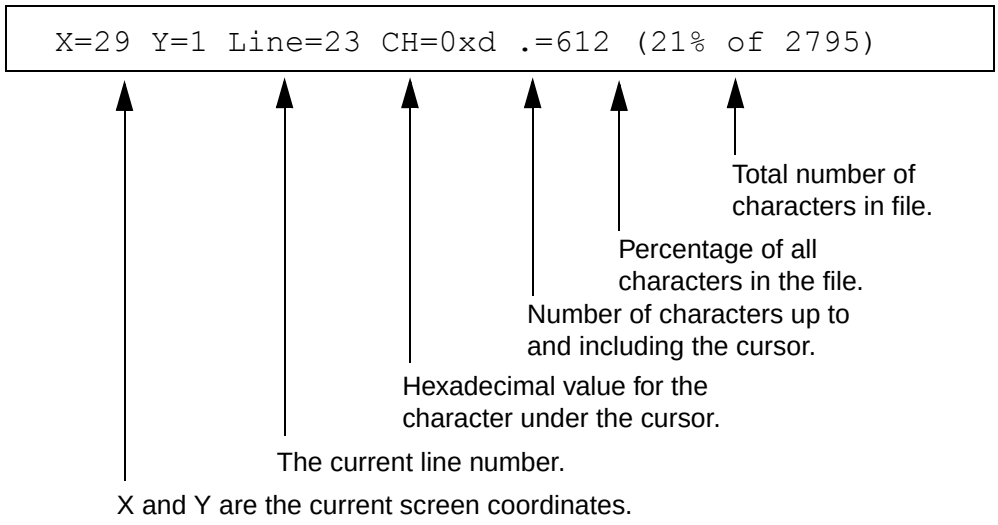
Switch Buffers

Use the `next-buffer` (`^x x`) command to switch between buffers. This places you in the next buffer in the buffer list (see the `list-buffer` command). When you are editing the last buffer in the list, the `next-buffer` command wraps around and places you in the first buffer.

Buffer Position

The `buffer-position` command (`^x =`) displays a status line with information concerning your current position in the buffer. The following is an example status line:

Figure 7-4. Buffer Position Status Line



Delete Buffer

Use the `delete-buffer` command (`^x k`) to delete a specified buffer. `delete-buffer` prompts for the name of the buffer to delete. You cannot delete the currently displayed buffer.

When you delete a buffer, it is removed only from your µMACS workspace. This does not affect any file in your directory.

Execute Buffer

Use `execute-buffer` to execute commands in the buffer. `execute-buffer` prompts for the name of the buffer to execute. µMACS tries to execute the buffer as a procedure file consisting of a series of µMACS commands. If the buffer is not executable, µMACS returns an error message. If only a part of the buffer is non-executable, µMACS executes the buffer until it reaches the non-executable portion, then returns an error message.

The `execute-buffer` command is by default unbound to any character sequence. Unless you bind it, you must implement `execute-buffer` with `execute-named-command` (`<esc> x`).

If your buffer contains a command requiring input, you must anticipate the reply and supply quotation marks. Each command in the buffer must be correctly named and on a line by itself. For example, if you use a buffer to search for the string "`begin`", the buffer looks like this:

```
search-forward "begin"
```

Window Commands

Buffers are displayed in windows. µMACS can display multiple windows simultaneously. A window may consist of the entire screen or as little as one line. Each window has a status line under it to distinguish it from any other windows on the screen. There are several commands you can use to manipulate windows.

Table 7-18. Window Commands

Command Name	Binding	Description
`split-current-window`	`^x 2`	Duplicate the current window in a new window.
`next-window`	`^x n`	Move the cursor to the next window.
`previous-window`	`^x p`	Move the cursor to the previous window.
`move-window-up`	`^x ^p`	Scroll the current window up one line.
`move-window-down`	`^x ^n`	Scroll the current window down one line.
`scroll-next-up`	`<esc> ^z`	Scroll the next window up one page.
`scroll-next-down`	`<esc> ^v`	Scroll the next window down one page.
`shrink-window`	`^x ^z`	Decrease the size of the current window.
`grow-window`	`^x z` `^x^`	Increase the current window's size.
`delete-other-windows`	`^x 1`	Display only the current window.

Open Additional Windows

There are two ways to open a second window on the screen.

- Use the `list-buffer` command (`^x ^b`). This opens a second window and displays the buffer list in the new window. The cursor remains in the original window. Use the `next-window` command (`^x o`) to move the cursor to the new window. Now this window is available for use.

  To read a new buffer into this window, use the `select-buffer` command or the `read-file` command (`^x ^r`). Now you have two windows on the screen with a different buffer in each.
- Use the `split-current-window` command (`^x 2`). This creates a new window on the screen containing a duplicate copy of the buffer that you were editing. This allows you to view the same file in two different areas.

You can manipulate each window with the cursor and scroll commands. Both windows contain the same file. Any text inserted or deleted in either window is inserted or deleted in the other.

You can also use the `split-current-window` command to read a new buffer or file into the new window. You can use the `split-current-window` command until each window on the screen has only one line. At this point, it is impossible to split the screen further; an error message is displayed.

Move to the Next or Previous Window

When more than one window is on the screen, a number of commands are available. The `next-window` command (`^x o`) moves the cursor to the first line displayed in the window below the current window. If the cursor is currently in the bottom window on the screen, the cursor moves to the top window.

The `previous-window` command (`^x p`) works in the same fashion. The cursor is moved to the window directly above the current window.

Scroll Text

Use the cursor commands to scroll the text of the current window. There are two additional commands to scroll the window one line at a time:

- `move-window-down` (`^x ^n`).
- `move-window-up` (`^x ^p`).

These commands affect the current window. To scroll the text of the other displayed window, use:

- `scroll-next-up` (`<esc> ^v`).
- `scroll-next-down` (`<esc> ^z`).

These commands scroll the next window one page forward or backward, respectively.

Change Window Size

Use the `shrink-window` command (`^x ^z`) or the `grow-window` command (`<control>x^` or `^x z`) to alter the size of the current window. These commands shrink or enlarge your current window, respectively. This also enlarges or shrinks the other windows displayed.

You can enlarge a window until all other windows display only one line. You can shrink a window until it only displays one line.

Delete All But Current Window

To delete all windows except the current window, use the `delete-other-windows` command (`^x1`). This displays the current window on the full screen. All other windows are saved in their respective buffers.

Termcap File Format

For µMACS to work properly, it must know the properties of the terminal on which it operates. µMACS uses the `termcap` database to determine the control codes your terminal uses for line delete, cursor positioning, etc.

µMACS looks for the `termcap` file in the `/dd/SYS` directory. `/dd` is the default device for your system. If it is not found, µMACS looks in `/h0/SYS` and then `/d0/SYS`.

The Termcap File

`termcap` is a text file containing control code definitions for one or more types of terminals. Each entry is a complete description list for a particular kind of terminal.

Each part of a `termcap` entry is separated by a vertical bar (`|`) and is another way of naming the terminal.

The first section of a `termcap` entry is divided into three parts.

1. The first part is a two character entry. This is a holdover from early UNIX editions.
2. The second part is the most common name for the terminal. This name cannot contain blanks.
3. The final part is a long name that fully describes the terminal. This name can contain blanks for readability. For example:

```
kh|abm85h|kimtron abm85h:
```

To check the values stored in `TERM`, use the `printenv` utility:

```
$ printenv
TERM=abm85h
```

The `TERM` environment variable must be set to the name used in the second part of the name section. In the following example, `TERM` is set to `abm85h`:

```
$ setenv TERM abm85h
```

The rest of the entry consists of a sequence of control code specifications for each control function. Each item in the list is separated by a colon (`:`) character. An entry may continue onto the next line by using a backslash (`\`) character as the last character of the line. It must appear after the ending colon of the previous item. The next line must begin with a colon.

For example:

```
ka|amb85|kimtron abm85:\
     :ct=\E3:  ...
```

Terminal Capabilities

Each item begins with a terminal *capability*. Each capability is a two character abbreviation. Each capability is either a boolean itself or it is followed by a string or a number. If a boolean capability is present in the `termcap` entry, then the capability exists on that terminal.

All numeric capabilities are followed by a pound sign (`#`) and a number. For example, the number of columns capability for an 80 column terminal could be described as follows:

```
co#80:
```

All string capabilities are followed by an equal sign (=) and a character string. You can enter a time delay in milliseconds directly after the equal sign (=) if padding is allowed in that capability. The padding characters are supplied by the editor after the remainder of the string is transmitted to provide the time delay. The time delay may be either an integer or an integer followed by an asterisk (`*`). The asterisk (`*`) specifies that the padding is proportional to the number of lines affected.

When you use an asterisk (`*`), it may be useful to specify the time delay in tenths of milliseconds. For example, use the following entry to specify the clear screen capability as `^z` with a time delay of 3.5 milliseconds:

```
cl=3.5*^z:
```

Special Characters

Use `\E` to indicate an escape sequence.

A control character is indicated by a circumflex (`^`) preceding the character.

The following special character constants are also supported:

Table 7-19. Special Characters

Character	Definition	Character	Definition
`\b`	backspace	`\f`	formfeed
`\n`	newline	`\r`	return
`\t`	tab	`\\`	backslash
`\^`	circumflex		

You can also specify characters as three Octal digits after a backslash (\). For example:

- If you must use a colon in a capability definition, it must be specified by \072.
- If you need to place a null character in a capability definition, use \200.

C routines using termcap strip the high bits of the output, therefore \200 is interpreted as \000.

Termcap Capabilities

You must define a number of basic capabilities for µMACS to work properly. The required capabilities are shown below.

Table 7-20. Termcap Capabilities

Name	Type	Padding	Description
ce	string	(P)	Clear to end of line.
cl	string	(P*)	Clear the screen.
cm	string	(P)	Cursor addressing.
se	string		End stand out mode
so	string		Begin stand out mode
sg	numeric		Number of blank characters left by so or se.
up	string		Up line (cursor up).

Cursor Addressing

Of the above capabilities, the most complex and important capability is cm (cursor addressing). The string specifying the cursor addressing is formatted similar to the C printf() command. It uses % notation to identify addressing encodings of the current line or column position. The line and the column to address could be considered the arguments to the cm string. All other characters are passed through unchanged.

The following are the notations used for cm strings:

Table 7-21. cm String Notations

Notation	Description
%d	A decimal number (origin 0).
%2	Same as %2d.

Table 7-21. cm String Notations (Continued)

Notation	Description
%3	Same as %3d.
%.	ASCII equivalent of value.
%+x	Add x to value, then %.
%>xy	if value > x adds y, no output.
%r	Reverse the order of row and column, no output.
%i	Increment line/column (for 1 origin).
%%	Give a single %.
%n	Exclusive or row and column with 0140.
%B	BCD (16*(x/10) + (x%10), no output.
%D	Reverse coding (x-2*(x%16)), no output.

Example Notations

The following examples illustrate the use of the above notations:

```
cm=6\E&%r%2c%2Y:
```

This terminal (*HP2645*) needs:

- A six millisecond delay.
- Rows and columns reversed.
- Rows and columns printed as two digits.

  The <escape>& and Y are sent unchanged.

  ```
  cm=5\E[%i%d;%dH:
  ```

This terminal (VT100) needs:

- A five millisecond delay.
- Rows and columns separated by a semicolon (;)
- Because of its origin of 1, rows and columns are incremented.

  The <escape>[; and H are transmitted unchanged. (VT100)

  ```
  cm=\E=%+ %+ :
  ```

This terminal (ABM85H) uses:

- Rows and columns offset by a blank character.

Example Termcap Entries

```
ka|abm85|kimtron abm85:\
      :ce=\ET:cm=\E=%+ %+ :cl=^Z:\
      :se=\Ek:so\Ej:up=^K:sg#1
```

If two entries in the same `termcap` file are very similar, with certain exceptions, one can be defined as identical to the other. To do this, the tc capability is used with the name of the similar terminal. This must be the last capability in the entry. All exceptions to the other terminal must appear before the `tc` listing.

To cancel a capability, use `<cap>@`. For example, a complete entry might be:

```
kh|abm85h|kimtron abm85h:\
      :ce@:cm=\E=%+ %+ :cl=^Z:\
      :se=\EG0:so\EG4:tc=abm85:
```

The `ce` capability is removed from `abm85h`.

uMACS Command Summary

This table contains a summary of the µMACS commands.

Table 7-22. µMACS Command Summary

Command Name	Binding	Description
abort	^g	Abort the current command.
add-mode	^x m	Add the specified mode to the current buffer.
add-global-mode	<esc> m	Add the specified mode to all new buffers.
backward-character	^b	Move the cursor one character backwards.
begin-macro	^x (	Begin the macro-command.
beginning-of-file	<esc> <	Move the cursor to the beginning of the file.
beginning-of-line	^a	Move the cursor to the beginning of the line.
bind-to-key	<esc> k	Bind the specified command to the specified key sequence.

Table 7-22. μMACS Command Summary (Continued)

Command Name	Binding	Description
buffer-position	^x =	Display the cursor position in the buffer.
case-region-lower	^x ^l	Change all letters in the region to lower case.
case-region-upper	^x ^u	Change all letters in the region to upper case.
case-word-capitalize	<esc> c	Change the letter under the cursor to upper case.
case-word-lower	<esc> l	Change all letters to the end of the word to lowercase.
case-word-upper	<esc> u	Change all letters to the end of the word to uppercase.
change-file-name	^x n	Change the name of current file to the specified name.
clear-and-redraw	^l	Redraw the screen.
copy-region	<esc> w	Copy a region to the kill buffer.
delete-blank-lines	^x ^o	Delete blank lines between text.
delete-buffer	^x k	Delete the specified buffer.
delete-mode	^x ^m	Delete the specified editing mode.
delete-global-mode	<esc> ^m	Delete the specified global mode.
delete-next-character	^d	Delete the character under the cursor.
delete-next-word	<esc> d	Delete from the cursor to the end of the word.
delete-other-windows	^x 1	Display only the current window.
delete-previous-character	^h	Delete the character before the cursor <bspace>.
delete-previous-word	<esc> ^h	Delete the word up to the cursor <esc> <bspace>.
describe-bindings	<unbound>	Display the key binding list.

Table 7-22. μMACS Command Summary (Continued)

Command Name	Binding	Description
describe-key	^x ?	Display the bound command (if any) for the specified key sequence.
end-macro	^x)	End the macro-command.
end-of-file	<esc> >	Move the cursor to end of file.
end-of-line	^e	Move the cursor to the end of the line.
exchange-point-and-mark	^x ^x	Exchange the marked bound of the region with the cursor position.
execute-buffer	<unbound>	Execute the specified buffer as a procedure file.
execute-command-line	<unbound>	Execute the command line.
execute-file	<unbound>	Execute the file as a procedure file.
execute-macro	^x e	Execute the macro-command.
execute-named-command	<esc> x	Execute the command by name.
exit-umacs	^x ^c	Exit after saving changed files.
fill-paragraph	<esc> o	Reformat the paragraph to new margins.
find-file	^x ^f	Read the file into new buffer.
forward-character	^f	Move the cursor forward one character.
goto-line	<esc> g	Move the cursor to the specified line.
grow-window	^x ^	Enlarge the current window.
handle-tab	^i	Insert/Redefine the tab character.
help	<esc> ?	Display the help file.
hunt-backward	<unbound>	Move the cursor backward to the last occurrence of a search string.

Table 7-22. μMACS Command Summary (Continued)

Command Name	Binding	Description
hunt-forward	<unbound>	Move the cursor forward to the next occurrence of a search string.
i-shell	^x c	Fork a shell; control remains in the shell until <esc>.
insert-file	^x ^i	Insert file into the current buffer.
insert-space	^c	Insert a space character before the cursor.
kill-paragraph	<esc> ^w	Delete the current paragraph.
kill-region	^w	Delete the marked region.
kill-to-end-of-line	^k	Delete text from the cursor to the end of the line.
list-buffer	^x ^b	Display the buffer list.
move-window-down	^x ^n	Scroll the window down one line.
move-window-up	^x ^p	Scroll the window up one line.
name-buffer	<esc> ^n	Rename the current buffer.
newline	^m	Insert a newline before the cursor.
newline-and-indent	^j	Insert a newline and indent the new line equal to twice that of the previous line.
next-buffer	^x x	Move the cursor to next buffer in the buffer list.
next-line	^n	Move the cursor to the next line.
next-page	^v	Scroll the file one page forward.
next-paragraph	<esc> n	Move the cursor to the next paragraph.
next-window	^x o	Move the cursor to the next window.
next-word	<esc> f	Move the cursor to the next word.

Table 7-22. μMACS Command Summary (Continued)

Command Name	Binding	Description
open-line	^o	Insert two newlines before the cursor.
previous-line	^p	Move the cursor up one line.
previous-page	^z	Move the cursor back one screen. <esc> v
previous-paragraph	<esc> p	Move the cursor back to the last paragraph.
previous-window	^x p	Move the cursor to the last previous window.
previous-word	<esc> b	Move the cursor backward one word.
query-replace-string	<esc> ^r	Prompt at each occurrence of the search string with the replacement string.
quick-exit	<esc> z	Exit after saving all changed files.
quote-character	<esc> q	Allow control characters to be printed.
read-file	^x ^r	Read file into current buffer (overwrite the current text).
redraw-display	<esc> ^l	Redraw the screen. <esc> !
replace-string	^r	Substitute all occurrences of the search string with the replacement string.
save-file	^x s	Save changed file.
scroll-next-down	<esc> ^v	Scroll the next window down one page.
scroll-next-up	<esc> ^z	Scroll the next window up one page.
search-forward	<esc> s	Move the cursor forward to the first occurrence of the specified search string.
search-reverse	<esc> r	Move the cursor back to the first occurrence of the search string previous to the original cursor position.

Table 7-22. μMACS Command Summary (Continued)

Command Name	Binding	Description
select-buffer	`^x b`	Select the buffer to be edited.
set-fill-column	`^x f`	Set the right margin using `<esc> <int>^XF`.
set-mark	`<esc> <space>`	Set the marked bound of the region. <esc> .
shell-command	`^x !`	Fork a `shell`; execute command; control is then returned to μMACS.
shrink-window	`^x ^z`	Decrease the size of the current window.
split-current-window	`^x 2`	Duplicate the current window in new window.
transpose-characters	`^t`	Transpose the character under the cursor with the character before the cursor.
unbind-key	`<esc> ^k`	Unbind the specified key sequence from all commands.
view-file	`^x ^v`	Display the specified file in VIEW mode.
write-file	`^x ^w`	Write the specifically named file to disk.
yank	`^y`	Paste the kill buffer at the cursor position.

8 Using the mar Utility

This chapter discusses the mar utility. The following sections are included:

Overview

The `mar` utility is a resident and cross-hosted utility that generates a modman archive from a set of disk files.

Code Overview

The syntax for the mar utility is shown below:

```
mar {<dirs>|<files>} {-n[=]<name>} -o=<path> -tp=<proc>
{-z[[=]<file>])
```

Parameter Definitions

The following list explains each of the utility's parameters in detail:

`-n[=]<name>` is an optional parameter used to specify the name of the directory structure module within the archive

It names the module that modman uses to create the file structure for the modules. It allows the user to have multiple file structures in the same bootfile. The default name is `mm_tree`.

`-o[=]<file>` is a required parameter specifying the name of the output file

`-tp[=]<proc>` is a required parameter specifying the target processor to pass through to `mkdatmod`

`-z[[=]<file>]` is an optional parameter allowing additional command line options or parameters to be read from a file, or `stdin` if a file is not specified

Pathlists

The archive generated by `mar` can be merged with other boot modules, the modman file manager, and modman device descriptor to simulate a diskless hierarchical file structure.

Each pathlist specified is merged into the archive. The nature of the pathlist determines the placement of the files in the simulated file structure.

There are four types of pathlists. They are listed below:

Table 8-1. Pathlists

Pathlist Type	Description
absolute directory	contents of the directory are placed at the root of the simulated file structure Any subdirectories become module directories in the root module directory of the system.
relative directory	contents of the directory are placed at the same relative pathlist from the root of the simulated file structure
absolute file	file appears in the root directory of the simulated file structure
relative file	file appears at the same relative pathlist from the root of the simulated file structure

Pathlist Examples

The following examples run on a Windows host machine.

Example 1

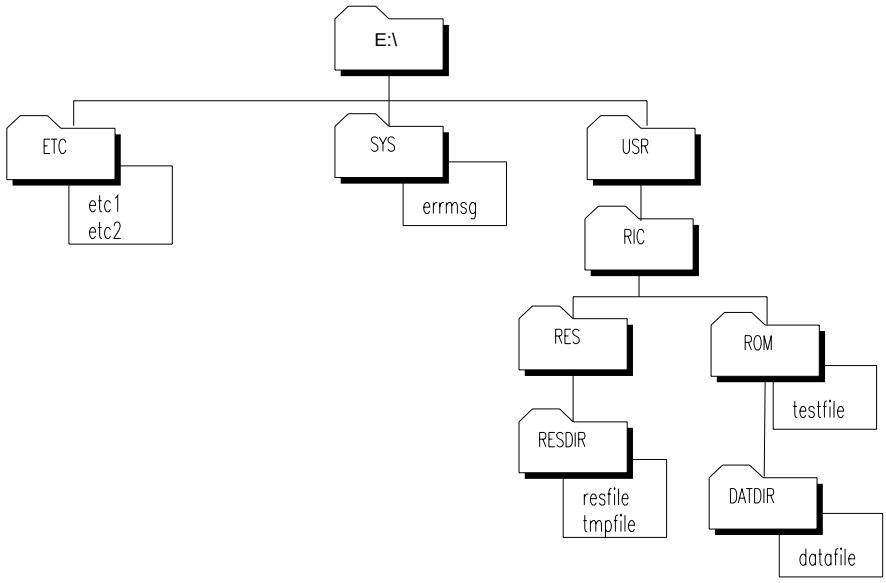
To create a modman archive of every file in a given directory, initiate the following:

```
mar *.* -tp=<proc> -o=outfile.mar
```

Example 2

Below is the Initial Directory Data Structure:

Figure 8-1. Initial Directory Structure



If the current directory is `E:\USR\RIC`, the following code generates the simulated file system shown in Figure 8-2.

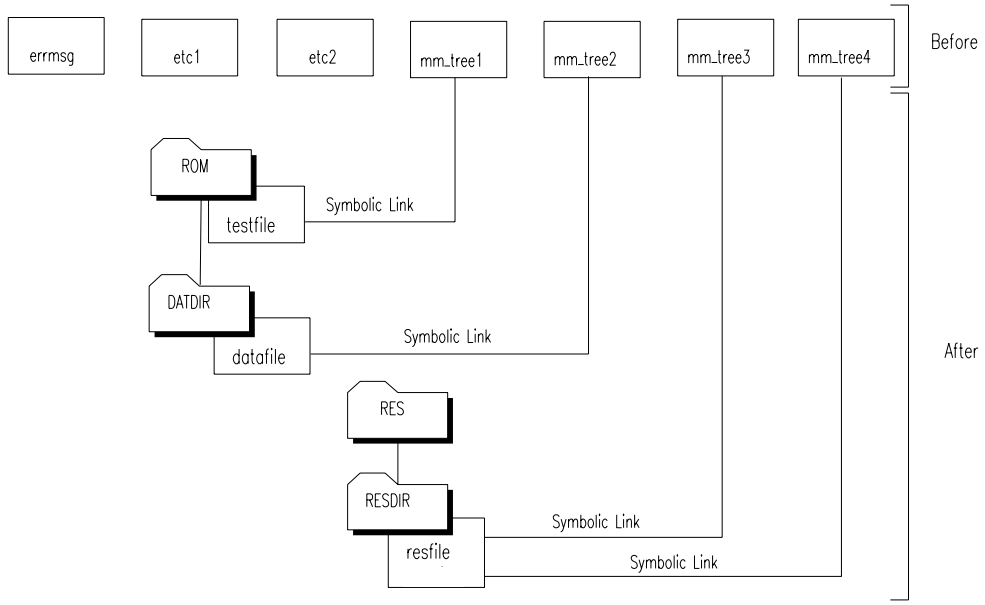
```
mar E:\MAR_EXAMPLE\SYS\errmsg E:\ETC
ROM RES\RESDIR\resfile -tp=<port_proc>
 -o=outfile.mar
```

After running the mar utility, use the OS-9 utility `ident` to examine the generated `outfile.mar` file.

```
$ ident -q outfile.mar
mm_tree    size #224      owner   0.0     ed #1    good crc - 956F09
mm_tree4   size #128      owner   0.0     ed #1    good crc - C3043C
mm_tree3   size #128      owner   0.0     ed #1    good crc - E1E367
mm_tree2   size #128      owner   0.0     ed #1    good crc - B7C26F
etc2       size #112      owner   0.0     ed #1    good crc - 1A6395
etc1       size #112      owner   0.0     ed #1    good crc - C1A593
mm_tree1   size #128      owner   0.0     ed #1    good crc - 4DA177
```

When modules are to appear deep in a file structure, the module names do not necessarily match the original file names. `mar` changes the names to ensure that they are unique with respect to the root module directory. Modules such as `mm_tree1` are actually the destinations of symbolic links with the original file names. These symbolic links will get created when the modman file manager is initialized.

Figure 8-2. Directory Structure Before and After Initializing modman



The following list shows each file that exists in the simulated file system and the reason it exists:

`errmsg`
: exists because an absolute file pathlist translates to the file being placed at the root

`etc1`
: exists because an absolute directory pathlist gets copied to the root of the simulated file system

`etc2`
: exists because an absolute directory pathlist gets copied to the root of the simulated file system

`ROM/testfile`

exists because relative directory pathlists are copied in their entirety at the same relative location in the simulated file system

`ROM/DATDIR/datafile`

exists because relative directory pathlists are copied in their entirety at the same relative location in the simulated file system

`RES/RESDIR/resfile`

exists because relative file pathlists are copied to the same location in the simulated file system

A ASCII Conversion Chart

ASCII is an acronym for American Standard Code for Information Interchange. It consists of 96 printable and 32 unprintable characters. The following conversion table includes Binary, Decimal, Octal, Hexadecimal, and ASCII.

The unprintable characters are defined below:

Table 0-1. ASCII Symbol Definitions

Symbol	Definition	Symbol	Definition
ACK	acknowledge	FS	file separator
BEL	bell	GS	group separator
BS	backspace	HT	horizontal tabulation
CAN	cancel	LF	line feed
CR	carriage return	NAK	negative acknowledgement
DC	device control	NUL	null
DEL	delete	RS	record shipment
DLE	data link escape	SI	shift in
EM	end of medium	SO	shift out
ENQ	enquiry	SOH	start of heading
EOT	end of transmission	SP	space
ESC	escape	STX	start of text
ETB	end of transmission	SUB	substitute
ETX	end of text	SYN	synchronous idle
FF	form feed	US	unit separator
		VT	vertical tabulation

Below is the conversion table.

Table 0-2. Conversion Table

Binary	Decimal	Octal	Hex	ASCII
0000000	0	0	0	NUL
0000001	1	1	1	SOH
0000010	2	2	2	STX
0000011	3	3	3	ETX
0000100	4	4	4	EOT
0000101	5	5	5	ENQ
0000110	6	6	6	ACK
0000111	7	7	7	BEL
0001000	8	10	8	BS
0001001	9	11	9	HT
0001010	10	12	A	LF
0001011	11	13	B	VT

Table 0-2. Conversion Table (Continued)

Binary	Decimal	Octal	Hex	ASCII
0001100	12	14	C	FF
0001101	13	15	D	CR
0001110	14	16	E	SO
0001111	15	17	F	SI
0010000	16	20	10	DLE
0010001	17	21	11	DC1
0010010	18	22	12	DC2
0010011	19	23	13	DC3
0010100	20	24	14	DC4
0010101	21	25	15	NAK
0010110	22	26	16	SYN
0010111	23	27	17	ETB
0011000	24	30	18	CAN
0011001	25	31	19	EM
0011010	26	32	1A	SUB
0011011	27	33	1B	ESC
0011100	28	34	1C	FS
0011101	29	35	1D	GS
0011110	30	36	1E	RS
0011111	31	37	1F	US
0100000	32	40	20	SP
0100001	33	41	21	!
0100010	34	42	22	"
0100011	35	43	23	#
0100100	36	44	24	$
0100101	37	45	25	%
0100110	38	46	26	&
0100111	39	47	27	’
0101000	40	50	28	(
0101001	41	51	29	)
0101010	42	52	2A	*
0101011	43	53	2B	+
0101100	44	54	2C	,
0101101	45	55	2D	-
0101110	46	56	2E	.

Table 0-2. Conversion Table (Continued)

Binary	Decimal	Octal	Hex	ASCII
0101111	47	57	2F	/
0110000	48	60	30	0
0110001	49	61	31	1
0110010	50	62	32	2
0110011	51	63	33	3
0110100	52	64	34	4
0110101	53	65	35	5
0110110	54	66	36	6
0110111	55	67	37	7
0111000	56	70	38	8
0111001	57	71	39	9
0111010	58	72	3A	:
0111011	59	73	3B	;
0111100	60	74	3C	<
0111101	61	75	3D	=
0111110	62	76	3E	>
0111111	63	77	3F	?
1000000	64	100	40	@
1000001	65	101	41	A
1000010	66	102	42	B
1000011	67	103	43	C
1000100	68	104	44	D
1000101	69	105	45	E
1000110	70	106	46	F
1000111	71	107	47	G
1001000	72	110	48	H
1001001	73	111	49	I
1001010	74	112	4A	J
1001011	75	113	4B	K
1001100	76	114	4C	L
1001101	77	115	4D	M
1001110	78	116	4E	N
1001111	79	117	4F	O
1010000	80	120	50	P
1010001	81	121	51	Q

Table 0-2. Conversion Table (Continued)

Binary	Decimal	Octal	Hex	ASCII
1010010	82	122	52	R
1010011	83	123	53	S
1010100	84	124	54	T
1010101	85	125	55	U
1010110	86	126	56	V
1010111	87	127	57	W
1011000	88	130	58	X
1011001	89	131	59	Y
1011010	90	132	5A	Z
1011011	91	133	5B	[
1011100	92	134	5C	\
1011101	93	135	5D	]
1011110	94	136	5E	^
1011111	95	137	5F	_
1100000	96	140	60	‘
1100001	97	141	61	a
1100010	98	142	62	b
1100011	99	143	63	c
1100100	100	144	64	d
1100101	101	145	65	e
1100110	102	146	66	f
1100111	103	147	67	g
1101000	104	150	68	h
1101001	105	151	69	i
1101010	106	152	6A	j
1101011	107	153	6B	k
1101100	108	154	6C	l
1101101	109	155	6D	m
1101110	110	156	6E	n
1101111	111	157	6F	o
1110000	112	160	70	p
1110001	113	161	71	q
1110010	114	162	72	r
1110011	115	163	73	s
1110100	116	164	74	t

Table 0-2. Conversion Table (Continued)

Binary	Decimal	Octal	Hex	ASCII
1110101	117	165	75	u
1110110	118	166	76	v
1110111	119	167	77	w
1111000	120	170	78	x
1111001	121	171	79	y
1111010	122	172	7A	z
1111011	123	173	7B	{
1111100	124	174	7C	|
1111101	125	175	7D	}
1111110	126	176	7E	~
1111111	127	177	7F	DEL