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bash Quick Reference

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In this quick reference, you'll find everything you need to know about the bash shell. Whether you print it out or read it on screen, this book gives you the answers to the annoying questions that always come up when you're writing shell scripts: What characters do you need to quote? How do you get variable substitution to do exactly what you want? How do you use arrays? It's also helpful for interactive use.

If you're a Unix user or programmer, or if you're using bash on Windows, you'll find this quick reference indispensable.

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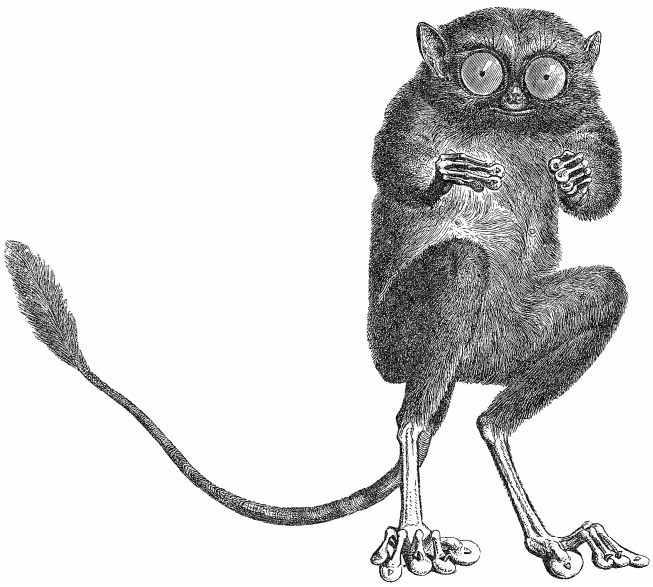

CHAPTER 1

The Bash Shell

This reference covers Bash, which is the primary shell for GNU/Linux and Mac OS X. In particular, it covers version 3.1 of Bash. Bash is available for Solaris and can be easily compiled for just about any other Unix system. This reference presents the following topics:

- History
- Overview of features
- Invoking the shell
- Syntax
- Functions
- Variables
- Arithmetic expressions
- Command history
- Job control
- Shell options
- Command execution
- Restricted shells
- Built-in commands
- Resources

History

The original Bourne shell distributed with V7 Unix in 1979 became the standard shell for writing shell scripts. The Bourne shell is still be found in `/bin/sh` on many commercial Unix systems. The Bourne shell itself has not changed that much since its initial release, although it has seen modest enhancements over the years. The most notable new features were the CDPATH variable and a built-in `test` command with System III (circa 1980), command hashing and shell functions for System V Release 2 (circa 1984), and the addition of job control features for System V Release 4 (1989).

Because the Berkeley C shell (`csh`) offered features that were more pleasant for interactive use, such as command history and job control, for a long time the standard practice in the Unix world was to use the Bourne shell for programming and the C shell for daily use. David Korn at Bell Labs was the first developer to enhance the Bourne shell by adding `csh`-like features to it: history, job control, and additional programmability. Eventually, the Korn shell's feature set surpassed both the Bourne shell and the C shell, while remaining compatible with the Bourne shell for shell programming. Today, the POSIX standard defines the "standard shell" language and behavior based on the System V Bourne shell, with a selected subset of features from the Korn shell.

The Free Software Foundation, in keeping with its goal to produce a complete Unix work-alike system, developed a clone of the Bourne shell, written from scratch, named "Bash," the Bourne-Again SHell. Over time, Bash has become a POSIX-compliant version of the shell, with many additional features. A large part of these additional features overlap the features of the Korn shell, but Bash is not an exact Korn shell clone.

Overview of Features

The Bash shell provides the following features:

- Input/output redirection
- Wildcard characters (metacharacters) for filename abbreviation
- Shell variables and options for customizing your environment
- A built-in command set for writing shell programs
- Shell functions, for modularizing tasks within a shell program
- Job control
- Command-line editing (using the command syntax of either `vi` or Emacs)
- Access to previous commands (command history)
- Integer arithmetic
- Arrays and arithmetic expressions
- Command-name abbreviation (aliasing)
- Upwards compliance with POSIX

- Internationalization facilities
- An arithmetic `for` loop

Invoking the Shell

The command interpreter for the Bash shell (`bash`) can be invoked as follows:

```
bash [options] [arguments]
```

Bash can execute commands from a terminal, from a file (when the first *argument* is a script), or from standard input (if no arguments remain or if `-s` is specified). The shell automatically prints prompts if standard input is a terminal, or if `-i` is given on the command line.

On many systems, `/bin/sh` is a link to Bash. When invoked as `sh`, Bash acts more like the traditional Bourne shell: login shells read `/etc/profile` and `~/.profile`, and regular shells read $ENV, if it's set. Full details are available in the *bash*(1) manpage.

Options

`-c` *`str`*
: Read commands from string *str*.

`-D`, `--dump-strings`
: Print all `$"..."` strings in the program.

`-i` Create an interactive shell (prompt for input).

`-O` *`option`*
: Enable `shopt` option *option*.

`-p` Start up as a privileged user. Don't read $ENV or $BASH_ENV, don't import functions from the environment, and ignore the value of $SHELLOPTS. The normal fixed-name startup files (such as `$HOME/.bash_profile`) are read.

`-r`, `--restricted`
: Create a restricted shell.

`-s` Read commands from standard input. Output from built-in commands goes to file descriptor 1; all other shell output goes to file descriptor 2.

`--debugger`
: Read the debugging profile at startup, turn on the `extdebug` option to `shopt`, and enable function tracing. For use by the Bash debugger (see *http://bashdb.sourceforge.net*).

`--dump-po-strings`
: Same as `-D`, but output in GNU `gettext` format.

`--help`
: Print a usage message and exit successfully.

`--init-file` *`file`*, `--rcfile` *`file`*
: Use *file* as the startup file instead of `~/.bashrc` for interactive shells.

`--login`
Shell is a login shell.

`--noediting`
Do not use the *readline* library for input, even in an interactive shell.

`--noprofile`
Do not read `/etc/profile` or any of the personal startup files.

`--norc`
Do not read `~/.bashrc`. Enabled automatically when invoked as `sh`.

`--posix`
Turn on POSIX mode.

`--verbose`
Same as `set -v`; the shell prints lines as it reads them.

`--version`
Print a version message and exit.

`-`, `--`
End option processing.

The remaining options are listed under the `set` built-in command.

Arguments

Arguments are assigned in order to the positional parameters `$1`, `$2`, etc. If the first argument is a script, commands are read from it, and the remaining arguments are assigned to `$1`, `$2`, etc. The name of the script is available as `$0`. The script file itself need not be executable, but it must be readable.

Syntax

This section describes the many symbols peculiar to the shell. The topics are arranged as follows:

- Special files
- Filename metacharacters
- Quoting
- Command forms
- Redirection forms

Special Files

The shell reads one or more startup files. Some of the files are read only when a shell is a login shell. Bash reads these files:

1. /etc/profile. Executed automatically at login.
2. The first file found from this list: ~/.bash_profile, ~/.bash_login, or ~/.profile. Executed automatically at login.
3. ~/.bashrc is read by every nonlogin shell. However, if invoked as sh, Bash instead reads $ENV, for POSIX compatibility.

The getpwnam() and getpwuid() functions are the sources of home directories for ~*name* abbreviations. (On single-user systems, the user database is stored in /etc/passwd. However, on networked systems, this information may come from NIS, NIS+, or LDAP, not your workstation password file.)

Filename Metacharacters

*	Match any string of zero or more characters.
?	Match any single character.
[*abc...*]	Match any one of the enclosed characters; a hyphen can specify a range (e.g., a-z, A-Z, 0-9).
[!*abc...*]	Match any character *not* enclosed as above.
~	Home directory of the current user.
~*name*	Home directory of user *name*.
~+	Current working directory ($PWD).
~-	Previous working directory ($OLDPWD).

With the extglob option on:

?(*pattern*)	Match zero or one instance of *pattern*.
*(*pattern*)	Match zero or more instances of *pattern*.
+(*pattern*)	Match one or more instances of *pattern*.
@(*pattern*)	Match exactly one instance of *pattern*.
!(*pattern*)	Match any strings that don't match *pattern*.

This *pattern* can be a sequence of patterns separated by |, meaning that the match applies to any of the patterns. This extended syntax resembles that available in egrep and awk.

Bash supports the POSIX [[=*c*=]] notation for matching characters that have the same weight, and [[.*c*.]] for specifying collating sequences. In addition, character classes, of the form [[:*class*:]], allow you to match the following classes of characters:

Class	*Characters matched*	*Class*	*Characters matched*
alnum	Alphanumeric characters	graph	Nonspace characters
alpha	Alphabetic characters	print	Printable characters
blank	Space or Tab	punct	Punctuation characters
cntrl	Control characters	space	Whitespace characters
digit	Decimal digits	upper	Uppercase characters
lower	Lowercase characters	xdigit	Hexadecimal digits

Bash also accepts the `[:word:]` character class, which is not in POSIX. `[[:word:]]` is equivalent to `[[:alnum:]_]`.

Examples

```
$ ls new*                          List new and new.1
$ cat ch?                          Match ch9 but not ch10
$ vi[D-R]*                         Match files that begin with uppercase D through R
$ pr !(*.o|core) | lp              Print files that are not object files or core dumps
```

NOTE: On modern systems, ranges such as `[D-R]` are not portable; the system's locale may include more than just the uppercase letters from `D` to `R` in the range.

Quoting

Quoting disables a character's special meaning and allows it to be used literally. The following table displays characters that have special meaning:

Character	*Meaning*
`;`	Command separator
`&`	Background execution
`()`	Command grouping
`|`	Pipe
`< > &`	Redirection symbols
`* ? [ ] ~ + - @ !`	Filename metacharacters
`" ' \`	Used in quoting other characters
`` ` ``	Command substitution
`$`	Variable substitution (or command or arithmetic substitution)
`space tab newline`	Word separators

These characters can be used for quoting:

`" "` Everything between `"` and `"` is taken literally, except for the following characters that keep their special meaning:

- `$` Variable (or command and arithmetic) substitution will occur.
- `` ` `` Command substitution will occur.
- `"` This marks the end of the double quote.

`' '` Everything between `'` and `'` is taken literally, except for another `'`. You cannot embed another `'` within such a quoted string.

`\` The character following a `\` is taken literally. Use within `" "` to escape `"`, `$`, and `` ` ``. Often used to escape itself, spaces, or newlines.

`$" "`
Just like `" "`, except that locale translation is done.

`$' '`
Similar to `' '`, but the quoted text is processed for the following escape sequences:

Sequence	*Value*	*Sequence*	*Value*
\a	Alert	\t	Tab
\b	Backspace	\v	Vertical tab
\c*X*	Control character *X*	*nnn*	Octal value *nnn*
\e	Escape	\x*nn*	Hexadecimal value *nn*
\E	Escape	\'	Single quote
\f	Form feed	\"	Double quote
\n	Newline	\\	Backslash
\r	Carriage return		

Examples

```
$ echo 'Single quotes "protect" double quotes'
Single quotes "protect" double quotes
$ echo "Well, isn't that \"special\"?"
Well, isn't that "special"?
$ echo "You have `ls | wc -l` files in `pwd`"
You have      43 files in /home/bob
$ echo "The value of \$x is $x"
The value of $x is 100
```

Command Forms

cmd &	Execute *cmd* in background.
cmd1 ; *cmd2*	Command sequence; execute multiple *cmd*s on the same line.
{ *cmd1* ; *cmd2* ; }	Execute commands as a group in the current shell.
(*cmd1* ; *cmd2*)	Execute commands as a group in a subshell.
cmd1 | *cmd2*	Pipe; use output from *cmd1* as input to *cmd2*.
cmd1 `*cmd2*`	Command substitution; use *cmd2* output as arguments to *cmd1*.
cmd1 $(*cmd2*)	POSIX shell command substitution; nesting is allowed.
cmd $((*expression*))	POSIX shell arithmetic substitution. Use the result of *expression* as argument to *cmd*.
cmd1 && *cmd2*	AND; execute *cmd1* and then (if *cmd1* succeeds) *cmd2*. This is a "short circuit" operation: *cmd2* is never executed if *cmd1* fails.
cmd1 || *cmd2*	OR; execute either *cmd1* or (if *cmd1* fails) *cmd2*. This is a "short circuit" operation; *cmd2* is never executed if *cmd1* succeeds.
! *cmd*	NOT; execute *cmd*, and produce a zero exit status if *cmd* exits with a nonzero status. Otherwise, produce a nonzero status when *cmd* exits with a zero status.

Examples

```
$ nroff file > file.txt &          Format in the background
$ cd; ls                           Execute sequentially
$ (date; who; pwd) > logfile       All output is redirected
$ sort file | pr -3 | lp           Sort file, page output, then print
$ vi `grep -l ifdef *.c`           Edit files found by grep
$ egrep '(yes|no)' `cat list`      Specify a list of files to search
$ egrep '(yes|no)' $(cat list)     POSIX version of previous
```

```
$ egrep '(yes|no)' $(< list)          Faster; not in POSIX
$ grep XX file && lp file             Print file if it contains the pattern
$ grep XX file || echo "XX not found" Otherwise, echo an error message
```

Redirection Forms

File descriptor	*Name*	*Common abbreviation*	*Typical default*
0	Standard input	`stdin`	Keyboard
1	Standard output	`stdout`	Screen
2	Standard error	`stderr`	Screen

The usual input source or output destination can be changed, as seen in the following sections.

Simple redirection

cmd `>` *`file`*
: Send output of *cmd* to *file* (overwrite).

cmd `>>` *`file`*
: Send output of *cmd* to *file* (append).

cmd `<` *`file`*
: Take input for *cmd* from *file*.

cmd `<<` *`text`*
: The contents of the shell script up to a line identical to *text* become the standard input for *cmd* (*text* can be stored in a shell variable). This command form is sometimes called a *here document*. Input is usually typed at the keyboard or in the shell program. Commands that typically use this syntax include `cat`, `ex`, and `sed`. (If `<<-` is used, leading tabs are stripped from the contents of the here document, and the tabs are ignored when comparing input with the end-of-input *text* marker.) If any part of *text* is quoted, the input is passed through verbatim. Otherwise, the contents are processed for variable, command, and arithmetic substitutions.

cmd `<<<` *`word`*
: Supply text of *word*, with trailing newline, as input to *cmd*. (This is known as a *here string*, from the free version of the `rc` shell.)

cmd `<>` *`file`*
: Open *file* for reading *and* writing on the standard input. The contents are not destroyed.*

cmd `>|` *`file`*
: Send output of *cmd* to *file* (overwrite), even if the shell's `noclobber` option is set.

* With <, the file is opened read-only, and writes on the file descriptor will fail. With <>, the file is opened read-write; it is up to the application to actually take advantage of this.

Redirection using file descriptors

cmd >&*n*	Send *cmd* output to file descriptor *n*.
cmd m>&*n*	Same as previous, except that output that would normally go to file descriptor *m* is sent to file descriptor *n* instead.
cmd >&-	Close standard output.
cmd <&*n*	Take input for *cmd* from file descriptor *n*.
cmd m<&*n*	Same as previous, except that input that would normally come from file descriptor *m* comes from file descriptor *n* instead.
cmd <&-	Close standard input.
cmd <&*n*-	Move input file descriptor *n* instead of duplicating it.
cmd >&*n*-	Move output file descriptor *n* instead of duplicating it.

Multiple redirection

cmd 2>*file*	Send standard error to *file*; standard output remains the same (e.g., the screen).
cmd > *file* 2>&1	Send both standard error and standard output to *file*.
cmd &> *file*	Same as previous. Preferred form.
cmd >& *file*	Same as previous.
cmd > *f1* 2>*f2*	Send standard output to file *f1* and standard error to file *f2*.
cmd | tee *files*	Send output of *cmd* to standard output (usually the terminal) and to *files*.
cmd 2>&1 | tee *files*	Send standard output and error output of *cmd* to standard output (usually the terminal) and to *files*.

No space should appear between file descriptors and a redirection symbol; spacing is optional in the other cases.

Bash allows multidigit file descriptor numbers. Other shells do not.

Examples

```
$ cat part1 > book
$ cat part2 part3 >> book
$ mail tim < report
$ sed 's/^/XX /g' << END_ARCHIVE
> This is often how a shell archive is "wrapped",
> bundling text for distribution. You would normally
> run sed from a shell program, not from the command line.
> END_ARCHIVE
XX This is often how a shell archive is "wrapped",
XX bundling text for distribution.  You would normally
XX run sed from a shell program, not from the command line.
```

To redirect standard output to standard error:

```
$ echo "Usage error: see administrator" 1>&2
```

The following command sends output (files found) to `filelist`, and error messages (inaccessible files) to file `no_access`:

```
$ find / -print > filelist 2>no_access
```

Functions

A shell *function* is a grouping of commands within a shell script. Shell functions let you modularize your program by dividing it up into separate tasks. This way, the code for each task need not be repeated every time you need to perform the task. The POSIX shell syntax for defining a function follows the Bourne shell:

```
name () {
    function body's code come here
}
```

Functions are invoked just as are regular shell built-in commands or external commands. The command-line parameters `$1`, `$2`, and so on receive the function's arguments, temporarily hiding the global values of `$1`, etc. For example:

```
# fatal --- print an error message and die:

fatal () {
    echo "$0: fatal error:" "$@" >&2     # messages to standard error
    exit 1
}
...
if [ $# = 0 ]    # not enough arguments
then
    fatal not enough arguments
fi
```

A function may use the `return` command to return an exit value to the calling shell program. Be careful *not* to use `exit` from within a function unless you really wish to terminate the entire program.

Bash allows you to define functions using an additional keyword, `function`, as follows:

```
function fatal {
   echo "$0: fatal error:" "$@" >&2     # messages to standard error
   exit 1
}
```

In Bash, all functions share traps with the "parent" shell (except the `DEBUG` trap, if function tracing has been turned on). With the `errtrace` option enabled (either `set -E` or `set -o errtrace`), functions also inherit the `ERR` trap. If function tracing has been enabled, functions inherit the `RETURN` trap. Functions may have local variables, and they may be recursive. Unlike the Korn shell, the syntax used to define a function is irrelevant.

Variables

This section describes the following:

- Variable assignment
- Variable substitution
- Built-in shell variables

- Other shell variables
- Arrays
- Special prompt strings

Variable Assignment

Variable names consist of any number of letters, digits, or underscores. Uppercase and lowercase letters are distinct, and names may not start with a digit. Variables are assigned values using the = operator. There may *not* be any whitespace between the variable name and the value. You can make multiple assignments on the same line by separating each one with whitespace:

```
firstname=Arnold lastname=Robbins numkids=4
```

By convention, names for variables used or set by the shell usually have all uppercase letters; however, you can use uppercase names in your scripts if you use a name that isn't special to the shell.

By default, the shell treats variable values as strings, even if the value of the string is all digits. However, when a value is assigned to an integer variable (created via `declare -i`), Bash evaluates the righthand side of the assignment as an expression (see the later section "*Arithmetic Expressions*"). For example:

```
$ i=5+3 ; echo $i
5+3
$ declare -i jj ; jj=5+3 ;  echo $jj
8
```

Beginning with Bash Version 3.1, the += operator allows you to add or append the righthand side of the assignment to an existing value. Integer variables treat the righthand side as an expression, which is evaluated and added to the value. Arrays add the new elements to the array (see the later section "*Arrays*"). For example:

```
$ name=Arnold
$ name+=" Robbins" ; echo $name          String variable
Arnold Robbins
$ declare -i jj ; jj=3+5 ; echo $jj      Integer variable
8
$ jj+=2+4 ; echo $jj
14
$ pets=(blacky rusty)                    Array variable
$ echo ${pets[*]}
blacky rusty
$ pets+=(raincloud sparky)
$ echo ${pets[*]}
blacky rusty raincloud sparky
```

Variable Substitution

No spaces should be used in the following expressions. The colon (`:`) is optional; if it's included, *var* must be nonnull as well as set.

var=*value* ...	Set each variable *var* to a *value*.
${*var*}	Use value of *var*; braces are optional if *var* is separated from the following text. They are required for array variables.
${*var*:-*value*}	Use *var* if set; otherwise, use *value*.
${*var*:=*value*}	Use *var* if set; otherwise, use *value* and assign *value* to *var*.
${*var*:?*value*}	Use *var* if set; otherwise, print *value* and exit (if not interactive). If *value* isn't supplied, print the phrase "parameter null or not set."
${*var*:+*value*}	Use *value* if *var* is set; otherwise, use nothing.
${#*var*}	Use the length of *var*.
${#*}	Use the number of positional parameters.
${#@}	Same as previous.
${*var*#*pattern*}	Use value of *var* after removing *pattern* from the left. Remove the shortest matching piece.
${*var*##*pattern*}	Same as #*pattern*, but remove the longest matching piece.
${*var*%*pattern*}	Use value of *var* after removing *pattern* from the right. Remove the shortest matching piece.
${*var*%%*pattern*}	Same as %*pattern*, but remove the longest matching piece.
${!*prefix**}, ${!*prefix*@}	List of variables whose names begin with *prefix*.
${*var*:*pos*}, ${*var*:*pos*:*len*}	Starting at position *pos* (0-based) in variable *var*, extract *len* characters, or extract rest of string if no *len*. *pos* and *len* may be arithmetic expressions.
${*var*/*pat*/*repl*}	Use value of *var*, with first match of *pat* replaced with *repl*.
${*var*/*pat*}	Use value of *var*, with first match of *pat* deleted.
${*var*//*pat*/*repl*}	Use value of *var*, with every match of *pat* replaced with *repl*.
${*var*/#*pat*/*repl*}	Use value of *var*, with match of *pat* replaced with *repl*. Match must occur at beginning of the value.
${*var*/%*pat*/*repl*}	Use value of *var*, with match of *pat* replaced with *repl*. Match must occur at end of the value.

Bash provides a special syntax that lets one variable indirectly reference another:

```
$ greet="hello, world"                  Create initial variable
$ friendly_message=greet                Aliasing variable
$ echo ${!friendly_message}             Use the alias
hello, world
```

Examples

```
$ u=up d=down blank=                    Assign values to three variables (last is null)
$ echo ${u}root                         Braces are needed here
uproot
$ echo ${u-$d}                          Display value of u or d; since u is set, it's printed
up
$ echo ${tmp-`date`}                    If tmp is not set, the date command is executed
Sun Jun 11 13:14:54 EDT 2006
$ echo ${blank="no data"}               blank is set, so it is printed (a blank line)
$ echo ${blank:="no data"}              blank is set but null, so the string is printed
no data
$ echo $blank                           blank now has a new value
no data
$ tail=${PWD##*/}                       Take the current directory name and remove the
                                        longest character string ending with /, which
                                        removes the leading pathname and leaves the tail
```

Built-in Shell Variables

Built-in variables are automatically set by the shell and are typically used inside shell scripts. Built-in variables can make use of the variable substitution patterns shown previously. Note that the `$` is not actually part of the variable name, although the variable is always referenced this way. The following are available in any Bourne-compatible shell:

`$#`	Number of command-line arguments.
`$-`	Options currently in effect (arguments supplied on command line or to `set`). The shell sets some options automatically.
`$?`	Exit value of last executed command.
`$$`	Process number of current process.
`$!`	Process number of last background command.
`$0`	First word; that is, the command name. This will have the full pathname if it was found via a PATH search.
`$`*n*	Individual arguments on command line (positional parameters). The Bourne shell allows only nine parameters to be referenced directly (*n* = 1–9); Bash allows *n* to be greater than 9 if specified as `${`*n*`}`.
`$*`, `$@`	All arguments on command line (`$1 $2` ...).
`"$*"`	All arguments on command line as one string (`"$1 $2..."`). The values are separated by the first character in IFS.
`"$@"`	All arguments on command line, individually quoted (`"$1" "$2"` ...).

Bash automatically sets the following additional variables. Many of these variables are for use by the Bash Debugger (see *http://bashdb.sourceforge.net*) or for providing programmable completion (see the section "*Programmable Completion*," later in this reference).

`$_`	Temporary variable; initialized to pathname of script or program being executed. Later, stores the last argument of previous command. Also stores name of matching MAIL file during mail checks.
`BASH`	The full pathname used to invoke this instance of Bash.
`BASH_ARGC`	Array variable. Each element holds the number of arguments for the corresponding function or dot-script invocation. Set only in extended debug mode, with `shopt -s extdebug`. Cannot be unset.
`BASH_ARGV`	An array variable similar to `BASH_ARGC`. Each element is one of the arguments passed to a function or dot-script. It functions as a stack, with values being pushed on at each call. Thus, the last element is the last argument to the most recent function or script invocation. Set only in extended debug mode, with `shopt -s extdebug`. Cannot be unset.
`BASH_COMMAND`	The command currently executing or about to be executed. Inside a trap handler, it is the command running when the trap was invoked.
`BASH_EXECUTION_STRING`	The string argument passed to the `-c` option.

BASH_LINENO	Array variable, corresponding to BASH_SOURCE and FUNCNAME. For any given function number i (starting at 0), ${FUNCNAME[i]} was invoked in file ${BASH_SOURCE[i]} on line ${BASH_LINENO[i]}. The information is stored with the most recent function invocation first. Cannot be unset.
BASH_REMATCH	Array variable, assigned by the =~ operator of the [[ ]] construct. Index 0 is the text that matched the entire pattern. The other indices are the text matched by parenthesized subexpressions. This variable is read-only.
BASH_SOURCE	Array variable, containing source filenames. Each element corresponds to those in FUNCNAME and BASH_LINENO. Cannot be unset.
BASH_SUBSHELL	This variable is incremented by one each time a subshell or subshell environment is created.
BASH_VERSINFO[0]	The major version number, or release, of Bash.
BASH_VERSINFO[1]	The minor version number, or version, of Bash.
BASH_VERSINFO[2]	The patch level.
BASH_VERSINFO[3]	The build version.
BASH_VERSINFO[4]	The release status.
BASH_VERSINFO[5]	The machine type; same value as in MACHTYPE.
BASH_VERSION	A string describing the version of Bash.
COMP_CWORD	For programmable completion. Index into COMP_WORDS, indicating the current cursor position.
COMP_LINE	For programmable completion. The current command line.
COMP_POINT	For programmable completion. The position of the cursor as a character index in COMP_LINE.
COMP_WORDBREAKS	For programmable completion. The characters that the *readline* library treats as word separators when doing word completion.
COMP_WORDS	For programmable completion. Array variable containing the individual words on the command line.
DIRSTACK	Array variable, containing the contents of the directory stack as displayed by dirs. Changing existing elements modifies the stack, but only pushd and popd can add or remove elements from the stack.
EUID	Read-only variable with the numeric effective UID of the current user.
FUNCNAME	Array variable, containing function names. Each element corresponds to those in BASH_SOURCE and BASH_LINENO.
GROUPS	Array variable, containing the list of numeric group IDs in which the current user is a member.
HISTCMD	The history number of the current command.
HOSTNAME	The name of the current host.
HOSTTYPE	A string that describes the host system.
LINENO	Current line number within the script or function.
MACHTYPE	A string that describes the host system in the GNU *cpu-company-system* format.
OLDPWD	Previous working directory (set by cd).

OPTARG	Name of argument to last option processed by `getopts`.
OPTIND	Numerical index of OPTARG.
OSTYPE	A string that describes the operating system.
PIPESTATUS	Array variable, containing the exit statuses of the commands in the most recent foreground pipeline.
PPID	Process number of this shell's parent.
PWD	Current working directory (set by `cd`).
RANDOM[=*n*]	Generate a new random number with each reference; start with integer *n*, if given.
REPLY	Default reply; used by `select` and `read`.
SECONDS[=*n*]	Number of seconds since the shell was started, or, if *n* is given, number of seconds since the assignment + *n*.
SHELLOPTS	A colon-separated list of shell options (for `set -o`). If set in the environment at startup, Bash enables each option present in the list.
SHLVL	Incremented by one every time a new Bash starts up.
UID	Read-only variable with the numeric real UID of the current user.

Other Shell Variables

The following variables are not automatically set by the shell, although many of them can influence the shell's behavior. You typically use them in your `.profile` file, where you can define them to suit your needs. Variables can be assigned values by issuing commands of the form:

```
variable=value
```

This list includes the type of value expected when defining these variables.

CDPATH=*dirs*	Directories searched by `cd`; allows shortcuts in changing directories; unset by default.
COLUMNS=*n*	Screen's column width; used in line edit modes and `select` lists.
COMPREPLY=(*words ...*)	Array variable from which Bash reads the possible completions generated by a completion function.
EMACS	If the value starts with `t`, Bash assumes it's running in an Emacs buffer and disables line editing.
ENV=*file*	Name of script that gets executed at startup; useful for storing alias and function definitions. For example, `ENV=$HOME/.shellrc.`
FCEDIT=*file*	Editor used by `fc` command. The default is `/bin/ed` when Bash is in POSIX mode. Otherwise, the default is $EDITOR if set, `vi` if unset.
FIGNORE=*patlist*	Colon-separated list of patterns describing the set of filenames to ignore when doing filename completion.
GLOBIGNORE=*patlist*	Colon-separated list of patterns describing the set of filenames to ignore during pattern matching.

HISTCONTROL=*list*	Colon-separated list of values controlling how commands are saved in the history file. Recognized values are `ignoredups`, `ignorespace`, `ignoreboth`, and `erasedups`.
HISTFILE=*file*	File in which to store command history.
HISTFILESIZE=*n*	Number of lines to be kept in the history file. This may be different than the number of commands.
HISTIGNORE=*list*	A colon-separated list of patterns that must match the entire command line. Matching lines are *not* saved in the history file. An unescaped `&` in a pattern matches the previous history line.
HISTSIZE=*n*	Number of history commands to be kept in the history file.
HISTTIMEFORMAT=*string*	A format string for *strftime*(3) to use for printing timestamps along with commands from the `history` command. If set (even if null), Bash saves timestamps in the history file along with the commands.
HOME=*dir*	Home directory; set by `login` (from `/etc/passwd` file).
HOSTFILE=*file*	Name of a file in the same format as `/etc/hosts` that Bash should use to find hostnames for hostname completion.
IFS='*chars*'	Input field separators; default is space, tab, and newline.
IGNOREEOF=*n*	Numeric value indicating how many successive EOF characters must be typed before Bash exits. If null or nonnumeric value, default is 10.
INPUTRC=*file*	Initialization file for the *readline* library. This overrides the default value of `~/.inputrc`.
LANG=*locale*	Default value for locale; used if no LC_* variables are set.
LC_ALL=*locale*	Current locale; overrides LANG and the other LC_* variables.
LC_COLLATE=*locale*	Locale to use for character collation (sorting order).
LC_CTYPE=*locale*	Locale to use for character class functions. (See the earlier section "*Filename Metacharacters*.")
LC_MESSAGES=*locale*	Locale to use for translating `$"..."` strings.
LC_NUMERIC=*locale*	Locale to use for the decimal-point character.
LC_TIME=*locale*	Locale to use for date and time formats.
LINES=*n*	Screen's height; used for `select` lists.
MAIL=*file*	Default file to check for incoming mail; set by `login`.
MAILCHECK=*n*	Number of seconds between mail checks; default is 600 (10 minutes).
MAILPATH=*files*	One or more files, delimited by a colon, to check for incoming mail. Along with each file, you may supply an optional message that the shell prints when the file increases in size. Messages are separated from the filename by a `?` character, and the default message is `You have mail in $_`. `$_` is replaced with the name of the file. For example, you might have: `MAILPATH="$MAIL? Candygram!:/etc/motd?New Login Message"`
OPTERR=*n*	When set to 1 (the default value), Bash prints error messages from the built-in `getopts` command.

PATH=*dirlist*	One or more pathnames, delimited by colons, in which to search for commands to execute. Default for many systems is /bin:/usr/bin. On Solaris, the default is /usr/bin:. However, the standard startup scripts change it to: /usr/bin:/usr/ucb:/etc:.
POSIXLY_CORRECT=*string*	When set at startup or while running, Bash enters POSIX mode, disabling behavior and modifying features that conflict with the POSIX standard.
PROMPT_COMMAND=*command*	If set, Bash executes this command each time before printing the primary prompt.
PS1=*string*	Primary prompt string; default is $.
PS2=*string*	Secondary prompt (used in multiline commands); default is >.
PS3=*string*	Prompt string in select loops; default is #?.
PS4=*string*	Prompt string for execution trace (bash -x or set -x); default is +.
SHELL=*file*	Name of default shell (e.g., /bin/sh). Bash sets this if it's not in the environment at startup.
TERM=*string*	Terminal type.
TIMEFORMAT=*string*	A format string for the output for the time keyword.
TMOUT=*n*	If no command is typed after *n* seconds, exit the shell. Also affects the read command and the select loop.
TMDIR=*directory*	Place temporary files created and used by the shell in *directory*.
auto_resume=*list*	Enables the use of simple strings for resuming stopped jobs. With a value of exact, the string must match a command name exactly. With a value of substring, it can match a substring of the command name.
histchars=*chars*	Two or three characters that control Bash's csh-style history expansion. The first character signals a history event; the second is the "quick substitution" character; the third indicates the start of a comment. The default value is !^#. See the section "*C-Shell–Style History*," later in this reference.

Arrays

Bash supports one-dimensional arrays. The first element is numbered 0. Bash has no limit on the number of elements. Arrays are initialized with a special form of assignment:

```
message=(hi there how are you today)
```

where the specified values become elements of the array. Individual elements may also be assigned to:

```
message[0]=hi                    This is the hard way
message[1]=there
message[2]=how
message[3]=are
message[4]=you
message[5]=today
```

Declaring arrays is not required. Any valid reference to a subscripted variable can create an array.

When referencing arrays, use the `${ ... }` syntax. This isn't needed when referencing arrays inside `(( ))` (the form of `let` that does automatic quoting). Note that `[` and `]` are typed literally (i.e., they don't stand for optional syntax).

`${`*`name`*`[`*`i`*`]}`	Use element *i* of array *name*. *i* can be any arithmetic expression as described under `let`.
`${`*`name`*`}`	Use element 0 of array *name*.
`${`*`name`*`[*]}`	Use all elements of array *name*.
`${`*`name`*`[@]}`	Same as previous.
`${#`*`name`*`[*]}`	Use the number of elements in array *name*.
`${#`*`name`*`[@]}`	Same as previous.

Special Prompt Strings

Bash processes the values of PS1, PS2, and PS4 for the following special escape sequences:

`\a`	An ASCII BEL character (octal 07).
`\A`	The current time in 24-hour HH:MM format.
`\d`	The date in "weekday month day" format.
`\D{`*`format`*`}`	The date as specified by the *strftime*(3) format *format*. The braces are required.
`\e`	An ASCII Escape character (octal 033).
`\h`	The hostname, up to the first period.
`\H`	The full hostname.
`\j`	The current number of jobs.
`\l`	The basename of the shell's terminal device.
`\n`	A newline character.
`\r`	A carriage return character.
`\s`	The name of the shell (basename of `$0`).
`\t`	The current time in 24-hour HH:MM:SS format.
`\T`	The current time in 12-hour HH:MM:SS format.
`\u`	The current user's username.
`\v`	The version of Bash.
`\V`	The release (version plus patchlevel) of Bash.
`\w`	The current directory, with $HOME abbreviated as `~`.
`\W`	The basename of the current directory, with $HOME abbreviated as `~`.
`\!`	The history number of this command.
`\#`	The command number of this command.
`\$`	If the effective UID is 0, a `#`; otherwise, a `$`.
`\@`	The current time in 12-hour a.m./p.m. format.
`\`*`nnn`*	The character represented by octal value *nnn*.
`\\`	A literal backslash.
`\[`	Start a sequence of nonprinting characters, such as for highlighting or changing colors on a terminal.
`\]`	End a sequence of nonprinting characters.

The PS1, PS2, and PS4 variables undergo substitution for escape sequences, variable substitution, command substitution, and arithmetic substitution. The escape sequences are processed first, and then, if the `promptvars` shell option is enabled via the `shopt` command (the default), the substitutions are performed.

Arithmetic Expressions

The `let` command performs arithmetic. Bash is restricted to integer arithmetic. The shell provides a way to substitute arithmetic values (for use as command arguments or in variables); base conversion is also possible:

`$(( `*`expr`*` ))`	Use the value of the enclosed arithmetic expression.
`B``#`*`n`*	Interpret integer *n* in numeric base *B*. For example, `8#100` specifies the octal equivalent of decimal 64.

Operators

The shell uses arithmetic operators from the C programming language, in decreasing order of precedence.

Operator	*Description*
`++ --`	Auto-increment and auto-decrement, both prefix and postfix.
`+ - ! ~`	Unary plus and minus, logical negation and binary inversion (one's complement).
`**`	Exponentiation.[a]
`* / %`	Multiplication; division; modulus (remainder).
`+ -`	Addition; subtraction.
`<< >>`	Bitwise left shift; bitwise right shift.
`< <= > >=`	Less than; less than or equal to; greater than; greater than or equal to.
`== !=`	Equality; inequality (both evaluated left to right).
`&`	Bitwise AND.
`^`	Bitwise exclusive OR.
`|`	Bitwise OR.
`&&`	Logical AND (short circuit).
`||`	Logical OR (short circuit).
`?:`	Inline conditional evaluation.
`= += -=`	
`*= /= %=`	
`<<= >>=`	Assignment.
`&= ^= |=`	
`,`	Sequential expression evaluation.

[a] The `**` operator is right-associative. Prior to Version 3.1, it was left-associative.

Examples

```
let "count=0" "i = i + 1"                    Assign i and count
let "num % 2"                                Test for an even number
(( percent >= 0 && percent <= 100 ))         Test the range of a value
```

See the **let** entry in the later section "*Built-in Commands*" for more information and examples.

Command History

The shell lets you display or modify previous commands. Commands in the history list can be modified using:

- Line-edit mode
- The `fc` command
- C-shell–style history

Line-Edit Mode

Line-edit mode emulates many features of the `vi` and Emacs editors. The history list is treated like a file. When the editor is invoked, you type editing keystrokes to move to the command line you want to execute. You can also change the line before executing it. When you're ready to issue the command, press the Enter key.

Emacs editing mode is the default. To control command-line editing, you must use either `set -o vi` or `set -o emacs`; Bash does not use variables to specify the editor.

Note that `vi` starts in input mode; to type a `vi` command, press the Escape key first.

Common editing keystrokes

vi	*Emacs*	*Result*
`k`	`CTRL-p`	Get previous command.
`j`	`CTRL-n`	Get next command.
`/`*`string`*	`CTRL-r` *`string`*	Get previous command containing *string*.
`h`	`CTRL-b`	Move back one character.
`l`	`CTRL-f`	Move forward one character.
`b`	`ESC-b`	Move back one word.
`w`	`ESC-f`	Move forward one word.
`X`	`DEL`	Delete previous character.
`x`	`CTRL-d`	Delete character under cursor.
`dw`	`ESC-d`	Delete word forward.
`db`	`ESC-h`	Delete word backward.
`xp`	`CTRL-t`	Transpose two characters.

The fc Command

`fc` stands for either "find command" or "fix command," since it does both jobs. Use `fc -l` to list history commands and `fc -e` to edit them. See the **fc** entry in the later section "*Built-in Commands*" for more information.

Examples

```
$ history                 List the last 16 commands
$ fc -l 20 30             List commands 20 through 30
$ fc -l -5                List the last 5 commands
$ fc -l cat               List all commands since the last command beginning with cat
$ fc -l 50                List all commands since command 50
$ fc -ln 5 > doit         Save command 5 to file doit
$ fc -e vi 5 20           Edit commands 5 through 20 using vi
$ fc -e emacs             Edit previous command using emacs
```

Interactive line-editing is easier to use than `fc`, since you can move up and down in the saved command history using your favorite editor commands (as long as your favorite editor is either `vi` or Emacs!). You may also use the Up and Down arrow keys to traverse the command history.

C-Shell–Style History

Besides the interactive editing features and POSIX `fc` command, Bash supports a command-line editing mode similar to that of the Berkeley C shell (`csh`). It can be disabled using `set +H`. Many users prefer the interactive editing features, but for those whose "finger habits" are still those of `csh`, this feature comes in handy.

Event designators

Event designators mark a command-line word as a history substitution.

Command	*Description*
`!`	Begin a history substitution.
`!!`	Previous command.
`!`*`N`*	Command number *N* in history list.
`!-`*`N`*	*N*th command back from current command.
`!`*`string`*	Most recent command that starts with *string*.
`!?`*`string`*`[?]`	Most recent command that contains *string*.
`^`*`old`*`^`*`new`*`^`	Quick substitution; change string *old* to *new* in previous command, and execute modified command.

Word substitution

Word specifiers allow you to retrieve individual words from previous command lines. They follow an initial event specifier, separated by a colon. The colon is optional if followed by any of `^`, `$`, `*`, `-`, or `%`.

Specifier	*Description*
`:0`	Command name
`:`*n*	Argument number *n*
`^`	First argument
`$`	Last argument
`%`	Argument matched by a `!?`*string*`?` search
`:`*n*`-`*m*	Arguments *n* through *m*
`-`*m*	Words 0 through *m*; same as `:0-`*m*
`:`*n*`-`	Arguments *n* through next-to-last
`:`*n*`*`	Arguments *n* through last; same as *n*`-$`
`*`	All arguments; same as `^-$` or `1-$`
`#`	Current command line up to this point (fairly useless)

History modifiers

There are several ways to modify command and word substitutions. The printing, substitution, and quoting modifiers are shown in the following table.

Modifier	*Description*
`:p`	Display command, but don't execute.
`:s/`*old*`/`*new*	Substitute string *new* for *old*, first instance only.
`:gs/`*old*`/`*new*	Substitute string *new* for *old*, all instances.
`:as/`*old*`/`*new*	Same as `:gs`.
`:Gs/`*old*`/`*new*	Like `:gs`, but apply the substitution to all the words in the command line.
`:&`	Repeat previous substitution (`:s` or `^` command), first instance only.
`:g&`	Repeat previous substitution, all instances.
`:q`	Quote a word list.
`:x`	Quote separate words.

The truncation modifiers are shown in the following table.

Modifier	*Description*
`:r`	Extract the first available pathname root (the portion before the last period).
`:e`	Extract the first available pathname extension (the portion after the last period).
`:h`	Extract the first available pathname header (the portion before the last slash).
`:t`	Extract the first available pathname tail (the portion after the last slash).

Programmable Completion

Bash and the *readline* library provide *completion* facilities, whereby you can type part of a command name, hit the Tab key, and have Bash fill in part or all of the rest of the command or filename. *Programmable completion* lets you, as a shell programmer, write code to

customize the list of possible completions that Bash will present for a particular, partially entered word. This is accomplished through the combination of several facilities.

- The `complete` command allows you provide a completion specification, or *compspec*, for individual commands. You specify, via various options, how to tailor the list of possible completions for the particular command. This is simple, but adequate for many needs. (See the **complete** entry in the section "*Built-in Commands*," later in this reference.)
- For more flexibility, you may use `complete -F` *`funcname command`*. This tells Bash to call *funcname* to provide the list of completions for *command*. You write the *funcname* function.
- Within the code for a `-F` function, the COMP* shell variables provide information about the current command line. COMPREPLY is an array into which the function places the final list of completion results.
- Also within the code for a `-F` function, you may use the `compgen` command to generate a list of results, such as "usernames that begin with `a`" or "all set variables." The intent is that such results would be used with an array assignment:

```
...
COMPREPLY=( $( compgen options arguments ) )
...
```

Compspecs may be associated with either a full pathname for a command or, more commonly, an unadorned command name (`/usr/bin/man` versus plain `man`). Completions are attempted in the following order, based on the options provided to the `complete` command.

1. Bash first identifies the command. If a pathname is used, Bash looks to see if a compspec exists for the full pathname. Otherwise, it sets the command name to the last component of the pathname, and searches for a compspec for the command name.
2. If a compspec exists, Bash uses it. If not, Bash falls back to the default built-in completions.
3. Bash performs the action indicated by the compspec to generate a list of possible matches. Of this list, only those that have the word being completed as a prefix are used for the list of possible completions. For the `-d` and `-f` options, the variable FIGNORE is used to filter out undesirable matches.
4. Bash generates filenames as specified by the `-G` option. GLOBIGNORE is not used to filter the results, but FIGNORE is.
5. Bash processes the argument string provided to `-W`. The string is split using the characters in $IFS. The resulting list provides the candidates for completion. This is often used to provide a list of options that a command accepts.
6. Bash runs functions and commands as specified by the `-F` and `-C` options. For both, Bash sets COMP_LINE and COMP_POINT as described previously. For a shell function, COMP_WORDS and COMP_CWORD are also set.

   Also for both functions and commands, `$1` is the name of the command whose arguments are being completed, `$2` is the word being completed, and `$3` is the word in front

of the word being completed. Bash does *not* filter the results of the command or function.

a. Functions named with `-F` are run first. The function should set the COMPREPLY array to the list of possible completions. Bash retrieves the list from there.

b. Commands provided with `-C` are run next, in an environment equivalent to command substitution. The command should print the list of possible completions, one per line. An embedded newline should be escaped with a backslash.

7. Once the list is generated, Bash filters the results according to the `-X` option. The argument to `-X` is a pattern specifying files to exclude. By prefixing the pattern with a `!`, the sense is reversed, and the pattern instead specifies that only matching files should be retained in the list.

   An `&` in the pattern is replaced with the text of the word being completed. Use `\&` to produce a literal `&`.

8. Finally, Bash prepends or appends any prefixes or suffixes supplied with the `-P` or `-S` options.

9. In the case that no matches were generated, if `-o dirnames` was used, Bash attempts directory name completion.

10. On the other hand, if `-o plusdirs` was provided, Bash *adds* the result of directory completion to the previously generated list.

11. Normally, when a compspec is provided, Bash's default completions are not attempted, nor are the *readline* library's default filename completions.

    a. If the compspec produces no results and `-o bashdefault` was provided, then Bash attempts its default completions.

    b. If neither the compspec nor the Bash default completions with `-o bashdefault` produced any results, and `-o default` was provided, then Bash has the *readline* library attempt its filename completions.

Ian Macdonald has collected a large set of useful compspecs, often distributed as the file `/etc/bash_completion`. If your system does not have it, one location for downloading it is *http://www.dreamind.de/files/bash-stuff/bash_completion*. It is worth retrieving and reviewing.

Examples

Restrict files for the C compiler to C, C++ and assembler source files, and relocatable object files:

```
complete -f -X '!*.[Ccos]' gcc cc
```

For the `man` command, restrict expansions to things that have manpages:

```
# Simple example of programmable completion for manual pages.
# A more elaborate example appears in the bash_completion file.
# Assumes   man [num] command   command syntax.

shopt -s extglob                                    Enable extended pattern matching
```

```
_man () {
   local dir mandir=/usr/share/man                    Local variables

   COMPREPLY=(  )                                     Clear reply list
   if [[ ${COMP_WORDS[1]} = +([0-9]) ]]               Section number provided
   then
       # section provided: man 3 foo
       dir=$mandir/man${COMP_WORDS[COMP_CWORD-1]}     Look in that directory
   else
       # no section, default to commands
       dir=$mandir/'man[18]'                          Look in command directories
   fi
   COMPREPLY=( $( find $dir -type f |                 Generate raw file list
     sed 's;..*/;;' |                                 Remove leading directories
       sed 's/\.[0-9].*$//' |                         Remove trailing suffixes
         grep "^${COMP_WORDS[$COMP_CWORD]}" |         Keep those that match given prefix
           sort                                       Sort final list
   ) )
}
complete -F _man man                                  Associate function with command
```

Job Control

Job control lets you place foreground jobs in the background, bring background jobs to the foreground, or suspend (temporarily stop) running jobs. All modern Unix systems, including Linux and BSD systems, support job control; thus, the job control features are automatically enabled. Many job control commands take a *jobID* as an argument. This argument can be specified as follows:

`%`*n* Job number *n*.

`%`*s* Job whose command line starts with string *s*.

`%?`*s* Job whose command line contains string *s*.

`%%` Current job.

`%+` Current job (same as above).

`%` Current job (same as above).

`%-` Previous job.

The shell provides the following job control commands. For more information on these commands, see the section "*Built-in Commands*," later in this reference.

`bg` Put a job in the background.

`fg` Put a job in the foreground.

`jobs`
List active jobs.

`kill`
Terminate a job.

`stty tostop`
: Stop background jobs if they try to send output to the terminal. (Note that `stty` is not a built-in command.)

`suspend`
: Suspend a job-control shell (such as one created by `su`).

`wait`
: Wait for background jobs to finish.

`CTRL-Z`
: Suspend a foreground job. Then use `bg` or `fg`. (Your terminal may use something other than `CTRL-Z` as the suspend character.)

Shell Options

Bash provides a number of shell options, settings that you can change to modify the shell's behavior. You control these options with the `shopt` command (see the **shopt** entry in the later section "*Built-in Commands*"). The following descriptions describe the behavior when set. Options marked with a dagger (†) are enabled by default.

`cdable_vars`
: Treat a nondirectory argument to `cd` as a variable whose value is the directory to go to.

`cdspell`
: Attempt spelling correction on each directory component of an argument to `cd`. Allowed in interactive shells only.

`checkhash`
: Check that commands found in the hash table still exist before attempting to use them. If not, perform a normal PATH search.

`checkwinsize`
: Check the window size after each command, and update LINES and COLUMNS if the size has changed.

`cmdhist` †
: Save all lines of a multiline command in one history entry. This permits easy re-editing of multiline commands.

`dotglob`
: Include filenames starting with a period in the results of filename expansion.

`execfail`
: Do not exit a noninteractive shell if the command given to `exec` cannot be executed. Interactive shells do not exit in such a case, no matter the setting of this option.

`expand_aliases` †
: Expand aliases created with `alias`. Disabled in noninteractive shells.

`extdebug`
: Enable behavior needed for debuggers:

- `declare -F` displays the source filename and line number for each function name argument.
- When a command run by the `DEBUG` trap fails, the next command is skipped.
- When a command run by the `DEBUG` trap inside a shell function or script sourced with `.` (dot) or `source` returns with an exit status of 2, the shell simulates a call to `return`.
- BASH_ARGC and BASH_ARGV are set as described earlier.
- Function tracing is enabled. Command substitutions, shell functions, and subshells invoked via `(...)` inherit the `DEBUG` and `RETURN` traps.
- Error tracing is enabled. Command substitutions, shell functions, and subshells invoked via `(...)` inherit the `ERR` trap.

`extglob`
: Enable extended pattern-matching facilities such as `+(...)`. (These were not in the Bourne shell and are not in POSIX; thus Bash requires you to enable them if you want them.)

`extquote` †
: Allow `$'...'` and `$"..."` within `${`*`variable`*`}` expansions inside double quotes.

`failglob`
: Cause patterns that do not match filenames to produce an error.

`force_fignore` †
: When doing completion, ignore words matching the list of suffixes in FIGNORE, even if such words are the only possible completions.

`gnu_errfmt`
: Print error messages in the standard GNU format. Enabled automatically when Bash runs in an Emacs terminal window.

`histappend`
: Append the history list to the file named by HISTFILE upon exit, instead of overwriting the file.

`histreedit`
: Allow a user to re-edit a failed `csh`-style history substitution with the *readline* library.

`histverify`
: Place the results of `csh`-style history substitution into the *readline* library's editing buffer instead of executing it directly, in case the user wishes to modify it further.

`hostcomplete` †
: If using *readline*, attempt hostname completion when a word containing an `@` is being completed.

`huponexit`
: Send a `SIGHUP` to all running jobs upon exiting an interactive login shell.

`interactive_comments` †
: Allow words beginning with `#` to start a comment in an interactive shell.

`lithist`
: If `cmdhist` is also set, save multiline commands to the history file with newlines instead of semicolons.

`login_shell`
: Set by the shell when it is a login shell. This is a read-only option.

`mailwarn`
: Print the message `The mail in` *`mailfile`* `has been read` when a file being checked for mail has been accessed since the last time Bash checked it.

`no_empty_cmd_completion`
: If using *readline*, do *not* search $PATH when a completion is attempted on an empty line.

`nocaseglob`
: Ignore letter case when doing filename matching.

`nocasematch`
: Ignore letter case when doing pattern matching for `case` and `[[ ]]`.

`nullglob`
: Expand patterns that do not match any files to the null string, instead of using the literal pattern as an argument.

`progcomp` †
: Enable programmable completion.

`promptvars` †
: Perform variable, command, and arithmetic substitution on the values of PS1, PS2, and PS4.

`restricted_shell`
: Set by the shell when it is a restricted shell. This is a read-only option.

`shift_verbose`
: Causes `shift` to print an error message when the shift count is greater than the number of positional parameters.

`sourcepath` †
: Causes the `.` (dot) and `source` commands to search $PATH in order to find the file to read and execute.

`xpg_echo`
: Causes `echo` to expand escape sequences, even without the `-e` or `-E` options.

Command Execution

When you type a command, Bash looks in the following places until it finds a match:

1. Keywords such as `if` and `for`.
2. Aliases. You can't define an alias whose name is a shell keyword, but you can define an alias that expands to a keyword, e.g., `alias aslongas=while`. When not in POSIX mode, Bash does allow you to define an alias for a shell keyword.
3. Special built-ins like `break` and `continue`. The list of POSIX special built-ins is `.` (dot), `:`, `break`, `continue`, `eval`, `exec`, `exit`, `export`, `readonly`, `return`, `set`, `shift`, `times`, `trap`, and `unset`. Bash adds `source`.
4. Functions. When not in POSIX mode, Bash finds functions before built-in commands.
5. Nonspecial built-ins such as `cd` and `test`.
6. Scripts and executable programs, for which the shell searches in the directories listed in the PATH environment variable.

The distinction between "special" built-in commands and nonspecial ones comes from POSIX. This distinction, combined with the `command` command, makes it possible to write functions that override shell built-ins, such as `cd`. For example:

```
cd () {                         Shell function; found before built-in cd
    command cd "$@"             Use real cd to change directory
    echo now in $PWD            Other stuff we want to do
}
```

Restricted Shells

A *restricted shell* is one that disallows certain actions, such as changing directory, setting PATH, or running commands whose names contain a `/` character.

The original V7 Bourne shell had an undocumented restricted mode. Later versions of the Bourne shell clarified the code and documented the facility. Bash also supplies a restricted mode. (See the manual page for the details.)

Shell scripts can still be run, since in that case the restricted shell calls the unrestricted version of the shell to run the script. This includes the `/etc/profile`, `$HOME/.profile`, and other startup files.

Restricted shells are not used much in practice, as they are difficult to set up correctly.

Built-in Commands

Examples to be entered as a command line are shown with the `$` prompt. Otherwise, examples should be treated as code fragments that might be included in a shell script. For convenience, some of the reserved words used by multiline commands are also included.

`! pipeline` **!**

Negate the sense of a pipeline. Returns an exit status of 0 if the pipeline exited nonzero, and an exit status of 1 if the pipeline exited zero. Typically used in `if` and `while` statements.

→

!
←

Example

This code prints a message if user `jane` is not logged on:

```
if ! who | grep jane > /dev/null
then
    echo jane is not currently logged on
fi
```

#

`#`

Ignore all text that follows on the same line. `#` is used in shell scripts as the comment character and is not really a command.

#!*shell*

`#!`*`shell`* [*`option`*]

Used as the first line of a script to invoke the named *shell*. Anything given on the rest of the line is passed *as a single argument* to the named *shell*. This feature is typically implemented by the kernel, but may not be supported on some older systems. Some systems have a limit of around 32 characters on the maximum length of *shell*. For example:

```
#!/bin/sh
```

:

`:`

Null command. Returns an exit status of 0. See this Example and the ones under **case**. The line is still processed for side effects, such as variable and command substitutions, or I/O redirection.

Example

Check whether someone is logged in:

```
if who | grep $1 > /dev/null
then :   # Do nothing if user is found
else echo "User $1 is not logged in"
fi
```

.

`.` *`file`* [*`arguments`*]

Read and execute lines in *file*. *file* does not have to be executable but must reside in a directory searched by PATH. The *arguments* are stored in the positional parameters. If Bash is not in POSIX mode and *file* is not found in PATH, Bash looks in the current directory for *file*. See also **source**.

`[[ expression ]]` — **[[ ]]**

Same as `test` *expression* or `[` *expression* `]`, except that `[[ ]]` allows additional operators. Word splitting and filename expansion are disabled. Note that the brackets (`[ ]`) are typed literally, and that they must be surrounded by white-space. See **test**.

Additional Operators

`&&`	Logical AND of test expressions (short circuit).
`||`	Logical OR of test expressions (short circuit).
`<`	First string is lexically "less than" the second.
`>`	First string is lexically "greater than" the second.

---

name `() { commands; }` — *name*()

Define *name* as a function. POSIX syntax. The function definition can be written on one line or across many. You may also provide the `function` keyword, an alternate form that works similarly. See the earlier section "*Functions*."

Example

```
$ count ( ) {
>     ls | wc -l
> }
```

When issued at the command line, `count` now displays the number of files in the current directory.

`alias` [*options*] [*name*[=*'cmd'*]] — **alias**

Assign a shorthand *name* as a synonym for *cmd*. If =*'cmd'* is omitted, print the alias for *name*; if *name* is also omitted, print all aliases. If the alias value contains a trailing space, the next word on the command line also becomes a candidate for alias expansion. See also **unalias**.

Option

`-p` Print the word `alias` before each alias.

Example

```
alias dir='echo ${PWD##*/}'
```

bind

```
bind [-m map] [options]
bind [-m map] [-q function] [-r sequence] [-u function]
bind [-m map] -f file
bind [-m map] -x sequence:command
bind [-m map]  sequence:function
bind readline-command
```

Manage the *readline* library. Nonoption arguments have the same form as in a `.inputrc` file.

Options

`-f` *file*
: Read key bindings from *file*.

`-l` List the names of all the *readline* functions.

`-m` *map*
: Use *map* as the keymap. Available keymaps are: `emacs`, `emacs-standard`, `emacs-meta`, `emacs-ctlx`, `vi`, `vi-move`, `vi-command`, and `vi-insert`. `vi` is the same as `vi-command`, and `emacs` is the same as `emacs-standard`.

`-p` Print the current *readline* bindings such that they can be reread from a `.inputrc` file.

`-P` Print the current *readline* bindings.

`-q` *function*
: Query which keys invoke the *readline* function *function*.

`-r` *sequence*
: Remove the binding for key sequence *sequence*.

`-s` Print the current *readline* key sequence and macro bindings such that they can be reread from a `.inputrc` file.

`-S` Print the current *readline* key sequence and macro bindings.

`-u` *function*
: Unbind all keys that invoke the *readline* function *function*.

`-v` Print the current *readline* variables such that they can be reread from a `.inputrc` file.

`-V` Print the current *readline* variables.

`-x` *sequence*`:`*command*
: Execute the shell command *command* whenever *sequence* is entered.

`bg` [*jobIDs*] **bg**

Put current job or *jobIDs* in the background. See the earlier section "*Job Control*."

`break` [*n*] **break**

Exit from a `for`, `while`, `select`, or `until` loop (or break out of *n* loops).

`builtin` *command* [*arguments* **...**] **builtin**

Run the shell built-in command *command* with the given arguments. This allows you to bypass any functions that redefine a built-in command's name. The `command` command is more portable.

Example

This function lets you do your own tasks when you change directory:

```
cd () {
    builtin cd "$@"          Actually change directory
    pwd                      Report location
}
```

`caller` [*expression*] **caller**

Print the line number and source filename of the current function call or dot file. With nonzero *expression*, prints that element from the call stack. The most recent is zero. This command is for use by the Bash debugger.

`case` *value* `in` **case**

```
  pattern1) cmds1;;
  pattern2) cmds2;;
  .
  .
  .
esac
```

Execute the first set of commands (*cmds1*) if *value* matches *pattern1*, execute the second set of commands (*cmds2*) if *value* matches *pattern2*, etc. Be sure the last command in each set ends with `;;`. *value* is typically a positional parameter or other shell variable. *cmds* are typically Unix commands, shell programming commands, or variable assignments. Patterns can use file-generation metacharacters. Multiple patterns (separated by `|`) can be specified on the same line; in this case, the associated *cmds* are executed whenever *value* matches any of these patterns. See the Examples here and under **eval**.

→

case
←

The shell allows *pattern* to be preceded by an optional open parenthesis, as in (*pattern*). In Bash, it's necessary for balancing parentheses inside a `$( )` construct. See also the `nocasematch` option in "*Shell Options*."

Examples

Check first command-line argument and take appropriate action:

```
case $1 in     # Match the first arg
no|yes) response=1;;
-[tT])  table=TRUE;;
*)      echo "unknown option"; exit 1;;
esac
```

Read user-supplied lines until user exits:

```
while :        # Null command; always true
do    printf "Type . to finish ==> "
      read line
      case "$line" in
      .)  echo "Message done"
          break ;;
      *)  echo "$line" >> $message ;;
      esac
done
```

cd

`cd` [`-LP`] [*dir*]
`cd` [`-LP`] [`-`]

With no arguments, change to home directory of user. Otherwise, change working directory to *dir*. Bash searches the CDPATH variable first, and then looks in the current directory for *dir*. A directory of - stands for the previous directory.

Options

`-L` Use the logical path (what the user typed, including any symbolic links) for `cd ..` and the value of PWD. This is the default.

`-P` Use the actual filesystem physical path for `cd ..` and the value of PWD.

Example

```
$ ls -ld /usr/tmp          /usr/tmp is a symbolic link
lrwxrwxrwx  1 root root 10 Dec 30  2004 /usr/tmp -> ../var/tmp
$ cd -L /usr/tmp           Logical change directory
$ pwd                      Show location
/usr/tmp                   Result is logical location
$ cd -P /usr/tmp           Physical change directory
$ pwd                      Show location
/var/tmp                   Result is physical location
```

`command` [`-pvV`] *`name`* [*`arg`* **...**] **command**

Without `-v` or `-V`, execute *name* with given arguments. This command bypasses any aliases or functions that may be defined for *name*. When used with a special built-in, prevents the built-in from exiting the script if it fails.

Options

`-p` Use a predefined default search path, not the current value of PATH.

`-v` Print a description of how the shell interprets *name*.

`-V` Print a more verbose description of how the shell interprets *name*.

Example

Create an alias for `rm` that will get the system's version, and run it with the `-i` option:

```
$ alias 'rm=command -p rm -i'
```

`compgen` [*`options`*] [*`string`*] **compgen**

Generate possible completions for *string* according to the options. Options are those accepted by `complete`, except for `-p` and `-r`. For more information, see the entry for **complete**.

`complete` [*`options`*] *`command ...`* **complete**

Specifies the way to complete arguments for each *command*. This is discussed in the section "*Programmable Completion*," earlier in the reference.

Options

`-a` Same as `-A alias`.

`-A` *`type`*

Use *type* to specify a list of possible completions. The *type* may be one of the following:

`alias`	Alias names.
`arrayvar`	Array variable names.
`binding`	Bindings from the *readline* library.
`builtin`	Shell built-in command names.
`command`	Command names.
`directory`	Directory names.
`disabled`	Names of disabled shell built-in commands.
`enabled`	Names of enabled shell built-in commands.
`export`	Exported variables.

→

`file`	Filenames.
`function`	Names of shell functions.
`group`	Group names.
`helptopic`	Help topics as allowed by the `help` built-in command.
`hostname`	Hostnames, as found in the file named by $HOSTFILE.
`job`	Job names.
`keyword`	Shell reserved keywords.
`running`	Names of running jobs.
`service`	Service names (from `/etc/services`).
`setopt`	Valid arguments for `set -o`.
`shopt`	Valid option names for the `shopt` built-in command.
`signal`	Signal names.
`stopped`	Names of stopped jobs.
`user`	Usernames.
`variable`	Shell variable names.

`-b` Same as `-A builtin`.

`-c` Same as `-A command`.

`-C` *`command`*
Run *command* in a subshell and use its output as the list of completions.

`-d` Same as `-A directory`.

`-e` Same as `-A export`.

`-f` Same as `-A file`.

`-F` *`function`*
Run shell function *function* in the current shell. Upon its return, retrieve the list of completions from the COMPREPLY array.

`-g` Same as `-A group`.

`-G` *`pattern`*
Expand *pattern* to generate completions.

`-j` Same as `-A job`.

`-k` Same as `-A keyword`.

`-o` *`option`*
Control the behavior of the completion specification. The value for *option* is one of the following:

`bashdefault`	Fall back to the normal Bash completions if no matches are produced.
`default`	Use the default *readline* completions if no matches are produced.

complete

`dirnames`	Do directory name completion if no matches are produced.
`filenames`	Inform the *readline* library that the intended output is filenames, so the library can do any filename-specific processing, such as adding a trailing slash for directories or removing trailing spaces.
`nospace`	Inform the *readline* library that it should not append a space to words completed at the end of a line.
`plusdirs`	Attempt directory completion and add any results to the list of completions already generated.

`-p` With no commands, print all completion settings in a way that can be reread.

`-P` *`prefix`*
The *prefix* is added to each resulting string as a prefix after all the other options have been applied.

`-r` Remove the completion settings for the given commands, or all settings if no commands.

`-s` Save as `-A service`.

`-S` *`suffix`*
The *suffix* is added to each resulting string as a suffix after all the other options have been applied.

`-u` Same as `-A user`.

`-v` Same as `-A variable`.

`-W` *`wordlist`*
Split *wordlist* (a single shell word) using $IFS. The generated list contains the members of the split list that matched the word being completed. Each member is expanded using brace expansion, tilde expansion, parameter and variable expansion, command substitution, and arithmetic expansion. Shell quoting is respected.

`-X` *`pattern`*
Exclude filenames matching *pattern* from the filename completion list. With a leading `!`, the sense is reversed, and only filenames matching *pattern* are retained.

`continue` [*n*]

continue

Skip remaining commands in a `for`, `while`, `select`, or `until` loop, resuming with the next iteration of the loop (or skipping *n* loops).

declare

`declare` [*options*] [*name*[=*value*]]

Declare variables and manage their attributes. In function bodies, variables are local, as if declared with the `local` command. See also **typeset**.

Options

`-a` Each *name* is an array.

`-f` Each *name* is a function.

`-F` For functions, print just the function's name and attributes, not the function definition (body).

`-i` Each variable is an integer; in an assignment, the value is evaluated as an arithmetic expression.

`-p` With no *names*, print all variables and their values. With *names*, print the names, attributes, and values of the given variables.

`-r` Mark *names* as read-only. Subsequent assignments will fail, and read-only variables cannot be unset.

`-t` Apply the *trace* attribute to each name. Traced functions inherit the `DEBUG` trap. This attribute has no meaning for variables.

`-x` Mark *names* for export into the environment of child processes.

With a + instead of a –, the given attribute is disabled. With no variable names, all variables having the given attribute(s) are printed in a form that can be reread as input to the shell.

Examples

```
$ declare -i val                    Make val an integer
$ val=4+7                           Evaluate value
$ echo $val                         Show result
11

$ declare -r z=42                   Make z read-only
$ z=31                              Try to assign to it
bash: z: readonly variable          Assignment fails
$ echo $z
42

$ declare -p val z                  Show attributes and values
declare -i val="11"
declare -r z="42"
```

dirs

`dirs` [`-clpv`] [`+`*n*] [`-`*n*]

Print the directory stack, which is managed with `pushd` and `popd`.

Options **dirs**

`+`*n* Print the *n*th entry from the left; first entry is zero.

`-`*n* Print the *n*th entry from the right; first entry is zero.

`-c` Remove all entries from (clear) the directory stack.

`-l` Produce a longer listing, one that does not replace $HOME with `~`.

`-p` Print the directory stack, one entry per line.

`-v` Print the directory stack, one entry per line, with each entry preceded by its index in the stack.

`disown` [`-ahr`] [*job* **...**] **disown**

Removes *jobs* from the list of jobs managed by Bash.

Options

`-a` Remove all jobs. With `-h`, mark all jobs.

`-h` Instead of removing jobs from the list of known jobs, mark them to *not* receive `SIGHUP` when Bash exits.

`-r` With no jobs, remove (or mark) only running jobs.

`do` **do**

Reserved word that precedes the command sequence in a `for`, `while`, `until`, or `select` statement.

`done` **done**

Reserved word that ends a `for`, `while`, `until`, or `select` statement.

`echo` [`-eEn`] [*string*] **echo**

Built-in version. Write *string* to standard output.

Options

If the `xpg_echo` shell option is set, along with POSIX mode (`set -o posix`), `echo` does not interpret any options.

→

echo
←

`-e` Enable interpretation of the following escape sequences, which must be quoted (or escaped with a \) to prevent interpretation by the shell:

`\a` Alert (ASCII BEL).

`\b` Backspace.

`\c` Suppress the terminating newline (same as `-n`).

`\e` ASCII Escape character.

`\f` Formfeed.

`\n` Newline.

`\r` Carriage return.

`\t` Tab character.

`\v` Vertical-tab character.

`\\` Backslash.

`\0`*nnn*
ASCII character represented by octal number *nnn*, where *nnn* is zero, one, two, or three digits and is preceded by a 0.

`\`*nnn*
ASCII character represented by octal number *nnn*, where *nnn* is one, two, or three digits.

`\x`*HH*
ASCII character represented by hexadecimal number *HH*, where *HH* is one or two hexadecimal digits.

`-E` Do not interpret escape sequences, even on systems where the default behavior of the built-in `echo` is to interpret them.

`-n` Do not print the terminating newline.

Examples

```
$ echo "testing printer" | lp
$ echo "Warning: ringing bell \a"
```

---

enable

`enable` [`-adnps`] [`-f` *file*] [*command* **...**]

Enable or disable shell built-in commands. Disabling a built-in lets you use an external version of a command that would otherwise use a built-in version, such as `echo` or `test`.

Options **enable**

`-a` For use with `-p`; print information about all built-in commands, disabled and enabled.

`-d` Remove (delete) a built-in previously loaded with `-f`.

`-f` *`file`*
Load a new built-in command *command* from the shared library file *file*.

`-n` Disable the named built-in commands.

`-p` Print a list of enabled built-in commands.

`-s` Print only the POSIX special built-in commands. When combined with `-f`, the new built-in command becomes a POSIX special built-in.

`esac` **esac**

Reserved word that ends a `case` statement.

`eval` *`args`* **eval**

Typically, `eval` is used in shell scripts, and *args* is a line of code that contains shell variables. `eval` forces variable expansion to happen first and then runs the resulting command. This "double-scanning" is useful any time shell variables contain input/output redirection symbols, aliases, or other shell variables. (For example, redirection normally happens before variable expansion, so a variable containing redirection symbols must be expanded first using `eval`; otherwise, the redirection symbols remain uninterpreted.)

Example

This fragment of a shell script shows how `eval` constructs a command that is interpreted in the right order:

```
for option
do
    case "$option" in Define where output goes
    save) out=' > $newfile' ;;
    show) out=' | more' ;;
    esac
done

eval sort $file $out
```

exec

exec [*command args* **...**]
exec [-a *name*] [-cl] [*command args* **...**]

Execute *command* in place of the current process (instead of creating a new process). exec is also useful for opening, closing, or copying file descriptors.

Options

-a Use *name* for the value of argv[0].

-c Clear the environment before executing the program.

-l Place a minus sign at the front of argv[0], just as *login*(1) does.

Examples

```
trap 'exec 2>&-' 0        Close standard error when shell script exits (signal 0)

$ exec /bin/csh           Replace shell with C shell
$ exec < infile           Reassign standard input to infile
```

exit

exit [*n*]

Exit a shell script with status *n* (e.g., exit 1). *n* can be 0 (success) or nonzero (failure). If *n* is not given, the shell's exit status is that of the most recent command. exit can be issued at the command line to close a window (log out). Exit statuses can range in value from 0 to 255.

Example

```
if [ $# -eq 0 ]
then
    echo "Usage: $0 [-c] [-d] file(s)" 1>&2
    exit 1               # Error status
fi
```

export

export [*variables*]
export [*name*=[*value*] **...**]
export -p
export [-fn] [*name*=[*value*] **...**]

Pass (export) the value of one or more shell *variables*, giving global meaning to the variables (which are local by default). For example, a variable defined in one shell script must be exported if its value is used in other programs called by the script. If no *variables* are given, export lists the variables exported by the current shell. The second form is the POSIX version, which is similar to the first form, except that you can set a variable *name* to a *value* before exporting it.

export

Options

`-f` Names refer to functions; the functions are exported in the environment.

`-n` Remove the named variables or functions from the environment.

`-p` Print `export` before printing the names and values of exported variables. This allows saving a list of exported variables for rereading later.

Examples

In the original Bourne shell, you would type:

```
TERM=vt100
export TERM
```

In Bash, you could type this instead:

```
export TERM=vt100
```

---

false

`false`

Built-in command in that exits with a false return value.

---

fc

`fc` [*options*] [*first* [*last*]]
`fc -e -` [*old=new*] [*command*]
`fc -s` [*old=new*] [*command*]

Display or edit commands in the history list. (Use only one of `-e`, `-l` or `-s`.) *first* and *last* are numbers or strings specifying the range of commands to display or edit. If *last* is omitted, `fc` applies to a single command (specified by *first*). If both *first* and *last* are omitted, `fc` edits the previous command or lists the last 16. The second form of `fc` takes a history *command*, replaces *old* with *new*, and executes the modified command. If no strings are specified, *command* is just reexecuted. If no *command* is given either, the previous command is reexecuted. *command* is a number or string like *first*. See the examples in the earlier section "*Command History*." The third form is equivalent to the second form.

Options

`-e` [*editor*]
Invoke *editor* to edit the specified history commands. The default *editor* is set by the shell variable FCEDIT. If that variable is not set, the default is `/bin/ed`. (Bash defaults to `vi`; versions 3.1 and newer default to `/bin/ed` when in POSIX mode.) Bash tries FCEDIT, then EDITOR, and then `/bin/ed`.

→

fc
←

`-e -`
Execute (or redo) a history command; refer to second syntax line above.

`-l` List the specified command or range of commands, or list the last 16.

`-n` Suppress command numbering from the `-l` listing.

`-r` Reverse the order of the `-l` listing.

`-s` Equivalent to `-e -`.

---

fg

`fg [jobIDs]`

Bring current job or *jobIDs* to the foreground. See the earlier section "*Job Control*."

---

fi

`fi`

Reserved word that ends an `if` statement. (Don't forget to use it!)

---

for

```
for x [in list]
do
  commands
done
```

For variable *x* (in optional *list* of values), do *commands*. If `in` *list* is omitted, `"$@"` (the positional parameters) is assumed.

Examples

Paginate files specified on the command line, and save each result:

```
for file; do
    pr $file > $file.tmp
done
```

Same, but put entire loop into the background:

```
for file; do
    pr $file > $file.tmp
done &
```

Search chapters for a list of words (like `fgrep -f`):

```
for item in `cat program_list`
do
    echo "Checking chapters for"
    echo "references to program $item..."
    grep -c "$item.[co]" chap*
done
```

Extract a one-word title from each file and use as new filename:

for

```
for file
do
    name=`sed -n 's/NAME: //p' $file`
    mv $file $name
done
```

`for ((`*init*`;` *cond*`;` *incr*`))`
`do`
  commands
`done`

for

Arithmetic `for` loop, similar to C's. Evaluate *init*. While *cond* is true, execute the body of the loop. Evaluate *incr* before retesting *cond*. Any one of the expressions may be omitted; a missing *cond* is treated as being true.

Example

Search for a phrase in each odd chapter:

```
for ((x=1; x <= 20; x += 2))
do
    grep $1 chap$x
done
```

`function` *name* `{` *commands*`; }`
`function` *name* `() {` *commands*`; }`

function

Define *name* as a shell function. See the description of function semantics in the earlier section "*Functions*."

Example

Define a function to count files.

```
$ function fcount {
>    ls | wc -l
> }
```

`getopts` *string name* [*args*]

getopts

Process command-line arguments (or *args*, if specified) and check for legal options. `getopts` is used in shell script loops and is intended to ensure standard syntax for command-line options. Standard syntax dictates that command-line options begin with a –. Options can be stacked; i.e., consecutive letters can follow a single –. End processing of options by specifying `--` on the command line. *string* contains the option letters to be recognized by `getopts` when running the shell script. Valid options are processed in turn and stored in the shell variable *name*. If an option character in the options

→

getopts ←

string is followed by a colon, the actual option must be followed by one or more arguments. (Multiple arguments must be given to the command as one shell *word*. This is done by quoting the arguments or separating them with commas. The application must be written to expect multiple arguments in this format.) `getopts` uses the shell variables OPTARG, OPTIND, and OPTERR.

hash

`hash` [`-dlrt`] [`-p` *`file`*] [*`commands`*]

As the shell finds commands along the search path ($PATH), it remembers the found location in an internal hash table. The next time you enter a command, the shell uses the value stored in its hash table.

With no arguments, `hash` lists the current hashed commands. The display shows *hits* (the number of times the command has been called by the shell) and the command name.

With *commands*, the shell adds those commands to the hash table.

Options

`-d` Remove (delete) just the specified commands from the hash table.

`-l` Produce output in a format that can be reread to rebuild the hash table.

`-p` *`file`*
Associate *file* with *command* in the hash table.

`-r` Remove all commands from the hash table.

`-t` With one name, print the full pathname of the command. With more than one name, print the name and the full path, in two columns.

Besides the `-r` option, the hash table is also cleared when PATH is assigned. Use `PATH=$PATH` to clear the hash table without affecting your search path. This is most useful if you have installed a new version of a command in a directory that is earlier in $PATH than the current version of the command.

help

`help` [`-s`] [*`pattern`*]

Print usage information on standard output for each command that matches *pattern*. The information includes descriptions of each command's options. With the `-s` option, print only brief usage information.

Examples

```
$ help -s cd          Short help
cd: cd [-L|-P] [dir]

$ help true           Full help
true: true
Return a successful result.
```

history

`history` [*count*]
`history` [*options*]

Print commands in the history list or manage the history file. With no options or arguments, display the history list with command numbers. With a *count* argument, print only that many of the most recent commands.

Options

`-a` Append new history lines (those executed since the beginning of the session) to the history file.

`-c` Clear the history list (remove all entries).

`-d` *position*
Delete the history item at position *position*.

`-n` Read unread history lines from the history file into the history list.

`-p` *argument ...*
Perform `csh`-style history expansion on each *argument*, printing the results to standard output. The results are not saved in the history list.

`-r` Read the history file and replace the history list with its contents.

`-s` *argument ...*
Store the *arguments* in the history list, as a single entry.

`-w` Write the current history list to the history file, overwriting it entirely.

if

```
if condition1
then commands1
[ elif condition2
  then commands2 ]
  .
  .
  .
[ else commands3 ]
fi
```

If *condition1* is met, do *commands1*; otherwise, if *condition2* is met, do *commands2*; if neither is met, do *commands3*. Conditions are often specified with the `test` and `[[ ]]` commands. See **test** and [[ ]] for a full list of conditions, and see additional Examples under **:** and **exit**.

Examples

Insert a 0 before numbers less than 10:

```
if [ $counter -lt 10 ]
then number=0$counter
else number=$counter
fi
```

→

if
←

Make a directory if it doesn't exist:

```
if [ ! -d $dir ]; then
    mkdir -m 775 $dir
fi
```

jobs

`jobs` [*`options`*] [*`jobIDs`*]

List all running or stopped jobs, or list those specified by *jobIDs*. For example, you can check whether a long compilation or text format is still running. Also useful before logging out. See the earlier section "*Job Control*."

Options

`-l` List job IDs and process group IDs.

`-n` List only jobs whose status changed since last notification.

`-p` List process group IDs only.

`-r` List running jobs only.

`-x` *`cmd`*
Replace each job ID found in *cmd* with the associated process ID and then execute *cmd*.

kill

`kill` [*`options`*] *`IDs`*

Terminate each specified process *ID* or job *ID*. You must own the process or be a privileged user. This built-in is similar to the external `kill` command, but also allows symbolic job names. Stubborn processes can be killed using signal 9. See the earlier section "*Job Control*."

The command `kill -l` prints a list of the available signal names. The list varies by system architecture; for a PC-based system, it looks like this:

```
$ kill -l                                          From Bash on GNU/Linux
 1) SIGHUP       2) SIGINT       3) SIGQUIT      4) SIGILL
 5) SIGTRAP      6) SIGABRT      7) SIGBUS       8) SIGFPE
 9) SIGKILL     10) SIGUSR1     11) SIGSEGV     12) SIGUSR2
13) SIGPIPE     14) SIGALRM     15) SIGTERM     17) SIGCHLD
18) SIGCONT     19) SIGSTOP     20) SIGTSTP     21) SIGTTIN
22) SIGTTOU     23) SIGURG      24) SIGXCPU     25) SIGXFSZ
26) SIGVTALRM   27) SIGPROF     28) SIGWINCH    29) SIGIO
30) SIGPWR      31) SIGSYS      33) SIGRTMIN    34) SIGRTMIN+1
35) SIGRTMIN+2  36) SIGRTMIN+3  37) SIGRTMIN+4  38) SIGRTMIN+5
39) SIGRTMIN+6  40) SIGRTMIN+7  41) SIGRTMIN+8  42) SIGRTMIN+9
43) SIGRTMIN+10 44) SIGRTMIN+11 45) SIGRTMIN+12 46) SIGRTMIN+13
47) SIGRTMIN+14 48) SIGRTMIN+15 49) SIGRTMAX-15 50) SIGRTMAX-14
51) SIGRTMAX-13 52) SIGRTMAX-12 53) SIGRTMAX-11 54) SIGRTMAX-10
55) SIGRTMAX-9  56) SIGRTMAX-8  57) SIGRTMAX-7  58) SIGRTMAX-6
59) SIGRTMAX-5  60) SIGRTMAX-4  61) SIGRTMAX-3  62) SIGRTMAX-2
63) SIGRTMAX-1  64) SIGRTMAX
```

The signals and their numbers are defined in the C `<signal.h>` header file. This file may include others, thus the actual location varies across systems.

Options

`-l` List the signal names. (Used by itself.)

`-n` *num*
Send the given signal number.

`-s` *name*
Send the given signal name.

-signal
The signal number (from `<signal.h>`) or name (from `kill -l`). With a signal number of 9, the kill is absolute.

kill

`let` *expressions*
`((` *expressions* `))`

Perform arithmetic as specified by one or more *expressions*. *expressions* consist of numbers, operators, and shell variables (which don't need a preceding `$`). Expressions must be quoted if they contain spaces or other special characters. The `(( ))` form does the quoting for you. For more information and examples, see the section "*Arithmetic Expressions*," earlier in this reference. See also *expr*(1).

Examples

Each of these examples adds 1 to variable `i`:

```
i=`expr $i + 1`          All Bourne shells
let i=i+1                Bash
let "i = i + 1"
(( i = i + 1 ))
(( i += 1 ))
(( i++ ))
```

let

`local` [*options*] [*name*[=*value*]]

Declares local variables for use inside functions. The *options* are the same as those accepted by `declare`; see **declare** for the full list. It is an error to use `local` outside a function body.

local

`logout`

Exit a login shell. The command fails if the current shell is not a login shell.

logout

popd

`popd` [`-n`] [`+`*`count`*] [`-`*`count`*]

Pop the top directory off the directory stack (as shown by the `dirs` command), and change to the new top directory, or manage the directory stack.

Options

`-n` Don't change to the new top directory; just manipulate the stack.

`+`*`count`*
: Remove the item *count* entries from the left, as shown by `dirs`. Counting starts at zero. No directory change occurs.

`-`*`count`*
: Remove the item *count* entries from the right, as shown by `dirs`. Counting starts at zero. No directory change occurs.

printf

`printf` [`-v` *`var`*] *`format`* [*`val`* **...**]

Formatted printing, like the ANSI C `printf` function.

Option

`-v` *`var`*
: Save the result in *var* instead of printing it to standard output.

Additional Format Letters

Bash accepts these additional format letters:

`%b` Expand escape sequences in strings (e.g., `\t` to tab, and so on).

`%q` Print a quoted string that can be reread later on.

pwd

`pwd` [`-LP`]

Print your present working directory on standard output.

Options

Options give control over the use of logical versus physical treatment of the printed path. See also the entry for **cd**, earlier in this section.

`-L` Use logical path (what the user typed, including any symbolic links) and the value of PWD for the current directory. This is the default.

`-P` Use the actual filesystem physical path for the current directory.

pushd

`pushd` [`-n`] [*`directory`*]
`pushd` [`-n`] [`+`*`count`*] [`-`*`count`*]

Add *directory* to the directory stack, or rotate the directory stack. With no arguments, swap the top two entries on the stack, and change to the new top entry.

Options

`-n` Don't change to the new top directory; just manipulate the stack.

`+`*`count`*
Rotate the stack so that the *count*'th item from the left, as shown by `dirs`, is the new top of the stack. Counting starts at zero. The new top becomes the current directory.

`-`*`count`*
Rotate the stack so that the *count*'th item from the right, as shown by `dirs`, is the new top of the stack. Counting starts at zero. The new top becomes the current directory.

---

read

`read` [*`options`*] [*`variable1`* [*`variable2`* **...**]]

Read one line of standard input and assign each word to the corresponding *variable*, with all leftover words assigned to the last variable. If only one variable is specified, the entire line is assigned to that variable. See the Examples here and under **case**. The return status is 0 unless *EOF* is reached. If no variables are given, input is stored in the REPLY variable.

Options

`-a` *`array`*
Read into indexed array *array*.

`-d` *`delim`*
Read up to first occurrence of *delim*, instead of newline.

`-e` Use the *readline* library if reading from a terminal.

`-n` *`count`*
Read at most *count* bytes.

`-p` *`prompt`*
Print *prompt* before reading input.

`-r` Raw mode; ignore \ as a line-continuation character.

`-s` Read silently; characters are not echoed.

`-t` *`timeout`*
When reading from a terminal or pipe, if no data is entered after *timeout* seconds, return 1. This prevents an application from hanging forever, waiting for user input.

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read
←

`-u`[*n*]
Read input from file descriptor *n* (default is 0).

Examples

Read three variables:

```
$ read first last address
Sarah Caldwell 123 Main Street

$ echo "$last, $first\n$address"
Caldwell, Sarah
123 Main Street
```

Prompt yourself to enter two temperatures:

```
$ read -p "High low: " n1 n2
High low: 65 33
```

readonly

`readonly` [`-afp`] [*variable*[`=`*value*] **...**]

Prevent the specified shell variables from being assigned new values. An initial value may be supplied using the assignment syntax, but that value may not be changed subsequently. Read-only variables may not be unset.

Options

`-a` Each *variable* must refer to an array.

`-f` Each *variable* must refer to a function.

`-p` Print `readonly` before printing the names and values of read-only variables. This allows saving a list of read-only variables for rereading later.

return

`return` [*n*]

Use inside a function definition. Exit the function with status *n* or with the exit status of the previously executed command.

select

`select` *x* [`in` *list*]
`do`
  commands
`done`

Display a list of menu items on standard error, numbered in the order they are specified in *list*. If no `in` *list* is given, items are taken from the command line (via `"$@"`). Following the menu is a prompt string (set by PS3). At the PS3 prompt, users select a menu item by typing its number, or they redisplay the menu by pressing the Enter key. User input is stored in the shell variable REPLY. If a valid item number is typed, *commands* are executed. Typing *EOF*

terminates the loop.

select

Example

```
PS3="Select the item number: "
select event in Format Page View Exit
do
    case "$event" in
    Format) nroff $file | lp;;
    Page)   pr $file | lp;;
    View)   more $file;;
    Exit)   exit 0;;
    *   )   echo "Invalid selection";;
    esac
done
```

The output of this script looks like this:

```
1. Format
2. Page
3. View
4. Exit
Select the item number:
```

`set` [*options arg1 arg2 ...*]

set

With no arguments, `set` prints the values of all variables known to the current shell. Options can be enabled (*-option*) or disabled (*+option*). Options can also be set when the shell is invoked. (See the earlier section "*Invoking the Shell*.") Arguments are assigned in order to `$1`, `$2`, etc.

Options

`-a` From now on, automatically mark variables for export after defining or changing them.

`-b` Print job completion messages as soon as jobs terminate; don't wait until the next prompt.

`-B` Enable brace expansion. On by default.

`-C` Prevent overwriting via > redirection; use `>|` to overwrite files.

`-e` Exit if a command yields a nonzero exit status. The `ERR` trap executes before the shell exits.

`-E` Cause shell functions, command substitutions, and subshells to inherit the `ERR` trap.

`-f` Ignore filename metacharacters (e.g., `* ? [ ]`).

`-h` Locate commands as they are defined. On by default. See **hash**.

→

`-H` Enable `csh`-style history substitution. On by default.

`-k` Assignment of environment variables (*var*=*value*) takes effect regardless of where they appear on the command line. Normally, assignments must precede the command name.

`-m` Enable job control; background jobs execute in a separate process group. `-m` is usually set automatically.

`-n` Read commands but don't execute; useful for checking syntax. The shell ignores this option if interactive.

`+o` [*mode*]
With *mode*, disable the given shell option. Plain `set +o` prints the settings of all the current options. This is in a form that can be reread by the shell later.

`-o` [*mode*]
List shell modes, or turn on mode *mode*. Many modes can be set by other options. Modes are:

`allexport`	Same as `-a`.
`braceexpand`	Same as `-B`.
`emacs`	Set command-line editor to `emacs`.
`errexit`	Same as `-e`.
`errtrace`	Same as `-E`.
`functrace`	Same as `-T`.
`hashall`	Same as `-h`.
`histexpand`	Same as `-H`.
`history`	Enable command history. On by default.
`ignoreeof`	Don't process *EOF* signals. To exit the shell, type `exit`.
`keyword`	Same as `-k`.
`monitor`	Same as `-m`.
`noclobber`	Same as `-C`.
`noexec`	Same as `-n`.
`noglob`	Same as `-f`.
`nolog`	Omit function definitions from history file. Accepted but ignored by Bash.
`notify`	Same as `-b`.
`nounset`	Same as `-u`.
`onecmd`	Same as `-t`.
`physical`	Same as `-P`.
`pipefail`	Change pipeline exit status to be that of the rightmost command that failed, or zero if all exited successfully.
`posix`	Change to POSIX mode.
`privileged`	Same as `-p`.
`verbose`	Same as `-v`.

vi	Set command-line editor to vi.
xtrace	Same as -x.

+p Reset effective UID to real UID.

-p Start up as a privileged user. Don't read $ENV or $BASH_ENV, don't import functions from the environment, and ignore the value of $SHELLOPTS.

-P Always use physical paths for cd and pwd.

-t Exit after one command is executed.

-T Cause shell functions, command substitutions, and subshells to inherit the DEBUG trap.

-u In substitutions, treat unset variables as errors.

-v Show each shell command line when read.

-x Show commands and arguments when executed, preceded by the value of PS4. This provides step-by-step tracing of shell scripts.

- Turn off -v and -x, and turn off option processing. Included for compatibility with older versions of the Bourne shell.

-- Used as the last option; -- turns off option processing so that arguments beginning with – are not misinterpreted as options. (For example, you can set $1 to -1.) If no arguments are given after --, unset the positional parameters.

Option Summary

Option	*Same as*
-a	-o allexport
-b	-o notify
-B	-o braceexpand
-C	-o noclobber
-e	-o errexit
-E	-o errtrace
-f	-o noglob
-h	-o hashall
-H	-o histexpand
-k	-o keyword
-m	-o monitor
-n	-o noexec
-o allexport	-a
-o braceexpand	-B
-o emacs	
-o errexit	-e

→

set ←

Option	*Same as*
`-o errtrace`	`-E`
`-o functrace`	`-T`
`-o hashall`	`-h`
`-o history`	
`-o histexpand`	`-H`
`-o ignoreeof`	
`-o keyword`	`-k`
`-o monitor`	`-m`
`-o noclobber`	`-C`
`-o noexec`	`-n`
`-o noglob`	`-f`
`-o nolog`	
`-o notify`	`-b`
`-o nounset`	`-u`
`-o onecmd`	`-t`
`-o physical`	`-P`
`-o pipefail`	
`-o posix`	
`-o privileged`	`-p`
`-o verbose`	`-v`
`-o vi`	
`-o xtrace`	`-x`
`-p`	`-o privileged`
`-P`	`-o physical`
`-t`	`-o onecmd`
`-T`	`-o functrace`
`-u`	`-o nonunset`
`-v`	`-o verbose`
`-x`	`-o xtrace`

Examples

`set -- "$num" -20 -30`	*Set $1 to $num, $2 to -20, $3 to -30*
`set -vx`	*Read each command line; show it; execute it; show it again (with arguments)*
`set +x`	*Stop command tracing*
`set -o noclobber`	*Prevent file overwriting*
`set +o noclobber`	*Allow file overwriting again*

shopt

`shopt` [`-opqsu`] [*option*]

Set or unset shell options. With no options or just `-p`, prints the names and settings of the options.

Options **shopt**

`-o` Each *option* must be one of the shell option names for `set -o`, instead of the options listed earlier in "*Shell Options*."

`-p` Print the option settings as `shopt` commands that can be reread later.

`-q` Quiet mode. The exit status is zero if the given option is set, nonzero otherwise. With multiple options, all of them must be set for a zero exit status.

`-s` Set the given *options*. With no *options*, prints only those that are set.

`-u` Unset the given *options*. With no *options*, prints only those that are unset.

`shift` [*n*] **shift**

Shift positional arguments (e.g., `$2` becomes `$1`). If *n* is given, shift to the left *n* places. Used in `while` loops to iterate through command-line arguments.

Examples

```
shift $(($1 + $6))                    Use expression result as shift count
```

`source` *file* [*arguments*] **source**

Identical to the `.` (dot) command; see that entry.

`suspend` [`-f`] **suspend**

Suspend the current shell. Often used to stop an `su` command.

Option

`-f` Force the suspension, even if the shell is a login shell.

`test` *condition* **test**
`[` *condition* `]`
`[[` *condition* `]]`

Evaluate a *condition* and, if its value is true, return a zero exit status; otherwise, return a nonzero exit status. An alternate form of the command uses `[ ]` rather than the word `test`. An additional alternate form uses `[[ ]]`, in which case word splitting and pathname expansion are not done. (See the [[ ]] entry.) *condition* is constructed using the following expressions. Conditions are true if the description holds true.

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File Conditions

`-a` *`file`*	*file* exists. (Deprecated; use `-e` instead.)
`-b` *`file`*	*file* exists and is a block special file.
`-c` *`file`*	*file* exists and is a character special file.
`-d` *`file`*	*file* exists and is a directory.
`-e` *`file`*	*file* exists. (Same as `-a`, for POSIX compatibility.)
`-f` *`file`*	*file* exists and is a regular file.
`-g` *`file`*	*file* exists, and its set-group-id bit is set.
`-G` *`file`*	*file* exists, and its group is the effective group ID.
`-h` *`file`*	*file* exists and is a symbolic link. (Same as `-L`.)
`-k` *`file`*	*file* exists, and its sticky bit is set.
`-L` *`file`*	*file* exists and is a symbolic link. (Same as `-h`.)
`-N` *`file`*	*file* exists and was modified after it was last read.
`-O` *`file`*	*file* exists, and its owner is the effective user ID.
`-p` *`file`*	*file* exists and is a named pipe (FIFO).
`-r` *`file`*	*file* exists and is readable.
`-s` *`file`*	*file* exists and has a size greater than zero.
`-S` *`file`*	*file* exists and is a socket.
`-t` [*n*]	The open file descriptor *n* is associated with a terminal device; default *n* is 1.
`-u` *`file`*	*file* exists, and its set-user-id bit is set.
`-w` *`file`*	*file* exists and is writable.
`-x` *`file`*	*file* exists and is executable.
`f1` `-ef` *`f2`*	Files *f1* and *f2* are linked (refer to same file).
`f1` `-nt` *`f2`*	File *f1* is newer than *f2*.
`f1` `-ot` *`f2`*	File *f1* is older than *f2*.

String Conditions

`string`	*string* is not null.
`-n` *`s1`*	String *s1* has nonzero length.
`-z` *`s1`*	String *s1* has zero length.
`s1` `==` *`s2`*	Strings *s1* and *s2* are identical. Inside `[[...]]`, *s2* can be a wildcard pattern. Quote *s2* to treat it literally. (See the section "*Filename Metacharacters*," earlier in this reference.) See also the `nocasematch` option in "*Shell Options*."
`s1` `!=` *`s2`*	Strings *s1* and *s2* are *not* identical. Inside `[[...]]`, *s2* can be a wildcard pattern. Quote *s2* to treat it literally.
`s1` `=~` *`s2`*	String *s1* matches extended regular expression *s2*. Only available inside `[[...]]`. Quote *s2* to keep the shell from expanding embedded shell metacharacters. Strings matched by parenthesized subexpressions are placed into elements of the BASH_REMATCH array. See the description of BASH_REMATCH in the "*Built-in Shell Variables*" section, earlier in this reference.

s1 < *s2* ASCII value of *s1* precedes that of *s2*. (Use only within `[[ ]]`.)
s1 > *s2* ASCII value of *s1* follows that of *s2*. (Use only within `[[ ]]`.)

Internal Shell Conditions

`-o` *opt* Option *opt* for `set -o` is on.

Integer Comparisons

n1 `-eq` *n2* *n1* equals *n2*.
n1 `-ge` *n2* *n1* is greater than or equal to *n2*.
n1 `-gt` *n2* *n1* is greater than *n2*.
n1 `-le` *n2* *n1* is less than or equal to *n2*.
n1 `-lt` *n2* *n1* is less than *n2*.
n1 `-ne` *n2* *n1* does not equal *n2*.

Combined Forms

(*condition*)
True if *condition* is true (used for grouping). For `test` and `[ ]`, the `( )`s should be quoted by a `\`. The form using `[[ ]]` doesn't require quoting the parentheses.

! *condition*
True if *condition* is false.

condition1 `-a` *condition2*
True if both conditions are true.

condition1 `&&` *condition2*
True if both conditions are true. (Use only within `[[ ]]`.)

condition1 `-o` *condition2*
True if either condition is true.

condition1 `||` *condition2*
True if either condition is true. (Use only within `[[ ]]`.)

Examples

The following examples show the first line of various statements that might use a test condition:

```
while test $# -gt 0                 While there are arguments...
while [ -n "$1" ]                   While there are nonempty arguments...
if [ $count -lt 10 ]                If $count is less than 10...
if [ -d RCS ]                       If the RCS directory exists...
if [ "$answer" != "y" ]             If the answer is not y...
if [ ! -r "$1" -o ! -f "$1" ]       If the first argument is not a
                                    readable file or a regular file...
```

time

`time` *`command`*

Execute *command* and print the total elapsed time, user time, and system time (in seconds). Same as the external command `time`, except that the built-in version can also time other built-in commands as well as all commands in a pipeline.

times

`times`

Print accumulated process times for user and system.

trap

`trap` [[*`commands`*] *`signals`*]
`trap -p`
`trap -l`

Execute *commands* if any *signals* are received. The second form prints the current trap settings in a form suitable for rereading later. The third form lists all signals and their numbers, like `kill -l`.

Common signals include `EXIT` (0), `HUP` (1), `INT` (2), and `TERM` (15). Multiple commands must be quoted as a group and separated by semicolons internally. If *commands* is the null string (i.e., `trap ""` *`signals`*), *signals* are ignored by the shell. If *commands* are omitted entirely, reset processing of specified signals to the default action. If *commands* is "-", reset *signals* to their initial defaults.

If both *commands* and *signals* are omitted, list current trap assignments. See the Examples here and in **exec**.

Signals

A list of signal names, numbers, and meanings were given earlier in the **kill** entry. The shell allows you to use either the signal number or the signal name (without the `SIG` prefix). In addition, the shell supports "pseudo-signals," signal names or numbers that aren't real operating system signals but which direct the shell to perform a specific action. These signals are:

`DEBUG`	Execution of any command.
`ERR`	Nonzero exit status.
`EXIT`	Exit from shell (usually when shell script finishes).
`0`	Same as `EXIT`, for historical compatibility with the Bourne shell.
`RETURN`	A `return` is executed, or a script run with `.` (dot) or `source` finishes.

Examples

```
trap "" INT      Ignore interrupts (signal 2)
trap INT         Obey interrupts again
```

trap

Remove a `$tmp` file when the shell program exits, or if the user logs out, presses `CTRL-C`, or does a `kill`:

```
trap "rm -f $tmp; exit" EXIT HUP INT TERM    POSIX style
trap "rm -f $tmp; exit" 0 1 2 15             Pre-POSIX Bourne shell style
```

Print a "clean up" message when the shell program receives signals `SIGHUP`, `SIGINT`, or `SIGTERM`:

```
trap 'echo Interrupt!  Cleaning up...' HUP INT TERM
```

---

true

`true`

Built-in command that exits with a true return value.

---

type

`type` [`-afpPt`] *commands*

Show whether each command name is an external command, a built-in command, an alias, a shell keyword, or a defined shell function.

Options

`-a` Print all locations in $PATH that include *command*, including aliases and functions. Use `-p` together with `-a` to suppress aliases and functions.

`-f` Suppress function lookup, as with `command`.

`-p` If `type -t` would print `file` for a given *command*, this option prints the full pathname for the executable files. Otherwise, it prints nothing.

`-P` Like `-p`, but force a PATH search, even if `type -t` would not print `file`.

`-t` Print a word describing each *command*. The word is one of `alias`, `builtin`, `file`, `function`, or `keyword`, depending upon the type of each *command*.

Example

```
$ type mv read if
mv is /bin/mv
read is a shell builtin
if is a shell keyword
```

---

typeset

`typeset` [*options*] [*variable*[=*value* **...**]]

Identical to `declare`. See **declare**.

ulimit

`ulimit` [*options*] [*n*]

Print the value of one or more resource limits, or, if *n* is specified, set a resource limit to *n*. Resource limits can be either hard (`-H`) or soft (`-S`). By default, `ulimit` sets both limits or prints the soft limit. The options determine which resource is acted on.

Options

`-H` Hard limit. Anyone can lower a hard limit; only privileged users can raise it.

`-S` Soft limit. Must be less than or equal to the hard limit.

`-a` Print all limits.

`-c` Maximum size of core files.

`-d` Maximum kilobytes of data segment or heap.

`-f` Maximum size of files (the default option).

`-i` Maximum number of pending signals.

`-l` Maximum size of address space that can be locked in memory.

`-m` Maximum kilobytes of physical memory. (Not effective on all Unix systems.)

`-n` Maximum number of file descriptors.

`-p` Size of pipe buffers. (Not effective on all Unix systems.)

`-q` Maximum number of bytes in POSIX message queues.

`-s` Maximum kilobytes of stack segment.

`-t` Maximum CPU seconds.

`-u` Maximum number of processes a single user can have.

`-v` Maximum kilobytes of virtual memory.

`-x` Maximum number of file locks.

umask

`umask` [*nnn*]
`umask` [`-pS`] [*mask*]

Display file creation mask or set file creation mask to octal value *nnn*. The file creation mask determines which permission bits are turned off (e.g., `umask 002` produces `rw-rw-r--`). For the second form, a symbolic mask represents permissions to keep.

umask

Options

`-p` Output is in a form that can be reread later by the shell.

`-S` Print the current mask using symbolic notation.

---

unalias

`unalias` *`names`*
`unalias -a`

Remove *names* from the alias list. See also **alias**.

Option

`-a` Remove all aliases.

---

unset

`unset` [*`options`*] *`names`*

Erase definitions of functions or variables listed in *names*.

Options

`-f` Unset functions *names*.

`-v` Unset variables *names* (default).

---

until

```
until condition
do
  commands
done
```

Until *condition* is met, do *commands*. *condition* is often specified with the `test` command. See the Examples under **case** and **test**.

---

wait

`wait` [*`ID`*]

Pause in execution until all background jobs complete (exit status 0 is returned), or pause until the specified background process *ID* or job *ID* completes (exit status of *ID* is returned). Note that the shell variable `$!` contains the process ID of the most recent background process.

Example

```
wait $!    Wait for most recent background process to finish
```

while	`while` *`condition`*
	`do`
	  `commands`
	`done`
	
	While *condition* is met, do *commands*. *condition* is often specified with the `test` commands. See the Examples under **case** and **test**.

filename	*`filename`* [*`arguments`*] Read and execute commands from executable file *filename*, or execute a binary object file.

Resources

This section briefly describes other sources of information about Bash.

Online Resources

ftp://ftp.gnu.org/gnu/bash
: The top-level directory for Bash source code releases. Source code is usually made available as `.tar.gz` files, such as `bash-3.1.tar.gz`.

ftp://ftp.gnu.org/pub/gnu/bash/bash-3.1-patches
: Patches for Bash 3.1 are in this directory.

http://www.gnu.org/software/bash/bash.html
http://cnswww.cns.cwru.edu/~chet/bash/bashtop.html
: The two "home pages" for the Bash shell.

http://bashdb.sourceforge.net
: The Bash debugger.

Books

1. *Classic Shell Scripting*, by Arnold Robbins and Nelson H.F. Beebe. O'Reilly Media, Sebastopol, CA, USA, 2005. ISBN 0-596-00595-4.
2. *Learning the bash Shell*, Third Edition, by Cameron Newham. O'Reilly Media, Sebastopol, CA, USA, 2005. ISBN 0-596-00965-8.

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—Arnold Robbins