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This is the second volume of documentation in the Turbo C package. This volume, the Turbo C Reference Guide, contains definitions of all the Turbo C library routines, common variables, and common defined types, along with example program code to illustrate how to use many of these routines, variables, and types.

If you are new to C programming, you should first read the other book in your Turbo C package—the Turbo C User's Guide. In that book you'll find instructions on how to install Turbo C on your system, an overview of Turbo C's window and menu system, and tutorial-style chapters designed to get you started programming in Turbo C. The user's guide also summarizes Turbo C's implementation of the C language and discusses some advanced programming techniques. For those of you who are Turbo Pascal and Turbo Prolog programmers, the user's guide provides information to help you integrate your understanding of those languages with your new knowledge of C.

You should refer to the Introduction in the user's guide for information on the Turbo C implementation, a summary of the contents of Volume I, and a short bibliography.

Volume II: The Reference Guide

The Turbo C Reference Guide is written for experienced C programmers; it provides implementation-specific details about the language and the runtime environment. In addition, it provides definitions for each of the Turbo C functions, listed in alphabetical order.
These are the chapters and appendixes in the programmer's reference guide:

Chapter 1: Using Turbo C Library Routines summarizes Turbo C's input/output (I/O) support, and lists and describes the #include (.h) files.

Chapter 2: The Turbo C Library is an alphabetical reference of all Turbo C library functions. Each definition gives syntax, include files, related functions, an operative description, return values, and portability information for the function.

Appendix A: The Turbo C Interactive Editor gives a more thorough explanation of the editor commands—for those who need more information than that given in Chapter 2 of the Turbo C User's Guide.

Appendix B: Compiler Error Messages lists and explains each of the error messages and summarizes the possible or probable causes of the problem that generated the message.

Appendix C: Options describes each of the Turbo C user-selectable compiler options.

Appendix D: Turbo C Utilities discusses the MAKE utility, CPP, and the Turbo Link Utility. The section on CPP summarizes how the Turbo C preprocessor functions. The section on the stand-alone MAKE utility documents when, where, and how to use MAKE for rebuilding program files. The section on TLINK, the stand-alone Turbo Link Utility, summarizes how to use the command-line version of Turbo C's built-in linker.

Appendix E: Language Syntax Summary uses modified Backus-Naur Forms to detail the syntax of all Turbo C constructs.

Appendix F: Customizing Turbo C guides you through the installation program (TCINST), which lets you customize your keyboard, modify default values, change your screen colors, resize your Turbo C windows, and more.

Appendix G: MicroCalc introduces the spreadsheet program included with your Turbo C package and gives directions for compiling and running the program.
Typographic Conventions

All typefaces used in this manual were produced by Borland's Sprint: The Professional Word Processor, on an Apple LaserWriter Plus. Their special uses are as follows:

**Monospaced type**
This typeface represents text as it appears on the screen or in your program and anything you must type (such as command-line options).

[ ]
Square brackets in text or DOS command lines enclose optional input or data that depends on your system, which should not be typed verbatim.

<>
Angle brackets in the function reference section enclose the names of include files.

**Boldface**
Turbo C function names (such as `printf`) are shown in boldface when mentioned within text (but not in program examples).

**Italics**
Italics indicate variable names (identifiers) within sections of text and to emphasize certain words (especially new terms).

**Bold monospaced**
This typeface represents Turbo C keywords (such as `char`, `switch`, `near`, and `cdecl`).

**Keycaps**
This special typeface indicates a key on your keyboard. It is often used when describing a particular key you should type, e.g., “press Esc to cancel a menu.”

Borland’s No-Nonsense License Statement

This software is protected by both United States Copyright Law and International Treaty provisions. Therefore, you must treat this software just like a book with the following single exception: Borland International authorizes you to make archival copies of Turbo C for the sole purpose of backing up your software and protecting your investment from loss.

By saying, “just like a book,” Borland means, for example, that this software may be used by any number of people and may be freely moved from one computer location to another so long as there is no possibility of its being used at one location while it’s being used at another. Just like a book that can’t be read by two different people in two different places at
the same time, neither can the software be used by two different people in two different places at the same time. (Unless, of course, Borland's copyright has been violated.)

Acknowledgments

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- Turbo Pascal, Turbo Prolog and Sprint: The Professional Word Processor are registered trademarks of Borland International Inc.
- WordStar is a trademark of MicroPro Inc.
- IBM PC, XT, and AT are trademarks of International Business Machines Inc.
- MS-DOS is a registered trademark of Microsoft Corporation.
- UNIX is a registered trademark of American Telephone and Telegraph

How to Contact Borland

If, after reading these manuals and using Turbo C, you would like to contact Borland with comments, questions, or suggestions, we suggest the following procedures:

The best way to contact Borland is to log on to Borland's Forum on CompuServe: Type GO BOR from the main CompuServe menu and select "Enter Language Products Forum" from the Borland main menu. Leave your questions or comments there for the support staff to process.

If you prefer, write a letter detailing your comments and send it to

Technical Support Department
Borland International
4585 Scotts Valley Drive
Scotts Valley, CA
95066, USA

As a last resort, if, for some reason, you cannot write to us, you can telephone our Technical Support department. If you're calling with a problem, please have the following information handy before you call:

- product name and version number
- computer make and model number
- operating system and version number
Using Turbo C Library Routines

Turbo C comes equipped with over 300 library routines—functions and macros that you call from within your C programs to perform a wide variety of tasks, including low- and high-level I/O, string and file manipulation, memory allocation, process control, data conversion, mathematical calculations, and much more.

Turbo C’s routines are contained in the library files (Cx.LIB and MATHx.LIB). Because Turbo C supports six distinct memory models, each model has its own library file and math file, containing versions of the routines written for that particular model.

Turbo C supports the draft ANSI C standard which, among other things, allows function prototypes to be given for the routines in your C programs. All of Turbo C’s library routines are declared with prototypes in one or more header file (these are the .H or “include” files that you copied from the distribution disks into your INCLUDE directory).

In This Chapter...

This first part of the Turbo C Reference Guide provides an overview of the Turbo C library routines and include files.
In this chapter, we:

- list and describe the include files
- summarize the different categories of tasks performed by the library routines
- describe (in look-up fashion) common global variables implemented in many of the library routines

The Library Routine Lookup Section

The second part of this reference guide is an alphabetical lookup; it contains descriptions for each of the Turbo C routines. Many of the routines are grouped by “family” (such as memory-allocation routines, formatted-output routines, etc.) because they perform similar or related tasks.

However, since you might not intuitively know which family of related routines a particular one belongs to, we have included an individual entry in the lookup for each and every routine. For instance, if you want to look up information about the free routine, you would first look under free; there you would find a listing for free that:

- summarizes what free does
- gives the Usage (syntax) for calling free
- tells you which header file contains the prototype for free
- refers you to malloc (the “family” listing) for a detailed description of how free is implemented and how it relates to the other memory-allocation routines

The last part of this reference guide contains several appendices designed to give you detailed reference and usage information about some of Turbo C’s special features; the editor, error messages, and the stand-alone utilities.

Why You Should License the Turbo C Run-Time Library Source Code

The Turbo C Run-Time Library contains over 300 functions, covering a broad range of areas: low-level control of your IBM PC, interfacing with DOS, input/output, process management, string and memory manipulations, math, sorting and searching, and so on.
Using Turbo C, you may find that the particular function you want to write is similar to, but not the same as, a function in the library. With access to the Run-Time Library source code, you can tailor that function to your own needs.

Sometimes, when you have trouble debugging code, you may wish that you knew more about the internals of a library function. This is a time when having the source code to the Run-Time Library would be of great help.

When you can’t figure out what a library function is really supposed to do, it is very useful to be able to take a quick look at that function’s source code.

You may dislike the underscore convention on C symbols, and wish you had a version of the libraries without leading underscores. Again, access to the source code to the Run-Time Library will let you eliminate leading underscores.

You can also learn a lot from studying tight, professionally written library source code.

For all these reasons, and more, you will want to have access to the Turbo C Run-Time Library source code. Because Borland deeply believes in the concepts of “open architecture,” the Turbo C Run-Time Library source code is available for licensing. All you have to do is fill out the order form distributed with this documentation, include your payment, and we’ll ship you the Turbo C Run-Time Library source code.
The Turbo C Include Files

ALOC.H  Declares memory management functions (allocation, deallocation, etc.).
ASSERT.H Defines the assert debugging macro.
BIOS.H  Declares various functions used in calling IBM-PC ROM BIOS routines.
CONIO.H  Declares various functions used in calling the DOS console I/O routines.
CTYPE.H  Contains information used by the character classification and character conversion macros (such as isalpha and toascii).
DIR.H  Contains structures, macros and functions for working with directories and path names.
DOS.H  Defines various constants and gives declarations needed for MS-DOS and 8086-specific calls.
ERRNO.H  Defines constant mnemonics for the error codes.
FCNTL.H  Defines symbolic constants used in connection with the library routine open.
FLOAT.H  Contains parameters for floating-point routines.
IO.H  Contains structures and declarations for low-level Input/Output routines.
LIMITS.H  Contains environmental parameters, information about compile-time limitations, and ranges of integral quantities.
MATH.H  Declares prototypes for the math functions; also defines the macro HUGE_VAL, and declares the exception structure used by the matherr and _matherr routines.
MEM.H  Declares the memory-manipulation functions. (Many of these are also defined in STRING.H.)
PROCESS.H  Contains structures and declarations for spawn... and exec... functions.
<table>
<thead>
<tr>
<th>Header File</th>
<th>Description</th>
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| SETJMP.H    | Defines a type `jmp_buf` used by the `longjmp` and `setjmp` functions and declares the routines `longjmp` and `setjmp`.
| SHARE.H     | Defines parameters used in functions which make use of file-sharing.
| SIGNAL.H    | Defines the constants `SIG_IGN` and `SIG_DFL`, and declares the `ssignal` and `gsignal` functions.
| STDARG.H    | Defines macros used for reading the argument list in functions declared to accept a variable number of arguments (such as `vprintf`, `vscanf`, etc.).
| STDDEF.H    | Defines several common data types and macros.
| STDIO.H     | Defines types and macros needed for the Standard I/O Package defined in Kernighan and Ritchie and extended under UNIX System V. Defines the standard I/O predefined streams `stdin`, `stdout`, and `stderr`, and declares stream-level I/O routines.
| STDLIB.H    | Declares several commonly used routines; conversion routines, search/sort routines, and other miscellany.
| STRING.H    | Declares several string-manipulation and memory-manipulation routines.
| SYS\STAT.H  | Defines symbolic constants used for opening and creating files.
| TIME.H      | Defines a structure filled in by the time-conversion routines `asctime`, `localtime` and `gmtime`, and a type used by the routines `ctime`, `difftime`, `gmtime`, `localtime`, and `stime`; also provides prototypes for these routines.
| VALUES.H    | Defines important constants, including machine dependencies; provided for UNIX System V compatibility.
Library Routines by Category

The Turbo C library routines perform a variety of tasks. In this section, we list the routines, and the include files in which they are declared, under several general categories of task performed.

Classification Routines

These routines classify ASCII characters as letters, control characters, punctuation, uppercase, etc.

- `isalnum` (ctype.h)
- `isalpha` (ctype.h)
- `isscntrl` (ctype.h)
- `isascii` (ctype.h)

Conversion Routines

These routines convert characters and strings: from alpha to different numeric representations (floating-point, integers, longs), and vice versa; and from uppercase to lowercase (and vice versa).

- `isdigit` (ctype.h)
- `isgraph` (ctype.h)
- `islower` (ctype.h)
- `isprint` (ctype.h)
- `ispunct` (ctype.h)
- `isspace` (ctype.h)
- `isupper` (ctype.h)
- `isxdigit` (ctype.h)

Directory Control Routines

These routines manipulate directories and path names.

- `chdir` (dir.h)
- `findfirst` (dir.h)
- `findnext` (dir.h)
- `fnmerge` (dir.h)
- `fnsplit` (dir.h)
- `getcurdir` (dir.h)
- `getcwd` (dir.h)
- `getdisk` (dir.h)
- `mkdir` (dir.h)
- `mktemp` (dir.h)
- `rmdir` (dir.h)
- `searchpath` (dir.h)
- `setdisk` (dir.h)
- `mktemp` (dir.h)
Diagnostic Routines
These routines provide built-in troubleshooting capability.

assert (assert.h)
matherr (math.h)
perror (errno.h)

Input/Output Routines
These routines provide stream-level and DOS-level I/O capability.

access (io.h) fputc (stdio.h) puts (stdio.h)
cgets (conio.h) fprintf (stdio.h) putw (stdio.h)
_chmod (io.h) fputs (stdio.h) read (io.h)
chmod (io.h) fread (stdio.h) read (io.h)
clearenr (stdio.h) freopen (stdio.h) remove (stdio.h)
close (io.h) fscanf (stdio.h) rename (stdio.h)
_close (io.h) fseek (stdio.h) rewind (stdio.h)
cprintf (conio.h) ftell (stdio.h) setbuf (stdio.h)
cputs (conio.h) fwrite (stdio.h) setftime (io.h)
creat (io.h) fwrite (stdio.h) setmode (io.h)
_creat (io.h) gets (stdio.h) setvbuf (stdio.h)
createnew (io.h) getchar (stdio.h) sopen (io.h)
createtemp (io.h) getch (stdio.h) sprintf (stdio.h)
cscanf (conio.h) getche (stdio.h) scanf (stdio.h)
dup (io.h) getftime (io.h) sscanf (stdio.h)
dup2 (io.h) getpass (stdio.h) signal (signal.h)
eof (io.h) gets (stdio.h) stat (sys\stat.h)
fclose (stdio.h) getw (stdio.h) strerror (stdio.h)
closeall (stdio.h) gsignal (signal.h) tell (io.h)
fcloseall (stdio.h) ioctl (io.h) ungetc (stdio.h)
feof (stdio.h) isatty (io.h) ungetc (stdio.h)
ferror (stdio.h) khit (conio.h) ungetch (io.h)
fflush (stdio.h) lock (io.h) unlock (io.h)
getc (stdio.h) lseek (io.h) vfprintf (stdio.h)
getchar (stdio.h) open (io.h) vscanf (stdio.h)
getf (stdio.h) open (io.h) vprintf (stdio.h)
filelength (io.h) perror (stdio.h) vscanf (stdio.h)
fileno (stdio.h) printf (stdio.h) vsscanf (stdio.h)
flushall (stdio.h) putc (stdio.h) _write (io.h)
fprintf (stdio.h) putchar (stdio.h) write (io.h)
Interface Routines (DOS, 8086, BIOS)

These routines provide DOS, BIOS and machine-specific capabilities.

<table>
<thead>
<tr>
<th>Routine</th>
<th>Header</th>
</tr>
</thead>
<tbody>
<tr>
<td>absread</td>
<td>dos.h</td>
</tr>
<tr>
<td>abswrite</td>
<td>dos.h</td>
</tr>
<tr>
<td>bdos</td>
<td>dos.h</td>
</tr>
<tr>
<td>bdosptr</td>
<td>dos.h</td>
</tr>
<tr>
<td>bioscom</td>
<td>bios.h</td>
</tr>
<tr>
<td>biosdisk</td>
<td>bios.h</td>
</tr>
<tr>
<td>biosequip</td>
<td>bios.h</td>
</tr>
<tr>
<td>bioskey</td>
<td>bios.h</td>
</tr>
<tr>
<td>biosmemory</td>
<td>bios.h</td>
</tr>
<tr>
<td>biostime</td>
<td>bios.h</td>
</tr>
<tr>
<td>country</td>
<td>bios.h</td>
</tr>
<tr>
<td>ctrlbrk</td>
<td>dos.h</td>
</tr>
<tr>
<td>disable</td>
<td>dos.h</td>
</tr>
<tr>
<td>dosexterr</td>
<td>dos.h</td>
</tr>
<tr>
<td>enable</td>
<td>dos.h</td>
</tr>
<tr>
<td>FP_OFF</td>
<td>dos.h</td>
</tr>
<tr>
<td>FP_SEG</td>
<td>dos.h</td>
</tr>
<tr>
<td>freemem</td>
<td>dos.h</td>
</tr>
<tr>
<td>geninterrupt</td>
<td>dos.h</td>
</tr>
<tr>
<td>getcbzk</td>
<td>dos.h</td>
</tr>
<tr>
<td>getdfree</td>
<td>dos.h</td>
</tr>
<tr>
<td>getdta</td>
<td>dos.h</td>
</tr>
<tr>
<td>getfat</td>
<td>dos.h</td>
</tr>
<tr>
<td>getfatd</td>
<td>dos.h</td>
</tr>
<tr>
<td>getpsp</td>
<td>dos.h</td>
</tr>
<tr>
<td>getvect</td>
<td>dos.h</td>
</tr>
<tr>
<td>getverify</td>
<td>dos.h</td>
</tr>
<tr>
<td>harderr</td>
<td>dos.h</td>
</tr>
<tr>
<td>hardresume</td>
<td>dos.h</td>
</tr>
<tr>
<td>hardreadn</td>
<td>dos.h</td>
</tr>
<tr>
<td>import</td>
<td>dos.h</td>
</tr>
<tr>
<td>importb</td>
<td>dos.h</td>
</tr>
<tr>
<td>int86</td>
<td>dos.h</td>
</tr>
<tr>
<td>int86x</td>
<td>dos.h</td>
</tr>
<tr>
<td>intdos</td>
<td>dos.h</td>
</tr>
<tr>
<td>intdosx</td>
<td>dos.h</td>
</tr>
<tr>
<td>intr</td>
<td>dos.h</td>
</tr>
<tr>
<td>MK_FP</td>
<td>dos.h</td>
</tr>
<tr>
<td>outport</td>
<td>dos.h</td>
</tr>
<tr>
<td>outportb</td>
<td>dos.h</td>
</tr>
<tr>
<td>parsfnm</td>
<td>dos.h</td>
</tr>
<tr>
<td>peek</td>
<td>dos.h</td>
</tr>
<tr>
<td>peekb</td>
<td>dos.h</td>
</tr>
<tr>
<td>poke</td>
<td>dos.h</td>
</tr>
<tr>
<td>pokeb</td>
<td>dos.h</td>
</tr>
<tr>
<td>randbrd</td>
<td>dos.h</td>
</tr>
<tr>
<td>randbwr</td>
<td>dos.h</td>
</tr>
<tr>
<td>segread</td>
<td>dos.h</td>
</tr>
<tr>
<td>setcbkr</td>
<td>dos.h</td>
</tr>
<tr>
<td>setdta</td>
<td>dos.h</td>
</tr>
<tr>
<td>setvect</td>
<td>dos.h</td>
</tr>
<tr>
<td>setverify</td>
<td>dos.h</td>
</tr>
<tr>
<td>sleep</td>
<td>dos.h</td>
</tr>
<tr>
<td>unlink</td>
<td>dos.h</td>
</tr>
</tbody>
</table>

Manipulation Routines (String, Memory)

These routines handle strings and blocks of memory; copying, comparing, converting, and searching.

<table>
<thead>
<tr>
<th>Routine</th>
<th>Header</th>
</tr>
</thead>
<tbody>
<tr>
<td>memccpy</td>
<td>mem.h and string.h</td>
</tr>
<tr>
<td>memchr</td>
<td>mem.h and string.h</td>
</tr>
<tr>
<td>memcmp</td>
<td>mem.h and string.h</td>
</tr>
<tr>
<td>memcmp</td>
<td>mem.h and string.h</td>
</tr>
<tr>
<td>memmove</td>
<td>mem.h and string.h</td>
</tr>
<tr>
<td>memset</td>
<td>mem.h and string.h</td>
</tr>
<tr>
<td>movebytes</td>
<td>mem.h</td>
</tr>
<tr>
<td>movedata</td>
<td>mem.h and string.h</td>
</tr>
<tr>
<td>movemem</td>
<td>mem.h and string.h</td>
</tr>
<tr>
<td>setmem</td>
<td>mem.h</td>
</tr>
<tr>
<td>stpcpy</td>
<td>string.h</td>
</tr>
<tr>
<td>strcat</td>
<td>string.h</td>
</tr>
<tr>
<td>strncpy</td>
<td>string.h</td>
</tr>
<tr>
<td>strcat</td>
<td>string.h</td>
</tr>
<tr>
<td>strncmp</td>
<td>string.h</td>
</tr>
<tr>
<td>strchr</td>
<td>string.h</td>
</tr>
<tr>
<td>strncmp</td>
<td>string.h</td>
</tr>
<tr>
<td>strcmp</td>
<td>string.h</td>
</tr>
<tr>
<td>strlen</td>
<td>string.h</td>
</tr>
<tr>
<td>strdup</td>
<td>string.h</td>
</tr>
<tr>
<td>strerror</td>
<td>string.h</td>
</tr>
<tr>
<td>strstr</td>
<td>string.h</td>
</tr>
<tr>
<td>strrev</td>
<td>string.h</td>
</tr>
<tr>
<td>strset</td>
<td>string.h</td>
</tr>
<tr>
<td>strspn</td>
<td>string.h</td>
</tr>
<tr>
<td>strspn</td>
<td>string.h</td>
</tr>
<tr>
<td>strncat</td>
<td>string.h</td>
</tr>
<tr>
<td>strpbrk</td>
<td>string.h</td>
</tr>
<tr>
<td>strrcspn</td>
<td>string.h</td>
</tr>
<tr>
<td>strstr</td>
<td>string.h</td>
</tr>
<tr>
<td>strtok</td>
<td>string.h</td>
</tr>
<tr>
<td>strucat</td>
<td>string.h</td>
</tr>
<tr>
<td>strupr</td>
<td>string.h</td>
</tr>
</tbody>
</table>
Math Routines

These routines perform mathematical calculations and conversions.

<table>
<thead>
<tr>
<th>Function</th>
<th>Header</th>
</tr>
</thead>
<tbody>
<tr>
<td>abs</td>
<td>(stdlib.h)</td>
</tr>
<tr>
<td>acos</td>
<td>(math.h)</td>
</tr>
<tr>
<td>asin</td>
<td>(math.h)</td>
</tr>
<tr>
<td>atan</td>
<td>(math.h)</td>
</tr>
<tr>
<td>atan2</td>
<td>(math.h)</td>
</tr>
<tr>
<td>atof</td>
<td>(stdlib.h)</td>
</tr>
<tr>
<td>atof</td>
<td>(math.h)</td>
</tr>
<tr>
<td>atoi</td>
<td>(stdlib.h)</td>
</tr>
<tr>
<td>atol</td>
<td>(stdlib.h) and (stdlib.h)</td>
</tr>
<tr>
<td>cabs</td>
<td>(math.h)</td>
</tr>
<tr>
<td>ceil</td>
<td>(math.h)</td>
</tr>
<tr>
<td>_clear87</td>
<td>(float.h)</td>
</tr>
<tr>
<td>_control87</td>
<td>(float.h)</td>
</tr>
<tr>
<td>cos</td>
<td>(math.h)</td>
</tr>
<tr>
<td>cosh</td>
<td>(math.h)</td>
</tr>
<tr>
<td>ecvt</td>
<td>(stdlib.h)</td>
</tr>
<tr>
<td>exp</td>
<td>(math.h)</td>
</tr>
<tr>
<td>fabs</td>
<td>(math.h)</td>
</tr>
<tr>
<td>fcntv</td>
<td>(stdlib.h)</td>
</tr>
<tr>
<td>floor</td>
<td>(math.h)</td>
</tr>
<tr>
<td>fmod</td>
<td>(math.h)</td>
</tr>
<tr>
<td>_fpreset87</td>
<td>(float.h)</td>
</tr>
<tr>
<td>frexp</td>
<td>(math.h)</td>
</tr>
<tr>
<td>gcvt</td>
<td>(stdlib.h)</td>
</tr>
<tr>
<td>hypot</td>
<td>(math.h)</td>
</tr>
<tr>
<td>_itoa</td>
<td>(stdlib.h)</td>
</tr>
<tr>
<td>labs</td>
<td>(stdlib.h)</td>
</tr>
<tr>
<td>ldexp</td>
<td>(math.h)</td>
</tr>
<tr>
<td>log</td>
<td>(math.h)</td>
</tr>
<tr>
<td>log10</td>
<td>(math.h)</td>
</tr>
<tr>
<td>ltoa</td>
<td>(stdlib.h)</td>
</tr>
<tr>
<td>_matherr</td>
<td>(math.h)</td>
</tr>
<tr>
<td>pow</td>
<td>(math.h)</td>
</tr>
<tr>
<td>pow10</td>
<td>(math.h)</td>
</tr>
<tr>
<td>rand</td>
<td>(stdlib.h)</td>
</tr>
<tr>
<td>sin</td>
<td>(math.h)</td>
</tr>
<tr>
<td>sinh</td>
<td>(math.h)</td>
</tr>
<tr>
<td>sqrt</td>
<td>(math.h)</td>
</tr>
<tr>
<td>srand</td>
<td>(stdlib.h)</td>
</tr>
<tr>
<td>_status87</td>
<td>(float.h)</td>
</tr>
<tr>
<td>strtod</td>
<td>(stdlib.h)</td>
</tr>
<tr>
<td>strtol</td>
<td>(stdlib.h)</td>
</tr>
<tr>
<td>tan</td>
<td>(math.h)</td>
</tr>
<tr>
<td>tanh</td>
<td>(math.h)</td>
</tr>
<tr>
<td>ultoa</td>
<td>(stdlib.h)</td>
</tr>
</tbody>
</table>

Memory Allocation Routines

These routines provide dynamic memory allocation in the small-data and large-data models.

<table>
<thead>
<tr>
<th>Function</th>
<th>Header</th>
</tr>
</thead>
<tbody>
<tr>
<td>allocmem</td>
<td>(dos.h)</td>
</tr>
<tr>
<td>brk</td>
<td>(alloc.h)</td>
</tr>
<tr>
<td>calloc</td>
<td>(alloc.h)</td>
</tr>
<tr>
<td>coreleft</td>
<td>(alloc.h) and (stdlib.h)</td>
</tr>
<tr>
<td>faralloc</td>
<td>(alloc.h)</td>
</tr>
<tr>
<td>farcoreleft</td>
<td>(alloc.h)</td>
</tr>
<tr>
<td>farfree</td>
<td>(alloc.h)</td>
</tr>
<tr>
<td>farmalloc</td>
<td>(alloc.h)</td>
</tr>
<tr>
<td>farrealloc</td>
<td>(alloc.h)</td>
</tr>
<tr>
<td>free</td>
<td>(alloc.h) and (stdlib.h)</td>
</tr>
<tr>
<td>malloc</td>
<td>(alloc.h) and (stdlib.h)</td>
</tr>
<tr>
<td>realloc</td>
<td>(alloc.h) and (stdlib.h)</td>
</tr>
<tr>
<td>sbk</td>
<td>(alloc.h)</td>
</tr>
<tr>
<td>setblock</td>
<td>(dos.h)</td>
</tr>
</tbody>
</table>

Miscellaneous Routines

These routines provide non-local goto capabilities.

<table>
<thead>
<tr>
<th>Function</th>
<th>Header</th>
</tr>
</thead>
<tbody>
<tr>
<td>setjmp</td>
<td>(setjmp.h)</td>
</tr>
<tr>
<td>longjmp</td>
<td>(setjmp.h)</td>
</tr>
</tbody>
</table>
Process Control Routines

These routines invoke and terminate new processes from within another.

abort (process.h)  exit (process.h)
exec (process.h)   spawnl (process.h)
exce (process.h)   spawnle (process.h)
excul (process.h)  spawnlp (process.h)
exclpe (process.h) spawnlpe (process.h)
execv (process.h)  spawn1v (process.h)
execve (process.h) spawnve (process.h)
execvp (process.h) spawnvp (process.h)
excvpe (process.h) spawnvpe (process.h)
_exit (process.h)  system (process.h)

Standard Routines

These are standard routines.

abort (stdlib.h)  fcvt (stdlib.h)  putenv (stdlib.h)
abs (stdlib.h)    free (stdlib.h)  qsort (stdlib.h)
atexit (stdlib.h) gcvt (stdlib.h)  rand (stdlib.h)
atof (stdlib.h)   getenv (stdlib.h) realloc (stdlib.h)
atoi (stdlib.h)   labs (stdlib.h)  srand (stdlib.h)
atol (stdlib.h)   labs (stdlib.h)  strftime (stdlib.h)
bsearch (stdlib.h) lfind (stdlib.h) strto1 (stdlib.h)
calloc (stdlib.h) lsearch (stdlib.h) strftime (stdlib.h)
ecvt (stdlib.h)   ltoa (stdlib.h)  system (stdlib.h)
_exit (stdlib.h)   malloc (stdlib.h) ultoa (stdlib.h)
exit (stdlib.h)    

Time and Date Routines

These are time-conversion and time-manipulation routines.

asctime (time.h)  localtime (time.h)
ctime (time.h)    setdate (dos.h)
difftime (time.h) settime (dos.h)
dostounix (dos.h) strftime (time.h)
getdate (dos.h)   stime (time.h)
gettime (dos.h)   time (time.h)
gmtime (time.h)   tzset (time.h)

Variable Argument List Routines

These routines are for use when accessing variable argument lists (such as with vprintf, etc).

va_arg (stdarg.h)
va_end (stdarg.h)
va_start (stdarg.h)
The main Function

Every C program must have a **main** function; where you place it is a matter of preference. Some programmers place **main** at the beginning of the file, others at the very end. But regardless of its location, the following points about **main** always apply.

The Arguments to main

Three parameters (arguments) are passed to main by the Turbo C start-up routine: **argc**, **argv** and **env**.

- **argc**, an integer, is the number of command-line arguments passed to **main**.

- **argv** is an array of strings
  - under 3.x versions of DOS, **argv[0]** is defined as the full path name of the program being run
  - under versions of DOS before 3.0, **argv[0]** points to the null string (""").
  - **argv[1]** contains the first string typed on the DOS command line after the program name
  - **argv[2]** contains the second string typed after the program name
  - ...**argv[argc]** contains **NULL**

- **env** is also an array of strings. Each element of **env[]** holds a string of the form **ENVVAR=value**
  - **ENVVAR** is the name of an environment variable, such as **PATH**, or **87**.
  - **value** is the value to which an **ENVVAR** is set, such as **C:\DOS;C\TURBOC** (for **PATH**), or **YES** (for **87**)

The Turbo C start-up routine always passes these three arguments to **main**: You have the option of whether or not to declare them in your program. If
you declare some (or all) of these arguments to main, they are made available as local variables to your main routine.

Note, however, that if you do declare any of these parameters, you must declare them exactly in the order given: argc, argv, env.

For example, the following are all valid declarations of main's arguments:

```c
main()
main(int argc)
main(int argc, char * argv[])
main(int argc, char * argv[], char * env[])
```

**Note:** The declaration `main(int argc)` is legal, but it's very unlikely that you would use `argc` in your program without also using the elements of `argv`.

**Another Note:** The argument `env` is also available via the global variable `environ`. Refer to the `environ` lookup entry (in this chapter) and the `putenv` and `getenv` lookup entries (in Chapter 2) for more information.

**An Example Program Using argc, argv and env**

Here is an example program, named ARGS.EXE, that demonstrates a simple way of implementing these arguments passed to main.

```c
#include <stdio.h>
#include <stdlib.h>

main(int argc, char * argv[], char * env[])
{
    int i;

    printf("The value of argc is %d \n\n", argc);
    printf("These are the %d command-line arguments passed to main:\n\n", argc);

    for (i = 0; i < argc; i++)
        printf(" argv[%d]: %s\n", i, argv[i]);

    printf("\nThe environment string(s) on this system are:\n\n");

    for (i = 0; env[i] != NULL; i++)
        printf(" env[%d]: %s\n", i, env[i]);
}
```
Suppose you run ARGS.EXE at the DOS prompt with the following command line:

> args first_argument "argument with blanks" 3 4 "last but one" stop!

Note that you can pass arguments with embedded blanks by surrounding the with double quotes, as shown by "argument with blanks" and "last but one" in this example command line.

The output of ARGS.EXE (assuming that the environment variables are set as shown here) would then be like this:

The value of argc is 7

These are the 7 command-line arguments passed to main:

argv[0]: C:\TURBO\TESTARGS.EXE
argv[1]: first_argument
argv[2]: argument with blanks
argv[3]: 3
argv[4]: 4
argv[5]: last but one
argv[6]: stop!
argv[7]: (null)

The environment string(s) on this system are:

env[0]: COMSPEC=C:\COMMAND.COM
env[1]: PROMPT=$p $g
env[2]: PATH=C:\SPRINT;C:\DOS;C:\TURBO

Note: The maximum combined length of the command-line arguments passed to main (including the space between adjacent arguments) is 128 characters: this is a DOS limit.

When You Compile Using -p (Pascal Calling Conventions)

If you compile your program using Pascal calling conventions (which are described in detail in Chapter 9), you must remember to explicitly declare main as being a C type.

You do this with the cdecl keyword, like this:

cdecl main(int argc, char * argv[], char * envp[])

Using Turbo C Library Routines 19
The Value main Returns

In all but two instances, the value returned by main is the status code of the program: an int. If, however, your program uses the routine exit (or _exit) to terminate, the value returned by main is the argument passed to the call to exit (or to _exit).

For example, if your program contains the call

    exit(1)

the status is 1.

If you are using the Integrated Environment version of Turbo C (TC.EXE) to run your program, you can display the return value from main by pressing Alt-V when the "Press any key" message appears (after you run the program).
Global Variables

daylight, timezone

Names     daylight, timezone
Usage     extern int daylight;
           extern long timezone;
Declared in time.h
Description These variables are used by the time-and-date functions.
             daylight: This variable = 1 for Daylight Savings Time, 0 for Standard Time.
             timezone: This variable is a calculated value; it is assigned a long value that is the difference, in seconds, between the current local time and Greenwich Mean Time.

errno, _doserrno, sys_errlist, sys_nerr

Names     errno, _doserrno, sys_errlist, sys_nerr
Usage     extern int errno;
           extern int _doserrno;
           extern char * sys_errlist[ ];
           extern int sys_nerr;
Declared in errno.h  (errno, _doserrno, sys_errlist, sys_nerr)
           dos.h     (_doserrno)
Description

Three of these variables (errno, sys_errlist, and sys_nerr) are used by the perror function to print error messages when certain library routines fail to accomplish their appointed tasks. _doserrno is a variable that maps many MS-DOS error codes to errno; however, perror does not use _doserrno directly.

_doserrno: When an MS-DOS system call results in an error, _doserrno is set to the actual MS-DOS error code. errno is a parallel error variable inherited from UNIX.

erro: Whenever an error in a system call occurs, errno is set to indicate the type of error. Sometimes errno and _doserrno are equivalent. Other times, errno does not contain the actual DOS error code (which is contained in _doserrno). Still other errors might occur which set only errno, not _doserrno.

sys_errlist: To provide more control over message formatting, the array of message strings is provided in sys_errlist. errno can be used as an index into the array to find the string corresponding to the error number. The string does not include any newline character.

sys_nerr: This variable is defined as the number of error message strings in sys_errlist.

The following table gives mnemonics for the values stored in sys_errlist and their meanings.

<table>
<thead>
<tr>
<th>mnemonic</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>E2BIG</td>
<td>Arg list too long</td>
</tr>
<tr>
<td>EACCES</td>
<td>Permission denied</td>
</tr>
<tr>
<td>EBADF</td>
<td>Bad file number</td>
</tr>
<tr>
<td>ECONTR</td>
<td>Memory blocks destroyed</td>
</tr>
<tr>
<td>ECURDIR</td>
<td>Attempt to remove CurDir</td>
</tr>
<tr>
<td>EDOM</td>
<td>Domain error</td>
</tr>
<tr>
<td>EINVACC</td>
<td>Invalid access code</td>
</tr>
<tr>
<td>EINVALAL</td>
<td>Invalid argument</td>
</tr>
<tr>
<td>EINVDAT</td>
<td>Invalid data</td>
</tr>
<tr>
<td>EINVDRV</td>
<td>Invalid drive specified</td>
</tr>
<tr>
<td>EINVENV</td>
<td>Invalid environment</td>
</tr>
<tr>
<td>EINVFMT</td>
<td>Invalid format</td>
</tr>
<tr>
<td>EINVFNC</td>
<td>Invalid function number</td>
</tr>
<tr>
<td>mnemonic</td>
<td>MS-DOS error code</td>
</tr>
<tr>
<td>------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>EINVAL</td>
<td>Bad function</td>
</tr>
<tr>
<td>E2BIG</td>
<td>Bad environ</td>
</tr>
<tr>
<td>EACCES</td>
<td>Access denied</td>
</tr>
<tr>
<td>EACCES</td>
<td>Bad access</td>
</tr>
<tr>
<td>EACCES</td>
<td>Is current dir</td>
</tr>
<tr>
<td>EBADF</td>
<td>Bad handle</td>
</tr>
<tr>
<td>EFAULT</td>
<td>Reserved</td>
</tr>
<tr>
<td>EINVAL</td>
<td>Bad data</td>
</tr>
<tr>
<td>EMFILE</td>
<td>Too many open</td>
</tr>
<tr>
<td>ENOENT</td>
<td>File not found</td>
</tr>
<tr>
<td>ENOENT</td>
<td>Path not found</td>
</tr>
<tr>
<td>ENOENT</td>
<td>No more files</td>
</tr>
<tr>
<td>ENOEXEC</td>
<td>Bad format</td>
</tr>
<tr>
<td>ENOMEM</td>
<td>Mcb destroyed</td>
</tr>
<tr>
<td>ENOMEM</td>
<td>Out of memory</td>
</tr>
<tr>
<td>ENOMEM</td>
<td>Bad block</td>
</tr>
<tr>
<td>EXDEV</td>
<td>Bad drive</td>
</tr>
<tr>
<td>EXDEV</td>
<td>Not same device</td>
</tr>
</tbody>
</table>

The following list gives mnemonics for the actual DOS error codes to which _doserrno can be set. (This value of _doserrno may or may not be mapped—through errno—to an equivalent error message string in sys_errlist.)
Refer to the Microsoft *MS-DOS Programmer's Reference Manual* for more information about MS-DOS error returns.

---

**fmode**

<table>
<thead>
<tr>
<th>Name</th>
<th>_fmode – default file-translation mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>extern int _fmode;</td>
</tr>
<tr>
<td>Declared in</td>
<td>fcntl.h</td>
</tr>
<tr>
<td>Description</td>
<td>This variable determines in which mode (text or binary) files will be opened and translated. The value of _fmode is O_TEXT by default, which specifies that files will be read in text mode. If _fmode is set to O_BINARY, the files are opened and read in binary mode. (O_TEXT and O_BINARY are defined in fcntl.h.) In text mode, on input, carriage-return/line-feed (CR/LF) combinations are translated to a single line-feed character (LF). On output, the reverse is true: LF characters are translated to CR/LF combinations. In binary mode, no such translation occurs. You can override the default mode as set by _fmode by specifying a t (for text mode) or b (for binary mode) in the argument type in the library routines fopen, fdopen, and freopen. Also, in the routine open, the argument access can include either O_BINARY or O_TEXT, which will explicitly define the file being opened (given by the open pathname argument) to be in either binary or text mode.</td>
</tr>
</tbody>
</table>
### _psp, environ

<table>
<thead>
<tr>
<th>Names</th>
<th>_psp, environ</th>
</tr>
</thead>
</table>
| Usage      | extern unsigned int _psp;  
environ[ ]; |
| Declared in| dos.h (_psp)  
dos.h (environ) |
| Description| _psp: This variable contains the segment address of the program segment prefix (PSP) for the current program. The PSP is an MS-DOS process descriptor; it contains initial DOS information about the program.  
Refer to the Microsoft MS-DOS Programmer’s Reference Manual for more information on the PSP.  
environ: This is an array of strings; it is used to access and alter a process environment. Each string is of the form  
envvar = varvalue |

where envvar is the name of an environment variable (such as PATH), and varvalue is the string value to which envvar is set (such as C: \BIN; C: \DOS). The string varvalue may be empty.

When a program begins execution, the MS-DOS environment settings are passed directly to the program. Note that envp, the third argument to main, is equal to the initial setting of environ.

The environ array can be accessed by getenv; however, the putenv function is the only routine that should be used to add, change or delete the environ array entries. (This is because modification can resize and relocate the process environment array, but environ is automatically adjusted so that it always points to the array.)
**stklen**

<table>
<thead>
<tr>
<th>Name</th>
<th>Usage</th>
<th>Description</th>
</tr>
</thead>
</table>
| Name   | _stklen – stack length variable | In large data models (compact, large, and huge), _stklen is the exact stack size in bytes. In small data models (tiny, small, and medium), the startup code uses _stklen to compute the minimum size of the DATA segment. The DATA segment includes initialized global data, uninitialized data, and the stack.  

\[
\text{min DATA segment size} = \\
\text{size of DATA segment} + \text{size of BSS segment} + \text{stklen} + \text{MINSTACK(128 words)}
\]

If the memory available is less than this, the startup aborts the program. The maximum DATA segment size is, of course, 64K.

**version, osmajor, osminor**

<table>
<thead>
<tr>
<th>Names</th>
<th>_version, _osmajor, _osminor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>extern unsigned int _version; extern unsigned char _osmajor; extern unsigned char _osminor;</td>
</tr>
<tr>
<td>Declared in</td>
<td>dos.h</td>
</tr>
</tbody>
</table>
Description

_version contains the MS-DOS version number, with the major version number in the low byte and the minor version number in the high byte. (For MS-DOS version x.y, the x is the major version number, and y is the minor.)

The major and minor version numbers are also available individually through _osmajor and _osminor, where _osmajor is the major version number and _osminor is the minor version number.

These variables can be useful when you want to write modules that will run on MS-DOS versions 2.x and 3.x. Some library routines behave differently depending on the MS-DOS version number, while others only work under MS-DOS 3.x. (For example, refer to _open, creatnew, and ioctl in the lookup section of this reference guide.)

_8087

Name

_8087 – coprocessor chip flag

Usage

extern int _8087;

Description

The _8087 variable is set to 1 if the start-up code auto-detection logic detects a floating-point coprocessor (an 8087, 80287, or 80387), or if the 87 environment variable is set to Y (SET 87 = Y). The _8087 variable is set to 0 otherwise.

(Refer to Chapter 9 in the Turbo C User’s Guide for more information about the 87 environment variable.)

You must have floating-point code in your program for the _8087 variable to be set to 1.
The Turbo C Library

This sample library look-up entry explains how to use this section of the Turbo C Reference Guide.

using library routine entries

<table>
<thead>
<tr>
<th>Name</th>
<th>routine – summary of what the library routine does</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>#include &lt;header.h&gt; Only listed if it must be included</td>
</tr>
<tr>
<td></td>
<td>routine(modifier parameter[, ...]); Declaration syntax</td>
</tr>
<tr>
<td>Related functions usage</td>
<td>routine2(modifier parameter[, ...]);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>header.h File containing prototype for routine</td>
</tr>
<tr>
<td>Description</td>
<td>This describes what routine does, the parameters it takes, and any details you need to use routine and the related routines listed.</td>
</tr>
<tr>
<td>Return value</td>
<td>The value that routine returns (if any), is given here. If the global variable errno is set, that’s also listed here.</td>
</tr>
<tr>
<td>Portability</td>
<td>Specifies systems routine is available on.</td>
</tr>
<tr>
<td>See also</td>
<td>Lists other routines you may wish to read about.</td>
</tr>
</tbody>
</table>
# abort

**Name**  
abort – abnormally terminates a process

**Usage**  
void abort(void);

**Prototype in**  
stdlib.h  
process.h

**Description**  
This function writes a termination message on stderr and aborts the program via a call to _exit, with an exit code.

**Return value**  
This function does not return a value.

**Portability**  
Available on UNIX systems.

**See also**  
assert, _exit, exec..., exit, spawn...

---

# abs

**Name**  
abs – absolute value

**Usage**  
int abs(int i);

**Related functions usage**  
double cabs(struct complex znum);  
double fabs(double x);  
long labs(long n);

**Prototype in**  
stdlib.h (abs, labs)  
math.h (cabs, fabs)

**Description**  
abs returns the absolute value of the integer argument i. If abs is called when stdlib.h has been included, abs will be treated as a macro that expands to in-line code.

If you don’t include stdlib.h (or if you do include it and #undef abs) you will get the abs function rather than a macro.
cabs is a macro that calculates the absolute value of znum, a complex number. znum is a structure with type complex; the structure is defined in math.h as:

```c
struct complex {
    double x, y;
};
```

Calling cabs is equivalent to calling sqrt with the real and imaginary components of znum, as shown here:

```
sqrt(znum.x*znum.x + znum.y*znum.y)
```

If you don’t include math.h (or if you do include it and #undef cabs) you will get the cabs function rather than a macro.

fabs calculates the absolute value of x, a double.

labs calculates the absolute value of n, a long integer.

**Return value**

abs returns an integer in the range of 0 to 32767, with the exception that an argument of -32768 is returned as -32768.

cabs returns the absolute value of znum, a double. On overflow, cabs returns HUGE_VAL and sets errno to ERANGE Result out of range

Error handling for cabs can be modified through the function matherr.

fabs returns the absolute value of x. labs returns the absolute value of n. There are no error returns.

**Portability**

Available on UNIX systems.

See also

matherr

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absread

Name       absread – reads data
Usage      int absread(int drive, int nsects, int sectno, void *buffer);
Related functions usage int abswrite(int drive, int nsects, int sectno, void *buffer);
Prototype in dos.h
Description These functions read and write specific disk sectors. They ignore the logical structure of a disk and pay no attention to files, FATs, or directories.

absread reads specific disk sectors via DOS interrupt 0x25; abswrite writes specific disk sectors via DOS interrupt 0x26.

    drive = drive number to read (0 = A, 1 = B, etc.)
    nsects = number of sectors to read
    sectno = beginning logical sector number
    buffer = memory address where the data is to be read or written

The number of sectors to read is limited to the amount of memory in the segment above buffer. Thus, 64K bytes is the largest amount of memory that can be read in a single call to absread or abswrite.

Return value If successful, both routines return 0.

On error, the routines return -1 and set errno to the value of the AX register returned by the system call. See the MS-DOS documentation for the interpretation of errno.

Portability Unique to MS-DOS.
### abswrite

<table>
<thead>
<tr>
<th>Name</th>
<th>abswrite – writes data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>int abswrite(int drive, int nsects, int sectno, void *buffer);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>dos.h</td>
</tr>
<tr>
<td>Description</td>
<td>see absread</td>
</tr>
</tbody>
</table>

### access

<table>
<thead>
<tr>
<th>Name</th>
<th>access – determines accessibility of a file</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>int access(char *filename, int amode);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>io.h</td>
</tr>
<tr>
<td>Description</td>
<td>access checks a named file to determine if it exists and whether it can be read, written to, or executed. filename points to a string naming the file. The bit pattern contained in amode is constructed as follows: 06 Check for read and write permission 04 Check for read permission 02 Check for write permission 01 Execute (ignored) 00 Check for existence of file</td>
</tr>
</tbody>
</table>

**Note:** Under MS-DOS, all existing files have read access (amode = 04), so 00 and 04 give the same result. In the same vein, amode values of 06 and 02 are equivalent because under MS-DOS, write access implies read access. If filename refers to a directory, access simply determines whether the directory exists or not.
Return value

If the requested access is allowed, 0 is returned; otherwise, a value of −1 is returned and errno is set to one of the following:

- ENOENT   Path or file name not found
- EACCESS  Permission denied

Portability

Available on UNIX systems.

See also

chmod

Example

```c
#include <stdio.h>
#include <io.h>

/* returns 1 if filename exists, else 0 */

int file_exists(char *filename)
{
    return (access(filename, 0) == 0);
}

main()
{
    printf("Does NOTEXIST.FIL exist: %s\n",
            file_exists("NOTEXIST.FIL") ? "YES" : "NO");
}
```

Program output

Does NOTEXIST.FIL exist: NO

---

**acos**

Name   acos – trigonometric function

Usage  double acos(double x);

Prototype in  math.h

Description  see trig
# allocmem

**Name**  
allocmem – allocates DOS memory segment

**Usage**  
int allocmem(unsigned size, unsigned *seg);

**Related functions usage**  
int freemem(unsigned seg);
int setblock(int seg, int newsize);

**Prototype in**  
dos.h

**Description**  
allocmem uses the MS-DOS system call 0x48 to allocate a block of free memory and returns the segment address of the allocated block.

`size` is the desired size in paragraphs. `seg` is a pointer to a word which will be assigned the segment address of the newly allocated block. No assignment is made to the word pointed to by `seg` if not enough room is available.

All allocated blocks are paragraph aligned.

freemem frees a memory block allocated by a previous call to allocmem. `seg` is the segment address of that block.

setblock modifies the size of a memory segment. `seg` is the segment address returned by a previous call to allocmem. `newsize` is the new, requested size in paragraphs.

**Return value**  
allocmem returns -1 on success. In the event of error, a number (the size of the largest available block) is returned.

freemem returns 0 on success. In the event of error, -1 is returned and `errno` is set to

```
ENOMEM Insufficient memory
```

setblock returns -1 on success. In the event of error, the size of the largest possible block is returned.
An error return from any `allocmem` or `setblock` will set `_doserrno` and will set the global variable `errno` to `ENOMEM` Not enough core

**Portability**
Unique to MS-DOS.

**See also**
`malloc`

---

### asctime

**Name**
asctime – converts date and time to ASCII

**Usage**
```c
#include <time.h>
char *asctime(struct tm *tm);
```

**Prototype in**
time.h

**Description**
see `ctime`

---

### asin

**Name**
asin – trigonometric function

**Usage**
```c
double asin(double x);
```

**Prototype in**
math.h

**Description**
see `trig`
assert

Name assert – tests a condition and possibly aborts

Usage #include <assert.h>
    void assert(int test);

Prototype in assert.h

Description assert is a macro that expands to an if statement which, if the test fails, will print a message and abort the program. The message is:

    Assertion failed: file filename, line linenum

The filename and linenumber listed are the source file name and line number where the assert macro appears. A call to abort is used to abort the program.

If you place the #define NDEBUG directive in the source code before the #include assert.h directive, the effect is to “comment out” the assert statement.

Return value None

Portability This macro is available on some UNIX systems including Systems III and V.

See also abort

Example

    /* add an item to a list. verify the item is not NULL. */
    
    #include <assert.h>
    #include <stdio.h>

    struct ITEM {
        int key;
        int value;
    };

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void additem(struct ITEM *itemptr)
{
    assert(itemptr != NULL);
    /* ... add the item ... */
}

main()
{
    additem(NULL);
}

Program output
Assertion failed: file C:\TURBO\ASSERT.C, line 13

atan

Name       atan – trigonometric arctangent function
Usage      double atan(double x);
Prototype in math.h
Description see trig

atan2

Name       atan – trigonometric function
Usage      double atan2(double y, double x);
Prototype in math.h
Description see trig
### atexit

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>atexit</td>
<td>registers the function pointed to by <code>func</code> as an “exit function”. Upon normal termination of the program, <code>exit</code> calls <code>*func</code> (without arguments) just before returning to the operating system. The called function is of type <code>atexit_t</code>, which is defined in a <code>typedef</code> in <code>stdlib.h</code>. Each call to <code>atexit</code> registers another exit function; up to 32 functions can be registered, and they are executed on a last in, first out basis.</td>
</tr>
</tbody>
</table>

**Prototype in** stdlib.h

**Return value** atexit returns 0 on success and non-zero on failure (no space left to register the function).

#### Example

```c
#include <stdlib.h>
#include <stdio.h>

void exit_fn1()
{
    printf("Exit Function 1 called\n");
}

void exit_fn2()
{
    printf("Exit Function 2 called\n");
}

main()
{
    atexit(exit_fn1); /* post exit_fn1 */
    atexit(exit_fn2); /* post exit_fn2 */
    printf("Main quitting ...\n");
}
```
Program output

Main quitting ...
Exit Function 2 called
Exit Function 1 called

**atof**

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>atof</strong></td>
<td>converts a string to a floating point number</td>
</tr>
</tbody>
</table>

**Usage**

double atof(char *nptr);

**Related functions usage**

int atoi(char *nptr);
long atol(char *nptr);

**Prototype in**

- math.h  (atof)
- stdlib.h (atof, atoi, atol)

**Description**

- an optional string of tabs and spaces
- an optional sign
- then a string of digits and an optional decimal point
- then an optional e or E followed by an optional signed integer

**atof** converts a string pointed to by *nptr* to **double**; this function recognizes

**atoi** converts a string pointed to by *nptr* to **int**; **atol** converts the string to **long**. **atoi** and **atol** recognize

- an optional string of tabs and spaces
- an optional sign
- then a string of digits

In all three of these functions, the first unrecognized character ends the conversion.

There are no provisions for overflow in any of these functions.
### atoi

**Name**
atoi – converts a string to an integer

**Usage**
int atoi(char *nptr);

**Prototype in**
stdlib.h

**Description**
see atof

### atol

**Name**
atol – converts a string to a long

**Usage**
long atol(char *nptr);

**Prototype in**
stdlib.h

**Description**
see atof
bdos

Name  bdos – MS-DOS system call
Usage  int bdos(int dosfun, unsigned dosdx, unsigned dosal);
Related functions usage  int bdosptr(int dosfun, void *argument, unsigned dosal);
Prototype in  dos.h
Description  These calls provide direct access to many of the MS-DOS system calls. Refer to the MS-DOS Programmer’s Reference Manual for details of each system call.

Those system calls which require an integer argument use bdos, while those which require a pointer argument use bdosptr.

For the small data models (tiny, small and medium), bdos and bdosptr are similar. In the large data models (compact, large and huge), it is important to use bdosptr for system calls that require a pointer as the call argument.

dosfun is defined in the MS-DOS Programmer’s Reference Manual.

In the small data models, the argument parameter to bdosptr specifies DX; in the large data models, it gives the DS:DX values to be used by the system call.

dosdx is the value of register DX for the bdos call.

dosal is the value of register AL.

For an example that demonstrates the use of bdosptr, refer to harderr.
Return value

The return value of `bdos` is the value of AX set by the system call.

The return value of `bdosptr` is the value of AX on success, or -1 on failure. On failure `errno` and `_doserrno` are set.

Portability

Unique to MS-DOS.

Example

```c
#include <stdio.h>
#include <dos.h>

/* get current drive as 'A', 'B', ... */

char current_drive(void)
{
    char curdrive;

    curdrive = bdos(Ox19, 0, 0); /* get current disk as 0, 1, ... */
    return ( 'A' + curdrive );
}

main()
{
    printf("The current drive is %c:\n", current_drive());
}
```

Program output

The current drive is C:

---

**bdosptr**

<table>
<thead>
<tr>
<th>Name</th>
<th><code>bdosptr</code> – MS-DOS system call</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td><code>int bdosptr(int dosfun, void *argument, unsigned dosal);</code></td>
</tr>
<tr>
<td>Prototype in</td>
<td><code>dos.h</code></td>
</tr>
<tr>
<td>Description</td>
<td>see <code>bdos</code></td>
</tr>
</tbody>
</table>
bioscom

<table>
<thead>
<tr>
<th>Name</th>
<th>bioscom – communications I/O</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>int bioscom(int cmd, char byte, int port);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>bios.h</td>
</tr>
<tr>
<td>Description</td>
<td>bioscom performs various RS232 communications over the I/O port given in port.</td>
</tr>
<tr>
<td></td>
<td>A port value of 0 corresponds to COM1, 1 corresponds to COM2, and so forth.</td>
</tr>
<tr>
<td></td>
<td>The value of cmd can be one of the following:</td>
</tr>
<tr>
<td></td>
<td>0 Sets the communications parameters to the value in byte</td>
</tr>
<tr>
<td></td>
<td>1 Sends the character in byte out over the communications line</td>
</tr>
<tr>
<td></td>
<td>2 Receives a character from the communications line</td>
</tr>
<tr>
<td></td>
<td>3 Returns the current status of the communications port</td>
</tr>
</tbody>
</table>

byte is a combination of the following bits:

- 0x02 7 data bits
- 0x03 8 data bits
- 0x00 1 stop bit
- 0x04 2 stop bits
- 0x00 No parity
- 0x08 Odd parity
- 0x18 Even parity
<table>
<thead>
<tr>
<th>Value</th>
<th>Baud Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x00</td>
<td>110 baud</td>
</tr>
<tr>
<td>0x20</td>
<td>150 baud</td>
</tr>
<tr>
<td>0x40</td>
<td>300 baud</td>
</tr>
<tr>
<td>0x60</td>
<td>600 baud</td>
</tr>
<tr>
<td>0x80</td>
<td>1200 baud</td>
</tr>
<tr>
<td>0xA0</td>
<td>2400 baud</td>
</tr>
<tr>
<td>0xC0</td>
<td>4800 baud</td>
</tr>
<tr>
<td>0xE0</td>
<td>9600 baud</td>
</tr>
</tbody>
</table>

For example, giving a value for `byte` of 0xEB (0xE0 | 0x08 | 0x00 | 0x03) sets the communications port to 9600 baud, odd parity, 1 stop bit, and 8 data bits.

**Return value**

For all values of `cmd`, the return value is a 16-bit integer where the upper 8 bits are status bits, and the lower 8 bits vary depending on the value of `cmd`. The upper bits of the return value are defined as follows:

- bit 15  Time out
- bit 14  Transmit shift register empty
- bit 13  Transmit holding register empty
- bit 12  Break detect
- bit 11  Framing error
- bit 10  Parity error
- bit 9   Overrun error
- bit 8   Data ready

With a `cmd` value of 1, and if bit 15 is set, the `byte` value could not be transmitted. Otherwise, the remaining upper and lower bits are appropriately set.

With a `cmd` value of 2, the byte read is in the lower bits of the return value if there was no error.

If an error occurred, at least one of the upper bits are set. If no upper bits are set, the byte was received without error.
With a \textit{cmd} value of 0 or 3, the return value has the upper bits set as defined, and the lower bits are defined as follows:

- bit 7 \hspace{1em} Received line signal detect
- bit 6 \hspace{1em} Ring indicator
- bit 5 \hspace{1em} Data set ready
- bit 4 \hspace{1em} Clear to send
- bit 3 \hspace{1em} Delta receive line signal detector
- bit 2 \hspace{1em} Trailing edge ring detector
- bit 1 \hspace{1em} Delta data set ready
- bit 0 \hspace{1em} Delta clear to send

\textbf{Portability} \hspace{1em} This function works only with IBM PCs or compatibles.

\section*{biosdisk}

\begin{tabular}{|l|}
\hline
\textbf{Name} & \textit{biosdisk} – hard disk/floppy I/O \tabularnewline
\textbf{Usage} & \texttt{int biosdisk(int \textit{cmd}, int \textit{drive}, int \textit{head}, int \textit{track},} \tabularnewline & \texttt{\hspace{1em} int \textit{sector}, int \textit{nsects}, void *\textit{buffer});} \tabularnewline
\textbf{Prototype in} & \texttt{bios.h} \tabularnewline
\textbf{Description} & This function uses interrupt 0x13 to issue disk operations directly to the BIOS. \tabularnewline
& \textit{drive} is a number that specifies which disk drive is to be used: 0 for the first floppy disk drive, 1 for the second floppy disk drive, 2 for the third, etc. For hard disk drives, a \textit{drive} value of 0x80 specifies the first drive, 0x81 specifies the second, 0x82 the third, etc. \tabularnewline & For hard disks, the physical drive is specified, not the disk partition. The application program must interpret the partition table information itself if it needs to do so. \tabularnewline & \textit{cmd} indicates the operation to perform. Depending on the value of \textit{cmd}, the other parameters may or may not be needed. The following are the possible values for \textit{cmd} for any IBM PC, XT, or AT. \tabularnewline
\hline
\end{tabular}
0  Resets diskette system. This forces the drive controller to do a hard reset. All other parameters are ignored.

1  Returns the status of the last disk operation. All other parameters are ignored.

2  Reads one or more disk sectors into memory. The starting sector to read is given by head, track, and sector. The number of sectors is given by nsects. The data is read, 512 bytes per sector, into buffer.

3  Writes one or more disk sectors from memory. The starting sector to write is given by head, track, and sector. The number of sectors is given by nsects. The data is written, 512 bytes per sector, from buffer.

4  Verifies one or more sectors. The starting sector is given by head, track, and sector. The number of sectors is given by nsects.

5  Formats a track. The track is specified by head and track. buffer points to a table of sector headers to be written on the named track. See the Technical Reference Manual for the IBM PC for a description of this table and the format operation.

The following cmd values are allowed only for an XT or AT:

6  Formats a track and sets bad sector flags
7  Formats the drive beginning at a specific track
8  Returns the current drive parameters

The drive information is returned in buffer in the first four bytes.
9 Initializes drive-pair characteristics
10 Does a long read, which reads 512 plus 4 extra bytes per sector
11 Does a long write, which writes 512 plus 4 extra bytes per sector
12 Does a disk seek
13 Alternates disk reset
14 Reads sector buffer
15 Writes sector buffer
16 Tests whether the named drive is ready
17 Recalibrates the drive
18 Controller RAM diagnostic
19 Drive diagnostic
20 Controller internal diagnostic

Return value  These operations return a status byte composed of the following bits:

0x00  Operation successful
0x01  Bad command
0x02  Address mark not found
0x04  Record not found
0x05  Reset failed
0x07  Drive parameter activity failed
0x09  Attempt to DMA across 64K boundary
0x0B  Bad track flag detected
0x10  Bad ECC on disk read
0x11  Ecc corrected data error
0x20  Controller has failed
0x40  Seek operation failed
0x80  Attachment failed to respond
0xBB  Undefined error occurred
0xFF  Sense operation failed

Note that 0x11 is not an error because the data is correct. The value is returned anyway to give the application an opportunity to decide for itself.

Portability  This function works with IBM PCs and compatibles, only.
biosequip

Name          biosequip – checks equipment
Usage         int biosequip(void);
Prototype in  bios.h
Description   This function returns an integer describing the equip­
               ment connected to the system. BIOS interrupt 0x11 is
               used for this.
Return value  The return value is interpreted as a collection of bit­
               sized fields. The values for the IBM PC are:

               bit 15  Numbers of printers
               bit 14  Numbers of printers
               bit 13  Serial printer attached
               bit 12  Game I/O attached
               bit 11  Number of RS232 ports
               bit 10  Number of RS232 ports
               bit  9  Number of RS232 ports
               bit  8  NOT DMA
                     bit 8 = 0  machine has DMA
                     bit 8 = 1  machine does not have DMA; for
                     example, PC Jr.
               bit  7  Number of diskettes
               bit  6  Number of diskettes
                     00 = 1 drive
                     01 = 2 drives
                     10 = 3 drives
                     11 = 4 drives, only if bit 0 is 1
               bit  5  Initial
               bit  4  Video mode
                     00 = Unused
                     01 = 40x25 BW with color card
                     10 = 80x25 BW with color card
11 = 80x25 BW with mono card

bit 3   Motherboard
bit 2   Ram size
  00 = 16K
  01 = 32K
  10 = 48K
  11 = 64K

bit 1   Floating-point coprocessor
bit 0   Boot from diskette

Portability   This function works with IBM PCs and compatibles, only.

bioskey

Name      bioskey – keyboard interface
Usage     int bioskey(int cmd);
Prototype in bios.h
Description This function performs various keyboard operations using BIOS interrupt 0x14. The parameter cmd determines the exact operation.

0   Returns the next key struck at the keyboard. If the lower 8 bits are non-zero, that is the ASCII character struck. If the lower 8 bits are zero, the upper 8 bits are the extended keyboard codes defined in the Technical Reference Manual for the IBM PC.

1   This tests whether a keystroke is available to be read. A return value of zero means no key is available. Otherwise, the value of the next keystroke is returned. The keystroke itself is kept to be returned by the next call to bioskey that has a cmd value of zero.
2 Requests the current shift key status. The value is composed from ORing the following values together:

- 0x80  Insert toggled
- 0x40  Caps toggled
- 0x20  Num Lock toggled
- 0x10  Scroll Lock toggled
- 0x08  Alt down
- 0x04  Ctrl down
- 0x02  Left Shift down
- 0x01  Right Shift down

**Portability**  This function works with IBM PCs and compatibles, only.

**Example**

```c
#include <stdio.h>
#include <bios.h>
#include <ctype.h>

#define RIGHT 0x0001
#define LEFT  0x0002
#define CTRL 0x0004
#define ALT  0x0008

main ()
{
    int key, modifiers;
    /* function 1 returns 0 until a key is struck. Wait for an input by repeatedly checking for a key. */
    while(bioskey(1) == 0); 

    /* now use function 0 to get return value of the key. */
    key = bioskey(0);
    printf("Key Pressed was: ");

    /* use function 2 to determine if shift keys were used */
    modifiers = bioskey(2);
    if (modifiers) {
        printf("[");
        if (modifiers & RIGHT) printf("RIGHT ");
        if (modifiers & LEFT ) printf("LEFT ");
        if (modifiers & CTRL ) printf("CTRL ");
        if (modifiers & ALT  ) printf("ALT ");
        printf("]");
    }
    if (isalnum(key & 0xFF))
        printf("%c\n",key);
    else
        printf("%#02x\n",key);
} 
```

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### biosmemory

<table>
<thead>
<tr>
<th>Name</th>
<th>biosmemory – returns memory size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>int biosmemory(void);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>bios.h</td>
</tr>
<tr>
<td>Description</td>
<td>This function returns the memory size using BIOS interrupt 0x12.</td>
</tr>
<tr>
<td>Return value</td>
<td>The return value is the size of memory in 1K blocks.</td>
</tr>
<tr>
<td>Portability</td>
<td>This function works with IBM PCs and compatibles, only.</td>
</tr>
</tbody>
</table>

### biosprint

<table>
<thead>
<tr>
<th>Name</th>
<th>biosprint – printer I/O</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>int biosprint(int cmd, int byte, int port);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>bios.h</td>
</tr>
<tr>
<td>Description</td>
<td>This function performs various printer functions on the printer identified by the parameter port.</td>
</tr>
<tr>
<td></td>
<td>A port value of 0 corresponds to LPT1, port value of 1 corresponds to LPT2, etc.</td>
</tr>
<tr>
<td></td>
<td>The value of cmd can be one of the following:</td>
</tr>
<tr>
<td></td>
<td>0 Print the character in byte</td>
</tr>
<tr>
<td></td>
<td>1 Initialize the printer port</td>
</tr>
<tr>
<td></td>
<td>2 Read the printer status</td>
</tr>
<tr>
<td></td>
<td>The value of byte can be 0 to 255.</td>
</tr>
</tbody>
</table>
**Return value**  The value returned from any of these operations is the current printer status composed by ORing these bit values together:

- 0x01  Device time out
- 0x08  I/O error
- 0x10  Selected
- 0x20  Out of paper
- 0x40  Acknowledge
- 0x80  Not busy

With `cmd` equal to 0, a return value with *device time out* set indicates an output error.

**Portability**  This function works with IBM PCs and compatibles, only.

---

**biostime**

**Name**  `biostime` – returns time of day

**Usage**  `long biostime(int cmd, long newtime);`

**Prototype in**  `bios.h`

**Description**  This function either reads or sets the BIOS timer. This is a timer counting ticks since midnight at a rate of roughly 18.2 ticks per second.

If `cmd = 0`, `biostime` returns the current value of the timer.

If `cmd = 1`, the timer is set to the `long` value in `newtime`.

**Return value**  When `biostime` reads the BIOS timer, `(cmd = 0)`, it returns the timer’s current value.

**Portability**  This function works with IBM PCs and compatibles, only.
brk

Name               brk – changes data-segment space allocation
Usage              int brk(void *endds);
Related            char *sbrk(int incr);
functions usage    alloc.h
Description        brk is used to dynamically change the amount of space
                    allocated to the calling program’s data segment. The
                    change is made by resetting the program’s break value,
                    which is the address of the first location beyond the end
                    of the data segment. The amount of allocated space
                    increases as the break value increases.
                    
                    brk sets the break value to endds and changes the
                    allocated space accordingly.
                    
                    sbrk adds incr bytes to the break value and changes the
                    allocated space accordingly. incr can be negative, in
                    which case the amount of allocated space is decreased.
                    
                    Both functions will fail without making any change in
                    the allocated space if such a change would result in
                    more space being allocated than is allowable.
                    
Return value       Upon successful completion, brk returns a value of 0,
                    and sbrk returns the old break value.
                    
                    On failure, both functions return a value of -1, and errno
                    is set to
                    
                    ENOMEM        Not enough core
                    
Portability        brk is available on UNIX systems.
See also           coreleft
bsearch

Name bsearch – binary search

Usage void *bsearch(void *key, void *base,
                     int *nelem, int width, int (*fcmp)( ));

Related functions usage
void *lfind(void *key, void *base, int *nelem,
            int width, int (*fcmp)( ));
void *lsearch(void *key, void *base,
              int *nelem, int width, int (*fcmp)( ));

Prototype in stdlib.h

Description bsearch is a binary search algorithm designed to search an arbitrary table of information. The entries in the table must be sorted into ascending order before bsearch is called.

lfind and lsearch also search a table for information. However, because these are linear searches, the table entries do not need to be sorted before a call to lfind or lsearch. If the item that key points to is not in the table, lsearch appends that item to the table, but lfind does not.

- base points to the base (0th element) of the search table.
- nelem points to an integer containing the number of entries in the table.
- width contains the number of bytes in each entry.
- key points to the item to be searched for (the "search key").

The argument fcmp points to a user-written comparison routine. That routine compares two items and returns a value based on the comparison.

To search the table, these three search functions make repeated calls to the routine whose address is passed in fcmp.
On each call to the comparison routine, the search functions pass two arguments: key, a pointer to the item being searched for; and elem, a pointer to the element of base being compared.

fcmp is free to interpret the search key and the table entries any way it likes.

Return value
Each function returns the address of the first entry in the table that matches the search key. If no match is found, bsearch and lfind return 0.

In bsearch

If the search key is
Greater than *elem  fcmp returns
Identical to *elem  An integer < 0
Less than *elem  0
An integer > 0

In lsearch and lfind

If the search key is
Not identical to *elem  fcmp returns
Identical to *elem  An integer != 0
0

Portability
Available on UNIX systems.

See also
qsort

Example

```c
#include <stdio.h>
#include <stdlib.h>

#define NELEMS(arr)  (sizeof(arr) / sizeof(arr[0]))

int numarray[] = { 123, 145, 512, 627, 800, 993 };
int numeric(int *p1, int *p2)
{
    return (*p1 - *p2);
}
```
/* return 1 if key is in the table, 0 if not */
int lookup(int key)
{
    int *itemptr;

    /* bsearch() returns a pointer to the item that is found */
    itemptr = (int *) bsearch(&key, numarray, NELEMS(numarray),
                               sizeof(int), numeric);
    return (itemptr != NULL);
}

main()
{
    printf("Is 512 in table? ");
    printf("%s\n", lookup(512) ? "YES" : "NO");
}

Program output
Is 512 in table? YES

Another Example

#include <stdlib.h>
#include <stdio.h>
#include <string.h> /* for strcmp declaration */

char *colors[10] = { "red", "blue", "green" };
int ncolors = 3;
/* return 1 if already in the table, 0 if not and was added */
/* assumes there is room for new additions */

int addelem(char *color)
{
    int oldn = ncolors;

    lsearch(color, colors, &ncolors, sizeof(colors[0]), strcmp);
    return (ncolors == oldn);
}

main()
{
    if (addelem("purple"))
        printf("purple already in colors table\n");
    else
        printf("purple added to colors table, now %d colors\n", ncolors);
}

Program output
purple added to colors table, now 4 colors
cabs

Name: cabs – absolute value of complex number
Usage: #include <math.h>
       double cabs(struct complex znum);
Prototype in: math.h
Description: see abs

calloc

Name: calloc – allocates main memory
Usage: void *calloc(unsigned nelem, unsigned elsize);
Prototype in: stdlib.h and alloc.h
Description: see malloc

ceil

Name: ceil – rounds up
Usage: double ceil(double x);
Prototype in: math.h
Description: see floor
cgets

Name     cgets – reads string from console
Usage    char *cgets(char *string);
Prototype in  conio.h
Description see gets

chdir

Name     chdir – changes working directory
Usage    int chdir(char *path);
Prototype in  dir.h
Description chdir causes the directory specified by path to become the current working directory. path must specify an existing directory.
A drive can also be specified in the path argument, such as:

    chdir("\a:\\turboc") or chdir("a:/turboc")

Return value Upon successful completion, chdir returns a value of 0. Otherwise, a value of −1 is returned and errno is set to

    ENOENT  Path or file name not found

Portability chdir is available on UNIX systems.
See also mkdir
**_chmod**

Name: _chmod - changes access mode of file

Usage:
#include <dos.h>
int _chmod(char *filename, int func [, int attrib]);

Prototype in: io.h

Description: see chmod

---

**chmod**

Name: chmod - changes access mode of file

Usage:
#include <sys\stat.h>
int chmod(char *filename, int perm iss);

Related functions usage:
int _chmod(char *filename, int func [, int attrib]);

Prototype in: io.h

Description: chmod sets the file-access permissions of the file filename according to the mask given by perm iss. filename points to a string naming the file.

perm iss can contain one or both of the symbolic constants S_IWRITE and S_IREAD (defined in sys\stat.h).

<table>
<thead>
<tr>
<th>Value of perm iss</th>
<th>Access Permission</th>
</tr>
</thead>
<tbody>
<tr>
<td>S_IWRITE</td>
<td>Permission to write</td>
</tr>
<tr>
<td>S_IREAD</td>
<td>Permission to read</td>
</tr>
<tr>
<td>S_IREAD</td>
<td>S_IWRITE</td>
</tr>
</tbody>
</table>

The _chmod function may either fetch or set the MS-DOS file attributes. If func is 0, the function returns the current MS-DOS attributes for the file. If func is 1, the attribute is set to attrib.
attrib can be one of the following symbolic constants (defined in dos.h).

- FA_RDONLY Read only attribute
- FA_HIDDEN Hidden file
- FA_SYSTEM System file

Return value
Upon successfully changing the file-access mode, chmod returns 0. Otherwise, chmod returns a value of -1.

Upon successful completion, _chmod returns the file attribute word; otherwise, it returns a value of -1.

In the event of an error, errno is set to one of the following:

- ENOENT Path or file name not found
- EACCES Permission denied

Portability
chmod is available on UNIX systems. _chmod is unique to MS-DOS.

See also
access, open, unlink

Example

```c
#include <stdio.h>
#include <sys/stat.h>
#include <io.h>

void make_read_only(char *filename)
{
  int stat;

  stat = chmod(filename, S_IREAD);
  if (stat)
    printf("couldn't make %s read-only\n", filename);
  else
    printf("made %s read-only\n", filename);
}

main()
{
  make_read_only("NOTEXIST.FIL");
  make_read_only("MYFILE.FIL");
}
```

Program output

couldn't make NOTEXIST.FIL read-only
made MYFILE.FIL read-only
clear87

Name       clear87 – clears floating-point status word
Usage      unsigned int clear87 (void);
Prototype in float.h
Description clear87 clears the floating-point status word, which is a combination of the 8087/80287 status word and other conditions detected by the 8087/80287 exception handler.
Return value The bits in the value returned indicate the old floating-point status. See float.h for a complete definition of the bits returned by clear87.
See also _fpreset, _status87

clearerr

Name       clearerr – resets error indication
Usage      #include <stdio.h>
            void clearerr(FILE *stream);
Prototype in stdio.h
Description see ferror
_close

Name  _close – closes a file handle
Usage  int _close(int handle);
Prototype in io.h
Description see close

close

Name  close – closes a file handle
Usage  int close(int handle);
Related functions usage  int _close(int handle);
Prototype in io.h
Description close and _close both close the file handle indicated by
handle. handle is a file handle obtained from a _creat, creat, creatnew, creattemp, dup, dup2, _open, or open
call.

Note: These functions do not write a Ctrl-Z character at
the end of the file. If you want to terminate the file with
a Ctrl-Z, you must explicitly output one.

Return value  Upon successful completion, close and _close return 0.
Otherwise, a value of −1 is returned.

Both fail if handle is not a valid, open file handle, and set
errno to

EBADFD Bad file number
Portability  close is available on UNIX systems.
              _close is unique to MS-DOS.
See also    creat, dup, fclose, fcntl, open

/control87

Name       _control87 – manipulates floating-point control word
Usage      unsigned int _control87(unsigned int newvals,
                     unsigned int mask);
Prototype in float.h
Description This function is used to retrieve or change the floating-
              point control word.

The floating-point control word is an unsigned int
          that, bit by bit, specifies certain modes in the floating-
          point package; namely, the precision, infinity and
          rounding modes. Changing these modes allows you to
          mask or unmask floating-point exceptions.

/control87 matches the bits in mask to the bits in newvals.
If a mask bit = 1, the corresponding bit in newvals
contains the new value for the same bit in the floating-
point control word, and _control87 sets that bit in the
control word to the new value.

Here’s a simple illustration of how this works:

   Original control word: 0100 0011 0110 0011

   mask          1000 0001 0100 1111
   newvals       1110 1001 0000 0101

   Changing bits 1--- ---1 -0-- 0101

If mask = 0, _control87 returns the floating-point control
word without altering it.

Return value The bits in the value returned reflect the new floating-
              point control word. For a complete definition of the bits
              returned by _control87, see float.h.
<table>
<thead>
<tr>
<th>Name</th>
<th>Usage</th>
<th>Prototype in</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>coreleft</td>
<td>returns a measure of unused memory</td>
<td>alloc.h</td>
<td>see malloc</td>
</tr>
<tr>
<td>cos</td>
<td>trigonometric function</td>
<td>double cos(double x);</td>
<td>math.h</td>
</tr>
<tr>
<td>cosh</td>
<td>hyperbolic functions</td>
<td>double cosh(double x);</td>
<td>math.h</td>
</tr>
</tbody>
</table>
## country

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>country</td>
<td>returns country-dependent information</td>
</tr>
</tbody>
</table>

### Usage

```c
#include <dos.h>
struct country *country(int countrycode, struct country *countryp);
```

### Prototype in
dos.h

### Description

`country` specifies how certain country-dependent data, such as dates, times, and currency, will be formatted. The values set by this function depend on the version of DOS being used.

If `countryp` has a value of -1, the current country is set to the value of `countrycode`, which must be non-zero. Otherwise, the `country` structure pointed to by `countryp` is filled with the country-dependent information of:

- the current country (if `countrycode` is set to 0), or
- the country given by `countrycode`.

The structure `country` is defined as follows:

```c
struct country {
    int co_date;        /* Date format */
    char co_curr[5];   /* Currency symbol */
    char co_thsep[2];  /* Thousand separator */
    char co_desep[2];  /* Decimal separator */
    char co_dtsep[2];  /* Date separator */
    char co_tmsep[2];  /* Time separator */
    char co_currstyle; /* Currency style */
    char co_digits;    /* Number of significant digits in currency */
    int(far *co_case)(); /* Case map function */
    char co_dasep;     /* Data separator */
    char co_fill[10];  /* Filler */
};
```
The date format in `co_date` is

0 for the USA style of month, day, year
1 for the European style of day, month, year
2 for the Japanese style of year, month, day

Currency display style is given by `co_currstyle` as follows:

0 Currency symbol precedes value with no spaces between the symbol and the number.
1 Currency symbol follows value with no spaces between the number and the symbol.
2 Currency symbol precedes value with a space after the symbol.
3 Currency symbol follows the number with a space before the symbol.

Return value: `country` returns the pointer argument `countryp`.

Portability: Unique to MS-DOS.

---

**cprintf**

**Name**
cprintf - sends formatted output to the console

**Usage**

```
int cprintf(char *format, argument, ...);
```

**Prototype in**
conio.h

**Description**
see printf
**cputs**

Name: cputs - writes a string to the console  
Usage: void cputs(char *string);  
Prototype in: conio.h  
Description: see puts

**_creat**

Name: _creat - creates a new file or rewrites an existing one  
Usage: #include <dos.h>  
int _creat(char *filename, int attrib);  
Prototype in: io.h  
Description: see creat

**creat**

Name: creat - creates a new file or rewrites an existing one  
Usage: #include <sys/stat.h>  
int creat(char *filename, int perm);  
Related functions usage: int _creat(char *filename, int attrib);  
int creatnew(char *filename, int attrib);  
int creattemp(char *filename, int attrib);  
Prototype in: io.h
**Description**

`creat` creates a new file or prepares to rewrite an existing file named by the string pointed to by `filename`. `permis` only applies to newly created files.

If the file exists and the write attribute is set, `creat` truncates the file to a length of zero bytes, leaving the file attributes unchanged. If the existing file has the read-only attribute set, the `creat` call fails, and the file remains unchanged.

The `creat` call examines only one bit of the access-mode word `permis`; this is the UNIX owner-write permission bit.

If the owner-write permission bit is 1, the file is writable. If the bit is 0, the file is marked as read-only. All other MS-DOS attributes are set to 0.

`permis` can be one of the following (defined in `sys\stat.h`):

<table>
<thead>
<tr>
<th>Value of <code>permis</code></th>
<th>Access Permission</th>
</tr>
</thead>
<tbody>
<tr>
<td>S_IWRITE</td>
<td>Permission to write</td>
</tr>
<tr>
<td>S_IREAD</td>
<td>Permission to read</td>
</tr>
<tr>
<td>S_IREAD|S_IWRITE</td>
<td>Permission to read and write</td>
</tr>
</tbody>
</table>

Note: In DOS, write permission implies read permission.

A file created with `_creat` is always created in the translation mode specified by the global variable `_fmode` (`O_TEXT` or `O_BINARY`).

To create a file in a particular mode, you can either assign to `_fmode`, or call `open` with the `O_CREAT` and `O_TRUNC` option ORed with the translation mode desired. For example, the call

```c
open ("xmp", O_CREAT|O_TRUNC|O_BINARY, S_IREAD)
```

will create a binary-mode, read-only file named XMP, truncating its length to 0 bytes if it already existed.

`_creat` accepts `attrib`, an MS-DOS attribute word. Any attribute bits may be set in this call. The file is always opened in binary mode. Upon successful file creation, the file pointer is set to the beginning of the file. The file is opened for both reading and writing.
creatnew is identical to _create, with the exception that, if the file exists, the creatnew call returns an error and leaves the file untouched.

creattemp is similar to _creat except that the filename is a path name ending with a backslash (\). A unique file name is selected in the directory given by filename. The newly created file name is stored in the filename string supplied. filename should be long enough to hold the resulting file name. The file is not automatically deleted when the program terminates.

The attrib argument to _creat, creatnew, and creattemp can be one of the following constants (defined in dos.h):

<table>
<thead>
<tr>
<th>Constant</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FA_RDONLY</td>
<td>Read only attribute</td>
</tr>
<tr>
<td>FA_HIDDEN</td>
<td>Hidden file</td>
</tr>
<tr>
<td>FA_SYSTEM</td>
<td>System file</td>
</tr>
</tbody>
</table>

Return value

Upon successful completion, the new file handle, a non-negative integer, is returned; otherwise, a -1 is returned.

In the event of error, errno is set to one of the following:

- ENOENT Path or file name not found
- EMFILE Too many open files
- EACCES Permission denied

Portability

creat is available on UNIX systems. _creat is unique to MS-DOS. creatnew and creattemp are unique to MS-DOS 3.0 and will not work on earlier DOS versions.

See also

bsearch, close, dup, _fmode (variable), open, read, write

---

**creatnew**

---

**Name**
creatnew – creates a new file

**Usage**

```c
#include <dos.h>
int creatnew(char *filename, int attrib);
```

**Prototype in**
io.h

**Description**

see creat
**creattemp**

**Name**
creattemp – creates a new file or rewrites an existing one

**Usage**
#include <dos.h>
int creattemp(char *filename, int attrib);

**Prototype in**
io.h

**Description**
see creat

**cscanf**

**Name**
cscanf – performs formatted input from console

**Usage**
int cscanf(char *format[, argument, ...]);

**Prototype in**
conio.h

**Description**
see scanf

**ctime**

**Name**
cftime – converts date and time to a string

**Usage**
char *ctime(long *clock);

**Related functions usage**
char *asctime(struct tm *tm);
double difftime(time_t time2, time_t time1);
struct tm *gmtime(long *clock);
struct tm *localtime(long *clock);
void tzset( void);
Prototype in time.h

Description
ctime converts a time pointed to by clock (such as returned by the function time) into a 26-character string in the following form:

Mon Nov 21 11:31:54 1983

All the fields have constant width.

asctime converts a time stored as a structure to a 26-character string of the same form as the ctime string.

difftime calculates the elapsed time, in seconds, from time1 to time2.

localtime and gmtime return pointers to structures containing the broken-down time. localtime corrects for the time zone and possible daylight savings time; gmtime converts directly to GMT.

The global long variable timezone contains the difference in seconds between GMT and local standard time (in EST, timezone is 5*60*60). The global variable daylight is non-zero if and only if the standard U.S.A. Daylight Savings Time conversion should be applied.

The program knows about the peculiarities of this conversion in 1974 and 1975; if necessary, a table for these years can be extended.

tzset is provided for UNIX compatibility and does nothing in this implementation.

The structure declaration from the time.h include file is:

```c
struct tm {
    int tm_sec;
    int tm_min;
    int tm_hour;
    int tm_mday;
    int tm_mon;
    int tm_year;
    int tm_wday;
    int tm_yday;
    int tm_isdst;
};
```

These quantities give the time on a 24-hour clock, day of month (1-31), month (0-11), weekday (Sunday equals 0),
year – 1900, day of year (0-365), and a flag that is non-zero if daylight savings time is in effect.

**Return value**

cftime and asctime return a pointer to the character string containing the date and time. This string is a static which is overwritten with each call.

difftime returns the result of its calculation as a double.

localtime and gmtime return the broken down time structure. This structure is a static which is overwritten with each call.

**Portability**

All functions are available on UNIX systems.

**See also**

gdate, time

**Example**

```c
#include <stdio.h>
#include <time.h>

main()
{
    struct tm *tm_now;
    long secs_now;
    char *str_now;

    time(&secs_now); /* in seconds */
    str_now = ctime(&secs_now); /* make it a string */

    printf("The number of seconds since Jan 1, 1970 is %ld\n", secs_now);
    printf("In other words, the current time is %s\n", str_now);

    tm_now = localtime(&secs_now); /* make it a structure */
    printf("From the structure: day %d %02d-%02d-%02d %02d:%02d:%02d\n",
            tm_now->tm_yday, tm_now->tm_mon, tm_now->tm_mday, tm_now->tm_year,
            tm_now->tm_hour, tm_now->tm_min, tm_now->tm_sec);

    str_now = asctime(tm_now); /* from structure to string */
    printf("Once more, the current time is %s\n", str_now);
}
```

**Program output**

The number of seconds since Jan 1, 1970 is 315594553
In other words, the current time is Tue Jan 01 12:09:13 1980

From the structure: day 0 00-01-80 12:09:13
Once more, the current time is Tue Jan 01 12:09:13 1980

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# ctrlbrk

<table>
<thead>
<tr>
<th>Name</th>
<th>ctrlbrk – sets control-break handler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>void ctrlbrk(int (*fptr)(void));</td>
</tr>
<tr>
<td>Prototype in</td>
<td>dos.h</td>
</tr>
<tr>
<td>Description</td>
<td>ctrlbrk sets a new control-break handler function pointed to by fptr. The interrupt vector 0x23 is modified to call the named function. The named function is not called directly. ctrlbrk establishes a DOS interrupt handler that calls the named function. The handler function may perform any number of operations and system calls. The handler does not have to return; it may use longjmp to return to an arbitrary point in the program. ctrlbrk returns nothing. The handler function returns 0 to abort the current program; any other value will cause the program to resume execution.</td>
</tr>
<tr>
<td>Return value</td>
<td>ctrlbrk returns nothing. The handler function returns 0 to abort the current program; any other value will cause the program to resume execution.</td>
</tr>
<tr>
<td>Portability</td>
<td>Unique to MS-DOS.</td>
</tr>
<tr>
<td>See also</td>
<td>longjmp, setjmp</td>
</tr>
<tr>
<td>Example</td>
<td></td>
</tr>
</tbody>
</table>

```c
#include <stdio.h>
#include <dos.h>
#define ABORT 0

int c_break(void)
{
    printf("Control-Break hit. Program aborting ...\n");
    return(ABORT);
}
```
main()
{
    ctrlbrk(c break);
    for (;;) /* infinite loop */
        printf("Looping ...
");
}

Program output
Looping ...
Looping ...
Looping ...
"C
Control-Break hit. Program aborting ...

difftime

Name          difftime – computes difference between two times
Usage          #include <time.h>
Prototype in   time.h
Description    see ctime

disable

Name          disable – disables interrupts
Usage          #include <dos.h>
Related functions usage   void enable(void);
Prototype in   dos.h
These macros are designed to provide a programmer with flexible hardware interrupt control.

The `disable` macro disables interrupts. Only the NMI interrupt will still be allowed from any external device.

The `enable` macro enables interrupts. This allows any device interrupts to occur.

The `geninterrupt` macro triggers a software trap for the interrupt given by `intr_num`.

`disable` and `enable` return nothing. For `geninterrupt` the return value depends on the interrupt that was called.

These macros are unique to the 8086 architecture.

### dosexterr

**Name**

dosexterr – gets extended error

**Usage**

```c
#include <dos.h>
int dosexterr(struct DOSERR *eblkp);
```

**Prototype in**
dos.h

**Description**

This function fills in the DOSERR structure pointed to by `eblkp` with extended error information after an MS-DOS call has failed. The structure is defined as follows:

```c
struct DOSERR {
    int exterror;          /* Extended error */
    char class;            /* Error class */
    char action;           /* Action */
    char locus;            /* Error locus */
};
```

The values in this structure are obtained via DOS call 0x59. An `exterror` value of 0 indicates the prior MS-DOS call did not result in an error.
<table>
<thead>
<tr>
<th>Return value</th>
<th>dosexterr returns the value <em>exterror</em>.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portability</td>
<td>Unique to MS-DOS 3.x; cannot be used on earlier releases of MS-DOS.</td>
</tr>
</tbody>
</table>

## dostounix

<table>
<thead>
<tr>
<th>Name</th>
<th>dostounix – converts date and time to UNIX time format</th>
</tr>
</thead>
</table>
| Usage         | `#include <dos.h>`
               | long dostounix(struct date *dateptr, struct time *timeptr); |
| Related functions usage | void unixtodos(long utime, struct date *dateptr, struct time *timeptr); |
| Prototype in  | dos.h |
| Description   | dostounix converts a date and time as returned from getdate and gettime into UNIX-format time. `dateptr` points to a date structure, and `timeptr` points to a time structure containing valid DOS date and time information. unixtodos converts the UNIX-format time given in `utime` to DOS format and fills in the date and time structures pointed to by `dateptr` and `timeptr`. |
| Return value  | dostounix UNIX version of current time: number of seconds since 00:00:00 on January 1, 1970 (GMT). unixtodos returns nothing. |
| Portability   | Both functions are unique to MS-DOS. |
| See also      | ctime, getdate, gettime |
**dup**

<table>
<thead>
<tr>
<th>Name</th>
<th>dup – duplicates a file handle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>int dup(int handle);</td>
</tr>
<tr>
<td>Related functions usage</td>
<td>int dup2(int oldhandle, int newhandle);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>io.h</td>
</tr>
<tr>
<td>Description</td>
<td>dup and dup2 each return a new file handle that has the following in common with the original file handle:</td>
</tr>
<tr>
<td></td>
<td>• same open file or device</td>
</tr>
<tr>
<td></td>
<td>• same file pointer (that is, changing the file pointer of one changes the other)</td>
</tr>
<tr>
<td></td>
<td>• same access mode (read, write, read/write)</td>
</tr>
<tr>
<td>dup2 returns the next file handle available; dup2 returns a new handle with the value of newhandle. If the file associated with newhandle is open when dup2 is called, it is closed.</td>
<td></td>
</tr>
<tr>
<td>handle and oldhandle are file handles obtained from a creat, open, dup, dup2, or fcntl call.</td>
<td></td>
</tr>
<tr>
<td>Return value</td>
<td>Upon successful completion, dup returns the new file handle, a non-negative integer; otherwise, dup returns -1.</td>
</tr>
<tr>
<td></td>
<td>dup2 returns 0 on successful completion, -1 otherwise.</td>
</tr>
<tr>
<td></td>
<td>In the event of error, errno is set to one of the following:</td>
</tr>
<tr>
<td></td>
<td>EFILE Too many open files</td>
</tr>
<tr>
<td></td>
<td>EBADF Bad file number</td>
</tr>
<tr>
<td>Portability</td>
<td>dup is available on all UNIX systems.</td>
</tr>
<tr>
<td></td>
<td>dup2 is available on some UNIX systems, but not System III.</td>
</tr>
<tr>
<td>See also</td>
<td>close, creat, open, read, write</td>
</tr>
</tbody>
</table>

Turbo C Reference Guide
**dup2**

<table>
<thead>
<tr>
<th>Name</th>
<th>dup2 – duplicates a file handle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>int dup2(int oldhandle, int newhandle);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>io.h</td>
</tr>
<tr>
<td>Description</td>
<td>see dup</td>
</tr>
</tbody>
</table>

**ecvt**

<table>
<thead>
<tr>
<th>Name</th>
<th>ecvt – converts a floating-point number to a string</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>char *ecvt(double value, int ndigit, int *decpt, int *sign);</td>
</tr>
<tr>
<td>Related functions usage</td>
<td>char *fcvt(double value, int ndigit, int *decpt, int *sign);</td>
</tr>
<tr>
<td></td>
<td>char *gcvt(double value, int ndigit, char *buf);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>stdlib.h</td>
</tr>
</tbody>
</table>
| Description | ecvt converts value to a null-terminated string of ndigit digits and returns a pointer to the string. The position of the decimal point relative to the beginning of the string is stored indirectly through decpt (a negative value for decpt means to the left of the returned digits). If the sign of the result is negative, the word pointed to by sign is non-zero; otherwise, it is 0. The low-order digit is rounded.

fcvt is identical to ecvt, except that the correct digit has been rounded for Fortran F-format output of the number of digits specified by ndigit.

gcvt converts value to a null-terminated ASCII string in buf and returns a pointer to buf. It attempts to produce ndigit significant digits in Fortran F-format if possible;
otherwise, E-format (ready for printing) is returned. Trailing zeros may be suppressed.

**Return value**
The return values of `ecvt` and `fcvt` point to static data whose content is overwritten by each call to `ecvt` or `fcvt`. `gcvt` returns the string pointed to by `buf`.

**Portability**
Available on UNIX.

**See also**
printf

---

### enable

<table>
<thead>
<tr>
<th>Name</th>
<th>enable – enables interrupts</th>
</tr>
</thead>
</table>
| Usage      | `#include <dos.h>`
|            | void enable(void);         |
| Prototype in | dos.h                      |
| Description | see disable                |

### eof

<table>
<thead>
<tr>
<th>Name</th>
<th>eof – detects end-of-file</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td><code>int eof(int *handle);</code></td>
</tr>
<tr>
<td>Prototype in</td>
<td>io.h</td>
</tr>
<tr>
<td>Description</td>
<td><code>eof</code> determines whether the file associated with <code>handle</code> has reached end-of-file.</td>
</tr>
</tbody>
</table>

**Return value**
If the current position is end-of-file, `eof` returns the value 1; otherwise, it returns 0. A return value of -1 indicates an error; and `errno` is set to

- EBADF Bad file number

**See also**
`ferror`, `perror`
## exec...

<table>
<thead>
<tr>
<th>Name</th>
<th>exec... – functions that load and run other programs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td><strong>Prototype in</strong> process.h</td>
</tr>
<tr>
<td>Description</td>
<td>The functions in the exec... family load and run (execute) other programs, known as child processes. When an exec... call is successful, the child process overlays the parent process. There must be sufficient memory available for loading and executing the child process.</td>
</tr>
<tr>
<td></td>
<td><strong>pathname</strong> is the file name of the called child process. The exec... functions search for <strong>pathname</strong> using the standard MS-DOS search algorithm:</td>
</tr>
<tr>
<td></td>
<td>- no extension or no period—search for exact file name; if not successful, add .exe and search again</td>
</tr>
<tr>
<td></td>
<td>- extension given—search only for exact file name</td>
</tr>
<tr>
<td></td>
<td>- period given—search only for file name with no extension</td>
</tr>
<tr>
<td></td>
<td>The suffixes l, v, p, and e added to the exec... “family name” specify that the named function will operate with certain capabilities.</td>
</tr>
</tbody>
</table>
\( p \) specifies that the function will search for the child in those directories specified by the DOS PATH environment variable. Without the \( p \) suffix, the function only searches the root and current working directory.

\( l \) specifies that the argument pointers \((\text{arg}0, \text{arg}1, \ldots, \text{arg}n)\) are passed as separate arguments. Typically, the \( l \) suffix is used when you know in advance the number of arguments to be passed.

\( v \) specifies that the argument pointers \((\text{argv}[0] \ldots, \text{argv}[n])\) are passed as an array of pointers. Typically, the \( v \) suffix is used when a variable number of arguments is to be passed.

\( e \) specifies that the argument \( \text{envp} \) may be passed to the child process, allowing you to alter the environment for the child process. Without the \( e \) suffix, child processes inherit the environment of the parent process.

Each function in the exec... family must have one of the two argument-specifying suffixes (either \( l \) or \( v \)). The \textit{path search} and \textit{environment inheritance} suffixes (\( p \) and \( e \)) are optional.

For example,

- \textbf{execl} is an exec... function that takes separate arguments, searches only the root or current directory for the child, and passes on the parent’s environment to the child.

- \textbf{execvpe} is an exec... function that takes an array of argument pointers, incorporates PATH in its search for the child process, and accepts the \( \text{envp} \) argument for altering the child’s environment.

The exec... functions must pass at least one argument to the child process \((\text{arg}0 \text{ or } \text{argv}[0])\): This argument is, by convention, a copy of \textit{pathname}. (Using a different value for this zeroth argument won’t produce an error.)

Under MS-DOS 3.x, \textit{pathname} is available for the child process; under earlier versions, the child process cannot use the passed value of the zeroth argument \((\text{arg}0 \text{ or } \text{argv}[0])\).
When the \texttt{l} suffix is used, \texttt{arg0} usually points to \texttt{pathname}, and \texttt{arg1}, \ldots, \texttt{argn} point to character strings that form the new list of arguments. A mandatory NULL following \texttt{argn} marks the end of the list.

When the \texttt{e} suffix is used, you pass a list of new environment settings through the argument \texttt{envp}. This environment argument is an array of \texttt{char*}. Each element points to a null-terminated character string of the form

\texttt{envvar\ math<equal\ mtext>value}

where \texttt{envvar} is the name of an environment variable, and \texttt{value} is the string value to which \texttt{envvar} is set. The last element in \texttt{envp[ ]} is NULL. When \texttt{envp[0]} is NULL, the child inherits the parents' environment settings.

The combined length of \texttt{arg0} + \texttt{arg1} + \ldots + \texttt{argn} (or of \texttt{argv[0]} + \texttt{argv[1]} + \ldots + \texttt{argn[n]}), including space characters that separate the arguments, must be less than 128 bytes. Null terminators are not counted.

When an \texttt{exec...} function call is made, any open files remain open in the child process.

**Return value**

If successful, the \texttt{exec...} functions return no value. On error, the \texttt{exec...} functions return \texttt{-1}, and \texttt{errno} is set to one of the following:

- \texttt{E2BIG} \quad \text{Arg list too long}
- \texttt{EACCES} \quad \text{Permission denied}
- \texttt{EMFILE} \quad \text{Too many open files}
- \texttt{ENOENT} \quad \text{Path or file name not found}
- \texttt{ENOEXEC} \quad \text{Exec format error}
- \texttt{ENOMEM} \quad \text{Not enough core}

**See also**

\texttt{abort, atexit, exit, searchpath, spawn, system}

**Example**

\begin{verbatim}
#include <stdio.h>
#include <process.h>

main()
{
    int stat;

    printf("About to exec child with arg1 arg2 ...\n");
    stat = execl("CHILD.EXE", "CHILD.EXE", "arg1", "arg2", NULL);
\end{verbatim}

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/* execl will return only if it cannot run CHILD */
printf("execl error = %d\n", stat);
exit(1);
}

/* CHILD.C */
#include <stdio.h>

main(int argc, char *argv[])
{
   int i;
   printf("Child running ... \n");
   /* print out its arguments */
   for (i=0; i<argc; i++)
      printf("argv[%d]: %s\n", i, argv[i]);
}

Program output

About to exec child with arg1 arg2 ...
Child running ...
argv[0]: CHILD.EXE
argv[1]: arg1
argv[2]: arg2

_exit

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>_exit</td>
<td>_exit – terminates program</td>
</tr>
<tr>
<td>Usage</td>
<td>void _exit(int status);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>process.h</td>
</tr>
<tr>
<td>Description</td>
<td>see exit</td>
</tr>
</tbody>
</table>
exit

Name exit - terminates program
Usage void exit(int status);
Related functions usage void _exit(int status);
Prototype in process.h
Description exit terminates the calling process. Before exiting, all files are closed, buffered output (waiting to be output) is written, and any registered "exit functions" (posted with atexit) are called.

_exit terminates without closing any files, flushing any output, or calling any exit functions.

In either case, status is provided for the calling process as the exit status of the process. Typically a value of 0 is used to indicate a normal exit, and a non-zero value indicates some error.

Return value These functions never return a value.
Portability exit and _exit are available on UNIX systems.
See also abort, atexit, exec..., spawn...

exp

Name exp - exponential function; returns e^x
Usage double exp(double x);
Related functions usage double frexp(double value, int *eptr);
double ldexp(double value, int exp);
Prototype in: math.h

Description:

exp calculates the exponential function $e^x$.

frexp calculates the mantissa $x$ (a double $<1$) and $n$ (an integer) such that $value = x \cdot 2^n$. frexp stores $n$ in the integer that eptr points to.

ldexp calculates the double $value \cdot 2^{\exp}$.

log calculates the natural logarithm of $x$.

log10 calculates the base 10 logarithm of $x$.

pow calculates $x^y$.

pow10 computes $10^p$.

sqrt calculates $+\sqrt{x}$.

Return value:

All these functions, on success, return the value they calculated.

exp returns $e^x$.

frexp returns $x$ ($<1$) where $value = x \cdot 2^n$.

ldexp returns $x$ where $x = value \cdot 2^{\exp}$.

log returns $ln(x)$.

log10 returns $log_{10}(x)$.

pow returns $p$ where $p = x^y$.

pow10 returns $x$ where $x = 10^p$.

sqrt returns $q$ where $q = +\sqrt{x}$.

Sometimes the arguments passed to these functions produce results that overflow or are incalculable. When the correct value would overflow, exp and pow return the value HUGE_VAL. Results of excessively large magnitude can cause errno to be set to.
Portability

The following errors cause `errno` to be set to

**EDOM**  Domain error
- The argument `x` passed to `log` or `log10` is less than or equal to 0.
- The argument `x` passed to `pow` is less than or equal to 0 and `y` is not a whole number.
- The arguments `x` and `y` passed to `pow` are both 0.
- The argument `x` passed to `sqrt` is less than 0.

When these errors occur
- `log`, `log10`, and `pow` return the value negative `HUGE_VAL`.
- `sqrt` returns 0.

Error handling for these routines can be modified through the function `matherr`.

**Portability**  Available on UNIX systems.

**See also**  `hyperb`, `trig`, `matherr`

---

**fabs**

<table>
<thead>
<tr>
<th>Name</th>
<th>fabs – absolute value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>double fabs(double x);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>math.h</td>
</tr>
<tr>
<td>Description</td>
<td>see abs</td>
</tr>
</tbody>
</table>
**faralloc**

Name  
faralloc – allocates memory from the far heap

Usage  
void far * faralloc(unsigned long nunits,  
unsigned long unitsz);

Prototype in  
alloc.h

Description  
see farmalloc

**farcoreleft**

Name  
farcoreleft – returns measure of unused memory in far heap

Usage  
long farcoreleft(void);

Prototype in  
alloc.h

Description  
see farmalloc

**farfree**

Name  
farfree – frees a block from far heap

Usage  
void farfree(void far * block);

Prototype in  
alloc.h

Description  
see farmalloc
farmalloc

<table>
<thead>
<tr>
<th>Name</th>
<th>farmalloc – allocates from far heap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>void far *farmalloc(unsigned long size);</td>
</tr>
<tr>
<td>Related</td>
<td>void far *farcalloc(unsigned long nunits,</td>
</tr>
<tr>
<td>functions usage</td>
<td>unsigned long unitsz);</td>
</tr>
<tr>
<td></td>
<td>long farcoreleft(void);</td>
</tr>
<tr>
<td></td>
<td>void farfree(void far *block);</td>
</tr>
<tr>
<td></td>
<td>void far *farrealloc(void far *block,</td>
</tr>
<tr>
<td></td>
<td>unsigned long newsize);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>alloc.h</td>
</tr>
<tr>
<td>Description</td>
<td>farmalloc allocates a block of memory size bytes long</td>
</tr>
<tr>
<td></td>
<td>from the far heap.</td>
</tr>
<tr>
<td></td>
<td>farcalloc allocates memory from the far heap for an</td>
</tr>
<tr>
<td></td>
<td>array containing nunits elements, each unitsz bytes long.</td>
</tr>
<tr>
<td></td>
<td>farcoreleft returns a measure of the amount of unused</td>
</tr>
<tr>
<td></td>
<td>memory in the far heap beyond the highest allocated</td>
</tr>
<tr>
<td></td>
<td>block.</td>
</tr>
<tr>
<td></td>
<td>farfree releases a block of previously allocated far</td>
</tr>
<tr>
<td></td>
<td>memory.</td>
</tr>
<tr>
<td></td>
<td>farrealloc adjusts the size of the allocated block to</td>
</tr>
<tr>
<td></td>
<td>newsize, copying the contents to a new location if</td>
</tr>
<tr>
<td></td>
<td>necessary.</td>
</tr>
</tbody>
</table>

For allocating from the far heap, note that:

- all of available RAM can be allocated
- blocks larger than 64K can be allocated
- far pointers are used to access the allocated blocks

In the compact, large, and huge memory models, these functions are similar, though not identical, to the normal memory allocation functions. These functions take
unsigned long parameters, while the normal ones (malloc, etc.) take unsigned. (Refer to malloc.)

The tiny model cannot make use of these functions because it cannot have any segment fixups, which are often produced by far pointers.

In the small and medium memory models, blocks allocated by farmalloc may not be freed via normal free, and blocks allocated via malloc cannot be freed via farfree. In these models the two heaps are completely distinct.

Return value

farmalloc and farcalloc return a pointer to the newly allocated block, or NULL if not enough space exists for the new block.

farrealloc returns the address of the reallocated block. This may be different than the address of the original block. If the block cannot be reallocated, farrealloc returns NULL.

farcoreleft returns the total amount of space left between the highest allocated block and the end of memory.

Portability

Unique to MS-DOS.

See also

malloc

Example

/* Far Memory Management

farmalloc - allocates space on the far heap
farrealloc - adjusts allocated block in far heap
farfree - frees far heap

*/
#include <stdio.h>
#include <alloc.h>

main()
{
char far * block;
long size = 65000;

/* Find out what's out there */

printf("%lu bytes free\n", farcoreleft());
/* Get a piece of it */

block = farmalloc(size);
if (block == NULL) {
    printf("failed to allocate\n");
    exit(1);
}
printf("%lu bytes allocated, ",size);
printf("%lu bytes free\n", farcoreleft());

/* Shrink the block */
size /= 2;
block = farrealloc(block, size);
printf("block now reallocated to %lu bytes, ",size);
printf("%lu bytes free\n", farcoreleft());

/* Let it go entirely */
printf("Free the block\n");
farfree(block);
printf("block now freed, ");
printf("%lu bytes free\n", farcoreleft());

} /* End of main */

Program output

359616 bytes free
65000 bytes allocated, 294608 bytes free
block now reallocated to 32500 bytes, 262100 bytes free
Free the block
Block now freed, 359616 bytes free

farrealloc

Namefarrealloc – adjusts allocated block in far heap
Usage void far * farrealloc(void far * block,
                           unsigned long newsize);
Prototype in alloc.h
Description see farmalloc
fclose

Name  fclose – closes a stream

Usage  
#include <stdio.h>
int fclose(FILE *stream);

Related functions usage  int fcloseall(void);
int fflush(FILE *stream);
int flushall(void);

Prototype in  stdio.h

Description  fclose closes the named stream; generally, all buffers associated with stream are flushed before closing. System-allocated buffers are freed upon closing. Buffers assigned with setbuf or setvbuf are not automatically freed.

fcloseall closes all open streams except stdin and stdout.

fflush causes the contents of the buffer associated with an open output stream to be written to stream, and clears the buffer contents if stream is an open input stream. stream remains open.

flushall clears all buffers associated with open input streams, and writes all buffers associated with open output streams to their respective files. Any read operation following flushall reads new data into the buffers from the input files.

Return value  fclose and fflush return 0 on success; fcloseall returns the total number of streams it closed. fclose, fcloseall, and fflush return EOF if any errors were detected.

flushall returns an integer, which is the number of open input and output streams.

Portability  These functions are available on UNIX systems.

See also  close, fopen, setbuf
**fcloseall**

<table>
<thead>
<tr>
<th>Name</th>
<th>fcloseall – closes open streams</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>int fcloseall(void);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>stdio.h</td>
</tr>
<tr>
<td>Description</td>
<td>see fclose</td>
</tr>
</tbody>
</table>

**fcvt**

<table>
<thead>
<tr>
<th>Name</th>
<th>fcvt – converts a floating-point number to a string</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>char *fcvt(double value, int ndigit, int *decpt, int *sign);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>stdlib.h</td>
</tr>
<tr>
<td>Description</td>
<td>see ecvt</td>
</tr>
</tbody>
</table>

**fdopen**

<table>
<thead>
<tr>
<th>Name</th>
<th>fdopen – associates a stream with a file handle</th>
</tr>
</thead>
</table>
| Usage         | #include <stdio.h>  
               | FILE *fdopen(int handle, char *type);               |
| Prototype in  | stdio.h                                             |
| Description   | see fopen                                           |
### `feof`

<table>
<thead>
<tr>
<th>Name</th>
<th><code>feof</code> – detects end-of-file on stream</th>
</tr>
</thead>
</table>
| Usage       | `#include <stdio.h>`
             | `int feof(FILE * stream);`           |
| Prototype in| `stdio.h`                             |
| Description | see `ferror`                          |

### `ferror`

<table>
<thead>
<tr>
<th>Name</th>
<th><code>ferror</code> – detects errors on stream</th>
</tr>
</thead>
</table>
| Usage       | `#include <stdio.h>`
             | `int ferror(FILE * stream);`        |
| Related     | **clearerr**
             | `void clearerr(FILE * stream);`     |
| functions   | **feof**
             | `int feof(FILE * stream);`          |
| usage       | **rewind**
             | ``                                    |
| Prototype in| `stdio.h`                             |
| Description | `ferror` is a macro that tests the given stream for a read or write error. If the stream's error indicator has been set, it remains set until `clearerr` or `rewind` is called, or until the stream is closed.

`clearerr` sets the stream's error and end-of-file indicators to 0.

`feof` is a macro that tests the given stream for an end-of-file indicator. Once the indicator is set, read operations on the file return the indicator until `rewind` is called or the file is closed.

**Return value**  
`ferror` returns non-zero if an error was detected on the named stream.
clearerr resets the error and end-of-file indicators on the named stream; it returns nothing.

feof returns non-zero if an end-of-file indicator was detected on the last input operation on the named stream.

The end-of-file indicator is reset with each input operation.

**Portability**
These functions are available on UNIX systems.

**See also**
eof, fopen, getc, gets, open, putc, puts

---

### fflush

**Name**
flush – flushes a stream

**Usage**
```
#include <stdio.h>
int fflush(FILE *stream);
```

**Prototype in**
stdio.h

**Description**
see fclose

---

### fgetc

**Name**
fgetc – gets character from stream

**Usage**
```
#include <stdio.h>
int fgetc(FILE *stream);
```

**Prototype in**
stdio.h

**Description**
see getc
### fgetchar

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>fgetchar</td>
<td>gets character from stream</td>
</tr>
</tbody>
</table>

| Usage        | int fgetchar(void);          |
| Prototype in | stdio.h                      |
| Description  | see getc                     |

### fgets

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>fgets</td>
<td>gets a string from a stream</td>
</tr>
</tbody>
</table>

| Usage        | #include <stdio.h>           |
| Prototype in | char *fgets(char *string, int n, FILE *stream); |
| Description  | see gets                     |

### filelength

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>filelength</td>
<td>gets file size in bytes</td>
</tr>
</tbody>
</table>

| Usage        | long filelength(int handle); |
| Prototype in | io.h                         |
| Description  | filelength returns the length (in bytes) of the file associated with handle. |
Return value  On success, filelength returns a long value, the file length in bytes. On error, the return value is -1L and errno is set to

EBADF     Bad file number

fileno

Name     fileno – gets file handle
Usage    #include <stdio.h>
int fileno(FILE * stream);
Prototype in stdio.h
Description  fileno is a macro that returns the file handle for the given stream. If stream has more than one handle, fileno returns the handle assigned to the stream when it was first opened.
Return value  fileno returns the integer file handle associated with the stream.
Portability  Available on UNIX systems.

findfirst

Name     findfirst – searches disk directory
Usage    #include <dir.h>
#include <dos.h>
int findfirst(char *pathname, struct ffblk *ffblk, int attrib);
Related functions usage  int findnext(struct ffblk *ffblk);
Prototype in dir.h
Description  findfirst begins a search of a disk directory by using the MS-DOS system call 0x4E.
pathname is a string with an optional drive specifier, path and file name of the file to be found. The file name portion may contain wildcard match characters (such as ? or *). If a matching file is found, the ffblk structure is filled with the file-directory information.

attrib is an MS-DOS file-attribue byte used in selecting eligible files for the search. attrib can be one of the following constants defined in dos.h.

- FA_RDONLY Read only attribute
- FA_HIDDEN Hidden file
- FA_SYSTEM System file
- FA_LABEL Volume label
- FA_DIREC Directory
- FA_ARCH Archive

For more detailed information about these attributes, refer to the MS-DOS Programmer's Reference Manual.

findnext is used to fetch subsequent files which match the pathname given in findfirst. ffblk is the same block filled in by the findfirst call. This block contains necessary information for continuing the search. One file name for each call to findnext will be returned until no more files are found in the directory matching the pathname.

The format of the structure ffblk is as follows:

```c
struct ffblk {
    char ff_reserved[21];          /* Reserved by DOS */
    char ff_attrib;                /* Attribute found */
    int ff_ftime;                  /* File time */
    int ff_fdate;                  /* File date */
    long ff_fsize;                 /* File size */
    char ff_name[13];              /* Found file name */
};
```

Note that findfirst and findnext set the MS-DOS disk-transfer address (DTA) to the address of the ffblk.

If you need this DTA value, you should save it and restore it (using getdta and setdta) after each call to findfirst or findnext.

Return value findfirst and findnext return 0 on successfully finding a file matching the search pathname. When no more files
can be found or if there is some error in the file name, –1 is returned, and the global variable errno is set to one of the following:

ENOENT Path or file name not found
ENMFILE No more files

Portability Unique to MS-DOS.

Example

```c
#include <stdio.h>
#include <dir.h>

main()
{
    struct ffblk ffblk;
    int done;

    printf("Directory listing of *.*\n");
    done = findfirst("*.*", &ffblk, 0);
    while (!done) {
        printf(" %s\n", ffblk.ff_name);
        done = findnext(&ffblk);
    }
}
```

Program output

Directory listing of *.*
FINDFRST.C
FINDFRST.OBJ
FINDFRST.MAP
FINDFRST.EXE

findnext

<table>
<thead>
<tr>
<th>Name</th>
<th>findnext – fetches files which match findfirst</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>#include &lt;dir.h&gt; int findnext(struct ffblk **ffblk);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>dir.h</td>
</tr>
<tr>
<td>Description</td>
<td>see findfirst</td>
</tr>
</tbody>
</table>

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### floor

<table>
<thead>
<tr>
<th>Name</th>
<th>floor – rounds down</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>double floor(double x);</td>
</tr>
<tr>
<td>Related functions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>double ceil(double x);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>math.h</td>
</tr>
<tr>
<td>Description</td>
<td>floor finds the largest integer not greater than x. ceil finds the smallest integer not less than x.</td>
</tr>
<tr>
<td>Return value</td>
<td>floor and ceil each return the integer found (as a double).</td>
</tr>
<tr>
<td>Portability</td>
<td>These functions are available on UNIX systems.</td>
</tr>
<tr>
<td>See also</td>
<td>abs</td>
</tr>
</tbody>
</table>

### flushall

<table>
<thead>
<tr>
<th>Name</th>
<th>flushall – clears all buffers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>int flushall(void);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>stdio.h</td>
</tr>
<tr>
<td>Description</td>
<td>see fclose</td>
</tr>
</tbody>
</table>
fmod

Name  

fmod – calculates $x$ modulo $y$, the remainder of $x/y$.

Usage  

double fmod(double x, double y);

Related functions usage  

double modf(double value, double *iptr);

Prototype in  

math.h

Description  

fmod calculates $x$ modulo $y$ (the remainder $f$ where $x = iy + f$ for some integer $i$ and $0 < f < y$).

modf breaks the double value into two parts: the integer and the fraction. It stores the integer in iptr and returns the fraction.

Return value  

fmod returns the remainder $f$ where $x = iy + f$ (as described).

modf returns the fractional part of value.

fnmerge

Name  

fnmerge – makes new file name

Usage  

#include <dir.h>

void fnmerge(char *path, char *drive, char *dir, char *name, char *ext);

Related functions usage  

int fnsplit(char *path, char *drive, char *dir, char *name, char *ext);

Prototype in  

dir.h

Description  

fnmerge makes a file name from its components. The new file’s full path name is

$X:\DIR\SUBDIR\NAME.EXT$
where

\[ x \text{ is given by } drive \]
\[ \text{\backslash DIR\backslash SUBDIR\backslash is given by } dir \]
\[ \text{NAME.OUT is given by } name \text{ and } ext \]

\textbf{fnsplit} takes a file’s full path name \((path)\) as a string in the form

\[ X:\text{\backslash DIR\backslash SUBDIR\backslash NAME.OUT} \]

and splits \(path\) into its four components. It then stores those components in the strings pointed to by \(drive\), \(dir\), \(name\) and \(ext\). (Each component is required but can be a NULL, which means the corresponding component will be parsed but not stored.)

The maximum sizes for these strings are given by the constants MAXDRIVE, MAXDIR, MAXPATH, MAXNAME and MAXEXT, (defined in dir.h) and each size includes space for the null-terminator.

<table>
<thead>
<tr>
<th>Constant</th>
<th>(Max.)</th>
<th>String</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAXPATH</td>
<td>(80)</td>
<td>(path)</td>
</tr>
<tr>
<td>MAXDRIVE</td>
<td>(3)</td>
<td>(drive); includes colon (:)</td>
</tr>
<tr>
<td>MAXDIR</td>
<td>(66)</td>
<td>(dir); includes leading and trailing backslashes ()</td>
</tr>
<tr>
<td>MAXFILE</td>
<td>(9)</td>
<td>(name)</td>
</tr>
<tr>
<td>MAXEXT</td>
<td>(5)</td>
<td>(ext); includes leading dot (.)</td>
</tr>
</tbody>
</table>

\textbf{fnsplit} assumes that there is enough space to store each non-NULL component. \textbf{fnmerge} assumes that there is enough space for the constructed path name. The maximum constructed length is MAXPATH.

When \textbf{fnsplit} splits \(path\), it treats the punctuation as follows:

- \(drive\) keeps the colon attached (C:, A:, etc.)
- \(dir\) keeps the leading and trailing backslashes (\textbackslash\textbackslash texttt\{\texttt\backslash turboc\textbackslash \texttt\include\}, etc.)
- \(ext\) keeps the dot preceding the extension (.c, .exe, etc.)

These two functions are invertible; if you split a given \(path\) with \textbf{fnsplit}, then merge the resultant components with \textbf{fnmerge}, you end up with \(path\).
Return value  \texttt{fnsplit} returns an integer (composed of five flags, defined in \texttt{dir.h}) indicating which of the full path name components were present in \textit{path}; these flags and the components they represent are:

- \texttt{EXTENSION} an extension
- \texttt{FILENAME} a filename
- \texttt{DIRECTORY} a directory (and possibly subdirectories)
- \texttt{DRIVE} a drive specification (see \texttt{dir.h})
- \texttt{WILDCARDS} wildcards (* or ? cards)

Portability  Available on MS-DOS systems only.

See also

Example

```c
#include <stdio.h>
#include <dir.h>

char drive[MAXDRIVE];
char dir[MAXDIR];
char file[MAXFILE];
char ext[MAXEXT];

int main()
{
  char s[MAXPATH], t[MAXPATH];
  int flag;

  for (;;) {
    printf("> ");          /* print input prompt */
    if (!gets(s)) break;  /* while there is more input */
    flag = fnsplit(s,drive,dir,file,ext);

    /* print the components */
    printf(" drive: %s, dir: %s, file: %s, ext: %s, ",
            drive, dir, file, ext);
    printf("flags: ");
    if (flag & DRIVE)
      printf("d");
    if (flag & DIRECTORY)
      printf("d");
    if (flag & FILENAME)
      printf("f");
    if (flag & EXTENSION)
      printf("e");
    printf("\n");
  }
}
```

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/* glue the parts back together and compare to original */
fnmerge(t, drive, dir, file, ext);
if (strcmp(t, s) != 0) /* shouldn't happen! */
    printf(" --> strings are different!");
}

Program output

> C:\TURBOC\FN.C
> FILE.C
> \TURBOC\SUBDIR\NOEXT.
  drive: , dir: \TURBOC\SUBDIR\, file: NOEXT, ext: ., flags: dfe
> C:MYFILE
  drive: C:, dir: , file: MYFILE, ext: , flags: :f
> ^Z

fnsplit

<table>
<thead>
<tr>
<th>Name</th>
<th>fnsplit – splits a full path name into its components</th>
</tr>
</thead>
</table>
| Usage      | #include <dir.h>
            | int fnsplit(char *path, char *drive, char *dir, |
            |     char *name, char *ext);                        |
| Prototype in | dir.h |
| Description | see fnmerge |

Turbo C Reference Guide
# fopen

**Name**  
fopen – opens a stream

**Usage**  
#include <stdio.h>  
FILE *fopen(char *filename, char *type);

**Related functions usage**  
FILE *fdopen(int handle, char *type);  
FILE *freopen(char *filename, char *type, FILE *stream);

**Prototype in**  
stdio.h

**Description**  
fopen opens the file named by filename and associates a stream with it. fopen returns a pointer to be used to identify the stream in subsequent operations.

fdopen associates a stream with a file handle obtained from creat, dup, dup2, or open. The type of stream must match the mode of the open handle.

freopen substitutes the named file in place of the open stream. The original stream is closed, regardless of whether the open succeeds. freopen is useful for changing the file attached to stdin, stdout, or stderr.

The type string used in each of these calls is one of the following values:

- **r**  
  Open for reading only.

- **w**  
  Create for writing.

- **a**  
  Append; open for writing at end of file or create for writing if the file does not exist.

- **r+**  
  Open an existing file for update (reading and writing).

- **w+**  
  Create a new file for update.

- **a+**  
  Open for append; open (or create if the file does not exist) for update at the end of the file.

---

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To specify that a given file is being opened or created in text mode, you can append a t to the value of type (rt, w+t, etc.); similarly, to specify binary mode, you can append a b to the type value (wb, a+b, etc.)

If a t or b is not given in type, the mode is governed by the global variable _fmode. If _fmode is set to O_BINARY, files will be opened in binary mode. If _fmode is set to O_TEXT, they will be opened in text mode. These O constants are defined in fcntl.h.

When a file is opened for update, both input and output may be done on the resulting stream. However, output may not be directly followed by input without an intervening fseek or rewind, and input may not be directly followed by output without an intervening fseek, rewind, or an input which encounters end-of-file.

**Return value**

On successful completion, each function returns the newly open stream. freopen returns the argument stream. In the event of error, each function returns NULL.

**Portability**

These functions are available on UNIX systems. fopen is defined by Kernighan and Ritchie.

**See also**

creat, dup, fclose, ferror, _fmode (variable), fread, fseek, getc, gets, open, putc, puts, rewind, setbuf, setmode

**Example**

```c
#include <stdio.h>
#include <fcntl.h>  /* needed to define the mode used in open */

main()
{
    int handle, status;
    FILE *stream;
    /* open a file */
    handle = open("MYFILE.TXT", O_CREAT);
    /* now turn it into a stream */
    stream = fdopen(handle, "w");
    if (stream == NULL)
        printf("fdopen failed\n");
    else {
        fprintf(stream, "Hello, world\n");
        fclose(stream);
    }
}
```

Turbo C Reference Guide
# FP_OFF

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FP_OFF</td>
<td>gets a far address offset</td>
</tr>
<tr>
<td>Usage</td>
<td>#include &lt;dos.h&gt;\nunsigned FP_OFF(void far *farptr);</td>
</tr>
<tr>
<td>Related</td>
<td><strong>functions usage</strong>\nunsinged FP_SEG(void far*farptr);</td>
</tr>
<tr>
<td></td>
<td>void far *MK_FP(unsigned seg, unsigned off);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>dos.h</td>
</tr>
<tr>
<td>Description</td>
<td>The FP_OFF macro can be used to get the offset of the far pointer farptr.</td>
</tr>
<tr>
<td></td>
<td><strong>FP_SEG</strong> is a macro used to get the segment value of the far pointer farptr.</td>
</tr>
<tr>
<td></td>
<td><strong>MK_FP</strong> is a macro that makes a far pointer from its component segment (seg) and offset (off) parts.</td>
</tr>
<tr>
<td>Return value</td>
<td>FP_OFF returns an unsigned integer value representing an offset value.</td>
</tr>
<tr>
<td></td>
<td>FP_SEG returns an unsigned integer representing a segment value.</td>
</tr>
<tr>
<td></td>
<td>MK_FP returns a far pointer.</td>
</tr>
</tbody>
</table>

## Example

```c
#include &lt;stdio.h&gt;
#include &lt;dos.h&gt;

main ()
{
    char far *ptr;
    unsigned seg, off;

    ptr = MK_FP(OxB000, 0);
    seg = FP_SEG(ptr);
    off = FP_OFF(ptr);
    printf("far ptr %Fp, segment %04x, offset %04x\n",
            ptr, seg, off);
}
```

The Turbo C Library
Program output

far ptr B000:0000, segment b000, offset 0000

---

**FP_SEG**

<table>
<thead>
<tr>
<th>Name</th>
<th>FP_SEG – gets far address segment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>#include &lt;dos.h&gt; unsigned FP_SEG(void *farptr);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>dos.h</td>
</tr>
<tr>
<td>Description</td>
<td>see FP_OFF</td>
</tr>
</tbody>
</table>

---

**_fpreset**

<table>
<thead>
<tr>
<th>Name</th>
<th>_fpreset – reinitializes floating-point math package</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>void _fpreset();</td>
</tr>
<tr>
<td>Prototype in</td>
<td>float.h</td>
</tr>
<tr>
<td>Description</td>
<td>_fpreset reinitializes the floating-point math package. This function is usually used in conjunction with signal, system, or the exec... or spawn... functions. Note: Under MS-DOS versions prior to 2.x and 3.x, if an 8087/80287 coprocessor is used in a program, a child process (executed by system or by an exec... or spawn... function) might alter the parent process's floating-point state. If you use an 8087/80287, take the following precautions:</td>
</tr>
</tbody>
</table>

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Do not call system or an exec..., or spawn... function while a floating-point expression is being evaluated.

Call _fpreset to reset the floating-point state after using system, exec..., or spawn... if there is any chance that the child process performed a floating-point operation with the 8087/80287.

Return value
There is no return value.

See also
exec..., longjmp, signal, spawn..., system

fprintf

Name
fprintf – sends formatted output to a stream

Usage
#include <stdio.h>
int fprintf(FILE *stream, char *format[, argument, ...]);

 Prototype in
stdio.h

Description
see printf

fputc

Name
fputc – puts a character on a stream

Usage
#include <stdio.h>
int fputc(int ch, FILE *stream);

 Prototype in
stdio.h

Description
see putc
fputchar

Name       fputchar – puts a character on stdout
Usage      int fputchar(char ch);
Prototype in stdio.h
Description see putc

fputs

Name       fputs – puts a string on a stream
Usage      #include <stdio.h>
            int fputs(char *string, FILE *stream);
Prototype in stdio.h
Description see puts

fread

Name       fread – reads data from a stream
Usage      #include <stdio.h>
            int fread(void *ptr, int size, int nitems, FILE *stream);
Related functions usage int fwrite(void *ptr, int size, int nitems, FILE *stream);
Prototype in stdio.h
Description fread reads nitems of data, each of length size bytes, from the named input stream into a block pointed to by ptr.
fwrite appends *nitems of data, each of length *size bytes, to the named output *stream. The data appended begins at *ptr.

For both functions, the total number of bytes read is (*nitems * *size).

*ptr in the declarations is a pointer to any object. *size is the size of the object *ptr points to. The expression sizeof *ptr will produce the proper value.

**Return value**

On successful completion, each function returns the number of items (not bytes) actually read or written. fread returns a short count (possibly 0) on end-of-file or error. fwrite returns a short count on error.

**Portability**

These functions are available on all UNIX systems.

**See also**

fopen, getc, gets, printf, putc, puts, read, scanf, write

---

**free**

**Name**

free – frees allocated block

**Usage**

void free(void *ptr);

**Prototype in**

stdlib.h and alloc.h

**Description**

see malloc

---

**freemem**

**Name**

freemem – frees a previously allocated DOS memory block

**Usage**

int freemem(unsigned seg);

**Prototype in**

dos.h

**Description**

see allocmem

---

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### freopen

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>freopen – replaces a stream</td>
</tr>
</tbody>
</table>
| Usage     | #include <stdio.h>
            | FILE *freopen(char *filename, char *type, FILE *stream); |
| Prototype in | stdio.h                                        |
| Description | see fopen                                      |

### frexp

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>frexp – splits a double number into mantissa and exponent</td>
</tr>
<tr>
<td>Usage</td>
<td>double frexp(double value, int *eptr);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>math.h</td>
</tr>
<tr>
<td>Description</td>
<td>see exp</td>
</tr>
</tbody>
</table>

### fscanf

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>fscanf – performs formatted input from a stream</td>
</tr>
</tbody>
</table>
| Usage     | #include <stdio.h>
            | int fscanf(FILE *stream, char *format[, argument, ...]); |
| Prototype in | stdio.h                                        |
| Description | see scanf                                     |
fseek

Name  fseek – repositions a file pointer on a stream

Usage  #include <stdio.h>
int fseek(FILE *stream, long offset, int fromwhere);

Related functions usage  long ftell(FILE *stream);
int rewind(FILE *stream);

Prototype in  stdio.h

Description  fseek sets the file pointer associated with stream to a new position that is offset bytes beyond the file location given by fromwhere.

fromwhere must be one of the values 0, 1 or 2, which represent three symbolic constants (defined in stdio.h) as follows:

<table>
<thead>
<tr>
<th>fromwhere</th>
<th>File Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEEK_SET</td>
<td>(0) file beginning</td>
</tr>
<tr>
<td>SEEK_CUR</td>
<td>(1) current file pointer position</td>
</tr>
<tr>
<td>SEEK_END</td>
<td>(2) end-of-file</td>
</tr>
</tbody>
</table>

fseek discards any character pushed back using ungetc.

ftell returns the current file pointer located in stream. The offset is measured in bytes from the beginning of the file.

rewind(stream) is equivalent to fseek(stream, 0L, SEEK_SET), except that rewind clears the end-of-file and error indicators, while fseek only clears the end-of-file indicator.

After fseek or rewind, the next operation on an update file may be either input or output.

Return value  fseek and rewind return 0 if the pointer successfully moved and a non-zero value on failure.
`ftell` returns the current file-pointer position on success or `-1L` on error.

**Portability**

These functions are available on all UNIX systems.

**See also**

`fopen`, `ftell`, `getc`, `lseek`, `setbuf`, `ungetc`

**Example**

```c
#include <stdio.h>

/* returns the number of bytes in file stream */

long filesize(FILE *stream)
{
    long curpos, length;

    curpos = ftell(stream);
    fseek(stream, 0L, SEEK_END);
    length = ftell(stream);
    fseek(stream, curpos, SEEK_SET);
    return(length);
}

main ()
{
    FILE *stream;
    stream = fopen("MYFILE.TXT", "r");
    printf("filesize of MYFILE.TXT is %ld bytes\n", filesize(stream));
}
```

**Program output**

```
filesize of MYFILE.TXT is 15 bytes
```

---

**fstat**

**Name**

`fstat` – gets open file information

**Usage**

```c
#include <sys/stat.h>
int fstat(char *handle, struct stat *buff)
```

**Prototype in**

`sys\stat.h`

**Description**

See `stat`
ftell

Name ftell – returns the current file pointer
Usage #include <stdio.h>
long ftell(FILE *stream);
Prototype in stdio.h
Description see fseek

fwrite

Name fwrite – writes to a stream
Usage #include <stdio.h>
int fwrite(void *ptr, int size, int nitems, FILE *stream);
Prototype in stdio.h
Description see fread

gcvt

Name gcvt – converts floating-point number to string
Usage #include <dos.h>
char *gcvt(double value, int ndigit, char *buf);
Prototype in stdlib.h
Description see ecvt
geninterrupt

Name                geninterrupt – generates software interrupt
Usage               #include <dos.h>
                     void geninterrupt(int intr_num);
Prototype in        dos.h
Description         see disable

getc

Name                getc – gets character from stream
Usage               #include <stdio.h>
                     int getc(FILE *stream);
Related functions usage
Prototype in        stdio.h
                     conio.h  (getch, getche, ungetch)
Description         getc is a macro that returns the next character on the named input stream.
                     getchar is a macro defined to be getc(stdin).
                     ungetc pushes the character c back onto the named input stream. This character will be returned on the next
call to getc or fread for that stream. One character may be pushed back in all situations. A second call to ungetc without a call to getc will force the previous character to be forgotten. fseek erases all memory of a pushed-back character.

getc behaves exactly like getc, except that it is a true function while getc is a macro.

fgetchar is a function that is the same as fgetc(stdin).

getch is a function that reads a single character directly from the console, without echoing.

getche is a function that reads and echoes a single character from the console.

ungetch pushes the character c back to the console, causing c to be the next character read. The ungetch function fails if it is called more than once before the next read.

getw returns the next integer in the named input stream. getw assumes no special alignment in the file.

Return value

On success, getc, getchar, fgetc, and fgetchar return the character read, after converting it to an int without sign extension. On end-of-file or error, they return EOF.

getch and getche return the character read. There is no error return for these two functions.

getw returns the next integer on the input stream. On end-of-file or error, getw returns EOF. Because EOF is a legitimate value for getw to return, feof or ferror should be used to detect end-of-file or error.

ungetc always returns the character pushed back.

ungetch returns the character c if it is successful. A return value of EOF indicates an error.

Portability

getch, getche, and ungetche are MS-DOS specific. fgetc, fgetchar, getc, getchar, getw, and ungetc are available on UNIX systems. getc and getchar are defined in Kernighan and Ritchie.

See also ferror, fopen, fread, fseek, gets, putc, read, scanf

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**getcbrk**

Name: `getcbrk` - gets control-break setting

Usage:

```c
int getcbrk(void);
```

Related functions usage:

```c
int setcbrk(int value);
```

Prototype in:

`dos.h`

Description:

`getcbrk` uses the MS-DOS system call `0x33` to return the current setting of control-break checking.

`setcbrk` uses the MS-DOS system call `0x33` to set control-break checking on or off.

- `value = 0`: Turns checking off (check only during I/O to console, printer, or communications devices)
- `value = 1`: Turns checking on (check at every system call)

Return value:

- `getcbrk` returns 0 if control-break checking is off and returns 1 if checking is on.
- `setcbrk` returns `value`.

Portability:

Unique to MS-DOS.

---

**getch**

Name: `getch` - gets character from console, no echoing

Usage:

```c
int getch(void);
```

Prototype in:

`conio.h`

Description:

see `getc`
### getchar

<table>
<thead>
<tr>
<th>Name</th>
<th>getchar – gets character from stream</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td><code>#include &lt;stdio.h&gt;</code></td>
</tr>
<tr>
<td></td>
<td><code>int getchar(void);</code></td>
</tr>
<tr>
<td>Prototype in</td>
<td>stdio.h</td>
</tr>
<tr>
<td>Description</td>
<td>see getc</td>
</tr>
</tbody>
</table>

### getche

<table>
<thead>
<tr>
<th>Name</th>
<th>getche – gets character from the console, with echoing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td><code>int getche(void);</code></td>
</tr>
<tr>
<td>Prototype in</td>
<td>conio.h</td>
</tr>
<tr>
<td>Description</td>
<td>see getc</td>
</tr>
</tbody>
</table>

### getcurdir

<table>
<thead>
<tr>
<th>Name</th>
<th>getcurdir – gets current directory for specified drive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td><code>int getcurdir(int drive, char *direc);</code></td>
</tr>
<tr>
<td>Prototype in</td>
<td>dir.h</td>
</tr>
</tbody>
</table>
| Description | getcurdir gets the name of the current working directory for the named `drive`.  
  
  `drive` contains a drive number (0 = default, 1 = A, etc.).  
  
  `direc` points to an area of memory of length MAXDIR where the directory name will be placed. The null- |
terminated name does not contain the drive specification and does not begin with a backslash.

**Return value**

getcurdir returns 0 on success or -1 in the event of error.

**Portability**

Unique to MS-DOS.

**See also**

free, getcwd

**Example**

```c
#include <dir.h>
#include <stdio.h>,

char *current_directory(char *path) {
    strcpy(path, "X:\");
    path[0] = 'A' + getdisk();
    getcurdir(0, path+3);
    return(path);
}

main() {
    char curdir[MAXPATH];
    current_directory(curdir);
    printf("The current directory is %s\n", curdir);
}
```

**Program output**

The current directory is C:\TURBOC

---

**getcwd**

**Name**

getcwd – gets current working directory

**Usage**

char *getcwd(char *buf, int n);

**Prototype in**

dir.h

**Description**

getcwd gets the full path name of the cwd (current working directory, including the drive), up to n bytes long, and stores it in buf. If the full path name length
(including the null-terminator) is longer than \( n \), an error occurs.

If \( buf \) is NULL, a buffer \( n \) bytes long will be allocated for you with \texttt{malloc}. You can later \texttt{free} the allocated buffer by passing the \texttt{getcwd} return value to the function \texttt{free}.

**Return value**

\texttt{getcwd} returns \( buf \); on error, it returns NULL.

In the event of an error return, the global variable \texttt{errno} is set to one of the following:

- \texttt{ENODEV} No such device
- \texttt{ENOMEM} Not enough core
- \texttt{ERANGE} Result out of range

**Portability**

Unique to MS-DOS.

**See also**

\texttt{free, getcurdir, malloc}

---

### getdate

**Name**

\texttt{getdate} – gets MS-DOS date

**Usage**

```c
#include <dos.h>
void getdate(struct date *dateblk);
```

**Related functions usage**

```c
void gettime(struct time *timep);
void setdate(struct date *dateblk);
void settime(struct time *timep);
```

**Prototype in**

dos.h

**Description**

\texttt{getdate} fills in the \texttt{date} structure (pointed to by \texttt{dateblk}) with the system's current date.

\texttt{gettime} fills in the \texttt{time} structure pointed to by \texttt{timep} with the system's current time.

\texttt{setdate} sets the system date (month, day, and year) to that in the \texttt{date} structure pointed to by \texttt{dateblk}.

\texttt{settime} sets the system time to the values in the \texttt{time} structure pointed to by \texttt{timep}.
The **date** structure is defined as follows:

```c
struct date {
    int da_year;          /* Current year */
    char da_day;          /* Day of the month */
    char da_mon;          /* Month (1 = Jan) */
};
```

The **time** structure is defined as follows:

```c
struct time {
    unsigned char ti_min;     /* Minutes */
    unsigned char ti_hour;    /* Hours */
    unsigned char ti_hund;    /* Hundredths of seconds */
    unsigned char ti_sec;     /* Seconds */
};
```

**Return value** These functions do not return any value.

**Portability** Unique to MS-DOS.

**See also** ctime

**Example**

```c
#include <stdio.h>
#include <dos.h>

main()
{
    struct date today;
    struct time now;

    getdate(&today);
    printf("Today's date is %d/%d/%d\n", today.da_mon, today.da_day, today.da_year);

    gettime(&now);
    printf("The time is %02d:%02d:%02d.%02d\n", now.ti_hour, now.ti_min, now.ti_sec, now.ti_hund);
}
```

**Program output**

Today's date is 1/1/1980
The time is 17:08:22.42
getdfree

Name               getdfree – gets disk free space
Usage              #include <dos.h>
                    void getdfree(int drive, struct dfree *dfreep);
Prototype in       dos.h
Description        getdfree accepts a drive specifier in drive (0 = default,
                    1 = A, etc.) and fills in the dfree structure pointed to by
dfreep with disk characteristics.
                    The dfree structure is defined as follows:

                    struct dfree {
                        unsigned df_avail; /* Available clusters */
                        unsigned df_total; /* Total clusters */
                        unsigned df_bsec; /* Bytes per sector */
                        unsigned df_sclus; /* Sectors per cluster */
                    }

Return value       getdfree returns no value. In the event of an error,
                    df_sclus in the dfree structure is set to -1.
Portability        Unique to MS-DOS.
See also           getfat

getdisk

Name               getdisk – gets current drive
Usage              int getdisk(void);
Related functions usage int setdisk(int drive);
Prototype in       dir.h
**getdisk** gets the current drive and returns an integer: 0 = A:, 1 = B:, 2 = C:, etc. (Equivalent to DOS function 0x19.) For an example that demonstrates how to use getdisk, refer to getcurdir.

**setdisk** sets the current drive to the one associated with drive: 0 = A:, 1 = B:, 2 = C:, etc. (Equivalent to DOS function 0x0E.)

**Return value**
- getdisk returns the current drive.
- setdisk returns the total number of drives available.

**Portability** Unique to MS-DOS.

**See also** getcurdir, setdisk

---

### getdta

**Name** getdta – gets disk transfer address

**Usage**
```c
char far *getdta(void);
```

**Related functions usage**
```c
void setdta(char far *dta);
```

**Prototype in** dos.h

**Description**
getdta returns the current setting of the disk transfer address (DTA).

In the small and medium memory models, it is assumed that the segment is the current data segment. If C is used exclusively, this will be the case, but assembly routines may set the disk transfer address to any hardware address.

In the compact, large, or huge memory models, the address returned by getdta is the correct hardware address and may be located outside the program.

setdta changes the current setting of DTA to the value pointed to by dta.
Return value

getdta returns a pointer to the current disk transfer address.

setdta returns nothing.

Portability

Unique to MS-DOS.

---

### getenv

Name

getenv - gets string from environment

Usage

char *getenv(char *envvar);

Related functions usage

int putenv(char *envvar);

Prototype in

stdlib.h

Description

The MS-DOS environment consists of a series of entries that are of the form

\[ \text{envvar} = \text{varvalue} \]

getenv searches the environment for the entry corresponding to envvar, then returns a pointer to varvalue.

putenv accepts the string envvar and adds it to the current environment.

putenv can also be used to modify or delete an existing envvar. Delete an existing entry by making varvalue empty; for example, \"MYVAR=\".

Return value

On success, getenv returns a pointer to the value associated with envvar. The pointer is overwritten on subsequent calls. If the specified envvar is not defined in the environment, getenv returns 0.

On success, putenv returns 0; on failure, -1.

Portability

Available on UNIX systems.

See also

environ (variable), getdfree
Example

```c
#include <stdio.h>
#include <stdlib.h>

main()
{
    char *path, *dummy;
    path = getenv("PATH");
    dummy = getenv("DUMMY");

    printf("PATH = %s\n", path);
    printf("old value of DUMMY: %s\n",
           (dummy == NULL) ? "*none*": dummy);
    putenv("DUMMY=TURBOC");
    dummy = getenv("DUMMY");
    printf("new value of DUMMY: %s\n", dummy);
}
```

Program output

```
PATH = C:\BIN;C:\BIN\DOS;C:
old value of DUMMY: *none*
new value of DUMMY: TURBOC
```

getfat

<table>
<thead>
<tr>
<th>Name</th>
<th>getfat – gets file-allocation table information</th>
</tr>
</thead>
</table>
| Usage     | `#include <dos.h>`
           | `void getfat(int drive, struct fatinfo *fatblkp);` |
| Related functions usage | `void getfatd(struct fatinfo *fatblkp);` |
| Prototype in | dos.h |
| Description | `getfat` returns information from the file-allocation table for the drive specified by `drive` (0 = default, 1 = A:, 2 = B:, etc.). `fatblkp` points to the `fatinfo` structure to be filled in.

`getfatd` performs the same function as `getfat` except that the default drive (0) is always used.
The `fatinfo` structure filled in by `getfat` and `getfatd` is defined as follows:

```c
struct fatinfo {
    char fi_sclus;       /* Sectors per cluster */
    char fi_fatid;       /* The FAT id byte */
    int fi_nclus;        /* Number of clusters */
    int fi_bysec;        /* Bytes per sector */
};
```

Return value
None

Portability
Unique to MS-DOS.

See also
`getdfree`

---

### getfatd

**Name**
getfatd – gets file-allocation table information

**Usage**
```c
#include <dos.h>
void getfatd(struct fatinfo *fatblkp);
```

**Prototype in**
dos.h

**Description**
see getfat

---

### getftime

**Name**
gftime – gets file date and time

**Usage**
```c
#include <dos.h>
int getftime(int handle, struct ftime *ftimep);
```

**Related functions usage**
```c
int setftime(int handle, struct ftime *ftimep);
```

**Prototype in**
dos.h

**Description**
`getftime` retrieves the file time and date for the disk file associated with the open `handle`. The `ftime` structure

---

The Turbo C Library
setftime sets the file date and time of the disk file associated with the open handle to the date and time in the ftime structure pointed to by ftimep.

The ftime structure is defined as follows:

```c
struct ftime {
    unsigned ft_tsec: 5;       /* Two seconds */
    unsigned ft_min: 6;        /* Minutes */
    unsigned ft_hour: 5;       /* Hours */
    unsigned ft_day: 5;        /* Days */
    unsigned ft_month: 4;      /* Months */
    unsigned ft_year: 7;       /* Year - 1980*/
};
```

Return value

Both functions return 0 on success.

In the event of an error return, -1 is returned and the global variable errno is set to one of the following:

- EINVFNC Invalid function number
- EBADF Bad file number

Portability

Unique to MS-DOS.

See also

fread

getpass

getpass – reads a password

```c
char *getpass(char *prompt);
```

Description

getpass reads a password from the system console after prompting with the null-terminated string prompt and disabling the echo. A pointer is returned to a null-terminated string of up to eight characters at most (not counting the null-terminator).
Return value The return value is a pointer to a static string which is overwritten with each call.

Portability Available on UNIX systems.

getpsp

Name getpsp - gets the program segment prefix
Usage unsigned getpsp(void);
Prototype in dos.h
Description getpsp gets the segment address of the program segment prefix (the PSP) using DOS call 0x62.
This call only exists in DOS 3.x. For versions of MS-DOS 2.x and 3.x, the global variable _psp set by the start-up code may be used instead.
Return value getpsp returns the segment value of the PSP.
Portability Unique to MS-DOS 3.0; not available under earlier versions of MS-DOS.
See also _psp (variable)

gets

Name gets - gets a string from a stream
Usage char *gets(char *string);
Related functions usage char *cgets(char *string);
char *fgets(char *string, int n, FILE *stream);
Prototype in stdio.h (fgets, gets)
conio.h (cgets)
Description
gets reads a string into string from the standard input stream stdin. The string is terminated by a newline character, which is replaced in string by a null character (\0).

cgets reads a string of characters from the console, storing the string (and the string length) in the location pointed to by string.

cgets reads characters until it encounters a CR/LF combination or until the maximum allowable number of characters have been read. If cgets reads a CR/LF combination, it replaces the combination with a \0 (null-terminator) before storing it.

Before cgets is called, string[0] should be set to the maximum length of the string to be read. On return, string[1] is set to the number of characters actually read. The characters read start at string[2] and end with a null-terminator. Thus, string must be at least string[0] + 2 bytes long.

fgets reads characters from stream into the string string: The function stops reading when it either reads n – 1 characters or reads a newline character (whichever comes first). fgets retains the newline character. The last character read into string is followed by a null character.

Return value
gets and fgets, on success, return the string argument string; each returns NULL on end-of-file or error.

cgets returns &string[2], a pointer to the string of characters that were read. There is no error return.

Portability
Available on UNIX systems. fgets is also defined in Kernighan and Ritchie.

See also
ferror, fopen, fread, getc, puts, scanf

Example

```c
#include <stdio.h>
#include <conio.h>

main()
{
    char buffer[82];
    char *p;
```
buffer[0] = 80;  /* there's space for 80 characters */
p = cgets(buffer);
printf("cgets got %d chars: "%s"
", buffer[1], p);
printf("the returned pointer is %p, buffer[2] is at %p
",
        p, &buffer[2]);

buffer[0] = 5;     /* leave space for 5 chars only */
p = cgets(buffer);
printf("cgets got %d chars: "%s"
", buffer[1], p);
printf("the returned pointer is %p, buffer[2] is at %p
",
        p, &buffer[2]);

Program output

abcdefgijklm
cgets got 12 chars: "abcdefgijklm"
the returned pointer is FEF6, buffer[2] is at FEF6
abcd
cgets got 4 chars: "abcd"
the returned pointer is FEF6, buffer[2] is at FEF6

gettime

Name         gettime – gets system time
Usage        #include <dos.h>
              void gettime(struct time *timep);
Prototype in dos.h
Description   see getdate
getvect

Name           getvect – gets interrupt vector entry
Usage          void interrupt(*getvect(int intr_num)) ();
Related         void setvect(int intr_num, void interrupt (*isr) ());
functions usage
Prototype in    dos.h
Description     MS-DOS includes a set of “hard-wired” interrupt vectors, numbered 0 to 255. The 4-byte value in each vector is actually an address, which is the location of an interrupt function.

getvect reads the value of the vector named by intr_num and interprets that value read as a (far) pointer to some interrupt function.

setvect sets the value of the vector named by intr_num to a new value, vector, which is a far pointer containing the address of a new interrupt function. The address of a C routine may only be passed to vector if that routine is declared to be an interrupt routine.

Note: If you use the prototypes declared in dos.h, you can simply pass the address of an interrupt function to setvect in any memory model.

Return value   getvect returns the current 4-byte value stored in the interrupt vector named by intr_num. setvect returns nothing.
Portability     Unique to MS-DOS.
See also        disable
### getverify

<table>
<thead>
<tr>
<th>Name</th>
<th>getverify – gets verify state</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>int getverify(void);</td>
</tr>
<tr>
<td>Related functions usage</td>
<td>void setverify(int value);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>dos.h</td>
</tr>
<tr>
<td>Description</td>
<td>getverify gets the current state of the verify flag.</td>
</tr>
<tr>
<td></td>
<td>setverify sets the current state of the verify flag to value.</td>
</tr>
<tr>
<td></td>
<td>A value of 0 = verify flag off.</td>
</tr>
<tr>
<td></td>
<td>A value of 1 = verify flag on.</td>
</tr>
<tr>
<td>Return value</td>
<td>getverify returns the current state of the verify flag, either 0 or 1.</td>
</tr>
<tr>
<td></td>
<td>A return of 0 = verify flag off.</td>
</tr>
<tr>
<td></td>
<td>A return of 1 = verify flag on.</td>
</tr>
<tr>
<td>Portability</td>
<td>Unique to MS-DOS.</td>
</tr>
</tbody>
</table>

### getw

<table>
<thead>
<tr>
<th>Name</th>
<th>getw – gets integer from stream</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>#include &lt;stdio.h&gt;</td>
</tr>
<tr>
<td></td>
<td>int getw(FILE * stream);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>stdio.h</td>
</tr>
<tr>
<td>Description</td>
<td>see getc</td>
</tr>
</tbody>
</table>

*The Turbo C Library*
### gmtime

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>gmtime</td>
<td>gmtime – converts date and time to Greenwich Mean Time</td>
</tr>
</tbody>
</table>

**Usage**

```
#include <time.h>
struct tm * gmtime(long * clock);
```

**Prototype in**

```
time.h
```

**Description**

see ctime

### gsignal

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>gsignal</td>
<td>gsignal – software signals</td>
</tr>
</tbody>
</table>

**Usage**

```
int gsignal(int sig);
```

**Prototype in**

```
signal.h
```

**Description**

see ssignal

### harderr

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>harderr</td>
<td>harderr – establishes a hardware error handler</td>
</tr>
</tbody>
</table>

**Usage**

```
void harderr(int (*fptr)());
```

**Related functions usage**

```
void hardresume(int rescde);
void hardretn(int errcode);
```

**Prototype in**

```
dos.h
```
harderr establishes a hardware error handler for the current program. This handler is invoked whenever an interrupt 0x24 occurs. (See the MS-DOS Programmer’s Reference Manual for a discussion of the interrupt.)

The function pointed to by fptr will be called when such an interrupt occurs. The handler function will be called with the following arguments:

\[ \text{handler(int errval, int ax, int bp, int si);} \]

errval is the error code set in the DI register by MS-DOS. ax, bp, and si are the values MS-DOS sets for the AX, BP, and SI registers, respectively.

- ax indicates whether a disk error or other device error was encountered. If ax is non-negative, a disk error was encountered; otherwise, the error was a device error. For a disk error, ax ANDed with 0x00FF will give the failing drive number (1 = A, 2 = B, etc.).
- bp and si together point to the device driver header of the failing driver.

The named function is not called directly. harderr establishes a DOS interrupt handler that calls the function.

peek and peekb can be used to retrieve device information from this driver header. bp is the segment address, and si is the offset.

The handler may issue bdos calls 1 through 0xC, but any other bdos call will corrupt MS-DOS. In particular, any of the C standard I/O or UNIX-emulation I/O calls may not be used.

The driver header may not be altered via poke or pokeb.

The error handler may return or call hardresume to return to MS-DOS. The return value of the handler or rescodex (result code) of hardresume contains an abort (2), retry (1), or ignore (0) indicator. The abort is accomplished by invoking DOS interrupt 0x23, the control-break interrupt.

The error handler may return directly to the application program by calling hardretn.
Return value  The handler must return 0 for ignore, 1 for retry, and 2 for abort.

Portability  Unique to MS-DOS.

See also  peek, poke, setjmp

Example

```c
#include <stdio.h>
#include <dos.h>

#define DISPLAY_STRING 0x09
#define IGNORE 0
#define RETRY 1
#define ABORT 2

int handler(int errval, int ax, int bp, int si)
{
    char msg[25]; int drive;
    if (ax < 0) { /* device error */
        /* can only use dos functions 0 - 0x0C */
        bdosptr(DISPLAY_STRING, "device error$", 0);
        hardret(-1); /* return to calling program */
    }
    drive = (ax & 0x00FF);
    sprintf(msg, "disk error on drive %c$", 'A' + drive);
    bdosptr(DISPLAY_STRING, msg, 0);
    return(ABORT); /* abort calling program */
}

main()
{
    harderr(handler);

    printf("Make sure there is no disk in drive A:\n");
    printf("Press a key when ready...\n");
    getch();

    printf("Attempting to access A:\n");
    fopen("A:ANY.FIL","r");
}
```

Program output

Make sure there is no disk in drive A:
Press a key when ready...
Attempting to access A:
disk error on drive A
### hardresume

<table>
<thead>
<tr>
<th>Name</th>
<th>Usage</th>
<th>Prototype in</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>hardresume</td>
<td>void hardresume(int rescode);</td>
<td>dos.h</td>
<td>see harderr</td>
</tr>
</tbody>
</table>

### hardretn

<table>
<thead>
<tr>
<th>Name</th>
<th>Usage</th>
<th>Prototype in</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>hardretn</td>
<td>void hardretn(int errcode);</td>
<td>dos.h</td>
<td>see harderr</td>
</tr>
</tbody>
</table>

### hyperb

<table>
<thead>
<tr>
<th>Name</th>
<th>Usage</th>
<th>Prototype in</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>hyperb</td>
<td>double sinh(double x);</td>
<td>math.h</td>
<td>These functions compute the designated hyperbolic functions for real arguments.</td>
</tr>
<tr>
<td>Related functions usage</td>
<td>double cosh(double x);</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>double tanh(double x);</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Return value</td>
<td>These functions return their computed results.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
When the correct value would overflow, `sinh` and `cosh` return the value `<HUGE_VAL>` of appropriate sign.

Error handling for these routines can be modified through the function `matherr`.

### Portability
Available on UNIX systems.

### See also
`exp`

## hypot

### Name
hypot – calculates hypotenuse of right triangle

### Usage
double hypot(double x, double y);

### Prototype in
`math.h`

### Description
hypot calculates the value \( z \) where

\[ z^2 = x^2 + y^2 \]

(This is equivalent to the length of the hypotenuse of a right triangle, if the lengths of the two sides are \( x \) and \( y \).)

### Return value
On success, hypot returns \( z \), a double. On error (such as an overflow), hypot sets `errno` to

- **ERANGE** Result out of range

and returns the value `<HUGE_VAL>`.

Error handling for hypot can be modified through the function `matherr`.

### Portability
Available on UNIX systems.

### See also
`trig`
## inport

<table>
<thead>
<tr>
<th>Name</th>
<th>inport – inputs from hardware port</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>#include &lt;dos.h&gt; int inport(int port);</td>
</tr>
<tr>
<td>Related functions usage</td>
<td>int inportb(int port); void outport(int port, int word); void outportb(int port, char byte);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>dos.h</td>
</tr>
<tr>
<td>Description</td>
<td>inport reads a word from the input port specified by port. inportb is a macro that reads a byte from the input port specified by port. outport writes the word given by word to the output port specified by port. outportb is a macro that writes the byte given by byte to the output port specified by port. If inportb or outportb is called when dos.h has been included, they will be treated as macros that expand to in-line code. If you don't include dos.h, or if you do include dos.h and #undef the macros inportb and outportb, you will get the inportb and outportb functions.</td>
</tr>
<tr>
<td>Return value</td>
<td>inport and inportb return the value read. outport and outportb return nothing.</td>
</tr>
<tr>
<td>Portability</td>
<td>Unique to the 8086 family.</td>
</tr>
</tbody>
</table>
### inportb

**Name**  
inportb – inputs from hardware port

**Usage**  
int inportb(int port);

**Prototype in**  
dos.h

**Description**  
see inport

### int86

**Name**  
int86 – general 8086 software interrupt interface

**Usage**  
#include <dos.h>

int int86(int intr_num, union REGS *inregs,
            union REGS *outregs);

**Prototype in**  
dos.h

**Description**  
Both of these functions execute an 8086 software interrupt specified by the argument intr_num.

Before executing the software interrupt, both functions copy register values from inregs into the registers.

In addition, int86x copies the segregs->x.ds and segregs->x.es values into the corresponding registers before executing the software interrupt. This feature allows programs that use far pointers, or that use a large data memory model, to specify which segment is to be used during the software interrupt.

After the software interrupt returns, both functions copy the current register values to outregs, copy the status of the system carry flag to the x.cflag field in outregs, and
copy the value of the 8086 flags register to the x.flags field in outregs. In addition, \texttt{int86x} restores DS, and sets the \texttt{segregs}→es and \texttt{segregs}→ds fields to the values of the corresponding segment registers.

If the carry flag is set, it indicates that an error occurred.

\texttt{int86x} allows you to invoke an 8086 software interrupt that takes a value of DS different from the default data segment, and/or that takes an argument in ES.

Note that \texttt{inregs} can point to the same structure that \texttt{outregs} points to.

**Return value**

\texttt{int86} and \texttt{int86x} return the value of AX after completion of the software interrupt. If the carry flag is set (\texttt{outregs→x.cflag} \(!= 0\)), indicating an error, these functions set \texttt{doserrno} to the error code.

**Portability**

Unique to MS-DOS. \texttt{int86} and \texttt{int86x} will work on 8086 family processors.

**See also**

see \texttt{intdos}

**Example**

\begin{verbatim}
#include <dos.h>

#define VIDEO 0x10

/* positions cursor at line y, column x */

void gotoxy(int x, int y)
{
    union REGS regs;
    regs.h.ah = 2; /* set cursor position */
    regs.h.dh = y;
    regs.h.dl = x;
    regs.h.bh = 0; /* video page 0 */
    int86(VIDEO, &regs, &regs);
}
\end{verbatim}
### int86x

<table>
<thead>
<tr>
<th>Name</th>
<th>int86x – general 8086 software interrupt interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>#include &lt;dos.h&gt;</td>
</tr>
<tr>
<td></td>
<td>int int86x(int intr_num, union REGS *inregs,</td>
</tr>
<tr>
<td></td>
<td>union REGS *outregs, struct SREGS *segregs);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>dos.h</td>
</tr>
<tr>
<td>Description</td>
<td>see int86</td>
</tr>
</tbody>
</table>

### intdos

<table>
<thead>
<tr>
<th>Name</th>
<th>intdos – general MS-DOS interrupt interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>#include &lt;dos.h&gt;</td>
</tr>
<tr>
<td></td>
<td>int intdos(union REGS * inregs, union REGS * outregs);</td>
</tr>
<tr>
<td>Related functions usage</td>
<td>int intdosx(union REGS *inregs, union REGS *outregs,</td>
</tr>
<tr>
<td></td>
<td>struct SREGS *segregs);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>dos.h</td>
</tr>
<tr>
<td>Description</td>
<td>Both of these functions execute DOS interrupt 0x21 to</td>
</tr>
<tr>
<td></td>
<td>invoke a specified DOS function. The value of</td>
</tr>
<tr>
<td></td>
<td>inregs→h.al specifies the DOS function to be invoked.</td>
</tr>
<tr>
<td></td>
<td>In addition, intdosx copies the segregs→x.ds and</td>
</tr>
<tr>
<td></td>
<td>segregs→x.es values into the corresponding registers</td>
</tr>
<tr>
<td></td>
<td>before invoking the DOS function. This feature allows</td>
</tr>
<tr>
<td></td>
<td>programs that use far pointers, or that use a large data</td>
</tr>
<tr>
<td></td>
<td>memory model, to specify which segment is to be used</td>
</tr>
<tr>
<td></td>
<td>during the function execution.</td>
</tr>
</tbody>
</table>

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After the interrupt Ox21 returns, both functions copy the current register values to outregs, copy the status of the system carry flag to the x.cflag field in outregs, and copy the value of the 8086 flags register to the x.flags field in outregs. In addition, intdosx restores DS, and sets the segregs→es and segregs→ds fields to the values of the corresponding segment registers.

If the carry flag is set, it indicates that an error occurred.

intdosx allows you to invoke a DOS function that takes a value of DS different from the default data segment, and/or that takes an argument in ES.

Note that inregs can point to the same structure that outregs points to.

**Return value**

intdos and intdosx return the value of AX after completion of the DOS function call. If the carry flag is set (outregs→x.cflag != 0), indicating an error, these functions set _doserrno to the error code.

**Portability**

Unique to MS-DOS.

**See also**

segread

**Example**

```c
#include <stdio.h>
#include <dos.h>

/* deletes filename; returns 0 on success, non-zero error code on failure */

int delete_file(char near *filename) {
    union REGS regs; struct SREGS sregs;
    int ret;

    regs.h.ah = Ox41; /* delete file */
    regs.x.dx = (unsigned) filename;
    sregs.ds = DS;
    ret = intdosx(&regs, &regs, &sregs);
    /* if carry flag is set, there was an error */
    return(regs.x.cflag ? ret : 0);
}

main() {
    int err;
}
```

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err = delete_file("NOTEXIST.$$$");
printf("Able to delete NOTEXIST.$$$: %s\n",
   (!err) ? "YES" : "NO");
}

Program output
Able to delete NOTEXIST.$$$: NO

intdosx

<table>
<thead>
<tr>
<th>Name</th>
<th>intdosx – general MS-DOS interrupt interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>#include &lt;dos.h&gt;</td>
</tr>
<tr>
<td></td>
<td>int intdosx(union REGS *inregs, union REGS *outregs,</td>
</tr>
<tr>
<td></td>
<td>struct SREGS *segregs);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>dos.h</td>
</tr>
<tr>
<td>Description</td>
<td>see intdos</td>
</tr>
</tbody>
</table>

intr

<table>
<thead>
<tr>
<th>Name</th>
<th>intr – alternate 8086 software interrupt interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>#include &lt;dos.h&gt;</td>
</tr>
<tr>
<td></td>
<td>void intr(int intr_num, struct REGPACK *preg);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>dos.h</td>
</tr>
<tr>
<td>Description</td>
<td>The intr function is an alternate interface for executing</td>
</tr>
<tr>
<td></td>
<td>software interrupts. It generates an 8086 software</td>
</tr>
<tr>
<td></td>
<td>interrupt specified by the argument intr_num.</td>
</tr>
<tr>
<td></td>
<td>intr copies register values from the REGPACK structure</td>
</tr>
<tr>
<td></td>
<td>preg into the registers before executing the software</td>
</tr>
<tr>
<td></td>
<td>interrupt. After the software interrupt completes, intr</td>
</tr>
<tr>
<td></td>
<td>copies the current register values into preg. The flags are</td>
</tr>
<tr>
<td></td>
<td>preserved.</td>
</tr>
</tbody>
</table>
The arguments passed to \texttt{intr} are as follows:

\begin{tabular}{ll}
\textit{intr\_num} & the interrupt number to be executed \\
\textit{preg} & the address of a structure containing \\
& (a) the input registers before the call \\
& (b) the value of the registers after the \\
& interrupt call.
\end{tabular}

The REGPACK structure \textit{preg} (described in dos.h) has the following format:

\begin{verbatim}
struct REGPACK
{
  unsigned r_ax, r_bx, r_cx, r_dx;
  unsigned r_bp, r_si, r_di, r_ds, r_es, r_flags;
};
\end{verbatim}

\textbf{Return value} No value is returned. The REGPACK structure \textit{preg} contains the value of the registers after the interrupt call.

\textbf{Portability} Unique to MS-DOS; will work on 8086-family processors.

\textbf{See also} \texttt{int86}, \texttt{intdos}

---

**ioctl**

\textbf{Name} \texttt{ioctl} – controls I/O device

\textbf{Usage} \begin{verbatim}
int ioctl(int handle, int cmd, int *argdx, int argcx);
\end{verbatim}

\textbf{Prototype in} \texttt{io.h}

\textbf{Description} This is a direct interface to the MS-DOS call 0x44 (IOCTL).

The exact function depends on the value of \textit{cmd} as follows:

\begin{enumerate}
\item 0 \ Get device information
\item 1 \ Set device information (in \textit{argdx})
\item 2 \ Read \textit{argcx} bytes into the address pointed to by \textit{argdx}
\end{enumerate}
3 Write argcx bytes from the address pointed to by argdx
4 Same as 2, except handle is treated as a drive number (0 = default, 1 = A, etc.)
5 Same as 3, except handle is a drive number (0 = default, 1 = A, etc.)
6 Get input status
7 Get output status
8 Test removability; DOS 3.x only
11 Set sharing conflict retry count; DOS 3.x only

ioctl can be used to get information about device channels. Regular files can also be used, but only cmd values 0, 6, and 7 are defined for them. All other calls return an EINVAL error for files.

See the documentation for system call 0x44 in the MS-DOS Programmer's Reference Manual for detailed information on argument or return values.

The arguments argdx and argcx are optional.

ioctl provides a direct interface to DOS 2.0 device drivers for special functions. As a result, the exact behavior of this function will vary across different vendors' hardware and in different devices. Also, several vendors do not follow the interfaces described here. Refer to the vendor BIOS documentation for exact use of ioctl.

**Return value**

For cmd 0 or 1, the return value is the device information (DX of the IOCTL call).

For cmd values of 2 through 5, the return value is the number of bytes actually transferred.

For cmd values of 6 or 7, the return value is the device status.

In any event, if an error is detected, a value of -1 is returned, and errno is set to one of the following:

<table>
<thead>
<tr>
<th>Error Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EINVAL</td>
<td>Invalid argument</td>
</tr>
<tr>
<td>EBADF</td>
<td>Bad file number</td>
</tr>
<tr>
<td>EINVALDAT</td>
<td>Invalid data</td>
</tr>
</tbody>
</table>

**Portability**

ioctl is available on UNIX systems, but not with these parameters or functionality. UNIX version 7 and System
III differ from each other in their use of ioctl. ioctl calls are not portable to UNIX and are rarely portable across MS-DOS machines.

DOS 3.0 extends ioctl with cmd values of 8 and 11.

Example

```c
#include <stdio.h>
#include <io.h>
#include <dir.h>

main()
{
    int stat;
    /* use function 8 to determine if the default drive is removable */
    stat = ioctl(0, 8, 0, 0);
    printf("Drive %c %s changeable\n", getdisk() + 'A',
            (stat == 0) ? "is" : "is not");
}
```

Program output

Drive C is not changeable

---

is...

<table>
<thead>
<tr>
<th>Name</th>
<th>is... – character classification macros</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>#include &lt;ctype.h&gt;</td>
</tr>
<tr>
<td></td>
<td>int isalpha(int ch);</td>
</tr>
<tr>
<td></td>
<td>int isalnum(int ch);</td>
</tr>
<tr>
<td></td>
<td>int isascii(int ch);</td>
</tr>
<tr>
<td></td>
<td>int iscntrl(int ch);</td>
</tr>
<tr>
<td></td>
<td>int isdigit(int ch);</td>
</tr>
<tr>
<td></td>
<td>int isgraph(int ch);</td>
</tr>
<tr>
<td></td>
<td>int islower(int ch);</td>
</tr>
<tr>
<td></td>
<td>int isprint(int ch);</td>
</tr>
<tr>
<td></td>
<td>int ispunct(int ch);</td>
</tr>
</tbody>
</table>

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Prototype in  
io.h

Description  
These are macros that classify ASCII-coded integer values by table lookup. Each is a predicate returning non-zero for true and 0 for false.

isspace is defined on all integer values; the rest of the macros are defined only when isascii is true, or when ch is EOF.

Return value

<table>
<thead>
<tr>
<th>Macro</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>isalpha</td>
<td>Non-zero if ch is a letter. ('A'-'Z', 'a'-'z')</td>
</tr>
<tr>
<td>isalnum</td>
<td>Non-zero if ch is a letter or a digit. ('A'-'Z', 'a'-'z', '0'-'9')</td>
</tr>
<tr>
<td>isascii</td>
<td>Non-zero if ch is in the range 0-127. (0x00 – 0x7F)</td>
</tr>
<tr>
<td>iscntrl</td>
<td>Non-zero if ch is a delete character or ordinary control character. (0x7F, or 0x00 – 0x1F)</td>
</tr>
<tr>
<td>isdigit</td>
<td>Non-zero if ch is a digit. ('0' – '9')</td>
</tr>
<tr>
<td>isgraph</td>
<td>Non-zero if ch is a printing character, like isprint, except that a space character is excluded. (0x21 – 0x7E)</td>
</tr>
<tr>
<td>islower</td>
<td>Non-zero if ch is a lowercase letter. ('a'-'z')</td>
</tr>
<tr>
<td>isprint</td>
<td>Non-zero if ch is a printing character. (0x20 – 0x7E)</td>
</tr>
<tr>
<td>ispunct</td>
<td>Non-zero if ch is a punctuation character. (iscntrl or isspace)</td>
</tr>
<tr>
<td>isspace</td>
<td>Non-zero if ch is a space, tab, carriage return, newline, vertical tab, or form-feed. (0x09 – 0x0D, 0x20)</td>
</tr>
<tr>
<td>isupper</td>
<td>Non-zero if ch is an uppercase letter. ('A'-'Z')</td>
</tr>
<tr>
<td>isxdigit</td>
<td>Non-zero if ch is a hexadecimal digit. ('0'-'9', 'A'-'F', 'a'-'f')</td>
</tr>
</tbody>
</table>

Portability  
All these macros are available on UNIX machines. isalpha, isdigit, islower, isspace, and isupper are defined in Kernighan and Ritchie.
## isatty

<table>
<thead>
<tr>
<th>Name</th>
<th>isatty – checks for device type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>int isatty(int handle);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>io.h</td>
</tr>
<tr>
<td>Description</td>
<td>isatty is a function that determines whether handle represents any one of the following character devices:</td>
</tr>
<tr>
<td></td>
<td>- a terminal</td>
</tr>
<tr>
<td></td>
<td>- a console</td>
</tr>
<tr>
<td></td>
<td>- a printer</td>
</tr>
<tr>
<td></td>
<td>- a serial port</td>
</tr>
<tr>
<td>Return value</td>
<td>If the device is a character device, isatty returns a non-zero integer. If it is not such a device, isatty returns 0.</td>
</tr>
</tbody>
</table>

## itoa

<table>
<thead>
<tr>
<th>Name</th>
<th>itoa – converts an integer to a string</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>char *itoa(int value, char *string, int radix);</td>
</tr>
<tr>
<td>Related functions usage</td>
<td>char *ltoa(long value, char *string, int radix);</td>
</tr>
<tr>
<td></td>
<td>char *ultoa(unsigned long value, char *string, int radix);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>stdlib.h</td>
</tr>
<tr>
<td>Description</td>
<td>These functions convert value to a null-terminated string and store the result in string. With itoa, value is an integer; with ltoa it is a long; with ultoa it is an unsigned long.</td>
</tr>
</tbody>
</table>
|             | radix specifies the base to be used in converting value; it must be between 2 and 36 (inclusive). With itoa and ltoa, if value is negative, and radix is 10, the first
character of string is the minus sign (-). This does not occur with ultoa. Also, ultoa performs no overflow checking.

Note: The space allocated for string must be large enough to hold the returned string including the terminating null character (\0). itoa can return up to 17 bytes; ltoa and ultoa, up to 33 bytes.

Return value
All these functions return a pointer to string. There is no error return.

kbhit

Name        kbhit – checks for recent keystrokes
Usage       int kbhit(void);
Prototype in conio.h
Description  kbhit checks to see if a keystroke is currently available. Any available keystrokes can be retrieved with getch or getche.
Return value If a keystroke is available, kbhit returns a non-zero integer. If not, it returns 0.
See also getc

keep

Name        keep – exits and remains resident
Usage       void keep(int status, int size);
Prototype in dos.h
Description  keep returns to MS-DOS with the exit status in status. The current program remains resident, however. The program is set to size paragraphs in length, and the remainder of the memory of the program is freed.
### labs

- **Name**: labs - gives long absolute value
- **Usage**: long labs(long n);
- **Prototype in**: stdlib.h
- **Description**: see abs

### ldexp

- **Name**: ldexp - calculates $value \times 2^{exp}$
- **Usage**: double ldexp(double value, int exp);
- **Prototype in**: math.h
- **Description**: see exp

### lfind

- **Name**: lfind - performs a linear search
- **Usage**: void *lfind(void *key, void *base, int *nelem, int width, int (*fcmp)( ));
- **Prototype in**: stdlib.h
- **Description**: see bsearch

*keep* can be used when installing a TSR program. *keep* uses DOS function 0x31.

**Return value**: None

**Portability**: Unique to MS-DOS.
### localtime

<table>
<thead>
<tr>
<th>Name</th>
<th>localtime – converts date and time to a structure</th>
</tr>
</thead>
</table>
| Usage       | `#include <time.h>`  
|             | `struct tm *localtime(long *clock);`             |
| Prototype in| `time.h`                                           |
| Description | `see ctime`                                         |

### lock

<table>
<thead>
<tr>
<th>Name</th>
<th>lock – sets file sharing locks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td><code>int lock(int handle, long offset, long length);</code></td>
</tr>
<tr>
<td>Related functions usage</td>
<td><code>int unlock(int handle, long offset, long length);</code></td>
</tr>
<tr>
<td>Prototype in</td>
<td><code>io.h</code></td>
</tr>
</tbody>
</table>
| Description | `lock and unlock provide an interface to the MS-DOS 3.x file-sharing mechanism.  
lock can be placed on arbitrary, non-overlapping regions of any file. A program attempting to read or write into a locked region will retry the operation three times. If all three retries fail, the call fails with an error.  
unlock removes lock; to avoid error, lock must be removed before a file is closed. A program must release all lock(s) before completing.  
Both functions return 0 on success, -1 on error.` |
| Return value| `Portability` Unique to MS-DOS 3.x. Older versions of MS-DOS do not support these calls. |
| See also    | `open` |

---

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### log

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>log</td>
<td>log – logarithm function (\ln(x))</td>
</tr>
<tr>
<td>Usage</td>
<td>double log(double (x));</td>
</tr>
<tr>
<td>Prototype in</td>
<td>math.h</td>
</tr>
<tr>
<td>Description</td>
<td>see exp</td>
</tr>
</tbody>
</table>

### log10

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>log10</td>
<td>log10 – logarithm function (\log_{10}(X))</td>
</tr>
<tr>
<td>Usage</td>
<td>double log10(double (x));</td>
</tr>
<tr>
<td>Prototype in</td>
<td>math.h</td>
</tr>
<tr>
<td>Description</td>
<td>see exp</td>
</tr>
</tbody>
</table>

### longjmp

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>longjmp</td>
<td>longjmp – performs nonlocal goto</td>
</tr>
</tbody>
</table>
| Usage         | #include <setjmp.h>
                   void longjmp(jmp_buf \(env\), int \(val\)); |
| Related       | int setjmp(jmp_buf \(env\));     |
| functions usage |                                |
| Prototype in  | setjmp.h                         |
| Description   | setjmp captures the complete task state in \(env\) and returns 0. |
A later call to `longjmp` with that `env` restores the captured task state and returns in such a way that it appears that `setjmp` returned with the value `val`.

`setjmp` must first be called before `longjmp`. The routine that called `setjmp` and set up `env` must still be active and cannot have returned before the `longjmp` is called. If this happens, the results are unpredictable.

A task state is:

- all segment registers (CS, DS, ES, SS)
- register variables (SI, DI)
- stack pointer (SP)
- frame pointer (FP)
- flags

A task state is complete enough that `setjmp` and `longjmp` can be used to implement co-routines.

These routines are useful for dealing with errors and exceptions encountered in a low-level subroutine of a program.

**Return value**

`setjmp` returns 0 when it is initially called.

`longjmp` cannot return the value 0; if passed 0 in `val`, `longjmp` will return 1.

**Portability**

Available on UNIX systems.

**See also**

`ctrlbrk`, `ssignal`

**Example**

```c
#include <stdio.h>
#include <setjmp.h>

int value;
jmp_buf jumper;

main()
{
    value = setjmp(jumper);
    if (value != 0) {
        printf("Longjmp with value %d\n", value);
        exit(value);
    }
    printf("About to call subroutine ...
  subroutine();
```

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subroutine()
{
    longjmp(jumper,1);
}

Program output

About to call subroutine ...
Longjmp with value 1

---

Isearch

Name      lsearch – searches and updates a table
Usage     void *lsearch(void *key, void *base, int *nelem,
                        int width, int (*fcmp)());
Prototype in stdlib.h
Description see bsearch

---

Iseek

Name      lseek – moves read/write file pointer
Usage     #include <io.h>
           long lseek(int handle, long offset, int fromwhere);
Related functions usage long tell(int handle);
Prototype in io.h
Description lseek sets the file pointer associated with handle to a new position that is offset bytes beyond the file location given by fromwhere. fromwhere must be one of the values 0, 1 or 2, which represent three symbolic constants (defined in stdio.h) as follows:
**fromwhere** | **File Location**
---|---
SEEK_SET (0) | file beginning
SEEK_CUR (1) | current file pointer position
SEEK_END (2) | end-of-file

tell gets the current position of the file pointer associated with *handle* and expresses it as the number of bytes from the beginning of the file.

**Return value**

*lsseek* returns the offset of the pointer’s new position, measured in bytes from the file beginning. *lsseek* returns -1L on error, and *errno* is set to one of the following:

- EBADF    Bad file number
- EINVAL   Invalid argument

On devices incapable of seeking (such as terminals and printers), the return value is undefined.

tell returns the current file pointer position. A return of -1 (long) indicates an error, and *errno* is set to:

- EBADF    Bad file number

**Portability**

These functions are available on all UNIX systems.

**See also**

*fopen, fseek, ftell, getc, setbuf, ungetc*
**Itoa**

Name  
Itoa – converts a long to a string

Usage  
char *ltoa(long value, char *string, int radix);

Prototype in  
stdlib.h

Description  
see itoa

**malloc**

Name  
malloc – allocates main memory

Usage  
void *malloc(unsigned size);

Related functions usage  
void *calloc(unsigned nelem, unsigned elsize);

In the tiny, small, and medium models
unsigned coreleft(void);

In the compact, large, and huge models
unsigned long coreleft(void);

void free(void *ptr);

void *realloc(void *ptr, unsigned newsize);

Prototype in  
stdlib.h and alloc.h

Description  
These functions provide access to the C memory heap. The heap is available for dynamic allocation of creating variable-sized blocks of memory. Many data structures such as trees and lists naturally employ heap memory allocation.

   All the space between the end of the data segment and the top of the program stack is available for use in the small data models, except for a 256-byte margin
immediately before the top of the stack. This margin is intended to allow the application some room to grow the stack plus a small amount needed by MS-DOS.

In the large data models, all the space beyond the program stack to the end of physical memory is available for the heap.

malloc returns a pointer to a memory block of length size. If not enough memory is available to allocate the block, malloc returns NULL. The contents of the block are left unchanged.

calloc allocates a block like malloc, except the block is of size nelem times elsise. The block is cleared to 0.

coreleft returns a measure of the unused memory. It gives different values of measurement, depending on whether the memory model is small data group or large data group.

free deallocates a previously allocated block. ptr must contain the address of the first byte of the block.

realloc adjusts the size of the allocated block to newsize, copying the contents to a new location if necessary.

Return value

malloc and calloc return a pointer to the newly allocated block, or NULL if not enough space exists for the new block.

realloc returns the address of the reallocated block. This may be different than the address of the original block. If the block cannot be reallocated, realloc returns NULL.

In the large data models, coreleft returns the amount of unused memory between the heap and the stack.

In the small data memory models, coreleft returns the amount of unused memory between the stack and the data segment, minus 256 bytes.

Portability

calloc, free, malloc, and realloc are available on UNIX systems. calloc is defined in Kernighan and Ritchie.

See also

allocmem, farmalloc, setbuf
Example

```c
#include <stdio.h>
#include <stdlib.h>

typedef struct {
    /* ... */
} OBJECT;

OBJECT *NewObject() {
    return ((OBJECT *) malloc(sizeof(OBJECT)));
}

void FreeObject(OBJECT *obj) {
    free(obj);
}

main()
{
    OBJECT *obj;
    obj = NewObject();
    if (obj == NULL) {
        printf("failed to create a new object\n");
        exit(1);
    }
    /* ... */
    free(obj);
}
```

_matherr

<table>
<thead>
<tr>
<th>Name</th>
<th>_matherr – floating-point error handling routine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>#include &lt;math.h&gt;</td>
</tr>
<tr>
<td></td>
<td>double _matherr(_mexcep why, char *fun, double *arg1p, double *arg2p, double retval);</td>
</tr>
<tr>
<td>Related</td>
<td></td>
</tr>
<tr>
<td>functions usage</td>
<td>#include &lt;math.h&gt;</td>
</tr>
<tr>
<td></td>
<td>matherr();</td>
</tr>
<tr>
<td>Prototype in</td>
<td>math.h</td>
</tr>
</tbody>
</table>

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Description

_matherr serves as a focal point for error handling in all math library functions; it calls matherr and processes the return value from matherr. _matherr should never be called directly by user programs.

Whenever an error occurs in one of the math library routines _matherr is called with several arguments.

_matherr does four things;

- It uses its arguments to fill out an exception structure.
- It calls matherr with e, a pointer to the exception structure, to see if matherr can resolve the error.
- It examines the return value from matherr as follows:
  - If matherr returned 0, (indicating that matherr was not able to resolve the error) _matherr sets errno (see following) and prints an error message.
  - If matherr returns non-zero, (indicating that matherr was able to resolve the error) _matherr is silent; it does not set errno or print any messages.
- It returns e->retval to the original caller. Note that matherr might modify e->retval to specify the value it wants propagated back to the original caller.

When _matherr sets errno (based on a 0 return from matherr), it maps the kind of error that occurred (from the type field in the exception structure) onto an errno value of either EDOM or ERANGE.

Return value

_matherr returns the value, e->retval. This value is initially the value of the input parameter retval passed to _matherr, and might be modified by matherr.

For math function results with a magnitude greater than MAXDOUBLE, retval defaults to the macro HUGE_VAL of appropriate sign before being passed to _matherr. For math function results with a magnitude less than MINDOUBLE, retval is set to 0, then passed to _matherr. In both of these extremes, if matherr does not modify e->retval, _matherr sets errno to

ERANGE Result out of range

See also

matherr
matherr

Name  matherr – user-modifiable math error handler
Usage  #include <math.h>
       int matherr(struct exception *e);
Prototype in  math.h
Description  The default version of Turbo C’s matherr routine simply returns 0; it serves as a hook that you can replace when writing your own math error-handling routine—see the following example of a user-defined matherr implementation.

You can modify matherr to be a custom error-handling routine (such as one that catches and resolves certain types of errors); the modified matherr should return 0 if it failed to resolve the error, or non-zero if the error was resolved. When matherr returns non-zero, no error message is printed, and errno is not changed.

This is the exception structure (defined in math.h):

```c
struct exception {
    int    type;
    char   *name;
    double arg1, arg2, retval;
};
```

The members of the exception structure are shown in the following table.
### Member What It Is (or Represents)

<table>
<thead>
<tr>
<th>Member</th>
<th>What It Is (or Represents)</th>
</tr>
</thead>
<tbody>
<tr>
<td>type</td>
<td>the type of mathematical error that occurred; an <code>enum</code> type defined in the <code>typedef _mexccep</code> (see definition after this list)</td>
</tr>
<tr>
<td>name</td>
<td>a pointer to a null-terminated string holding the name of the math library function that resulted in an error</td>
</tr>
<tr>
<td>arg1, arg2</td>
<td>the arguments (passed to the function <code>name</code> points to) that caused the error; if only one argument was passed to the function, it is stored in <code>arg1</code></td>
</tr>
<tr>
<td>retval</td>
<td>the default return value for <code>matherr</code>; you can modify this value</td>
</tr>
</tbody>
</table>

The `typedef _mexccep`, also defined in `math.h`, enumerates the following symbolic constants representing possible mathematical errors:

<table>
<thead>
<tr>
<th>Symbolic Constant</th>
<th>Mathematical Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOMAIN</td>
<td>argument was not in domain of function (such as <code>log(-1)</code>)</td>
</tr>
<tr>
<td>SING</td>
<td>arguments would result in a singularity (such as <code>pow(0, -2)</code>)</td>
</tr>
<tr>
<td>OVERFLOW</td>
<td>argument would produce a function result greater than MAXDOUBLE (such as <code>exp(1000)</code>)</td>
</tr>
<tr>
<td>UNDERFLOW</td>
<td>argument would produce a function result less than MINDOUBLE (such as <code>exp(-1000)</code>)</td>
</tr>
<tr>
<td>TLOSS</td>
<td>arguments would produce function result with total loss of significant digits (such as <code>sin(10 e 70)</code>)</td>
</tr>
</tbody>
</table>

The symbolic constants MAXDOUBLE and MINDOUBLE are defined in `values.h`.
Note that _matherr is not meant to be modified. The matherr function is more widely found in C run-time libraries and thus is recommended for portable programming.

The UNIX-style matherr default behavior (printing a message and terminating) is not ANSI compatible. If you desire a UNIX-style version of matherr, use matherr.c provided on the Turbo C distribution diskettes.

**Return value**

The default return value for matherr is simply 0. matherr can also modify e->reval, which propagates through _matherr back to the original caller.

When matherr returns 0, (indicating that it was not able to resolve the error) _matherr sets errno and prints an error message. (See _matherr for details.)

When matherr returns non-zero (indicating that it was able to resolve the error) errno is not set and no messages are printed.

**Example**

```c
/*
   This is a user-defined matherr function that catches negative arguments passed to sqrt and converts them to non-negative values before sqrt processes them.
*/

#include<math.h>
#include<string.h>

int matherr(struct exception *a);
{
    if (a -> type == DOMAIN) {
        if(strcmp(a -> name, "sqrt") == 0) {
            a -> reval = sqrt (-(a -> argl));
            return (1);
        }
    }
    return (0);
}
```

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### mem...

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>mem</strong>...</td>
<td>- manipulates memory arrays</td>
</tr>
<tr>
<td><strong>Related functions usage</strong></td>
<td>void *memccpy(void *destin, void *source, unsigned char ch, unsigned n);</td>
</tr>
<tr>
<td></td>
<td>void *memchr(void *s, char ch, unsigned n);</td>
</tr>
<tr>
<td></td>
<td>void *memcmp(void *s1, void *s2, unsigned n);</td>
</tr>
<tr>
<td></td>
<td>int memicmp(void *s1, void *s2, unsigned n);</td>
</tr>
<tr>
<td></td>
<td>void *memmove(void *destin, void *source, unsigned n);</td>
</tr>
<tr>
<td></td>
<td>void *memcpy(void *destin, void *source, unsigned n);</td>
</tr>
<tr>
<td></td>
<td>void *memset(void *s, char ch, unsigned n);</td>
</tr>
<tr>
<td><strong>Prototype in</strong></td>
<td>string.h mem.h</td>
</tr>
<tr>
<td><strong>Description</strong></td>
<td>These functions, all members of the mem... family, manipulate memory arrays. In all of these functions, arrays are n bytes in length.</td>
</tr>
</tbody>
</table>

- **memcpy** copies a block of n bytes from source to destin. If the source and destination blocks overlap, the copy direction is chosen so that overlapping bytes are copied correctly.

- **memmove** identical to memcpy.

- **memset** sets all of the bytes of s to the byte ch. The size of the s array is given by n.

- **memcmp** compares two strings, s1 and s2, for a length of exactly n bytes. This function compares bytes as unsigned chars, so

  ```
  memcmp ("\xFF", "\x7F", 1)
  ```

  returns a value > 0.

- **memicmp** compares the first n bytes of s1 and s2, ignoring character case (upper or lower).
memccpy copies bytes from source to destin. The copying stops as soon as either of the following occurs:

- The character ch is first copied into destin.
- n bytes have been copied in.

memchr searches the first n bytes of array s for character ch.

Return value

memmove and memcpy return destin.

memset returns the value of s.

memcmp and memcmp return a value

\[
\begin{align*}
< 0 & \quad \text{if } s1 \text{ is less than } s2 \\
= 0 & \quad \text{if } s1 \text{ is the same as } s2 \\
> 0 & \quad \text{if } s1 \text{ is greater than } s2
\end{align*}
\]

memccpy returns a pointer to the byte in destin immediately following ch, if ch was copied; otherwise, memccpy returns NULL.

memchr returns a pointer to the first occurrence of ch in s; it returns NULL if ch does not occur in the s array.

Portability

Available on UNIX System V systems.

See also

str...

MK_FP

Name

MK_FP – makes a far pointer

Usage

#include <dos.h>
void far *MK_FP(unsigned seg, unsigned off);

Prototype in
dos.h

Description

see FP_OFF
mkdir

Name     mkdir – creates a directory
Usage    int mkdir(char *pathname);
Related
functions usage     int rmdir(char *pathname);
Prototype in     dir.h
Description     mkdir takes the given pathname and creates a new
directory with that name.

rmdir deletes the directory given by pathname. The
directory named by pathname

• must be empty
• must not be the current working directory
• must not be the root directory

Return value     mkdir returns the value 0 if the new directory was
created.

rmdir returns 0 if the directory is successfully deleted.

With either function, a return value of -1 indicates an
error, and errno is set to one of the following values:

EACCES    Permission denied
ENOENT    Path or file name not found

See also     chdir

mktemp

Name     mktemp – makes a unique file name
Usage    char *mktemp(char *template);
Prototype in     dir.h
**Description**

*mktemp* replaces *template* by a unique file name and returns the address of *template*.

The *template* should be a null-terminated string with six trailing X’s. These X’s are replaced with a unique collection of letters plus a dot, so that there are two letters, a dot, and three suffix letters in the new file name.

Starting with AA.AAA, the new file name is assigned by looking up the names on the disk and avoiding pre-existing names of the same format.

**Return value**

If *template* is well-formed, *mktemp* returns the address of the *template* string. Otherwise, it does not create or open the file.

**Portability**

Available on UNIX systems.

---

**modf**

**Name**

*modf* – splits into mantissa and exponent

**Usage**

double modf(double *value, double *iptr);

**Prototype in**

math.h

**Description**

see *fmod*

---

**movedata**

**Name**

*movedata* – copies bytes

**Usage**

void movedata(int *segsrc, int offsrc, int *segdest,
               int *offdest, unsigned *numbytes);

**Prototype in**

mem.h

string.h

**Description**

*movedata* copies *numbytes* bytes from the source address (*segsrc:offsrc*) to the destination address (*segdest:offdest*).
movedata is useful for moving far data in tiny, small, and medium model programs, where data segment addresses are not known implicitly. memcpy can be used in compact, large, and huge model programs, since segment addresses are known implicitly.

Return value
There is no return value.

See also
FP_OFF, memcpy, segread

Example
#include <mem.h>

#define MONO_BASE 0xB000

/* saves the contents of the monochrome screen in buffer */

void save_mono_screen(char near *buffer)
{
    movedata(MONO_BASE, 0, DS, (unsigned)buffer, 80*25*2);
}

main()
{
    char buf[80*25*2];
    save_mono_screen(buf);
}

movmem

Name       movmem – moves a block of bytes
Usage      void movmem(void *source, void *destin, unsigned len);
Related functions usage
            void setmem(void *addr, int len, char value);
Prototype in mem.h
Description movmem copies a block of len bytes from source to destin. If the source and destination strings overlap, the copy direction is chosen so that the data is always copied correctly.
setmem sets the first bytes of the block pointed to by addr to the byte value.

Return value movmem and setmem return nothing.

Portability Unique to the 8086 family.

See also mem..., str...

---

### open

<table>
<thead>
<tr>
<th>Name</th>
<th>_open – opens a file for reading or writing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>#include &lt;fcntl.h&gt; int _open(char *pathname, int access);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>io.h</td>
</tr>
<tr>
<td>Description</td>
<td>see open</td>
</tr>
</tbody>
</table>

### open

<table>
<thead>
<tr>
<th>Name</th>
<th>open – opens a file for reading or writing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>#include &lt;fcntl.h&gt; #include&lt;sys\stat.h&gt; int open(char *pathname, int access [,int permis]);</td>
</tr>
<tr>
<td>Related functions usage</td>
<td>int _open(char *pathname, int access); int sopen(char *pathname, int access, int shflag, int permis);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>io.h</td>
</tr>
</tbody>
</table>
| Description  | open opens the file specified by pathname, then prepares it for reading and/or writing as determined by the value of access. For open, access is constructed by bitwise ORing flags from the following two lists. Only one flag from the first
list may be used; the remaining flags may be used in any logical combination.

List 1: Read/Write flags

- O_RDONLY      Open for reading only.
- O_WRONLY      Open for writing only.
- O_RDWR        Open for reading and writing.

List 2: Other access flags

- O_NDELAY     Not used; for UNIX compatibility.
- O_APPEND     If set, the file pointer will be set to the end of the file prior to each write.
- O_CREAT      If the file exists, this flag has no effect.
               If the file does not exist, the file is created, and the bits of permiss are used to set the file attribute bits, as in chmod.
- O_TRUNC      If the file exists, its length is truncated to 0. The file attributes remain unchanged.
- O_EXCL       Used only with O_CREAT. If the file already exists, an error is returned.
- O_BINARY     This flag can be given to explicitly open the file in binary mode.
- O_TEXT       This flag can be given to explicitly open the file in text mode.

These O_... symbolic constants are defined in fcntl.h.

If neither O_BINARY nor O_TEXT is given, the file is opened in the translation mode set by the global variable _fmode.

If the O_CREAT flag is used in constructing access, you need to supply the permiss argument to open, from the following symbolic constants defined in sys\stat.h.

<table>
<thead>
<tr>
<th>Value of permiss</th>
<th>Access Permission</th>
</tr>
</thead>
<tbody>
<tr>
<td>S_IWRITE</td>
<td>Permission to write</td>
</tr>
<tr>
<td>S_IREAD</td>
<td>Permission to read</td>
</tr>
<tr>
<td>S_IREAD</td>
<td>S_IWRITE</td>
</tr>
</tbody>
</table>
For _open, the value of access in MS-DOS 2.x is limited to O_RDONLY, O_WRONLY, and O_RDWR. For MS-DOS 3.x, the following additional values can also be used:

- O_NOINHERIT: Included if the file is not to be passed to child programs.
- O_DENYALL: Allows only the current handle to have access to the file.
- O_DENYWRITE: Allows only reads from any other open to the file.
- O_DENYREAD: Allows only writes from any other open to the file.
- O_DENYNONE: Allows other shared opens to the file.

Only one of the O_DENYxxx values may be included in a single _open under DOS 3.x. These file-sharing attributes are in addition to any locking performed on the files.

The maximum number of simultaneously open files is a system configuration parameter.

sopen is a macro defined as

```c
open(pathname, (access | shflag), permss)
```

where pathname, access, and permss are the same as for open, and shflag is a flag specifying the type of file-sharing allowed on the file pathname. Symbolic constants for shflag are defined in share.h.

**Return value**

On successful completion, these routines return a non-negative integer (the file handle), and the file pointer (that marks the current position in the file) is set to the beginning of the file. On error, they return -1 and errno is set to one of the following:

- ENOENT: Path or file name not found
- EMFILE: Too many open files
- EACCES: Permission denied
- EINVACC: Invalid access code

**Portability**

open and sopen are available on UNIX systems. On UNIX version 7, the O_type mnemonics are not defined.
UNIX System III uses all of the O_type mnemonics except O_BINARY.

_open is unique to MS-DOS.

See also chmod, close, creat, dup, ferror, _fmode (variable), fopen, lock, lseek, read, searchpath, setmode, write

---

### outport

<table>
<thead>
<tr>
<th>Name</th>
<th>outport – output to a hardware port</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>void outport(int port, int word);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>dos.h</td>
</tr>
<tr>
<td>Description</td>
<td>see inport</td>
</tr>
</tbody>
</table>

### outportb

<table>
<thead>
<tr>
<th>Name</th>
<th>outportb – output to a hardware port</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>#include &lt;dos.h&gt;</td>
</tr>
<tr>
<td></td>
<td>void outportb(int port, char byte);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>dos.h</td>
</tr>
<tr>
<td>Description</td>
<td>see inport</td>
</tr>
</tbody>
</table>

### parsfnm

<table>
<thead>
<tr>
<th>Name</th>
<th>parsfnm – parses file name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>#include &lt;dos.h&gt;</td>
</tr>
<tr>
<td></td>
<td>char *parsfnm(char *cmdline, struct fcb *fcbptr, int option);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>dos.h</td>
</tr>
</tbody>
</table>
parsfnm parses a string, normally a command line, pointed to by *cmdline for a file name. The file name is placed in an FCB as a drive, file name, and extension. The FCB is pointed to by fcbptr.

The option parameter is the value documented for AL in the DOS parse system call. See the MS-DOS Programmer’s Reference Manual under system call 0x29 for a description of the parsing operations performed on the file name.

On successfully completing the parse of a file name, parsfnm returns a pointer to the next byte after the end of the file name. If there is any error in parsing the file name, parsfnm returns 0.

Unique to MS-DOS.

peek

peek - examines memory location

int peek(int segment, unsigned offset);

char peekb(int segment, unsigned offset);

dos.h
peek and peekb examine the memory location addressed by segment:offset.

If these routines are called when dos.h has been included, they will be treated as macros that expand to in-line code. If you don’t include dos.h (or if you do include it and #undef the routines) you will get the functions rather than the macros.

peek and peekb return the value stored at the memory location segment:offset. peek returns a word, and peekb returns a byte.

Unique to the 8086 family.

harderr, poke
peekb

<table>
<thead>
<tr>
<th>Name</th>
<th>peekb – examines memory location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>#include &lt;dos.h&gt;</td>
</tr>
<tr>
<td></td>
<td>char peekb(int segment, unsigned offset);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>dos.h</td>
</tr>
<tr>
<td>Description</td>
<td>see peek</td>
</tr>
</tbody>
</table>

perror

<table>
<thead>
<tr>
<th>Name</th>
<th>perror – system error messages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>void perror(char *string);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>stdio.h</td>
</tr>
<tr>
<td>Description</td>
<td>perror prints an error message to stderr, describing the most recent error encountered in a system call from the current program.</td>
</tr>
</tbody>
</table>

First the argument string is printed, then a colon, then the message corresponding to the current value of errno, and finally a newline. The convention is to pass the name of the program as the argument string.

To provide more control over message formatting, the array of message strings is provided in sys_errlist. errno can be used as an index into the array to find the string corresponding to the error number. The string does not include any newline character.

sys_nerr contains the number of entries in the array.

Refer to errno, sys_errlist, and sys_nerr in the "Variables" section of this chapter for more information.

Return value  None
Portability  Available on UNIX systems.
See also  eof

---

**poke**

Name  poke – stores value at a given memory location
Usage  void poke(int segment, int offset, int value);
Related functions usage  void pokeb(int segment, int offset, char value);
Prototype in  dos.h
Description  poke stores the integer value at the memory location segment:offset.

If these routines are called when dos.h has been included, they will be treated as macros that expand to in-line code. If you don't include dos.h (or if you do include it and #undef the routines) you will get the functions rather than the macros.

**pokeb** is the same as **poke**, except that a byte value is deposited instead of an integer.

Return value  None
Portability  Unique to the 8086 family.
See also  peek
**pokeb**

Name  pokeb – value at memory location  
Usage  
#include <dos.h>  
void pokeb(int segment, int offset, char value);  
Prototype in  dos.h  
Description  see poke

**poly**

Name  poly – generates a polynomial from arguments  
Usage  double poly(double x, int n, double c[]);  
Prototype in  math.h  
Description  poly generates a polynomial in \( x \), of degree \( n \), with coefficients \( c[0], c[1], \ldots, c[n] \). For example, if \( n = 4 \), the generated polynomial is  
Return value  poly returns the value of the polynomial as evaluated for the given \( x \).  
Portability  Available on UNIX systems.
### pow

<table>
<thead>
<tr>
<th>Name</th>
<th><strong>pow</strong> – power function, ( x^y )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>double pow(double ( x ), double ( y ));</td>
</tr>
<tr>
<td>Prototype in</td>
<td>math.h</td>
</tr>
<tr>
<td>Description</td>
<td>see exp</td>
</tr>
</tbody>
</table>

### pow10

<table>
<thead>
<tr>
<th>Name</th>
<th><strong>pow10</strong> – power function, ( 10^p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>double pow10(int ( p ));</td>
</tr>
<tr>
<td>Prototype in</td>
<td>math.h</td>
</tr>
<tr>
<td>Description</td>
<td>see exp</td>
</tr>
</tbody>
</table>

### ...printf

<table>
<thead>
<tr>
<th>Name</th>
<th><strong>...printf</strong> – functions that send formatted output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>int printf(char *format, ...);</td>
</tr>
<tr>
<td>Related functions usage</td>
<td>int cprintf(char *format[, argument, ...]);</td>
</tr>
<tr>
<td></td>
<td>int fprintf(FILE *stream, char *format[, argument, ...]);</td>
</tr>
<tr>
<td></td>
<td>int sprintf(char *string, char *format[, argument, ...]);</td>
</tr>
<tr>
<td></td>
<td>int vfprintf(FILE *stream, char *format, va_list param);</td>
</tr>
</tbody>
</table>
Prototype in stdio.h

Description

The ...printf family of functions all "print" formatted output; they all:

- accept a format string that determines how the output will be formatted (this is given as format in the Usage)
- apply the format string to a variable number of values to produce formatted output (the values are given as either "argument, ..." or va_list param in the Usage)

The output location is implicit in three of the ...printf functions.

printf places its output on stdout; so does vprintf.
cprintf sends its output directly to the console.

The other four ...printf functions also accept another argument (the first in the list of parameters). This additional argument designates where the output goes.

fprintf and vfprintf place output in a named stream.
sprintf and vsprintf place output in a string in memory.

Four of the ...printf functions accept the arguments to be formatted from the function call (printf, cprintf, fprintf, and sprintf).

The other three (vprintf, vfprintf, and vsprintf) accept the arguments to be formatted from a variable argument list. The v...printf functions are known as alternate entry points for the ...printf functions.

See the definition of va_... for more information.

Here is a summary of each of the ...printf functions.

printf places its output on stdout.
cprintf sends its output directly to the console: it does not translate line-feed characters into CR/LF combinations.
fprintf places its output on the named stream.
The Turbo C Library

sprintf places its output as a null-terminated string starting at string. With sprintf, it is the user’s responsibility to ensure there is enough space in string to hold the string.

vprintf behaves exactly like printf, except that it accepts arguments from the va_arg array va_list param.

vfprintf behaves exactly like fprintf, except that it accepts arguments from the va_arg array va_list param.

vsprintf behaves exactly like sprintf, except that it accepts arguments from the va_arg array va_list param.

For an example of how to use vprintf, refer to va....

The Format String

The format string, present in each of the printf function calls, controls how each function will convert, format, and print its arguments. There must be enough arguments for the format; if not, the results are unpredictable and likely disastrous. Excess arguments (more than required by the format) are merely ignored.

The format string is a character string that contains two types of objects—plain characters and conversion specifications:

The plain characters are simply copied verbatim to the output stream.

The conversion specifications fetch arguments from the argument list and apply formatting to them.

Format Specifications

printf format specifications have the following form:

% [flags] [width] [.prec] [F|N|h|l] type
Each conversion specification begins with the percent character (%). After the % come the following, in this order:

- an optional sequence of flag characters [flags]
- an optional width specifier [width]
- an optional precision specifier [.prec]
- an optional input size modifier [F|N|h|l]
- the conversion type character [type]

Optional Format String Components

These are the general aspects of output formatting controlled by the optional characters, specifiers, and modifiers in the format string:

<table>
<thead>
<tr>
<th>Character or Specifier</th>
<th>What It Controls or Specifies</th>
</tr>
</thead>
<tbody>
<tr>
<td>flags</td>
<td>output justification, numeric signs, decimal points, trailing zeroes, octal and hex prefixes</td>
</tr>
<tr>
<td>width</td>
<td>minimum number of characters to print, padding with blanks or zeroes</td>
</tr>
<tr>
<td>precision</td>
<td>maximum number of characters to print; for integers, minimum number of digits to print</td>
</tr>
<tr>
<td>size</td>
<td>override default size of argument (N = \text{near pointer}, F = \text{far pointer} \ h = \text{short int}, l = \text{long})</td>
</tr>
</tbody>
</table>

...printf Conversion Type Characters

The following table lists the ...printf conversion type characters, the type of input argument accepted by each, and in what format the output will appear.

The information in this table of type characters is based on the assumption that no flag characters, width specifiers, precision specifiers, or input-size
modifiers were included in the format specification. To see how the addition of the optional characters and specifiers affects the `printf` output, refer to the tables following this one.

<table>
<thead>
<tr>
<th>Type Character</th>
<th>Input Argument</th>
<th>Format of Output</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>d</code></td>
<td>integer</td>
<td>signed decimal int</td>
</tr>
<tr>
<td><code>i</code></td>
<td>integer</td>
<td>signed decimal int</td>
</tr>
<tr>
<td><code>o</code></td>
<td>integer</td>
<td>unsigned octal int</td>
</tr>
<tr>
<td><code>u</code></td>
<td>integer</td>
<td>unsigned decimal int</td>
</tr>
<tr>
<td><code>x</code></td>
<td>integer</td>
<td>unsigned hexadecimal int (with a, b, c, d, e, f)</td>
</tr>
<tr>
<td><code>X</code></td>
<td>integer</td>
<td>unsigned hexadecimal int (with A, B, C, D, E, F)</td>
</tr>
<tr>
<td><code>f</code></td>
<td>floating point</td>
<td>signed value of the form <code>[-]dddd.dddd</code></td>
</tr>
<tr>
<td><code>e</code></td>
<td>floating point</td>
<td>signed value of the form <code>[-]d.dddd e [+/-]ddd</code></td>
</tr>
<tr>
<td><code>g</code></td>
<td>floating point</td>
<td>signed value in either <code>e</code> or <code>f</code> form, based on given value and precision. Trailing zeroes and the decimal point are printed only if necessary.</td>
</tr>
<tr>
<td>Type Character</td>
<td>Input Argument</td>
<td>Format of Output</td>
</tr>
<tr>
<td>---------------</td>
<td>--------------------</td>
<td>----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Numerics (continued)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>floating point</td>
<td>same as e, but with E for exponent</td>
</tr>
<tr>
<td>G</td>
<td>floating point</td>
<td>same as g, but with E for exponent if e format used</td>
</tr>
<tr>
<td><strong>Characters</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c</td>
<td>character</td>
<td>single character</td>
</tr>
<tr>
<td>s</td>
<td>string pointer</td>
<td>prints characters until a null-terminator is hit or precision is reached</td>
</tr>
<tr>
<td>%</td>
<td>none</td>
<td>the % character is printed</td>
</tr>
<tr>
<td><strong>Pointers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>pointer to int</td>
<td>stores (in the location pointed to by the input argument) a count of the characters written so far</td>
</tr>
<tr>
<td>p</td>
<td>pointer</td>
<td>prints the input argument as a pointer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>far pointers are printed as XXXX:YYYY. near pointers are printed as YYYY (offset only)</td>
</tr>
</tbody>
</table>
Conventions

Certain conventions accompany some of these specifications, as summarized in the following table.

<table>
<thead>
<tr>
<th>Characters</th>
<th>Conventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>e or E</td>
<td>The argument is converted to match the style ([-)\ d.ddd...e[ +/- ]ddd ] where:</td>
</tr>
<tr>
<td></td>
<td>• one digit precedes the decimal point</td>
</tr>
<tr>
<td></td>
<td>• the number of digits after the decimal point is equal to the precision</td>
</tr>
<tr>
<td></td>
<td>• the exponent always contains three digits</td>
</tr>
<tr>
<td>f</td>
<td>The argument is converted to decimal notation in the style ([-)\ ddd.ddd... ] where the number of digits after the decimal point is equal to the precision (if a non-zero precision was given).</td>
</tr>
<tr>
<td>g or G</td>
<td>The argument is printed in style e, E or f, with the precision specifying the number of significant digits. Trailing zeroes are removed from the result, and a decimal point appears only if necessary. The argument is printed in style e or f (with some restraints) if g is the conversion character, and in style E if the character is G. Style e is used only if the exponent that results from the conversion is either (a) greater than the precision or (b) less than -4.</td>
</tr>
<tr>
<td>x or X</td>
<td>For x conversions, the letters a, b, c, d, e, and f will appear in the output; for X conversions, the letters A, B, C, D, E, and F will appear.</td>
</tr>
</tbody>
</table>
Flag Characters

The flag characters are minus (-), plus (+), sharp (#) and blank ( ): They can appear in any order and combination.

<table>
<thead>
<tr>
<th>Flag</th>
<th>What It Specifies</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>Left-justifies the result, pads on the right with blanks. If not given, right-justifies result, pads on left with zeroes or blanks.</td>
</tr>
<tr>
<td>+</td>
<td>Signed conversion results always begin with a plus (+) or minus (-) sign.</td>
</tr>
<tr>
<td>blank</td>
<td>If value is non-negative, the output begins with a blank instead of a plus; negative values still begin with minus.</td>
</tr>
<tr>
<td>#</td>
<td>Specifies that arg is to be converted using an &quot;alternate form.&quot; See the following table.</td>
</tr>
</tbody>
</table>

Note: Plus takes precedence over blank if both given.
Alternate Forms

If the # flag is used with a conversion character, it has the following effect on the argument (arg) being converted:

<table>
<thead>
<tr>
<th>Conversion Character</th>
<th>How # Affects arg</th>
</tr>
</thead>
<tbody>
<tr>
<td>c, s, d, i, u</td>
<td>No effect</td>
</tr>
<tr>
<td>o</td>
<td>0 will be prepended to a non-zero arg.</td>
</tr>
<tr>
<td>x or X</td>
<td>0x (or 0X) will be prepended to arg.</td>
</tr>
<tr>
<td>e, E or f</td>
<td>The result will always contain a decimal point even if no digits follow the point. Normally, decimal point appears in these results only if a digit follows it.</td>
</tr>
<tr>
<td>g or G</td>
<td>Same as e and E, with the addition that trailing zeroes will not be removed.</td>
</tr>
</tbody>
</table>
Width Specifiers

The width specifier sets the minimum field width for an output value.

Width is specified in one of two ways; directly, through a decimal digit string, or indirectly, through an asterisk (*). If you use an asterisk for the width specifier, the next argument in the call (which must be an int) specifies the minimum output field width.

In no case does a non-existent or small field width cause truncation of a field. If the result of a conversion is wider than the field width, the field is simply expanded to contain the conversion result.

<table>
<thead>
<tr>
<th>Width Specifier</th>
<th>How Output Width Is Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>At least n characters are printed. If the output value has less than n characters, the output is padded with blanks (right-padded if &quot;-&quot; flag given, left-padded otherwise).</td>
</tr>
<tr>
<td>On</td>
<td>At least n characters are printed. If the output value has less than n characters, it is filled on the left with zeroes.</td>
</tr>
<tr>
<td>*</td>
<td>The argument list supplies the width specifier, which must precede the actual argument being formatted.</td>
</tr>
</tbody>
</table>
Precision Specifiers

Precision specification always begins with a dot (.), to separate it from any preceding width specifier. Then, like width, precision is specified either directly, through a decimal digit string, or indirectly, through an asterisk (*). If you use an asterisk for the precision specifier, the next argument in the call (treated as an int) specifies the precision.

If you use asterisks for the width or the precision, or for both, the width argument must immediately follow the specifiers, followed by the precision argument, then the argument for the data to be converted.

<table>
<thead>
<tr>
<th>Precision Specifier</th>
<th>How Output Precision Is Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>(none given)</td>
<td>Precision set to default</td>
</tr>
<tr>
<td></td>
<td>(default = 1 for d, i, o, u, x, X types; default = 6 for e, E, f types; default = all significant digits for g, G types; default = print to first null character for s types; no effect on c types.)</td>
</tr>
<tr>
<td>.0</td>
<td>for d, i, o, u, x types, precision set to default</td>
</tr>
<tr>
<td></td>
<td>for e, E, f types, no decimal point is printed</td>
</tr>
<tr>
<td>.n</td>
<td>n characters or n decimal places are printed. If the output value has more than n characters, the output might be truncated or rounded. (Whether or not this happens depends on the type character.)</td>
</tr>
<tr>
<td>*</td>
<td>The argument list supplies the precision specifier, which must precede the actual argument being formatted.</td>
</tr>
</tbody>
</table>
### Conversion Character

<table>
<thead>
<tr>
<th>Character</th>
<th>How Precision Specification (.n) Affects Conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>d</td>
<td>.n specifies that at least n digits will be printed. If the input argument has less than n digits, the output value is left-padded with zeroes.</td>
</tr>
<tr>
<td>i</td>
<td>If the input argument has more than n digits, the output value is not truncated.</td>
</tr>
<tr>
<td>o</td>
<td>.n specifies that n characters will be printed after the decimal point, and the last digit printed is rounded.</td>
</tr>
<tr>
<td>u</td>
<td>.n specifies that at most n significant digits will be printed.</td>
</tr>
<tr>
<td>x</td>
<td>.n has no effect on the output.</td>
</tr>
<tr>
<td>X</td>
<td>.n specifies that no more than n characters will be printed.</td>
</tr>
</tbody>
</table>

### Input Size Modifier

The input-size modifier character (F, N, h or l) gives the size of the subsequent input argument:

- F = far pointer
- N = near pointer
- h = short int
- l = long

The input-size modifiers (F, N, h, and l) affect how the ...printf functions interpret the data-type of the corresponding input argument arg. F and N apply only to input args that are pointers (%p, %s, and %n). h and l apply to input args that are numeric (integers and floating-point).

Both F and N reinterpret the input arg. Normally, the arg for a %p, %s, or %n conversion is a pointer of the default size for the memory model. F says "interpret arg as a far pointer". N says "interpret arg as a near pointer".

Both h and l override the default size of the numeric data input args: l applies to integer (d, i, o, u, x, X) and floating-point (e, E, f, g, and G) types,
while h applies to integer types only. Neither h nor I affect character (c, s) or pointer (p, n) types.

<table>
<thead>
<tr>
<th>Input-Size Modifier</th>
<th>How arg Is Interpreted</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>arg is read as a far pointer</td>
</tr>
<tr>
<td>N</td>
<td>arg is read as a near pointer</td>
</tr>
<tr>
<td>h</td>
<td>arg is interpreted as a short int for d, i, o, u, x, or X.</td>
</tr>
<tr>
<td>l</td>
<td>arg is interpreted as a long int for d, i, o, u, x, or X; arg is interpreted as a double for e, E, f, g, or G.</td>
</tr>
</tbody>
</table>

**Return value**
Each function returns the number of bytes output. `sprintf` does not include the null byte in the count. In the event of error, these functions return EOF.

**Portability**
The functions `printf`, `fprintf`, `fprintf`, and `sprintf` are available on UNIX systems and are defined in Kernighan and Ritchie.

`vprintf`, `vfprintf`, and `vsprintf` are available on UNIX System V but are not defined in Kernighan and Ritchie.

**See also**
ecvt, fread,putc, puts, scanf, va...

**Example**
```c
#define I 555
#define R 5.5

main()
{
    int i,j,k,l;
    char buf[7];
    char *prefix = &buf;
    char tp[20];
```
```c
printf("prefix 6d 6o 8x 10.2e 10.2f\n");
strcpy(prefix, ";");
for (i=0;i<2;i++) {
    for (j=0;j<2;j++)
        for (k=0;k<2;k++)
            for (l=0;l<2;l++) {
                if (i==0) strcat(prefix, "+");
                if (j==0) strcat(prefix, "-");
                if (k==0) strcat(prefix, "#"l);
                if (l==0) strcat(prefix, "0");
                printf("%s ", prefix);
                strcpy(tp, prefix);
                strcat(tp, "6d ");
                printf(tp, I);
                strcpy(tp, ");
                strcat(tp, "60 ");
                printf(tp, I);
                strcpy(tp, ");
                strcat(tp, "8x ");
                printf(tp, I);
                strcpy(tp, ");
                strcat(tp, "10.2e ");
                printf(tp, R);
                strcpy(tp, prefix);
                strcat(tp, "10.2f ");
                printf(tp, R);
                printf(" 
");
                strcpy(prefix, ";");
            }
        }
    }
}``

Program output

<table>
<thead>
<tr>
<th>prefix</th>
<th>6d</th>
<th>6o</th>
<th>8x</th>
<th>10.2e</th>
<th>10.2f</th>
</tr>
</thead>
<tbody>
<tr>
<td>%+#0</td>
<td>+555</td>
<td>101053</td>
<td>10x22b</td>
<td>+5.50e+000</td>
<td>+5.50</td>
</tr>
<tr>
<td>%+##</td>
<td>+555</td>
<td>101053</td>
<td>10x22b</td>
<td>+5.50e+000</td>
<td>+5.50</td>
</tr>
<tr>
<td>%+##</td>
<td>+555</td>
<td>101053</td>
<td>10x22b</td>
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</tr>
<tr>
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<td>+555</td>
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</tr>
<tr>
<td>%+##</td>
<td>+555</td>
<td>101053</td>
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</tr>
<tr>
<td>%##</td>
<td>+555</td>
<td>101053</td>
<td>10x22b</td>
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<td>+5.50</td>
</tr>
<tr>
<td>%##</td>
<td>+555</td>
<td>101053</td>
<td>10x22b</td>
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<td>+5.50</td>
</tr>
<tr>
<td>%##</td>
<td>+555</td>
<td>101053</td>
<td>10x22b</td>
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<td>+5.50</td>
</tr>
<tr>
<td>##</td>
<td>+555</td>
<td>101053</td>
<td>10x22b</td>
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<td>+5.50</td>
</tr>
<tr>
<td>##</td>
<td>+555</td>
<td>101053</td>
<td>10x22b</td>
<td>+5.50e+000</td>
<td>+5.50</td>
</tr>
<tr>
<td>%</td>
<td>+555</td>
<td>101053</td>
<td>10x22b</td>
<td>+5.50e+000</td>
<td>+5.50</td>
</tr>
<tr>
<td>%</td>
<td>+555</td>
<td>101053</td>
<td>10x22b</td>
<td>+5.50e+000</td>
<td>+5.50</td>
</tr>
<tr>
<td>%</td>
<td>+555</td>
<td>101053</td>
<td>10x22b</td>
<td>+5.50e+000</td>
<td>+5.50</td>
</tr>
<tr>
<td>%</td>
<td>+555</td>
<td>101053</td>
<td>10x22b</td>
<td>+5.50e+000</td>
<td>+5.50</td>
</tr>
<tr>
<td>%</td>
<td>+555</td>
<td>101053</td>
<td>10x22b</td>
<td>+5.50e+000</td>
<td>+5.50</td>
</tr>
<tr>
<td>%</td>
<td>+555</td>
<td>101053</td>
<td>10x22b</td>
<td>+5.50e+000</td>
<td>+5.50</td>
</tr>
</tbody>
</table>

Turbo C Reference Guide
## putc

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>putc</td>
<td>putc – outputs a character to a stream</td>
</tr>
</tbody>
</table>

### Usage

```
#include <stdio.h>
int putc(int ch, FILE *stream);
```

### Related functions usage

```
int fputc(int ch, FILE *stream);
int fputchar(char ch);
int putch(int ch);

int putchar(int ch);
int putw(int w, FILE *stream);
```

### Prototype in

```
stdio.h
```

### Description

**putc** is a macro that outputs the character *ch* to the named output *stream*.

**putchar(ch)** is a macro defined to be **putc(ch, stdout)**.

**fputc** is like **putc** but it is a true function that outputs *ch* to the named *stream*.

**fputchar** outputs *ch* to *stdout*. **fputchar(char ch)** is the same as **fputc(char ch, stdout)**.

**putch** outputs the character *ch* to the console.

**putw** outputs the integer *w* to the output *stream*. **putw** neither expects nor causes special alignment in the file.

### Return value

On success **putc**, **fputc**, **fputchar**, and **putchar** return the character *ch*, while **putw** returns the integer *w*, and **putch** returns nothing.

On error, all the functions except **putch** return EOF. **putch** returns nothing.

Since EOF is a legitimate integer, **ferror** should be used to detect errors with **putw**.
<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>putch</td>
<td>puts character on console</td>
</tr>
<tr>
<td>putchar</td>
<td>puts character on a stream</td>
</tr>
<tr>
<td>putenv</td>
<td>adds string to current environment</td>
</tr>
</tbody>
</table>

### putch

- **Name**: putch - puts character on console
- **Usage**: `int putch(int ch);`
- **Prototype in**: conio.h
- **Description**: see putc

### putchar

- **Name**: putchar - puts character on a stream
- **Usage**: `#include <stdio.h>
              int putchar(int ch);`
- **Prototype in**: stdio.h
- **Description**: see putc

### putenv

- **Name**: putenv - adds string to current environment
- **Usage**: `int putenv(char *envvar);`
- **Prototype in**: stdlib.h
- **Description**: see getenv

All these functions are available on UNIX systems. putc and putchar and are defined in Kernighan and Ritchie. See also perror, fopen, fread, getc, printf, puts, setbuf.
puts

Name  puts – puts a string on a stream
Usage  int puts(char *string);
Related functions usage  void cputs(char *string);
                        int fputs(char *string, FILE *stream);
Prototype in  stdio.h   (fputs and puts)
               conio.h   (cputs)
Description  puts copies the null-terminated string string to the
             standard output stream stdout and appends a newline
             character.
             cputs writes the null-terminated string string to the
             console; it does not append a newline character.
             fputs copies the null-terminated string string to the
             named output stream; it does not append a newline
             character.
Return value  On successful completion, puts and fputs return the last
             character written. Otherwise, a value of EOF is returned.
             cputs returns no value.
Portability  These functions are available on UNIX systems.
             Kernighan and Ritchie also define fputs.
See also    ferror, fopen, fread, gets, open, printf, putc
## putw

<table>
<thead>
<tr>
<th>Name</th>
<th>putw – puts character or word on a stream</th>
</tr>
</thead>
</table>
| Usage     | `#include <stdio.h>`
          | int putw(int w, FILE *stream);         |
| Prototype in | stdio.h                            |
| Description | see putc                            |

## qsort

<table>
<thead>
<tr>
<th>Name</th>
<th>qsort – sorts using the quick sort routine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>void qsort(void *base, int nelem, int width, int (*fcmp)());</td>
</tr>
<tr>
<td>Prototype in</td>
<td>stdlib.h</td>
</tr>
</tbody>
</table>
| Description | qsort is an implementation of the “median of three“ variant of the quicksort algorithm. qsort sorts the entries in a table into order by repeatedly calling the user-defined comparison function pointed to by fcmp.

- `base` points to the base (0th element) of the table to be sorted.
- `nelem` is the number of entries in the table.
- `width` is the size of each entry in the table, in bytes.

`fcmp`, the comparison function, accepts two arguments, `elem1` and `elem2`, each a pointer to an entry in the table. The comparison function compares each of the pointed-to items (*elem1 and *elem2), and returns an integer based on the result of the comparison.
**If the items**

<table>
<thead>
<tr>
<th>Comparison</th>
<th><code>fcnpj</code> returns</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>*elem1 &lt; *elem2</code></td>
<td>an integer &lt; 0</td>
</tr>
<tr>
<td><code>*elem1 == *elem2</code></td>
<td>0</td>
</tr>
<tr>
<td><code>*elem1 &gt; *elem2</code></td>
<td>an integer &gt; 0</td>
</tr>
</tbody>
</table>

In the comparison, the *less than* symbol (<) means that the left element should appear before the right element in the final, sorted sequence. Similarly, the *greater than* (>) symbol means that the left element should appear after the right element in the final, sorted sequence.

**Return value**

`qsort` does not return a value.

**Portability**

Available on UNIX systems.

**See also**

`bsearch`, `lsearch`

---

**rand**

**Name**

`rand` – random number generator

**Usage**

`int rand(void);`

**Related functions usage**

`void srand(unsigned seed);`

**Prototype in**

`stdlib.h`

**Description**

`rand` uses a multiplicative congruential random-number generator with period $2^{32}$ to return successive pseudo-random numbers in the range from 0 to $2^{15} - 1$.

The generator is reinitialized by calling `srand` with an argument value of 1. It can be set to a new starting point by calling `srand` with a given `seed` number.

**Portability**

Available on UNIX systems.

**Example**

```c
#include <time.h>
#include <stdio.h>
#include <stdlib.h>
```
main() /* Prints 5 random numbers from 0 to 32767 */
{
    int i; long now;

    srand(time(&now) % 37); /* start at a random place */
    for (i=0; i<5; i++)
        printf("%d\n", rand());
}

Program output

9680
7414
22510
13860
6005

randbrd

Name randbrd – random block read
Usage #include <dos.h>
    int randbrd(struct fcb *fcbptr, int reccnt);
Related functions usage int randbwr(struct fcb *fcbptr, int reccnt);
Prototype in dos.h
Description randbrd reads reccnt number of records using the open FCB pointed to by fcbptr. The records are read into memory at the current disk transfer address. They are read from the disk record indicated in the random record field of the FCB. This is accomplished by calling DOS system call 0x27.

randbwr performs essentially the same function as randbrd, except that data is written to disk instead of read from disk. This is accomplished using DOS system call DOS 0x28. If reccnt is 0, the file is truncated to the length indicated by the random record field.

The actual number of records read or written can be determined by examining the random record field of the
FCB. The random record field will be advanced by the number of records actually read or written.

Return value

The following values are returned, depending upon the result of the randbrd or randbwr operation:

0 All records are read or written.

1 End-of-file is reached and the last record read is complete.

2 Reading records would have wrapped around address OxFFFF (as many records as possible are read).

3 End-of-file is reached with the last record incomplete.

randbwr returns 1 if there is not enough disk space to write the records (no records are written).

Portability

Unique to MS-DOS.

**randbwr**

Name     randbwr – random block write
Usage    #include <dos.h>
          int randbwr(struct fcb *fcbptr, int recnt);
Prototype in  dos.h
Description  see randbrd
_read

Name     _read – reads from file
Usage    int _read(int handle, void *buf, int nbyte);
Prototype in    io.h
Description    see read

read

Name     read – reads from file
Usage    int read(int handle, void *buf, int nbyte);
Related functions usage    int _read(int handle, void *buf, int nbyte);
Prototype in    io.h
Description    read and _read attempt to read nbyte bytes from the file associated with handle into the buffer pointed to by buf. _read is a direct call to the MS-DOS read system call.

For a file opened in text mode, read removes carriage returns and reports end-of-file when a Ctrl-Z character is read. No such removal or reporting is performed by _read.

handle is a file handle obtained from a creat, open, dup, dup2, or fcntl call.

On disk files, these functions begin reading at the current file pointer. When the reading is complete, they increment the file pointer by the number of bytes read. On devices, the bytes are read directly from the device.

Return value    Upon successful completion, a positive integer is returned indicating the number of bytes placed in the
buffer; if the file was opened in text mode, read does not count carriage returns or Ctrl-Z characters in the number of bytes read.

On end-of-file, both functions return zero. On error, both functions return -1 and errno is set to one of the following:

- EACCES  Permission denied
- EBADF   Bad file number

Portability  
read is available on UNIX systems. 
_read is unique to MS-DOS.

See also  
creat, dup, fread, getc, open

---

realloc

Name  realloc – reallocates memory
Usage  void *realloc(void *ptr, unsigned newsize);
Prototype in  stdlib.h and alloc.h
Description  see malloc

---

remove

Name  remove – removes a file
Usage  int remove(char *filename);
Prototype in  stdio.h
Description  see unlink
### rename

<table>
<thead>
<tr>
<th>Name</th>
<th>rename – renames a file</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>int rename(char *oldname, char *newname);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>stdio.h</td>
</tr>
<tr>
<td>Description</td>
<td>rename changes the name of a file from oldname to newname. If a drive specifier is given in newname, the specifier must be the same as that given in oldname. Directories in a path need not be the same, so rename can be used to move a file from one directory to another. Wildcards are not allowed.</td>
</tr>
<tr>
<td>Return value</td>
<td>On successfully renaming the file, rename returns 0. In the event of error, −1 is returned, and errno is set to one of the following:</td>
</tr>
<tr>
<td>Portability</td>
<td>Unique to MS-DOS.</td>
</tr>
</tbody>
</table>

#### ENOENT Path or file name not found
#### EACCES Permission denied
#### ENOTSAM Not same device

### rewind

<table>
<thead>
<tr>
<th>Name</th>
<th>rewind – repositions a stream</th>
</tr>
</thead>
</table>
| Usage  | #include <stdio.h>  
      | int rewind(FILE *stream); |
| Prototype in | stdio.h |
| Description | see fseek |
rmdir

Name       rmdir – removes directory
Usage      int rmdir(char *pathname);
Prototype in dir.h
Description see mkdir

sbrk

Name       sbrk – changes data segment space allocation
Usage      char *sbrk(int incr);
Prototype in alloc.h
Description see brk

...scanf

Name       ...scanf – performs formatted input
Usage      int scanf(char *format[, argument ...]);
Related functions usage
            int cscanf(char *format[, argument, ...]);
            int fscanf(FILE *stream, char *format[, argument, ...]);
            int sscanf(char *string, char *format[, argument, ...]);
            int vscanf(char *format, va_list argp);
            int vsscanf(char *string, char *format, va_list argp);
            int vsscanf(char *string, char *format, va_list argp);
#include <stdio.h>

The ...scanf family of functions all scan input fields, one character at a time, and convert them according to a given format; these functions all:

- accept a format string that determines how the input fields are to be interpreted (this is given as format in the Usage)
- apply the format string to a variable number of input fields in order to format the input
- store the formatted input in the addresses given as arguments after the format string (these addresses are given as either "argument, ..." or va_list param in the Usage)

When a ...scanf function encounters its first format specification in the format string, it scans and converts the first input field according to that specification, then stores the result in the location given by the first address argument; it then scans, converts and stores the second input field, then the third, etc.

The input source is implicit in three of the ...scanf functions.

- scanf accepts its input from stdin; so does vscanf.
- cscanf accepts its input directly from the console.

The other four ...scanf functions also take an other argument (the first in the list of parameters). This additional argument designates the input source.

- fscanf and vfscanf accept their input from a stream (pointed to by stream).
- sscanf and vsscanf accept their input from a string in memory (pointed to by string).

Four of the ...scanf functions take the set of address arguments directly from the function call (scanf, cscanf, fscanf, sscanf).

The other three (vscanf, vfscanf, vsscanf) take their address arguments from a variable argument list. The v...scanf functions are known as alternate entry points for the ...scanf functions.
See the definition of `va_...` for more information about variable argument lists.

Here is a summary of each of the ...`scanf` functions.

`scanf` reads data from `stdin` and stores it in the locations given by the address arguments `&arg1, ..., &argn`.

`cscanf` reads data directly from the console and stores it in the locations given by the address arguments `&arg1, ..., &argn`.

`fscanf` reads data from the named input stream into the locations given by the address arguments `&arg1, ..., &argn`.

`sscanf` reads data (stored in character string `string`) into the locations given by the address arguments `&arg1, ..., &argn`. `sscanf` does not change the source string `string`.

`vscanf` behaves exactly like `scanf` except that it accepts address arguments from the `va_arg` array `va_list param`.

`vfscanf` behaves exactly like `fscanf` except that it accepts address arguments from the `va_arg` array `va_list param`.

`vsscanf` behaves exactly like `sscanf` except that it accepts address arguments from the `va_arg` array `va_list param`.

The Format String

The format string, present in each of the ...`scanf` function calls, controls how each function will scan, convert and store its input fields. There must be enough address arguments for the given format specifications; if not, the results are unpredictable, and likely disastrous. Excess address arguments (more than required by the format) are merely ignored.

The format string is a character string that contains three types of objects: whitespace characters, non-whitespace characters, and format specifications.
The whitespace characters are blank ( ), tab (\t) or newline (\n). If a \texttt{...scanf} function encounters a whitespace character in the format string, it will read, but not store, all consecutive whitespace characters up to the next non-whitespace character in the input.

The non-whitespace characters are all other ASCII characters except the percent sign (%). If a \texttt{...scanf} function encounters a non-whitespace character in the format string, it will read, but not store, a matching non-whitespace character.

The format specifications direct the \texttt{...scanf} functions to read and convert characters from the input field into specific types of values, then store them in the locations given by the address arguments.

Trailing white space is left unread (including a newline), unless explicitly matched in the format string.

\textbf{Format Specifications}

\texttt{...scanf} format specifications have the following form:

\begin{equation}
  \% [\ast] [\text{width}] [F|N] [h|l] \text{type character}
\end{equation}

Each format specification begins with the percent character (\%). After the \% come the following, in this order:

- an optional assignment-suppression character \texttt{[\ast]}
- an optional width-specifier \texttt{[width]}
- an optional pointer size-specifier \texttt{[F|N]}
- an optional argument-type modifier \texttt{[h|l]}
- the type character

\textbf{Optional Format String Components}

These are the general aspects of input formatting controlled by the optional characters and specifiers in the \texttt{...scanf} format string:
### Character or Specifier | What It Controls or Specifies
---|---
* | suppresses assignment of the next input field
width | maximum number of characters to read; fewer characters might be read if the \texttt{...scanf} function encounters a white-space or non-convertible character
size | overrides default size of address argument  
\(N = \text{near pointer}, \ F = \text{far pointer}\)
argument type | overrides default type of address argument  
\(h = \text{pointer to short int}, \ l = \text{pointer to long int}\)

#### \texttt{...scanf} Type Characters

The following table lists the \texttt{...scanf} type characters, the type of input expected by each, and in what format the input will be stored.

The information in this table is based on the assumption that no optional characters, specifiers or modifiers (*, width, or size) were included in the format specification. To see how the addition of the optional elements affects the \texttt{...scanf} input, refer to the tables following this one.
<table>
<thead>
<tr>
<th>Type Character</th>
<th>Input</th>
<th>Type of Argument</th>
</tr>
</thead>
<tbody>
<tr>
<td>d</td>
<td>Decimal integer</td>
<td>Pointer to int (int *arg)</td>
</tr>
<tr>
<td>D</td>
<td>Decimal integer</td>
<td>Pointer to long (long *arg)</td>
</tr>
<tr>
<td>o</td>
<td>Octal integer</td>
<td>Pointer to int (int *arg)</td>
</tr>
<tr>
<td>O</td>
<td>Octal integer</td>
<td>Pointer to long (long *arg)</td>
</tr>
<tr>
<td>i</td>
<td>Decimal, octal or hexadecimal integer</td>
<td>Pointer to int (int *arg)</td>
</tr>
<tr>
<td>I</td>
<td>Decimal, octal or hexadecimal integer</td>
<td>Pointer to long (long *arg)</td>
</tr>
<tr>
<td>u</td>
<td>Unsigned decimal integer</td>
<td>Pointer to unsigned int (unsigned int *arg)</td>
</tr>
<tr>
<td>U</td>
<td>Unsigned decimal integer</td>
<td>Pointer to unsigned long (unsigned long *arg)</td>
</tr>
<tr>
<td>x</td>
<td>Hexadecimal integer</td>
<td>Pointer to int (int *arg)</td>
</tr>
<tr>
<td>X</td>
<td>Hexadecimal integer</td>
<td>Pointer to long (long *arg)</td>
</tr>
<tr>
<td>Type Character</td>
<td>Input</td>
<td>Type of Argument</td>
</tr>
<tr>
<td>---------------</td>
<td>---------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>e</td>
<td>Floating</td>
<td>Pointer to float (float *arg)</td>
</tr>
<tr>
<td>E</td>
<td>Floating</td>
<td>Pointer to double (double *arg)</td>
</tr>
<tr>
<td>f</td>
<td>Floating</td>
<td>Pointer to float (float *arg)</td>
</tr>
<tr>
<td>g</td>
<td>Floating</td>
<td>Pointer to float (float *arg)</td>
</tr>
<tr>
<td>G</td>
<td>Floating</td>
<td>Pointer to double (double *arg)</td>
</tr>
</tbody>
</table>

**Numerics (continued)**

**Characters**

<table>
<thead>
<tr>
<th>Type Character</th>
<th>Input</th>
<th>Type of Argument</th>
</tr>
</thead>
<tbody>
<tr>
<td>s</td>
<td>Character</td>
<td>Pointer to array of string characters (char arg[])</td>
</tr>
<tr>
<td>c</td>
<td>Character</td>
<td>Pointer to character (char *arg) If a field width W is given along with the c type character (such as %5c): Pointer to array of W characters (char arg[W])</td>
</tr>
<tr>
<td>%</td>
<td>% character</td>
<td>No conversion is done; the % character is stored.</td>
</tr>
</tbody>
</table>

**Pointers**

<table>
<thead>
<tr>
<th>Type Character</th>
<th>Input</th>
<th>Type of Argument</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>(none)</td>
<td>Pointer to int (int *arg) The number of characters read successfully, up to the %n, is stored in this pointer.</td>
</tr>
<tr>
<td>p</td>
<td>Hexadecimal number in the form YYY:ZZZZ or ZZZZ</td>
<td>Pointer to an object (far * or near *) %p conversions default to the pointer size native to the memory model</td>
</tr>
</tbody>
</table>
Input Fields

Any one of the following is an input field:

- all characters up to (but not including) the next whitespace character
- all characters up to the first one that cannot be converted under the current format specification (such as an 8 or 9 under octal format)
- up to n characters, where n is the specified field width

Conventions

Certain conventions accompany some of these format specifications, as summarized here.

%c conversion

This specification reads the next character, including a whitespace character. To skip one whitespace character and read the next non-whitespace character, use %1s.

%W conversion (W = width specification)

The address argument is a pointer to an array of characters; the array consists of W elements (char arg[W]).

%s conversion

The address argument is a pointer to an array of characters (char arg[]). The array size must be at least (n+1) bytes, where n=length of string s (in characters). A space or newline terminates the input field. A null-terminator is automatically appended to the string and stored as the last element in the array.

%[search_set] conversion

The set of characters surrounded by square brackets can be substituted for the s type character. The address argument is a pointer to an array of characters (char arg[]).

These square brackets surround a set of characters that define a search set of possible characters making up the string (the input field).

If the first character in the brackets is a caret (^), the search set is inverted to include all ASCII characters except those between the square brackets. (Normally, a caret will be included in the inverted search set unless explicitly listed somewhere after the first caret.)
The input field is a string not delimited by whitespace. The `scanf` function reads the corresponding input field up to the first character it reaches that does not appear in the search set (or in the inverted search set). Two examples of this type of conversion are

```
%[abcd]  which will search for any of the characters a, b, c, and d in the input field
%[^abcd] which will search for any characters except a, b, c, and d in the input field.
```

You can also use a "range facility" shortcut to define a range of characters (numerics or letters) in the search set. For example, to catch all decimal digits, you could define the search set by using

```
%[0123456789]
```

or you could use the shortcut to define the same search set by using

```
%[0-9]
```

To catch alphanumerics, you could use the following shortcuts:

```
%[A-Z]  catches all uppercase letters
%[0-9A-Za-z] catches all decimal digits and all letters (uppercase and lowercase)
%[A-FT-Z] catches all uppercase letters from A through F and from T through Z
```

The rules covering these search set ranges are straightforward.

- The character prior to the dash (-) must be lexically less than the one after it.
- The dash must not be the first nor the last character in the set. (If it is first or last, it is considered to just be the dash character, not a range definer.)
- The characters on either side of the dash must be the ends of the range, and not part of some other range.

Here are some examples where the dash just means the dash character, not a range between two ends:

```
%[-+*/]  the four arithmetic operations
%[z-a]   the characters 'z', '-', and 'a'
%[+0-9A-F] the characters '+' and '-', and the ranges 0 through 9 and A through Z
%[+0-9A-F-] also the characters '+' and '-', and the ranges 0 through 9 and A through Z
```
all characters except ‘+’ and ‘-’, and those in the ranges 0 through 9 and A through Z

%e, %E, %f, %g and %G (floating-point) conversions

Floating-point numbers in the input field must conform to the following generic format:

\[ [+/-] \text{ddd} \text{dddd} \text{ddd} \text{.} \text{dddd} \text{[E | e]} [+/-] \text{ddd} \]

where [item] indicates that item is optional and ddd represents decimal, octal or hexadecimal digits.

%d, %i, %o, %x, %D, %I, %O, %X, %c, %n conversions

A pointer to unsigned character, unsigned integer, or unsigned long can be used in any conversion where a pointer to a character, integer, or long is allowed.

Assignment-Suppression Character

The assignment-suppression character is an asterisk (*); it is not to be confused with the C indirection (pointer) operator (also an asterisk).

If this character (*) follows the % in a format specification, the next input field will be scanned but will not be assigned to the next address argument. The suppressed input data is assumed to be of the type specified by the type character that follows the * character.

The success of literal matches and suppressed assignments is not directly determinable.

Width Specifiers

The width specifier (n), a decimal integer, controls the maximum number of characters that will be read from the current input field.

If the input field contains less than n characters, the scanf function reads all the characters in the field, then proceeds with the next field and format specification.

If a whitespace or non-convertible character occurs before width characters are read, the characters up to that character are read, converted and stored, then the function attends to the next format specification.
A non-convertible character is one that cannot be converted according to the given format (such as an 8 or 9 when the format is octal, or a J or K when the format is hexadecimal or decimal).

<table>
<thead>
<tr>
<th>Width Specifier</th>
<th>How Width of Stored Input Is Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>up to n characters will be read, converted, and stored in the current address argument.</td>
</tr>
</tbody>
</table>

**Input-Size and Argument-Type Modifiers**

The input-size modifiers (N and F) and argument-type modifiers (h and l) affect how the scanf functions interpret the corresponding address argument arg.

F and N override the default or declared size of arg.

h and l indicate which type (version) of the following input data is to be used (h = short, l = long). The input data will be converted to the specified version, and the arg for that input data should point to an object of the corresponding size (short object for %h, long or double object for %l).
<table>
<thead>
<tr>
<th>Modifier</th>
<th>How Conversion Is Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>overrides default or declared size; arg interpreted as far pointer</td>
</tr>
<tr>
<td>N</td>
<td>overrides default or declared size; arg interpreted as near pointer Cannot be used with any conversion in huge model.</td>
</tr>
<tr>
<td>h</td>
<td>for d, i, o, u, x types: convert input to short int, store in short object for D, I, O, U, X types: has no effect for e, f, c, s, n, p types: has no effect</td>
</tr>
<tr>
<td>l</td>
<td>for d, i, o, u, x types: convert input to long int, store in long object for e, f types: convert input to double, store in double object for D, I, O, U, X types: has no effect for c, s, n, p types: has no effect</td>
</tr>
</tbody>
</table>

When ...scanf Functions Stop Scanning

The ...scanf functions may stop scanning a particular field before reaching the normal field-end character (whitespace), or may terminate entirely, for a variety of reasons.

The ...scanf function will stop scanning and storing the current field and proceed to the next input field if any of the following occurs:

- An assignment-suppression character (*) appears after the percent character in the format specification; the current input field is scanned but not stored.
- width characters have been read (width = width specification, a positive decimal integer in the format specification).
- The next character read cannot be converted under the current format (for example, an A when the format is decimal).
- The next character in the input field does not appear in the search set (or does appear in an inverted search set).

When the ...scanf function stops scanning the current input field for one of these reasons, the next character is assumed to be unread and to be the first
character of the following input field, or the first character in a subsequent read operation on the input.

The \texttt{...scanf} function will terminate under the following circumstances:

- The next character in the input field conflicts with a corresponding non-whitespace character in the format string.
- The next character in the input field is EOF.
- The format string has been exhausted.

If a character sequence that is not part of a format specification occurs in the format string, it must match the current sequence of characters in the input field; the \texttt{...scanf} function will scan, but not store, the matched characters. When a conflicting character occurs, it remains in the input field as if it were never read.

\textbf{Return value} All the \texttt{...scanf} functions return the number of input fields successfully scanned, converted and stored; the return value does not include scanned fields that were not stored.

If one of these functions attempts to read at end-of-file (or end-of-string for \texttt{sscanf} and \texttt{vsscanf}), the return value is EOF.

If no fields were stored, the return value is 0.

\textbf{Portability} The functions \texttt{scanf}, \texttt{fscanf}, \texttt{sscanf}, and \texttt{vscanf} are available on UNIX systems and are defined in Kernighan and Ritchie.

\texttt{vscanf}, \texttt{vfscanf}, and \texttt{vsscanf} are available on UNIX System V but are not defined in Kernighan and Ritchie.

\textbf{See also} \texttt{atof}, \texttt{getc}, \texttt{printf}

---

\textbf{searchpath}

\textbf{Name} \texttt{searchpath} – searches the DOS path

\textbf{Usage} \texttt{char *searchpath(char *filename);}

\textbf{Prototype in} \texttt{dir.h}
Description  

`searchpath` attempts to locate a file, given by `filename`, using the MS-DOS path. A pointer to the complete path-name string is returned as the function value.

The current directory of the current drive is checked first. If the file is not found there, the PATH environment variable is fetched, and each directory in the path is searched in turn until the file is found or the path is exhausted.

When the file is located, a string is returned containing the full path name. This string can be used in a call to `open` or `exec...` to access the file.

The string returned is located in a static buffer and is destroyed on each subsequent call to `searchpath`.

Return value  

A pointer to a `filename` string is returned if the file is successfully located; otherwise, `searchpath` returns NULL.

Portability  

Unique to MS-DOS.

See also  

`exec...`, `open`, `system`

Example  

```c
#include <stdio.h>
#include <dir.h>

main()
{
    char *p;

    p = searchpath("TLINK.EXE");
    printf("Search for TLINK.EXE : %s\n", p);
    p = searchpath("NOTEXIST.FIL");
    printf("Search for NOTEXIST.FIL : %s\n", p);
}
```

Program output  

Search for TLINK.EXE : C:\BIN\TLINK.EXE
Search for NOTEXIST.FIL : (null)
segread

Name segread – reads segment registers
Usage #include <dos.h>
void segread(struct SREGS *segtbl);
Prototype in dos.h
Description segread places the current values of the segment registers (stored in SEGREGS) into the structure pointed to by segtbl.
This call is intended for use with intdosx and int86x.
Return value None
Portability Unique to MS-DOS.
See also FP_OFF, intdos, int86

setblock

Name setblock – modifies the size of a previously allocated DOS memory segment
Usage int setblock(int seg, int newsize);
Prototype in dos.h
Description see allocmem
**setbuf**

**Name**
setbuf – assigns buffering to a stream

**Usage**
#include <stdio.h>
void setbuf(FILE *stream, char *buf);

**Related functions usage**
int setvbuf(FILE *stream, char *buf, int type, unsigned size);

**Prototype in**
stdio.h

**Description**
setbuf and setvbuf cause the buffer buf to be used for I/O buffering instead of an automatically allocated buffer. They are used after the given stream is opened.

In setbuf, if buf is NULL, I/O will be unbuffered; otherwise, it will be fully buffered. The buffer must be BUFSIZ bytes long (specified in stdio.h). In setvbuf, if buf is NULL, a buffer will be allocated using malloc; the buffer will use size as the amount allocated. The size parameter specifies the buffer size and must be greater than zero.

stdin and stdout are unbuffered if they are not redirected; otherwise, they are fully buffered. setbuf may be used to change the buffering style being used.

Unbuffered means that characters written to a stream are immediately output to the file or device, while buffered means that the characters are accumulated and written as a block.

In setvbuf, the type parameter is one of the following:

- **_IOFBF** The file is fully buffered. When a buffer is empty, the next input operation will attempt to fill the entire buffer. On output the buffer will be completely filled before any data is written to the file.
_IOLBF  The file is line buffered. When a buffer is empty, the next input operation will still attempt to fill the entire buffer. On output, however, the buffer will be flushed whenever a newline character is written to the file.

SIONBF  The file is unbuffered. The buf and size parameters are ignored. Each input operation will read directly from the file, and each output operation will immediately write the data to the file.

setbuf will produce unpredictable results if it is called for a stream, except immediately after opening the stream or any call to fseek. Calling setbuf after a stream has been unbuffered is legal and will not cause problems.

A common cause for error is to allocate the buffer as an automatic (local) variable and then fail to close the file before returning from the function where the buffer was declared.

Return value  setbuf returns nothing.

setvbuf returns 0 on success. It returns non-zero if an invalid value is given for type or size, if buf is NULL, or if there is not enough space to allocate a buffer.

setvbuf returns 0 on success.

Portability  Available on UNIX systems.

See also  fopen, fclose, fseek, malloc, open

Example

#include <stdio.h>

main ()
{
  FILE *input, *output;
  char bufr[512];

  input = fopen("file.in", "r");
  output = fopen("file.out", "w");

  /* Set up the input stream for minimal disk access,
     using our own character buffer */
if (setvbuf(input, bufr, IOFBF, 512) != 0)
    printf("failed to set up buffer for input file\n");
else
    printf("buffer set up for input file\n");

/* Set up the output stream for line buffering using space that will be obtained through an indirect call to malloc */
if (setvbuf(output, NULL, IOLBF, 132) != 0)
    printf("failed to set up buffer for output file\n");
else
    printf("buffer set up for output file\n");

/* Perform file I/O here */

/* Close files */

fclose(input);
fclose(output);

---

**setcbrk**

**Name**          setcbrk – gets control-break setting  
**Usage**         int setcbrk(int value);  
**Prototype in**  dos.h  
**Description**   see getcbrk

---

**setdate**

**Name**          setdate – sets MS-DOS date  
**Usage**         #include <dos.h>  
void setdate(struct date *dateblk);  
**Prototype in**  dos.h  
**Description**   see getdate
### setdisk

<table>
<thead>
<tr>
<th>Name</th>
<th>setdisk – sets current disk drive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>int setdisk(int drive);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>dir.h</td>
</tr>
<tr>
<td>Description</td>
<td>see getdisk</td>
</tr>
</tbody>
</table>

### setdta

<table>
<thead>
<tr>
<th>Name</th>
<th>setdta – sets disk transfer address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>void setdta(char far *dta);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>dos.h</td>
</tr>
<tr>
<td>Description</td>
<td>see getdta</td>
</tr>
</tbody>
</table>

### setftime

<table>
<thead>
<tr>
<th>Name</th>
<th>setftime – gets file date and time</th>
</tr>
</thead>
</table>
| Usage      | #include <io.h>  
int setftime(int handle, struct ftime *ftimep); |
| Prototype in | io.h                                       |
| Description | see getftime                                   |

---

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setjmp

Name setjmp – nonlocal goto
Usage #include <setjmp.h>
       int setjmp(jmp_buf env);
Prototype in setjmp.h
Description see longjmp

setmem

Name setmem – assigns a value to memory
Usage void setmem(void *addr, int len, char value);
Prototype in mem.h
Description see movmem

setmode

Name setmode – sets mode of open file
Usage int setmode(int handle, unsigned mode);
Prototype in io.h
Description setmode sets the mode of the open file associated with
       handle to either binary or text. The argument mode must
       have a value of either O_BINARY or O_TEXT, never
       both.
Return value setmode returns 0 if successful; on error it returns -1
       and sets errno to
Portability

setmode is available on UNIX systems.

See also

fread, read, fmode (variable),

dos.h

Description see gettime

setvbuf

Name setvbuf – assigns buffering to a stream

Usage #include <stdio.h>
int setvbuf(FILE *stream, char *buf, int type, 
unsigned size);

Prototype in stdio.h

Description see setbuf
## setvect

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>setvect</td>
<td>sets interrupt vector entry</td>
</tr>
<tr>
<td>Usage</td>
<td>void setvect(int intr_num, void interrupt (*isr) ( ));</td>
</tr>
<tr>
<td>Prototype in</td>
<td>dos.h</td>
</tr>
<tr>
<td>Description</td>
<td>see getvect</td>
</tr>
</tbody>
</table>

## setverify

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>setverify</td>
<td>sets verify state</td>
</tr>
<tr>
<td>Usage</td>
<td>void setverify(int value);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>dos.h</td>
</tr>
<tr>
<td>Description</td>
<td>see getverify</td>
</tr>
</tbody>
</table>

## sin

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>sin</td>
<td>trigonometric sine function</td>
</tr>
<tr>
<td>Usage</td>
<td>double sin(double x);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>math.h</td>
</tr>
<tr>
<td>Description</td>
<td>see trig</td>
</tr>
</tbody>
</table>
### sinh

<table>
<thead>
<tr>
<th>Name</th>
<th>sinh – hyperbolic sine function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>double sinh(double x);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>math.h</td>
</tr>
<tr>
<td>Description</td>
<td>see hyperb</td>
</tr>
</tbody>
</table>

### sleep

<table>
<thead>
<tr>
<th>Name</th>
<th>sleep – suspends execution for interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>unsigned sleep(unsigned seconds);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>dos.h</td>
</tr>
<tr>
<td>Description</td>
<td>With a call to sleep, the current program is suspended from execution for the number of seconds specified by the argument seconds. The interval is only accurate to the nearest hundredth of a second, or the accuracy of the MS-DOS clock, whichever is less accurate.</td>
</tr>
<tr>
<td>Return value</td>
<td>None</td>
</tr>
<tr>
<td>Portability</td>
<td>Available on UNIX systems.</td>
</tr>
</tbody>
</table>
sopen

Name       sopen – opens a shared file
Usage      
Prototype in io.h
Description see open

spawn...

Name       spawn... – creates and runs child processes
Usage      
Prototype in
Description

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Prototype in process.h

Description

The functions in the spawn... family create and run (execute) other files, known as child processes. There must be sufficient memory available for loading and executing the child process.

The value of mode determines what action the calling function (the parent process) will take after the spawn call. The possible values of mode are:

- **P_WAIT** Puts parent process "on hold" until child process completes execution.
- **P_NOWAIT** Continues to run parent process while child process runs.
- **P_OVERLAY** Overlays child process in memory location formerly occupied by parent. Same as an exec... call.

**Note:** P_NOWAIT is currently not available; using it will generate an error value.

**pathname** is the file name of the called child process. The spawn... function calls search for pathname using the standard MS-DOS search algorithm:

- No extension or no period: Search for exact file name; if not successful, add .EXE and search again.
- Extension given: Search only for exact file name.
- Period given: Search only for file name with no extension.

The suffixes l, v, p, and e added to the spawn... "family name" specify that the named function will operate with certain capabilities.

- **p** Specifies that the function will search for the child in those directories specified by the DOS PATH environment variable. Without the p suffix, the function will only search the root and current working directory.

- **l** Specifies that the argument pointers arg0, arg1, ..., argn are passed as separate arguments. Typically, the l suffix is used when you know in advance the number of arguments to be passed.
v Specifies that the argument pointers argv[0], ..., argv[n] are passed as an array of pointers. Typically, the v suffix is used when a variable number of arguments is to be passed.

e Specifies that the argument envp may be passed to the child process, allowing you to alter the environment for the child process. Without the e suffix, child processes inherit the environment of the parent process.

Each function in the spawn... family must have one of the two argument-specifying suffixes (either l or v). The path search and environment inheritance suffixes (p and e) are optional.

For example:

- spawnl is a spawn... function that takes separate arguments, searches only the root or current directory for the child, and passes on the parent's environment to the child.

- spawnvpe is a spawn... function that takes an array of argument pointers, incorporates PATH in its search for the child process, and accepts the envp argument for altering the child's environment.

The spawn... functions must pass at least one argument to the child process (arg0 or argv[0]): This argument is, by convention, a copy of pathname. (Using a different value for this zeroth argument won't produce an error.)

Under MS-DOS 3.0 and later, pathname is available for the child process; under earlier versions, the child process cannot use the passed value of the zeroth argument (arg0 or argv[0]).

When the l suffix is used, arg0 usually points to pathname, and arg1, ..., argn point to character strings that form the new list of arguments. A mandatory NULL following argn marks the end of the list.

When the e suffix is used, you pass a list of new environment settings through the argument envp. This environment argument is an array of char*. Each
element points to a null-terminated character string of the form

\[ envvar = value \]

where \( envvar \) is the name of an environment variable, and \( value \) is the string value to which \( envvar \) is set. The last element in \( envp[] \) is NULL. When \( envp[0] \) is NULL, the child inherits the parents' environment settings.

The combined length of \( arg0 + arg1 + ... + argn \) (or of \( argv[0] + argv[1] + ... + argv[n] \)), including space characters that separate the arguments, must be < 128 bytes. Null-terminators are not counted.

When a \( \text{spawn} \ldots \) function call is made, any open files remain open in the child process.

**Return value**

On a successful execution, the return value is the child process's exit status (0 for a normal termination). If the child specifically calls \( \text{exit} \) with a non-zero argument, its exit status can be set to a non-zero value.

On error, the \( \text{spawn} \ldots \) functions return -1, and \( \text{errno} \) is set to one of the following:

- E2BIG    Arg list too long
- EINVAL   Invalid argument
- ENOENT   Path or file name not found
- ENOEXEC  Exec format error
- ENOMEM   Not enough core

**See also**

\( \text{abort, atexit, exit, exec...}, \text{system} \)

**Example**

```c
/*
   This program is SPAWNFAM.C

   To run this example, you must first compile CHILD.C to an EXE file.
*/

#include <stdio.h>
#include <process.h>

status(int val)
{
    if (val == -1)
        printf("failed to start child process\n");
```
else
    if (val > 0) printf("child terminated abnormally\n");
}

main()
{

/**
 ** NOTE: These environment strings should be changed
to work on your machine. **
*/

/* create an environment string */
char *envp[] = { "PATH=C:\", 
                "DUMMY=YES",
                };

/* create a pathname */
char *pathname = "C:\\CHILDREN\\CHILD.EXE";

/* create an argument string */
char *args[] = { "CHILD.EXE",
                "1st",
                "2nd",
                NULL
                };

printf("SPAWNL: \n");
status(spawnl(P_WAIT, pathname, args[0], args[1], NULL));

printf(" \nSPAWNV: \n");
status(spawnv(P_WAIT, pathname, args));

printf(" \nSPAWNL: \n");
status(spawnle(P_WAIT, pathname, args[0], args[1], NULL, envp));

printf(" \nSPAWNVPE: \n");
status(spawnvpe(P_WAIT, pathname, args, envp));

} /* main */

/*
 * This is CHILD.C --- the child process for SPAWNFAM.C
 */

#include <stdio.h>
#include <stdlib.h>

main(int argc, char *argv[])
{
    int i;
    char *path, *dummy;

    ...
path = getenv("PATH");
dummy = getenv("DUMMY");

for (i = 0; i < argc; i++)
    printf("argv[%d] %s\n", i, argv[i]);

if (path)
    printf("PATH = %s\n", path);

if (dummy)
    printf("DUMMY = %s\n", dummy);

    exit(0); /* return to parent with error code 0 */
} /* main */

---

**sprintf**

**Name**  
`sprintf` – sends formatted output to a string

**Usage**  
`int sprintf(char *string, char *format[, argument, ...]);`

**Prototype in**  
`stdio.h`

**Description**  
see `printf`

---

**sqrt**

**Name**  
`sqrt` – calculates square root

**Usage**  
`double sqrt(double x);`

**Prototype in**  
`math.h`

**Description**  
see `exp`
**srand**

<table>
<thead>
<tr>
<th>Name</th>
<th>srand – initializes random number generator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>void srand(unsigned seed);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>stdlib.h</td>
</tr>
<tr>
<td>Description</td>
<td>see rand</td>
</tr>
</tbody>
</table>

**sscanf**

<table>
<thead>
<tr>
<th>Name</th>
<th>sscanf – performs formatted input from a string</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>int sscanf(char *string, char *format[, argument, ...]);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>stdio.h</td>
</tr>
<tr>
<td>Description</td>
<td>see scanf</td>
</tr>
</tbody>
</table>

**ssignal**

<table>
<thead>
<tr>
<th>Name</th>
<th>ssignal – implements software signals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>int (*ssignal(int sig, int (*action)( ))( );</td>
</tr>
<tr>
<td>Related functions usage</td>
<td>int gsignal(int sig);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>signal.h</td>
</tr>
<tr>
<td>Description</td>
<td>ssignal and gsignal implement a software-signalling facility. Software signals are associated with integers in the range from 1 to 15.</td>
</tr>
</tbody>
</table>
gsignal raises the signal given by sig and executes the action routine.

ssignal is used to establish an action routine for servicing a signal. The first argument to ssignal, sig, is a number identifying the type of signal for which an action is established.

The second argument, action, defines the action; it is either the name of a user-defined action function or one of the constants SIG_DFL (default) or SIG_IGN (ignore). These constants are defined in signal.h.

If an action function has been established for sig, then that action is reset to SIG_DFL, and the action function is entered with argument sig.

Return value

ssignal returns the action previously established or, if the signal number is illegal, returns SIG_DFL.

gsignal returns the value returned to it by the action function. gsignal’s return values for actions assigned to sig are listed in the following:

<table>
<thead>
<tr>
<th>Action</th>
<th>Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIG_IGN</td>
<td>1</td>
</tr>
<tr>
<td>SIG_DFL</td>
<td>0</td>
</tr>
<tr>
<td>Illegal value or no action specified</td>
<td>0</td>
</tr>
</tbody>
</table>

In all cases, gsignal takes no action other than returning a value.

Portability

Available on UNIX systems.
stat

Name stat – gets information about open file
Usage #include <sys/stat.h>
    int stat(char *pathname, struct stat *buff)
Related functions usage int fstat(char *handle, struct stat *buff)
Prototype in sys/stat.h
Description stat and fstat store information about a given open file (or directory) in the stat structure.

stat gets information about the open file or directory given by pathname.

fstat gets information about the open file associated with handle.

In both functions, buff points to the stat structure (defined in sys/stat.h). That structure contains the following fields:

- **st_mode**: bit mask giving information about the open file’s mode
- **st_dev**: drive number of disk containing the file, or file handle if the file is on a device
- **st_rdev**: same as st_dev
- **st_nlink**: set to the integer constant 1
- **st_size**: size of the open file, in bytes
- **st_atime**: most recent time the open file was modified
- **st_mtime**: same as st_atime
- **st_ctime**: same as st_atime
The stat structure contains three more fields not mentioned here: they contain values that are not meaningful under MS-DOS.

The bit mask that gives information about the mode of the open file includes the following bits:

One of the following bits will be set:

- **S_IFCHR** set if `handle` refers to a device (fstat)
- **S_IFREG** set if an ordinary file is referred to by `handle` (fstat), or specified by `pathname` (stat)
- **S_IFDIR** set if `pathname` specifies a directory (stat)

One or both of the following bits will be set:

- **S_IWRITE** set if user has permission to write to file
- **S_IREAD** set if user has permission to read to file

For **stat**, the bit mask also contains user-execute bits; these are set according to the open file's extension.

The bit mask also includes the read/write bits; these are set according to the file's permission mode.

**Return value**

Both functions return 0 if they successfully retrieved the information about the open file. On error (failure to get the information), each function returns -1 and sets **errno**.

On failure, **stat** sets **errno** to

- **ENOENT** File or path not found

On failure, **fstat** sets **errno** to

- **EBADF** Bad file handle

### _status87

**Name** _status87 – gets floating-point status

**Usage**

```c
unsigned int _status87();
```

**Prototype in** float.h

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_status87 gets the floating-point status word, which is a combination of the 8087/80287 status word and other conditions detected by the 8087/80287 exception handler.

The bits in the return value give the floating-point status. See float.h for a complete definition of the bits returned by _status87.

See also _clear87, _control87, _fpreset

**stime**

<table>
<thead>
<tr>
<th>Name</th>
<th>stime – sets time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>int stime(long *tp);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>time.h</td>
</tr>
<tr>
<td>Description</td>
<td>see time</td>
</tr>
</tbody>
</table>

**stpcpy**

<table>
<thead>
<tr>
<th>Name</th>
<th>stpcpy – copies one string into another</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>char *stpcpy(char *destin, char *source);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>string.h</td>
</tr>
<tr>
<td>Description</td>
<td>see str...</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
</tr>
<tr>
<td>str...</td>
<td>family of string manipulation functions</td>
</tr>
</tbody>
</table>

### str... Functions

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>char *</td>
<td>stpcpy(char *destin, char *source);</td>
</tr>
<tr>
<td>char *</td>
<td>strcat(char *destin, char *source);</td>
</tr>
<tr>
<td>char *</td>
<td>strchr(char *str, char c);</td>
</tr>
<tr>
<td>int</td>
<td>strcmp(char *str1, char *str2);</td>
</tr>
<tr>
<td>char *</td>
<td>strcpy(char *destin, char *source);</td>
</tr>
<tr>
<td>int</td>
<td>strcspsn(char *str1, char *str2);</td>
</tr>
<tr>
<td>char *</td>
<td>strdup(char *str);</td>
</tr>
<tr>
<td>int</td>
<td>stricmp(char *str1, char *str2);</td>
</tr>
<tr>
<td>int</td>
<td>strlen(char *str);</td>
</tr>
<tr>
<td>unsigned</td>
<td>strlwr(char *str);</td>
</tr>
<tr>
<td>char *</td>
<td>strlwr(char *str);</td>
</tr>
<tr>
<td>char *</td>
<td>strncat(char *destin, char *source, int maxlen);</td>
</tr>
<tr>
<td>int</td>
<td>strnicmp(char *str1, char *str2, int maxlen);</td>
</tr>
<tr>
<td>char *</td>
<td>strncpy(char *destin, char *source, int maxlen);</td>
</tr>
<tr>
<td>int</td>
<td>strnicmp(char *str1, char *str2, unsigned maxlen);</td>
</tr>
<tr>
<td>int</td>
<td>strnicmpi(char *str1, char *str2, unsigned maxlen);</td>
</tr>
<tr>
<td>char *</td>
<td>strnset(char *str, char ch, unsigned n);</td>
</tr>
<tr>
<td>char *</td>
<td>strpbrk(char *str1, char *str2);</td>
</tr>
<tr>
<td>char *</td>
<td>strrchr(char *str, char c);</td>
</tr>
<tr>
<td>char *</td>
<td>strrev(char *str);</td>
</tr>
<tr>
<td>char *</td>
<td>strset(char *str, char ch);</td>
</tr>
<tr>
<td>int</td>
<td>strspn(char *str1, char *str2);</td>
</tr>
<tr>
<td>char *</td>
<td>strstr(char *str1, char *str2);</td>
</tr>
<tr>
<td>double</td>
<td>strtod(char *str, char **endptr);</td>
</tr>
<tr>
<td>long</td>
<td>strtol(char *str, char **endptr, int base);</td>
</tr>
<tr>
<td>char *</td>
<td>strtok(char *str1, char *str2);</td>
</tr>
<tr>
<td>char *</td>
<td>strupr(char *str);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>string.h</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Description</td>
<td>Here is an alphabetical summary of the <code>str...</code> functions. Following this list are detailed explanations of these <em>string manipulation</em> functions, organized by the types or categories of tasks they perform. The category is listed in parentheses after each entry.</td>
</tr>
<tr>
<td><code>strcat</code></td>
<td>appends one string to another (binding)</td>
</tr>
<tr>
<td><code>strchr</code></td>
<td>scans a string for the first occurrence of a given character (searching)</td>
</tr>
<tr>
<td><code>strcmp</code></td>
<td>compares one string to another (comparing)</td>
</tr>
<tr>
<td><code>strcpy</code></td>
<td>copies one string into another (copying)</td>
</tr>
<tr>
<td><code>strcspn</code></td>
<td>scans a string for the first segment not containing any subset of a given set of characters (searching)</td>
</tr>
<tr>
<td><code>strdup</code></td>
<td>copies a string into a newly-created location (copying)</td>
</tr>
<tr>
<td><code>stricmp</code></td>
<td>compares one string to another, without case sensitivity (comparing)</td>
</tr>
<tr>
<td><code>strcmpi</code></td>
<td>compares one string to another, without case sensitivity (comparing)</td>
</tr>
<tr>
<td><code>strlen</code></td>
<td>calculates the length of a string (searching)</td>
</tr>
<tr>
<td><code>strlwr</code></td>
<td>converts uppercase letters in a string to lowercase (changing)</td>
</tr>
<tr>
<td><code>strncat</code></td>
<td>appends a portion of one string to another (binding)</td>
</tr>
<tr>
<td><code>strncmp</code></td>
<td>compares a portion of one string to a portion of another (comparing)</td>
</tr>
<tr>
<td><code>strncpy</code></td>
<td>copies a given number of bytes from one string into another, truncating or padding as necessary (copying)</td>
</tr>
<tr>
<td><code>strncmpeq</code></td>
<td>compares a portion of one string to a portion of another, without case sensitivity (comparing)</td>
</tr>
</tbody>
</table>
**strnicmp** compares a portion of one string to a portion of another, without case sensitivity (comparing)

**strnset** sets a specified number of characters in a string to a given character (changing)

**strpbrk** scans a string for the first occurrence of any character from a given set (searching)

**strchr** scans a string for the last occurrence of a given character (searching)

**strrev** reverses a string (changing)

**strset** sets all characters in a string to a given character (changing)

**strspn** scans a string for the first segment that is a subset of a given set of characters (searching)

**strstr** scans a string for the occurrence of a given substring (searching)

**strtod** converts a string to a double value (converting)

**strtok** searches one string for tokens, which are separated by delimiters defined in a second string (searching)

**strtol** converts a string to a long value (converting)

**strupr** converts lowercase letters in a string to uppercase (changing)

These 27 string manipulation functions perform a variety of tasks. These can be broken down into six general categories:

- binding
- changing
- comparing
- converting
- copying
- searching
Here is a more complete explanation of what each str... function does; these are organized by the type (or category) of task the functions perform.

**Binding (concatenation)**

`strcat` appends a copy of `source` to the end of `destin`. The length of the resulting string is `strlen(destin) + strlen(source)`.

`strncat` copies at most `maxlen` characters of `source` to the end of `destin` and then appends a null character. The maximum length of the resulting string is `strlen(destin) + maxlen`.

**Changing**

`strlwr` converts uppercase letters in string `str` to lowercase. No other changes occur.

`strupr` converts lowercase letters in string `str` to uppercase. No other changes occur.

`strset` sets all characters in the string `str` to the character `ch`.

`strnset` sets up to the first `n` bytes of the string `str` to the character `ch`. If `n > strlen(str)`, then `strlen(str)` replaces `n`.

`strrev` reverses all characters in a string (except the terminating null character).

**Comparing**

`strcmp` compares `str1` to `str2`.

`stricmp` compares `str1` to `str2`, without case sensitivity.

`strcmpi` compares `str1` to `str2`, without case sensitivity (same as `stricmp`—implemented as a macro).

`strncmp` makes the same comparison as `strcmp`, but looks at no more than `maxlen` characters.

`strnicmp` compares `str1` to `str2`, for a maximum length of `maxlen` bytes, without case sensitivity.
**strncmpi** compares *str1* to *str2*, for a maximum length of *maxlen* bytes, without case sensitivity (same as **strnicmp**—implemented as a macro).

All these comparing functions return a value (<0, 0 or >0) based on the result of comparing *str1* (or part of it) to *str2* (or part of it).

The routines **strcmpi** and **strncmpi** are the same, respectively, as **stricmp** and **strnicmp**. They (**strcmpi** and **strncmpi**) are implemented via macros in string.h. These macros translate calls from **strcmpi** to **stricmp**, and calls from **strncmpi** to **strnicmp**. Therefore, in order to use **strcmpi** or **strncmpi**, you must `#include` the header file string.h for the macros to be available. These macros are provided for compatibility with other C compilers.

**Converting**

**strtod** converts a character string, *str*, to a **double** value. *str* is a sequence of characters that can be interpreted as a double value; they must match this generic format:

```
[ws] [sn] [ddd] [.][ddd] [fmt[sn]ddd]
```

where

- `[ws]` = optional whitespace
- `[sn]` = optional sign (+ or –)
- `[ddd]` = optional digits
- `[fmt]` = optional e or E
- `[.]` = optional decimal point

For example, here are some character strings that **strtod** can convert to double:

```
+1231.1981 e-1
502.85E2
-2010.952
```
`strtod` stops reading the string at the first character that cannot be interpreted as an appropriate part of a double value.

If `endptr` is not NULL, `strtod` sets `endptr` to point to the character that stopped the scan (`*endptr = &stopper`).

`strtol` converts a character string, `str`, to a long integer value. `str` is a sequence of characters that can be interpreted as a long value; they must match this generic format

```
[ws] [sn] [0] [x] [ddd]
```

where

- `[ws]` = optional whitespace
- `[sn]` = optional sign (+ or -)
- `[0]` = optional zero (0)
- `[x]` = optional x or X
- `[ddd]` = optional digits

`strtol` stops reading the string at the first character that it doesn't recognize.

If `base` is between 2 and 36, the long integer is expressed in base `base`.

If `base` is 0, the first few characters of `str` determine the base of the value being converted.

<table>
<thead>
<tr>
<th>First Character</th>
<th>Second Character</th>
<th>String Interpreted as</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1-7</td>
<td>octal</td>
</tr>
<tr>
<td>0</td>
<td>x or X</td>
<td>hexadecimal</td>
</tr>
<tr>
<td>1-9</td>
<td></td>
<td>decimal</td>
</tr>
</tbody>
</table>

If `base` is 1, it is considered to be an invalid value.

If `base` is < 0, it is considered to be an invalid value.

If `base` is > 36, it is considered to be an invalid value.
Any invalid value for `base` causes the result to be 0 and sets the next character pointer to the starting string pointer.

If the value in `str` is meant to be interpreted as octal, any character other than 0 to 7 would be unrecognized.

If the value in `str` is meant to be interpreted as decimal, any character other than 0 to 9 would be unrecognized.

If the value in `str` is meant to be interpreted as a number in any other base, then only the numerals and letters used to represent numbers in that base would be recognized. (For example, if `base = 5`, only 0 to 4 would be recognized; if `base = 20`, only 0 to 9 and `A` to `J` would be recognized.)

### Copying

- **strcpy** copies string `source` to `destin`, stopping after the terminating null character has been moved.

- **strncpy** copies exactly `maxlen` characters from `source` into `destin`, truncating or null-padding `destin`. The target string, `destin`, might not be null-terminated if the length of `source` is `maxlen` or more.

- **stpcpy** copies the bytes of `source` into `destin` and stops after copying the terminating null character of `source`. **stpcpy** `(a, b)` is the same as **strcpy** `(a, b)` except that the return values differ.

- **strcpy** `(a, b)` returns `a`, while **stpcpy** `(a, b)` returns `a + strlen (b)`.

- **strdup** makes a duplicate of string `str`, obtaining space with a call to `malloc`. The allocated space is `(strlen (str) + 1)` bytes long.
Searching

**strchr** scans a string in the forward direction, looking for a specific character. *strchr* finds the *first* occurrence of the character *ch* in the string *str*.

The null-terminator is considered to be part of the string, so that, for example

```c
strchr(strs, 0)
```

returns a pointer to the terminating null character of the string "strs".

**strrchr** scans a string in the reverse direction, looking for a specific character. *strrchr* finds the *last* occurrence of the character *ch* in the string *str*. The null-terminator is considered to be part of the string.

**strpbrk** scans a string, *str1*, for the first occurrence of any character appearing in *str2*.

**strspn** returns the length of the initial segment of string *str1* that consists entirely of characters from string *str2*.

**strcspn** returns the length of the initial segment of string *str1* that consists entirely of characters *not* from string *str2*.

**strstr** scans *str1* for the first occurrence of the substring *str2*.

**strtok** considers the string *str1* to consist of a sequence of zero or more text tokens, separated by spans of one or more characters from the separator string *str2*.

The first call to *strtok* returns a pointer to the first character of the first token in *str1* and writes a null character into *str1* immediately following the returned token. Subsequent calls with NULL for the first argument will work through the string *str1* in this way until no tokens remain.
The separator string, \textit{str2}, may be different from call to call.

When no tokens remain in \textit{str1}, \texttt{strtok} returns a NULL pointer.

**Return value**

These are the return values for the \texttt{str...} functions, arranged in alphabetical order by the function names.

- \texttt{strcpy} returns \texttt{destin + strlen(source)}.
- \texttt{strchr} returns a pointer to the first occurrence of the character \texttt{ch} in \texttt{str}; if \texttt{ch} does not occur in \texttt{str}, \texttt{strchr} returns NULL.
- \texttt{strcmp}, \texttt{stricmp}, \texttt{strcmpi}, \texttt{strncmp}, \texttt{strnicmp} and \texttt{strncpy} all these routines return an \texttt{int} value that is
  - \texttt{< 0} if \texttt{str1} is less than \texttt{str2}
  - \texttt{= 0} if \texttt{str1} is the same as \texttt{str2}
  - \texttt{> 0} if \texttt{str1} is greater than \texttt{str2}

  All six of these functions perform a signed comparison.

- \texttt{strncpy} returns \texttt{destin}.
- \texttt{strdup} returns a pointer to the storage location containing the duplicated \texttt{str}, or returns NULL if space could not be allocated.
- \texttt{strlen} returns the number of characters in \texttt{str}, not counting the null-terminating character.
- \texttt{strncpy} returns \texttt{destin}.
- \texttt{strpbrk} returns a pointer to the first occurrence of any of the characters in \texttt{str2}; if none of the \texttt{str2} characters occurs in \texttt{str1}, it returns NULL.
- \texttt{strrchr} returns a pointer to the last occurrence of the character \texttt{ch}. If \texttt{ch} does not occur in \texttt{str}, \texttt{strrchr} returns NULL.
- \texttt{strrev} returns a pointer to the reversed string. There is no error return.
- \texttt{strstr} returns a pointer to the element in \texttt{str1} that contains \texttt{str2} (points to \texttt{str2} in \texttt{str1}). If \texttt{str2} does not occur in \texttt{str1}, \texttt{strstr} returns NULL.
Portability  Available on UNIX systems. Kernighan and Ritchie define strcat.

See also  malloc, mem..., movmem

Example

/* strtok - This example demonstrates the use of strtok to parse dates. Note that in order to parse dates of varying formats (e.g., 12/3/87; Dec.12,1987; January 15, 1987 12-FEB-87, etc.), you must specify the delimiter string to contain either a period, space, comma, minus, or slash. Notice in the output that the delimiters are not returned.
*/

#include <stdio.h>
#include <string.h>

main ()
{
    char *ptr;
    ptr = strtok("FEB.14,1987", ". ,/- ");
    printf("ptr = %s\n", ptr);
    ptr = strtok(NULL, ". ,/- ");
    printf("ptr = %s\n", ptr);
}

Program output

ptr = FEB
ptr = 14

strerror

Name  strerror - returns pointer to error message string
Usage  char *strerror(char *str);
Prototype in  string.h
**Description**  
stderr allows you to generate customized error messages; it returns a pointer to a null-terminated string containing an error message.

If *str* is NULL, the return value contains the most recently generated system error message; this string is null-terminated.

If *str* is not NULL, the return value contains *str* (your customized error message), a colon, a space, the most recently generated system error message, and a newline.

The length of *str* should be 94 characters or less.

stderr is different from perror in that it does not print error messages.

For accurate error-handling, stderr should be called as soon as a library routine generates an error return.

**Return value**  
stderr returns a pointer to a constructed error string. The error message string is constructed in a static buffer that is over-written with each call to perror.

**Portability**  
Available on UNIX systems.

**See also**  
perror

---

**swab**

**Name**  
swab – swaps bytes

**Usage**  
void swab(char *from, char *to, int nbytes);

**Prototype in**  
stdlib.h

**Description**  
swab copies *n* bytes from the *from* string to the *to* string. Adjacent even- and odd-byte positions are swapped. This is useful for moving data from one machine to another machine with a different byte order. *nbytes* should be even.

**Return value**  
There is no return value.

**Portability**  
Available on UNIX systems.
### system

<table>
<thead>
<tr>
<th>Name</th>
<th>system – issues an MS-DOS command</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>int system(char *command);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>stdlib.h</td>
</tr>
<tr>
<td>Description</td>
<td>system invokes the MS-DOS COMMAND.COM file to execute a command given in the string command, as if the command had been typed at the DOS prompt. The COMSPEC environment variable is used to find the COMMAND.COM file, so the file does not need to be in the current directory.</td>
</tr>
<tr>
<td>Return value</td>
<td>system returns the exit status of COMMAND.COM when the given command is completed.</td>
</tr>
<tr>
<td>Portability</td>
<td>Available on UNIX systems. Defined in Kernighan and Ritchie.</td>
</tr>
<tr>
<td>See also</td>
<td>exec..., searchpath, spawn...</td>
</tr>
</tbody>
</table>

### tan

<table>
<thead>
<tr>
<th>Name</th>
<th>tan – trigonometric tangent function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>double tan(double x);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>math.h</td>
</tr>
<tr>
<td>Description</td>
<td>see trig</td>
</tr>
</tbody>
</table>
### tanh

<table>
<thead>
<tr>
<th>Name</th>
<th>tanh – hyperbolic tangent function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>double tanh(double x);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>math.h</td>
</tr>
<tr>
<td>Description</td>
<td>see hyperb</td>
</tr>
</tbody>
</table>

### tell

<table>
<thead>
<tr>
<th>Name</th>
<th>tell – gets current position of file pointer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>long tell(int handle);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>io.h</td>
</tr>
<tr>
<td>Description</td>
<td>see fseek</td>
</tr>
</tbody>
</table>

### time

<table>
<thead>
<tr>
<th>Name</th>
<th>time – gets time of day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>long time(long *tp);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>time.h</td>
</tr>
<tr>
<td>Related functions usage</td>
<td>int stime(long *tp);</td>
</tr>
<tr>
<td>Description</td>
<td>time gives the current time, in seconds, elapsed since 00:00:00 GMT, January 1, 1970, and stores that value in the location pointed to by tloc.</td>
</tr>
</tbody>
</table>
**Stime** sets the system time and date. *tp* points to the value of the time as measured in seconds from 00:00:00 GMT, January 1, 1970

**Return value**

- **time** returns the elapsed time, in seconds, as described.
- **stime** returns a value of 0.

**Portability**

Available on UNIX systems.

---

**toascii**

**Name**

*toascii* – translates characters to ASCII format

**Usage**

```c
int toascii(int c);
```

**Related functions**

```c
int tolower(int c);
int toupper(int c);
int _tolower(int c);
int _toupper(int c);
```

**Prototype in**

`ctype.h`

**Description**

*toascii* is a function that converts the integer *c* to ASCII by clearing all but the lower seven bits; this gives a value in the range 0 to 127. It is intended for compatibility with other systems.

*tolower* is a function that converts an integer *c* (in the range EOF to 255) to its lowercase value (if it was uppercase): all others are left unchanged.

*toupper* is a function that converts an integer *c* (in the range EOF to 255) to its uppercase value (if it was lowercase): all others are left unchanged.

*_tolower* is a macro that does the same conversion as *tolower*, except that it should be used only when *c* is known to be uppercase.

*_toupper* is a macro that does the same conversion as *toupper*, except that it should be used only when *c* is known to be lowercase.
To use `_tolower` or `_toupper`, you must include `ctype.h`.

<table>
<thead>
<tr>
<th>Return value</th>
<th>Each function and macro returns the converted value of <code>c</code>, on success, and nothing on failure.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portability</td>
<td>All functions are available on UNIX systems; <code>_toupper</code> and <code>_tolower</code> are defined in Kernighan and Ritchie.</td>
</tr>
</tbody>
</table>

**_tolower**

<table>
<thead>
<tr>
<th>Name</th>
<th><code>_tolower</code> – translates characters to lowercase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td><code>#include &lt;ctype.h&gt;</code>&lt;br&gt;<code>int _tolower(int c);</code></td>
</tr>
<tr>
<td>Prototype in</td>
<td><code>ctype.h</code></td>
</tr>
<tr>
<td>Description</td>
<td><code>see toascii</code></td>
</tr>
</tbody>
</table>

**tolower**

<table>
<thead>
<tr>
<th>Name</th>
<th><code>tolower</code> – translates characters to lowercase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td><code>int tolower(int c);</code></td>
</tr>
<tr>
<td>Prototype in</td>
<td><code>ctype.h</code></td>
</tr>
<tr>
<td>Description</td>
<td><code>see toascii</code></td>
</tr>
</tbody>
</table>
**_toupper**

Name: _toupper - translates characters to uppercase
Usage: #include <ctype.h>
int _toupper(int c);
Prototype in: ctype.h
Description: see toascii

**toupper**

Name: toupper - translates characters to uppercase
Usage: int toupper(int c);
Prototype in: ctype.h
Description: see toascii

**trig**

Name: trig - trigonometric functions
Usage: double acos(double x);
double asin(double x);
double atan(double x);
double atan2(double y, double x);
double cos(double x);
double sin(double x);
double tan(double x);
Prototype in: math.h
Description

sin, cos, and tan return the corresponding trigonometric functions. Angles are specified in radians.

asin, acos, and atan return the arc sine, arc cosine, and arc tangent, respectively, of the input value. Arguments to asin and acos must be in the range -1 to 1. Arguments outside that range will cause asin or acos to return 0 and set errno to:

EDOM Domain error

atan2 returns the arc tangent of y/x and will produce correct results even when the resulting angle is near pi/2 or -pi/2 (x near 0).

Return value

sin and cos return a value in the range -1 to 1.
asin returns a value in the range -pi/2 to pi/2.
acos returns a value in the range 0 to pi.
atan returns a value in the range -pi/2 to pi/2.
atan2 returns a value in the range -pi to pi.

tan returns any value for valid angles. For angles close to pi/2 or -pi/2, tan returns 0 and errno is set to:

ERANGE Result out of range

Error handling for these routines can be modified through the function matherr.

Portability

Available on UNIX systems.

See also

_matherr, matherr, perror

tzset

Name
tzset – UNIX time compatibility

Usage
void tzset(void);

Prototype in
time.h

Description
see ctime
**ultoa**

Name  | ultoa – converts an unsigned long to a string  
Usage | char *ultoa(unsigned long value, char *string, int radix);  
Prototype in | stdlib.h  
Description | see itoa  

**ungetc**

Name  | ungetc – pushes a character back into input stream  
Usage | #include <stdio.h>  
| int ungetc(char c, FILE *stream);  
Prototype in | stdio.h  
Description | see getc  

**ungetch**

Name  | ungetch – pushes a character back to the keyboard buffer  
Usage | int ungetch(int c);  
Prototype in | conio.h  
Description | see getc
unixtodos

Name  unixtodos – converts date and time to DOS format
Usage  #include <dos.h>
void unixtodos(long utime, struct date *dateptr,  
struct time *timeptr);
Prototype in dos.h
Description see dostounix

unlink

Name  unlink – deletes a file
Usage  int unlink(char *filename);
Related functions usage  int remove(char *filename);
Prototype in dos.h
Description unlink deletes a file specified by filename. Any MS-DOS  
drive, path, and file name may be used as a filename. Wildcards are not allowed.
Read-only files cannot be deleted by this call. To remove read-only files, first use chmod or _chmod to change the  
read-only attribute.
remove is a macro that simply translates the call to a call to unlink.
Return value  On successful completion, a 0 is returned. On error, a –1 is returned, and errno is set to one of the following  
values:
ENOENT  Path or file name not found
EACCES  Permission denied
### Portability
Available on UNIX systems.

### See also
chmod

---

## unlock

**Name**
unlock – releases file-sharing locks

**Usage**
int unlock(int handle, long offset, long length);

**Prototype in**
dos.h

**Description**
see lock

---

## va...

**Name**
va... – implements variable argument list

**Usage**
#include <stdarg.h>
void va_start(va_list param, lastfix);

*type* va_arg(va_list param, *type*);

void va_end(va_list param);

**Prototype in**
stdarg.h

**Description**
Some C functions, such as *vfprintf* and *vprintf*, take variable argument lists in addition to taking a number of fixed (known) parameters. The *va...* macros provide a portable way to access these argument lists. They are used for stepping through a list of arguments when the called function does not know the number and types of the arguments being passed.

The header file stdarg.h declares one type (*va_list*), and three macros (*va_start*, *va_arg*, and *va_end*).

*va_list*
This array holds information needed by `va_arg` and `va_end`. When a called function takes a variable argument list, it declares a variable `param` of type `va_list`.

**va_start**

This routine (implemented as a macro) sets `param` to point to the first of the variable arguments being passed to the function. `va_start` must be used before the first call to `va_arg` or `va_end`.

`va_start` takes two parameters; `param` and `lastfix`. (`param` is explained under `va_list` in the preceding paragraph; `lastfix` is the name of the last fixed parameter being passed to the called function.)

**va_arg**

This routine (also implemented as a macro) expands to an expression that has the same type and value as the next argument being passed (one of the variable arguments). The variable `param` to `va_arg` should be the same `param` that `va_start` initialized.

The first time `va_arg` is used, it returns the first argument in the list. Each successive time `va_arg` is used, it returns the next argument in the list. It does this by first de-referencing `param`, and then incrementing `param` to point to the following item. `va_arg` uses the type to both perform the de-reference and to locate the following item. Each successive time `va_arg` is invoked, it modifies `param` to point to the next argument in the list.

**va_end**

This macro helps the called function perform a normal return. `va_end` might modify `param` in such a way that it cannot be used unless `va_start` is re-called. `va_end` should be called after `va_arg` has read all the arguments: failure to do so might cause strange, undefined behavior in your program.

**Return value**

`va_start` and `va_end` return no values; `va_arg` returns the current argument in the list (the one that `param` is pointing to).
Portability  Available on UNIX systems.
See also  ...scanf, printf

Example

#include <stdio.h>
#include <stdarg.h>

/* calculate sum of a 0 terminated list */

void sum(char *msg, ...)
{
    int total = 0;
    va_list ap;
    int arg;

    va_start(ap, msg);
    while ((arg = va_arg(ap, int)) != 0) {
        total += arg;
    }
    printf(msg, total);
}

main()
{
    sum("The total of 1+2+3+4 is %d\n", 1,2,3,4,0);
}

Program output

The total of 1+2+3+4 is 10

Another example

#include <stdio.h>
#include <stdarg.h>

void error(char *format,...)
{
    va_list argptr;

    printf("error: ");
    va_start(argptr, format);
    vprintf(format, argptr);
    va_end(argptr);
}

main()
{
    int value = -1;
}
```c
error("this is just an error message\n");
error("invalid value %d encountered\n", value);
}
```

**Program output**

```
error: this is just an error message
error: invalid value -1 encountered
```

---

### va_arg

<table>
<thead>
<tr>
<th>Name</th>
<th><strong>va_arg</strong> – accesses variable argument list</th>
</tr>
</thead>
</table>
| Usage         | `#include <stdarg.h>`
|               | `type va_arg(va_list param, type);` |
| Prototype in  | `stdarg.h` |
| Description   | see va__ |

---

### va_end

<table>
<thead>
<tr>
<th>Name</th>
<th><strong>va_end</strong> – ends variable argument access</th>
</tr>
</thead>
</table>
| Usage         | `#include <stdarg.h>`
|               | `void va_end(va_list param);` |
| Prototype in  | `stdarg.h` |
| Description   | see va__ |
### va_start

<table>
<thead>
<tr>
<th>Name</th>
<th>va_start – begins variable argument access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td><code>#include &lt;stdarg.h&gt;</code></td>
</tr>
<tr>
<td></td>
<td><code>void va_start(va_list param, lastfix);</code></td>
</tr>
<tr>
<td>Prototype in</td>
<td><code>stdarg.h</code></td>
</tr>
<tr>
<td>Description</td>
<td>see va...</td>
</tr>
</tbody>
</table>

### vfprintf

<table>
<thead>
<tr>
<th>Name</th>
<th>vfprintf – sends formatted output to a stream</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td><code>#include &lt;stdio.h&gt;</code></td>
</tr>
<tr>
<td></td>
<td><code>#include &lt;stdarg.h&gt;</code></td>
</tr>
<tr>
<td></td>
<td><code>int vfprintf(FILE *stream, char *format, va_list param);</code></td>
</tr>
<tr>
<td>Prototype in</td>
<td><code>stdio.h</code></td>
</tr>
<tr>
<td></td>
<td><code>stdarg.h</code></td>
</tr>
<tr>
<td>Description</td>
<td>see printf</td>
</tr>
</tbody>
</table>

### vfscanf

<table>
<thead>
<tr>
<th>Name</th>
<th>vfscanf – performs formatted input from a stream</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td><code>#include &lt;stdio.h&gt;</code></td>
</tr>
<tr>
<td></td>
<td><code>int vfscanf(FILE *stream, char *format, va_list param);</code></td>
</tr>
<tr>
<td>Prototype in</td>
<td><code>stdio.h</code></td>
</tr>
<tr>
<td>Description</td>
<td>see ...scanf</td>
</tr>
</tbody>
</table>

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### vprintf

<table>
<thead>
<tr>
<th>Name</th>
<th>vprintf – send formatted output to <code>stdout</code></th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>int vprintf(char *format, va_list param);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>stdio.h</td>
</tr>
<tr>
<td>Description</td>
<td>see printf</td>
</tr>
</tbody>
</table>

### vscanf

<table>
<thead>
<tr>
<th>Name</th>
<th>vscanf – performs formatted input from <code>stdin</code></th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>int vscanf(char *format, va_list param);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>stdio.h</td>
</tr>
<tr>
<td>Description</td>
<td>see ...scanf</td>
</tr>
</tbody>
</table>

### vsprintf

<table>
<thead>
<tr>
<th>Name</th>
<th>vsprintf – sends formatted output to a string</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>int vsprintf(char *string, char *format, va_list param);</td>
</tr>
<tr>
<td>Prototype in</td>
<td>stdio.h</td>
</tr>
<tr>
<td>Description</td>
<td>see printf</td>
</tr>
</tbody>
</table>
vsscanf

Name      vsscanf – performs formatted input from a stream
Usage     int vsscanf(char *s, char *format, va_list param);
Prototype in stdio.h
Description see ...scanf

_write

Name      _write – writes to a file
Usage     int _write(int handle, void *buf, int nbyte);
Prototype in io.h
Description see write

write

Name      write – writes to a file
Usage     int write(int handle, void *buf, int nbyte);
Related functions usage int _write(int handle, void *buf, int nbyte);
Prototype in io.h
Description Both write and _write are functions that write a buffer of data to the file or device named by the given handle. handle is a file handle obtained from a creat, open, dup, dup2, or fcntl call.
These functions attempt to write \textit{nbyte} bytes from the buffer pointed to by \textit{buf} to the file associated with \textit{handle}. Except when \texttt{write} is used to write to a text file, the number of bytes written to the file will be no more than the number requested.

On text files, when \texttt{write} sees a linefeed (LF) character, it outputs a CR-LF pair. \texttt{_write} does no such translation, since all of its files are binary files.

If the number of bytes actually written is less than that requested, the condition should be considered an error and probably indicates a full disk.

For disk or diskette files, writing always proceeds from the current file pointer (see \texttt{lseek}). For devices, bytes are directly sent to the device.

For files opened with the O\_APPEND option, the file pointer is positioned to EOF by \texttt{write} (but not by \texttt{_write}) before writing the data.

\textbf{Return value} \hfill The number of bytes written are returned by both functions. A \texttt{write} to a text file does not count generated carriage returns. In case of error, each function returns -1 and sets the global variable \textit{errno} to one of the following:

\begin{itemize}
\item EACCES \hfill Permission denied
\item EBADF \hfill Bad file number
\end{itemize}

\textbf{Portability} \hfill \texttt{Write} is available on UNIX systems.
\texttt{_write} is unique to MS-DOS.

\textbf{See also} \hfill \texttt{creat, dup, lseek, open}
The Turbo C Interactive Editor

Introduction

Turbo C's built-in editor is specifically designed for creating program source text. If you are familiar with the Turbo Pascal or SideKick editor, or MicroPro's WordStar program, you already know how to use the Turbo C editor, since its commands are almost identical to one of these editors. A section at the end of this appendix summarizes the few differences between Turbo C's editor commands and WordStar's commands.

The Turbo C editor, unlike WordStar, has a "restore" facility that lets you take back changes if you haven't yet left the line. This command (Ctrl-Q L) is described in "Miscellaneous Editing Commands."

Quick In, Quick Out

To invoke the editor, choose Edit from Turbo C's main menu. The Edit window becomes the "active" window; the Edit window's title is highlighted and the cursor is positioned in the Edit window.

To enter text, type as though you were using a typewriter. To end a line, press the Enter key.

To invoke the main menu from within the editor, press F10 (the data in the Edit window remains on screen).
**The Edit Window Status Line**

The status line in the top bar of the Edit window gives you information about the file you are editing, where in the file the cursor is located, and which editing modes are activated:

<table>
<thead>
<tr>
<th>Line</th>
<th>Col</th>
<th>Insert</th>
<th>Indent</th>
<th>Tab</th>
<th>X:FILENAME.TYP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line</td>
<td>Shows which file line number contains the cursor.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Col</td>
<td>Shows which file column number contains the cursor.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insert</td>
<td>Tells you that the editor is in “Insert mode”; characters entered on the keyboard are inserted at the cursor position, and text in front of the cursor moves to the right. Use the <em>Ins</em> key or <em>Ctrl-V</em> to toggle the editor between Insert mode and Overwrite mode. In Overwrite mode, text entered at the keyboard overwrites characters under the cursor, instead of inserting them before existing text.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indent</td>
<td>Indicates the autoindent feature is on. You toggle it off and on with the command <em>Ctrl-O l.</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tab</td>
<td>Indicates whether or not you can insert tabs. Use <em>Ctrl-O T</em> to toggle this on or off.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X:FILENAME.TYP</td>
<td>Indicates the drive (X:), name (FILENAME), and extension (.TYP) of the file you are editing. If the file name and extension is NONAME.C, then you have not specified a file name yet. (NONAME.C is Turbo C’s default file name.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Editor Commands

The editor uses approximately 50 commands to move the cursor around, page through text, find and replace strings, and so on. These commands can be grouped into four main categories:

- cursor movement commands (basic and extended)
- insert and delete commands
- block commands
- miscellaneous commands

Table A.1 summarizes the commands. Each entry in the table consists of a command definition, followed by the default keystrokes used to activate the command. In the pages after Table A.1, we further explain the actions of each editor command.

<table>
<thead>
<tr>
<th>Basic Cursor Movement Commands</th>
<th>Quick Cursor Movement Commands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Character left</td>
<td>Beginning of line</td>
</tr>
<tr>
<td>Character right</td>
<td>Ctrl-Q S or Home</td>
</tr>
<tr>
<td>Word left</td>
<td>Ctrl-Q D or End</td>
</tr>
<tr>
<td>Word right</td>
<td>Ctrl-Q E</td>
</tr>
<tr>
<td>Line up</td>
<td>Ctrl-Q X</td>
</tr>
<tr>
<td>Line down</td>
<td>Ctrl-Q R or PgUp</td>
</tr>
<tr>
<td>Scroll up</td>
<td>Ctrl-Q C or PgDn</td>
</tr>
<tr>
<td>Scroll down</td>
<td>Ctrl-Q P</td>
</tr>
<tr>
<td>Page up</td>
<td></td>
</tr>
<tr>
<td>Page down</td>
<td></td>
</tr>
</tbody>
</table>

Table A.1: Summary of Editor Commands
## Insert and Delete Commands

- **Insert mode on/off**: Ctrl-V or Ins
- **Insert line**: Ctrl-N
- **Delete line**: Ctrl-Y
- **Delete to end of line**: Ctrl-Q Y
- **Delete character left of cursor**: Ctrl-H or Backspace
- **Delete character under cursor**: Ctrl-G or Del
- **Delete word right of cursor**: Ctrl-T

## Block Commands

- **Mark block-begin**: Ctrl-K B
- **Mark block-end**: Ctrl-K K
- **Mark single word**: Ctrl-K T
- **Copy block**: Ctrl-K C
- **Delete block**: Ctrl-K Y
- **Hide/display block**: Ctrl-K H
- **Move block**: Ctrl-K V
- **Read block from disk**: Ctrl-K R
- **Write block to disk**: Ctrl-K W

## Miscellaneous Commands

- **Abort operation**: Ctrl-U
- **Autoindent on/off**: Ctrl-O I
- **Control character prefix**: Ctrl-P
- **Find**: Ctrl-Q F
- **Find and replace**: Ctrl-Q A
- **Find place marker**: Ctrl-Q N
- **Invoke main menu**: F10
- **Load file**: F3
- **Quit edit, no save**: Ctrl-K D or Ctrl-K Q
- **Repeat last find**: Ctrl-I
- **Restore line**: Ctrl-Q L
- **Save and edit**: Ctrl-K S or F2
- **Set place marker**: Ctrl-K N
- **Tab**: Ctrl-I or Tab
- **Tab mode**: Ctrl-O T
Basic Cursor Movement Commands

The editor uses control-key commands to move the cursor up, down, back, and forth on the screen. To control cursor movement in the part of your file currently on-screen, use the following sequences:

When you press      The cursor does this:

Clin-A               Moves to first letter in word to left of cursor
Clin-S               Moves to first position to left of cursor
Clin-D               Moves to first position to right of cursor
Clin-F               Moves to first letter in word to right of cursor
Clin-E               Moves up one line
Clin-R               Moves up one full screen
Clin-X               Moves down one line
Clin-C               Moves down one full screen
Clin-W               Scrolls screen down one line; cursor stays in line
Clin-Z               Scrolls screen up one line; cursor stays in line
PgUp                 Scrolls screen and cursor up one screen
PgDn                 Scrolls screen and cursor down one screen

Quick Cursor Movement Commands

The editor also provides six commands to move the cursor quickly to the extreme ends of lines, to the beginning and end of the file, and to the last cursor position.

When you press      The cursor does this:

Clin-Q S             Moves to column one of the current line
or Home
Clin-Q D             Moves to the end of the current line
or End
Clin-Q E             Moves to the top of the screen
Clin-Q X             Moves to the bottom of the screen
Clin-Q R             Moves to the first character in the file
Clin-Q C             Moves to the last character in the file
The Ctrl-Q prefix with a B, K, or P character allows you to jump to certain special points in a document.

**Ctrl-Q B**  Moves the cursor to the block-begin marker set with Ctrl-K B. The command works even if the block is not displayed (see “Hide/display block” under “Block Commands”) or if the block-end marker is not set.

**Ctrl-Q K**  Moves the cursor to the block-end marker set with Ctrl-K K. The command works even if the block is not displayed (see “Hide/display block”) or the block-begin marker is not set.

**Ctrl-Q P**  Moves to the last position of the cursor before the last command. This command is particularly useful after a Find or Find/Replace operation has been executed and you’d like to return to the last position before its execution.

---

**Insert and Delete Commands**

To write a program, you need to know more than just how to move the cursor around. You also need to be able to insert and delete text. The following commands insert and delete characters, words, and lines.

**Insert mode on/off**

When entering text, you can choose between two basic entry modes: *Insert* and *Overwrite*. You can switch between these modes with the Insert mode toggle, Ctrl-V or Ins. The current mode is displayed in the status line at the top of the screen.

Insert mode is the Turbo C editor’s default; this lets you insert new characters into old text. Text to the right of the cursor simply moves to the right as you enter new text.

Use Overwrite mode to replace old text with new; any characters entered replace existing characters under the cursor.

**Delete character left of cursor**

Moves one character to the left and deletes the character positioned there. Any characters to the right of the cursor move one position to the left. You can use this command to remove line breaks.

**Delete character under cursor**

Deletes the character under the cursor and moves any characters to the right of the cursor one position to the left. This command does not work across line breaks.
Delete word right of cursor

Deletes the word to the right of the cursor. A word is defined as a sequence of characters delimited by one of the following characters:

```
  space  <  >  ,  ;  .  (  )  
  [  ]  ^  '  *  +  -  /  $  
```

This command works across line breaks, and may be used to remove them.

Insert line

Inserts a line break at the cursor position.

Delete line

Deletes the line containing the cursor and moves any lines below one line up. There's no way to restore a deleted line, so use this command with care.

Delete to end of line

Deletes all text from the cursor position to the end of the line.

Block Commands

The block commands also require a control-character command sequence. A block of text is any amount of text, from a single character to hundreds of lines, that has been surrounded with special block-marker characters. There can be only one block in a document at a time.

You mark a block by placing a block-begin marker before the first character and a block-end marker after the last character of the desired portion of text. Once marked, you can copy, move, or delete the block, or write it to a file.

Mark block-begin

Marks the beginning of a block. The marker itself is not visible, and the block itself only becomes visible when the block-end marker is set. Marked text (a block) is displayed in a different intensity.

Mark block-end

Marks the end of a block. The marker itself is invisible, and the block itself becomes visible only when the block-begin marker is also set.
Mark single word  
Marks a single word as a block, replacing the block-begin/block-end sequence. If the cursor is placed within a word, then the word will be marked. If it is not within a word, then the word to the left of the cursor will be marked.

Copy block  
Copies a previously marked block to the current cursor position. The original block is unchanged, and the markers are placed around the new copy of the block. If no block is marked or the cursor is within the marked block, nothing happens.

Delete block  
Deletes a previously marked block. There is no provision to restore a deleted block, so be careful with this command.

Hide/display block  
Causes the visual marking of a block to be alternately switched off and on. The block manipulation commands (copy, move, delete, and write to a file) work only when the block is displayed. Block-related cursor movements (jump to beginning/end of block) work whether the block is hidden or displayed.

Move block  
Moves a previously marked block from its original position to the cursor position. The block disappears from its original position, and the markers remain around the block at its new position. If no block is marked, nothing happens.

Read block from disk  
Reads a previously marked disk file into the current text at the cursor position, exactly as if it were a block. The text read is then marked as a block of different intensity.

When you issue this command, Turbo C's editor prompts you for the name of the file to read. You can use DOS wildcards to select a file to read; a directory appears in a small window on-screen. The file specified may be any legal file name. If you specify no file type (.C, .TXT, .BAK, etc.) the editor assumes you meant .C. To read a file that lacks an extension, append a period to the file name.

Write block to disk  
Writes a previously marked block to a file. The block is left unchanged in the current file, and the markers remain in place. If no block is marked, nothing happens.
When you issue this command, Turbo C’s editor prompts you for the name of the file to write to. To select a file to overwrite, use DOS wildcards; a directory appears in a small window on-screen. If the file specified already exists, the editor issues a warning and prompts for verification before overwriting the existing file. You can give the file any legal name (the default extension is .C). To write a file that lacks an extension, append a period to the file name.

**Miscellaneous Editing Commands**

This section describes commands that do not fall into any of the categories already covered. These commands are listed in alphabetical order.

**Abort operation**  
*Ctrl-U*

Lets you abort any command in process whenever it pauses for input, such as when Find/Replace asks Replace Y/N?, or when you are entering a search string or a file name (Block read and write).

**Autoindent on/off**  
*Ctrl-O /

Provides automatic indenting of successive lines. When autoindent is active, the cursor does not return to column one when you press Enter; instead, it returns to the starting column of the line you just terminated.

When you want to change the indentation, use the space bar and Left arrow key to select the new column. When autoindent is on, the message Indent shows up in the status line; when off, the message disappears. Autoindent is on by default. (When Tab is on, autoindent is disabled.)

**Control character prefix**  
*Ctrl-P*

Allows you to enter control characters into the file by prefixing the desired control character with a Ctrl-P; that is, first press Ctrl-P, then press the desired control character. Control characters will appear as low-intensity capital letters on the screen (or inverse, depending on your screen setup).

**Find**  
*Ctrl-Q F*

Lets you search for a string of up to 30 characters. When you enter this command, the status line is cleared, and the editor prompts you for a search string. Enter the string you are looking for and then press Enter.
The search string may contain any characters, including control characters. You enter control characters into the search string with the ^p prefix. For example, enter a Ctrl-T by holding down the Ctrl key as you press P, and then press T. You may include a line break in a search string by specifying Ctrl-M J (carriage return/line feed). Note that Ctrl-A has special meaning: It matches any character and may be used as a wildcard in search strings.

You may edit search strings with the character left, character right, word left, and word right commands. Word right recalls the previous search string, which you may then edit. To abort (quit) the search operation, use the abort command (Ctrl-U).

When you specify the search string, Turbo C’s editor asks for search options. The following options are available:

**B** Searches backward from the current cursor position toward the beginning of the text.

**G** Globally searches the entire text, irrespective of the current cursor position. This stops only at the last occurrence of the string.

**N** Finds the next occurrence of a search string, starting at the current cursor position in your file. When using both the N and the G options at the same time, the G option overrides the N option.

**n** Where n equals a number, finds the nth occurrence of the search string, counted from the current cursor position.

**U** Ignores uppercase/lowercase distinctions.

**W** Searches for whole words only, skipping matching patterns embedded in other words.

**Examples of Find Options:**

**W** Searches for whole words only. The search string term will match term, for example, but not terminal.

**BU** Searches backward and ignores uppercase/lowercase differences. Block matches both blockhead and BLOCKADE, and so on.

**125** Finds the 125th occurrence of the search string.
You can end the list of find options (if any) by pressing Enter; the search starts. If the text contains a target matching the search string, the editor positions the cursor on the target. The search operation may be repeated by the Repeat last find command (Ctrl-L).

**Find and replace**

This operation works identically to the Find command, except that you can replace the “found” string with any other string of up to 30 characters. Note that Ctrl-A only functions as a wildcard in the Find string; it has no special meaning in the Replace string.

When you specify the search string, the editor asks you to enter the string that will replace the search string. Enter up to 30 characters; control character entry and editing is performed as with the Find command. If you just press Enter, the editor replaces the target with nothing, effectively deleting it.

Your choice of options are the same as those in the Find command with the addition of the following:

- **N** Replaces without asking; does not ask for confirmation of each occurrence of the search string.
- **n** Replaces the next n cases of the search string. If the G option is used, the search starts at the top of the file; otherwise it starts at the current cursor position.

**Examples of Find and Replace Options:**

- **N10** Finds the next ten occurrences of the search string and replaces each without asking.
- **GW** Finds and replaces whole words in the entire text, ignoring uppercase/lowercase. It prompts for a replacement string.
- **GNU** Finds (throughout the file) uppercase and lowercase small, antelope-like creatures and replaces them without asking.

Again, you can end the option list (if any) by pressing Enter; the Find/Replace operation starts. When the editor finds the item (and if the N option is not specified), it then positions the cursor at one end of the item, and asks Replace (Y/N)? in the prompt line at the top of the screen. You may abort the Find/Replace operation at this point with the Abort command (Ctrl-U). You can repeat the Find/Replace operation with the Repeat last find command (Ctrl-L).
Find place marker  
Ctrl-Q N  
Finds up to four place markers (0-3) in text. Move the cursor to any previously set marker by pressing Ctrl-Q and the marker number, n.

Load file  
F3  
Lets you edit an existing file or create a new file.

Quit edit, no save  
Ctrl-K D or Ctrl-K Q  
Quits the editor and returns you to the main menu. You can save the edited file on disk either explicitly with the main menu's Save option under the Files command or manually while in the editor (Ctrl-K S or F2).

Repeat last find  
Ctrl-L  
Repeats the latest Find or Find/Replace operation as if all information had been re-entered.

Restore line  
Ctrl-Q L  
Lets you undo changes made to a line, as long as you have not left the line. The line is restored to its original state regardless of any changes you have made.

Save file  
Ctrl-K S or F2  
Saves the file and remains in the editor.

Set place marker  
Ctrl-K N  
You can mark up to four places in text; press Ctrl-K, followed by a single digit n (0-3). After marking your location, you can work elsewhere in the file and then easily return to the marked location by using the Ctrl-Q N command.

Tab  
Ctrl-I or Tab  
Tabs are fixed to eight columns apart in the Turbo C editor.

Tab mode  
Ctrl-O T  
With Tab mode on, a tab is placed in the text using a fixed tab stop of 8. Toggle it off, and it spaces to the beginning of the first letter of each word in the previous line.

The Turbo C Editor Vs. WordStar

A few of the Turbo C editor's commands are slightly different from WordStar. Also, although the Turbo C editor contains only a subset of WordStar's commands, several features not found in WordStar have been
added to enhance program source-code editing. These differences are discussed here, in alphabetical order.

Autoindent:
The Turbo C editor’s Ctrl-O l command toggles the autoindent feature on and off.

Carriage returns:
In Turbo C, carriage returns cannot be entered at the end of a file in Overwrite mode. (If you press Enter at the end of a line when Insert mode is off, the editor will not insert a carriage return character or move the cursor to the next line.) To enter carriage returns, you can either switch to Insert mode or use Ctrl-N in Overwrite mode.

Cursor movement:
Turbo C’s cursor movement controls—Ctrl-S, Ctrl-D, Ctrl-E, and Ctrl-X—move freely around on the screen without jumping to column one on empty lines. This does not mean that the screen is full of blanks, on the contrary, all trailing blanks are automatically removed. This way of moving the cursor is especially useful for program editing, for example, when matching indented statements.

Delete to left:
The WordStar sequence Ctrl-Q Del, delete from cursor position to beginning of line, is not supported.

Mark word as block:
Turbo C allows you to mark a single word as a block using Ctrl-K T. This is more convenient than WordStar’s two-step process of separately marking the beginning and the end of the word.

Movement across line breaks:
Ctrl-S and Ctrl-D do not work across line breaks. To move from one line to another you must use Ctrl-E, Ctrl-X, Ctrl-A, or Ctrl-F.

Quit edit:
Turbo C’s Ctrl-K Q does not resemble WordStar’s Ctrl-K Q (quit edit) command. In Turbo C, the changed text is not abandoned—it is left in memory, ready to be compiled and saved.

Undo:
Turbo C’s Ctrl-Q L command restores a line to its pre-edit contents as long as the cursor has not left the line.

Updating disk file:
Since editing in Turbo C is done entirely in memory, the Ctrl-K D command does not change the file on disk as it does in WordStar. You
must explicitly update the disk file with the Save option within the File menu or by using Ctrl-K S or F2 within the editor.
The Turbo C compiler diagnostic messages fall into three classes: Fatals, Errors, and Warnings.

**Fatal** errors are rare and probably indicate an internal compiler error. When a fatal error occurs, compilation immediately stops. You must take appropriate action and then restart compilation.

**Errors** indicate program syntax errors, disk or memory access errors, and command line errors. The compiler will complete the current phase of the compilation and then stop. The compiler attempts to find as many real errors in the source program as possible during each phase (preprocessing, parsing, optimizing and code-generating).

**Warnings** do not prevent the compilation from finishing. They indicate conditions which are suspicious, but which are legitimate as part of the language. Also, the compiler will produce warnings if you use machine-dependent constructs in your source files.

The compiler prints messages with the message class first, then the source file name and line number where the compiler detected the condition, and finally the text of the message itself.

In the following lists, messages are presented alphabetically within message class. With each message, a probable cause and remedy are provided.

You should be aware of one detail about line numbers in error messages: the compiler only generates messages as they are detected. Because C does not force any restrictions on placing statements on a line of text, the true
cause of the error may be one or more lines before the line number mentioned. In the following message list, we have indicated those messages which often appear (to the compiler) to be on lines after the real cause.

**Fatal Errors**

**Bad call of in-line function**
You have used an in-line function taken from a macro definition, but have called it incorrectly. An in-line function is one that begins and ends with a double underbar (\_\_).

**Irreducible expression tree**
This is a sign of some form of compiler error. Some expression on the indicated line of the source file has caused the code generator to be unable to generate code. Whatever the offending expression is, it should be avoided. You should notify Borland International if the compiler ever encounters this error.

**Register allocation failure**
This is a sign of some form of compiler error. Some expression on the indicated line of the source file was so complicated that the code generator could not generate code for it. You should simplify the offending expression, and if this fails to solve the problem, the expression should be avoided. Notify Borland International if the compiler encounters this error.
Errors

#operator not followed by macro argument name
In a macro definition, the # may be used to indicate stringizing a macro argument. The # must be followed by a macro argument name.

'XXXXXXXX' not an argument
Your source file declared the named identifier as a function argument but the identifier was not in the function argument list.

Ambiguous symbol 'XXXXXXXX'
The named structure field occurs in more than one structure with different offsets, types, or both. The variable or expression used to refer to the field is not a structure containing the field. Cast the structure to the correct type, or correct the field name if it is wrong.

Argument # missing name
A parameter name has been left out in a function prototype used to define a function. If the function is defined with a prototype, the prototype must include the parameter names.

Argument list syntax error
Arguments to a function call must be separated by spaces and closed with a right parenthesis. Your source file contained an argument followed by a character other than comma or right parenthesis.

Array bounds missing ]
Your source file declared an array in which the array bounds were not terminated by a right bracket.

Array size too large
The declared array would be too large to fit in the available memory of the processor.

Assembler statement too long
In-line assembly statements may not be longer than 480 bytes.

Bad configuration file
The TURBOC.CFG file contains uncommented text that is not a proper command option. Configuration file command options must begin with a dash (-).
Bad file name format in include directive
Include file names must be surrounded by quotes ("filename.h") or angle brackets (<filename.h>). The file name was missing the opening quote or angle bracket. If a macro was used, the resulting expansion text is incorrect; that is, not surrounded by quote marks.

Bad ifdef directive syntax
An #ifdef directive must contain a single identifier (and nothing else) as the body of the directive.

Bad ifndef directive syntax
An #ifndef directive must contain a single identifier (and nothing else) as the body of the directive.

Bad undef directive syntax
An #undef directive must contain a single identifier (and nothing else) as the body of the directive.

Bit field size syntax
A bitfield must be defined by a constant expression between 1 and 16 bits in width.

Call of non-function
The function being called is declared as a non-function. This is commonly caused by incorrectly declaring the function or misspelling the function name.

Cannot modify a const object
This indicates an illegal operation on an object declared to be const, such as an assignment to the object.

Case outside of switch
The compiler encountered a case statement outside a switch statement. This is often caused by mismatched curly braces.

Case statement missing :
A case statement must have a constant expression followed by a colon. The expression in the case statement either was missing a colon or had some extra symbol before the colon.

Cast syntax error
A cast contains some incorrect symbol.

Character constant too long
Character constants may only be one or two characters long.

Compound statement missing }
The compiler reached the end of the source file and found no closing brace. This is most commonly caused by mismatched braces.
Conflicting type modifiers
This occurs when a declaration is given that includes, for example, both near and far keywords on the same pointer. Only one addressing modifier may be given for a single pointer, and only one language modifier (cdecl, pascal, or interrupt) may be given on a function.

Constant expression required
Arrays must be declared with constant size. This error is commonly caused by misspelling a #define constant.

Could not find file ‘XXXXXXXX.XXX’
The compiler is unable to find the file supplied on the command line.

Declaration missing;
Your source file contained a struct or union field declaration that was not followed by a semicolon.

Declaration needs type or storage class
A declaration must include at least a type or a storage class. This means a statement like the following is not legal:

i, j;

Declaration syntax error
Your source file contained a declaration that was missing some symbol or had some extra symbol added to it.

Default outside of switch
The compiler encountered a default statement outside a switch statement. This is most commonly caused by mismatched curly braces.

Define directive needs an identifier
The first non-whitespace character after a #define must be an identifier. The compiler found some other character.

Division by zero
Your source file contained a divide or remainder in a constant expression with a zero divisor.

Do statement must have while
Your source file contained a do statement that was missing the closing while keyword.

Do-while statement missing (In a do statement, the compiler found no left parenthesis after the while keyword.)
Do-while statement missing)
In a do statement, the compiler found no right parenthesis after the test expression.

Do-while statement missing ;
In a do statement test expression, the compiler found no semicolon after the right parenthesis.

Duplicate case
Each case of a switch statement must have a unique constant expression value.

Enum syntax error
An enum declaration did not contain a properly formed list of identifiers.

Enumeration constant syntax error
The expression given for an enum value was not a constant.

Error Directive: XXXX
This message is issued when an #error directive is processed in the source file. The text of the directive is displayed in the message.

Error writing output file
This error most often occurs when the work disk is full. It could also indicate a faulty diskette. If the diskette is full, try deleting unneeded files and restarting the compilation.

Expression syntax
This is a catch-all error message when the compiler parses an expression and encounters some serious error. This is most commonly caused by two consecutive operators, mismatched or missing parentheses, or a missing semicolon on the previous statement.

Extra parameter in call
A call to a function, via a pointer defined with a prototype, had too many arguments given.

Extra parameter in call to XXXXXXXX
A call to the named function (which was defined with a prototype) had too many arguments given in the call.

File name too long
The file name given in an #include directive was too long for the compiler to process. File names in DOS must be no more than 64 characters long.

For statement missing ()
In a for statement, the compiler found no left parenthesis after the for keyword.
For statement missing )  
In a for statement, the compiler found no right parenthesis after the control expressions.

For statement missing ;  
In a for statement, the compiler found no semicolon after one of the expressions.

Function call missing )  
The function call argument list had some sort of syntax error, such as a missing or mismatched right parenthesis.

Function definition out of place  
A function definition may not be placed inside another function. Any declaration inside a function that looks like the beginning of a function with an argument list is considered a function definition.

Function doesn't take a variable number of arguments  
Your source file used the va_start macro inside a function that does not accept a variable number of arguments.

Goto statement missing label  
The goto keyword must be followed by an identifier.

If statement missing (  
In an if statement, the compiler found no left parenthesis after the if keyword.

If statement missing )  
In an if statement, the compiler found no right parenthesis after the test expression.

Illegal character 'C' (0xXX)  
The compiler encountered some invalid character in the input file. The hexadecimal value of the offending character is printed.

Illegal initialization  
Initializations must be either constant expressions, or else the address of a global extern or static variable plus or minus a constant.

Illegal octal digit  
The compiler found an octal constant containing a non-octal digit (8 or 9).

Illegal pointer subtraction  
This is caused by attempting to subtract a pointer from a non-pointer.
Illegal structure operation
Structures may only be used with dot (.), address-of (&) or assignment (=) operators, or be passed to or from a function as parameters. The compiler encountered a structure being used with some other operator.

Illegal use of floating point
Floating point operands are not allowed in shift, bitwise boolean, conditional (? :), indirection (*), or certain other operators. The compiler found a floating-point operand with one of these prohibited operators.

Illegal use of pointer
Pointers may only be used with addition, subtraction, assignment, comparison, indirection (*) or arrow (->). Your source file used a pointer with some other operator.

Improper use of a typedef symbol
Your source file used a typedef symbol where a variable should appear in an expression. Check for the declaration of the symbol and possible misspellings.

In-line assembly not allowed
Your source file contains in-line assembly language statements and you are compiling it from within the Integrated Environment. You must use the TCC command to compile this source file.

Incompatible storage class
Your source file used the extern keyword on a function definition. Only static (or no storage class at all) is allowed.

Incompatible type conversion
Your source file attempted to convert one type to another, but the two types were not convertible. This includes converting a function to or from a non-function, converting a structure or array to or from a scalar type, or converting a floating point value to or from pointer type.

Incorrect command line argument: XXXXXXXX
The compiler did not recognize the command line parameter as legal.

Incorrect configuration file argument: XXXXXXXX
The compiler did not recognize the configuration file parameter as legal; check for a preceding dash ("-").

Incorrect number format
The compiler encountered a decimal point in a hexadecimal number.

Incorrect use of default
The compiler found no colon after the default keyword.
Initializer syntax error
An initializer has a missing or extra operator, mismatched parentheses, or is otherwise malformed.

Invalid indirection
The indirection operator (*) requires a non-void pointer as the operand.

Invalid macro argument separator
In a macro definition, arguments must be separated by commas. The compiler encountered some other character after an argument name.

Invalid pointer addition
Your source file attempted to add two pointers together.

Invalid use of arrow
An identifier must immediately follow an arrow operator (->).

Invalid use of dot
An identifier must immediately follow a dot operator (.)

Lvalue required
The left hand side of an assignment operator must be an addressable expression. These include numeric or pointer variables, structure field references or indirection through a pointer, or a subscripted array element.

Macro argument syntax error
An argument in a macro definition must be an identifier. The compiler encountered some non-identifier character where an argument was expected.

Macro expansion too long
A macro may not expand to more than 4096 characters. This error often occurs if a macro recursively expands itself. A macro cannot legally expand to itself.

May compile only one file when an output file name is given
You have supplied an -o command line option, which allows only one output file name. The first file is compiled but the other files are ignored.

Mismatched number of parameters in definition
The parameters in a definition do not match the information supplied in the function prototype.

Misplaced break
The compiler encountered a break statement outside a switch or looping construct.
Misplaced continue
The compiler encountered a continue statement outside a looping construct.

Misplaced decimal point
The compiler encountered a decimal point in a floating point constant as part of the exponent.

Misplaced else
The compiler encountered an else statement without a matching if statement. Beyond just being an extra else, this could also be caused by an extra semicolon, missing curly braces, or some syntax error in a previous if statement.

Misplaced elif directive
The compiler encountered an #elif directive without any matching #if, #ifdef or #ifndef directive.

Misplaced else directive
The compiler encountered an #else directive without any matching #if, #ifdef or #ifndef directive.

Misplaced endif directive
The compiler encountered an #endif directive without any matching #if, #ifdef or #ifndef directive.

Must be addressable
An ampersand (&) has been applied to an object that is not addressable, such as a register variable.

Must take address of memory location
Your source file used the address-of operator (&) with an expression which cannot be used that way, for example a register variable.

No file name ending
The file name in an #include statement was missing the correct closing quote or angle bracket.

No file names given
The Turbo C compile command (TCC) contained no file names. A compile has to have something to work on.

Non-portable pointer assignment
Your source file assigned a pointer to a non-pointer, or vice versa. Assigning a constant zero to a pointer is allowed as a special case. You should use a cast to suppress this error message if the comparison is proper.
Non-portable pointer comparison
Your source file made a comparison between a pointer and a non-pointer other than the constant zero. You should use a cast to suppress this error message if the comparison is proper.

Non-portable return type conversion
The expression in a return statement was not the same type as the function declaration. With one exception, this is only triggered if the function or the return expression is a pointer. The exception to this is that a function returning a pointer may return a constant zero. The zero will be converted to an appropriate pointer value.

Not an allowed type
Your source file declared some sort of forbidden type, for example a function returning a function or array.

Out of memory
The total working storage is exhausted. Try it on a machine with more memory, or if you already have 640K, you may have to simplify the source file.

Pointer required on left side of →
Nothing but a pointer is allowed on the left side of the arrow (→).

Redeclaration of ‘XXXXXXXX’
The named identifier was previously declared.

Size of structure or array not known
Some expression (such as a sizeof or storage declaration) occurred with an undefined structure or an array of empty length. Structures may be referenced before they are defined as long as their size is not needed. Arrays may be declared with empty length if the declaration does not reserve storage or if the declaration is followed by an initializer giving the length.

Statement missing ;
The compiler encountered an expression statement without a semicolon following it.

Structure or union syntax error
The compiler encountered the struct or union keyword without an identifier or opening curly brace following it.

Structure size too large
Your source file declared a structure which reserved too much storage to fit in the memory available.
Subscripting missing
The compiler encountered a subscripting expression which was missing its closing bracket. This could be caused by a missing or extra operator, or mismatched parentheses.

Switch statement missing (In a switch statement, the compiler found no left parenthesis after the switch keyword.

Switch statement missing )
In a switch statement, the compiler found no right parenthesis after the test expression.

Too few parameters in call
A call to a function with a prototype (via a function pointer) had too few arguments. Prototypes require that all parameters be given.

Too few parameters in call to ‘XXXXXXXX’
A call to the named function (declared using a prototype) had too few arguments.

Too many cases
A switch statement is limited to 257 cases.

Too many decimal points
The compiler encountered a floating point constant with more than one decimal point.

Too many default cases
The compiler encountered more than one default statement in a single switch.

Too many exponents
The compiler encountered more than one exponent in a floating point constant.

Too many initializers
The compiler encountered more initializers than were allowed by the declaration being initialized.

Too many storage classes in declaration
A declaration may never have more than one storage class.

Too many types in declaration
A declaration may never have more than one of the basic types: char, int, float, double, struct, union, enum or typedef-name.
Too much auto memory in function
The current function declared more automatic storage than there is room for in the available memory.

Too much code defined in file
The combined size of the functions in the current source file exceeds 64K bytes. You may have to remove unneeded code, or split up the source file.

Too much global data defined in file
The sum of the global data declarations exceeds 64K bytes. Check the declarations for any array that may be too large. Also consider reorganizing the program if all the declarations are needed.

Two consecutive dots
Because an ellipsis contains three dots (...), and a decimal point or member selection operator uses one dot (.), there is no way two dots can legally occur in a C program.

Type mismatch in parameter #
The function called, via a function pointer, was declared with a prototype; the given parameter #N (counting left-to-right from 1) could not be converted to the declared parameter type.

Type mismatch in parameter # in call to 'XXXXXXXX'
Your source file declared the named function with a prototype, and the given parameter #N (counting left-to-right from 1) could not be converted to the declared parameter type.

Type mismatch in parameter 'XXXXXXXX'
Your source file declared the function called via a function pointer with a prototype, and the named parameter could not be converted to the declared parameter type.

Type mismatch in parameter 'XXXXXXXX' in call to 'YYYYYYYY'
Your source file declared the named function with a prototype, and the named parameter could not be converted to the declared parameter type.

Type mismatch in redeclaration of 'XXX'
Your source file redeclared a variable with a different type than was originally declared for the variable. This can occur if a function is called and subsequently declared to return something other than an integer. If this has happened, you must insert an extern declaration of the function before the first call to it.
Unable to create output file ‘XXXXXXXX.XXX’
This error occurs if the work diskette is full or write protected. If the diskette is full, try deleting unneeded files and restarting the compilation. If the diskette is write protected, move the source files to a writable diskette and restart the compilation.

Unable to create turboc.lnk
The compiler cannot create the temporary file TURBOC.$LN because it cannot access the disk or the disk is full.

Unable to execute command ‘XXXXXXXX’
TLINK or MASM cannot be found, or possibly the disk is bad.

Unable to open include file ‘XXXXXXXX.XXX’
The compiler could not find the named file. This could also be caused if an #include file included itself, or if you do not have FILES set in CONFIG.SYS on your root directory (try FILES=20). Check whether the named file exists.

Unable to open input file ‘XXXXXXXX.XXX’
This error occurs if the source file cannot be found. Check the spelling of the name and whether the file is on the proper diskette or directory.

Undefined label ‘XXXXXXXX’
The named label has a goto in the function, but no label definition.

Undefined structure ‘XXXXXXXX’
Your source file used the named structure on some line before where the error is indicated (probably on a pointer to a structure) but had no definition for the structure. This is probably caused by a misspelled structure name or a missing declaration.

Undefined symbol ‘XXXXXXXX’
The named identifier has no declaration. This could be caused by a misspelling either at this point or at the declaration. This could also be caused if there was an error in the declaration of the identifier.

Unexpected end of file in comment started on line #
The source file ended in the middle of a comment. This is normally caused by a missing close of comment (*/).

Unexpected end of file in conditional started on line #
The source file ended before the compiler encountered #endif. The #endif either was missing or misspelled.
Unknown preprocessor directive: ‘XXX’
The compiler encountered a # character at the beginning of a line, and
the directive name following was not one of these: define, undef, line,
if, ifdef, ifndef, include, else or endif.

Unterminated character constant
The compiler encountered an unmatched apostrophe.

Unterminated string
The compiler encountered an unmatched quote character.

Unterminated string or character constant
The compiler found no terminating quote after the beginning of a string
or character constant.

User break
You typed a Ctrl-Break while compiling or linking in the Integrated
Environment.

While statement missing (  
In a while statement, the compiler found no left parenthesis after the
while keyword.

While statement missing )
In a while statement, the compiler found no right parenthesis after the
test expression.

Wrong number of arguments in call of ‘XXXXXXXX’
Your source file called the named macro with an incorrect number of
arguments.
Warnings

`XXXXXXX' declared but never used
Your source file declared the named variable as part of the block just ending, but the variable was never used. The warning is indicated when the compiler encounters the closing curly brace of the compound statement or function. The declaration of the variable occurs at the beginning of the compound statement or function.

`XXXXXXX' is assigned a value which is never used
The variable appears in an assignment, but is never used anywhere else in the function just ending. The warning is indicated only when the compiler encounters the closing curly brace.

`XXXXXXX' not part of structure
The named field was not part of the structure on the left hand side of the dot (.) or arrow (- >), or else the left hand side was not a structure (for a dot) or pointer to structure (for an arrow).

Ambiguous operators need parentheses
This warning is displayed whenever two shift, relational or bitwise-boolean operators are used together without parentheses. Also, an addition or subtraction operator that appears unparenthesized with a shift operator will produce this warning. Programmers frequently confuse the precedence of these operators, since the precedence assigned to them is somewhat counter-intuitive.

Both return and return of a value used
This warning is issued when the compiler encounters a return statement that disagrees with some previous return statement in the function. It is almost certainly an error for a function to return a value in only some of the return statements.

Call to function with no prototype
This message is given if the "Prototypes required" warning is enabled and you call a function without first giving a prototype for that function.

Call to function 'XXXX' with no prototype
This message is given if the "Prototypes required" warning is enabled and you call function XXXX without first giving a prototype for that function.
Code has no effect
This warning is issued when the compiler encounters a statement with
some operators which have no effect. For example the statement:

```
a + b;
```

has no effect on either variable. The operation is unnecessary and
probably indicates a bug.

Constant is long
The compiler encountered either a decimal constant greater than 32767
or an octal (or hexadecimal) constant greater than 65535 without a letter l
or L following it. The constant is treated as a long.

Constant out of range in comparison
Your source file includes a comparison involving a constant sub-
expression that was outside the range allowed by the other sub-
expression’s type. For example, comparing an unsigned quantity to −1
makes no sense. To get an unsigned constant greater than 32767 (in
decimal), you should either cast the constant to unsigned (e.g.,
(unsigned)65535) or append a letter u or U to the constant (e.g., 65535u).

Conversion may lose significant digits
For an assignment operator or some other circumstance, your source file
requires a conversion from long or unsigned long to int or unsigned
int type. On some machines, since int type and long type variables
have the same size, this kind of conversion may alter the behavior of a
program being ported.

Whenever this message is issued, the compiler will still generate code to
do the comparison. If this code ends up always giving the same result,
such as comparing a char expression to 4000, the code will still perform
the test. This also means that comparing an unsigned expression to −1
will do something useful, since an unsigned can have the same bit
pattern as a −1 on the 8086.

Function should return a value
Your source file declared the current function to return some type other
than int or void, but the compiler encountered a return with no value.
This is usually some sort of error. int functions are exempt, since in old
versions of C there was no void type to indicate functions which return
nothing.

Mixing pointers to signed and unsigned char
You converted a char pointer to an unsigned char pointer, or vice
versa, without using an explicit cast. (Strictly speaking, this is incorrect,
but on the 8086, it is often harmless.)
No declaration for function ‘XXXXXXXX’
This message is given if the “Declaration required” warning is enabled and you call a function without first declaring that function. The declaration can be either classic or modern (prototype) style.

Non-portable pointer assignment
Your source file assigned a pointer to a non-pointer, or vice versa. Assigning a constant zero to a pointer is allowed as a special case. You should use a cast to suppress this warning if the comparison is proper.

Non-portable pointer comparison
Your source file compared a pointer to a non-pointer other than the constant zero. You should use a cast to suppress this warning if the comparison is proper.

Non-portable return type conversion
The expression in a return statement was not the same type as the function declaration. With one exception, this is only triggered if the function or the return expression is a pointer. The exception to this is that a function returning a pointer may return a constant zero. The zero will be converted to an appropriate pointer value.

Parameter ‘XXXXXXXX’ is never used
The named parameter, declared in the function, was never used in the body of the function. This may or may not be an error and is often caused by misspelling the parameter. This warning can also occur if the identifier is redeclared as an automatic (local) variable in the body of the function. The parameter is masked by the automatic variable and remains unused.

Possible use of ‘XXXXXXXX’ before definition
Your source file used the named variable in an expression before it was assigned a value. The compiler uses a simple-minded scan of the program to determine this condition. If the use of a variable occurs physically before any assignment, this warning will be generated. Of course, the actual flow of the program may assign the value before the program uses it.

Possibly incorrect assignment
This warning is generated when the compiler encounters an assignment operator as the main operator of a conditional expression (i.e. part of an if, while or do-while statement). More often than not, this is a typographical error for the equality operator. If you wish to suppress this warning, enclose the assignment in parentheses and compare the whole thing to zero explicitly. Thus:

    if (a = b) ...

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should be rewritten as:

\[
\text{if } ((a = b) \neq 0) \ldots
\]

Redefinition of ‘’ is not identical

Your source file redefined the named macro using text that was not exactly the same as the first definition of the macro. The new text replaces the old.

Restarting compile using assembly

The compiler encountered an \texttt{asm} with no accompanying \texttt{-B} command line option or \texttt{#pragma inline} statement. The compile restarts using assembly language capabilities.

Structure passed by value

If "Structure passed by value" warning is enabled, this warning is generated anytime a structure is passed by value as an argument. It is a frequent programming mistake to leave an address-of operator (&) off a structure when passing it as an argument. Because structures can be passed by value, this omission is acceptable. This warning provides a way for the compiler to warn you of this mistake.

Superfluous & with function or array

An address-of operator (&) is not needed with an array name or function name; any such operators are discarded.

Suspicious pointer conversion

The compiler encountered some conversion of a pointer which caused the pointer to point to a different type. You should use a cast to suppress this warning if the conversion is proper.

Undefined structure ‘’

The named structure was used in the source file, probably on a pointer to a structure, but had no definition in the source file. This is probably caused by a misspelled structure name or a missing declaration.

Unknown assembler instruction

The compiler encountered an in-line assembly statement with a disallowed opcode. Check the spelling of the opcode. Also check the list of allowed opcodes to see if the instruction is acceptable.

Unreachable Code

A \texttt{break}, \texttt{continue}, \texttt{goto} or \texttt{return} statement was not followed by a label or the end of a loop or function. The compiler checks \texttt{while}, \texttt{do} and \texttt{for} loops with a constant test condition, and attempts to recognize loops which cannot fall through.
Void functions may not return a value
Your source file declared the current function as returning `void`, but the compiler encountered a return statement with a value. The value of the return statement will be ignored.

Zero length structure
Your source file declared a structure whose total size was zero. Any use of this structure would be an error.
Command-Line Options

This appendix lists each of the Turbo C compile-time command-line options in alphabetical order under option type, and describes what each option does. The options are broken down into three general types:

- compiler options
- linker options
- environment options

Within the compiler options, there are several categories of options; these specify

- memory model
- #defines (macro definitions)
- code generation options
- optimization options
- source code options
- error-reporting options
- segment-naming control

To see an on-screen listing of all the TCC (command-line Turbo C) options, type `tcc Enter` at the DOS prompt (when you’re in the TURBOC directory). Most of the command-line options have counterparts in the Turbo C Integrated Development Environment (TC) Options menus (and a few other menus). See Table C.1 for a correlation of the TC menu selections and the TCC command-line options.
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<td>-a- **</td>
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<td>-f- **</td>
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<td>-mh</td>
<td>O/C/Model...Huge</td>
</tr>
<tr>
<td>-ml</td>
<td>O/C/Model...Large</td>
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<td>-mm</td>
<td>O/C/Model...Medium</td>
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<td>O/C/Model...Tiny</td>
</tr>
<tr>
<td>-N</td>
<td>O/C/Code generation/Test stack overflow...On</td>
</tr>
<tr>
<td>-npathname</td>
<td>O/E/Output directory</td>
</tr>
<tr>
<td>-O</td>
<td>O/C/Optimization/Optimize for...Size</td>
</tr>
<tr>
<td>-ofilename</td>
<td>(Not available)</td>
</tr>
<tr>
<td>-p</td>
<td>O/C/Code generation/Calling convention...Pascal</td>
</tr>
<tr>
<td>-p- **</td>
<td>C/Code generation/Calling convention...C</td>
</tr>
<tr>
<td>-r</td>
<td>O/C/Optimization/Use register variables...On</td>
</tr>
<tr>
<td>-S</td>
<td>(Not available)</td>
</tr>
<tr>
<td>-U name</td>
<td>(Not available)</td>
</tr>
<tr>
<td>-u- **</td>
<td>O/C/Code generation/Generate underbars...On</td>
</tr>
<tr>
<td>-w</td>
<td>O/C/Errors/Display warnings...On</td>
</tr>
<tr>
<td>-w-</td>
<td>O/C/Errors/Display warnings...Off</td>
</tr>
<tr>
<td>-wxxx</td>
<td>O/C/Errors/Portability warnings, ANSI violations, Common errors, or Less common errors...On</td>
</tr>
<tr>
<td>-w-xxx</td>
<td>O/C/Errors/Portability warnings, ANSI violations, Common errors, or Less common errors...Off</td>
</tr>
<tr>
<td>-v</td>
<td>O/C/Code generation/Line numbers...On</td>
</tr>
<tr>
<td>-Z</td>
<td>O/C/Optimization/Register optimization...On</td>
</tr>
<tr>
<td>-zAname</td>
<td>O/C/Names/Code/Class</td>
</tr>
<tr>
<td>-zBname</td>
<td>O/C/Names/Data/Class</td>
</tr>
<tr>
<td>-zCname</td>
<td>O/C/Names/Code/Segment</td>
</tr>
<tr>
<td>-zDname</td>
<td>O/C/Names/BSS/Segment</td>
</tr>
<tr>
<td>-zEname</td>
<td>O/C/Names/Data/Group</td>
</tr>
<tr>
<td>-zFname</td>
<td>O/C/Names/Code/Group</td>
</tr>
<tr>
<td>-zGname</td>
<td>O/C/Names/Data/Segment</td>
</tr>
<tr>
<td>-zHname</td>
<td>O/C/Names/Code/Group</td>
</tr>
<tr>
<td>-zIname</td>
<td>O/C/Names/BSS/Group</td>
</tr>
<tr>
<td>-zJname</td>
<td>O/C/Names/BSS/Class</td>
</tr>
<tr>
<td>-l</td>
<td>O/C/Code generation...80186/80286</td>
</tr>
<tr>
<td>-l- **</td>
<td>O/C/Code generation...8088/8086</td>
</tr>
</tbody>
</table>

O/ = Options    C/ = Compiler    E/ = Environment    ** = On by default
Turning Options On and Off

You select command-line options by entering a dash (-) immediately followed by the option letter (like this, -D). To turn an option off, add another dash after the option letter. For example, -A turns the ANSI keywords option on and -A- turns the option off.

This feature is useful for disabling or enabling individual switches on the command line, thereby overriding the corresponding settings in the configuration file.

Syntax

You select Turbo C compiler options through a DOS command line, with the following syntax:

```bash
tcc [option option ...] filename filename ...
```

Turbo C compiles files according to the following set of rules:

- `filename.asm`: invoke MASM to assemble to .OBJ
- `filename.obj`: include as object at link time
- `filename.lib`: include as library at link time
- `filename`: compile filename.c
- `filename.c`: compile filename.c
- `filename.xyz`: compile filename.xyz

For example, given the following command line

```bash
tcc -a -f -C -O -Z -emyexe oldfile1.c oldfile2 nextfile.c
```

TCC will compile OLDFILE1.C, OLDFILE2.C, and NEXTFILE.C to .OBJ, producing an executable program file named MYEXE.EXE with the word alignment (-a), floating-point emulation (-f), nested comments (-C), jump optimization (-O), and register optimization (-Z) options selected.

TCC will invoke MASM if you give it an .ASM file on the command line or if a .C file contains in-line assembly. The switches TCC gives to MASM are

```bash
/mx /D _mdi_
```
where \( \textit{mdl} \) is one of: TINY, SMALL, MEDIUM, COMPACT, LARGE, or HUGE. The /\texttt{mx} switch tells MASM to assemble with case-sensitivity on.

### Compiler Options

Turbo C’s command-line compiler options can be broken down into eight logical groups. These groups, and the ties that bind them, are as follows:

- **Memory model options** allow you to specify under which memory model Turbo C will compile your program. (The models range from Tiny to Huge.)
- **\#defines (macro definitions)** allow you to define macros (also known as manifest or symbolic constants) to the default (which is 1), to a numeric value, or to a string; these options also allow you to undefine previously-defined macros.
- **Code generation options** govern characteristics of the generated code to be used at run-time, such as the floating-point mode, calling convention, char type, or CPU instructions.
- **Optimization options** allow you to specify how the object code is to be optimized; for size or speed, with or without the use of register variables, and with or without redundant load operations.
- **Source code options** cause the compiler to recognize (or ignore) certain features of the source code; implementation-specific (non-ANSI) keywords, nested comments, and identifier lengths.
- **Error-reporting options** allow you to tailor which warning messages the compiler will report, and the maximum number of warnings (and errors) that can occur before the compilation stops.
- **Segment-naming control** allows you to rename segments and to reassign their groups and classes.
- **Compilation control options** allow you to direct the compiler to
  - compile to assembly code (rather than to an object module)
  - compile a source file that contains in-line assembly
  - compile without linking.
Memory Model

-mc Compile using compact memory model.
-mh Compile using huge memory model.
-ml Compile using large memory model.
-mm Compile using medium memory model.
-ms Compile using small memory model (the default).
-mt Compile using tiny memory model. Generates almost the same code as the small memory model, but uses C0T.OBJ in any link performed to produce a tiny model program.

For details about the Turbo C memory models, refer to Chapter 9 in the Turbo C User’s Guide.

#define

-Dxxx Defines the named identifier xxx to the string consisting of the single space character ( )
-Dxxx=string Defines the named identifier xxx to the string string after the equal sign. string cannot contain any spaces or tabs.
-Uxxx Undefines any previous definitions of the named identifier xxx.

Code Generation Options

-1 Causes Turbo C to generate extended 80186 instructions. This option is also used when generating 80286 programs running in the unprotected mode, such as with the IBM PC/AT under MS-DOS 3.0.
-a Forces integer size items to be aligned on a machine-word boundary. Extra bytes will be inserted in a structure to insure field alignment. Automatic and global variables will be aligned properly. char and unsigned char variables and fields may be placed at any address; all others must be placed at an even numbered address.
-d Merges literal strings when one string matches another; this produces smaller programs. (Off by default.)
-f87 Generates floating-point operations using in-line 8087 instructions rather than using calls to 8087 emulation library routines. Specifies that a floating-point processor will be available at run time, so programs compiled with this option will not run on a machine that does not have a floating-point chip.

-f Emulates 8087 calls at run time if the run-time system does not have an 8087; if it does have one, calls the 8087 for floating-point calculations (the default).

-f- Specifies that the program contains no floating-point calculations, so no floating-point libraries will be linked at the link step.

-K Causes the compiler to treat all char declarations as if they were unsigned char type. This allows for compatibility with other compilers that treat char declarations as unsigned. By default, char declarations are signed.

-k Generates a standard stack frame, which is useful when using a debugger to trace back through the stack of called subroutines.

-N Generates stack overflow logic at the entry of each function: This will cause a stack overflow message to appear when a stack overflow is detected. This is costly in both program size and speed but is provided as an option because stack overflows can be very difficult to detect. If an overflow is detected, the message “Stack overflow!” is printed and the program exits with an exit code of 1.

-p Forces the compiler to generate all subroutine calls and all functions using the Pascal parameter-passing sequence. The resulting function calls are smaller and faster. Functions must pass the correct number and type of arguments, unlike normal C usage which permits a variable number of function arguments. You can use the cdecl statement to override this option and specifically declare functions to be C-type.

-u With -u selected, when you declare an identifier, Turbo C automatically sticks an underscore (_) on the front before saving that identifier in the object module.

Turbo C treats pascal-type identifiers (those modified by the pascal keyword) differently—they are uppercased and are not prefixed with an underscore.

Underscores for C identifiers are optional, but on by default. You can turn them off with -u-. However, if you are using the standard Turbo C libraries, you will then encounter problems unless you rebuild the
libraries. (To do this, you will need the Turbo C Run-Time Library Source Code; contact Borland International for more information.)


Note: Unless you are an expert, don't use -u-.

-y Includes line numbers in the object file for use by a symbolic debugger. This increases the size of the object file but will not affect size or speed of the executable program.

This option is only useful in concert with a symbolic debugger that can use the information.

Optimization Options

-G Causes the compiler to bias its optimization in favor of speed over size.

-O Optimizes by eliminating redundant jumps, and reorganizing loops and switch statements.

-r- Suppresses the use of register variables.

When you are using the -r- option, the compiler will not use register variables, and it also will not preserve register variables (SI,DI) from any caller. For that reason, you should not have code that uses register variables call code which has been compiled with -r-. On the other hand, if you are interfacing with existing assembly-language code that does not preserve SI,DI, the -r- option will allow you to call that code for Turbo C.

-r Enables the use of register variables (the default).

-Z Suppresses redundant load operations by remembering the contents of registers and reusing them as often as possible.

Note: You should exercise caution when using this option, because the compiler cannot detect if a register has been invalidated indirectly by a pointer.

For example, if a variable A is loaded into register DX, it is retained. If A is later assigned a value, the value of DX is reset to indicate that its contents are no longer current. Unfortunately, if the value of A is modified indirectly (by assigning through a pointer that points to A),
Turbo C will not catch this and will continue to remember that DX contains the (now obsolete) value of A.

The \(-z\) optimization is designed to suppress register loads when the value being loaded is already in a register. This can eliminate whole instructions and also convert instructions from referring to memory locations to using registers instead.

The following artificial sequence illustrates both the benefits and the drawbacks of this optimization, and demonstrates why you need to exercise caution when using \(-z\).

```c
func()
{
    int A, *P, B;
    A = 4;
    ...
    B = A;
    P = &A;
    *P = B + 5;
    printf("%d\n", A);
}
```

<table>
<thead>
<tr>
<th>C Code</th>
<th>Optimized Assembler</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mov A, 4</td>
</tr>
<tr>
<td></td>
<td>mov ax, a</td>
</tr>
<tr>
<td></td>
<td>mov B, ax</td>
</tr>
<tr>
<td></td>
<td>lea bx, A</td>
</tr>
<tr>
<td></td>
<td>mov P, bx</td>
</tr>
<tr>
<td></td>
<td>mov dx, ax</td>
</tr>
<tr>
<td></td>
<td>add dx, 5</td>
</tr>
<tr>
<td></td>
<td>mov [bx], dx</td>
</tr>
<tr>
<td></td>
<td>push ax</td>
</tr>
</tbody>
</table>

Note first that on the statement \(*P = B + 5\), the code generated uses a move from \(ax\) to \(dx\) first. Without the \(-z\) optimization, the move would be from \(B\), generating a longer and slower instruction.

Second, the assignment into \(*P\) recognizes that \(P\) is already in \(bx\), so a move from \(P\) to \(bx\) after the \(add\) instruction has been eliminated. These improvements are harmless and generally useful.

The call to \(printf\), however, is not correct. Turbo C sees that \(ax\) contains the value of \(A\), and so pushes the contents of the register rather than the contents of the memory location. The \(printf\) will then display a value of 4 rather than the correct value of 9. The indirect assignment through \(P\) has hidden the change to \(A\).
If the statement \( *P = B + 5 \) had been written as \( A = B + 5 \), Turbo C would recognize a change in value.

The contents of registers are forgotten whenever a function call is made or when a point is reached where a jump could go (such as a label, a case statement, or the beginning or end of a loop). Because of this limit and the small number of registers in the 8086 family of processors, most programs using this optimization will never behave incorrectly.

**Source Options**

- **-A** Creates ANSI-compatible code: Any of the Turbo C extension keywords are ignored and may be used as normal identifiers. These keywords include:

  ```
  near  far  huge  cdecl
  asm  pascal  interrupt  _cs  _ss
  _es  _ds
  ```

  and the register pseudo-variables, such as \_AX, \_BX, \_SI, etc.

- **-C** Allows nesting of comments. Comments may not normally be nested.

- **-i#** Causes the compiler to recognize only the first # characters of identifiers. All identifiers, whether variables, preprocessor macro names, or structure member names, are treated as distinct only if their first # characters are distinct.

By default, Turbo C uses 32 characters per identifier. Other systems, including UNIX, ignore characters beyond the first 8. If you are porting to these other environments, you may wish to compile your code with a smaller number of significant characters. Compiling in this manner will help you see if there are any name conflicts in long identifiers when they are truncated to a shorter significant length.

**Errors Options**

- **-g#** Stops compiling after # messages (warning and error messages combined).

- **-j#** Stops compiling after # error messages.
-wxxx Enables the warning message indicated by xxx. The option -w-xxx suppresses the warning message indicated by xxx. The possible values for -wxxx are as follows:

(ANSI Violations)

-wdup Redefinition of ‘XXXXXXXX’ is not identical.
-wret Both return and return of a value used.
-wstr ‘XXXXXXXX’ not part of structure.
-wstu Undefined structure ‘XXXXXXXX’.
-wsus Suspicious pointer conversion.
-wvoi Void functions may not return a value.
-wzst Zero length structure.

(Common Errors)

-waus ‘XXXXXXXX’ is assigned a value that is never used.
-wdef Possible use of ‘XXXXXXXX’ before definition.
-weff Code has no effect.
-wpar Parameter ‘XXXXXXXX’ is never used.
-wpia Possibly incorrect assignment.
-wrch Unreachable code.
-wrvl Function should return a value.

(Less Common Errors)

-wamb Ambiguous operators need parentheses.
-wamp Superfluous & with function or array.
-wnod No declaration for function ‘XXXXXXXX’.
-wpro Call to function with no prototype.
-wstv Structure passed by value.
-wuse ‘XXXXXXXX’ declared but never used.

(Portability Warnings)

-wapt Non-portable pointer assignment.
-wcln Constant is long.
-wcpt Non-portable pointer comparison.
-wdgn Constant out of range in comparison.
-wrpt Non-portable return type conversion.
-wsig Conversion may lose significant digits.
-wucp Mixing pointers to signed and unsigned char.
**Segment-Naming Control**

- **-zAname**  Changes the name of the code segment class to *name*. By default, the code segment is assigned to class _CODE.

- **-zBname**  Changes the name of the uninitialized data segments class to *name*. By default, the uninitialized data segments are assigned to class _BSS.

- **-zCname**  Changes the name of the code segment to *name*. By default, the code segment is named _TEXT, except for the medium, large and huge models, where the name is *filename* TEXT. (*filename* here is the source file name).

- **-zDname**  Changes the name of the uninitialized data segment to *name*. By default, the uninitialized data segment is named _BSS, except in the huge model where no uninitialized data segment is generated.

- **-zGname**  Changes the name of the uninitialized data segments group to *name*. By default, the data group is named DGROUP, except in the huge model where there is no data group. This switch is ignored in the huge model.

- **-zPname**  Causes any output files to be generated with a code group for the code segment named *name*. This option should not be used with the tiny model.

- **-zRname**  Sets the name of the initialized data segment to *name*. By default, the initialized data segment is named _DATA except in the huge model where the segment is named *filename* DATA.

- **-zSname**  Changes the name of the initialized data segments group to *name*. By default, the data group is named DGROUP, except in the huge model, where there is no data group. This switch is ignored in the huge model.

- **-zTname**  Sets the name of the initialized data segment class to *name*. By default the initialized data class segment is named _DATA.

- **-zX***  Uses the default name for X: for example, -zA* assigns the default class name _CODE to the code segment.

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Compilation Control Options

-\texttt{B} Compiles and calls the assembler to process in-line assembly code.

\textit{Note that this option is not available in the Integrated Environment (TC.EXE).}

-\texttt{c} Compiles and assembles the named .C and .ASM files, but does not execute a link command.

-\texttt{ofilename} Compiles the named file to the specified filename.OBJ.

-\texttt{S} Compiles the named source files and produces assembly language output files (.ASM), but does not assemble.

\textit{Note that this option is not available in the Integrated Environment (TC.EXE).}

Linker Options

-\texttt{efilename} Derives the executable program's name from filename by adding .EXE (the program name will then be FILENAME.EXE). filename must immediately follow the -e, with no intervening whitespace. Without this option, the linker derives the .EXE file's name from the name of the first source or object file in the file name list.

-\texttt{M} Forces the linker to produce a full link map. The default is to produce no link map.

Environment Options

-\texttt{ldirectory} Searches directory, the drive specifier or path name of a subdirectory, for include files (in addition to searching the standard places). A drive specifier is a single letter, either uppercase or lowercase, followed by a colon (:). A directory is any valid path name of a directory file. Multiple -I directory options can be given.

-\texttt{ldirectory} Forces the linker to get the C0x.OBJ start-up object file and the Turbo C library files (Cx.LIB, MATHx.LIB, EMU.LIB, and
FP87.LIB) from the named directory. By default, the linker looks for them in the current directory.

--nxxx Places any .OBJ or .ASM files created by the compiler in the directory or drive named by the path xxx.
Turbo C Utilities

Your Turbo C package supplies much more than just two versions of the fastest C compiler available. It also provides three powerful stand-alone utilities. You can use these stand-alone utilities with your Turbo C files as well as with your other modules.

These three highly useful adjuncts to Turbo C are CPP (the Turbo C Preprocessor), MAKE, and TLINK (the Turbo Linker).

This appendix explains what each utility is and illustrates, with code and command-line examples, how to use them. The Turbo C stand-alone utilities are discussed in the following order:

CPP
MAKE
TLINK

CPP: The Turbo C Preprocessor Utility

The CPP utility is a utility that augments the Turbo C compiler. CPP is not needed for normal compilations of C programs at all; its purpose is to produce a listing file of a C source program in which include files and define macros have been expanded.

Often, when the compiler reports an error inside a macro or an include file, you can get more information about what the error is if you can see the results of the macro expansions or the include files. In many multi-pass
compilers a separate pass is responsible for performing that work and the results of that pass can be examined.

Since Turbo C uses an integrated single-pass compiler, CPP supplies the first-pass functionality found in other compilers. In addition, you can use CPP as a macro preprocessor.

You use CPP like you would use TCC, the stand-alone compiler. CPP reads the same TURBOC.CFG file for default options, and accepts the same command-line options as TCC.

The TCC options that don't pertain to CPP are simply ignored by CPP. To see the list of arguments handled by CPP, type

```cpp
cpp
```
at the DOS prompt.

With one exception, the file names listed on the CPP command line are treated like they are in TCC, with wildcards allowed. The exception to this is that all files are treated as C source files. There is no special treatment for .OBJ, .LIB, or .ASM files.

For each file processed by CPP, the output is written to a file in the current directory (or the output directory named by the `-n` option) with the same name as the source name but with an extension of `.i`.

This output file is a text file containing each line of the source file and any include files. Any preprocessing directive lines have been removed, along with any conditional text lines excluded from the compile. Text lines are prefixed with the file name and line number of the source or include file the line came from. Within a text line, any macros are replaced with their expansion text.

Subsequently, the resulting output of CPP cannot be compiled because of the file name and line number prefix attached to each source line.

**CPP as a Macro Preprocessor**

The `-P` option to CPP tells it to prefix each line with the source file name and line number. If `-P-` is given, however, CPP omits this line number information. With this option turned off, CPP can be used as a macro preprocessor; the resultant `.i` file can then be compiled with TC or TCC.
**An Example**

The following simple program illustrates how CPP preprocesses a file, first with \(-P\) selected, then with \(-P-\).

**Source file: HELLOJOE.C**

```c
/* This is an example of the output of CPP */
#define NAME "Joe Smith"
#define BEGIN {
#define END }

main() BEGIN
  printf("%s\\n", NAME);
END
```

**Command Line Used to Invoke CPP as a Preprocessor:**

```
cpp hellojoe.c
```

**Output:**

```
hellojoe.c 2:
hellojoe.c 3:
hellojoe.c 4:
hellojoe.c 6: main()
hellojoe.c 7:
  printf("%s\\n","Joe Smith");
hellojoe.c 9: }
```

**Command Line Used to Invoke CPP as a Macro Preprocessor:**

```
cpp -P- hellojoe.c
```

**Output:**

```
main()
{
  printf("%s\\n","Joe Smith");
}
```
The Stand-Alone MAKE Utility

Turbo C places a great deal of power and flexibility at your fingertips. You can use it to manage large, complex programs that are built from numerous header, source, and object files. Unfortunately, that same freedom requires that you remember which files are required to produce other files. Why? Because if you make a change in one file, you must then do all the necessary recompilation and linking. One solution, of course, is simply to recompile everything each time you make a change—but as your program grows in size, that becomes more and more time consuming. So what do you do?

The answer is simple: you use MAKE. Turbo C’s MAKE is an intelligent program manager that—given the proper instructions—does all the work necessary to keep your program up-to-date. In fact, MAKE can do far more than that. It can make backups, pull files out of different subdirectories, and even automatically run your programs should the data files that they use be modified. As you use MAKE more and more, you’ll see new and different ways it can help you to manage your program development.

MAKE is a stand-alone utility; it is different from Project-Make, which is part of the Integrated Environment.

In this section we describe how to use stand-alone MAKE with TCC and TLINK.

A Quick Example

Let’s start off with an example to illustrate MAKE’s usefulness. Suppose you’re writing some programs to help you display information about nearby star systems. You have one program—GETSTARS—that reads in a text file listing star systems, does some processing on it, then produces a binary data file with the resulting information in it.

GETSTARS uses certain definitions, stored in STARDEFS.H, and certain routines, stored in STARLIB.C (and declared in STARLIB.H). In addition, the program GETSTARS itself is broken up into three files:

- GSPARSE.C
- GSCOMP.C
GETSTARS.C

The first two files, GSPARSE and GSCOMP, have corresponding header files (GSPARSE.H and GSCOMP.H). The third file, GETSTARS.C has the main body of the program. Of the three files, only GSCOMP.C and GETSTARS.C make use of the STARLIB routines.

Here are the custom header files (other than the Turbo C headers that declare standard run-time library routines) needed by each .C file:

<table>
<thead>
<tr>
<th>.C File</th>
<th>Custom Header File(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>STARLIB.C</td>
<td>none</td>
</tr>
<tr>
<td>GSPARSE.C</td>
<td>STARDEFS.H</td>
</tr>
<tr>
<td>GSCOMP.C</td>
<td>STARDEFS.H, STARLIB.H</td>
</tr>
<tr>
<td>GETSTARS.C</td>
<td>STARDEFS.H, STARLIB.H, GSPARSE.H, GSCOMP.H</td>
</tr>
</tbody>
</table>

To produce GETSTARS.EXE (assuming a medium data model), you would enter the following command lines:

tcc -c -mm -f starlib
  tcc -c -mm -f gsparse
  tcc -c -mm -f gscomp
  tcc -c -mm -f getstars
  tlink lib\emu starlib gsparse gscomp getstars,
    getstars, getstars, lib\emu lib\mathm lib\cm

Note: DOS requires that the TLINK command line all fit on one line: we show it here as two lines simply because the page isn’t wide enough to fit it all in one line.

Looking at the preceding information, you can see some file dependencies.

- GSPARSE, GSCOMP, and GETSTARS all depend on STARDEFS.H; in other words, if you make any changes to STARDEFS.H, then you’ll have to recompile all three.
- Likewise, any changes to STARLIB.H will require GSCOMP and GETSTARS to be recompiled.
- Changes to GSPARSE.H means GETSTARS will have to be recompiled; the same is true of GSCOMP.H.
- Of course, any changes to any source code file (STARLIB.C, GSPARSE.C, etc.) means that file must be recompiled.
- Finally, if any recompiling is done, then the link has to be done again.

Quite a bit to keep track of, isn’t it? What happens if you make a change to STARLIB.H, recompile GETSTARS.C, but forget to recompile GSCOMP.C?
You could make a .BAT file to do the four compilations and the one linkage given above, but you’d have to do them every time you made a change. Let’s see how MAKE can simplify things for you.

Creating a Makefile

A makefile is just a combination of the two lists just given: dependencies and the commands needed to satisfy them.

For example, let’s take the lists given, combine them, massage them a little, and produce the following:

```makefile
getstars.exe: getstars.obj gscomp.obj gsparse.obj starlib.obj
tlink lib\c0m starlib gsparse gscomp getstars, getstars, \
              getstars, lib\emu lib\mathm lib\cm
getstars.obj: getstars.c stardefs.h starlib.h gscomp.h gsparse.h
tcc -c -mm -f getstars.c

gscomp.obj: gscomp.c stardefs.h starlib.h
tcc -c -mm -f gscomp.c

gsparse.obj: gsparse.c stardefs.h
tcc -c -mm -f gsparse.c

starlib.obj: starlib.c
tcc -c -mm -f starlib.c
```

This just restates what was said before, but with the order reversed somewhat. Here’s how MAKE interprets this file:

- The file GETSTARS.EXE depends on four files: GETSTARS.OBJ, GSCOMP.OBJ, GSPARSE.OBJ, and STARLIB.OBJ. If any of those four change, then GETSTARS.EXE must be recompiled. How? By using the TLINK command given.
- The file GETSTARS.OBJ depends on five files: GETSTARS.C, STARDEFS.H, STARLIB.H, GS_COMP.H, and GSPARSE.H. If any of those files change, then GETSTARS.OBJ must be recompiled by using the TCC command given.
- The file GS_COMP.OBJ depends on three files—GS_COMP.C, STARDEFS.H, and STARLIB.H—and if any of those three change, GS_COMP.OBJ must be recompiled using the TCC command given.
- The file GSPARSE.OBJ depends on two files—GSPARSE.OBJ and STARDEFS.H—and, again, must be recompiled using the TCC command given if either of those files change.
The file STARLIB.OBJ depends on only one file—STARLIB.C—and must be recompiled via TCC if STARLIB.C changes.

What do you do with this? Type it into a file, which (for now) we’ll call MAKEFILE. You’re then ready to use MAKE.EXE.

Using a Makefile

Assuming you’ve created MAKEFILE as described above—and, of course, assuming that the various source code and header files exist—then all you have to do is type the command:

```
make
```

Simple, wasn’t it? MAKE looks for MAKEFILE (you can call it something else; we’ll talk about that later) and reads in the first line, describing the dependencies of GETSTARS.EXE. It checks to see if GETSTARS.EXE exists and is up-to-date.

This requires that it check the same thing about each of the files upon which GETSTARS.EXE depends: GETSTARS.OBJ, GSCOMP.OBJ, GSPARSE.OBJ, and STARLIB.OBJ. Each of those files depends, in turn, on other files, which must also be checked. The various calls to TCC are made as needed to update the .OBJ files, ending with the execution of the TLINK command (if necessary) to create an up-to-date version of GETSTARS.EXE.

What if GETSTARS.EXE and all the .OBJ files already exist? In that case, MAKE compares the time and date of the last modification of each .OBJ file with the time and date of its dependencies. If any of the dependency files are more recent than the .OBJ file, MAKE knows that changes have been made since the last time the .OBJ file was created and executes the TCC command.

If MAKE does update any of the .OBJ files, then when it compares the time and date of GETSTARS.EXE with them, it sees that it must execute the TLINK command to make an updated version of GETSTARS.EXE.

Stepping Through

Here’s a step-by-step example to help clarify the previous description. Suppose that GETSTARS.EXE and all the .OBJ files exist, and that GETSTARS.EXE is more recent than any of the .OBJ files, and, likewise, each .OBJ file is more recent than any of its dependencies.
If you then enter the command

    make

nothing happens, since there is no need to update anything.

Now, suppose that you modify STARLIB.C and STARLIB.H, changing, say, the value of some constant. When you enter the command

    make

MAKE sees that STARLIB.C is more recent than STARLIB.OBJ, so it issues the command

    tcc -c -mm -f starlib.c

It then sees that STARLIB.H is more recent than GSCOMP.OBJ, so it issues the command

    tcc -c -mm -f gscomp.c

STARLIB.H is also more recent than GETSTARS.OBJ, so the next command is

    tcc -c -mm -f getstars.c

Finally, because of these three commands, the files STARLIB.OBJ, GSCOMP.OBJ, and GETSTARS.OBJ are all more recent than GETSTARS.EXE, so the final command issued by MAKE is

    tlink lib\c0m starlib gsparse gscomp getstars, getstars, getstars, lib\emu lib\mathm lib\cm

which links everything together and creates a new version of GETSTARS.EXE. (Note that this TLINK command line must actually be one line.)

You have a good idea of the basics of MAKE: what it's for, how to create a makefile, and how MAKE interprets that file. Let's now look at MAKE in more detail.
Creating Makefiles

A makefile contains the definitions and relationships needed to help MAKE keep your program(s) up-to-date. You can create as many makefiles as you want and name them whatever you want; MAKEFILE is just the default name that MAKE looks for if you don’t specify a makefile when you run MAKE.

You create a makefile with any ASCII text editor, such as Turbo C’s built-in interactive editor. All rules, definitions, and directives end with a newline; if a line is too long (such as the TLINK command in the previous example), you can continue it to the next line by placing a backslash (\) as the last character on the line.

Whitespace—blanks and tabs—is used to separate adjacent identifiers (such as dependencies) and to indent commands within a rule.

Components of a Makefile

Creating a makefile is almost like writing a program, with definitions, commands, and directives. Here’s a list of the constructs allowed in a makefile:

- comments
- explicit rules
- implicit rules
- macro definitions
- directives: file inclusion, conditional execution, error detection, macro definition

Let’s look at each of these in more detail.

Comments Comments begin with a sharp (#) character; the rest of the line following the # is ignored by MAKE. Comments can be placed anywhere and never have to start in a particular column.

A backslash (\) will not continue a comment onto the next line; instead, you must use a # on each line. In fact, you cannot use a backslash as a continuation character in a line that has a comment. If it precedes the #, it is no longer the last character on the line; if it follows the #, then it is part of the comment itself.
Here are some examples of comments in a makefile:

```makefile
# makefile for GETSTARS.EXE
# does complete project maintenance
getstars.exe: getstars.obj gscomp.obj gsparse.obj starlib.obj
# can't put a comment at the end of the next line
tlink lib\cOm starlib gsparse gscomp getstars, getstars,
getstars, lib\emu lib\mathm lib\cm
# legal comment
# can't put a comment between the next two lines
getstars.obj: getstars.c stardefs.h starlib.h gscomp.h gsparse.h
tcc -c -mm -f getstars.c # you can put a comment here
```

**Explicit Rules**

You are already familiar with explicit rules, since those are what you used in the makefile example given earlier. Explicit rules take the form

```
target [target ...]: [source source ...]
[command]
[command]
```

where `target` is the file to be updated, `source` is a file upon which `target` depends, and `command` is any valid MS-DOS command (including invocation of .BAT files and execution of .COM and .EXE files).

Explicit rules define one or more target names, zero or more source files, and an optional list of commands to be performed. Target and source file names listed in explicit rules can contain normal MS-DOS drive and directory specifications, but they cannot contain wildcards.

Syntax here is important. `target` must be at the start of a line (in column 1), whereas each `command` must be indented, (must be preceded by at least one blank or tab). As mentioned before, the backslash (\) can be used as a continuation character if the list of source files or a given command is too long for one line. Finally, both the source files and the commands are optional; it is possible to have an explicit rule consisting only of `target [target ...]` followed by a colon.

The idea behind an explicit rule is that the command or commands listed will create or update `target`, usually using the `source` files. When MAKE encounters an explicit rule, it first checks to see if any of the `source` files are themselves target files elsewhere in the makefile. If so, then those rules are evaluated first.

Once all the `source` files have been created or updated based on other explicit (or implicit) rules, MAKE checks to see if `target` exists. If not, each
command is invoked in the order given. If target does exist, its time and date of last modification are compared against the time and date for each source. If any source has been modified more recently than target, the list of commands is executed.

A given file name can occur on the left side of an explicit rule only once in a given execution of MAKE.

Each command line in an explicit rule begins with whitespace. MAKE considers all lines following an explicit rule to be part of the command list for that rule, up to the next line that begins in column 1 (without any preceding whitespace) or to the end of the file. Blank lines are ignored.

Special Considerations

An explicit rule with no command lines following it is treated a little differently than an explicit rule with command lines.

- If an explicit rule exists for a target with commands, the only files that the target depends on are the ones listed in the explicit rule.
- If an explicit rule has no commands, the targets depend on the files given in the explicit rule, and they also depend on any file that matches an implicit rule for the target(s).

See the following section for a discussion of implicit rules.

Examples

Here are some examples of explicit rules:

```
myprog.obj: myprog.c
  tcc -c myprog.c

prog2.obj: prog2.c include\stdio.h
  tcc -c -K prog2.c

prog.exe: myprog.c prog2.c include\stdio.h
  tcc -c myprog.c
  tcc -c -K prog2.c
  tlink lib\c0s myprog prog2, prog, , lib\cs
```

- The first explicit rule states that MYPROG.OBJ depends upon MYPROG.C, and that MYPROG.OBJ is created by executing the given TCC command.
- Similarly, the second rule states that PROG2.OBJ depends upon PROG2.C and STDIO.H (in the INCLUDE subdirectory) and is created by the given TCC command.
The last rule states that PROG.EXE depends on MYPROG.C, PROG2.C, and STIOIO.H, and that should any of the three change, PROG.EXE can be rebuilt by the series of commands given. However, this may create unnecessary work, because, even if only MYPROG.C changes, PROG2.C will still be recompiled. This occurs because all of the commands under a rule will be executed as soon as that rule’s target is out of date.

If you place the explicit rule

```
prog.exe: myprog.obj prog2.obj
tlink lib\cs myprog prog2, prog, , lib\cs
```

as the first rule in a makefile and follow it with the rules given (for MYPROG.OBJ and PROG2.OBJ), only those files that need to be recompiled will be.

**Implicit Rules**

MAKE allows you to define implicit rules as well. Implicit rules are generalizations of explicit rules. What do we mean by that?

Here’s an example that illustrates the relationship between the two types of rules: consider this explicit rule from the previous sample program:

```
starlib.obj: starlib.e
  tcc -c -mm -f starlib.e
```

This rule is a common one, because it follows a general principle: an .OBJ file is dependent on the .C file with the same file name and is created by executing TCC. In fact, you might have a makefile where you have several (or even several dozen) explicit rules following this same format.

By redefining the explicit rule as an implicit rule, you can eliminate all the explicit rules of the same form. As an implicit rule, it would look like this:

```
.c.obj:
  tcc -c -mm -f $<
```

This rule means, “any file ending with .OBJ depends on the file with the same name that ends in .C, and the .OBJ file is created using the command

```
tcc -c -mm -f $<
```

where $< represents the file’s name with the source (.C) extension.” (The symbol $< is a special macro and is discussed in the next section.)
The syntax for an implicit rule is:

```
.source_extension.target_extension:
  {command}
  {command}
  ...
```

where, as before, the commands are optional and must be indented.

The `source_extension` (which must begin in column 1) is the extension of the source file; that is, it applies to any file having the format

```
fname.source_extension
```

Likewise, the `target_extension` refers to the the file

```
fname.target_extension
```

where `fname` is the same for both files. In other words, this implicit rule replaces all explicit rules having the format:

```
fname.target_extension: fname.source_extension
  {command}
  {command}
  ...
```

for any `fname`.

Implicit rules are used if no explicit rule for a given target can be found, or if an explicit rule with no commands exists for the target.

The extension of the file name in question is used to determine which implicit rule to use. The implicit rule is applied if a file is found with the same name as the target, but with the mentioned source extension.

For example, suppose you had a makefile (named MAKEFILE) whose contents were

```
.c.obj:
tcc -c -ms -f $<
```

If you had a C program named RATIO.C that you wanted to compile to RATIO.OBJ, you could use the command

```
make ratio.obj
```
MAKE would take RATIO.OBJ to be the target. Since there is no explicit rule for creating RATIO.OBJ, MAKE applies the implicit rule and generates the command

```
tcc -c -ms -f ratio.c
```

which, of course, does the compile step necessary to create RATIO.OBJ.

Implicit rules are also used if an explicit rule is given with no commands. Suppose, as mentioned before, you had the following implicit rule at the start of your makefile:

```
.o.obj:
tcc -c -mm -f $<
```

You could then rewrite the last several explicit rules as follows:

```
getstars.obj: stardefs.h starlib.h gseomp.h gsparse.h
gcomp.obj: stardefs.h starlib.h
gsparse.obj: stardefs.h
```

Since you don't have explicit information on how to create these .OBJ files, MAKE applies the implicit rule defined earlier. And since STARLIB.OBJ depends only on STARLIB.C, that rule was dropped altogether from this list; MAKE automatically applies it.

Several implicit rules can be written with the same target extension, but only one such rule can apply at a time. If more than one implicit rule exists for a given target extension, each rule is checked in the order the rules appear in the makefile, until all applicable rules are checked.

MAKE uses the first implicit rule that discovers a file with the source extension. Even if the commands of that rule fail, no more implicit rules are checked.

All lines following an implicit rule are considered to be part of the command list for the rule, up to the next line that begins without whitespace or to the end of the file. Blank lines are ignored. The syntax for a command line is provided later in this chapter.

**Special Considerations**

Unlike explicit rules, MAKE does not know the full file name with an implicit rule. For that reason, special macros are provided with MAKE that allow you to include the name of the file being built by the rule. (See the discussion of macro definitions in this section for details.)
Examples

Here are some examples of implicit rules:

```
.c.obj:
tcc -c $<

.asm.obj:
masm $* /mx;
```

In the first implicit rule example, the target files are .OBJ files and their source files are .C files. This example has one command line in the command list; command line syntax is covered later in this section.

The second example directs MAKE to assemble a given file from its .ASM source file, using MASM with the /mx option.

**Command Lists**

We've talked about both explicit and implicit rules, and how they can have lists of commands. Let’s talk about those commands and your options in setting them up.

Commands in a command list must be indented—that is, preceded by at least one blank or tab—and take the form

```
[ prefix ... ] command_body
```

Each command line in a command list consists of an (optional) list of prefixes, followed by a single command body.

**Prefix**

The prefixes allowed in a command modify the treatment of these commands by MAKE. The prefix is either the at (@) symbol or a hyphen (-) followed immediately by a number.

@ Forces MAKE to not display the command before executing it. The display is hidden even if the -s option was not given on the MAKE command line. This prefix applies only to the command on which it appears.
-num Affects how MAKE treats exit codes. If a number (num) is provided, then MAKE will abort processing only if the exit status exceeds the number given. In this example, MAKE will abort only if the exit status exceeds 4:

-4 myprog sample.x

If no -num prefix is given, MAKE checks the exit status for the command. If the status is non-zero, MAKE will stop and delete the current target file.

- With a dash, but no number, MAKE will not check the exit status at all. Regardless of what the exit status was, MAKE will continue.

Command body

The command body is treated exactly as it would be if it were entered as a line to COMMAND.COM, with the exception that redirection and pipes are not supported.

MAKE executes the following built-in commands by invoking a copy of COMMAND.COM to perform them:

- break  
- cd  
- chdir  
- cls  
- copy  
- ctty  
- date  
- del  
- dir  
- erase  
- md  
- mkdir  
- path  
- prompt  
- ren  
- rename  
- set  
- time  
- type  
- ver  
- verify  
- vol

MAKE searches for any other command name using the MS-DOS search algorithm:

- The current directory is searched first, followed by each directory in the path.
- In each directory, first a file with the extension .COM is checked, then a .EXE, and finally a .BAT.
- If a .BAT file is found, a copy of COMMAND.COM is invoked to execute the batch file.

Obviously, if an extension is supplied in the command line, MAKE searches only for that extension.
Examples

This command will cause COMMAND.COM to execute the command:

    cd c:\include

This command will be searched for using the full search algorithm:

    tlink lib\c0s x y,z,z,lib\cs

This command will be searched for using only the .COM extension:

    myprog.com geo.xyz

This command will be executed using the explicit file name provided:

    c:\myprogs\fil.exe -r

Macros

Often certain commands, file names, or options are used again and again in your makefile. In the example at the start of this appendix, all of the TCC commands used the switch \-mm, which means to compile to the medium memory model; likewise, the TLINK command used the files C0M.OBJ, MATHM.LIB, and CM.LIB. Suppose you wanted to switch to the large memory model; what would you do? You could go through and change all the \-mm options to \-ml, and rename the appropriate files in the TLINK command. Or, you could define a macro.

A macro is a name that represents some string of characters. A macro definition gives a macro name and the expansion text; thereafter, when MAKE encounters the macro name, it replaces the name with the expansion text.
Suppose you defined the following macro at the start of your makefile:

    MDL=m

You’ve defined the macro MDL, which is equivalent to the string m. You could now rewrite the makefile as follows:

    MDL=m

    getstars.exe: getstars.obj gscomp.obj gsparse.obj starlib.obj

    
    tlink lib\c0$(MDL) starlib gsparse gscomp getstars, \
    getstars, getstars, lib\emu lib\math$(MDL) lib\c$(MDL)

    getstars.obj: getstars.c stardefs.h starlib.h gscomp.h gsparse.h

    
    tcc -c -m$(MDL) getstars.c

    gscomp.obj: gscomp.c stardefs.h starlib.h

    
    tcc -c -m$(MDL) gscomp.c

    gsparse.obj: gsparse.c stardefs.h

    
    tcc -c -m$(MDL) gsparse.c

    starlib.obj: starlib.c

    
    tcc -c -m$(MDL) starlib.c

Everywhere a model is specified, you use the macro invocation $(MDL). When you run MAKE, $(MDL) is replaced with its expansion text, m. The result is the same set of commands you had before.

So, what have you gained? Flexibility. By changing the first line to

    MDL=l

you’ve changed all the commands to use the large memory model. In fact, if you leave out the first line altogether, you can specify which memory model you want each time you run MAKE, using the -D (Define) option:

    make -DMDL=l

This tells MAKE to treat MDL as a macro with the expansion text l.

**Defining Macros**

Macro definitions take the form

    macro_name=expansion text
where \textit{macro\_name} is the name of the macro: a string of letters and digits with no whitespace in it, though you can have whitespace between \textit{macro\_name} and the equals sign (=). The \textit{expansion text} is any arbitrary string containing letters, digits, whitespace, and punctuation; it is ended by newline.

If \textit{macro\_name} has previously been defined, either by a macro definition in the makefile or by the -D option on the MAKE command line, the new definition replaces the old.

Case is significant in macros; that is, the macros names mdl, Mdl, and MDL are all considered different.

\section*{Using Macros}

Macros are invoked in your makefile with the format

\begin{verbatim}
$(macro\_name)
\end{verbatim}

The parentheses are required for all invocations, even if the macro name is just one character long, with the exception of three special predefined macros that we'll talk about in just a minute. This construct—\begin{verbatim}$ (macro\_name)$\end{verbatim}—is known as a \textit{macro invocation}.

When MAKE encounters a macro invocation, it replaces the invocation with the macro’s expansion text. If the macro is not defined, MAKE replaces it with the null string.

\section*{Special Considerations}

\textbf{Macros in macros:} Macro cannot be invoked on the left (\textit{macro\_name}) side of a macro definition. They can be used on the right (\textit{expansion text}) side, but they are not expanded until the macro being defined is invoked. In other words, when a macro invocation is expanded, any macros embedded in its expansion text are also expanded.

\textbf{Macros in rules:} Macro invocations are expanded immediately in rule lines.

\textbf{Macros in directives:} Macro invocations are expanded immediately in \texttt{!if} and \texttt{!elif} directives. If the macro being invoked in an \texttt{!if} or \texttt{!elif} directive is not currently defined, it is expanded to the value 0 (FALSE).

\textbf{Macros in commands:} Macro invocations in commands are expanded when the command is executed.
Predefined Macros

MAKE comes with several special macros built in: $d$, $*$, $<$, $:$, $.$, and $&$. The first is a defined test macro, used in the conditional directives !if and !elif; the others are file name macros, used in explicit and implicit rules. In addition, the current SET environment strings are automatically loaded as macros, and the macro __MAKE__ is defined to be 1 (one).

Defined Test Macro ($d$) The defined test macro $d$ expands to 1 if the given macro name is defined, or to 0 if it is not. The content of the macro's expansion text does not matter. This special macro is allowed only in !if and !elif directives.

For example, suppose you wanted to modify your makefile so that it would use the medium memory model if you didn't specify one, you could put this at the start of your makefile:

```
! if !$d(MDL)
    MDL=m
!endif
```

If you invoke MAKE with the command line

`make -DMDL=l`

then MDL is defined as 1. If, however, you just invoke MAKE by itself:

`make`

then MDL is defined as m, your "default" memory model.

Various File Name Macros

The various file name macros work in similar ways, expanding to some variation of the full path name of the file being built:

**Base File name Macro ($*$$*)**

The base file name macro is allowed in the commands for an explicit or an implicit rule. This macro ($) expands to the file name being built, excluding any extension, like this:

File name is A:\P\TESTFILE.C

$* expands to A:\P\TESTFILE
For example, you could modify the explicit GETSTARS.EXE rule already
given to look like this:

```
getstars.exe: getstars.obj gscomp.obj gsparse.obj starlib.obj
tlink lib\c0$(MDL) starlib gsparse gacomp $*, $*, $*, 
   lib\emu lib\math$<$(MDL) lib\c$(MDL)
```

When the command in this rule is executed, the macro $* is replaced by the
target file name (sans extension), getstars. For implicit rules, this macro is
very useful.

For example, an implicit rule for Tee might look like this (assuming that
the macro MDL has been or will be defined, and that you are not using
floating point routines):

```
.c.obj:
tcc -c $*
```

**Full File name Macro ($<)**

The full file name macro ($<) is also used in the commands for an explicit
or implicit rule. In an explicit rule, $< expands to the full target file name
(including extension), like this:

```
File name is A:\P\TESTFILE.C
$< expands to A:\P\TESTFILE.C
```

For example, the rule

```
starlib.obj: starlib.c
copy $< \oldobjs
tcc -c $*
```

will copy STARLIB.OBJ to the directory \OLDOBJS before compiling
STARLIB.C.

In an implicit rule, $< takes on the file name plus the source extension. For
example, the previous implicit rule

```
.obj.c:
tcc -c *.c
```

can be rewritten as

```
.obj.c:
tcc -c $<
```
File Name Path Macro ($:)  
This macro expands to the path name (without the file name), like this:

File name is A:\P\TESTFILE.C
$: expands to A:\P\

File Name and Extension Macro ($.)  
This macro expands to the file name, with extension, like this:

File name is A:\P\TESTFILE.C
$. expands to TESTFILE.C

File Name Only Macro ($&)  
This macro expands to the file name only, without path or extension, like this:

File name is A:\P\TESTFILE.C
$& expands to TESTFILE

Directives  
Turbo C's MAKE allows something that other versions of MAKE don't: directives similar to those allowed for C itself. You can use these directives to include other makefiles, to make the rules and commands conditional, to print out error messages, and to "undefine" macros.

Directives in a makefile begin with an exclamation point (!) as the first character of the line, unlike C, which uses the sharp character (#). Here is the complete list of MAKE directives:

!include
!if
!else
!elif
!endif
!error
!undef

File-Inclusion Directive  
A file-inclusion directive (!include) specifies a file to be included into the makefile for interpretation at the point of the directive. It takes the following form:

!include " filename "
These directives can be nested arbitrarily deep. If an include directive attempts to include a file that has already been included in some outer level of nesting (so that a nesting loop is about to start), the inner include directive is rejected as an error.

How do you use this directive? Suppose you created the file MODEL.MAC which contained the following:

```plaintext
!if !$d(MDL)
  MDL=m
!endif
```

You could then make use of this conditional macro definition in any makefile by including the directive

```plaintext
!include "MODEL.MAC"
```

When MAKE encounters the `!include` directive, it opens the specified file and reads the contents as if they were in the makefile itself.

**Conditional Directives**

Conditional directives (`!if`, `!elif`, `!else`, and `!endif`) give a programmer a measure of flexibility in constructing makefiles. Rules and macros can be conditionalized so that a command-line macro definition (using the `-D` option) can enable or disable sections of the makefile.

The format of these directives parallels that of the C preprocessor:

```plaintext
!if expression
  [ lines ]
!endif

!if expression
  [ lines ]
!else
  [ lines ]
!endif

!if expression
  [ lines ]
!elif expression
  [ lines ]
!endif
```
Note: [lines] can be any of the following:

- macro_definition
- explicit_rule
- implicit_rule
- include_directive
- if_group
- error_directive
- undef_directive

The conditional directives form a group, with at least an !if directive beginning the group and an !endif directive closing the group.

- One !else directive can appear in the group.
- !elif directives can appear between the !if and any !else directives.
- Rules, macros, and other directives can appear between the various conditional directives in any number. Note that complete rules, with their commands, cannot be split across conditional directives.
- Conditional directive groups can be nested arbitrarily deep.

Any rules, commands, or directives must be complete within a single source file.

Any !if directives must have matching !endif directives within the same source file. Thus the following include file is illegal, regardless of what is contained in any file that might include it, because it does not have a matching !endif directive:

```c
!if $(FILE_COUNT) > 5
  some rules
!else
  other rules
<end-of-file>
```

Expressions Allowed in Conditional Directives

The expression allowed in an !if or an !elif directive uses a C-like syntax. The expression is evaluated as a simple 32-bit signed integer expression.

Numbers can be entered as decimal, octal, or hexadecimal constants. For example, these are legal constants in an expression:

```
4536   # decimal constant
0677   # octal constant
0x23af # hexadecimal constant
```
An expression can use any of the following unary operators:

- negation
- ~ bit complement
- ! logical not

An expression can use any of the following binary operators:

+ addition
- subtraction
* multiplication
/ division
% remainder
» right shift
< left shift
& bitwise and
| bitwise or
^ bitwise exclusive or
&& logical and
|| logical or
> greater than
< less than
>= greater than or equal
<= less than or equal
equality
!= inequality

An expression can contain the following ternary operator:

?: The operand before the ? is treated as a test.

If the value of that operand is non-zero, then the second operand (the part between the ? and :) is the result. If the value of the first operand is zero, the value of the result is the value of the third operand (the part after the :).

Parentheses can be used to group operands in an expression. In the absence of parentheses, binary operators are grouped according to the same precedence given in the C language.

As in C, for operators of equal precedence, grouping is from left to right, except for the ternary operator (?,?), which is right to left.

Macros can be invoked within an expression, and the special macro $d()$ is recognized. After all macros have been expanded, the expression must
Error Directive

The `!error` directive causes MAKE to stop and print a fatal diagnostic containing the text after `!error`. It takes the format

```
!error any_text
```

This directive is designed to be included in conditional directives to allow a user-defined abortion condition. For example, you could insert the following code in front of the first explicit rule:

```
!if !d(MDL)
  !error MDL not defined
!endif
```

If you reach this spot without having defined `MDL`, then MAKE will stop with this error message:

```
Fatal makefile 5: Error directive: MDL not defined
```

Undef Directive

The `!undef` directive causes any definition for the named macro to be forgotten. If the macro is currently undefined, this directive has no effect. The syntax is:

```
!undef macro_name
```

Using MAKE

You now know a lot about how to write makefiles; now's the time to learn how to use them with MAKE.

Command Line Syntax

The simplest way to use MAKE is to type the command

```
make
```
at the MS-DOS prompt. MAKE then looks for MAKEFILE; if it can’t find it, it looks for MAKEFILE.MAK; if it can’t find that, it halts with an error message.

What if you want to use a file with a name other than MAKEFILE or MAKEFILE.MAK? You give MAKE the file (-f) option, like this:

```make
make -fstars.mak
```

The general syntax for MAKE is

```make
make option option ... target target ...
```

where *option* is a MAKE option (discussed later) and *target* is the name of a target file to be handled by explicit rules.

Here are the syntax rules:

- The word *make* is followed by a space, then a list of make options.
- Each make option must be separated from its adjacent options by a space. Options can be placed in any order, and any number of these options can be entered (as long as there is room in the command line).
- After the list of make options comes a space, then an optional list of targets.
- Each target must also be separated from its adjacent targets by a space. MAKE evaluates the target files in the order listed, recompiling their constituents as necessary.

If the command line does not include any target names, MAKE uses the first target file mentioned in an explicit rule. If one or more targets are mentioned on the command line, they will be built as necessary.

Here are some more examples of MAKE command lines:

```make
make -n -fstars.mak
make -s
make -Iinclude -DMDL=c
```

**A Note About Stopping MAKE**

MAKE will stop if any command it has executed is aborted via a control-break. Thus, a *Ctrl-C* will stop the currently executing command and MAKE as well.
The BUILTINS.MAK File

When using MAKE, you will often find that there are macros and rules (usually implicit ones) that you use again and again. You’ve got three ways of handling them. First, you can put them in each and every makefile you create. Second, you can put them all in one file and use the `!include` directive in each makefile you create. Third, you can put them all in a file named BUILTINS.MAK.

Each time you run MAKE, it looks for a file named BUILTINS.MAK; if it finds the file, MAKE reads in it before handling MAKEFILE (or whichever makefile you want it to process).

The BUILTINS.MAK file is intended for any rules (usually implicit rules) or macros that will be commonly used in files anywhere on your computer.

There is no requirement that any BUILTINS.MAK file exist. If MAKE finds a BUILTINS.MAK file, it interprets that file first. If MAKE cannot find a BUILTINS.MAK file, it proceeds directly to interpreting MAKEFILE (or whatever makefile you specify).

How MAKE Searches for Makefiles

MAKE will search for BUILTINS.MAK in the current directory or any directory in the path. You should place this file in the same directory as the MAKE.EXE file.

MAKE always searches for the makefile in the current directory only. This file contains the rules for the particular executable program file being built. The two files have identical syntax rules.

MAKE also searches for any `!include` files in the current directory. If you use the `-I` (Include) option, it will also search in the specified directory.

The TOUCH Utility

There are times when you want to force a particular target file to be recompiled or rebuilt, even though no changes have been made to its sources. One way to do this is to use the TOUCH utility included with Turbo C. TOUCH changes the date and time of one or more files to the current date and time, making it “newer” than the files that depend on it.

To force a target file to be rebuilt, touch one of the files that target depends on. To touch a file (or files), enter
touch filename [filename ... ]

at the DOS prompt. TOUCH will then update the file's creation date(s).

Once you do this, you can invoke MAKE to rebuild the touched target file(s). (You can use the DOS wildcards * and ? with TOUCH.)

MAKE Command Line Options

We've alluded to several of MAKE's command line options; now we'll present a complete list of them. Note that case (upper or lower) is significant; the option -d is not a valid substitution for -D.

-D identifier
Defines the named identifier to the string consisting of the single character 1.

-D iden=string
Defines the named identifier iden to the string after the equal sign. The string cannot contain any spaces or tabs.

-I directory
MAKE will search for include files in the indicated directory (as well as in the current directory).

-U identifier
Undefines any previous definitions of the named identifier.

-s
Normally, MAKE prints each command as it is about to be executed. With the -s option, no commands are printed before execution.

-n
Causes MAKE to print the commands, but not actually perform them. This is useful for debugging a makefile.

-f filename
Uses filename as the MAKE file. If filename does not exist, and no extension is given, tries filename.mak.

-? or -h
Print help message.

MAKE Error Messages

MAKE diagnostic messages fall into two classes: fatals and errors. When a fatal error occurs, compilation immediately stops. You must take appropriate action and then restart the compilation. Errors will indicate some sort of syntax or semantic error in the source makefile. MAKE will complete interpreting the makefile and then stop.
Fatals

Don't know how to make XXXXXXXX
This message is issued when MAKE encounters a nonexistent file name in the build sequence, and no rule exists that would allow the file name to be built.

Error directive: XXXX
This message is issued when MAKE processes an #error directive in the source file. The text of the directive is displayed in the message.

Incorrect command line argument: XXX
This error occurs if MAKE is executed with incorrect command-line arguments.

Not enough memory
This error occurs when the total working storage has been exhausted. You should try this on a machine with more memory. If you already have 640K in your machine, you may have to simplify the source file.

Unable to execute command
This message is issued after a command was to be executed. This could be caused because the command file could not be found, or because it was misspelled. A less likely possibility is that the command exists but is somehow corrupted.

Unable to open makefile
This message is issued when the current directory does not contain a file named MAKEFILE.

Errors

Bad file name format in include statement
Include file names must be surrounded by quotes or angle brackets. The file name was missing the opening quote or angle bracket.

Bad undef statement syntax
An !undef statement must contain a single identifier and nothing else as the body of the statement.

Character constant too long
Character constants can be only one or two characters long.

Command arguments too long
The arguments to a command executed by MAKE were more than 127 characters—a limit imposed by MS-DOS.
Command syntax error
This message occurs if:

- The first rule line of the makefile contained any leading whitespace.
- An implicit rule did not consist of .ext.ext:.
- An explicit rule did not contain a name before the : character.
- A macro definition did not contain a name before the = character.

Division by zero
A divide or remainder in an !if statement has a zero divisor.

Expression syntax error in !if statement
The expression in an !if statement is badly formed—it contains a mismatched parenthesis, an extra or missing operator, or a missing or extra constant.

File name too long
The file name given in an !include directive was too long for the compiler to process. File names in MS-DOS must be no more than 64 characters long.

Illegal character in constant expression X
MAKE encountered some character not allowed in a constant expression. If the character is a letter, this indicates a (probably) misspelled identifier.

Illegal octal digit
An octal constant was found containing a digit of 8 or 9.

Macro expansion too long
A macro cannot expand to more than 4,096 characters. This error often occurs if a macro recursively expands itself. A macro cannot legally expand to itself.

Misplaced elif statement
An !elif directive was encountered without any matching !if directive.

Misplaced else statement
An !else directive was encountered without any matching !if directive.

Misplaced endif statement
An !endif directive was encountered without any matching !if directive.
No file name ending
The file name in an include statement was missing the correct closing quote or angle bracket.

Redefinition of target XXXXXXXX
The named file occurs on the left-hand side of more than one explicit rule.

Unable to open include file XXXXXXXXXX.XXX
The named file could not be found. This could also be caused if an include file included itself. Check whether the named file exists.

Unexpected end of file in conditional started on line #
The source file ended before MAKE encountered an !endif. The !endif was either missing or misspelled.

Unknown preprocessor statement
A ! character was encountered at the beginning of a line, and the statement name following was not error, undef, if, elif, include, else, or endif.
Turbo Link

In the Turbo C Integrated Development Environment (TC) the linker is built in. For the command-line version of Turbo C (TCC), the linker is invoked as a separate program. This separate program, TLINK, can also be used as a stand-alone linker.

TLINK is lean and mean; while it lacks some of the bells and whistles of other linkers, it is extremely fast and compact.

By default, Turbo C calls TLINK when compilation is successful; TLINK then combines object modules and library files to produce the executable file.

In this appendix, we describe how to use TLINK as a stand-alone linker.

Invoking TLINK

You can invoke TLINK at the DOS command line by typing tlink with or without parameters.

When invoked without parameters, TLINK displays a summary of parameters and options that looks like this:

```
Turbo Link Version 1.0 Copyright (c) 1987 Borland International
The syntax is: TLINK objfiles, exefile, mapfile, libfiles
@xxxx indicates use response file xxxx
Options: /m = map file with publics
/x = no map file at all
/i = initialize all segments
/l = include source line numbers
/s = detailed map of segments
/n = no default libraries
/d = warn if duplicate symbols in libraries
/c = lower case significant in symbols
```

In TLINK’s summary display, the line

```
The syntax is: TLINK objfiles, exefile, mapfile, libfiles
```

specifies that you supply file names in the given order, separating the file types with commas.
For example, if you supply the command line

```
tlink /c mainline wd ln tx,fin,mfin,lib\comm lib\support
```

TLINK will interpret it to mean that

- Case is significant during linking (/c).
- The .OBJ files to be linked are MAINLINE.OBJ, WD.OBJ, LN.OBJ, and TX.OBJ.
- The executable program name will be FIN.EXE.
- The map file is MFIN.MAP.
- The library files to be linked in are COMM.LIB and SUPPORT.LIB, both of which are in subdirectory LIB.

TLINK appends extensions to file names that have none:

- .OBJ for object files
- .EXE for executable files
- .MAP for map files
- .LIB for library files

Be aware that where no .EXE file name is specified, TLINK derives the name of the executable file by appending .EXE to the first object file name listed. If for example, you had not specified FIN as the .EXE file name in the previous example, TLINK would have created MAINLINE.EXE as your executable file.

TLINK always generates a map file, unless you explicitly direct it not to by including the /x option on the command line.

- If you give the /m option, the map file includes publics.
- If you give the /s option, the map file is a detailed segment map.

These are the rules TLINK follows when determining the name of the map file.

- If no .MAP file is specified, TLINK derives the map file name by adding a .MAP extension to the .EXE file name. (The .EXE file name can be given on the command line or in the response file; if no .EXE name is given, TLINK will derive it from the name of the first .OBJ file.)
- If a map file name is specified in the command line (or in the response file), TLINK adds the .MAP extension to the given name.

Note that even if you specify a map file name, if the /x option is specified then no map file will be created at all.
Using Response Files

TLINK lets you supply the various parameters on the command line, in a response file, or in any combination of the two.

A response file is just a text file that contains the options and/or file names that you would usually type in after the name TLINK on your command line.

Unlike the command line, however, a response file can be continued onto several lines of text. You can break a long list of object or library files into several lines by ending one line with a plus character and continuing the list on the next line.

Also, you can start each of the four components on separate lines: object files, executable file, map file, libraries. When you do this, you must leave out the comma used to separate components.

To illustrate these features, suppose that you rewrote the previous command-line example as a response file, FINRESP, like this:

```
/c mainline wd+
ln tx,fin+
mfin+
lib\comm lib\support
```

You would then enter your TLINK command as:

```
tlink @finresp
```

Note that you must precede the file name with an "at" character (@) to indicate that the next name is a response file.

Alternately, you may break your link command into multiple response files. For example, you can break the previous command line into the following two response files:

<table>
<thead>
<tr>
<th>File Name</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>LISTOBS</td>
<td>mainline+ wd+</td>
</tr>
<tr>
<td></td>
<td>ln tx</td>
</tr>
<tr>
<td>LISTLIBS</td>
<td>lib\comm+ lib\support</td>
</tr>
</tbody>
</table>

You would then enter the TLINK command as:

```
tlink /c @listobjs,fin,mfin,@listlibs
```
Using TLINK with Turbo C Modules

Turbo C supports six different memory models: tiny, small, compact, medium, large, and huge. When you create an executable Turbo C file using TLINK, you must include the initialization module and libraries for the memory model being used.

The general format for linking Turbo C programs with TLINK is

tlink C0x <myobjs>, <exe>,[map],<mylibs> [emulfp87 mathx] Cx

where these <filenames> represent the following:

<myobjs> = the .OBJ files you want linked
<exe> = the name to be given the executable file
[map] = the name to be given the map file  [optional ]
<mylibs> = the library files you want included at link time

The other filenames on this general TLINK command line represent Turbo C files, as follows:

C0x = initialization module for memory model x
emu|fp87 = the floating-point libraries (choose one)
mathx = math library for memory model x
Cx = run-time library for memory model x

Initialization Modules

The initialization modules have the name C0x.OBJ, where x is a single letter corresponding to the model: t, s, c, m, l, h. Failure to link in the appropriate initialization module usually results in a long list of error messages telling you that certain identifiers are unresolved and/or that no stack has been created.

The initialization module must also appear as the first object file in the list. The initialization module arranges the order of the various segments of the program. If it is not first, the program segments may not be placed in memory properly, causing some frustrating program bugs.

Be sure that you give an explicit .EXE file name on the TLINK command line. Otherwise, your program name will be C0x.EXE—probably not what you wanted!
Libraries

After your own libraries, the libraries of the corresponding memory model must also be included in the link command. These libraries must appear in a specific order; a floating-point library with the appropriate math library (these are optional), and the corresponding run-time library. We discuss those libraries in that order here.

If your Turbo C program uses any floating-point, you must include a floating-point library (EMU.LIB or FP87.LIB) plus a math library (MATHx.LIB) in the link command.

Turbo C's two floating-point libraries are independent of the program's memory model.

- If you want to include floating-point emulation logic so that the program will work both on machines with and without a math coprocessor (8087 or 80287) chip, you must use EMU.LIB.
- If you know that the program will always be run on a machine with a math coprocessor chip, the FP87.LIB library will produce a smaller and somewhat faster executable program.

The math libraries have the name MATHx.LIB, where $x$ is a single letter corresponding to the model: $t, s, c, m, l, h$.

You can always include the emulator and math libraries in a link command line. If your program does no floating-point work, nothing from those libraries will be added to your executable program file. However, if you know there is no floating-point work in your program, you can save time in your links by excluding those libraries from the command line.

You must always include the C run-time library for the program's memory model. The C run-time libraries have the name Cx.LIB, where $x$ is a single letter corresponding to the model, as before.

Note: if you are using floating-point operations, you must include the math and emulator libraries before the C run-time library. Failure to do this will likely result in a failed link.

Using TLINK with TCC

You can also use TCC, the stand-alone Turbo C compiler, as a “front end” to TLINK that will invoke TLINK with the correct start-up file, libraries, and executable-program name.
To do this, you give file names on the TCC command line with explicit .OBJ and .LIB extensions. For example, given the following TCC command line

```
tcc -mx mainfile.obj sub1.obj mylib.lib
```

TCC will invoke TLINK with the files C0x.OBJ, EMU.LIB, MATHx.LIB and Cx.LIB (initialization module, default 8087 emulation library, math library and run-time library for memory model x). TLINK will link these along with your own modules MAINLINE.OBJ and SUB1.OBJ, and your own library MYLIB.LIB.

Note: When TCC invokes TLINK, it always uses the /c (case-sensitive link) option.

**TLINK Options**

TLINK options can occur anywhere on the command line. The options consist of a slash (/) followed by the option-specifying letter (m, s, l, i, n, d, x, or c).

If you have more than one option, spaces are not significant (/m/c is the same as /m /c), and you can have them appear in different places on the command line. The following sections describe each of the options.

**The /x, /m, /s Options**

By default, TLINK always creates a map of the executable file. This default map includes only the list of the segments in the program, the program start address, and any warning or error messages produced during the link.

If you want to create a more complete map, the /m option will add a list of public symbols to the map file, sorted in increasing address order. This kind of map file is useful in debugging. Many debuggers, such as SYMDEB, can use the list of public symbols to allow you to refer to symbolic addresses when you are debugging.
The /s option creates a map file with segments, public symbols and the program start address just like the /m option did, but also adds a detailed segment map. The following is an example of a detailed segment map:

<table>
<thead>
<tr>
<th>Address</th>
<th>Length (Bytes)</th>
<th>Class</th>
<th>Segment Name</th>
<th>Group</th>
<th>Module</th>
<th>Alignment/Combining</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000:0000 0E5B C=CODE S=SYMB_TEXT G=(none) M=SYMB.C ACBP=28</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>00E5:0000B 2735 C=CODE S=QUAL_TEXT G=(none) M=QUAL.C ACBP=28</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0359:0000 002B C=CODE S=SCOPY_TEXT G=(none) M=SCOPY ACBP=28</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>035B:0000B 003A C=CODE S=LRSB_TEXT G=(none) M=LRSB ACBP=20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>035F:0005B 003C C=CODE S=PADA_TEXT G=(none) M=PADA ACBP=20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0367:0008 005B C=CODE S=PADD_TEXT G=(none) M=PADD ACBP=20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>036D:0003 0025 C=CODE S=PSBP_TEXT G=(none) M=PSBP ACBP=20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>036F:0008 05CE C=CODE S=BRK_TEXT G=(none) M=BRK ACBP=28</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>03CC:0006 066F C=CODE S=FLOAT_TEXT G=(none) M=FLOAT ACBP=20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0433:0000B 000B C=DATA S= DATA G=GROUP M=SYMB.C ACBP=48</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0433:0012 00D3 C=DATA S=DATA G=GROUP M=QUAL.C ACBP=48</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0433:0066 00E0 C=DATA S=DATA G=GROUP M=BRK ACBP=48</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0442:0004 0004 C=BSS S= BSS G=GROUP M=SYMB.C ACBP=48</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0442:0008 0002 C=BSS S= BSS G=GROUP M=QUAL.C ACBP=48</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0442:000A 000E C=BSS S= BSS G=GROUP M=BRK ACBP=48</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For each segment in each module, this map includes the address, length in bytes, class, segment name, group, module, and ACBP information.

If the same segment appears in more than one module, each module will appear as a separate line (for example, SYMB.C). Most of the information in the detailed segment map is self-explanatory, except for the ACBP field.

The ACBP field encodes the A (alignment) and C (combining) attributes into a set of 4 bit fields, as defined by Intel. TLINK uses only two of the fields, the A and C fields. The ACBP value in the map is printed in hexadecimal: The following values of the fields must be OR'ed together to arrive at the ACBP value printed.
<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>The A field</td>
<td>00</td>
<td>An Absolute segment.</td>
</tr>
<tr>
<td>(alignment)</td>
<td>20</td>
<td>A byte aligned segment.</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>A word aligned segment.</td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>A paragraph aligned segment.</td>
</tr>
<tr>
<td></td>
<td>80</td>
<td>A page aligned segment.</td>
</tr>
<tr>
<td></td>
<td>A0</td>
<td>An unnamed absolute portion of storage.</td>
</tr>
<tr>
<td>The C field</td>
<td>00</td>
<td>May not be combined.</td>
</tr>
<tr>
<td>(combination)</td>
<td>08</td>
<td>A public combining segment.</td>
</tr>
</tbody>
</table>

**The /l Option**

The /l option creates a section in the .MAP file for source code line numbers. To use it, you must have created the .OBJ files by compiling with the -y (Line numbers...On) option. If you tell TLINK to create no map at all (using the /x option), this option will have no effect.

**The /i Option**

The /i option causes trailing segments to be output into the executable file even if the segments do not contain data records. Note that this is not normally necessary.

**The /n Option**

The /n option causes the linker to ignore default libraries specified by some compilers. This option is necessary if the default libraries are in another directory, because TLINK does not support searching for libraries. You may want to use this option when linking modules written in another language.

**The /c Option**

The /c option forces the case to be significant in publics and externals. For example, by default, TLINK regards fred, Fred, and FRED as equal; the /c option makes them different.
The /d Option

Normally, TLINK will not warn you if a symbol appears in more than one library file. If the symbol must be included in the program, TLINK will use the copy of that symbol in the first file mentioned on the command line. Since this is a commonly used feature, TLINK does not normally warn about the duplicate symbols. The following hypothetical situation illustrates how you might want to use this feature.

Suppose you have two libraries: one called SUPPORT.LIB, and a supplemental one called DEBUGSUP.LIB. Suppose also that DEBUGSUP.LIB contains duplicates of some of the routines in SUPPORT.LIB (but the duplicate routines in DEBUGSUP.LIB include slightly different functionality, such as debugging versions of the routines). If you include DEBUGSUP.LIB first in the link command, you will get the debugging routines and not the routines in SUPPORT.LIB.

If you are not using this feature or are not sure which routines are duplicated, you may include the /d option. This will force TLINK to list all symbols duplicated in libraries, even if those symbols are not going to be used in the program.

The /d option also forces TLINK to warn about symbols that appear both in an .OBJ and a .LIB file. In this case, since the symbol that appears in the first (left-most) file listed on the command line is the one linked in, the symbol in the .OBJ file is the one that will be used.

With Turbo C, the distributed libraries you would use in any given link command do not contain any duplicated symbols. Thus while EMU.LIB and FP87.LIB (or CS.LIB and CL.LIB) obviously have duplicate symbols, they would never rightfully be used together in a single link. There are no symbols duplicated between EMU.LIB, MATHS.LIB, and CS.LIB, for example.

Restrictions

As we said earlier, TLINK is lean and mean; it does not have an excessive supply of options. Following are the only serious restrictions to TLINK:

- Overlays are not supported.
- Microsoft CodeView Debugger is not supported (but SST and SYMDEB work fine).
- Common variables are only partly supported: A public must be supplied to resolve them.
You can have a maximum of 8182 symbols and 4000 logical segments.

Segments that are of the same name and class should either all be able to be combined, or not. (Only assembler programmers might encounter this as a problem.)

Code compiled in Microsoft C or Microsoft Fortran cannot be linked with TLINK. This is because Microsoft languages have undocumented object record formats in their OBJ files, which TLINK does not currently support.

TLINK is designed to be used with Turbo C (both the Integrated Environment and command-line versions), as well as with MASM and other compilers; however, it is not a general replacement for MS Link.

**Error Messages**

TLINK has three types of errors: warnings, non-fatal errors, and fatal errors.

- Warnings are just that: warnings of conditions that you probably want to fix. When warnings occur .EXE and .MAP files are still created.
- A non-fatal error does not delete .EXE or .MAP files, but you shouldn’t try to execute the .EXE file.
- A fatal error causes TLINK to stop immediately; the .EXE and .MAP files are deleted.

The following generic names and values appear in the error messages listed in this section. When you get an error message, the appropriate name or value is substituted.

<sname> symbol name
</sname> module name
</fname> file name

XXXh a 4-digit hexadecimal number, followed by 'h'

**Warnings**

TLINK has only three warnings. The first two deal with duplicate definitions of symbols; the third, applicable to tiny model programs, indicates that no stack has been defined. Here are the messages:
Warning: XXX is duplicated in module YYY
The named symbol is defined twice in the named module. This could happen in Turbo C object files, for example, if two different pascal names were spelled using different cases in a source file.

Warning: XXX defined in module YYY is duplicated in module ZZZ
The named symbol is defined in each of the named modules. This could happen if a given object file is named twice in the command line, or if one of the two copies of the symbol were misspelled.

Warning: no stack
This warning is issued if no stack segment is defined in any of the object files or in any of the libraries included in the link. This is a normal message for the tiny memory model in Turbo C, or for any application program that will be converted to a .COM file. For other programs, this indicates an error.

If a Turbo C program produces this message for any but the tiny memory model, check the C0x start-up object files to be sure they are correct.

Non-Fatal Errors

TLINK has only two non-fatal errors. As mentioned, when a non-fatal error occurs, the .EXE and .MAP files are not deleted. However, these same errors are treated as fatal errors under the Integrated Environment. Here are the error messages:

XXX is unresolved in module YYY
The named symbol is referenced in the given module but is not defined anywhere in the set of object files and libraries included in the link. Check the spelling of the symbol for correctness. You will usually see this error from TLINK for Turbo C symbols if you did not properly match a symbol’s declarations of pascal and cdecl type in different source files

Fixup overflow, frame = xxxxh, target = xxxxh, offset = xxxxh in module XXXXXX
This indicates an incorrect data or code reference in an object file that TLINK must fix up at link time. In a fixup, the object file indicates the name of a memory location being referenced and the name of a segment that the memory location should be in. The frame value is the segment where the memory location should be according to the object file. The target value is the segment where the memory location actually is. The
offset field is the offset within the target segment where the memory location is.

This message is most often caused by a mismatch of memory models. A near call to a function in a different code segment is the most likely cause. This error can also result if you generate a near call to a data variable or a data reference to a function.

To diagnose the problem, generate a map with public symbols (\m). The value of the target and offset fields in the error message should be the address of the symbol being referenced. If the target and offset fields do not match some symbol in the map, look for the symbol nearest to the address given in the message. The reference is in the named module, so look in the source file of that module for the offending reference.

If these techniques do not identify the cause of the failure, or if you are programming in assembly language or some other high-level language besides Turbo C, there may be other possible causes for this message. Even in Turbo C, this message could be generated if you are using different segment or group names than the default values for a given memory model.

Fatal Errors

When fatal errors happen, TLINK stops and deletes the .EXE and .MAP files.

XXXXXXXX.XXX: bad object file
An ill-formed object file was encountered. This is most commonly caused by naming a source file or by naming an object file that was not completely built. This can occur if the machine was rebooted during a compile, or if a compiler did not delete its output object file when a Ctrl-brk was struck.

XXXXXXXX.XXX: unable to open file
This occurs if the named file does not exist or is misspelled.

Bad character in parameters
One of the following characters was encountered in the command line or in a response file: "", * < = > ? [ ] ! or any control character other than horizontal tab, line feed, carriage return, or Ctrl-Z.

msdos error, ax = XXXXh
This occurs if an MS-DOS call returned an unexpected error. The ax value printed is the resulting error code. This could indicate a TLINK
internal error or an MS-DOS error. The only MS-DOS calls TLINK makes where this error could occur are read, write, and close.

**Not enough memory**
There was not enough memory to complete the link process. Try removing any terminate-and-stay-resident applications currently loaded, or reduce the size of any RAM disk currently active. Then run TLINK again.

**Segment exceeds 64K**
This message will occur if too much data was defined for a given data or code segment, when segments of the same name in different source files are combined. This message also occurs if a group exceeds 64K bytes when the segments of the group are combined.

**Symbol limit exceeded**
You can define a maximum of 8,182 public symbols, segment names, and group names in a single link. This message is issued if that limit is exceeded.

**Unexpected group definition**
Group definitions in an object file must appear in a particular sequence. This message will generally occur only if a compiler produced a flawed object file. If this occurs in a file created by Turbo C, try recompiling the file. If the problem persists, contact Borland International.

**Unexpected segment definition**
Segment definitions in an object file must appear in a particular sequence. This message will generally occur only if a compiler produced a flawed object file. If this occurs in a file created by Turbo C, try recompiling the file. If the problem persists, contact Borland International.

**Unknown option**
A slash character (/) was encountered on the command line or in a response file without being followed by one of the allowed options.

**Write failed, disk full?**
This occurs if TLINK could not write all of the data it attempted to write. This is almost certainly caused by the disk being full.
Language Syntax Summary

This appendix uses a modified Backus-Naur Form to summarize the syntax for Turbo C constructs. These constructs are arranged categorically, as follows:

- **Lexical Grammar**: tokens, keywords, identifiers, constants, string literals, operators and punctuators
- **Phrase Structure Grammar**: expressions, declarations, statements, external definitions
- **Preprocessing directives**

**Lexical Grammar**

**Tokens**

token:
  - keyword
  - identifier
  - constant
  - string-literal
  - operator
  - punctuator
Keywords

**keyword**: one of the following

<table>
<thead>
<tr>
<th>Keyword</th>
<th>Keyword</th>
<th>Keyword</th>
<th>Keyword</th>
</tr>
</thead>
<tbody>
<tr>
<td>asm</td>
<td>do</td>
<td>goto</td>
<td>return</td>
</tr>
<tr>
<td>auto</td>
<td>double</td>
<td>huge</td>
<td>short</td>
</tr>
<tr>
<td>break</td>
<td>else</td>
<td>if</td>
<td>signed</td>
</tr>
<tr>
<td>case</td>
<td>enum</td>
<td>int</td>
<td>sizeof</td>
</tr>
<tr>
<td>cdecl</td>
<td>extern</td>
<td>interrupt</td>
<td>static</td>
</tr>
<tr>
<td>char</td>
<td>far</td>
<td>long</td>
<td>struct</td>
</tr>
<tr>
<td>const</td>
<td>float</td>
<td>near</td>
<td>switch</td>
</tr>
<tr>
<td>continue</td>
<td>for</td>
<td>pascal</td>
<td>typedef</td>
</tr>
<tr>
<td>default</td>
<td>register</td>
<td></td>
<td>_es</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>_ss</td>
</tr>
</tbody>
</table>

Identifiers

**identifier**:

- **nondigit**
- identifier nondigit
- identifier digit

**nondigit**: one of the following

```
abc def ghi jkl mno pqr stu vwx yz _ $
ABCDEFGHIJKLMNOPQRSTUVWXYZ
```

**digit**: one of the following

```
0 1 2 3 4 5 6 7 8 9
```

Constants

**constant**:  
- floating-constant
- integer-constant
- enumeration-constant
- character-constant

**floating-constant**:  
- fractional-constant exponent-part_opt floating-suffix_opt
  
- digit-sequence exponent-part floating-suffix_opt

**fractional-constant**:  
- digit-sequence_opt . digit-sequence
- digit-sequence .

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exponent-part:
   e sign<opt> digit-sequence
   E sign<opt> digit-sequence

sign: one of the following
   + -

digit-sequence:
   digit
   digit-sequence digit

floating-suffix: one of the following
   f F L

integer-constant:
   decimal-constant integer-suffix<opt>
   octal-constant integer-suffix<opt>
   hexadecimal-constant integer-suffix<opt>

decimal-constant:
   nonzero-digit
   decimal-constant digit

octal-constant:
   0
   octal-constant octal-digit

hexadecimal-constant:
   0 x hexadecimal-digit
   0 X hexadecimal-digit
   hexadecimal-constant hexadecimal-digit

nonzero-digit: one of the following
   1 2 3 4 5 6 7 8 9

octal-digit: one of the following
   0 1 2 3 4 5 6 7

hexadecimal-digit: one of the following
   0 1 2 3 4 5 6 7 8 9
   a b c d e f
   A B C D E F

integer-suffix:
   unsigned-suffix long-suffix<opt>
   long-suffix unsigned-suffix<opt>

unsigned-suffix: one of the following
   u U
long-suffix: one of the following
   1 L

enumeration-constant:
   identifier

character-constant:
   c-char-sequence

c-char-sequence:
   c-char
   c-char-sequence  c-char

c-char:
   any character in the source character set except
   the single-quote ('), backslash (\), or newline ( ) character

escape-sequence

escape-sequence: one of the following

   \'  \b  \v  \xhh
   \"  \f  \o  \xhhh
   \?  \n  \00  \Xh
   \  \r  \0oo  \Xhh
   \a  \t  \xh  \Xhhh

String Literals

string-literal:
   " s-char-sequence\opt "

s-char-sequence:
   s-char
   s-char-sequence  s-char

s-char:
   any character in the source character set except
   the double-quote ("), backslash (\), or newline ( ) character

escape-sequence
Operators

operator: one of the following

[] () . -> ++ --
& * + - - !
sizeof / % << >> <
> <= >= == ! =
^ | && || ? : =
*= /= %= += -= <<=
>=&= ^= |= . #
##

Punctuators

punctuator: one of the following

[ ] ( ) { } * , : = ; ... #

Phrase Structure Grammar

Expressions

primary-expression:
identifier
constant
pseudo-variable
string-literal
(expression)
pseudo-variable:

```
_AX    _AL    _AH    _SI    _ES
_BX    _BL    _BH    _DI    _SS
_CX    _CL    _CH    _BP    _CS
_DX    _DL    _DH    _SP    _DS
```

postfix-expression:
```
primary-expression
postfix-expression [ expression ]
postfix-expression ( argument-expression-list_opt )
postfix-expression . identifier
postfix-expression -> identifier
postfix-expression ++
postfix-expression --
```

argument-expression-list:
```
assignment-expression
argument-expression-list , assignment-expression
```

unary-expression:
```
postfix-expression
++ unary-expression
-- unary-expression
unary-operator cast-expression
sizeof unary-expression
sizeof ( type-name )
```

unary-operator: one of the following
```
&  *  +  -  ~  !
```

cast-expression:
```
unary-expression
( type-name ) cast-expression
```

multiplicative-expression:
```
cast-expression
multiplicative-expression * cast-expression
multiplicative-expression / cast-expression
multiplicative-expression % cast-expression
```

additive-expression:
```
multiplicative-expression
additive-expression + multiplicative-expression
additive-expression - multiplicative-expression
```
shift-expression:
  additive-expression
shift-expression << additive-expression
shift-expression >> additive-expression

relational-expression:
  shift-expression
relational-expression < shift-expression
relational-expression > shift-expression
relational-expression <= shift-expression
relational-expression >= shift-expression

equality-expression:
  relational-expression
equality expression == relational-expression
equality expression != relational-expression

AND-expression:
  equality-expression
  AND-expression & equality-expression

exclusive-OR-expression:
  AND-expression
  exclusive-OR-expression ^ AND-expression

inclusive-OR-expression:
  exclusive-OR-expression
  inclusive-OR-expression | exclusive-OR-expression

logical-AND-expression:
  inclusive-OR-expression
  logical-AND-expression && inclusive-OR-expression

logical-OR-expression:
  logical-AND-expression
  logical-OR-expression || logical-AND-expression

conditional-expression:
  logical-OR-expression
  logical-OR-expression ? expression : conditional-expression

assignment-expression:
  conditional-expression
  unary-expression assignment-operator assignment-expression

assignment-operator: one of the following

= *= /= %= += -=
expression:
  assignment-expression
  expression , assignment-expression

constant-expression:
  conditional-expression

Declarations

declaration:
  declaration-specifiers init-declarator-list \text{opt}

description-specifiers:
  storage-class-specifier declaration-specifiers \text{opt}
  type-specifier declaration-specifiers \text{opt}

init-declarator-list:
  init-declarator
  init-declarator-list , init-declarator

init-declarator:
  declarator
  declarator = initializer

storage-class-specifier:
  \texttt{typedef}
  \texttt{extern}
  \texttt{static}
  \texttt{auto}
  \texttt{register}
type-specifier:
  void
  char
  short
  int
  long
  float
  double
  signed
  unsigned
  const
  volatile
struct-or-union-specifier
enum-specifier
typedef-name

struct-or-union-specifier:
  struct-or-union identifier_{opt} \{ struct-declaration-list \}
  struct-or-union identifier

struct-or-union:
  struct
  union

struct-declaration-list:
  struct-declaration
  struct-declaration-list struct-declaration

struct-declaration:
  type-specifier-list struct-declarator-list;

type-specifier-list:
  type-specifier
  type-specifier-list type-specifier

struct-declarator-list:
  struct-declarator
  struct-declarator-list , struct-declarator

struct-declarator:
  declarator
  declarator_{opt} : constant-expression

enum-specifier:
  enum identifier_{opt} \{ enumerator-list \}
  enum identifier
enumerator-list:
  enumerator
  enumerator-list, enumerator

enumerator:
  enumeration-constant
  enumeration-constant = constant-expression

declarator:
  pointer_opt direct-declarator
  modifier-list_opt
direct-declarator:
  identifier
  ( declarator )
  direct-declarator [ constant-expression_opt ]
  direct-declarator ( parameter-type-list )
  direct-declarator ( identifier-list_opt )

pointer:
  * type-specifier-list_opt
  * type-specifier-list_opt pointer

modifier-list:
  modifier
  modifier-list modifier

modifier:
  cdecl
  pascal
  interrupt
  near
  far
  huge

parameter-type-list:
  parameter-list
  parameter-list, ...

parameter-list:
  parameter-declaration
  parameter-list, parameter-declaration

parameter-declaration:
  declaration-specifiers declarator
  declaration-specifiers abstract-declaration_opt
identifier-list:
  identifier
  identifier-list , identifier

type-name:
  type-specified-list abstract-declarator_opt

abstract-declarator:
  pointer
  pointer_opt direct-abstract-declarator_opt
  modifier-list_opt

modifier-list:
  modifier
  modifier-list modifier

modifier:
  cdecl
  pascal
  interrupt
  near
  far
  huge

direct-abstract-declarator:
  ( abstract-declarator )
  direct-abstract-declarator_opt [ constant-expression_opt ]
  direct-abstract-declarator_opt ( parameter-type-list_opt )
typedef-name:
  identifier

initializer:
  assignment-expression
  { initializer-list }
  { initializer-list , }

initializer-list:
  initializer
  initializer-list , initializer
Statements

statement:
  labeled-statement
  compound-statement
  expression-statement
  selection-statement
  iteration-statement
  jump-statement
  asm-statement

asm-statement
  asm tokens newline
  asm tokens;

labeled-statement:
  identifier : statement
  case constant-expression : statement
  default : statement

compound-statement:
  { declaration-list_opt statement-list_opt }

declaration-list:
  declaration
  declaration-list declaration

statement-list:
  statement
  statement-list statement

expression-statement:
  expression_opt

selection-statement:
  if (expression ) statement
  if (expression ) statement else statement
  switch (expression ) statement

iteration-statement:
  while (expression ) statement
  do statement while (expression );
  for (expression_opt ; expression_opt ; expression_opt ) statement
jump-statement
  goto identifier;
  continue;
  break;
  return expression_opt;

External Definitions

file:
  external-definition
  file external-definition
external-definition:
  function-definition
  declaration
asm-statement
  asm tokens newline
  asm tokens;
function-definition:
  declaration-specifiers_opt declarator declaration-list_opt compound-statement

Preprocessing Directives

preprocessing-file:
  group

group:
  group-part
  group group-part

group-part:
  pp-tokens_opt newline
  if-section
  control-line
if-section:
  if-group elif-groups_opt else-group_opt endif-line
if-group:
    #if constant-expression newline group_opt
    #ifdef identifier newline group_opt
    ifndef identifier newline group_opt

elif-groups:
    elif-group
    elif-groups elif-group

elif-group:
    #elif constant-expression newline group_opt

default-group:
    #else newline group_opt

default-line:
    #endif newline

control-line:
    #include pp-tokens newline
    #define identifier replacement-list newline
    #define identifier lparen identifier-list_opt) replacement-list newline
    #undef identifier newline
    #line pp-tokens newline
    #error pp-tokens_opt newline
    #pragma pp-tokens_opt newline
    #pragma warn action abbreviation newline
    #pragma inline newline
    # newline

action:
    +
    -
    .

abbreviation:
    amb   dyn   pia   str
    amp   dup   pro   stu
    apt   eff   rch   stv
    ans   fun   ret   sus
    cln   ign   rpt   use
    cpt   mod   rvl   voi
    def   par   sig   zst

lparen:
    the left-parenthesis character without preceding white space
replacement-list:
  pp-tokens_{opt}

pp-tokens:
  preprocessing-token
  pp-tokens preprocessing-token

preprocessing-token:
  header-name (only within an \#include directive)
  identifier (no keyword distinction)
  constant
  string-literal
  operator
  punctuator
  each non-whitespace character that cannot be one of the preceding

header-name:
  <h-char-sequence>

h-char-sequence:
  h-char
  h-char-sequence h-char

h-char:
  any character in the source character set except
  the newline greater than ( > ) character

newline:
  the newline character
Customizing Turbo C

Turbo C comes ready to run, as soon as you make working copies of the disk files. There is no installation, *per se*. But you do have the option of changing many of Turbo C's default modes of operation by running this customization program. This program, TCINST.COM, lets you do six things:

- set up a path to your configuration and Help files
- customize your Editor commands
- modify your default edit modes
- set up your default screen mode
- change your screen colors
- change the size of Turbo C's windows

If you want to store your help (TCHELP.TCH) or configuration files (TCCONFIG.TC) in a directory other than the one where you do your work, you'll need to use the Turbo C directory option to set a path to those files.

If you're either unfamiliar with Turbo C's editor or inexorably tied to another editor, you can use the Editor commands option to reconfigure (customize) the editor keystrokes to your liking.

You can also use the Default editor mode option to set several defaults for the editor. You can choose to

- load and save a pick list
- work in insert or overwrite mode
- turn tabs on or off
- work with auto-indent on or off

You can set up the display mode that Turbo C will use when it is in operation and specify whether you have a "snowy" video adapter.

You can customize the colors of almost every part of the Turbo C screen output.

And finally, you can change the default sizes of the Edit and Message windows.

**Running TCINST**

To get started, type TCINST at the DOS prompt. The first (main installation) menu lets you select the Turbo C directory, Editor commands, Default edit modes, Screen mode, Colors, Resize windows, or Quit/save/abort. You can either press the highlighted capital letter of the preferred option or use the Up and Down arrow keys to move to your selection and then press Enter; for instance, press D to modify the Default edit modes. In general, pressing Esc (more than once if necessary) will return you from a submenu to the main installation menu.

![Installation Menu](Turbo_C_Installation_Program.png)

Figure F.1: TCINST Installation Menu
The Turbo C Directory Option

You'll use the Turbo C directory option to specify a path to your standard configuration and Help files, so that they are accessible from wherever you call up Turbo C.

When you select the Turbo C directory option, you're prompted to enter the full path to your Turbo directory. (This is where your standard configuration and Help files are kept; see the Environment option in the Options pull-down menu in Chapter 2 of the Turbo C User's Guide. For example, if you want Turbo C to look for the standard configuration file in a directory called TURBOC (if it’s not found in your current directory), then you might type for your path name

    C:\TURBOC

After typing a path, press Enter to accept it, and the TCINST main installation menu will redisplay. When you exit the program, you're prompted whether you want to save the changes. Once you save the Turbo C path, the location is written to disk. (Note that the Quick-Ref line tells you which keystrokes to use when you're in this screen.)

The Editor Commands Option

This option allows you to change the default editing keys that you use while you're in the Turbo C editor. To modify the Editor commands, press E or move the selection bar to the option and press Enter. The help line at the top of the screen shows you which keys to use to move around and make changes. Most of these commands are simply movement commands; the R option, however, is useful when you want to restore the keystrokes to the factory defaults. You’ll notice that you can modify only the secondary, or highlighted, keystrokes.
Once you press *Enter* to modify the keystroke(s), you'll see a selection bar next to the command you want to redefine. If you take another look at the top of the screen, you'll see that the help line now lists the available commands:

< backspace C clear R restore ↓ accept edit <Scroll Lock> literal

**backspace**  Use the *Backspace* key to backspace or delete something in the keystroke box.

**clear**  The C option clears, or erases, the whole box.

**restore**  Use R to restore the original keystrokes before exiting from the screen.

**accept edit**  The ↓ stands for the *Enter* key; pressing *Enter* accepts the keystroke modification you've made.

**<Scroll Lock>**  This is a toggle that lets you alternate between command and literal modes.

To understand the **<Scroll Lock>** option, take a look at the *Enter* key, which is used to modify and accept the editing of a key command. If you wanted, for example, to use *Enter* as part of Find String's keystrokes (*Ctrl-Q F*), you would have to follow these steps:

1. Make sure **<Scroll Lock>** is toggled to *command* (check the upper right-hand corner of your screen).
2. Press Enter at the Find String command line.
3. Press Backspace to delete the Ctrl-F part of the string.
5. Again, toggle <Scroll Lock> to command and press Enter to accept.

After you’ve defined the new keystroke(s) for a command, press Enter to accept them. If you’ve finished making changes, press Esc to exit. If you still have more changes to make, use the arrow keys to scroll up and down the list and select your next command.

At this point, if you’ve accidentally assigned a keystroke sequence that’s been used as a control character sequence in the primary command column, the message

Command conflicts need to be corrected. Press <ESC>

will flash at the bottom of the screen. Any duplicated sequences will be highlighted, which enables you to easily search for any disallowed items and to reselect a sequence. If you change your mind, you can use the R option to restore all of the factory defaults.

Also, if you assign a hot key to one of the commands, the message

<function key> is a built-in hot key. Press <ESC>

flashes at the bottom of the screen. Pressing Esc takes you back to the command you were changing so that you can reselect a key assignment.

The Default Edit Modes Option

Press D to bring up the Default edit modes menu. There are four editor modes you can install: Load/save pick list, Insert mode, Auto-indent mode, and Tabs. These are all toggles.

Load/save pick list    With this option on, Turbo C will automatically save the current pick list when you exit Turbo C, and then reload that file upon reentering the program. If you have this option off when you exit Turbo C, your pick list will not be saved.

Insert      With Insert mode on, anything you enter at the keyboard is inserted at the cursor position, pushing any text to the right of the cursor further right. Toggling Insert mode off allows you to overwrite text at the cursor.
Auto-indent

With Auto-indent mode on, the cursor returns to the starting column of the previous line when you press Enter. When toggled off, the cursor always returns to column one.

Tab

With Tab mode on, a tab is placed in the text using a fixed tab stop of 8. Toggle it off, and it spaces to the beginning of the first letter of each word in the previous line.

When you load Turbo C, the default value for Load/save pick list is off; the default values for the other three modes are on. You can change the defaults to suit your preferences and save them back to Turbo C. Of course, you’ll still be able to toggle these modes from inside Turbo C’s editor.

Look at the Quick-Ref line for directions on how to select these options: Either use the arrow keys to move the selection bar to the option and then press Enter, or press the key that corresponds to the highlighted capital letter of the option.

The Screen Mode Option

Normally, Turbo C will correctly detect your system’s video mode so you should only change the Screen mode option if

- you want to select a mode other than your current video mode
- you have a Color/Graphics Adapter that doesn’t “snow”
- you think Turbo C is incorrectly detecting your hardware

Press S to select Screen mode from the installation menu. A pop-up menu will appear; from this menu you can select the screen mode Turbo C will use during operation. Your options include Default, Color, Black and white, or Monochrome. These are fairly intuitive.

Default

By default, Turbo C will always operate in the mode that is active when you load it.

Color

Turbo C will use color mode with 80 x 25 characters, no matter what mode is active, and switches back to the previously active mode when you exit.

Black and White

Turbo C will use black and white mode with 80 x 25 characters, no matter what mode is active, and switches back to the previously active mode when you exit.
Monochrome Turbo C will use monochrome mode, no matter what mode is active, and switches back to the previously active mode when you exit.

When you select one of the first three options, the program conducts a video test on your screen; the Quick-Ref line tells you what to do. When you press any key, a window comes up with the query Was there Snow on the screen?. You can choose

- Yes, the screen was “snowy;”
- No, always turn off snow checking;
- Maybe, always check the hardware; look to the Quick-Ref line for more about Maybe.

Press Esc to return to the main installation menu.

The Color Customization Option

Pressing C from the main installation menu allows you to make extensive changes to the Colors of your version of Turbo C. After pressing C, you will see a menu with these options:

- Customize colors
- 1st color set
- 2nd color set
- 3rd color set

Because there are nearly 50 different screen items that can be given their own customized colors, you will probably find it easier to choose a preset set of colors to your liking. Three preset color sets are on disk. Press 1, 2, or 3 and scroll through the colors for the Turbo C screen items using the PgUp and PgDn keys. If none of the preset color sets is to your liking, however, you can still design your own.

To make custom colors, press C to Customize colors. Now you have a choice of 12 types of items that can be color-customized in Turbo C; some of these are text items, some are screen lines and boxes. Choose one of these items by pressing a letter A through L.

Once you choose a screen item to color-customize, you will see a pop-up menu and a view port: The first is an example of the screen item you chose; the second displays the components of that selection, and also reflects the change in colors as you scroll through the color palette. For example, if you chose H to customize the colors of Turbo C’s error boxes, you would see a new menu with the four different parts of an error box: its Title, Border, Normal text, and Inverse text.
You must now select one of the components from the pop-up menu. Type the appropriate highlighted letter, and you're treated to a color palette for the item you chose. Using the arrow keys, select a color to your liking. Press Enter to record your selection.

Repeat this procedure for every screen item you want to change the color of. When you are finished, press Esc until you are back at the main installation menu.

Note: Turbo C maintains three internal color tables: one each for color, black and white, and monochrome. TCINST only allows you to change one set of colors at a time, based upon your current video mode. So, for example, if you wanted to change to the black and white color table, you would set your video mode to BW80 at the DOS prompt and then load TCINST.

The Resize Windows Option

This option allows you to change the respective sizes of the Edit and Message windows in Turbo C. Press R to choose Resize windows from the main installation menu.

Using the Up and Down arrow keys, you can move the bar dividing the Edit window from the Message window. Neither window can be smaller than three lines. When you have resized the windows to your liking, press Enter. You can discard your changes and return to the Installation menu by pressing Esc.

Quitting the Program

Once you have finished making all desired changes, select Quit/save/edit at the main installation menu. The message

Save changes to TC.EXE? (Y/N)

will appear at the bottom of the screen.

■ If you press Y (for Yes), all the changes you have made will be permanently installed into Turbo C. (Of course, you can always run this program again if you want to change them.)
■ If you press N (for No), your changes will be ignored and you will be returned to the operating system prompt.
If you decide you want to restore the original Turbo C factory defaults, simply copy TC.EXE from your master disk onto your work disk. You can also restore the Editor commands by selecting the E option at the main menu, then press R (for Restore) and Esc.
MicroCalc

MicroCalc—written in Turbo C—is a spreadsheet program. Its source code files and an object file are provided with your TURBO C system as an example program. The spreadsheet program is an electronic piece of paper on which you can enter text, numbers and formulas, and have MicroCalc do calculations on them automatically.

About MicroCalc

Since MicroCalc is only a demonstration program, it has its limitations (which you may have fun eliminating):

- You cannot copy formulas from one cell to others
- You cannot copy text or values from one cell to others
- Cells that are summed must be in the same column or row

In spite of its limitations, MicroCalc does provide some interesting features. Among these are the following:

- Writing directly to video memory for maximum display speed
- Full set of mathematical functions
- Built-in line editor for text and formula editing
- Ability to enter text across cells
In addition to these, MicroCalc offers many of the usual features of a spreadsheet program; you can do all of the following:

- Load a spreadsheet from the disk
- Save a spreadsheet on the disk
- Automatically recalculate after each entry (may be disabled)
- Print the spreadsheet on the printer
- Clear the current spreadsheet.
- Delete columns and rows
- Set a column’s width
- Insert blank columns and rows between existing ones

**How to Compile and Run MicroCalc**

Compiling MicroCalc is easy. All you need to do is copy all the MC*.* files from your distribution disk to your TURBOC directory (where TC.EXE and/or TCC.EXE reside). You can compile and run MicroCalc with either version of Turbo C. In both cases, compiling under a large data model (COMPACT, LARGE, or HUGE) will give you much more memory for your spreadsheets.

**With TC.EXE**

After you have set the INCLUDE and LIB directories in the O/Environment menu, do the following:

1. Run TC.EXE
2. In the Project menu, specify the project name “MCALC.PRJ”
3. From the main menu select the Run option

**With TCC.EXE**

Compile from DOS with the following command line:

```
TCC mcalc mcparsr mcdisply mcinput mcommand mcoutil mcmvsmem.obj
```
Note: You must also specify the INCLUDE and LIB directories with the -I and -L command-line options, respectively.

How to use MicroCalc

Once you have compiled MicroCalc, you can run it in one of two ways.

If you compiled with the Run command from TC, MicroCalc will come up on your screen; when you exit, you will return to Turbo C.

If you want to run MCALC.EXE from the DOS command line, just type MCALC. (If you already have a spreadsheet file, you can automatically load it by typing

    MCALC <your_file>

at the DOS prompt.)

This is an example of what you will see once MicroCalc is loaded:

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>22.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>2.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>28.00</td>
<td></td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

20
A5 Formula
A1+A2+A3+A4

The MicroCalc screen is divided into cells. A cell is a space on the spreadsheet designated by a column-row pair. By default, each column is 10 characters wide; you can change this to a maximum of 77 characters (each).

The columns are named A-Z and AA-CV; the rows are numbered 1-100. This gives a total of 10000 cells. You can change these limits by modifying the constants MAXROWS and MAXCOLS in MCALC.H.
A cell may contain a value, a formula or some text; these are known as cell types. The type of the cell and its coordinates are shown in the bottom left corner of the screen:

- **A5 Formula**: Means that the current cell, A5, contains a formula.
- **A1 Text**: Cell A1 contains text.
- **A2 Value**: Cell A2 contains a value and no cell references.

In this example the line **A5 Formula** shows that the active cell is cell A5 and that it contains a formula. The last line, **A1+A2+A3+A4**, says the active cell contains the sum of A1 through A4. These two lines mean that the numbers in cells A1, A2, A3 and A4 should be added and the result placed in cell A5.

The formula can be abbreviated to **A1:A4**, meaning “add all cells from A1 to A4”.

The following are examples of valid cell formulas:

- **A1+(B2−C7)** subtract cell C7 from B2 and add the result to cell A1
- **A1:A23** the sum of cells: A1,A2,A3..A23

The formulas may be as complicated as you want; for example:

\[
\sin(A1) \times \cos(A2) / ((1.2 \times A8) + \log(\text{abs}(A8) + 8.9 \times 10^{-3})) + (C1:C5)
\]

To enter data in any cell, move the cursor to that cell and enter the data. MicroCalc automatically determines if the cell’s type is value, formula, or text.
Standard MicroCalc Functions and Operators

<table>
<thead>
<tr>
<th>Standard Functions</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>+, -, *, /</td>
<td>addition, subtraction, multiplication, division</td>
</tr>
<tr>
<td>^</td>
<td>raises a number to a power (example: (2^3 = 8))</td>
</tr>
<tr>
<td>:</td>
<td>returns the sum of a group of cells (ex: A1:A4 = A1+A2+A3+A4)</td>
</tr>
<tr>
<td>ABS</td>
<td>absolute value</td>
</tr>
<tr>
<td>ACOS</td>
<td>arc cosine</td>
</tr>
<tr>
<td>ASIN</td>
<td>arc sine</td>
</tr>
<tr>
<td>ATAN</td>
<td>arc tangent</td>
</tr>
<tr>
<td>COS</td>
<td>cosine</td>
</tr>
<tr>
<td>COSH</td>
<td>hyperbolic cosine</td>
</tr>
<tr>
<td>EXP</td>
<td>exponential function</td>
</tr>
<tr>
<td>LOG</td>
<td>logarithm</td>
</tr>
<tr>
<td>LOG10</td>
<td>base 10 logarithm</td>
</tr>
<tr>
<td>POW10</td>
<td>raise argument to the 10th power</td>
</tr>
<tr>
<td>ROUND</td>
<td>round to the nearest whole number</td>
</tr>
<tr>
<td>SIN</td>
<td>sine</td>
</tr>
<tr>
<td>SINH</td>
<td>hyperbolic sine</td>
</tr>
<tr>
<td>SQR</td>
<td>square</td>
</tr>
<tr>
<td>SQRT</td>
<td>square root</td>
</tr>
<tr>
<td>TAN</td>
<td>tangent</td>
</tr>
<tr>
<td>TANH</td>
<td>hyperbolic tangent</td>
</tr>
<tr>
<td>TRUNC</td>
<td>return the whole part of a number</td>
</tr>
</tbody>
</table>
Standard MicroCalc Commands

/ brings up the main menu
/SL loads a spreadsheet
/SS saves the current spreadsheet
/SP prints the current spreadsheet
/SC clears the current spreadsheet
/F formats a group of cells
/D deletes the current cell
/G moves the cursor to a selected cell
/CI inserts a column
/CD deletes the current column
/CW changes the width of the current column
/RI inserts a row
/RD deletes the current row
/E edits the current cell
/UR recalculates the formulas in the spreadsheet
/UF toggles the display of the text of formulas in cells instead of the value of the formulas
/A toggles AutoCalc on/off
/Q quits from MicroCalc
DEL deletes the current cell
HOME moves to cell A1
END moves to the rightmost column and bottom row of the spreadsheet
PGUP and PGIN move up or down a full screen
F2 allows you to edit the data in the current cell.

While you’re editing, the following commands work:

ESC disregards changes made to the data.
←, → The left and right arrow keys move to the left and right.
↑, ↓, ↓ The up and down arrow keys, and the Enter key, enter the input then return to the current cell.
HOME moves to the start of the input.
END moves to the end of the input.
DEL deletes the character under the cursor.
INS changes between insert/overwrite mode.
Backspace deletes the character to the left of the cursor.
The MicroCalc Parser

This information is provided in case you want to modify the MicroCalc parser (for instance, you might want to add a function that takes two parameters). The state and goto information for the parser was created using the UNIX YACC utility. The input to YACC was as follows:

```
$token CONST CELL FUNC

e: e '+' t
  | e '-' t
  | t

t: t '*' f
  | t '/' f
  | f

f: x '*' f
  | x

x: '-' u
  | u

u: CELL ':' CELL
  | o

o: CELL
  | '(' e ')'f
  | CONST
  | FUNC '(' e ')

%%
```
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This quick-start tutorial gives you a concise history of computer programming languages, an explanation of computer functions, and a summary of how to write, compile, and run Turbo Pascal programs.

**Part II: A Programmer's Guide to Turbo Pascal**

This section covers the specifics of Turbo Pascal: program structure, data types, control structures, procedures, functions, arrays, strings, records, sets, pointers, dynamic allocation, files, and—last but not least—units (an important addition to Turbo Pascal 4.0). Bringing all these concepts together, the section culminates in an explanation of a working program: the Turbo TYPIST program (which is also provided on disk).

**Part III: Advanced Programming.**

This high-powered section of the Tutor takes you through such sophisticated topics as stacks, queues, lists, binary trees, graphs, and linked structures. Sorting and searching techniques follow, as do sections on typed constants, numbering systems, and Boolean integer operations.

**Technical Features**

- Includes disk and 400-page manual
- Covers all aspects of Turbo Pascal programming
- Describes the advanced features of Turbo Pascal 4.0
- Useful for both novice and experienced programmers
- Thousands of lines of fully commented example programs

**Suggested retail price: $69.95**

(not copy protected)

Minimum system requirements: For the IBM PS/2® and the IBM® and Compaq® families of personal computers and all 100% compatibles. PC-DOS (MS-DOS®) 2.0 or later, 256K memory, Turbo Pascal 4.0 or later.

All Borland products are trademarks or registered trademarks of Borland International, Inc. A Borland Turbo Tutor® product. Other brand and product names are trademarks or registered trademarks of their respective holders. Copyright ©1987 Borland International, Inc.
With the Turbo Pascal Database Toolbox you can build your own powerful, professional-quality database programs. And like all other Borland Toolboxes, it's advanced enough for professional programmers yet easy enough for beginners.

Ready-to-use modules

The Toolbox enhances your programming with two problem-solving modules: Turbo Access and Turbo Sort.

Turbo Sort uses the Quicksort method to sort data on single items or on multiple keys. Features virtual memory management for sorting large data files. (Commented source code is included on the disk.)

Turbo Pascal Access quickly locates, inserts, or deletes records in a database using B+ trees—the fastest method for finding and retrieving database information. (Source code is included.)

Trainer is a demonstration program that graphically displays how B+ trees work. You can key in sample records and see a visual index of B+ trees being built.

The Toolbox also includes routines for importing and exporting Reflex® database files to use with your database programs.

Free sample database

Included is a free sample database with source code. Just compile it, and it's ready to go to work for you—you can use it as is or customize it. You can search the database by keywords or numbers, and update, add or delete records, as needed.

Saves you time and money

If you're a professional programmer writing software for databases or other applications where search-and-sort capabilities are important, we can save you time and money. Instead of writing the same tedious but essential routines over and over again, you can simply include any of the Toolbox's modules in your own compiled programs.

Technical Features

- Maximum data/index files open: 15 files
- Maximum file size: unlimited
- Maximum record size: 64K
- Maximum number of records: +2 billion
- Maximum key size: 256 bytes
- Maximum number of keys: +2 billion

Suggested retail price $99.95 (not copy protected)

Minimum system requirements: For the IBM PS/2® and the IBM® and Compaq® families of personal computers and all 100% compatibles running Turbo Pascal 4.0, PC-DOS (MS-DOS®) 2.0 or later. Memory: 256K.

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Even if you're new to Turbo Pascal programming, the Turbo Pascal Graphix Toolbox will get you started immediately.

It's a collection of tools that will get you right into the fascinating world of high-resolution business graphics, including graphics window management. You get immediate, satisfying results. And you never have to pay royalties—even if you distribute your own compiled programs that include all or part of the Turbo Pascal Graphix Toolbox procedures.

The Toolbox Includes

- Commented source code on disk.
- Tools for drawing simple graphics.
- Tools for drawing complex graphics, including curves with optional smoothing.
- Routines that let you store and restore graphic images to and from disk.
- Tools allowing you to send screen images to Epson*-compatible printers.
- Full graphics window management
- Two different font styles for graphic labeling
- Choice of line-drawing styles

Suggested retail price $99.95 (not copy protected)

- Routines that will let you quickly plot functions and model experimental data.
- Routines that are structured into Pascal units so you don't have to recompile the toolbox code everytime you use it.

If you ever plan to create Turbo Pascal programs that make use of business graphics or scientific graphics, you need the Turbo Pascal Graphix Toolbox.

While most people only talk about low-cost personal computer software, Borland has been doing something about it. And Borland provides good technical support as part of the price.

John Markov & Paul Freiberger, syndicated columnists.
Build your own text editor or word processor with the Turbo Pascal Editor Toolbox routines

Turbo Pascal Editor Toolbox gives you three different text editors. You get the code, the manual, and the know-how. We provide all the editing routines. You plug in the features you want. You can build a WordStar®-like editor, with pull-down menus like Microsoft Word®, and make it as fast as WordPerfect®.

This is what you'll get:

- **MicroStar**: A full-blown text editor with a complete pull-down menu user interface.
- **FirstEd**: A complete editor equipped with block commands, windows, and memory-mapped screen routines.
- **Binary Editor**: Written in assembly language, a "black box" that you can easily incorporate into your programs.

To demonstrate the tremendous power of Turbo Pascal Editor Toolbox, we give you the source code for MicroStar and FirstEd, optimized for Turbo Pascal 4.0.

MicroStar gives you all the convenience and standard features of any advanced word processor, plus more.

- Easy installation and operation
- Adjustable/"smart" tab toggle
- Search, replace, and search/apply macro options
- Background printing
- Print formatting commands

"A 'write your own word processor' program for intermediate-level programmers, with lots of help in the form of prewritten procedures covering everything from word wrap to pull-down windows.

*Peter Feldmann, PC Magazine*

Best of all, you get the source code!

Include Turbo Pascal Editor Toolbox routines in your programs.

And pay no royalties.

Suggested retail price $99.95 (not copy protected)

Minimum system requirements: The Turbo Pascal Editor Toolbox requires an IBM PC, XT, AT, Portable, 3270, PCjr, or Compaq or any true compatibles with a minimum of 256K, running PC-DOS (MS-DOS®) 2.0 or greater. You must be using Turbo Pascal 4.0 for IBM, Compaq and compatibles.

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Three computer games ready to play, learn, or modify.

Explore the world of state-of-the-art computer games with Turbo Pascal GameWorks. Using easy-to-understand examples, Turbo Pascal GameWorks teaches you techniques to quickly create your own computer games. Or, for instant excitement, play the games we've included on disk—compiled and ready-to-run.

**Turbo Chess**

Test your chess-playing skills against your computer challenger. With Turbo Pascal GameWorks, you're on your way to becoming a master chess player. Explore the complete Turbo Pascal source code and discover the secrets of Turbo Chess.

What impressed me the most was the fact that with this program you can become a computer chess analyst. You can add new variations to the program at any time and make the program play stronger and stronger chess. There's no limit to the fun and enjoyment of playing Turbo GameWorks' Chess, and most important of all, with this chess program, there's no limit to how it can help you improve your game.

George Koltanowski, former President of the United Chess Federation

There has never been a bridge program written which plays at the expert level, and the ambitious user will enjoy tackling that challenge, with the format already structured in the program. And for the inexperienced player, the bridge program provides an easy-to-follow format that allows the user to start right out playing. The user can 'play bridge' against real competition without having to gather three other people.

Kit Woolsey, twice champion of the Blue Ribbon Pairs

**Turbo Go-Moku**

Prepare for battle when you challenge your computer to a game of Go-Moku—the exciting strategy game also known as "Pente". In this battle of wits, you and the computer take turns placing X's and O's on a grid of 19 × 19 squares until five pieces are lined up in a row. Vary the game if you like, using the source code available on your disk.

Suggested retail price $99.95 (not copy protected)

Minimum system requirements: IBM PS/2, PC, XT, AT, Portable, 3270, PCjr, and Compaq and true compatibles with 192K system memory, running PC-DOS (MS-DOS) 2.0 or later. To edit and compile the Turbo Pascal source code, you must be using Turbo Pascal 4.0.

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New from Borland's Scientific & Engineering Division, Turbo Pascal Numerical Methods Toolbox implements the latest high-level mathematical methods to solve common scientific and engineering problems. Fast.

Whenever you need to calculate an integral, work with Fourier Transforms or incorporate any of the classic numerical analysis tools into your programs, you won't have to reinvent the wheel. The Numerical Methods Toolbox is a complete collection of Turbo Pascal routines and programs that gives you applied state-of-the-art math tools.

It also includes two graphics demo programs, Least Squares Fit and Fast Fourier Transforms, to give you the picture along with the numbers.

The Numerical Methods Toolbox is a must for you if you're involved with any type of scientific or engineering computing. Because it comes with complete source code, you have total control of your application.

What Numerical Methods Toolbox can do for you:

- Find solutions to equations
- Interpolations
- Calculus: numerical derivatives and integrals
- Matrix operations: inversions, determinants, and eigenvalues
- Differential equations
- Least squares approximations
- Fourier transforms

Five free ways to look at “Least Squares Fit”!

As well as a free demo “Fast Fourier Transforms,” you also get “Least Squares Fit” in 5 different forms—which gives you 5 different methods of fitting curves to a collection of data points. The different forms are:

1. Power
2. Exponential
3. Logarithm
4. 5-term Fourier
5. 5-term Polynomial

They're all ready to compile and run "as is." To modify or add graphics to your own programs, you simply add Turbo Pascal Graphix Toolbox (version 4.0 or later) to your software library. Our Numerical Methods Toolbox is designed to work hand-in-hand with our Graphix Toolbox to make professional graphics in your own programs an instant part of the picture!

Suggested retail price $99.95 (not copy protected)

Minimum system configuration: For the IBM PS/2*, and the IBM* and Compaq* families of personal computers and all 100% compatibles. PC-DOS (MS-DOS*) 2.0 or later. 256K. Turbo Pascal 4.0 or later. The graphics modules require a graphics monitor with an IBM CGA, IBM EGA, IBM 3270 PC, ATT 6300, or Hercules compatible adapter card, and require the Turbo Pascal Graphix Toolbox version 4.0 or later. An 8087 or 80287 numeric coprocessor is not required, but recommended for optimal performance. Apple Macintosh version of this program is also available.

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The natural language of Artificial Intelligence

Turbo Prolog brings fifth-generation supercomputer power to your IBM*PC!

Turbo Prolog takes programming into a new, natural, and logical environment

With Turbo Prolog, because of its natural, logical approach, both people new to programming and professional programmers can build powerful applications such as expert systems, customized knowledge bases, natural language interfaces, and smart information management systems.

Turbo Prolog is a declarative language which uses deductive reasoning to solve programming problems.

Turbo Prolog provides a fully integrated programming environment like Borland's Turbo Pascal, the de facto worldwide standard.

You get the complete Turbo Prolog programming system

You get the 200-page manual you're holding, software that includes the lightning-fast Turbo Prolog six-pass compiler and interactive editor, and the free GeoBase natural query language database, which includes commented source code on disk, ready to compile. (GeoBase is a complete database designed and developed around U.S. geography. You can modify it or use it "as is").

Minimum system configuration: IBM PC, XT, AT, Portable, 3270, PCjr, and true compatibles. PC-DOS (MS-DOS) 2.0 or later. 384K RAM minimum.

Suggested Retail Price $99.95 (not copy protected)
**Turbo Prolog Toolbox**

Enhances Turbo Prolog with more than 80 tools and over 8,000 lines of source code

*Turbo Prolog, the natural language of Artificial Intelligence, is the most popular AI package in the world with more than 100,000 users. Our new Turbo Prolog Toolbox extends its possibilities.*

The Turbo Prolog Toolbox enhances Turbo Prolog—our 5th-generation computer programming language that brings supercomputer power to your IBM PC and compatibles—with its more than 80 tools and over 8,000 lines of source code that can be incorporated into your programs, quite easily.

**Turbo Prolog Toolbox features include:**
- Business graphics generation: boxes, circles, ellipses, bar charts, pie charts, scaled graphics
- Complete communications package: supports XModem protocol
- File transfers from Reflex, dBASE III, Lotus 1-2-3, Symphony
- A unique parser generator: construct your own compiler or query language
- Sophisticated user-interface design tools
- 40 example programs
- Easy-to-use screen editor: design your screen layout and I/O
- Calculated fields definition
- Over 8,000 lines of source code you can incorporate into your own programs

**Suggested Retail Price:** $99.95 (not copy protected)

**Minimum system configuration:** IBM PC, XT, AT or true compatibles. PC-DOS (MS-DOS) 2.0 or later. Requires Turbo Prolog 1.10 or higher. Dual-floppy disk drive or hard disk 512K.

Turbo Prolog Toolbox and Turbo Prolog are trademarks of Borland International, Inc. Reflex is a registered trademark of Borland/Analytica, Inc. dBASE III is a registered trademark of Ashton-Tate. Lotus 1-2-3 and Symphony are registered trademarks of Lotus Development Corp. IBM, XT, and AT are registered trademarks of International Business Machines Corp. MS-DOS is a registered trademark of Microsoft Corp.
The high-speed BASIC you've been waiting for!

You probably know us for our Turbo Pascal® and Turbo Prolog®. Well, we've done it again! We've created Turbo Basic, because BASIC doesn't have to be slow.

If BASIC taught you how to walk, Turbo Basic will teach you how to run!

With Turbo Basic, your only speed is "Full Speed Ahead"! Turbo Basic is a complete development environment with an amazingly fast compiler, an interactive editor and a trace debugging system. And because Turbo Basic is also compatible with BASICA, chances are that you already know how to use Turbo Basic.

Turbo Basic ends the basic confusion

There's now one standard: Turbo Basic. And because Turbo Basic is a Borland product, the price is right, the quality is there, and the power is at your fingertips. Turbo Basic is part of the fast-growing Borland family of programming languages we call the "Turbo Family." And hundreds of thousands of users are already using Borland's languages. So, welcome to a whole new generation of smart PC users!

Free spreadsheet included with source code!

Yes, we've included MicroCalc,® our sample spreadsheet, complete with source code. So you can get started right away with a "real program." You can compile and run it "as is," or modify it.

A technical look at Turbo Basic

- Full recursion supported
- Standard IEEE floating-point format
- Floating-point support, with full 8087 coprocessor integration. Software emulation if no 8087 present
- Program size limited only by available memory (no 64K limitation)
- EGA, CGA, MCGA and VGA support
- Full integration of the compiler, editor, and executable program, with separate windows for editing, messages, tracing, and execution
- Compile and run-time errors place you in source code where error occurred
- Access to local, static and global variables
- New long integer (32-bit) data type
- Full 80-bit precision
- Pull-down menus
- Full window management

Suggested Retail Price: $99.95 (not copy protected)

Minimum system configuration: IBM PC, AT, XT, PS/2 or true compatibles. 320K. One floppy drive. PC-DOS (MS-DOS) 2.0 or later.

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BOR 0265B
With the Turbo Basic Database Toolbox you can build your own powerful, professional-quality database programs. And like all other Borland Toolboxes, it’s advanced enough for professional programmers yet easy enough for beginners.

Three ready-to-use modules
The Toolbox enhances your programming with three problem-solving modules:

**Turbo Access** quickly locates, inserts, or deletes records in a database using B+ trees—the fastest method for finding and retrieving database information. (Source code is included.)

**Turbo Sort** uses the Quicksort method to sort data on single items or on multiple keys. Features virtual memory management for sorting large data files. (Commented source code is on disk.)

**TRAINER** is a demonstration program that graphically displays how B+ trees work. You can key in sample records and see a visual index of B+ trees being built.

Free sample database
Included is a free sample database with source code. Just compile it, and it’s ready to go to work for you—you can use it as is or customize it. You can search the database by keywords or numbers, update records, or add and delete them, as needed.

Saves you time and money
If you’re a professional programmer writing software for databases or other applications where search-and-sort capabilities are important, we can save you time and money. Instead of writing the same tedious but essential routines over and over again, you can simply include any of the Toolbox’s modules in your own compiled programs.

**Technical Features**

| ✔ Maximum number of files open: 15 files, or 7 data sets | ✔ Maximum number of records: +2 billion |
| ✔ Maximum file size: 32 Mb | ✔ Maximum field size: 32K |
| ✔ Maximum record size: 32K | ✔ Maximum key size: 128 bytes |
|   | ✔ Maximum number of keys: +2 billion |

**Suggested Retail Price:** $99.95 (not copy protected)

Minimum system requirements: For the IBM PS/2 and the IBM* and Compaq* families of personal computers and all 100% compatibles, running Turbo Basic 1.0. PC-DOS (MS-DOS*) 2.0 or later. Memory: 640K.

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With Turbo Basic we gave you the fastest BASIC around. Now the Turbo Basic Editor Toolbox will help you build your own superfast editor to incorporate into your Turbo Basic programs. We provide all the editing routines. You plug in the features you want!

Two sample editors with source code

To demonstrate the tremendous power of the Toolbox, we've included two sample editors with complete source code:

**FirstEd.** A complete editor with windows, block commands, and memory-mapped screen routines, all ready to include in your programs.

**MicroStar**: A full-blown text editor with a pull-down menu user interface and all the standard features you'd expect in any word processor. Plus features other word processors can't begin to match:

- RAM-based editor for superfast editing
- View and edit up to eight windows at a time
- Support for line, stream, and column block mode
- Instant paging, scrolling, and text display
- Up to eight hidden buffers at a time to edit, swap, and call text from
- Multitasking to let you print in the "background"
- Keyboard installation for customizing command keys
- Custom designing of colors for text, windows, menus, and status line
- Support for DOS functions like Copy file, Delete file, Change directory, and Change logged drive

Build the word processor of your choice!

We give you easy-to-install modules. Use them to build yourself a full-screen editor with pull-down menus, and make it work as fast as most word processors—without having to spend hundreds of dollars!

Source code for everything in the Toolbox is provided. Use any of its features in your own Turbo Basic programs or in programs you develop for others. You don't even have to pay royalties!

**Suggested Retail Price:** $99.95 (not copy protected)

Minimum system requirements: For the IBM PS/2® and the IBM® and Compaq® families of personal computers and all 100% compatibles running Turbo Basic 1.0. PC-DOS (MS-DOS®) 2.0 or greater. Memory: 640K.
EUREKA: THE SOLVER™

The solution to your most complex equations—in seconds!

If you're a scientist, engineer, financial analyst, student, teacher, or any other professional working with equations, Eureka: The Solver can do your Algebra, Trigonometry and Calculus problems in a snap.

Eureka also handles maximization and minimization problems, plots functions, generates reports, and saves an incredible amount of time. Even if you're not a computer specialist, Eureka can help you solve your real-world mathematical problems fast, without having to learn numerical approximation techniques. Using Borland's famous pull-down menu design and context-sensitive help screens, Eureka is easy to learn and easy to use—as simple as a hand-held calculator.

\[ X + \exp(X) = 10 \] solved instantly instead of eventually!

Imagine you have to “solve for X,” where \( X + \exp(X) = 10 \), and you don't have Eureka: The Solver. What you do have is a problem, because it's going to take a lot of time guessing at “X.” With Eureka, there's no guessing, no dancing in the dark—you get the right answer, right now. (PS: \( X = 2.0705799 \), and Eureka solved that one in .4 of a second!)

**How to use Eureka: The Solver**

1. Enter your equation into the full-screen editor
2. Select the “Solve” command
3. Look at the answer
4. You're done

**Some of Eureka's key features**

- A formula or formulas
- A series of equations—and solve for all variables
- Constraints (like X has to be \(< 2\) or \(= 2\))
- A function to plot
- Unit conversions
- Maximization and minimization problems
- Interest Rate/Present Value calculations
- Variables we call “What happens?,” like “What happens if I change this variable to 21 and that variable to 27?”

**Eureka: The Solver includes**

- A full-screen editor
- Pull-down menus
- Context-sensitive Help
- On-screen calculator
- Automatic 8087 math co-processor chip support
- Powerful financial functions
- Built-in and user-defined math and financial functions
- Ability to generate reports complete with plots and lists
- Polynomial finder
- Inequality solutions

**Minimum system configuration:** IBM PC, AT, XT, PS/2, Portable, 3270 and true compatibles. PC-DOS (MS-DOS) 2.0 and later. 384K.

**Suggested Retail Price:** $167.00 (not copy protected)

Eureka: The Solver is a trademark of Borland International, Inc. IBM, AT, and XT are registered trademarks of International Business Machines Corp. MS-DOS is a registered trademark of Microsoft Corp. Copyright 1987 Borland International
Borland's super graphic new generation spreadsheet: Twice the power at half the price! Ten types of presentation-quality graphs. Compatible with 1-2-3®, dBASE®, Paradox® and other spreadsheets and databases.

Quattro, Borland's new generation professional spreadsheet, proves there are better and faster ways to get your work done—whether it's graphics, recalculations, macros, or search and sort.

Presentation-quality graphics

Quattro has excellent built-in graphics capabilities that help you create a wide variety of graphs. Bar graphs, line graphs, pie charts, XY graphs, area charts—you can create up to 10 types of graphs, and print them directly from the spreadsheet or store them for future use.

Smarter recalculation

When a formula needs to be recalculated, Quattro uses "intelligent recalc" to recalculate only those formulas whose elements have changed. This makes Quattro smarter and faster than other spreadsheets.

Greater macro capability

You can create macros instantly by recording your actions and storing them in the spreadsheet. The number of macros is limited only by memory. A built-in macro debugging environment makes it easy to find and correct problem areas. Quattro also includes a set of over 40 macro commands which make up a programming language.

Direct compatibility

Quattro can directly load and use data files created with other spreadsheet and database programs like 1-2-3, dBASE, and Paradox. Quattro can read and even write WKS, WK1, and WKE files. You can also import ASCII and other text files into the spreadsheet.

Easy installation

Quattro can detect most computers and screen types, so it's always ready to load and run! Plus, like all other Borland products, Quattro is not copy protected!

Technical Features

- Understands your 1-2-3 macros
- 100 built-in financial and statistical functions
- Menu Builder add-in for customizing menus
- Supports 8087/80287 math coprocessors
- Supports EGA, CGA, and VGA graphics adapters
- Pop-up menus
- Shortcuts to menu commands
- Context-sensitive online help
- Three types of choice lists: @functions and syntax, macro commands, and existing block names
- Pointing lets you specify a block of cells using arrow keys
- Search (or Query) lets you find specific records or cells
- Lets you arrange/rearrange data in alphabetical, numerical, or chronological order
- Supports Expanded Memory Specification to create spreadsheets larger than 640K
- Supports PostScript™ printers and typesetters

Suggested retail price $199.95 (not copy protected)
**SIDEnICK: THE DESKTOP ORGANIZER** Release 2.0

*Macintosh™*

The most complete and comprehensive collection of desk accessories available for your Macintosh!

Thousands of users already know that SideKick is the best collection of desk accessories available for the Macintosh. With our new Release 2.0, the best just got better.

We’ve just added two powerful high-performance tools to SideKick—Outlook™: The Outliner and MacPlan™: The Spreadsheet. They work in perfect harmony with each other and while you run other programs!

**Outlook: The Outliner**
- It’s the desk accessory with more power than a stand-alone outliner
- A great desktop publishing tool, Outlook lets you incorporate both text and graphics into your outlines
- Works hand-in-hand with MacPlan
- Allows you to work on several outlines at the same time

**MacPlan: The Spreadsheet**
- Integrates spreadsheets and graphs
- Does both formulas and straight numbers
- Graph types include bar charts, stacked bar charts, pie charts and line graphs
- Includes 12 example templates free!
- Pastes graphics and data right into Outlook creating professional memos and reports, complete with headers and footers.

**SideKick: The Desktop Organizer,**
*Release 2.0 now includes*
- Outlook: The Outliner
- MacPlan: The Spreadsheet
- Mini word processor
- Calendar
- Phone Log
- Analog clock
- Alarm system
- Calculator
- Report generator
- Telecommunications (new version now supports XModem file transfer protocol)

**Suggested Retail Price:** $99.95 (not copy protected)

Minimum system configurations: Macintosh 512K or Macintosh Plus with one disk drive. One 800K or two 400K drives are recommended. With one 400K drive, a limited number of desk accessories will be installable per disk.

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BOR 00690
**Reflex Plus: The Database Manager**

**Macintosh**

All the Power & Flexibility of a Relational Database Made Easy!

Reflex Plus: The Database Manager is the first relational database that's easy to learn, powerful, and aimed at your needs. Reflex Plus is not a mere file organizer, nor is it a monstrously complicated behemoth aimed solely at consultants. Reflex Plus is the only relational database aimed at your needs and time constraints.

Reflex Plus accomplishes this by taking full advantage of the Macintosh's superior graphic ability while still giving users what they want: unlimited flexibility in creating databases, accessing data, and producing reports.

What puts the plus into Reflex Plus?

**Borland listens** to its customers and has added the most-asked-for features and improvements to Reflex Plus.

High-powered features of Reflex Plus:

- Multiple entry forms for the same database.
- Entry for more than one database in a single entry form.
- Your choice of having an entry form that shows one record at a time, or one that shows all the records at once.
- Calculated fields in entry forms.
- Display-only fields.
- Default (but editable) fields.
- New functions like GROUPBY, which lets you easily show records grouped by values in common.
- A selection of useful templates.
- Larger record size. (You can now choose record sizes of 1000, 2000, or 4000 characters.)

Check out these Reflex Plus features:

- Visual database design.
- A "what you see is what you get" design capability both for entry forms and reports.
- Compatible with all Macintoshes with at least 512K, including the SE", and Macintosh Plus.

The heart of Reflex Plus is in its special functions with which you create formulas. With over 50 function words to choose from, you are given all the power of programming without struggling with complex syntax. Reflex Plus functions are straightforward and can handle all types of data.

Armed with these functions, you create formulas that sort, search, calculate, quantity, qualify—you name it. And if you don't feel up to writing the formula yourself, Reflex Plus will do it for you. Using the FormulaBuild dialog box, you can master even the most complicated formula.

Display grouped data. Reflex Plus gives you unlimited flexibility when you want to display your data grouped in meaningful ways.

Flexible entry forms. Most databases have a data entry form, and that's that. Reflex Plus lets you design your own (but if you don't want to bother, Reflex Plus will make one for you). Here are just some of the options available in your entry forms:

- View all records at once.
- View one record at a time.
- Enter data into many databases at once.
- Use calculated fields.
- Default values in fields, display-only values, and lots more.

Convenience and Ease

- **Preset entry forms.** Let Reflex Plus create an entry form for you.
- **Preset reports.** Let Reflex Plus create a table-style report for you.
- **Paste Formula command.** Let Reflex Plus guide you through the steps of creating formulas for power searching and data manipulation.
- **On-line help facility.** Reflex Plus has an extensive on-screen, context-sensitive help feature.
- **Paste Choice command.** This command lets you paste in fields that duplicate all the attributes of another field. A great time saver. The command also lets you build formulas by pointing and clicking.
- **Auto-save.** You'll never lose data again with Reflex Plus's auto-save feature.


Suggested Retail Price: $279.00 (not copy protected)

Minimum system requirements: Runs on any Macintosh with at least 512K memory. Minimum setup is one 800K (double-sided) disk drive or two 400K (single-sided) drives. Works with the Hierarchical File System, Switcher, and most hard disks. Supports printing on the ImageWriter and the LaserWriter.
Borland’s Macintosh version of Turbo Pascal is so incredibly fast that it can compile 1,420 lines of source code in the 7.1 seconds it took you to read this!

And reading the rest of this takes about 5 minutes, which is plenty of time for Turbo Pascal to compile at least 60,000 more lines of source code!

Turbo Pascal does both Windows and Units

The separate compilation of routines offered by Turbo Pascal creates modules called Units, which can be linked to any Turbo Pascal program. This modular pathway gives you pieces that can be integrated into larger programs. You can use memory more efficiently and reduce the time it takes to develop large programs.

Turbo Pascal is so compatible with MPW that they should be living together

You can compile and run routines from Macintosh Programmer’s Workshop Pascal and Inside Macintosh with only the subtlest changes. Turbo Pascal is also compatible with the Hierarchical File System of the Macintosh.

The 27-second Guide to Turbo Pascal
- Compilation speed of more than 12,000 lines per minute
- Unit structure lets you create programs in modular form
- Multiple editing windows—up to 8 at a time
- Compilation options include compiling to disk or memory, or compile and run
- No need to switch between programs to compile or run a program
- Streamlined development and debugging
- Compatibility with Macintosh Programmer’s Workshop Pascal (with minimal changes)
- Compatibility with Hierarchical File System of your Macintosh
- Ability to define default volume and folder names used in compiler directives
- Search and change features in the editor speed up and simplify alteration of routines
- Ability to use all available Macintosh memory without limit
- Units included to call all the routines provided by Macintosh Toolbox

Suggested Retail Price: $99.95 (not copy protected)

Minimum system configuration: Macintosh 512K or Macintosh Plus with one disk drive.
From the folks who created Turbo Pascal. Borland’s new Turbo Pascal Tutor is everything you need to start programming in Turbo Pascal on the Macintosh! It takes you from the bare basics to advanced programming in a simple, easy-to-understand fashion.

No gimmicks. It’s all here.

The manual, the Tutor application, and 30 sample programs provide a step-by-step tutorial in three phases: programming in Pascal, programming on the Macintosh, and programming in Turbo Pascal on the Macintosh. Here’s how the manual is set up:

**Turbo Pascal for the Absolute Novice** delivers the basics—a concise history of Pascal, key terminology, your first program.

**A Programmer’s Guide to Turbo Pascal** covers Pascal specifics—program structure, procedures and functions, arrays, strings, and so on. We’ve also included Turbo Typist, a textbook sample program.

**Advanced Programming** takes you a step higher into stacks, queues, binary trees, linked structures, writing large programs, and more.

Using the Power of the Macintosh discusses the revolutionary hardware and software features of this machine. It introduces the 600-plus utility routines in the Apple Toolbox.

**Programming the Macintosh in Turbo Pascal** shows you how to create true Macintosh programs that use graphics, pull-down menus, dialog boxes, and so on. Finally, MacTypist, a complete stand-alone application featuring animated graphics, builds on Turbo Typist and demonstrates what you can do with all the knowledge you’ve just acquired.

The disk contains the source code for all the sample programs, including Turbo Typist, MacTypist, and Turbo Tutor. The Tutor’s split screen lets you run a procedure and view its source code simultaneously. After running it, you can take a test on the procedure. If you’re stuck for an answer, a Hint option steers you in the right direction.

The Macintosh topics included are

- ☑ memory management
- ☑ resources and resource files
- ☑ QuickDraw
- ☑ events
- ☑ windows
- ☑ controls
- ☑ menus
- ☑ desk accessory support
- ☑ dialogs
- ☑ File Manager
- ☑ debugging

Suggested Retail Price: $69.95

Minimum system requirements: Any Macintosh with at least 512K of RAM. Requires Turbo Pascal.

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Turbo Pascal Numerical Methods Toolbox for the Macintosh implements the latest high-level mathematical methods to solve common scientific and engineering problems. Fast.

So every time you need to calculate an integral, work with Fourier transforms, or incorporate any of the classical numerical analysis tools into your programs, you don’t have to reinvent the wheel, because the Numerical Methods Toolbox is a complete collection of Turbo Pascal routines and programs that gives you applied state-of-the-art math tools. It also includes two graphics demo programs that use least-square and Fast Fourier Transform routines to give you the picture along with the numbers.

The Turbo Pascal Numerical Methods Toolbox is a must if you’re involved with any type of scientific or engineering computing on the Macintosh. Because it comes with complete source code, you have total control of your application at all times.

What Numerical Methods Toolbox will do for you:

- Find solutions to equations
- Interpolations
- Calculus: numerical derivatives and integrals
- Matrix operations: inversions, determinants, and eigenvalues
- Differential equations
- Least-squares approximations
- Fourier transforms
- Graphics

Five free ways to look at Least-Squares Fit!

As well as a free demo of Fast Fourier Transforms, you also get the Least-Squares Fit in five different forms—which gives you five different methods of fitting curves to a collection of data points. You instantly get the picture! The five different forms are:

1. Power
2. Exponential
3. Logarithm
4. 5-term Fourier
5. 5-term

They’re all ready to compile and run as is.

Suggested Retail Price: $99.95 (not copy protected)

Minimum system requirements: Macintosh 512K, Macintosh Plus, SE, or II, with one 800K disk drive (or two 400K).
If you're a scientist, engineer, financial analyst, student, teacher, or any other professional working with equations, Eureka: The Solver can do your Algebra, Trigonometry and Calculus problems in a snap.

Eureka also handles maximization and minimization problems, plots functions, generates reports, and saves an incredible amount of time. Even if you're not a computer specialist, Eureka can help you solve your real-world mathematical problems fast, without having to learn numerical approximation techniques. Eureka is easy to learn and easy to use—as simple as a hand-held calculator.

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3. Look at the answer
4. You're done

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- Draw a graph
- Zoom in on interesting areas of the graph
- Generate a report and send the output to your printer or disk file
- Or all of the above

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You can key in:
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- A series of equations—and solve for all variables
- Constraints (like \( X \) must be \(<\) or \( =\) 2)
- Functions to plot
- Unit conversions
- Maximization and minimization problems
- Interest Rate/Present Value calculations
- Variables we call “What happens?,” like “What happens if I change this variable to 21 and that variable to 27?”

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Suggested Retail Price: $195.00 (not copy protected)

Minimum system configuration: Macintosh 512K, Macintosh Plus, SE, or II with one 800K disk drive or two 400K disk drives.

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- Links with relocatable object modules created using Borland's Turbo Prolog into a single program.
- ANSI C compatible.
- Start-up routine source code included.
- Both command line and integrated environment versions included.

Silicon benchmark:

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<th>Turbo C</th>
<th>Microsoft® C</th>
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*Benchmark run on a 6 MHz IBM AT using Turbo C version 1.0 and the Turbo Linker version 1.0, Microsoft C version 4.0 and the MS overlay linker version 3.51.

Minimum system requirements: IBM PC, XT, AT, PS/2 and true compatibles. PC-DOS (MS-DOS) 2.0 or later. One floppy drive. 384K.

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