Library Reference

VERSION
1.5

Borland® C++
for OS/2®

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Version 1.5

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100 Borland Way, Scotts Valley, CA 95066-3249

PRINTED IN THE UNITED STATES OF AMERICA

1E0R0294
9495969798-987654321
H1

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Introduction

This manual contains definitions of the Borland C++ classes, nonprivate class members, library routines, common variables, and common defined types for windows programming.

If you're new to C or C++ programming, or if you're looking for information on the contents of the Borland C++ manuals, see the introduction in the *User's Guide*.

Here is a summary of the chapters in this manual:

Chapter 1: The main function discusses arguments to *main* (including wildcard arguments), provides some example programs, and gives some information on Pascal calling conventions and the value that *main* returns.

Chapter 2: Run-time functions is an alphabetical reference of all Borland C++ library functions. Each entry gives syntax, portability information, an operative description, and return values for the function, together with a reference list of related functions and examples of how the functions are used.

Chapter 3: Global variables defines and discusses Borland C++'s global variables. You can use these to save yourself a great deal of programming time on commonly needed variables (such as dates, time, error messages, stack size, and so on).

Chapter 4: The C++ iostreams provides a description of the classes that provide support for I/O in C++ programs.

Chapter 5: Persistent stream classes and macros describes the persistent streams classes and macros.

Chapter 6: The C++ container classes is a description of the C++ objects provided by Borland C++ to support data structures and data abstraction.

Chapter 7: The C++ mathematical classes is a description of C++ mathematics using *bcd* and *complex* classes.

Chapter 8: Class diagnostic macros describes the classes and macros that support object diagnostics.

Chapter 9: Run-time support describes functions and classes that let you control the way your program executes at run time in case the program runs out of memory or encounters some exception.

Chapter 10: C++ utility classes describes the C++ *date*, *string*, and *time* classes.

Appendix A: Run-time library cross-reference contains an overview of the Borland C++ library routines and header files. The header files are listed alphabetically, and the library routines are grouped according to the tasks they commonly perform.

C H A P T E R 1

The main function

Every C and 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 end. Regardless of its location, the following points about *main* always apply.

Arguments to main

Three parameters (arguments) are passed to *main* by the Borland C++ startup routine: *argc*, *argv*, and *env*.

- *argc*, an integer, is the number of command-line arguments passed to *main*.
- *argv* is an array of pointers to strings (**char** *[]).
  - *argv*[0] is the name of the program being run, exactly as the user typed it on the command line.
  - *argv*[1] points to the first string typed on the operating system command line after the program name.
  - *argv*[2] points to the second string typed after the program name.
  - *argv*[*argc*-1] points to the last argument passed to *main*.
  - *argv*[*argc*] contains NULL.
- *env* is also an array of pointers to 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 COMSPEC.
  - *value* is the value to which ENVVAR is set, such as C:\APPS;C:\TOOLS; (for PATH) or C:\DOS\COMMAND.COM for COMSPEC.

If you 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:

```
int main()
int main(int argc)                /* legal but very unlikely */
int main(int argc, char * argv[])
int main(int argc, char * argv[], char * env[])]
```

Refer to the *environ* entry in Chapter 3 and the *putenv* and *getenv* entries in Chapter 2 for more information.

The declaration `int 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*.

The argument *env* is also available through the global variable *environ*.

argc and *argv* are also available via the global variables *_argc* and *_argv*.

An example program

Here is an example that demonstrates a simple way of using these arguments passed to *main*:

```
/* Program ARGS.C */
#include <stdio.h>
#include <stdlib.h>

int 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]);
   return 0;
   }
```

Suppose you run ARGS.EXE at the OS/2 prompt with the following command line:

```
C:> args first_arg "arg with blanks" 3  4 "last but one" stop!
```

Note that you can pass arguments with embedded blanks by surrounding them with 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]: args
   argv[1]: first_arg
```

```
argv[2]: args with blanks
argv[3]: 3
argv[4]: 4
argv[5]: last but one
argv[6]: stop!
```

```
The environment string(s) on this system are:
```

```
env[0]: USER_INI=C:\OS2\OS2.INI
env[1]: SYSTEM_INI=C:\OS2\OS2SYS.INI
env[2]: OS2_SHELL=C:\OS2\CMD.EXE
env[3]: AUTOSTART=PROGRAMS,TASKLIST,FOLDERS
env[4]: RUNWORKPLACE=C:\OS2\PMSHELL.EXE
env[5]: COMSPEC=C:\OS2\CMD.EXE
env[6]: PATH=C:\OS2;C:\OS2\SYSTEM;C:\;C:\OS2\APPS;
env[7]: DPATH=C:\OS2;C:\OS2\SYSTEM;C:\;C:\OS2\APPS;
env[8]: PROMPT=$i[$p]
env[9]: HELP=C:\OS2\HELP;C:\OS2\HELP\TUTORIAL;
env[10]: GLOSSARY=C:\OS2\HELP\GLOSS;
env[11]: KEYS=ON
env[12]: BOOKSHELF=C:\OS2\BOOK;
env[13]: EPATH=C:\OS2\APPS
```

Wildcard arguments

Command-line arguments containing wildcard characters can be expanded to all the matching file names, much the same way DOS expands wildcards when used with commands like COPY. All you have to do to get wildcard expansion is to link your program with the WILDARGS.OBJ object file, which is included with Borland C++.

Once WILDARGS.OBJ is linked into your program code, you can send wildcard arguments of the type *.* to your *main* function. The argument will be expanded (in the *argv* array) to all files matching the wildcard mask. The maximum size of the *argv* array varies, depending on the amount of memory available in your heap.

If no matching files are found, the argument is passed unchanged. (That is, a string consisting of the wildcard mask is passed to *main*.)

Arguments enclosed in quotes ("...") are not expanded.

An example program

The following commands compile the file ARGS.C and link it with the wildcard expansion module WILDARGS.OBJ, then run the resulting executable file ARGS.EXE:

```
BCC  ARGS.C  WILDARGS.OBJ
ARGS  C:\BORLANDC\INCLUDE\*.H  "*.C"
```

When you run ARGS.EXE, the first argument is expanded to the names of all the *.H files in your Borland C++ INCLUDE directory. Note that the expanded argument strings include the entire path. The argument *.C is not expanded because it is enclosed in quotes.

In the IDE, simply specify a project file (from the project menu) that contains the following lines:

```
ARGS
WILDARGS.OBJ
```

Then use the **Run | Arguments** option to set the command-line parameters.

If you prefer the wildcard expansion to be the default, modify your standard C?.LIB library files to have WILDARGS.OBJ linked automatically. To accomplish that, remove SETARGV and INITARGS from the libraries and add WILDARGS. The following commands invoke the Turbo librarian (TLIB) to modify all the standard library files (assuming the current directory contains the standard C and C++ libraries and WILDARGS.OBJ):

For more on TLIB, see the *User's Guide*.

```
tlib c2   -setargv -initargs +wildargs
tlib c2mt -setargv -initargs +wildargs
```

Using -p (Pascal calling conventions)

If you compile your program using Pascal calling conventions (described in detail in Chapter 2, "Language structure," in the *Programmer's Guide*), you must remember to explicitly declare *main* as a C type. Do this with the **_ _cdecl** keyword, like this:

```
int  _ _cdecl main(int argc, char* argv[], char* envp[])
```

The value main returns

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.

Passing file information to child processes

If your program uses the *exec* or *spawn* functions to create a new process, the new process will normally inherit all of the open file handles created by the original process. However, some information about these handles will be lost, including the access mode used to open the file. For example, if your program opens a file for read-only access in binary mode, and then spawns a child process, the child process might corrupt the file by writing to it, or by reading from it in text mode.

To allow child processes to inherit such information about open files, you must link your program with the object file FILEINFO.OBJ. For example:

```
bcc test.c \borlandc\lib\fileinfo.obj
```

The file information is passed in the environment variable _C_FILE_INFO. This variable contains encoded binary information, and your program should not attempt to read or modify its value. The child program must have been built with the C++ run-time library to inherit this information correctly. Other programs can ignore _C_FILE_INFO, and will not inherit file information.

Pop-up screens

POPUP.OBJ adds about 800 bytes of code to your program.

When the run-time library encounters an unrecoverable error, or your program uses the *assert* macro with a false condition, the library displays an error message to the standard error file (normally the display screen) and terminates the program. However, if your program uses a windowing system such as Presentation Manager, or redirects standard error, these error messages might be invisible or overwrite existing screen displays. You can cause error messages to be displayed in a pop-up screen by including the object file POPUP.OBJ when you link your program. For example: `bcc test.c \borlandclib\popup.obj`

Multi-thread programs

OS/2 programs can create more than one thread of execution. OS/2 provides a *DosCreateThread* function for this purpose. However, the C++ run-time library C2.LIB does not support more than one thread. If your program creates multiple threads, and these threads also use the C++ run-time library, you must use the C2MT.LIB library instead.

See the online Help example for *_beginthread* to see how to use these functions and *_threadid* in a program.

The C2MT.LIB library provides the function *_beginthread* function, which you use to create threads. C2MT.LIB also provides the function *_endthread*, which terminates threads, and a global variable *_threadid*. This global variable points to a long integer that contains the current thread's identification number (also known as the *thread ID*). The header file stddef.h contains the declaration of *_threadid*.

When you compile or link a program that uses multiple threads, you must use the –sm compiler switch. For example:

```
bcc -sm thread.c
```

Special care must be taken when using the *signal* function in a multi-thread program. See the description of the *signal* function for more information.

See "The run-time libraries" section in Appendix A for information about linking to the DLL version of the run-time library.

C H A P T E R 2

Run-time functions

Programming examples for each function are available in the online Help system. You can easily copy them from Help and paste them into your files.

This chapter contains a detailed description of each function in the Borland C++ library. The functions are listed in alphabetical order, although a few of the routines are grouped by "family" (the *exec...* and *spawn...* functions, for example) because they perform similar or related tasks.

Each function entry provides certain standard information. For instance, the entry for *free*

- Tells you which header file(s) contains the prototype for *free*.
- Summarizes what *free* does.
- Gives the syntax for calling *free*.
- Gives a detailed description of how *free* is implemented and how it relates to the other memory-allocation routines.
- Lists other language compilers that include similar functions.
- Refers you to related Borland C++ functions.

The following sample library entry lists each entry section and describes the information it contains. The alphabetical listings start on page 10.

Sample function entry — header file name

The *function* is followed by the header file(s) containing the prototype for *function* or definitions of constants, enumerated types, and so on used by *function*.

Function

Summary of what this *function* does.

Syntax

```
function(modifier parameter[,...]);
```

This gives you the declaration syntax for *function*; parameter names are *italicized*. The `[,...]` indicates that other parameters and their modifiers can follow.

Portability is indicated by marks (■) in the columns of the portability table. A sample portability table is shown here:

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2

Each entry in the portability table is described in the following table. Any additional restrictions are discussed in the *Remarks* section.

DOS	Available for DOS.
UNIX	Available under UNIX and/or POSIX.
Win 16	Compatible with 16-bit Windows programs running on Microsoft Windows 3.1, Windows for Workgroups 3.1, and Windows for Workgroups 3.11.
Win 32	Available to 32-bit Windows programs running on Win32s 1.0, and Windows NT 3.1 applications.
ANSI C	Defined by the ANSI C Standard.
ANSI C++	Included in the ANSI C++ proposal.
OS/2	Available for OS/2.

If more than one function is discussed and their portability features are identical, only one row is used. Otherwise, each function is represented in a separate row.

Remarks

This section describes what *function* does, the parameters it takes, and any details you need to use *function* and the related routines listed.

Return value

The value that *function* returns (if any) is given here. If *function* sets any global variables, their values are also listed.

See also

Routines related to *function* that you might want to read about are listed here. If a routine name contains an *ellipsis*, it indicates that you should refer to a family of functions (for example, *exec...* refers to the entire family of *exec* functions: *execl*, *execle*, *execlp*, *execlpe*, *execv*, *execve*, *execvp*, and *execvpe*).

Example

The *function* examples have been moved into online Help so that you can easily cut-and-paste them to your own applications.

abort — stdlib.h

Function

Abnormally terminates a program.

Syntax

```
void abort(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *abort* causes an abnormal program termination by calling *raise*(SIGABRT). If there is no signal handler for SIGABRT, then *abort* writes a termination message ("`Abnormal program termination`") on stderr, then aborts the program by a call to *_exit* with exit code 3.

Return value *abort* returns the exit code 3 to the parent process or to the operating system command processor.

See also *assert, atexit, _exit, exit, raise, signal, spawn...*

abs — stdlib.h

Function Returns the absolute value of an integer.

Syntax

```
int abs(int x);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *abs* returns the absolute value of the integer argument *x*. If *abs* is called when stdlib.h has been included, it's treated as a macro that expands to inline code.

If you want to use the *abs* function instead of the macro, include `#undef abs` in your program, after the `#include <stdlib.h>`.

This function can be used with *bcd* and *complex* types.

Return value The *abs* function returns an integer in the range of 0 to INT_MAX, with the exception that an argument with the value INT_MIN is returned as INT_MIN. The values for INT_MAX and INT_MIN are defined in header file limits.h.

See also *bcd, cabs, complex, fabs, labs*

access — io.h

Function Determines accessibility of a file.

Syntax

```
int access(const char *filename, int amode);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks

access checks the file named by *filename* to determine if it exists, and whether it can be read, written to, or executed.

The list of *amode* values is 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

Under DOS, OS/2, and Windows (16- and 32-bit) all existing files have read access (*amode* equals 04), so 00 and 04 give the same result. Similarly, *amode* values of 06 and 02 are equivalent because under OS/2 write access implies read access.

If *filename* refers to a directory, *access* simply determines whether the directory exists.

Return value

If the requested access is allowed, *access* returns 0; otherwise, it returns a value of –1, and the global variable *errno* is set to one of the following values:

EACCES	Permission denied
ENOENT	Path or file name not found

See also

chmod, fstat, stat

acos, acosl — math.h

Function

Calculates the arc cosine.

Syntax

```
double acos(double x);
long double acosl(long double x);
```

	DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
acos	■	■	■	■	■	■	■
acosl	■		■	■			■

Remarks

acos returns the arc cosine of the input value. *acosl* is the **long double** version; it takes a **long double** argument and returns a **long double** result. Arguments to *acos* and *acosl* must be in the range –1 to 1, or else *acos* and *acosl* return NAN and set the global variable *errno* to

EDOM	Domain error

This function can be used with *bcd* and *complex* types.

Return value *acos* and *acosl* of an argument between –1 and +1 return a value in the range 0 to *pi*. Error handling for these routines can be modified through the functions *_matherr* and *_matherrl*.

See also *asin, atan, atan2, bcd, complex, cos, _matherr, sin, tan*

alloca — malloc.h

Function Allocates temporary stack space.

Syntax

```
void *alloca(size_t size);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks *alloca* allocates size bytes on the stack; the allocated space is automatically freed up when the calling function exits.

Because *alloca* modifies the stack pointer, do not place calls to *alloca* in an expression that is an argument to a function.

The *alloca* function should not be used in the try-block of a C++ program. If an exception is thrown any values placed on the stack by *alloca* will be corrupted.

If the calling function does not contain any references to local variables in the stack, the stack will not be restored correctly when the function exits, resulting in a program crash. To ensure that the stack is restored correctly, use the following code in the calling function:

```
char *p;
char dummy[5];

dummy[0] = 0;
   ⋮
p = alloca(nbytes);
```

Return value If enough stack space is available, *alloca* returns a pointer to the allocated stack area. Otherwise, it returns NULL.

See also *malloc*

asctime — time.h

Function Converts date and time to ASCII.

Syntax

```
char *asctime(const struct tm *tblock);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

asctime converts a time stored as a structure in **tblock* to a 26-character string of the same form as the *ctime* string:

```
Sun Sep 16 01:03:52 1973\n\0
```

Return value

asctime returns a pointer to the character string containing the date and time. This string is a static variable that is overwritten with each call to *asctime*.

See also

ctime, difftime, ftime, gmtime, localtime, mktime, strftime, stime, time, tzset

asin, asinl — math.h

Function

Calculates the arc sine.

Syntax

```
double asin(double x);
long double asinl(long double x);
```

	DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
asin	■	■	■	■	■	■	■
asinl	■		■	■			■

Remarks

asin of a real argument returns the arc sine of the input value. *asinl* is the **long double** version; it takes a **long double** argument and returns a **long double** result.

Real arguments to *asin* and *asinl* must be in the range –1 to 1, or else *asin* and *asinl* return NAN and set the global variable *errno* to

EDOM Domain error

This function can be used with *bcd* and *complex* types.

Return value

asin and *asinl* of a real argument return a value in the range *–pi*/2 to *pi*/2. Error handling for these functions can be modified through the functions *_matherr* and *_matherrl.*

See also

acos, atan, atan2, bcd, complex, cos, _matherr, sin, tan

assert — assert.h

Function Tests a condition and possibly aborts.

Syntax

```
void assert(int test);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

assert is a macro that expands to an **if** statement; if *test* evaluates to zero, *assert* prints a message on *stderr* and aborts the program (by calling *abort*).

assert displays this message:

```
Assertion failed: test, file filename, line linenum
```

The *filename* and *linenum* listed in the message are the source file name and line number where the *assert* macro appears.

If you place the `#define NDEBUG` directive ("no debugging") in the source code before the `#include <assert.h>` directive, the effect is to comment out the *assert* statement.

Return value None.

See also *abort*

atan, atanl — math.h

Function Calculates the arc tangent.

Syntax

```
double atan(double x);
long double atanl(long double x);
```

	DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
atan	■	■	■	■	■	■	■
atanl	■		■	■			■

Remarks

atan calculates the arc tangent of the input value.

atanl is the **long double** version; it takes a **long double** argument and returns a **long double** result. This function can be used with *bcd* and *complex* types.

Return value

atan and *atanl* of a real argument return a value in the range *–pi*/2 to *pi*/2. Error handling for these functions can be modified through the functions *_matherr* and *_matherrl*.

See also

acos, asin, atan2, bcd, complex, cos, _matherr, sin, tan

atan2, atan2l — math.h

Function

Calculates the arc tangent of *y*/*x*.

Syntax

```
double atan2(double y, double x);
long double atan2l(long double y, long double x);
```

	DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
atan2	■	■	■	■	■	■	■
atan2l	■		■	■			■

Remarks

atan2 returns the arc tangent of *y*/*x*; it produces correct results even when the resulting angle is near *pi*/2 or *–pi*/2 (*x* near 0). If both *x* and *y* are set to 0, the function sets the global variable *errno* to EDOM, indicating a domain error.

atan2l is the **long double** version; it takes **long double** arguments and returns a **long double** result.

Return value

atan2 and *atan2l* return a value in the range *–pi* to *pi*. Error handling for these functions can be modified through the functions *_matherr* and *_matherrl*.

See also

acos, asin, atan, cos, _matherr, sin, tan

atexit — stdlib.h

Function

Registers termination function.

Syntax

```
int atexit(void (_USERENTRY * func)(void));
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■	■	■	■

Remarks

atexit registers the function pointed to by *func* as an exit function. Upon normal termination of the program, *exit* calls *func* just before returning to the operating system. *func* must be used with the _USERENTRY calling convention.

Each call to *atexit* registers another exit function. Up to 32 functions can be registered. They are executed on a last-in, first-out basis (that is, the last function registered is the first to be executed).

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

See also *abort, _exit, exit, spawn...*

atof, _atold — math.h

Function Converts a string to a floating-point number.

Syntax

```
double atof(const char *s);
long double _atold(const char *s);
```

	DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
atof	▪	▪	▪	▪	▪	▪	▪
_atold	▪		▪	▪			▪

Remarks *atof* converts a string pointed to by *s* to **double**; this function recognizes the character representation of a floating-point number, made up of the following:

- An optional string of tabs and spaces
- An optional sign
- A string of digits and an optional decimal point (the digits can be on both sides of the decimal point)
- An optional *e* or *E* followed by an optional signed integer

The characters must match this generic format:

[*whitespace*] [*sign*] [*ddd*] [.] [*ddd*] [e | E[*sign*]*ddd*]

atof also recognizes +INF and –INF for plus and minus infinity, and +NAN and –NAN for Not-a-Number.

In this function, the first unrecognized character ends the conversion.

_atold is the **long double** version; it converts the string pointed to by *s* to a **long double**.

strtod and *_strtold* are similar to *atof* and *_atold*; they provide better error detection, and hence are preferred in some applications.

Return value *atof* and *_atold* return the converted value of the input string.

If there is an overflow, *atof* (or *_atold*) returns plus or minus HUGE_VAL (or _LHUGE_VAL), *errno* is set to ERANGE (Result out of range), and *_matherr* (or *_matherrl*) is not called.

See also *atoi, atol, ecvt, fcvt, gcvt, scanf, strtod*

atoi — stdlib.h

Function Converts a string to an integer.

Syntax

```
int atoi(const char *s);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *atoi* converts a string pointed to by *s* to **int**; *atoi* recognizes (in the following order)

- An optional string of tabs and spaces
- An optional sign
- A string of digits

The characters must match this generic format:

[*ws*] [*sn*] [*ddd*]

In this function, the first unrecognized character ends the conversion. There are no provisions for overflow in *atoi* (results are undefined).

Return value *atoi* returns the converted value of the input string. If the string cannot be converted to a number of the corresponding type (**int**), atoi returns 0.

See also *atof, atol, ecvt, fcvt, gcvt, scanf, strtod*

atol — stdlib.h

Function Converts a string to a long.

Syntax

```
long atol(const char *s);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *atol* converts the string pointed to by *s* to **long**. *atol* recognizes (in the following order)

- An optional string of tabs and spaces
- An optional sign
- A string of digits

The characters must match this generic format:

[*ws*] [*sn*] [*ddd*]

In this function, the first unrecognized character ends the conversion. There are no provisions for overflow in *atol* (results are undefined).

Return value *atol* returns the converted value of the input string. If the string cannot be converted to a number of the corresponding type (**long**), *atol* returns 0.

See also *atof, atoi, ecvt, fcvt, gcvt, scanf, strtod, strtol, strtoul*

_atold

See *atof.*

_beginthread process.h

Function Starts execution of a new thread.

Syntax

```
int _beginthread(void (*start_address)(void *), unsigned stack_size, void *arglist)
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
			■			■

Remarks The *_beginthread* function creates and starts a new thread. The thread starts execution at *start_address*. The size of its stack in bytes is *stack_size*; the stack is allocated by the operating system after the stack size is rounded up to the next multiple of 4096. The thread is passed *arglist* as its only parameter; it can be NULL, but must be present. The thread terminates by simply returning, or by calling *_endthread*.

This function must be used instead of the operating system thread-creation API function because *_beginthread* performs initialization required for correct operation of the run-time library functions.

This function is available in C2MT.LIB, the multithread library; it is not in C2.LIB, the single-thread library.

Return value

_beginthread returns the thread ID of the new thread. In the event of an error, the function returns –1, and the global variable *errno* is set to one of the following values:

EAGAIN	Too many threads
EINVAL	Invalid request

See also

_endthread

bsearch — stdlib.h

Function

Binary search of an array.

Syntax

```
void *bsearch(const void *key, const void *base, size_t nelem, size_t width,
              int (_USERENTRY *fcmp)(const void *, const void *));
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

bsearch searches a table (array) of *nelem* elements in memory, and returns the address of the first entry in the table that matches the search key. The array must be in order. If no match is found, *bsearch* returns 0. Note that because this is a binary search, the first matching entry is not necessarily the first entry in the table.

The type *size_t* is defined in stddef.h header file.

- *nelem* gives the number of elements in the table.
- *width* specifies the number of bytes in each table entry.

The comparison routine *fcmp* must be used with the _USERENTRY calling convention.

fcmp is called with two arguments: *elem1* and *elem2*. Each argument points to an item to be compared. The comparison function compares each of the pointed-to items (**elem1* and **elem2*), and returns an integer based on the results of the comparison.

For *bsearch*, the *fcmp* return value is

- < 0 if **elem1* < **elem2*
- == 0 if **elem1* == **elem2*
- > 0 if **elem1* > **elem2*

Return value *bsearch* returns the address of the first entry in the table that matches the search key. If no match is found, *bsearch* returns 0.

See also *lfind, lsearch, qsort*

cabs, cabsl — math.h

Function Calculates the absolute value of complex number.

Syntax

```
double cabs(struct complex z);
long double cabsl(struct _complexl z);
```

	DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
cabs	■	■	■	■			■
cabsl	■		■	■			■

Remarks *cabs* is a macro that calculates the absolute value of *z*, a complex number. *z* is a structure with type *complex*. The structure is defined in math.h as

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


struct _complexl {
   long double x, y;
};
```

where *x* is the real part, and *y* is the imaginary part.

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

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

cabsl is the **long double** version; it takes a structure with type *_complexl* as an argument, and returns a **long double** result.

If you're using C++, you may also use the *complex* class defined in complex.h, and use the function *abs* to get the absolute value of a *complex* number.

Return value *cabs* (or *cabsl*) returns the absolute value of *z*, a double. On overflow, *cabs* (or *cabsl*) returns HUGE_VAL (or _LHUGE_VAL) and sets the global variable *errno* to

ERANGE Result out of range

Error handling for these functions can be modified through the functions *_matherr* and *_matherrl*.

See also *abs, complex, errno* (global variable), *fabs, labs, _matherr*

calloc — stdlib.h

Function Allocates main memory.

Syntax

```
void *calloc(size_t nitems, size_t size);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *calloc* provides access to the C memory heap. The heap is available for dynamic allocation of variable-sized blocks of memory. Many data structures, such as trees and lists, naturally employ heap memory allocation.

calloc allocates a block of size *nitems* × *size*. The block is cleared to 0.

Return value *calloc* returns a pointer to the newly allocated block. If not enough space exists for the new block or if *nitems* or *size* is 0, *calloc* returns NULL.

See also *free, malloc, realloc*

ceil, ceill — math.h

Function Rounds up.

Syntax

```
double ceil(double x);
long double ceill(long double x);
```

	DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
ceil	■	■	■	■	■	■	■
ceill	■		■	■			■

Remarks *ceil* finds the smallest integer not less than *x*. *ceill* is the **long double** version; it takes a **long double** argument and returns a **long double** result.

Return value These functions return the integer found as a **double** (*ceil*) or a **long double** (*ceill*).

See also *floor, fmod*

C

_c_exit — process.h

Function

Performs _exit cleanup without terminating the program.

Syntax

```
void _c_exit(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

_c_exit performs the same cleanup as *_exit*, except that it does not terminate the calling process.

Return value

None.

See also

abort, atexit, _cexit, exec..., _exit, exit, signal, spawn...

_cexit — process.h

Function

Performs exit cleanup without terminating the program.

Syntax

```
void _cexit(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

_cexit performs the same cleanup as *exit*, except that it does not close files or terminate the calling process. Buffered output (waiting to be output) is written, and any registered "exit functions" (posted with *atexit*) are called.

Return value

None.

See also

abort, atexit, _c_exit, exec..., _exit, exit, signal, spawn...

cgets — conio.h

Function

Reads a string from the console.

Syntax

```
char *cgets(char *str);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■			■			■

Remarks

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

cgets reads characters until it encounters a carriage-return/linefeed (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 character) before storing the string.

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

This function should not be used in PM applications.

Return value On success, *cgets* returns a pointer to *str*[2].

See also *cputs, fgets, getch, getche, gets*

chdir — dir.h

Function Changes current directory.

Syntax

```
int chdir(const char *path);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks *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:\\BC")
```

but this changes only the current directory on that drive; it doesn't change the active drive.

Only the current process is affected.

Return value Upon successful completion, *chdir* returns a value of 0. Otherwise, it returns a value of –1, and the global variable *errno* is set to

ENOENT   Path or file name not found

See also *getcurdir, getcwd, getdisk, mkdir, rmdir, setdisk, system*

_chdrive — direct.h

Function Sets current disk drive.

C

Syntax

```
int _chdrive(int drive);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

_chdrive sets the current drive to the one associated with *drive*: 1 for A, 2 for B, 3 for C, and so on.

Only the current process is affected.

Return value

_chdrive returns 0 if the current drive was changed successfully; otherwise, it returns –1.

See also

_dos_setdrive

_chmod — dos.h, io.h

Obsolete function. See *_rtl_chmod*.

chmod — sys\stat.h

Function

Changes file access mode.

Syntax

```
int chmod(const char *path, int amode);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks

chmod sets the file-access permissions of the file given by *path* according to the mask given by *amode*. *path* points to a string.

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

Value of *amode*	Access permission
S_IWRITE	Permission to write
S_IREAD	Permission to read
S_IREAD|S_IWRITE	Permission to read and write

Write permission implies read permission.

This function will fail (EACCES) if the file is currently open in any process.

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

In the event of an error, the global variable *errno* is set to one of the following values:

EACCES	Permission denied
ENOENT	Path or file name not found

See also *access, _rtl_chmod, fstat, open, sopen, stat*

chsize — io.h

Function Changes the file size.

Syntax

```
int chsize(int handle, long size);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *chsize* changes the size of the file associated with *handle*. It can truncate or extend the file, depending on the value of *size* compared to the file's original size.

The mode in which you open the file must allow writing.

If *chsize* extends the file, it will append null characters (\0). If it truncates the file, all data beyond the new end-of-file indicator is lost.

Return value On success, *chsize* returns 0. On failure, it returns –1 and the global variable *errno* is set to one of the following values:

EACCES	Permission denied
EBADF	Bad file number
ENOSPC	No space left on device

See also *close, creat, open, truncate, _rtl_creat*

_clear87 — float.h

Function Clears floating-point status word.

Syntax

```
unsigned int _clear87 (void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

C

Remarks *_clear87* clears the floating-point status word, which is a combination of the 80x87 status word and other conditions detected by the 80x87 exception handler.

Return value The bits in the value returned indicate the floating-point status before it was cleared. For information on the status word, refer to the constants defined in float.h.

See also *_control87, _fpreset, _status87*

clearerr stdio.h

Function Resets error indication.

Syntax

```
void clearerr(FILE *stream);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *clearerr* resets the named stream's error and end-of-file indicators to 0. Once the error indicator is set, stream operations continue to return error status until a call is made to *clearerr* or *rewind*. The end-of-file indicator is reset with each input operation.

Return value None.

See also *eof, feof, ferror, perror, rewind*

clock time.h

Function Determines processor time.

Syntax

```
clock_t clock(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■	■	■	■

Remarks *clock* can be used to determine the time interval between two events. To determine the time in seconds, the value returned by *clock* should be divided by the value of the macro *CLK_TCK*.

Return value The *clock* function returns the processor time elapsed since the beginning of the program invocation. If the processor time is not available, or its value cannot be represented, the function returns the value –1.

See also *time*

_close io.h

Obsolete function. See *_rtl_close*.

close io.h

Function Closes a file.

Syntax

```
int close(int handle);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks *close* closes the file associated with *handle*, a file handle obtained from a *_rtl_creat*, *creat*, *creatnew*, *creattemp*, *dup*, *dup2*, *_rtl_open*, or *open* call.

The function does 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* returns 0. Otherwise, the function returns a value of –1.

close fais if *handle* is not the handle of a valid, open file, and the global variable *errno* is set to

EBADF	Bad file number

See also *chsize*, *creat*, *creatnew*, *dup*, *fclose*, *open*, *_rtl_close*, *sopen*

closedir dirent.h

Function Closes a directory stream.

Syntax

```
int closedir(DIR *dirp);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks

On UNIX platforms, *closedir* is available on POSIX-compliant systems.

The *closedir* function closes the directory stream *dirp*, which must have been opened by a previous call to *opendir*. After the stream is closed, *dirp* no longer points to a valid directory stream.

Return value

If *closedir* is successful, it returns 0. Otherwise, *closedir* returns –1 and sets the global variable *errno* to

EBADF The *dirp* argument does not point to a valid open directory stream

See also

errno (global variable), *opendir*, *readdir*, *rewinddir*

clreol conio.h

Function

Clears to end of line in text window.

Syntax

```
void clreol(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

clreol clears all characters from the cursor position to the end of the line within the current text window, without moving the cursor.

This function should not be used in PM applications.

Return value

None.

See also

clrscr, *delline*, *window*

clrscr conio.h

Function

Clears the text-mode window.

Syntax

```
void clrscr(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

clrscr clears the current text window and places the cursor in the upper left-hand corner (at position 1,1).

This function should not be used in PM applications.

Return value

None.

See also

clreol, delline, window

_control87 float.h

Function

Manipulates the floating-point control word.

Syntax

```
unsigned int _control87(unsigned int newcw, unsigned int mask);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

_control87 retrieves or changes 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 lets you mask or unmask floating-point exceptions.

_control87 matches the bits in *mask* to the bits in *newcw*. If a *mask* bit equals 1, the corresponding bit in *newcw* 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:

Original control word:	0100	0011	0110	0011
mask:	1000	0001	0100	1111
newcw:	1110	1001	0000	0101
Changing bits:	1*xxx*	*xxx*1	*x*0*xx*	0101

If *mask* equals 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 the header file float.h.

See also

_clear87, _fpreset, signal, _status87

cos, cosl — math.h

C

Function Calculates the cosine of a value.

Syntax

```
double cos(double x);
long double cosl(long double x);
```

	DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
cos	■	■	■	■	■	■	■
cosl	■		■	■			■

Remarks *cos* computes the cosine of the input value. The angle is specified in radians.

cosl is the **long double** version; it takes a **long double** argument and returns a **long double** result.

This function can be used with *bcd* and *complex* types.

Return value *cos* of a real argument returns a value in the range –1 to 1. Error handling for these functions can be modified through *_matherr* (or *_matherrl*).

See also *acos, asin, atan, atan2, bcd, complex, _matherr, sin, tan*

cosh, coshl — math.h

Function Calculates the hyperbolic cosine of a value.

Syntax

```
double cosh(double x);
long double coshl(long double x);
```

	DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
cosh	■	■	■	■	■	■	■
coshl	■		■	■			■

Remarks *cosh* computes the hyperbolic cosine, $(e^x + e^{-x})/2$. *coshl* is the **long double** version; it takes a **long double** argument and returns a **long double** result.

This function can be used with *bcd* and *complex* types.

Return value *cosh* returns the hyperbolic cosine of the argument.

When the correct value would create an overflow, these functions return the value HUGE_VAL (*cosh*) or _LHUGE_VAL (*coshl*) with the appropriate sign, and the global variable *errno* is set to ERANGE. Error handling for these functions can be modified through the functions *_matherr* and *_matherrl*.

See also *acos, asin, atan, atan2, bcd, complex, cos, _matherr, sin, sinh, tan, tanh*

country — dos.h

Function Returns country-dependent information.

Syntax

```
struct COUNTRY *country(int xcode, struct COUNTRY *cp);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■				■

Remarks

The *country* function is not affected by *setlocale*.

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 operating system version being used.

The *COUNTRY* structure pointed to by *cp* is filled with the country-dependent information of the current country (if *xcode* is set to zero), or the country given by *xcode*.

The structure *COUNTRY* is defined as follows:

```
struct COUNTRY{
   int co_date;              /* date format */
   char co_curr[5];          /* currency symbol */
   char co_thsep[2];         /* thousands 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;           /* significant digits in currency */
   char co_time;             /* time format */
   long co_case;             /* NOT USED ON OS/2 */
   char co_dasep[2];         /* data separator */
   char co_fill[10];         /* filler */
};
```

The date format in *co_date* is

- 0 for the U.S. 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:

C

- 0 for the currency symbol to precede the value with no spaces between the symbol and the number.
- 1 for the currency symbol to follow the value with no spaces between the number and the symbol.
- 2 for the currency symbol to precede the value with a space after the symbol.
- 3 for the currency symbol to follow the number with a space before the symbol.

Return value On success, *country* returns the pointer argument *cp*. On error, it returns NULL.

cprintf — conio.h

Function Writes formatted output to the screen.

Syntax

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

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■			■			■

Remarks *cprintf* accepts a series of arguments, applies to each a format specifier contained in the format string pointed to by *format*, and outputs the formatted data directly to the current text window on the screen. There must be the same number of format specifiers as arguments.

See *printf* for details on format specifiers.

Unlike *fprintf* and *printf*, *cprintf* does not translate linefeed characters (\n) into carriage-return/linefeed character pairs (\r\n). Tab characters (specified by \t) are not expanded into spaces.

This function should not be used in PM applications.

Return value *cprintf* returns the number of characters output.

See also *fprintf, printf, putch, sprintf, vprintf*

cputs — conio.h

Function Writes a string to the screen.

Syntax

```
int cputs(const char *str);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■			■			■

Remarks

cputs writes the null-terminated string *str* to the current text window. It does not append a newline character.

Unlike *puts*, *cputs* does not translate linefeed characters (\n) into carriage-return/linefeed character pairs (\r\n).

This function should not be used in PM applications.

Return value

cputs returns the last character printed.

See also

cgets, fputs, putch, puts

_creat io.h

Obsolete function. See *_rtl_creat*.

creat io.h

Function

Creates a new file or overwrites an existing one.

Syntax

```
int creat(const char *path, int amode);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/
■	■	■	■			■

Remarks

creat creates a new file or prepares to rewrite an existing file given by *path*. *amode* applies only to newly created files.

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

If the file exists and the write attribute is set, *creat* truncates the file to a length of 0 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 the S_IWRITE bit of the access-mode word *amode*. If that bit is 1, the file can be written to. If the bit is 0, the file is marked as read-only. All other operating system attributes are set to 0.

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

C

Value of *amode*	Access permission
S_IWRITE	Permission to write
S_IREAD	Permission to read
S_IREAD|S_IWRITE	Permission to read and write

Write permission implies read permission.

Return value

Upon successful completion, *creat* returns the new file handle, a non-negative integer; otherwise, it returns –1.

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

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

See also

chmod, chsize, close, creatnew, creattemp, dup, dup2, _fmode (global variable), *fopen, open, _rtl_creat, sopen, write*

creatnew — io.h

Function

Creates a new file.

Syntax

```
int creatnew(const char *path, int mode);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

creatnew is identical to *_rtl_creat* with one exception: If the file exists, *creatnew* returns an error and leaves the file untouched.

The *mode* argument to *creatnew* can be zero or an OR-combination of any one of the following constants (defined in dos.h):

FA_HIDDEN	Hidden file
FA_RDONLY	Read-only attribute
FA_SYSTEM	System file

Return value

Upon successful completion, *creatnew* returns the new file handle, a non-negative integer; otherwise, it returns –1.

In the event of error, the global variable *errno* is set to one of the following values:

EACCES	Permission denied
EEXIST	File already exists

EMFILE	Too many open files
ENOENT	Path or file name not found

See also *close*, *_rtl_creat*, *creat*, *creattemp*, *_dos_creatnew*, *dup*, *_fmode* (global variable), *open*

creattemp — io.h

Function Creates a unique file in the directory associated with the path name.

Syntax

```
int creattemp(char *path, int attrib);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

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

Remember that a backslash in *path* requires '\\'.

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

creattemp accepts *attrib*, an OS/2 attribute word. Upon successful file creation, the file pointer is set to the beginning of the file. The file is opened for both reading and writing.

The *attrib* argument to *creattemp* can be zero or an OR-combination of any one of the following constants (defined in dos.h):

FA_HIDDEN	Hidden file
FA_RDONLY	Read-only attribute
FA_SYSTEM	System file

Return value Upon successful completion, the new file handle, a nonnegative integer, is returned; otherwise, –1 is returned.

In the event of error, the global variable *errno* is set to one of the following values:

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

See also *close*, *_rtl_creat*, *creat*, *creatnew*, *dup*, *_fmode* (global variable), *open*

_crotl, _crotr

stdlib.h

C

Function

Rotates an **unsigned char** left or right.

Syntax

```
unsigned char _crotl(unsigned char val, int count);
unsigned char _crotr(unsigned char val, int count);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

_crotl rotates the given *val* to the left *count* bits. *_crotr* rotates the given *val* to the right *count* bits.

The argument *val* is an **unsigned char**, or its equivalent in decimal or hexadecimal form.

Return value

The functions return the rotated *val.*

- *_crotl* returns the value of *val* left-rotated *count* bits.
- *_crotr* returns the value of *val* right-rotated *count* bits.

See also

_lrotl, _lrotr, _rotl, _rotr

cscanf

conio.h

Function

Scans and formats input from the console.

Syntax

```
int cscanf(char *format[, address, ...]);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■			■			■

Remarks

See *scanf* for details on format specifiers.

cscanf scans a series of input fields one character at a time, reading directly from the console. Then each field is formatted according to a format specifier passed to *cscanf* in the format string pointed to by *format*. Finally, *cscanf* stores the formatted input at an address passed to it as an argument following *format*, and echoes the input directly to the screen. There must be the same number of format specifiers and addresses as there are input fields.

cscanf might stop scanning a particular field before it reaches the normal end-of-field (whitespace) character, or it might terminate entirely for a number of reasons. See *scanf* for a discussion of possible causes.

➡ This function should not be used in PM applications.

Return value *cscanf* returns the number of input fields successfully scanned, converted, and stored; the return value does not include scanned fields that were not stored. If no fields were stored, the return value is 0.

If *cscanf* attempts to read at end-of-file , the return value is EOF.

See also *fscanf, getche, scanf, sscanf*

ctime — time.h

Function Converts date and time to a string.

Syntax

```
char *ctime(const time_t *time);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *ctime* converts a time value pointed to by *time* (the value returned by the function *time*) into a 26-character string in the following form, terminating with a newline character and a null character:

```
Mon Nov 21 11:31:54 1983\n\0
```

All the fields have constant width.

The global long variable *_timezone* contains the difference in seconds between GMT and local standard time (in PST, *_timezone* is 8×60×60). The global variable *_daylight* is nonzero *if and only if* the standard U.S. daylight saving time conversion should be applied. These variables are set by the *tzset* function, not by the user program directly.

Return value *ctime* returns a pointer to the character string containing the date and time. The return value points to static data that is overwritten with each call to *ctime*.

See also *asctime, _daylight* (global variable), *difftime, ftime, getdate, gmtime, localtime, settime, time, _timezone* (global variable), *tzset*

cwait — process.h

Function Waits for child process to terminate.

Syntax

```
int cwait(int *statloc, int pid, int action);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
			■			■

C

Remarks

The *cwait* function waits for a child process to terminate. The process ID of the child to wait for is *pid*. If *statloc* is not NULL, it points to the location where *cwait* will store the termination status. The *action* specifies whether to wait for the process alone, or for the process and all of its children.

If the child process terminated normally (by calling *exit*, or returning from *main*), the termination status word is defined as follows:

Bits 0-7 Zero.

Bits 8-15 The least significant byte of the return code from the child process. This is the value that is passed to *exit*, or is returned from *main*. If the child process simply exited from *main* without returning a value, this value will be unpredictable.

If the child process terminated abnormally, the termination status word is defined as follows:

Bits 0-7 Termination information about the child:

1 Critical error abort.
2 Execution fault, protection exception.
3 External termination signal.

Bits 8-15 Zero.

If *pid* is 0, *cwait* waits for any child process to terminate. Otherwise, *pid* specifies the process ID of the process to wait for; this value must have been obtained by an earlier call to an asynchronous *spawn* function.

The acceptable values for *action* are WAIT_CHILD, which waits for the specified child only, and WAIT_GRANDCHILD, which waits for the specified child *and* all of its children. These two values are defined in process.h.

Return value

When *cwait* returns after a normal child process termination, it returns the process ID of the child.

When *cwait* returns after an abnormal child termination, it returns –1 to the parent and sets *errno* to EINTR (the child process terminated abnormally).

If *cwait* returns without a child process completion, it returns a –1 value and sets *errno* to one of the following values:

ECHILD	No child exists or the *pid* value is bad
EINVAL	A bad *action* value was specified

See also *spawn, wait*

delline — conio.h

Function Deletes line in text window.

Syntax

```
void delline(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *delline* deletes the line containing the cursor and moves all lines below it one line up. *delline* operates within the currently active text window.

This function should not be used in PM applications.

Return value None.

See also *clreol, clrscr, insline, window*

difftime — time.h

Function Computes the difference between two times.

Syntax

```
double difftime(time_t time2, time_t time1);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

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

Return value *difftime* returns the result of its calculation as a **double**.

See also *asctime, ctime, _daylight* (global variable), *gmtime, localtime, time, _timezone* (global variable)

div — stdlib.h

Function Divides two integers, returning quotient and remainder.

Syntax

```
div_t  div(int numer, int denom);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■	■	■	■

Remarks *div* divides two integers and returns both the quotient and the remainder as a *div_t* type. *numer* and *denom* are the numerator and denominator, respectively. The *div_t* type is a structure of integers defined (with **typedef**) in stdlib.h as follows:

```
typedef struct {
   int  quot;      /* quotient */
   int  rem;       /* remainder */
} div_t;
```

Return value *div* returns a structure whose elements are *quot* (the quotient) and *rem* (the remainder).

See also *ldiv*

_dos_close — dos.h

Function Closes a file.

Syntax

```
unsigned _dos_close(int handle);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■				■

Remarks *_dos_close* closes the file associated with *handle*. *handle* is a file handle obtained from a *_dos_creat*, *_dos_creatnew*, or *_dos_open* call.

Return value Upon successful completion, *_dos_close* returns 0. Otherwise, it returns the operating system error code and the global variable *errno* is set to

EBADF Bad file number

See also *_dos_creat*, *_dos_open*, *_dos_read*, *_dos_write*

_dos_creat — dos.h, io.h

Function Creates a new file or overwrites an existing one.

Syntax

```
unsigned _dos_creat(const char *path,int attrib,int *handlep);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■				■

Remarks

_dos_creat opens the file specified by *path*. The file is always opened in binary mode. Upon successful file creation, the file pointer is set to the beginning of the file. *_dos_creat* stores the file handle in the location pointed to by *handlep*. The file is opened for both reading and writing.

If the file already exists, its size is reset to 0. (This is essentially the same as deleting the file and creating a new file with the same name.)

FA_RDONLY	Read-only attribute
FA_HIDDEN	Hidden file
FA_SYSTEM	System file

The *attrib* argument is an ORed combination of one or more of the following constants (defined in dos.h):

_A_NORMAL	Normal file
_A_RDONLY	Read-only file
_A_HIDDEN	Hidden file
_A_SYSTEM	System file

Return value

Upon successful completion, *_dos_creat* returns 0. If an error occurs, *_dos_creat* returns the operating system error code.

In the event of error, the global variable *errno* is set to one of the following values:

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

See also

chsize, close, creat, creatnew, creattemp, _rtl_chmod, _rtl_close

_dos_creatnew — dos.h

Function

Creates a new file.

Syntax

```
unsigned _dos_creatnew(const char *path, int attrib, int *handlep);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■				■

Remarks

_dos_creatnew creates and opens the new file *path*. The file is given the access permission *attrib*, an operating-system attribute word. The file is always opened in binary mode. Upon successful file creation, the file handle is stored in the location pointed to by *handlep*, and the file pointer is set to the beginning of the file. The file is opened for both reading and writing.

If the file already exists, *_dos_creatnew* returns an error and leaves the file untouched.

D

The *attrib* argument to *_dos_creatnew* is an OR combination of one or more of the following constants (defined in dos.h):

_A_NORMAL	Normal file
_A_RDONLY	Read-only file
_A_HIDDEN	Hidden file
_A_SYSTEM	System file

Return value Upon successful completion, *_dos_creatnew* returns 0. Otherwise, it returns the operating system error code, and the global variable *errno* is set to one of the following:

EACCES	Permission denied
EEXIST	File already exists
EMFILE	Too many open files
ENOENT	Path or file name not found

See also *creatnew, _dos_close, _dos_creat, _dos_getfileattr, _dos_setfileattr*

_dos_findfirst — dos.h

Function Searches a disk directory.

Syntax

```
unsigned _dos_findfirst(const char *pathname, int attrib,
                        struct find_t *ffblk);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■				■

Remarks *_dos_findfirst* begins a search of a disk directory.

pathname is a string with an optional drive specifier, path, and file name of the file to be found. The file name portion can contain wildcard match characters (such as ? or *). If a matching file is found, the *find_t* structure pointed to by *ffblk* is filled with the file-directory information.

attrib is an operating system file-attribute word used in selecting eligible files for the search. *attrib* is an OR combination of one or more of the following constants (defined in dos.h):

_A_NORMAL	Normal file
_A_RDONLY	Read-only attribute
_A_HIDDEN	Hidden file
_A_SYSTEM	System file
_A_VOLID	Volume label
_A_SUBDIR	Directory
_A_ARCH	Archive

For more detailed information about these attributes, refer to your operating system reference manuals.

Note that *wr_time* and *wr_date* contain bit fields for referring to the file's date and time. The structure of these fields was established by the operating system.

wr_time:

Bits 0-4	The result of seconds divided by 2 (for example, 10 here means 20 seconds)
Bits 5-10	Minutes
Bits 11-15	Hours

wr_date:

Bits 0-4	Day
Bits 5-8	Month
Bits 9-15	Years since 1980 (for example, 9 here means 1989)

Return value

_dos_findfirst returns 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, the operating system error code is returned, and the global variable *errno* is set to

ENOENT	Path or file name not found

See also

_dos_findnext

_dos_findnext — dos.h

Function

Continues *_dos_findfirst* search.

Syntax

```
unsigned _dos_findnext(struct find_t *ffblk);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■				■

Remarks

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

Return value

_dos_findnext returns 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, the operating system error code is returned, and the global variable *errno* is set to

ENOENT	Path or file name not found

See also

_dos_findfirst

_dos_getdate, _dos_setdate, getdate, setdate — dos.h

Function

Gets and sets system date.

Syntax

```
void _dos_getdate(struct dosdate_t *datep);
unsigned _dos_setdate(struct dosdate_t *datep);
void getdate(struct date *datep);
void setdate(struct date *datep);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■				■

Remarks

getdate fills in the *date* structure (pointed to by *datep*) with the system's current date. *setdate* sets the system date (month, day, and year) to that in the *date* structure pointed to by *datep*.

The *date* structure is defined as follows:

```
struct date {
   int da_year;      /* current year */
   char da_day;      /* day of the month */
   char da_mon;      /* month (1 = Jan) */
};
```

_dos_getdate fills in the *dosdate_t* structure (pointed to by *datep*) with the system's current date.

The *dosdate_t* structure is defined as follows:

```
struct dosdate_t {
   unsigned char day;        /* 1-31 */
   unsigned char month;      /* 1-12 */
   unsigned int  year;       /* 1980 - 2099 */
   unsigned char dayofweek; /* 0 - 6 (0=Sunday) */
};
```

Return value

_dos_getdate, *getdate*, and *setdate* do not return a value.

If the date is set successfully, *_dos_setdate* returns 0. Otherwise, it returns a nonzero value and the global variable *errno* is set to

EINVAL   Invalid date

See also

ctime, *gettime*, *settime*

_dos_getdiskfree — dos.h

Function

Gets disk free space.

Syntax

```
unsigned _dos_getdiskfree(unsigned char drive, struct diskfree_t *dtable);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■				■

Remarks

_dos_getdiskfree accepts a drive specifier in *drive* (0 for default, 1 for A, 2 for B, and so on) and fills in the *diskfree_t* structure pointed to by *dtable* with disk characteristics.

The *diskfree_t* structure is defined as follows:

```
struct diskfree_t {
   unsigned avail_clusters;       /* available clusters */
   unsigned total_clusters;       /* total clusters */
   unsigned bytes_per_sector;     /* bytes per sector */
   unsigned sectors_per_cluster;  /* sectors per cluster */
};
```

Return value

_dos_getdiskfree returns 0 if successful. Otherwise, it returns a nonzero value and the global variable *errno* is set to

EINVAL   Invalid drive specified

_dos_getdrive, _dos_setdrive — dos.h

Function

Gets and sets the current drive number.

Syntax

```
void _dos_getdrive(unsigned *drivep);
void _dos_setdrive(unsigned drivep, unsigned *ndrives);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■				■

Remarks

_dos_getdrive gets the current drive number.

_dos_setdrive sets the current drive and stores the total number of drives at the location pointed to by *ndrives*.

The drive numbers at the location pointed to by *drivep* are as follows: 1 for A, 2 for B, 3 for C, and so on.

Only the current process is affected.

Return value

None. Use *_dos_getdrive* to verify that the current drive was changed successfully.

See also

getcwd

_dos_getfileattr, _dos_setfileattr — dos.h

Function

Changes file access mode.

Syntax

```
int _dos_getfileattr(const char *path, unsigned *attribp);
int _dos_setfileattr(const char *path, unsigned attrib);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■				■

Remarks

_dos_getfileattr fetches the file attributes for the file *path*. The attributes are stored at the location pointed to by *attribp*.

_dos_setfileattr sets the file attributes for the file *path* to the value *attrib*. This function will fail (EACCES) if the file is currently open in any process. The file attributes can be an OR combination of the following symbolic constants (defined in dos.h):

_A_RDONLY	Read-only attribute
_A_HIDDEN	Hidden file
_A_SYSTEM	System file
_A_VOLID	Volume label
_A_SUBDIR	Directory
_A_ARCH	Archive
_A_NORMAL	Normal file (no attribute bits set)

Return value

Upon successful completion, *_dos_getfileattr* and *_dos_setfileattr* return 0. Otherwise, these functions return the operating system error code, and the global variable *errno* is set to

ENOENT	Path or file name not found

See also *chmod, stat*

_dos_getftime, _dos_setftime — dos.h

Function Gets and sets file date and time.

Syntax

```
unsigned _dos_getftime(int handle, unsigned *datep, unsigned *timep);
unsigned _dos_setftime(int handle, unsigned date, unsigned time);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■				■

Remarks

_dos_getftime retrieves the file time and date for the disk file associated with the open *handle*. The file must have been previously opened using *_dos_open*, *_dos_creat*, or *_dos_creatnew*. *_dos_getftime* stores the date and time at the locations pointed to by *datep* and *timep*.

_dos_setftime sets the file's new date and time values as specified by *date* and *time*. The file must be open for writing; an EACCES error will occur if the file is open for read-only access.

Note that the date and time values contain bit fields for referring to the file's date and time. The structure of these fields was established by the operating system.

Date:

Bits 0-4	Day
Bits 5-8	Month
Bits 9-15	Years since 1980 (for example, 9 here means 1989)

Time:

Bits 0-4	The result of seconds divided by 2 (for example, 10 here means 20 seconds)
Bits 5-10	Minutes
Bits 11-15	Hours

Return value

_dos_getftime and *_dos_setftime* return 0 on success.

In the event of an error return, the operating system error code is returned and the global variable *errno* is set to one of the following values:

EACCES	Permission denied
EBADF	Bad file number

See also *fstat, stat*

_dos_gettime, _dos_settime — dos.h

Function Gets and sets system time.

Syntax

```
void _dos_gettime(struct dostime_t *timep);
unsigned _dos_settime(struct dostime_t *timep);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■				■

Remarks *_dos_gettime* fills in the *dostime_t* structure pointed to by *timep* with the system's current time.

_dos_settime sets the system time to the values in the *dostime_t* structure pointed to by *timep*.

The *dostime_t* structure is defined as follows:

```
struct dostime_t {
   unsigned char hour;     /* hours 0-23 */
   unsigned char minute;   /* minutes 0-59 */
   unsigned char second;   /* seconds 0-59 */
   unsigned char hsecond;  /* hundredths of seconds 0-99 */
};
```

Return value *_dos_gettime* does not return a value.

If *_dos_settime* is successful, it returns 0. Otherwise, it returns the operating system error code, and the global variable *errno* is set to:

EINVAL Invalid time

See also *_dos_getdate, _dos_setdate, _dos_settime, stime, time*

_dos_open — fcntl.h, share.h, dos.h

Function Opens a file for reading or writing.

Syntax

```
unsigned _dos_open(const char *filename, unsigned oflags, int *handlep);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■				■

Remarks *_dos_open* opens the file specified by *filename*, then prepares it for reading or writing, as determined by the value of *oflags*. The file is always opened in binary mode. *_dos_open* stores the file handle at the location pointed to by *handlep*.

oflags uses the flags from the following two lists. Only one flag from the first list can be used (and one *must* be used); the remaining flags can be used in any logical combination.

List 1: Read/write flags

O_RDONLY	Open for reading.
O_WRONLY	Open for writing.
O_RDWR	Open for reading and writing.

The following additional values can be included in *oflags* (using an OR operation):

These symbolic constants are defined in fcntl.h and share.h.

List 2: Other access flags

O_NOINHERIT	The file is not passed to child programs.
SH_COMPAT	Identical to SH_DENYNO.
SH_DENYRW	Only the current handle can have access to the file.
SH_DENWR	Allow only reads from any other open to the file.
SH_DENYRD	Allow only writes from any other open to the file.
SH_DENYNO	Allow other shared opens to the file.

Only one of the SH_DENY*xx* values can be included in a single *_dos_open*. These file-sharing attributes are in addition to any locking performed on the files.

The maximum number of simultaneously open files is defined by HANDLE_MAX.

Return value

On successful completion, *_dos_open* returns 0, and stores the file handle at the location pointed to by *handlep*. The file pointer, which marks the current position in the file, is set to the beginning of the file.

On error, *_dos_open* returns the operating system error code. The global variable *errno* is set to one of the following:

EACCES	Permission denied
EINVACC	Invalid access code
EMFILE	Too many open files
ENOENT	Path or file not found

See also

open, *_rtl_read*, *sopen*

_dos_read — io.h, dos.h

Function

Reads from file.

Syntax

```
unsigned _dos_read(int handle, void *buf, unsigned len, unsigned *nread);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■				■

D

Remarks

_dos_read reads *len* bytes from the file associated with *handle* into *buf*. The actual number of bytes read is stored at the location pointed to by *nread;* when an error occurs, or the end-of-file is encountered, this number might be less than *len*.

_dos_read does not remove carriage returns because it treats all files as binary files.

handle is a file handle obtained from a *_dos_creat, _dos_creatnew,* or *_dos_open* call.

On disk files, *_dos_read* begins reading at the current file pointer. When the reading is complete, the function increments the file pointer by the number of bytes read. On devices, the bytes are read directly from the device.

The maximum number of bytes that *_dos_read* can read is UINT_MAX –1, because UINT_MAX is the same as –1, the error return indicator. UINT_MAX is defined in limits.h.

Return value

On successful completion, *_dos_read* returns 0. Otherwise, the function returns the DOS error code and sets the global variable *errno*.

EACCES	Permission denied
EBADF	Bad file number

See also

_rtl_open, read, _rtl_write

_dos_setdate

See *_dos_getdate*.

_dos_setdrive

See *_dos_getdrive*.

_dos_setfileattr

See *_dos_getfileattr*.

_dos_setftime

See *_dos_getftime*.

_dos_settime

See *_dos_gettime*.

_dos_write — dos.h

Function Writes to a file.

Syntax

```
unsigned _dos_write(int handle, const void *buf, unsigned len, unsigned *nwritten);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■				■

Remarks *_dos_write* writes *len* bytes from the buffer pointed to by the pointer *buf* to the file associated with *handle*. *_dos_write* does not translate a linefeed character (LF) to a CR/LF pair because it treats all files as binary data.

The actual number of bytes written is stored at the location pointed to by *nwritten*. 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 files, writing always proceeds from the current file pointer. On devices, bytes are directly sent to the device.

Return value On successful completion, *_dos_write* returns 0. Otherwise, it returns the operating system error code and the global variable *errno* is set to one of the following values:

EACCES	Permission denied
EBADF	Bad file number

See also *_dos_open*, *_dos_creat*, *_dos_read*

dostounix   dos.h

Function Converts date and time to UNIX time format.

Syntax

```
long dostounix(struct date *d, struct time *t);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *dostounix* converts a date and time as returned from *getdate* and *gettime* into UNIX time format. *d* points to a *date* structure, and *t* points to a *time* structure containing valid date and time information.

The date and time must not be earlier than or equal to Jan 1 1980 00:00:00.

Return value UNIX version of current date and time parameters: number of seconds since 00:00:00 on January 1, 1970 (GMT).

See also *getdate, gettime, unixtodos*

dup   io.h

Function Duplicates a file handle.

Syntax

```
int dup(int handle);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks *dup* creates a new file handle that has the following in common with the original file handle:

- Same open file or device
- Same file pointer (that is, changing the file pointer of one changes the other)
- Same access mode (read, write, read/write)

handle is a file handle obtained from a *_rtl_creat*, *creat*, *_rtl_open*, *open*, *dup*, or *dup2* call.

Return value Upon successful completion, *dup* returns the new file handle, a nonnegative integer; otherwise, *dup* returns –1.

In the event of error, the global variable *errno* is set to one of the following values:

EBADF	Bad file number
EMFILE	Too many open files

See also *_rtl_close, close, _rtl_creat, creat, creatnew, creattemp, dup2, fopen, _rtl_open, open*

dup2 — io.h

Function Duplicates a file handle (*oldhandle*) onto an existing file handle (*newhandle*).

Syntax

```
int dup2(int oldhandle, int newhandle);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks *dup2* creates a new file handle that has the following in common with the original file handle:

- Same open file or device
- Same file pointer (that is, changing the file pointer of one changes the other)
- Same access mode (read, write, read/write)

dup2 creates a new handle with the value of *newhandle*. If the file associated with *newhandle* is open when *dup2* is called, the file is closed.

newhandle and *oldhandle* are file handles obtained from a *creat, open, dup,* or *dup2* call.

Return value *dup2* returns 0 on successful completion, –1 otherwise.

In the event of error, the global variable *errno* is set to one of the following values:

EBADF	Bad file number
EMFILE	Too many open files

See also *_rtl_close, close, _rtl_creat, creat, creatnew, creattemp, dup, fopen, _rtl_open, open*

ecvt — stdlib.h

Function Converts a floating-point number to a string.

Syntax

```
char *ecvt(double value, int ndig, int *dec, int *sign);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

E

Remarks

ecvt converts *value* to a null-terminated string of *ndig* digits, starting with the leftmost significant digit, and returns a pointer to the string. The position of the decimal point relative to the beginning of the string is stored indirectly through *dec* (a negative value for *dec* means that the decimal lies to the left of the returned digits). There is no decimal point in the string itself. If the sign of *value* is negative, the word pointed to by *sign* is nonzero; otherwise, it's 0. The low-order digit is rounded.

Return value

The return value of *ecvt* points to static data for the string of digits whose content is overwritten by each call to *ecvt* and *fcvt*.

See also

fcvt, gcvt, sprintf

_endthread — process.h

Function

Terminates execution of a thread.

Syntax

```
void _endthread(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
			■			■

Remarks

The *_endthread* function terminates the currently executing thread. The thread must have been started by an earlier call to *_beginthread*.

This function is available in C2MT.LIB, the multithread library; it is not in C2.LIB, the single-thread library.

Return value

The function does not return a value.

See also

_beginthread

eof — io.h

Function

Checks for end-of-file.

Syntax

```
int eof(int handle);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

eof determines whether the file associated with *handle* has reached end-of-file.

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; the global variable *errno* is set to

EBADF	Bad file number

See also

clearerr, feof, ferror, perror

execl, execle, execlp, execlpe, execv, execve, execvp, execvpe process.h

Function

Loads and runs other programs.

Syntax

```
int execl(char *path, char *arg0 *arg1, ..., *argn, NULL);
int execle(char *path, char *arg0, *arg1, ..., *argn, NULL, char **env);

int execlp(char *path, char *arg0,*arg1, ..., *argn, NULL);
int execlpe(char *path, char *arg0, *arg1, ..., *argn, NULL, char **env);

int execv(char *path, char *argv[]);
int execve(char *path, char *argv[], char **env);

int execvp(char *path, char *argv[]);
int execvpe(char *path, char *argv[], char **env);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■			■			■

Remarks

The functions in the *exec...* family load and run (execute) other programs, known as *child processes*. When an *exec...* call succeeds, the child process overlays the *parent process*. There must be sufficient memory available for loading and executing the child process.

path is the file name of the called child process. The *exec...* functions search for *path* using the standard search algorithm:

- If no explicit extension is given, the functions search for the file as given. If the file is not found, they add .EXE and search again. If not found, they add .CMD and search again. If still not found, they add .BAT and search once more. The command processor (CMD.EXE) is used to run the executable file.
- If an explicit extension or a period is given, the functions search for the file exactly as given.

The suffixes *l*, *v*, *p*, and *e* added to the *exec...* "family name" specify that the named function operates with certain capabilities.

- *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] ..., arg[n]*) are passed as an array of pointers. Typically, the *v* suffix is used when a variable number of arguments is to be passed.
- *p* specifies that the function searches for the file in those directories specified by the PATH environment variable (without the *p* suffix, the function searches only the current working directory). If the *path* parameter does not contain an explicit directory, the function searches first the current directory, then the directories set with the PATH environment variable.
- *e* specifies that the argument *env* can be passed to the child process, letting you alter the environment for the child process. Without the *e* suffix, child processes inherit the environment of the parent process.

E

Each function in the *exec...* 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,

- *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.
- *execvpe* is an *exec...* function that takes an array of argument pointers, incorporates PATH in its search for the child process, and accepts the *env* argument for altering the child's environment.

The *exec...* functions must pass at least one argument to the child process (*arg0* or *argv[0]*); this argument is, by convention, a copy of *path*. (Using a different value for this 0th argument won't produce an error.)

When the *l* suffix is used, *arg0* usually points to *path*, 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 *env*. This environment argument is an array of character pointers. 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 *env* is null. When *env* is null, the child inherits the parents' environment settings. When an *exec...* function call is made, any open files remain open in the child process.

Return value

If successful, the *exec...* functions do not return. On error, the *exec...* functions return –1, and the global variable *errno* is set to one of the following values:

EACCES	Permission denied
EMFILE	Too many open files
ENOENT	Path or file name not found
ENOEXEC	Exec format error
ENOMEM	Not enough memory

See also

abort, atexit, _exit, exit, _fpreset, searchpath, spawn..., system

_exit — stdlib.h

Function

Terminates program.

Syntax

```
void _exit(int status);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks

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

The calling process uses *status* as the exit status of the process. Typically a value of 0 is used to indicate a normal exit, and a nonzero value indicates some error.

Return value

None.

See also

abort, atexit, exec..., exit, spawn...

exit — stdlib.h

Function

Terminates program.

Syntax

```
void exit(int status);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

exit terminates the calling process. Before termination, all files are closed, buffered output (waiting to be output) is written, and any registered "exit functions" (posted with *atexit*) are called.

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 nonzero value indicates some error. It can be, but is not required, to be set with one of the following:

EXIT_FAILURE	Abnormal program termination; signal to operating system that program has terminated with an error
EXIT_SUCCESS	Normal program termination

Return value

None.

See also

abort, atexit, exec..., _exit, signal, spawn...

exp, expl — math.h

Function

Calculates the exponential *e* to the *x*.

Syntax

```
double exp(double x);
long double expl(long double x);
```

	DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
exp	■	■	■	■	■	■	■
expl	■		■	■			■

Remarks

exp calculates the exponential function e^x.

expl is the **long double** version; it takes a **long double** argument and returns a **long double** result.

This function can be used with *bcd* and *complex* types.

Return value

exp returns e^x.

Sometimes the arguments passed to these functions produce results that overflow or are incalculable. When the correct value overflows, *exp* returns the value HUGE_VAL and *expl* returns _LHUGE_VAL. Results of excessively large magnitude cause the global variable *errno* to be set to

ERANGE Result out of range

On underflow, these functions return 0.0, and the global variable *errno* is not changed. Error handling for these functions can be modified through the functions *_matherr* and *_matherrl*.

See also *frexp, ldexp, log, log10, _matherr, pow, pow10, sqrt*

_expand — malloc.h

Function Grows or shrinks a heap block in place.

Syntax

```
void *_expand(void *block, size_t size);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
			■			■

Remarks This function attempts to change the size of an allocated memory *block* without moving the block's location in the heap. The data in the *block* are not changed, up to the smaller of the old and new sizes of the block. The block must have been allocated earlier with *malloc, calloc,* or *realloc,* and must *not* have been freed.

Return value If *_expand* is able to resize the block without moving it, *_expand* returns a pointer to the block, whose address is unchanged. If *_expand* is unsuccessful, it returns a NULL pointer and does not modify or resize the block.

See also *calloc, malloc, realloc*

fabs, fabsl — math.h

Function Returns the absolute value of a floating-point number.

Syntax

```
double fabs(double x);
long double fabsl(long double x);
```

	DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
fabs	■	■	■	■	■	■	■
fabsl	■		■	■			■

Remarks *fabs* calculates the absolute value of *x*, a double. *fabsl* is the **long double** version; it takes a **long double** argument and returns a **long double** result.

Return value *fabs* and *fabsl* return the absolute value of *x*.

See also *abs, cabs, labs*

fclose stdio.h

Function Closes a stream.

Syntax

```
int fclose(FILE *stream);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *fclose* closes the named stream. All buffers associated with the stream are flushed before closing. System-allocated buffers are freed upon closing. Buffers assigned with *setbuf* or *setvbuf* are not automatically freed. (But if *setvbuf* is passed null for the buffer pointer, it *will* free it upon close.)

Return value *fclose* returns 0 on success. It returns EOF if any errors were detected.

See also *close, fcloseall, fdopen, fflush, flushall, fopen, freopen*

fcloseall stdio.h

Function Closes open streams.

Syntax

```
int fcloseall(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks *fcloseall* closes all open streams except stdin, stdout, stdprn, stderr, and stdaux. stdprn and stdaux streams are not available on OS/2.

Return value *fcloseall* returns the total number of streams it closed. It returns EOF if any errors were detected.

See also *fclose, fdopen, flushall, fopen, freopen*

fcvt stdlib.h

Function Converts a floating-point number to a string.

Syntax

```
char *fcvt(double value, int ndig, int *dec, int *sign);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks

fcvt converts *value* to a null-terminated string digit, starting with the leftmost significant digit, with *ndig* digits to the right of the decimal point. *fcvt* then returns a pointer to the string. The position of the decimal point relative to the beginning of the string is stored indirectly through *dec* (a negative value for *dec* means to the left of the returned digits). There is no decimal point in the string itself. If the sign of *value* is negative, the word pointed to by *sign* is nonzero; otherwise, it is 0.

The correct digit has been rounded for the number of digits to the right of the decimal point specified by *ndig*.

Return value

The return value of *fcvt* points to static data whose content is overwritten by each call to *fcvt* and *ecvt*.

See also

ecvt, *gcvt*, *sprintf*

fdopen — stdio.h

Function

Associates a stream with a file handle.

Syntax

```
FILE *fdopen(int handle, char *type);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks

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*.

The *type* string used in a call to *fdopen* is one of the following values:

Value	Description
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.

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

If a *t* or *b* is not given in the *type* string, 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.

F

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

Return value On successful completion, *fdopen* returns a pointer to the newly opened stream. In the event of error, it returns NULL.

See also *fclose*, *fopen*, *freopen*, *open*

feof — stdio.h

Function Detects end-of-file on a stream.

Syntax

```
int feof(FILE *stream);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *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.

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

Return value *feof* returns nonzero if an end-of-file indicator was detected on the last input operation on the named stream, and 0 if end-of-file has not been reached.

See also *clearerr*, *eof*, *ferror*, *perror*

ferror — stdio.h

Function Detects errors on stream.

Syntax

```
int ferror(FILE *stream);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

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.

Return value

ferror returns nonzero if an error was detected on the named stream.

See also

clearerr, eof, feof, fopen, gets, perror

fflush stdio.h

Function

Flushes a stream.

Syntax

```
int fflush(FILE *stream);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

If the given stream has buffered output, *fflush* writes the output for *stream* to the associated file.

The stream remains open after *fflush* has executed. *fflush* has no effect on an unbuffered stream.

Return value

fflush returns 0 on success. It returns EOF if any errors were detected.

See also

fclose, flushall, setbuf, setvbuf

fgetc stdio.h

Function

Gets character from stream.

Syntax

```
int fgetc(FILE *stream);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

fgetc returns the next character on the named input stream.

Return value

On success, *fgetc* returns the character read, after converting it to an **int** without sign extension. On end-of-file or error, it returns EOF.

See also

fgetchar, fputc, getc, getch, getchar, getche, ungetc, ungetch

fgetchar — stdio.h

Function Gets character from stdin.

Syntax

```
int fgetchar(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks *fgetchar* returns the next character from stdin. It is defined as *fgetc*(*stdin*).

Return value On success, *fgetchar* returns the character read, after converting it to an **int** without sign extension. On end-of-file or error, it returns EOF.

See also *fgetc, fputchar, freopen, getchar*

fgetpos — stdio.h

Function Gets the current file pointer.

Syntax

```
int fgetpos(FILE *stream, fpos_t *pos);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■	■	■	■

Remarks *fgetpos* stores the position of the file pointer associated with the given stream in the location pointed to by *pos*. The exact value is unimportant; its value is opaque except as a parameter to subsequent *fsetpos* calls.

Return value On success, *fgetpos* returns 0. On failure, it returns a nonzero value and sets the global variable *errno* to

EBADF	Bad file number
EINVAL	Invalid number

See also *fseek, fsetpos, ftell, tell*

fgets — stdio.h

Function Gets a string from a stream.

Syntax

```
char *fgets(char *s, int n, FILE *stream);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *fgets* reads characters from *stream* into the string *s*. The function stops reading when it reads either *n* – 1 characters or a newline character, whichever comes first. *fgets* retains the newline character at the end of *s*. A null byte is appended to *s* to mark the end of the string.

Return value On success, *fgets* returns the string pointed to by *s*; it returns NULL on end-of-file or error.

See also *cgets, fputs, gets*

filelength — io.h

Function Gets file size in bytes.

Syntax

```
long filelength(int handle);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *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, it returns –1 and the global variable *errno* is set to

EBADF Bad file number

See also *fopen, lseek, open*

fileno — stdio.h

Function Gets file handle.

Syntax

```
int fileno(FILE *stream);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks *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 *stream*.

See also *fdopen, fopen, freopen*

findfirst dir.h

Function Searches a disk directory.

Syntax

```
int findfirst(const char *pathname, struct ffblk *ffblk, int attrib);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *findfirst* begins a search of a disk directory for files specified by attributes or wildcards.

pathname is a string with an optional drive specifier, path, and file name of the file to be found. Only the file name portion can contain wildcard match characters (such as ? or *). If a matching file is found, the *ffblk* structure is filled with the file-directory information.

The format of the structure *ffblk* is as follows:

```
struct ffblk {
   long           ff_reserved;
   long           ff_fsize;      /* file size */
   unsigned long  ff_attrib;     /* attribute found */
   unsigned short ff_ftime;      /* file time */
   unsigned short ff_fdate;      /* file date */
   char           ff_name[256];  /* found file name */
   };
```

attrib is a file-attribute byte used in selecting eligible files for the search. *attrib* should be selected from the following constants defined in dos.h:

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

A combination of constants can be ORed together.

For more detailed information about these attributes, refer to your operating system reference manuals.

Note that *ff_ftime* and *ff_fdate* contain bit fields for referring to the current date and time. The structure of these fields was established by the operating system. Both are 16-bit structures divided into three fields.

***ff_ftime*:**

Bits 0 to 4	The result of seconds divided by 2 (for example, 10 here means 20 seconds)
Bits 5 to 10	Minutes
Bits 11 to 15	Hours

***ff_fdate*:**

Bits 0-4	Day
Bits 5-8	Month
Bits 9-15	Years since 1980 (for example, 9 here means 1989)

The structure *ftime* declared in io.h uses time and date bit fields similar in structure to *ff_ftime*, and *ff_fdate*.

Return value

findfirst returns 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

ENOENT	Path or file name not found

and *_doserrno* is set to one of the following values:

ENMFILE	No more files
ENOENT	Path or file name not found

See also

findnext, *getftime*, *setftime*

findnext — dir.h

Function

Continues *findfirst* search.

Syntax

```
int findnext(struct ffblk *ffblk);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

findnext is used to fetch subsequent files that 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*.

Return value

findnext returns 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

ENOENT   Path or file name not found

and *_doserrno* is set to one of the following values:

ENMFILE   No more files
ENOENT   Path or file name not found

See also

findfirst

floor, floorl — math.h

Function

Rounds down.

Syntax

```
double floor(double x);
long double floorl(long double x);
```

	DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
floor	■	■	■	■	■	■	■
floorl	■		■	■			■

Remarks

floor finds the largest integer not greater than *x*. *floorl* is the **long double** version; it takes a **long double** argument and returns a **long double** result.

Return value

floor returns the integer found as a **double**. *floorl* returns the integer found as a **long double**.

See also

ceil, *fmod*

flushall — stdio.h

Function

Flushes all streams.

Syntax

```
int flushall(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks

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. Streams stay open after *flushall* executes.

Return value *flushall* returns an integer, the number of open input and output streams.

See also *fclose, fcloseall, fflush*

fmod, fmodl — math.h

Function Calculates x modulo y, the remainder of x/y.

Syntax

```
double fmod(double x, double y);
long double fmodl(long double x, long double y);
```

	DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
fmod	■	■	■	■	■	■	■
fmodl	■		■	■			■

Remarks *fmod* calculates x modulo y (the remainder f, where $x = ay + f$ for some integer a and $0 \leq f < y$). *fmodl* is the **long double** version; it takes **long double** arguments and returns a **long double** result.

Return value *fmod* and *fmodl* return the remainder f, where $x = ay + f$ (as described). Where y = 0, *fmod* and *fmodl* return 0.

See also *ceil, floor, modf*

fnmerge — dir.h

Function Builds a path from component parts.

Syntax

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

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *fnmerge* makes a path name from its components. The new path name is

```
X:\DIR\SUBDIR\NAME.EXT
```

where

drive = X:

dir = \DIR\SUBDIR\
name = NAME
ext = .EXT

fnmerge assumes there is enough space in *path* for the constructed path name. The maximum constructed length is MAXPATH. MAXPATH is defined in dir.h.

fnmerge and *fnsplit* are invertible; if you split a given *path* with *fnsplit*, then merge the resultant components with *fnmerge*, you end up with *path*.

F

Return value None.

See also *fnsplit*

fnsplit — dir.h

Function Splits a full path name into its components.

Syntax

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

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *fnsplit* takes a file's full path name (*path*) as a string in the form

X:\DIR\SUBDIR\NAME.EXT

and splits *path* into its four components. It then stores those components in the strings pointed to by *drive*, *dir*, *name*, and *ext*. All five components must be passed, but any of them can be a null, which means the corresponding component will be parsed but not stored. If any path component is null, that component corresponds to a non-NULL, empty string.

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

Constant	Max	String
MAXPATH	260	*path*
MAXDRIVE	3	*drive*; includes colon (:)
MAXDIR	256	*dir*; includes leading and trailing backslashes (\)
MAXFILE	256	*name*
MAXEXT	256	*ext*; includes leading dot (.)

fnsplit assumes that there is enough space to store each non-null component.

When *fnsplit* splits *path*, it treats the punctuation as follows:

- *drive* includes the colon (C:, A:, and so on).
- *dir* includes the leading and trailing backslashes (\BC\include\, \source\, and so on).
- *name* includes the file name.
- *ext* includes the dot preceding the extension (.C, .EXE, and so on).

fnmerge and *fnsplit* are invertible; if you split a given *path* with *fnsplit*, then merge the resultant components with *fnmerge*, you end up with *path*.

Return value

fnsplit returns an integer (composed of five flags, defined in dir.h) indicating which of the full path name components were present in *path*. These flags and the components they represent are

EXTENSION	An extension
FILENAME	A file name
DIRECTORY	A directory (and possibly subdirectories)
DRIVE	A drive specification (see dir.h)
WILDCARDS	Wildcards (* or ?)

See also

fnmerge

fopen — stdio.h

Function

Opens a stream.

Syntax

```
FILE *fopen(const char *filename, const char *mode);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

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.

The *mode* string used in calls to *fopen* is one of the following values:

Value	Description
r	Open for reading only.
w	Create for writing. If a file by that name already exists, it will be overwritten.
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 (reading and writing). If a file by that name already exists, it will be overwritten.
a+	Open for append; open for update at the end of the file, or create if the file does not exist.

To specify that a given file is being opened or created in text mode, append a *t* to the *mode* string (*rt*, *w+t*, and so on). Similarly, to specify binary mode, append a *b* to the *mode* string (*wb*, *a+b*, and so on). *fopen* also allows the *t* or *b* to be inserted between the letter and the + character in the mode string; for example, *rt+* is equivalent to *r+t*.

F

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

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

Return value On successful completion, *fopen* returns a pointer to the newly opened stream. In the event of error, it returns NULL.

See also *creat*, *dup*, *fclose*, *fdopen ferror*, *_fmode* (global variable), *fread*, *freopen*, *fseek*, *fwrite*, *open*, *rewind*, *setbuf*, *setmode*

_fpreset — float.h

Function Reinitializes floating-point math package.

Syntax

```
void _fpreset(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *_fpreset* reinitializes the floating-point math package. This function is usually used in conjunction with *system* or the *exec...* or *spawn...* functions. It is also used to recover from floating-point errors before calling *longjmp*.

Return value None.

See also *_clear87*, *_control87*, *_status87*

fprintf — stdio.h

Function

Writes formatted output to a stream.

Syntax

```
int fprintf(FILE *stream, const char *format[, argument, ...]);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

See *printf* for details on format specifiers.

fprintf accepts a series of arguments, applies to each a format specifier contained in the format string pointed to by *format*, and outputs the formatted data to a stream. There must be the same number of format specifiers as arguments.

Return value

fprintf returns the number of bytes output. In the event of error, it returns EOF.

See also

cprintf, fscanf, printf, putc, sprintf

fputc — stdio.h

Function

Puts a character on a stream.

Syntax

```
int fputc(int c, FILE *stream);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks

fputc outputs character *c* to the named stream.

Return value

On success, *fputc* returns the character *c*. On error, it returns EOF.

See also

fgetc, putc

fputchar — stdio.h

Function

Outputs a character on stdout.

Syntax

```
int fputchar(int c);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■		■	■		■

Remarks

fputchar outputs character *c* to stdout. *fputchar*(*c*) is the same as *fputc*(*c*, *stdout*).

This function should not be used in PM applications.

Return value

On success, *fputchar* returns the character *c*. On error, it returns EOF.

See also

fgetchar, *freopen*, *putchar*

fputs stdio.h

Function

Outputs a string on a stream.

Syntax

```
int fputs(const char *s, FILE *stream);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

fputs copies the null-terminated string *s* to the given output stream; it does not append a newline character, and the terminating null character is not copied.

Return value

On successful completion, *fputs* returns a non-negative value. Otherwise, it returns a value of EOF.

See also

fgets, *gets*, *puts*

fread stdio.h

Function

Reads data from a stream.

Syntax

```
size_t fread(void *ptr, size_t size, size_t n, FILE *stream);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

fread reads *n* items of data, each of length *size* bytes, from the given input stream into a block pointed to by *ptr*.

The total number of bytes read is ($n \times size$).

Return value

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

See also

fopen, *fwrite*, *printf*, *read*

free — stdlib.h

Function Frees allocated block.

Syntax

```
void free(void *block);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *free* deallocates a memory block allocated by a previous call to *calloc*, *malloc*, or *realloc*.

Return value None.

See also *calloc*, *malloc*, *realloc*, *strdup*

freopen — stdio.h

Function Associates a new file with an open stream.

Syntax

```
FILE *freopen(const char *filename, const char *mode, FILE *stream);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *freopen* substitutes the named file in place of the open stream. It closes *stream*, regardless of whether the open succeeds. *freopen* is useful for changing the file attached to stdin, stdout, or stderr.

The *mode* string used in calls to *fopen* is one of the following values:

Value	Description
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.

To specify that a given file is being opened or created in text mode, append a *t* to the *mode* string (*rt*, *w+t*, and so on); similarly, to specify binary mode, append a *b* to the *mode* string (*wb*, *a+b*, and so on).

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

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

Return value On successful completion, *freopen* returns the argument *stream*. In the event of error, it returns NULL.

See also *fclose, fdopen, fopen, open, setmode*

frexp, frexpl — math.h

Function Splits a number into mantissa and exponent.

Syntax

```
double frexp(double x, int *exponent);
long double frexpl(long double x, int *exponent);
```

	DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
frexp	■	■	■	■	■	■	■
frexpl	■		■	■			■

Remarks *frexp* calculates the mantissa *m* (a **double** greater than or equal to 0.5 and less than 1) and the integer value *n*, such that *x* (the original **double** value) equals $m \times 2^n$. *frexp* stores *n* in the integer that *exponent* points to.

frexpl is the **long double** version; it takes a **long double** argument for *x* and returns a **long double** result.

Return value *frexp* and *frexpl* return the mantissa *m*. Error handling for these routines can be modified through the functions *_matherr* and *_matherrl*.

See also *exp, ldexp, _matherr*

fscanf — stdio.h

Function Scans and formats input from a stream.

Syntax

```
int fscanf(FILE *stream, const char *format[, address, ...]);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

fscanf scans a series of input fields, one character at a time, reading from a stream. Then each field is formatted according to a format specifier passed to *fscanf* in the format string pointed to by *format*. Finally, *fscanf* stores the formatted input at an address passed to it as an argument following *format*. The number of format specifiers and addresses must be the same as the number of input fields.

See *scanf* for details on format specifiers.

fscanf can stop scanning a particular field before it reaches the normal end-of-field character (whitespace), or it can terminate entirely for a number of reasons. See *scanf* for a discussion of possible causes.

Return value

fscanf returns the number of input fields successfully scanned, converted, and stored; the return value does not include scanned fields that were not stored.

If *fscanf* attempts to read at end-of-file, the return value is EOF. If no fields were stored, the return value is 0.

See also

atof, cscanf, fprintf, printf, scanf, sscanf, vfscanf, vscanf, vsscanf

fseek — stdio.h

Function

Repositions a file pointer on a stream.

Syntax

```
int fseek(FILE *stream, long offset, int whence);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

fseek sets the file pointer associated with *stream* to a new position that is *offset* bytes from the file location given by *whence*. For text mode streams, *offset* should be 0 or a value returned by *ftell*.

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

Constant	*whence*	File location
SEEK_SET	0	File beginning
SEEK_CUR	1	Current file pointer position
SEEK_END	2	End-of-file

fseek discards any character pushed back using *ungetc*. *fseek* is used with stream I/O; for file handle I/O, use *lseek*.

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

Return value

fseek returns 0 if the pointer is successfully moved and nonzero on failure.

In the event of an error return, the global variable *errno* is set to one of the following values:

EBADF	Bad file pointer
EINVAL	Invalid argument
ESPIPE	Illegal seek on device

See also

fgetpos, *fopen*, *fsetpos*, *ftell*, *lseek*, *rewind*, *setbuf*, *tell*

F

fsetpos — stdio.h

Function

Positions the file pointer of a stream.

Syntax

```
int fsetpos(FILE *stream, const fpos_t *pos);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■	■	■	■

Remarks

fsetpos sets the file pointer associated with *stream* to a new position. The new position is the value obtained by a previous call to *fgetpos* on that stream. It also clears the end-of-file indicator on the file that *stream* points to and undoes any effects of *ungetc* on that file. After a call to *fsetpos*, the next operation on the file can be input or output.

Return value

On success, *fsetpos* returns 0. On failure, it returns a nonzero value and also sets the global variable *errno* to a nonzero value.

See also

fgetpos, *fseek*, *ftell*

_fsopen — stdio.h, share.h

Function

Opens a stream with file sharing.

Syntax

```
FILE *_fsopen(const char *filename, const char *mode, int shflag);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

_fsopen opens the file named by *filename* and associates a stream with it. *_fsopen* returns a pointer that is used to identify the stream in subsequent operations.

The *mode* string used in calls to *_fsopen* is one of the following values:

Mode	Description
r	Open for reading only.
w	Create for writing. If a file by that name already exists, it will be overwritten.
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 (reading and writing). If a file by that name already exists, it will be overwritten.
a+	Open for append; open for update at the end of the file, or create if the file does not exist.

To specify that a given file is being opened or created in text mode, append a *t* to the *mode* string (*rt*, *w+t*, and so on). Similarly, to specify binary mode, append a *b* to the *mode* string (*wb*, *a+b*, and so on). *_fsopen* also allows the *t* or *b* to be inserted between the letter and the + character in the mode string; for example, *rt+* is equivalent to *r+t*.

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

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

shflag specifies the type of file-sharing allowed on the file *filename*. Symbolic constants for *shflag* are defined in share.h.

Value of *shflag*	Description
SH_COMPAT	Sets compatibility mode
SH_DENYRW	Denies read/write access
SH_DENYWR	Denies write access

SH_DENYRD	Denies read access
SH_DENYNONE	Permits read/write access
SH_DENYNO	Permits read/write access

Return value On successful completion, *_fsopen* returns a pointer to the newly opened stream. In the event of error, it returns NULL.

See also *creat, _dos_open, dup, fclose, fdopen, ferror, _fmode* (global variable), *fopen, fread, freopen, fseek, fwrite, open, rewind, setbuf, setmode, sopen*

F

fstat, stat — sys\stat.h

Function Gets open file information.

Syntax

```
int fstat(int handle, struct stat *statbuf);
int stat(char *path, struct stat *statbuf);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks *fstat* stores information in the *stat* structure about the file or directory associated with *handle.*

stat stores information about a given file or directory in the *stat* structure. The name of the file is *path.*

statbuf points to the *stat* structure (defined in sys\stat.h). That structure contains the following fields:

st_mode	Bit mask giving information about the 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 file in bytes
st_atime	Most recent time the 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 meaningful only in UNIX.

The *st_mode* 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	If *handle* refers to a device.
S_IFREG	If an ordinary file is referred to by *handle*.

One or both of the following bits will be set:

S_IWRITE	If user has permission to write to file.
S_IREAD	If user has permission to read to file.

Return value

fstat and *stat* return 0 if they successfully retrieved the information about the open file. On error (failure to get the information), these functions return –1 and set the global variable *errno* to

EBADF	Bad file handle

See also

access, chmod

ftell — stdio.h

Function

Returns the current file pointer.

Syntax

```
long int ftell(FILE *stream);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

ftell returns the current file pointer for *stream*. The offset is measured in bytes from the beginning of the file (if the file is binary). The value returned by *ftell* can be used in a subsequent call to *fseek*.

Return value

ftell returns the current file pointer position on success. It returns –1L on error and sets the global variable *errno* to a positive value.

In the event of an error return, the global variable *errno* is set to one of the following values:

EBADF	Bad file pointer
ESPIPE	Illegal seek on device

See also

fgetpos, fseek, fsetpos, lseek, rewind, tell

ftime — sys\timeb.h

Function Stores current time in *timeb* structure.

Syntax

```
void ftime(struct timeb *buf)
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks On UNIX platforms, *ftime* is available only on System V systems.

ftime determines the current time and fills in the fields in the *timeb* structure pointed to by *buf*. The *timeb* structure contains four fields: *time*, *millitm*, *_timezone*, and *dstflag*:

```
struct timeb {
   long time ;
   short millitm ;
   short _timezone ;
   short dstflag ;
};
```

- *time* provides the time in seconds since 00:00:00 Greenwich mean time (GMT), January 1, 1970.
- *millitm* is the fractional part of a second in milliseconds.
- *_timezone* is the difference in minutes between GMT and the local time. This value is computed going west from GMT. *ftime* gets this field from the global variable *_timezone*, which is set by *tzset*.
- *dstflag* is used to indicate whether daylight saving time will be taken into account during time calculations.

ftime calls *tzset*. Therefore, it isn't necessary to call *tzset* explicitly when you use *ftime*.

Return value None.

See also *asctime, ctime, gmtime, localtime, stime, time, tzset*

_fullpath — stdlib.h

Function Converts a path name from relative to absolute.

Syntax

```
char * _fullpath(char *buffer, const char *path, int buflen);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

_fullpath converts the relative path name in *path* to an absolute path name that is stored in the array of characters pointed to by *buffer*. The maximum number of characters that can be stored at *buffer* is *buflen*. The function returns NULL if the buffer isn't big enough to store the absolute path name, or if the path contains an invalid drive letter.

If *buffer* is NULL, *_fullpath* allocates a buffer of up to _MAX_PATH characters. This buffer should be freed using *free* when it is no longer needed. _MAX_PATH is defined in stdlib.h

Return value

If successful, the *_fullpath* function returns a pointer to the buffer containing the absolute path name. Otherwise, it returns NULL.

See also

_makepath, *_splitpath*

fwrite — stdio.h

Function

Writes to a stream.

Syntax

```
size_t fwrite(const void *ptr, size_t size, size_t n, FILE *stream);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

fwrite appends *n* items of data, each of length *size* bytes, to the given output file. The data written begins at *ptr*. The total number of bytes written is ($n \times size$). *ptr* in the declarations is a pointer to any object.

Return value

On successful completion, *fwrite* returns the number of items (not bytes) actually written. It returns a short count on error.

See also

fopen, *fread*

gcvt — stdlib.h

Function

Converts floating-point number to a string.

Syntax

```
char *gcvt(double value, int ndec, char *buf);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks *gcvt* converts *value* to a null-terminated ASCII string and stores the string in *buf*. It produces *ndec* significant digits in FORTRAN F format, if possible; otherwise, it returns the value in the *printf* E format (ready for printing). It might suppress trailing zeros.

Return value *gcvt* returns the address of the string pointed to by *buf*.

See also *ecvt, fcvt, sprintf*

getc — stdio.h

G

Function Gets character from stream.

Syntax

```
int getc(FILE *stream);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *getc* is a macro that returns the next character on the given input stream and increments the stream's file pointer to point to the next character.

Return value On success, *getc* returns the character read, after converting it to an **int** without sign extension. On end-of-file or error, it returns EOF.

See also *fgetc, getch, getchar, getche, gets, putc, putchar, ungetc*

getch — conio.h

Function Gets character from keyboard, does not echo to screen.

Syntax

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

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■			■			■

Remarks *getch* reads a single character directly from the keyboard, without echoing to the screen.

This function should not be used in PM applications.

Return value *getch* returns the character read from the keyboard.

See also *cgets, cscanf, fgetc, getc, getchar, getche, getpass, kbhit, putch, ungetch*

getchar — stdio.h

Function Gets character from stdin.

Syntax

```
int getchar(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■		■	■	■	■

Remarks *getchar* is a macro that returns the next character on the named input stream stdin. It is defined to be *getc*(*stdin*).

Return value On success, *getchar* returns the character read, after converting it to an **int** without sign extension. On end-of-file or error, it returns EOF.

See also *fgetc, fgetchar, freopen, getc, getch, getche, gets, putc, putchar, scanf, ungetc*

getche — conio.h

Function Gets character from the keyboard, echoes to screen.

Syntax

```
int getche(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■			■			■

Remarks *getche* reads a single character from the keyboard and echoes it to the current text window.

This function should not be used in PM applications.

Return value *getche* returns the character read from the keyboard.

See also *cgets, cscanf, fgetc, getc, getch, getchar, kbhit, putch, ungetch*

getcurdir — dir.h

Function Gets current directory for specified drive.

Syntax

```
int getcurdir(int drive, char *directory);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

getcurdir gets the name of the current working directory for the drive indicated by *drive*. *drive* specifies a drive number (0 for default, 1 for A, and so on). *directory* points to an area of memory of length MAXDIR where the null-terminated directory name will be placed. The 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.

See also

chdir, getcwd, getdisk, mkdir, rmdir

G

getcwd — dir.h

Function

Gets current working directory.

Syntax

```
char *getcwd(char *buf, int buflen);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

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

If *buf* is NULL, a buffer *buflen* bytes long is allocated for you with *malloc*. You can later free the allocated buffer by passing the return value of *getcwd* to the function *free*.

Return value

getcwd returns the following values:

- If *buf* is not NULL on input, *getcwd* returns *buf* on success, NULL on error.
- If *buf* is NULL on input, *getcwd* returns a pointer to the allocated buffer.

In the event of an error return, the global variable *errno* is set to one of the following values:

ENODEV	No such device
ENOMEM	Not enough memory to allocate a buffer (*buf* is NULL)
ERANGE	Directory name longer than *buflen* (*buf* is not NULL)

See also

chdir, getcurdir, _getdcwd, getdisk, mkdir, rmdir

getdate

See *_dos_getdate* on page 45.

_getdcwd — direct.h

Function

Gets current directory for specified drive.

Syntax

```
char * _getdcwd(int drive, char *buffer, int buflen);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

_getdcwd gets the full path name of the working directory of the specified drive (including the drive name), up to *buflen* bytes long, and stores it in *buffer*. If the full path name length (including the null character) is longer than *buflen*, an error occurs. The *drive* is 0 for the default drive, 1=A, 2=B, and so on.

If *buffer* is NULL, *_getdcwd* allocates a buffer at least *buflen* bytes long. You can later free the allocated buffer by passing the *_getdcwd* return value to the *free* function.

Return value

If successful, *_getdcwd* returns a pointer to the buffer containing the current directory for the specified drive. Otherwise it returns NULL, and sets the global variable *errno* to one of the following values:

ENOMEM	Not enough memory to allocate a buffer (*buffer* is NULL)
ERANGE	Directory name longer than *buflen* (*buffer* is not NULL)

See also

chdir, getcwd, _getdrive, mkdir, rmdir

getdfree — dos.h

Function

Gets disk free space.

Syntax

```
void getdfree(unsigned char drive, struct dfree *dtable);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

getdfree accepts a drive specifier in *drive* (0 for default, 1 for A, and so on) and fills the *dfree* structure pointed to by *dtable* with disk attributes.

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 (**unsigned**) –1.

G

getdisk, setdisk — dir.h

Function Gets or sets the current drive number.

Syntax

```
int getdisk(void);
int setdisk(int drive);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *getdisk* gets the current drive number. It returns an integer: 0 for A, 1 for B, 2 for C, and so on. *setdisk* sets the current drive to the one associated with *drive*: 0 for A, 1 for B, 2 for C, and so on.

Only the current process is affected.

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

See also *getcurdir, getcwd*

_getdrive — direct.h

Function Gets current drive number.

Syntax

```
int _getdrive(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■				■

Remarks *_getdrive* gets the current drive number. It returns an integer: 1 for A, 2 for B, 3 for C, and so on.

Return value *_getdrive* returns the current drive number.

See also *_dos_getdrive, _dos_setdrive, _getdcwd*

getenv — stdlib.h

Function Gets a string from environment.

Syntax

```
char *getenv(const char *name);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *getenv* returns the value of a specified variable. On DOS and OS/2, *name* must be uppercase. On other systems, *name* can be either uppercase or lowercase. *name* must not include the equal sign (=). If the specified environment variable does not exist, *getenv* returns a NULL pointer.

To delete the variable from the environment, use `getenv("name=")`.

➡ Environment entries must not be changed directly. If you want to change an environment value, you must use *putenv*.

Return value On success, *getenv* returns the value associated with *name*. If the specified *name* is not defined in the environment, *getenv* returns a NULL pointer.

See also *_environ* (global variable), *putenv*

getftime, setftime — io.h

Function Gets and sets the file date and time.

Syntax

```
int getftime(int handle, struct ftime *ftimep);
int setftime(int handle, struct ftime *ftimep);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *getftime* retrieves the file time and date for the disk file associated with the open *handle*. The *ftime* structure pointed to by *ftimep* is filled in with the file's time and date.

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 file must not be written to after the *setftime* call or the changed information will be lost. The file must be open for writing; an EACCES error will occur if the file is open for read-only access.

The *ftime* structure is defined as follows:

```
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

getftime and *setftime* 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 values:

EACCES	Permission denied
EBADF	Bad file number
EINVFNC	Invalid function number

See also

fflush, open

getpass conio.h

Function

Reads a password.

Syntax

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

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■		■			■

Remarks

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 (not counting the null character).

This function should not be used in PM applications.

Return value

The return value is a pointer to a static string, which is overwritten with each call.

See also

getch

getpid process.h

Function Gets the process ID of a program.

Syntax

```
unsigned getpid(void)
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
▪	▪	▪	▪			▪

Remarks This function returns the current process ID—an integer that uniquely identifies the process.

Return value *getpid* returns the identification number of the current process.

gets stdio.h

Function Gets a string from stdin.

Syntax

```
char *gets(char *s);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
▪	▪		▪	▪	▪	▪

Remarks *gets* collects a string of characters terminated by a new line from the standard input stream stdin and puts it into *s*. The new line is replaced by a null character ('\0') in *s*.

gets allows input strings to contain certain whitespace characters (spaces, tabs). *gets* returns when it encounters a new line; everything up to the new line is copied into *s*.

➡ This function should not be used in PM applications.

Return value On success, *gets* returns the string argument *s*; it returns NULL on end-of-file or error.

See also *cgets, ferror, fgets, fopen, fputs, fread, freopen, getc, puts, scanf*

gettext conio.h

Function Copies text from text mode screen to memory.

Syntax

```
int gettext(int left, int top, int right, int bottom, void *destin);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■			■			■

Remarks

gettext stores the contents of an onscreen text rectangle defined by *left*, *top*, *right*, and *bottom* into the area of memory pointed to by *destin*.

All coordinates are absolute screen coordinates, not window-relative. The upper left corner is (1,1).

gettext reads the contents of the rectangle into memory sequentially from left to right and top to bottom.

Each position onscreen takes 2 bytes of memory: The first byte is the character in the cell, and the second is the cell's video attribute. The space required for a rectangle *w* columns wide by *h* rows high is defined as

bytes = (*h* rows) × (*w* columns) × 2

This function should not be used in PM applications.

Return value

gettext returns 1 if the operation succeeds. It returns 0 if it fails (for example, if you gave coordinates outside the range of the current screen mode).

See also

movetext, *puttext*

gettextinfo — conio.h

Function

Gets text mode video information.

Syntax

```
void gettextinfo(struct text_info *r);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■			■			■

Remarks

gettextinfo fills in the *text_info* structure pointed to by *r* with the current text video information.

The *text_info* structure is defined in conio.h as follows:

```
struct text_info {
   unsigned char winleft;       /* left window coordinate */
   unsigned char wintop;        /* top window coordinate */
   unsigned char winright;      /* right window coordinate */
   unsigned char winbottom;     /* bottom window coordinate */
   unsigned char attribute;     /* text attribute */
   unsigned char normattr;      /* normal attribute */
   unsigned char currmode;      /* BW40, BW80, C40, C80, or C4350 */
   unsigned char screenheight;  /* text screen's height */
```

```
    unsigned char screenwidth;    /* text screen's width */
    unsigned char curx;           /* x-coordinate in current window */
    unsigned char cury;           /* y-coordinate in current window */
};
```

This function should not be used in PM applications.

Return value *gettextinfo* returns nothing; the results are returned in the structure pointed to by *r*.

See also *textattr, textbackground, textcolor, textmode, wherex, wherey, window*

gettime, settime — dos.h

Function Gets and sets the system time.

Syntax

```
void gettime(struct time *timep);
void settime(struct time *timep);
```

	DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
gettime	■		■	■			■
settime	■		■				■

Remarks *gettime* fills in the *time* structure pointed to by *timep* with the system's current time.

settime sets the system time to the values in the *time* structure pointed to by *timep*.

The *time* structure is defined as follows:

```
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 None.

See also *_dos_gettime, _dos_settime, getdate, setdate, stime, time*

getverify — dos.h

Function Returns the state of the operating system verify flag.

Syntax

```
int getverify(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■				■

Remarks

getverify gets the current state of the verify flag.

The verify flag controls output to the disk. When verify is off, writes are not verified; when verify is on, all disk writes are verified to ensure proper writing of the data.

Return value

getverify returns the current state of the verify flag, either 0 (off) or 1 (on).

See also

setverify

G

getw — stdio.h

Function

Gets integer from stream.

Syntax

```
int getw(FILE *stream);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks

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

getw should not be used when the stream is opened in text mode.

Return value

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.

See also

putw

gmtime — time.h

Function

Converts date and time to Greenwich mean time (GMT).

Syntax

```
struct tm *gmtime(const time_t *timer);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

gmtime accepts the address of a value returned by *time* and returns a pointer to the structure of type *tm* containing the time elements. *gmtime* converts directly to GMT.

The global long variable *_timezone* should be set to the difference in seconds between GMT and local standard time (in PST, *_timezone* is 8×60×60). The global variable *_daylight* should be set to nonzero *only if* the standard U.S. daylight saving time conversion should be applied.

This is the *tm* structure declaration from the time.h header file:

```
struct tm {
   int tm_sec;          /* Seconds */
   int tm_min;          /* Minutes */
   int tm_hour;         /* Hour (0 - 23) */
   int tm_mday;         /* Day of month (1 - 31) */
   int tm_mon;          /* Month (0 - 11) */
   int tm_year;         /* Year (calendar year minus 1900) */
   int tm_wday;         /* Weekday (0 - 6; Sunday is 0) */
   int tm_yday;         /* Day of year (0 -365) */
   int tm_isdst;        /* Nonzero if daylight saving time is in effect. */
};
```

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

Return value *gmtime* returns a pointer to the structure containing the time elements. This structure is a static that is overwritten with each call.

See also *asctime, ctime, ftime, localtime, stime, time, tzset*

gotoxy — conio.h

Function Positions cursor in text window.

Syntax

```
void gotoxy(int x, int y);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *gotoxy* moves the cursor to the given position in the current text window. If the coordinates are in any way invalid, the call to *gotoxy* is ignored. An example of this is a call to *gotoxy*(40,30), when (35,25) is the bottom right position in the window.

Neither argument to *gotoxy* can be zero.

This function should not be used in PM applications.

Return value None.

See also *wherex, wherey, window*

_heapadd — malloc.h

Function Add a block to the heap.

Syntax

```
int _heapadd(void *block, size_t size);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
			■			■

Remarks This function adds a new block of memory to the heap. The block must not have been previously allocated from the heap. *_heapadd* is typically used to add large static data areas to the heap.

Return value *_heapadd* returns 0 if it is successful, and –1 if it is unsuccessful.

See also *free, malloc*

heapcheck — alloc.h

Function Checks and verifies the heap.

Syntax

```
int heapcheck(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■			■			■

Remarks *heapcheck* walks through the heap and examines each block, checking its pointers, size, and other critical attributes.

Return value The return value is less than 0 for an error and greater than 0 for success. The return values and their meaning are as follows:

_HEAPCORRUPT	Heap has been corrupted
_HEAPEMPTY	No heap
_HEAPOK	Heap is verified

heapcheckfree — alloc.h

Function Checks the free blocks on the heap for a constant value.

Syntax

```
int heapcheckfree(unsigned int fillvalue);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■			■			■

Return value

The return value is less then 0 for an error and greater than 0 for success. The return values and their meaning are as follows:

_BADVALUE	A value other than the fill value was found
_HEAPCORRUPT	Heap has been corrupted
_HEAPEMPTY	No heap
_HEAPOK	Heap is accurate

heapchecknode — alloc.h

Function

Checks and verifies a single node on the heap.

Syntax

```
int heapchecknode(void *node);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■			■			■

Remarks

If a node has been freed and *heapchecknode* is called with a pointer to the freed block, *heapchecknode* can return _BADNODE rather than the expected _FREEENTRY. This is because adjacent free blocks on the heap are merged, and the block in question no longer exists.

Return value

One of the following values:

_BADNODE	Node could not be found
_FREEENTRY	Node is a free block
_HEAPCORRUPT	Heap has been corrupted
_HEAPEMPTY	No heap
_USEDENTRY	Node is a used block

_heapchk — malloc.h

Function

Checks and verifies the heap.

Syntax

```
int _heapchk(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
			■			■

Remarks

_heapchk walks through the heap and examines each block, checking its pointers, size, and other critical attributes.

Return value

One of the following values:

_HEAPBADNODE	A corrupted heap block has been found
_HEAPEMPTY	No heap exists
_HEAPOK	The heap appears to be uncorrupted

H

See also

_heapset, *_rtl_heapwalk*

heapfillfree alloc.h

Function

Fills the free blocks on the heap with a constant value.

Syntax

```
int heapfillfree(unsigned int fillvalue);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■			■			■

Return value

One of the following values:

_HEAPCORRUPT	Heap has been corrupted
_HEAPEMPTY	No heap
_HEAPOK	Heap is accurate

_heapmin malloc.h

Function

Release unused heap areas.

Syntax

```
int _heapmin(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

The *_heapmin* function returns unused areas of the heap to the operating system. This allows blocks that have been allocated and then freed to be used by other processes. Due to fragmentation of the heap, *_heapmin* might not always be able to return unused memory to the operating system; this is not an error.

Return value *_heapmin* returns 0 if it is successful, or –1 if an error occurs.

See also *free, malloc*

_heapset — malloc.h

Function Fills the free blocks on the heap with a constant value.

Syntax

```
int _heapset(unsigned int fillvalue);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
			■			■

Remarks *_heapset* checks the heap for consistency using the same methods as *_heapchk*. It then fills each free block in the heap with the value contained in the least significant byte of *fillvalue*. This function can be used to find heap-related problems. It does *not* guarantee that subsequently allocated blocks will be filled with the specified value.

Return value One of the following values:

_HEAPOK	The heap appears to be uncorrupted
_HEAPEMPTY	No heap exists
_HEAPBADNODE	A corrupted heap block has been found

See also *_heapchk, _rtl_heapwalk*

heapwalk — alloc.h

Function *heapwalk* is used to "walk" through the heap, node by node.

Syntax

```
int heapwalk(struct heapinfo *hi);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■			■			■

Remarks *heapwalk* assumes the heap is correct. Use *heapcheck* to verify the heap before using *heapwalk*. _HEAPOK is returned with the last block on the heap. _HEAPEND will be returned on the next call to *heapwalk*.

heapwalk receives a pointer to a structure of type *heapinfo* (declared in alloc.h). For the first call to *heapwalk*, set the hi.ptr field to null. *heapwalk* returns with hi.ptr containing the address of the first block. hi.size holds the size of the block in bytes. hi.in_use is a flag that's set if the block is currently in use.

Return value

One of the following values:

_HEAPEMPTY	No heap
_HEAPEND	End of the heap has been reached
_HEAPOK	*Heapinfo* block contains valid data

See also

_rtl_heapwalk

_heapwalk — malloc.h

Remarks

Obsolete function. See *_rtl_heapwalk*.

highvideo — conio.h

Function

Selects high-intensity characters.

Syntax

```
void highvideo(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■			■			■

Remarks

highvideo selects high-intensity characters by setting the high-intensity bit of the currently selected foreground color.

This function does not affect any characters currently onscreen, but does affect those displayed by functions (such as *cprintf*) that perform direct video, text mode output *after highvideo* is called.

This function should not be used in PM applications.

Return value

None.

See also

cprintf, cputs, gettextinfo, lowvideo, normvideo, textattr, textcolor

hypot, hypotl — math.h

Function

Calculates hypotenuse of a right triangle.

Syntax

```
double hypot(double x, double y);
long double hypotl(long double x, long double y);
```

	DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
hypot	■	■	■	■			■
hypotl	■		■	■			■

Remarks

hypot calculates the value *z* where

$z^2 = x^2 + y^2$ and $z >= 0$

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

hypotl is the **long double** version; it takes **long double** arguments and returns a **long double** result.

Return value

On success, these functions return *z*, a **double** (*hypot*) or a **long double** (*hypotl*). On error (such as an overflow), they set the global variable *errno* to

ERANGE Result out of range

and return the value HUGE_VAL (*hypot*) or _LHUGE_VAL (*hypotl*). Error handling for these routines can be modified through the functions *_matherr* and *_matherrl*.

insline — conio.h

Function

Inserts a blank line in the text window.

Syntax

```
void insline(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■			■			■

Remarks

insline inserts an empty line in the text window at the cursor position using the current text background color. All lines below the empty one move down one line, and the bottom line scrolls off the bottom of the window.

This function should not be used in PM applications.

Return value

None.

See also

clreol, delline, window

isalnum — ctype.h

Function

Tests for an alphanumeric character.

Syntax

```
int isalnum(int c);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

isalnum is a macro that classifies ASCII-coded integer values by table lookup. The macro is affected by the current locale's LC_CTYPE category. For the default C locale, *c* is a letter (*A* to *Z* or *a* to *z*) or a digit (0 to 9).

You can make this macro available as a function by undefining (**#undef**) it.

Return value

It is a predicate returning nonzero for true and 0 for false. *isalnum* returns nonzero if *c* is a letter or a digit.

isalpha — ctype.h

Function

Classifies an alphabetical character.

Syntax

```
int isalpha(int c);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

isalpha is a macro that classifies ASCII-coded integer values by table lookup. The macro is affected by the current locale's LC_CTYPE category. For the default C locale, *c* is a letter (*A* to *Z* or *a* to *z*).

You can make this macro available as a function by undefining (**#undef**) it.

Return value

isalpha returns nonzero if *c* is a letter.

isascii — ctype.h

Function

Character classification macro.

Syntax

```
int isascii(int c);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks

isascii is a macro that classifies ASCII-coded integer values by table lookup. It is a predicate returning nonzero for true and 0 for false.

isascii is defined on all integer values.

Return value *isascii* returns nonzero if the low order byte of *c* is in the range 0 to 127 (0x00-0x7F).

isatty — io.h

Function Checks for device type.

Syntax

```
int isatty(int handle);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks *isatty* determines whether *handle* is associated with any one of the following character devices:

- A terminal
- A console
- A printer
- A serial port

Return value If the device is one of the four character devices listed above, *isatty* returns a nonzero integer. If it is not such a device, *isatty* returns 0.

iscntrl — ctype.h

Function Tests for a control character.

Syntax

```
int iscntrl(int c);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *iscntrl* is a macro that classifies ASCII-coded integer values by table lookup. The macro is affected by the current locale's LC_CTYPE category. For the default C locale, *c* is a delete character or control character (0x7F or 0x00 to 0x1F).

You can make this macro available as a function by undefining (**#undef**) it.

Return value *iscntrl* returns nonzero if *c* is a delete character or ordinary control character.

isdigit ctype.h

Function Tests for decimal-digit character.

Syntax

```
int isdigit(int c);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *isdigit* is a macro that classifies ASCII-coded integer values by table lookup. The macro is affected by the current locale's LC_CTYPE category. For the default C locale, *c* is a digit (0 to 9).

You can make this macro available as a function by undefining (#**undef**) it.

Return value *isdigit* returns nonzero if *c* is a digit.

isgraph ctype.h

Function Tests for printing character.

Syntax

```
int isgraph(int c);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *isgraph* is a macro that classifies ASCII-coded integer values by table lookup. The macro is affected by the current locale's LC_CTYPE category. For the default C locale, *c* is a printing character except blank space (' ').

You can make this macro available as a function by undefining (#**undef**) it.

Return value *isgraph* returns nonzero if *c* is a printing character.

islower ctype.h

Function Tests for lowercase character.

Syntax

```
int islower(int c);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

islower is a macro that classifies ASCII-coded integer values by table lookup. The macro is affected by the current locale's LC_CTYPE category. For the default C locale, *c* is a lowercase letter (*a* to *z*).

You can make this macro available as a function by undefining (**#undef**) it.

Return value

islower returns nonzero if *c* is a lowercase letter.

isprint — ctype.h

Function

Tests for printing character.

Syntax

```
int isprint(int c);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

isprint is a macro that classifies ASCII-coded integer values by table lookup. The macro is affected by the current locale's LC_CTYPE category. For the default C locale, *c* is a printing character including the blank space (' ').

You can make this macro available as a function by undefining (**#undef**) it.

Return value

isprint returns nonzero if *c* is a printing character.

ispunct — ctype.h

Function

Tests for punctuation character.

Syntax

```
int ispunct(int c);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

ispunct is a macro that classifies ASCII-coded integer values by table lookup. The macro is affected by the current locale's LC_CTYPE category. For the default C locale, *c* is any printing character that is neither an alphanumeric nor a blank space (' ').

You can make this macro available as a function by undefining (**#undef**) it.

Return value

ispunct returns nonzero if *c* is a punctuation character.

isspace ctype.h

Function Tests for space character.

Syntax

```
int isspace(int c);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *isspace* is a macro that classifies ASCII-coded integer values by table lookup. The macro is affected by the current locale's LC_CTYPE category.

You can make this macro available as a function by undefining (#**undef**) it.

Return value *isspace* returns nonzero if *c* is a space, tab, carriage return, new line, vertical tab, formfeed (0x09 to 0x0D, 0x20), or any other locale-defined space character.

isupper ctype.h

Function Tests for uppercase character.

Syntax

```
int isupper(int c);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *isupper* is a macro that classifies ASCII-coded integer values by table lookup. The macro is affected by the current locale's LC_CTYPE category. For the default C locale, *c* is an uppercase letter (*A* to *Z*).

You can make this macro available as a function by undefining (#**undef**) it.

Return value *isupper* returns nonzero if *c* is an uppercase letter.

isxdigit ctype.h

Function Tests for hexadecimal character.

Syntax

```
int isxdigit(int c);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

isxdigit is a macro that classifies ASCII-coded integer values by table lookup. The macro is affected by the current locale's LC_CTYPE category.

You can make this macro available as a function by undefining (**#undef**) it.

Return value

isxdigit returns nonzero if *c* is a hexadecimal digit (0 to 9, *A to F, a to f*) or any other hexadecimal digit defined by the locale.

itoa — stdlib.h

Function

Converts an integer to a string.

Syntax

```
char *itoa(int value, char *string, int radix);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

itoa converts *value* to a null-terminated string and stores the result in *string*. With *itoa, value* is an integer.

radix specifies the base to be used in converting *value*; it must be between 2 and 36, inclusive. If *value* is negative and *radix* is 10, the first character of *string* is the minus sign (–).

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 33 bytes.

Return value

itoa returns a pointer to *string*.

See also

ltoa, ultoa

kbhit — conio.h

Function

Checks for currently available keystrokes.

Syntax

```
int kbhit(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *kbhit* checks to see if a keystroke is currently available. Any available keystrokes can be retrieved with *getch* or *getche*.

This function should not be used in PM applications.

Return value If a keystroke is available, *kbhit* returns a nonzero value. Otherwise, it returns 0.

See also *getch, getche*

labs math.h

Function Gives long absolute value.

Syntax

```
long labs(long int x);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

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Remarks *labs* computes the absolute value of the parameter *x*.

Return value *labs* returns the absolute value of *x*.

See also *abs, cabs, fabs*

ldexp, ldexpl math.h

Function Calculates $x \times 2^{exp}$.

Syntax

```
double ldexp(double x, int exp);
long double ldexpl(long double x, int exp);
```

	DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
ldexp	■	■	■	■	■	■	■
ldexpl	■		■	■			■

Remarks *ldexp* calculates the **double** value $x \times 2^{exp}$.

expl is the **long double** version; it takes a **long double** argument for *x* and returns a **long double** result.

Return value On success, *ldexp* (or *ldexpl*) returns the value it calculated, $x \times 2^{exp}$. Error handling for these routines can be modified through the functions *_matherr* and *_matherrl*.

See also *exp, frexp, modf*

ldiv — stdlib.h

Function Divides two **long**s, returning quotient and remainder.

Syntax

```
ldiv_t ldiv(long int numer, long int denom);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■	■	■	■

Remarks *ldiv* divides two **long**s and returns both the quotient and the remainder as an *ldiv_t* type. *numer* and *denom* are the numerator and denominator, respectively. The *ldiv_t* type is a structure of **long**s defined in stdlib.h as follows:

```
typedef struct {
   long int quot;      /* quotient */
   long int rem;       /* remainder */
   } ldiv_t;
```

Return value *ldiv* returns a structure whose elements are *quot* (the quotient) and *rem* (the remainder).

See also *div*

lfind — stdlib.h

Function Performs a linear search.

Syntax

```
void  *lfind(const void *key, const void *base, size_t *num, size_t width,
             int (_USERENTRY *fcmp)(const void *, const void *));
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks *lfind* makes a linear search for the value of *key* in an array of sequential records. It uses a user-defined comparison routine *fcmp*. The *fcmp* function must be used with the _USERENTRY calling convention.

The array is described as having **num* records that are *width* bytes wide, and begins at the memory location pointed to by *base*.

Return value *lfind* returns the address of the first entry in the table that matches the search key. If no match is found, *lfind* returns NULL. The comparison routine must return 0 if **elem1* == **elem2*, and nonzero otherwise (*elem1* and *elem2* are its two parameters).

See also *bsearch, lsearch, qsort*

localeconv — locale.h

Function Queries the locale for numeric format.

Syntax

```
struct lconv *localeconv(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■	■	■	■

Remarks This function provides information about the monetary and other numeric formats for the current locale. The information is stored in a **struct** *lconv* type. The structure can only be modified by the *setlocale*. Subsequent calls to *localeconv* will update the *lconv* structure.

The *lconv* structure is defined in locale.h. It contains the following fields:

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Table 2.1: Locale monetary and numeric settings

Field	Application
char **decimal_point;*	Decimal point used in nonmonetary formats. This can never be an empty string.
char **thousands_sep;*	Separator used to group digits to the left of the decimal point. Not used with monetary quantities.
char **grouping;*	Size of each group of digits. Not used with monetary quantities. See the value listing table below.
char **int_curr_symbol;*	International monetary symbol in the current locale. The symbol format is specified in the *ISO 4217 Codes for the Representation of Currency and Funds.*
char **currency_symbol;*	Local monetary symbol for the current locale.
char **mon_decimal_point;*	Decimal point used to format monetary quantities.
char **mon_thousands_sep;*	Separator used to group digits to the left of the decimal point for monetary quantities.
char **mon_grouping;*	Size of each group of digits used in monetary quantities. See the value listing table below.
char **positive_sign;*	String indicating nonnegative monetary quantities.
char **negative_sign;*	String indicating negative monetary quantities.
char *int_frac_digits;*	Number of digits after the decimal point that are to be displayed in an internationally formatted monetary quantity.
char *frac_digits;*	Number of digits after the decimal point that are to be displayed in a formatted monetary quantity.
char *p_cs_precedes;*	Set to 1 if *currency_symbol* precedes a nonnegative formatted monetary quantity. If *currency_symbol* is after the quantity, it is set to 0.

Table 2.1: Locale monetary and numeric settings (continued)

char *p_sep_by_space;*	Set to 1 if *currency_symbol* is to be separated from the nonnegative formatted monetary quantity by a space. Set to 0 if there is no space separation.
char *n_cs_precedes;*	Set to 1 if *currency_symbol* precedes a negative formatted monetary quantity. If *currency_symbol* is after the quantity, set to 0.
char *n_sep_by_space;*	Set to 1 if *currency_symbol* is to be separated from the negative formatted monetary quantity by a space. Set to 0 if there is no space separation.
char *p_sign_posn;*	Indicate where to position the positive sign in a nonnegative formatted monetary quantity.
char *n_sign_posn;*	Indicate where to position the positive sign in a negative formatted monetary quantity.

Any of the above strings (except *decimal_point*) that is empty "" is not supported in the current locale. The nonstring **char** elements are nonnegative numbers. Any nonstring **char** element that is set to *CHAR_MAX* indicates that the element is not supported in the current locale.

The *grouping* and *mon_grouping* elements are set and interpreted as follows:

Value	Meaning
CHAR_MAX	No further grouping is to be performed.
0	The previous element is to be used repeatedly for the remainder of the digits.
any other integer	Indicates how many digits make up the current group. The next element is read to determine the size of the next group of digits before the current group.

The *p_sign_posn* and *n_sign_posn* elements are set and interpreted as follows:

Value	Meaning
0	Use parentheses to surround the quantity and *currency_symbol*
1	Sign string precedes the quantity and *currency_symbol.*
2	Sign string succeeds the quantity and *currency_symbol.*
3	Sign string immediately precedes the quantity and *currency_symbol.*
4	Sign string immediately succeeds the quantity and *currency_symbol.*

Return value

Returns a pointer to the filled-in structure of type **struct** *lconv*. The values in the structure will change whenever *setlocale* modifies the LC_MONETARY or LC_NUMERIC categories.

See also

setlocale

localtime — time.h

Function

Converts date and time to a structure.

Syntax

```
struct tm *localtime(const time_t *timer);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

localtime accepts the address of a value returned by *time* and returns a pointer to the structure of type *tm* containing the time elements. It corrects for the time zone and possible daylight saving time.

The global long variable *timezone* contains the difference in seconds between GMT and local standard time (in PST, *timezone* is 8×60×60). The global variable *daylight* contains nonzero *only if* the standard U.S. daylight saving time conversion should be applied. These values are set by *tzset*, not by the user program directly.

This is the *tm* structure declaration from the time.h header file:

```
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 to 31), month (0 to 11), weekday (Sunday equals 0), year – 1900, day of year (0 to 365), and a flag that is nonzero if daylight saving time is in effect.

Return value

localtime returns a pointer to the structure containing the time elements. This structure is a static that is overwritten with each call. If the local time cannot be represented, *localtime* returns NULL.

See also *asctime, ctime, ftime, gmtime, stime, time, tzset*

lock — io.h

Function Sets file-sharing locks.

Syntax

```
int lock(int handle, long offset, long length);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *lock* provides an interface to the operating system file-sharing mechanism. A lock can be placed on arbitrary, nonoverlapping regions of any file.

Return value *lock* returns 0 on success. On error, *lock* returns –1 and sets the global variable *errno* to

EACCES Locking violation

See also *locking, open, sopen, unlock*

locking — io.h, sys\locking.h

Function Sets or resets file-sharing locks.

Syntax

```
int locking(int handle, int cmd, long length);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *locking* provides an interface to the operating system file-sharing mechanism. The file to be locked or unlocked is the open file specified by *handle*. The region to be locked or unlocked starts at the current file position, and is *length* bytes long.

Locks can be placed on arbitrary, nonoverlapping 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.

The *cmd* values (defined in sys\locking.h) specify the action to be taken:

LK_LOCK Lock the region. If the lock is unsuccessful, try once a second for 10 seconds before giving up.

LK_RLCK Same as LK_LOCK, except that on OS/2 other processes are allowed shared (read-only) access.

LK_NBLCK	Lock the region. If the lock if unsuccessful, give up immediately.
LK_NBRLCK	Same as LK_NBLCK, except that on OS/2, other processes are allowed shared (read-only) access.
LK_UNLCK	Unlock the region, which must have been previously locked.

Return value

On successful operations, *locking* returns 0. Otherwise, it returns –1, and the global variable *errno* is set to one of the following values:

EACCES	File already locked or unlocked
EBADF	Bad file number
EDEADLOCK	File cannot be locked after 10 retries (*cmd* is LK_LOCK or LK_RLCK)
EINVAL	Invalid *cmd*

See also

_fsopen, lock, open, sopen, unlock

log, logl math.h

Function

Calculates the natural logarithm of *x*.

Syntax

```
double log(double x);
long double logl(long double x);
```

	DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
log	■	■	■	■	■	■	■
logl	■		■	■			■

Remarks

log calculates the natural logarithm of *x*.

logl is the **long double** version; it takes a **long double** argument and returns a **long double** result.

This function can be used with *bcd* and *complex* types.

Return value

On success, *log* and *logl* return the value calculated, *ln*(*x*).

If the argument *x* passed to these functions is real and less than 0, the global variable *errno* is set to

EDOM Domain error

If *x* is 0, the functions return the value negative HUGE_VAL (*log*) or negative _LHUGE_VAL (*logl*), and set *errno* to ERANGE. Error handling for these routines can be modified through the functions *_matherr* and *_matherrl*.

See also *bcd, complex, exp, log10, sqrt*

log10, log10l math.h

Function Calculates log $_{10}(x)$.

Syntax

```
double log10(double x);
long double log10l(long double x);
```

	DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
log10	■	■	■	■	■	■	■
log10l	■		■	■			■

Remarks *log10* calculates the base 10 logarithm of *x*.

log10l is the **long double** version; it takes a **long double** argument and returns a **long double** result.

This function can be used with *bcd* and *complex* types.

Return value On success, *log10* (or *log10l*) returns the value calculated, $log_{10}(x)$.

If the argument *x* passed to these functions is real and less than 0, the global variable *errno* is set to

EDOM Domain error

If *x* is 0, these functions return the value negative HUGE_VAL (*log10*) or _LHUGE_VAL (*log10l*). Error handling for these routines can be modified through the functions *_matherr* and *_matherrl*.

See also *bcd, complex, exp, log*

longjmp setjmp.h

Function Performs nonlocal goto.

Syntax

```
void longjmp(jmp_buf jmpb, int retval);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

A call to *longjmp* restores the task state captured by the last call to *setjmp* with the argument *jmpb*. It then returns in such a way that *setjmp* appears to have returned with the value *retval*.

A task state includes:

- no segment registers are saved
- register variables (EBX, EDI, ESI)
- stack pointer (ESP)
- frame base pointer (EBP)
- flags are not saved

A task state is complete enough that *setjmp* and *longjmp* can be used to implement co-routines.

setjmp must be called before *longjmp*. The routine that called *setjmp* and set up *jmpb* must still be active and cannot have returned before the *longjmp* is called. If this happens, the results are unpredictable.

longjmp cannot pass the value 0; if 0 is passed in *retval*, *longjmp* will substitute 1.

You can not use *longjmp* to switch between different threads in a multithread process. That is, do not jump to a *jmp_buf* that was saved by a *setjmp* call in a different thread.

Return value None.

See also *setjmp*, *signal*

K-M

lowvideo — conio.h

Function Selects low-intensity characters.

Syntax

```
void lowvideo(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■			■			■

Remarks

lowvideo selects low-intensity characters by clearing the high-intensity bit of the currently selected foreground color.

This function does not affect any characters currently onscreen. It affects only those characters displayed by functions that perform text mode, direct console output *after* this function is called.

This function should not be used in PM applications.

Return value None.

See also *highvideo, normvideo, textattr, textcolor*

_lrotl, _lrotr — stdlib.h

Function Rotates an **unsigned long** integer value to the left or right.

Syntax

```
unsigned long _lrotl(unsigned long val, int count);
unsigned long _lrotr(unsigned long val, int count);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *_lrotl* rotates the given *val* to the left *count* bits. *_lrotr* rotates the given *val* to the right *count* bits.

Return value The functions return the rotated integer:

- *_lrotl* returns the value of *val* left-rotated *count* bits.
- *_lrotr* returns the value of *val* right-rotated *count* bits.

See also *_crotr, _crotl, _rotl, _rotr*

lsearch — stdlib.h

Function Performs a linear search.

Syntax

```
void *lsearch(const void *key, void *base, size_t *num, size_t width,
              int (_USERENTRY *fcmp)(const void *, const void *));
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks *lsearch* searches a table for information. Because this is a linear search, the table entries do not need to be sorted before a call to *lsearch*. If the item that *key* points to is not in the table, *lsearch* appends that item to the table.

- *base* points to the base (0th element) of the search table.
- *num* 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 function *fcmp* must be used with the _USERENTRY calling convention.

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

To search the table, *lsearch* makes repeated calls to the routine whose address is passed in *fcmp*.

On each call to the comparison routine, *lsearch* passes 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 in any way.

Return value

lsearch returns the address of the first entry in the table that matches the search key.

If the search key is not identical to **elem, fcmp* returns a nonzero integer. If the search key is identical to **elem, fcmp* returns 0.

See also

bsearch, lfind, qsort

K-M

lseek — io.h

Function

Moves file pointer.

Syntax

```
long lseek(int handle, long offset, int fromwhere);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks

lseek sets the file pointer associated with *handle* to a new position *offset* bytes beyond the file location given by *fromwhere*. *fromwhere* must be one of the following symbolic constants (defined in io.h):

fromwhere	File location
SEEK_CUR	Current file pointer position
SEEK_END	End-of-file
SEEK_SET	File beginning

Return value

lseek returns the offset of the pointer's new position measured in bytes from the file beginning. *lseek* returns –1L on error, and the global variable *errno* is set to one of the following values:

EBADF	Bad file handle
EINVAL	Invalid argument
ESPIPE	Illegal seek on device

On devices incapable of seeking (such as terminals and printers), the return value is undefined.

See also *filelength, fseek, ftell, getc, open, sopen, ungetc, _rtl_write, write*

ltoa — stdlib.h

Function Converts a **long** to a string.

Syntax

```
char *ltoa(long value, char *string, int radix);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *ltoa* converts *value* to a null-terminated string and stores the result in *string*. *value* is a long integer.

radix specifies the base to be used in converting *value*; it must be between 2 and 36, inclusive. If *value* is negative and *radix* is 10, the first character of *string* is the minus sign (–).

The space allocated for *string* must be large enough to hold the returned string, including the terminating null character (\0). *ltoa* can return up to 33 bytes.

Return value *ltoa* returns a pointer to *string*.

See also *itoa, ultoa*

_makepath — stdlib.h

Function Builds a path from component parts.

Syntax

```
void _makepath(char *path, const char *drive, const char *dir,
               const char *name, const char *ext);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *_makepath* makes a path name from its components. The new path name is

```
X:\DIR\SUBDIR\NAME.EXT
```

where

drive = `X:`
dir = `\DIR\SUBDIR\`
name = `NAME`
ext = `.EXT`

If *drive* is empty or NULL, no drive is inserted in the path name. If it is missing a trailing colon (:), a colon is inserted in the path name.

If *dir* is empty or NULL, no directory is inserted in the path name. If it is missing a trailing slash (\ or /), a backslash is inserted in the path name.

If *name* is empty or NULL, no file name is inserted in the path name.

If *ext* is empty or NULL, no extension is inserted in the path name. If it is missing a leading period (.), a period is inserted in the path name.

_makepath assumes there is enough space in *path* for the constructed path name. The maximum constructed length is _MAX_PATH. _MAX_PATH is defined in stdlib.h.

_makepath and *_splitpath* are invertible; if you split a given *path* with *_splitpath*, then merge the resultant components with *_makepath*, you end up with *path*.

Return value None.

See also *_fullpath*, *_splitpath*

malloc stdlib.h

Function Allocates main memory.

Syntax

```
void *malloc(size_t size);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *malloc* allocates a block of *size* bytes from the memory heap. It allows a program to allocate memory explicitly as it's needed, and in the exact amounts needed.

The heap is used for dynamic allocation of variable-sized blocks of memory. Many data structures, for example, trees and lists, naturally employ heap memory allocation.

Return value On success, *malloc* returns a pointer to the newly allocated block of memory. If not enough space exists for the new block, it returns NULL. The contents of the block are left unchanged. If the argument *size* == 0, *malloc* returns NULL.

See also *calloc, free, realloc*

_matherr, _matherrl — math.h

Function User-modifiable math error handler.

Syntax

```
int _matherr(struct _exception *e);
int _matherrl(struct _exceptionl *e);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *_matherr* is called when an error is generated by the math library.

_matherrl is the **long double** version; it is called when an error is generated by the **long double** math functions.

_matherr and *_matherrl* each serve as a user hook (a function that can be customized by the user) that you can replace by writing your own math error handling routine. The example shows a user-defined *_matherr* implementation.

_matherr and *_matherrl* are useful for trapping domain and range errors caused by the math functions. They do not trap floating-point exceptions, such as division by zero. See *signal* for information on trapping such errors.

You can define your own *_matherr* or *_matherrl* routine to be a custom error handler (such as one that catches and resolves certain types of errors); this customized function overrides the default version in the C library. The customized *_matherr* or *_matherrl* should return 0 if it fails to resolve the error, or nonzero if the error is resolved. If nonzero is returned, no error message is printed and the global variable *errno* is not changed.

Here are the *_exception* and *_exceptionl* structures (defined in math.h):

```
struct _exception {
   int   type;
   char  *name;
   double arg1, arg2, retval;
};

struct _exceptionl {
```

```
    int   type;
    char  *name;
    long double arg1, arg2, retval;
};
```

The members of the *_exception* and *_exceptionl* structures are shown in the following table:

Member	What it is (or represents)
type	The type of mathematical error that occurred; an **enum** type defined in the **typedef** *_mexcep* (see definition after this list).
name	A pointer to a null-terminated string holding the *name* of the math library function that resulted in an error.
arg1, *arg2*	The arguments (passed to the function that *name* points to) caused the error; if only one argument was passed to the function, it is stored in *arg1*.
retval	The default return value for *_matherr* (or *_matherrl*); you can modify this value.

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The **typedef** *_mexcep*, also defined in math.h, enumerates the following symbolic constants representing possible mathematical errors:

Symbolic constant	Mathematical error
DOMAIN	Argument was not in domain of function, such as *log*(-1).
SING	Argument would result in a singularity, such as *pow*(0, –2).
OVERFLOW	Argument would produce a function result greater than DBL_MAX (or LDBL_MAX), such as *exp*(1000).
UNDERFLOW	Argument would produce a function result less than DBL_MIN (or LDBL_MIN), such as *exp*(-1000).
TLOSS	Argument would produce function result with total loss of significant digits, such as *sin*(10e70).

The macros DBL_MAX, DBL_MIN, LDBL_MAX, and LDBL_MIN are defined in float.h.

The source code to the default *_matherr* and *_matherrl* is on the Borland C++ distribution disks.

The UNIX-style *_matherr* and *_matherrl* default behavior (printing a message and terminating) is not ANSI compatible. If you want a UNIX-style version of these routines, use MATHERR.C and MATHERRL.C provided on the Borland C++ distribution disks.

Return value

The default return value for *_matherr* and *_matherrl* is 1 if the error is UNDERFLOW or TLOSS, 0 otherwise. *_matherr* and *_matherrl* can also modify *e –> retval*, which propagates back to the original caller.

When *_matherr* and *_matherrl* return 0 (not able to resolve the error), the global variable *errno* is set to 0 and an error message is printed.

When *_matherr* and *_matherrl* return nonzero (able to resolve the error), the global variable *errno* is not set and no messages are printed.

max — stdlib.h

Function

Returns the larger of two values.

Syntax

```
(type) max(a, b);
template <class T> T max( T t1, T t2 );  // C++ template function
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

The C macro and the C++ template function compare two values and return the larger of the two. Both arguments and the routine declaration must be of the same type.

Return value

max returns the larger of two values.

See also

min

mblen — stdlib.h

Function

Determines the length of a multibyte character.

Syntax

```
int mblen(const char *s, size_t n);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■	■	■	■

Remarks

If *s* is not null, *mblen* determines the number of bytes in the multibyte character pointed to by *s*. The maximum number of bytes examined is specified by *n*.

The behavior of *mblen* is affected by the setting of LC_CTYPE category of the current locale.

Return value If *s* is null, *mblen* returns a nonzero value if multibyte characters have state-dependent encodings. Otherwise, *mblen* returns 0.

If *s* is not null, *mblen* returns 0 if *s* points to the null character, and –1 if the next *n* bytes do not comprise a valid multibyte character; the number of bytes that comprise a valid multibyte character.

See also *mbstowcs, mbtowc, setlocale*

mbstowcs stdlib.h

Function Converts a multibyte string to a *wchar_t* array.

Syntax

```
size_t mbstowcs(wchar_t *pwcs, const char *s, size_t n);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
▪		▪	▪	▪	▪	▪

K-M

Remarks The function converts the multibyte string *s* into the array pointed to by *pwcs*. No more than *n* values are stored in the array. If an invalid multibyte sequence is encountered, *mbstowcs* returns (*size_t*) –1.

The *pwcs* array will not be terminated with a zero value if *mbstowcs* returns *n*.

The behavior of *mbstowcs* is affected by the setting of LC_CTYPE category of the current locale.

Return value If an invalid multibyte sequence is encountered, *mbstowcs* returns (*size_t*) –1. Otherwise, the function returns the number of array elements modified, not including the terminating code, if any.

See also *mblen, mbtowc, setlocale*

mbtowc stdlib.h

Function Converts a multibyte character to *wchar_t* code.

Syntax

```
int mbtowc(wchar_t *pwc, const char *s, size_t n);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
▪		▪	▪	▪	▪	▪

Remarks If *s* is not null, *mbtowc* determines the number of bytes that comprise the multibyte character pointed to by *s*. Next, *mbtowc* determines the value of the type wchar_t that corresponds to that multibyte character. If there is a successful match between wchar_t and the multibyte character, and *pwc* is not null, the wchar_t value is stored in the array pointed to by *pwc*. At most *n* characters are examined.

Return value

When *s* points to an invalid multibyte character, –1 is returned. When *s* points to the null character, 0 is returned. Otherwise, *mbtowc* returns the number of bytes that comprise the converted multibyte character.

The return value never exceeds MB_CUR_MAX or the value of *n*.

The behavior of *mbtowc* is affected by the setting of LC_CTYPE category of the current locale.

See also

mblen, mbstowcs, setlocale

memccpy — mem.h

Function

Copies a block of *n* bytes.

Syntax

```
void *memccpy(void *dest, const void *src, int c, size_t n);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks

memccpy is available on UNIX System V systems.

memccpy copies a block of *n* bytes from *src* to *dest*. The copying stops as soon as either of the following occurs:

- The character *c* is first copied into *dest*.
- *n* bytes have been copied into *dest*.

Return value

memccpy returns a pointer to the byte in *dest* immediately following *c*, if *c* was copied; otherwise, *memccpy* returns NULL.

See also

memcpy, memmove, memset

memchr — mem.h

Function

Searches *n* bytes for character *c*.

Syntax

```
void *memchr(const void *s, int c, size_t n);                    /* C only */
```

```
const void *memchr(const void *s, int c, size_t n);          // C++ only
void *memchr(void *s, int c, size_t n);                      // C++ only
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

memchr is available on UNIX System V systems.

memchr searches the first *n* bytes of the block pointed to by *s* for character *c*.

Return value

On success, *memchr* returns a pointer to the first occurrence of *c* in *s*; otherwise, it returns NULL.

If you are using the intrinsic version of these functions, the case of *n*=0 will return NULL.

memcmp — mem.h

K-M

Function

Compares two blocks for a length of exactly *n* bytes.

Syntax

```
int memcmp(const void *s1, const void *s2, size_t n);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

memcmp is available on UNIX System V systems.

memcmp compares the first *n* bytes of the blocks *s1* and *s2* as **unsigned chars**.

Return value

Because it compares bytes as **unsigned chars**, *memcmp* returns a value that is

- < 0 if *s1* is less than *s2*
- = 0 if *s1* is the same as *s2*
- > 0 if *s1* is greater than *s2*

For example,

```
memcmp("\xFF", "\x7F", 1)
```

returns a value greater than 0.

If you are using the intrinsic version of these functions, the case of *n*=0 will return NULL.

See also

memicmp

memcpy — mem.h

Function Copies a block of *n* bytes.

Syntax

```
void *memcpy(void *dest, const void *src, size_t n);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *memcpy* is available on UNIX System V systems.

memcpy copies a block of *n* bytes from *src* to *dest*. If *src* and *dest* overlap, the behavior of *memcpy* is undefined.

Return value *memcpy* returns *dest*.

See also *memccpy, memmove, memset*

memicmp — mem.h

Function Compares *n* bytes of two character arrays, ignoring case.

Syntax

```
int memicmp(const void *s1, const void *s2, size_t n);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks *memicmp* is available on UNIX System V systems.

memicmp compares the first *n* bytes of the blocks *s1* and *s2*, ignoring character case (upper or lower).

Return value *memicmp* returns a value that is

- < 0 if *s1* is less than *s2*
- = 0 if *s1* is the same as *s2*
- > 0 if *s1* is greater than *s2*

See also *memcmp*

memmove — mem.h

Function Copies a block of *n* bytes.

Syntax

```
void *memmove(void *dest, const void *src, size_t n);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *memmove* copies a block of *n* bytes from *src* to *dest*. Even when the source and destination blocks overlap, bytes in the overlapping locations are copied correctly.

Return value *memmove* returns *dest*.

See also *memccpy, memcpy*

memset mem.h

Function Sets *n* bytes of a block of memory to byte *c*.

Syntax

```
void *memset(void *s, int c, size_t n);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *memset* sets the first *n* bytes of the array *s* to the character *c*.

Return value *memset* returns *s*.

See also *memccpy, memcpy*

min stdlib.h

Function Returns the smaller of two values.

Syntax

```
(type) min(a, b);
template <class T> T min( T t1, T t2 );    // C++ template function
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks The C macro and the C++ template function compare two values and return the smaller of the two. Both arguments and the routine declaration must be of the same type.

Return value *min* returns the smaller of two values.

See also *max*

mkdir — dir.h

Function

Creates a directory.

Syntax

```
int mkdir(const char *path);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks

mkdir is available on UNIX, though it then takes an additional parameter.

mkdir creates a new directory from the given path name *path*.

Return value

mkdir returns the value 0 if the new directory was created.

A return value of –1 indicates an error, and the global variable *errno* is set to one of the following values:

EACCES	Permission denied
ENOENT	No such file or directory

See also

chdir, *getcurdir*, *getcwd*, *rmdir*

mktemp — dir.h

Function

Makes a unique file name.

Syntax

```
char *mktemp(char *template);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks

mktemp replaces the string pointed to by *template* with a unique file name and returns *template*.

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 period, so that there are two letters, a period, and three suffix letters in the new file name.

Starting with AA.AAA, the new file name is assigned by looking up the name 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 returns null.

mktime **time.h**

Function Converts time to calendar format.

Syntax

```
time_t mktime(struct tm *t);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■	■	■	■

Remarks Converts the time in the structure pointed to by *t* into a calendar time with the same format used by the *time* function. The original values of the fields *tm_sec, tm_min, tm_hour, tm_mday,* and *tm_mon* are not restricted to the ranges described in the *tm* structure. If the fields are not in their proper ranges, they are adjusted. Values for fields *tm_wday* and *tm_yday* are computed after the other fields have been adjusted. If the calendar time cannot be represented, *mktime* returns –1.

The allowable range of calendar times is Jan 1 1970 00:00:00 to Jan 19 2038 03:14:07.

K-M

Return value See Remarks.

See also *localtime, strftime, time*

modf, modfl **math.h**

Function Splits a **double** or **long double** into integer and fractional parts.

Syntax

```
double modf(double x, double *ipart);
long double modfl(long double x, long double *ipart);
```

	DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
modf	■	■	■	■	■	■	■
modfl	■		■	■			■

Remarks *modf* breaks the **double** *x* into two parts: the integer and the fraction. *modf* stores the integer in *ipart* and returns the fraction.

modfl is the **long double** version; it takes **long double** arguments and returns a **long double** result.

Return value *modf* and *modfl* return the fractional part of *x*.

See also *fmod, ldexp*

movetext conio.h

Function Copies text onscreen from one rectangle to another.

Syntax

```
int movetext(int left, int top, int right, int bottom, int destleft, int desttop);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■			■			■

Remarks

movetext copies the contents of the onscreen rectangle defined by *left, top, right,* and *bottom* to a new rectangle of the same dimensions. The new rectangle's upper left corner is position (*destleft, desttop*).

All coordinates are absolute screen coordinates. Rectangles that overlap are moved correctly.

movetext is a text mode function performing direct video output.

This function should not be used in PM applications.

Return value

movetext returns nonzero if the operation succeeded. If the operation failed (for example, if you gave coordinates outside the range of the current screen mode), *movetext* returns 0.

See also

gettext, puttext

_msize malloc.h

Function Returns the size of a heap block.

Syntax

```
size_t _msize(void *block);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
			■			■

Remarks

_msize returns the size of the allocated heap block whose address is *block*. The block must have been allocated with *malloc, calloc,* or *realloc*. The returned size can be larger than the number of bytes originally requested when the block was allocated.

Return value

_msize returns the size of the block in bytes.

See also

malloc, free, realloc

normvideo — conio.h

Function Selects normal-intensity characters.

Syntax

```
void normvideo(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■			■			■

Remarks *normvideo* selects normal characters by returning the text attribute (foreground and background) to the value it had when the program started.

This function does not affect any characters currently on the screen, only those displayed by functions (such as *cprintf*) performing direct console output functions after *normvideo* is called.

This function should not be used in PM applications.

Return value None.

See also *highvideo, lowvideo, textattr, textcolor*

offsetof — stddef.h

Function Gets the byte offset to a structure member.

Syntax

```
size_t offsetof(struct_type, struct_member);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *offsetof* is available only as a macro. The argument *struct_type* is a **struct** type. *struct_member* is any element of the **struct** that can be accessed through the member selection operators or pointers.

If *struct_member* is a bit field, the result is undefined.

See also Chapter 2 in the *Programmer's Guide* for a discussion of the **sizeof** operator, memory allocation and alignment of structures.

Return value *offsetof* returns the number of bytes from the start of the structure to the start of the named structure member.

_open — fcntl.h, share.h, dos.h

Remarks Obsolete function. See *_rtl_open*.

open — fcntl.h, io.h

Function Opens a file for reading or writing.

Syntax

```
int open(const char *path, int access [, unsigned mode]);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks *open* opens the file specified by *path,* then prepares it for reading and/or writing as determined by the value of *access.*

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

```
open("XMP",O_CREAT|O_TRUNC|O_BINARY,S_IREAD)
```

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

For *open, access* is constructed by bitwise ORing flags from the following two lists. Only one flag from the first list can be used (and one *must* be used); the remaining flags can be used in any logical combination.

These symbolic constants are defined in fcntl.h.

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 *mode* 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	Can be given to explicitly open the file in binary mode.
O_TEXT	Can be given to explicitly open the file in text mode.

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 *mode* argument to *open* from the following symbolic constants defined in sys\stat.h.

Value of *mode*	Access permission
S_IWRITE	Permission to write
S_IREAD	Permission to read
S_IREAD|S_IWRITE	Permission to read and write

Return value

On successful completion, *open* returns a nonnegative integer (the file handle). The file pointer, which marks the current position in the file, is set to the beginning of the file. On error, *open* returns –1 and the global variable *errno* is set to one of the following values:

EACCES	Permission denied
EINVACC	Invalid access code
EMFILE	Too many open files
ENOENT	No such file or directory

N-P

See also

chmod, chsize, close, creat, creatnew, creattemp, dup, dup2, fdopen, filelength, fopen, freopen, getftime, lseek, lock, _rtl_open, read, sopen, _rtl_creat, _rtl_write, write

opendir — dirent.h

Function

Opens a directory stream for reading.

Syntax

```
DIR *opendir(char *dirname);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks

opendir is available on POSIX-compliant UNIX systems.

The *opendir* function opens a directory stream for reading. The name of the directory to read is *dirname*. The stream is set to read the first entry in the directory.

A directory stream is represented by the *DIR* structure, defined in dirent.h. This structure contains no user-accessible fields. Multiple directory streams can be opened and read simultaneously. Directory entries can be created or deleted while a directory stream is being read.

Use the *readdir* function to read successive entries from a directory stream. Use the *closedir* function to remove a directory stream when it is no longer needed.

Return value

If successful, *opendir* returns a pointer to a directory stream that can be used in calls to *readdir*, *rewinddir*, and *closedir*. If the directory cannot be opened, *opendir* returns NULL and sets the global variable *errno* to

ENOENT	The directory does not exist
ENOMEM	Not enough memory to allocate a DIR object

See also

closedir, *readdir*, *rewinddir*

_pclose — stdio.h

Function

Waits for piped command to complete.

Syntax

```
int _pclose(FILE * stream);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
			■			■

Remarks

This function is not available in Win32s programs.

_pclose closes a pipe stream created by a previous call to *_popen*, and then waits for the associated child command to complete.

Return value

If it is successful, *_pclose* returns the termination status of the child command. This is the same value as the termination status returned by *cwait*, except that the high and low order bytes of the low word are swapped. If *_pclose* is unsuccessful, it returns –1.

See also

_pipe, *_popen*

perror — stdio.h

Function

Prints a system error message.

Syntax

```
void perror(const char *s);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
▪	▪		▪	▪	▪	▪

Remarks

perror prints to the *stderr* stream (normally the console) the system error message for the last library routine that set *errno.*

First the argument *s* is printed, then a colon, then the message corresponding to the current value of the global variable *errno,* and finally a newline. The convention is to pass the file name of the program as the argument string.

The array of error message strings is accessed through the global variable *_sys_errlist*. The global variable *errno* can be used as an index into the array to find the string corresponding to the error number. None of the strings include a newline character.

The global variable *_sys_nerr* contains the number of entries in the array.

Refer to *errno*, *_sys_errlist*, and *_sys_nerr* in Chapter 3 for more information.

The following messages are generated by *perror*:

Arg list too big
Attempted to remove current directory
Bad address
Bad file number
Block device required
Broken pipe
Cross-device link
Error 0
Exec format error
Executable file in use
File already exists
File too large
Illegal seek
Inappropriate I/O control operation
Input/output error
Interrupted function call
Invalid access code
Invalid argument
Invalid data
Invalid environment
Invalid format
Invalid function number
Invalid memory block address
Is a directory
Math argument
Memory arena trashed
Name too long
No child processes
No more files
No space left on device
No such device
No such device or address
No such file or directory
No such process
Not a directory
Not enough memory
Not same device
Operation not permitted
Path not found
Permission denied
Possible deadlock
Read-only file system
Resource busy

N-P

Resource temporarily unavailable	Too many links
Result too large	Too many open files
	Too many open files

This function should not be used in PM applications.

Return value None.

See also *clearerr, eof, freopen, _strerror, strerror*

_pipe — fcntl.h, io.h

Function Creates a read/write pipe.

Syntax

```
int _pipe(int *handles, unsigned int size, int mode);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
			■			■

Remarks This function is not available in Win32s programs.

The *_pipe* function creates an anonymous pipe that can be used to pass information between processes. The pipe is opened for both reading and writing. Like a disk file, a pipe can be read from and written to, but it does not have a name or permanent storage associated with it; data written to and from the pipe exist only in a memory buffer managed by the operating system.

The read handle is returned to *handles*[0], and the write handle is returned to *handles*[1]. The program can use these handles in subsequent calls to *read, write, dup, dup2,* or *close.* When all pipe handles are closed, the pipe is destroyed.

The size of the internal pipe buffer is *size.* A recommended minimum value is 512 bytes.

The translation mode is specified by *mode,* as follows:

O_BINARY	The pipe is opened in binary mode
O_TEXT	The pipe is opened in text mode

If *mode* is zero, the translation mode is determined by the external variable *_fmode.*

Return value On successful completion, *_pipe* returns 0 and returns the pipe handles to *handles*[0] and *handles*[1]. Otherwise it returns –1 and sets *errno* to one of the following values:

EMFILE	Too many open files
ENOMEM	Out of memory

See also *_pclose*, *_popen*

poly, polyl — math.h

Function Generates a polynomial from arguments.

Syntax

```
double poly(double x, int degree, double coeffs[]);
long double polyl(long double x, int degree, long double coeffs[]);
```

	DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
poly	■	■	■	■			■
polyl	■		■	■			■

Remarks *poly* generates a polynomial in *x*, of degree *degree*, with coefficients *coeffs[0]*, *coeffs[1]*, ..., *coeffs[degree]*. For example, if $n = 4$, the generated polynomial is

$$coeffs[4]x^4 + coeffs[3]x^3 + coeffs[2]x^2 + coeffs[1]x + coeffs[0]$$

polyl is the **long double** version; it takes **long double** arguments and returns a **long double** result.

Return value *poly* and *polyl* return the value of the polynomial as evaluated for the given *x*.

N-P

_popen — stdio.h

Function Creates a command processor pipe.

Syntax

```
FILE *_popen (const char *command, const char *mode);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
			■			■

Remarks This function is not available in Win32s programs.

The *_popen* function creates a pipe to the command processor. The command processor is executed asynchronously, and is passed the command line in *command*. The *mode* string specifies whether the pipe is connected to the command processor's standard input or output, and whether the pipe is to be opened in binary or text mode.

The *mode* string can take one of the following values:

Value	Description
rt	Read child command's standard output (text).
rb	Read child command's standard output (binary).
wt	Write to child command's standard input (text).
wb	Write to child command's standard input (binary).

The terminating *t* or *b* is optional; if missing, the translation mode is determined by the external variable *_fmode*.

Use the *_pclose* function to close the pipe and obtain the return code of the command.

Return value

If *_popen* is successful it returns a FILE pointer that can be used to read the standard output of the command, or to write to the standard input of the command, depending on the *mode* string. If *_popen* is unsuccessful, it returns NULL.

See also

_pclose, *_pipe*

pow, powl — math.h

Function

Calculates *x* to the power of *y*.

Syntax

```
double pow(double x, double y);
long double powl(long double x, double y);
```

	DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
pow	■	■	■	■	■	■	■
powl	■		■	■			■

Remarks

pow calculates x^y.

powl is the **long double** version; it takes **long double** arguments and returns a **long double** result.

This function can be used with *bcd* and *complex* types.

Return value

On success, *pow* and *powl* return the value calculated, x^y.

Sometimes the arguments passed to these functions produce results that overflow or are incalculable. When the correct value would overflow, the functions return the value HUGE_VAL (*pow*) or _LHUGE_VAL (*powl*).

Results of excessively large magnitude can cause the global variable *errno* to be set to

ERANGE	Result out of range

If the argument *x* passed to *pow* or *powl* is real and less than 0, and *y* is not a whole number, or you call *pow(0, 0)*, the global variable *errno* is set to

EDOM	Domain error

Error handling for these functions can be modified through the functions *_matherr* and *_matherrl.*

See also *bcd, complex, exp, pow10, sqrt*

pow10, pow10l — math.h

Function Calculates 10 to the power of *p*.

Syntax

```
double pow10(int p);
long double pow10l(int p);
```

	DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
pow10	■	■	■	■			■
pow10l	■		■	■			■

N-P

Remarks *pow10* computes 10^p.

Return value On success, *pow10* returns the value calculated, 10^p.

The result is actually calculated to **long double** accuracy. All arguments are valid, although some can cause an underflow or overflow.

powl is the **long double** version; it returns a **long double** result.

See also *exp, pow*

printf — stdio.h

Function Writes formatted output to stdout.

Syntax

```
int printf(const char *format[, argument, ...]);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■		■	■	■	■

Remarks

printf accepts a series of arguments, applies to each a format specifier contained in the format string given by *format*, and outputs the formatted data to *stdout*. There must be the same number of format specifiers as arguments.

The specifiers **N** and **F** (discussed below) are provided only to ease porting code that was previously written for segmented architectures. In the OS/2 32-bit flat memory model, **near** and **far** pointers are not used.

This function should not be used in PM applications.

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 will be unpredictable and possibly disastrous.* Excess arguments (more than required by the format) are ignored.

The format string is a character string that contains two types of objects—*plain characters* and *conversion specifications*:

- Plain characters are copied verbatim to the output stream.
- Conversion specifications fetch arguments from the argument list and apply formatting to them.

Format specifiers

...*printf* format specifiers have the following form:

```
% [flags] [width] [.prec] [F|N|h|l|L] type
```

Each format specifier 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|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:

Character or specifier	What it controls or specifies
Flags	Output justification, numeric signs, decimal points, trailing zeros, octal and hex prefixes

Width	Minimum number of characters to print, padding with blanks or zeros
Precision	Maximum number of characters to print; for integers, minimum number of digits to print
Size	Override default size of argument: N = **near** pointer F = **far** pointer h = **short int** l = **long** L = **long double**

*The specifiers **N** and **F** are provided only for ease of code portability.*

...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 appears.

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 specifiers. To see how the addition of the optional characters and specifiers affects the *...printf* output, refer to the tables following this one.

Type character	Input argument	Format of output
Numerics		
d	Integer	**signed** decimal **int**.
i	Integer	**signed** decimal **int**.
o	Integer	**unsigned** octal **int**.
u	Integer	**unsigned** decimal **int**.
x	Integer	**unsigned** hexadecimal **int** (with **a**, **b**, **c**, **d**, **e**, **f**).
X	Integer	**unsigned** hexadecimal **int** (with **A**, **B**, **C**, **D**, **E**, **F**).
f	Floating-point	**signed** value of the form [-]*dddd.dddd*.
e	Floating-point	**signed** value of the form [-]*d.dddd* or **e** [+/-]*ddd*.
g	Floating-point	**signed** value in either **e** or **f** form, based on given value and precision.
		Trailing zeros and the decimal point are printed only if necessary.
E	Floating-point	Same as **e**, but with **E** for exponent.
G	Floating-point	Same as **g**, but with **E** for exponent if **e** format used.
Characters		
c	Character	Single character.
s	String pointer	Prints characters until a null-terminator is pressed or precision is reached.
%	None	The **%** character is printed.

N-P

Pointers		
n	Pointer to **int**	Stores (in the location pointed to by the input argument) a count of the characters written so far.
p	Pointer	Prints the argument as a pointer. Eight hexadecimal digits in format XXXXXXXX.

Conventions Certain conventions accompany some of these specifications. The decimal-point character used in the output is determined by the current locale's LC_NUMERIC category. The conventions are summarized in the following table:

Characters	Conventions
e or **E**	The argument is converted to match the style [-] *d.ddd*...**e**[+/-]*ddd*, where ■ One digit precedes the decimal point. ■ The number of digits after the decimal point is equal to the precision. ■ The exponent always contains at least two digits.
f	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 nonzero precision was given).
g or **G**	The argument is printed in style **e**, **E** or **f**, with the precision specifying the number of significant digits. Trailing zeros are removed from the result, and a decimal point appears only if necessary.

Characters	Conventions
	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 greater than the precision or less than –4.
x or **X**	For **x** conversions, the letters **a**, **b**, **c**, **d**, **e**, and **f** appear in the output; for **X** conversions, the letters **A**, **B**, **C**, **D**, **E**, and **F** appear.

Infinite floating-point numbers are printed as +INF and –INF. An IEEE Not-a-Number is printed as +NAN or –NAN.

Flag characters The flag characters are minus (-), plus (+), sharp (#), and blank (). They can appear in any order and combination.

Flag	What it specifies
–	Left-justifies the result, pads on the right with blanks. If not given, it right-justifies the result, pads on the left with zeros or blanks.
+	Signed conversion results always begin with a plus (+) or minus (-) sign.
blank	If value is nonnegative, the output begins with a blank instead of a plus; negative values still begin with a minus.
#	Specifies that *arg* is to be converted using an "alternate form." See the following table.

Plus (+) takes precedence over blank () if both are given.

Alternate forms

If the # flag is used with a conversion character, it has the following effect on the argument (*arg*) being converted:

Conversion character	How # affects *arg*
c,s,d,i,u	No effect.
0	0 is prepended to a nonzero *arg*.
x or **X**	0x (or 0X) is prepended to *arg*.
e, **E**, or **f**	The result always contains a decimal point even if no digits follow the point. Normally, a decimal point appears in these results only if a digit follows it.
g or **G**	Same as **e** and **E**, with the addition that trailing zeros are not removed.

N-P

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 nonexistent 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.

Width specifier	How output width is affected
n	At least *n* characters are printed. If the output value has less than *n* characters, the output is padded with blanks (right-padded if – flag given, left-padded otherwise).

0*n*	At least *n* characters are printed. If the output value has less than *n* characters, it is filled on the left with zeros.
*	The argument list supplies the width specifier, which must precede the actual argument being formatted.

Precision specifiers

A precision specification always begins with a period (.) 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.

Precision specifier	How output precision is affected
(none given)	Precision set to default: 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
.0	For *d, i, o, u, x* types, precision set to default; for *e, E, f* types, no decimal point is printed.
.*n*	*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 this happens depends on the type character.)
.*	The argument list supplies the precision specifier, which must precede the actual argument being formatted.

If an explicit precision of zero is specified, *and* the format specifier for the field is one of the integer formats (that is, *d, i, o, u, x*), *and* the value to be printed is 0, no numeric characters will be output for that field (that is, the field will be blank).

Conversion character	How precision specification (.n) affects conversion
d **i** **o** **u** **x** **X**	.*n* specifies that at least *n* digits are printed. If the input argument has less than *n* digits, the output value is left-padded with zeros. If the input argument has more than *n* digits, the output value is not truncated.

e **E** **f**	*.n* specifies that *n* characters are printed after the decimal point, and the last digit printed is rounded.
g **G**	*.n* specifies that at most *n* significant digits are printed.
c	*.n* has no effect on the output.
s	*.n* specifies that no more than *n* characters are printed.

Input-size modifier

The input-size modifier character (*F, N, h, l,* or *L*) gives the size of the subsequent input argument:

The specifiers **N** *and* **F** *are provided only for ease of code portability.*

F = **far** pointer
N = **near** pointer
h = **short int**
l = **long**
L = **long double**

The input-size modifiers (*F, N, h, l,* 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, L,* and *L* apply to input *args* that are numeric (integers and floating-point).

h, l, and *L* override the default size of the numeric data input arguments: *l* and *L* apply 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 *l* affect character (*c, s*) or pointer (*p, n*) types.

N-P

The specifiers **N** *and* **F** *are provided only for ease of code portability.*

Input-size modifier	How *arg* is interpreted
F	*arg* is read as a **far** pointer.
N	*arg* is read as a **near** pointer. *N* cannot be used with any conversion in **huge** model.
h	*arg* is interpreted as a **short int** for *d, i, o, u, x,* or *X.*
l	*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.*
L	*arg* is interpreted as a **long double** for *e, E, f, g,* or *G.*

Return value

printf returns the number of bytes output. In the event of error, *printf* returns EOF.

See also

cprintf, ecvt, fprintf, fread, freopen, fscanf, putc, puts, putw, scanf, sprintf, vprintf, vsprintf

putc — stdio.h

Function Outputs a character to a stream.

Syntax

```
int putc(int c, FILE *stream);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *putc* is a macro that outputs the character *c* to the stream given by *stream*.

Return value On success, *putc* returns the character printed, *c*. On error, *putc* returns EOF.

See also *fprintf, fputc, fputchar, fputs, fwrite, getc, getchar, printf, putch, putchar, putw, vprintf*

putch — conio.h

Function Outputs character to screen.

Syntax

```
int putch(int c);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *putch* outputs the character *c* to the current text window. It is a text mode function performing direct video output to the console. *putch* does not translate linefeed characters (\n) into carriage-return/linefeed pairs.

This function should not be used in PM applications.

Return value On success, *putch* returns the character printed, *c*. On error, it returns EOF.

See also *cprintf, cputs, getch, getche, putc, putchar*

putchar — stdio.h

Function Outputs character on stdout.

Syntax

```
int putchar(int c);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *putchar*(*c*) is a macro defined to be *putc*(*c, stdout*).

Return value On success, *putchar* returns the character *c*. On error, *putchar* returns EOF.

See also *fputchar, getc, getchar, printf, putc, putch, puts, putw, freopen, vprintf*

putenv stdlib.h

Function Adds string to current environment.

Syntax

```
int putenv(const char *name);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks *putenv* accepts the string *name* and adds it to the environment of the *current* process. For example,

```
putenv("PATH=C:\\BC");
```

putenv can also be used to modify an existing *name*. On DOS and OS/2, *name* must be uppercase. On other systems, *name* can be either uppercase or lowercase. *name* must not include the equal sign (=). You can set a variable to an empty value by specifying an empty string on the right side of the '=' sign. This effectively removes the environment variable. Environment variables created by *putenv* can be lower or upper case.

putenv can be used only to modify the current program's environment. Once the program ends, the old environment is restored. The environment of the current process is passed to child processes, including any changes made by *putenv*.

Note that the string given to *putenv* must be static or global. Unpredictable results will occur if a local or dynamic string given to *putenv* is used after the string memory is released.

Return value On success, *putenv* returns 0; on failure, –1.

See also *getenv*

puts stdio.h

Function Outputs a string to stdout.

Syntax

```
int puts(const char *s);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■		■

Remarks

puts copies the null-terminated string *s* to the standard output stream stdout and appends a newline character.

This function should not be used in PM applications.

Return value

On successful completion, *puts* returns a nonnegative value. Otherwise, it returns a value of EOF.

See also

cputs, fputs, gets, printf, putchar, freopen

puttext conio.h

Function

Copies text from memory to the text mode screen.

Syntax

```
int puttext(int left, int top, int right, int bottom, void *source);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■			■			■

Remarks

puttext writes the contents of the memory area pointed to by *source* out to the onscreen rectangle defined by *left, top, right,* and *bottom.*

All coordinates are absolute screen coordinates, not window-relative. The upper left corner is (1,1).

puttext places the contents of a memory area into the defined rectangle sequentially from left to right and top to bottom.

Each position onscreen takes 2 bytes of memory: The first byte is the character in the cell, and the second is the cell's video attribute. The space required for a rectangle *w* columns wide by *h* rows high is defined as

$$bytes = (h \text{ rows}) \times (w \text{ columns}) \times 2$$

This function should not be used in PM applications.

Return value

puttext returns a nonzero value if the operation succeeds; it returns 0 if it fails (for example, if you gave coordinates outside the range of the current screen mode).

See also

gettext, movetext, window

putw — stdio.h

Function Puts an integer on a stream.

Syntax

```
int putw(int w, FILE *stream);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks *putw* outputs the integer *w* to the given stream. *putw* neither expects nor causes special alignment in the file.

Return value On success, *putw* returns the integer *w*. On error, *putw* returns EOF. Because EOF is a legitimate integer, use *ferror* to detect errors with *putw*.

See also *getw, printf*

qsort — stdlib.h

Function Sorts using the quicksort algorithm.

Syntax

```
void qsort(void *base, size_t nelem, size_t width,
        int (_USERENTRY *fcmp)(const void *, const void *));
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *qsort* is an implementation of the "median of three" variant of the quicksort algorithm. *qsort* sorts the entries in a table 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, must be used with the _USERENTRY calling convention.

fcmp 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.

- **elem1* < **elem2* — *fcmp* returns an integer < 0

- **elem1 == *elem2* — *fcmp* returns 0
- **elem1 > *elem2* — *fcmp* returns an integer > 0

In the comparison, the less-than symbol (<) means the left element should appear before the right element in the final, sorted sequence. Similarly, the greater-than (>) symbol means the left element should appear after the right element in the final, sorted sequence.

Return value None.

See also *bsearch, lsearch*

raise — signal.h

Function Sends a software signal to the executing program.

Syntax

```
int raise(int sig);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *raise* sends a signal of type *sig* to the program. If the program has installed a signal handler for the signal type specified by *sig*, that handler will be executed. If no handler has been installed, the default action for that signal type will be taken.

The signal types currently defined in signal.h are noted here:

Signal	Description
SIGABRT	Abnormal termination
SIGFPE	Bad floating-point operation
SIGILL	Illegal instruction
SIGINT	*Ctrl-C* interrupt
SIGSEGV	Invalid access to storage
SIGTERM	Request for program termination
SIGUSR1	User-defined signal
SIGUSR2	User-defined signal
SIGUSR3	User-defined signal
SIGBREAK	*Ctrl-Break* interrupt

SIGABRT isn't generated by Borland C++ during normal operation. However, it can be generated by *abort*, *raise*, or unhandled exceptions.

Return value *raise* returns 0 if successful, nonzero otherwise.

See also *abort, signal*

rand — stdlib.h

Function Random number generator.

Syntax

```
int rand(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *rand* uses a multiplicative congruential random number generator with period 2^{32} to return successive pseudorandom numbers in the range from 0 to RAND_MAX. The symbolic constant RAND_MAX is defined in stdlib.h.

Return value *rand* returns the generated pseudorandom number.

See also *random, randomize, srand*

random — stdlib.h

Function Random number generator.

Syntax

```
int random(int num);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *random* returns a random number between 0 and (*num*-1). *random*(*num*) is a macro defined in stdlib.h. Both *num* and the random number returned are integers.

Return value *random* returns a number between 0 and (*num*-1).

See also *rand, randomize, srand*

Q-R

randomize — stdlib.h, time.h

Function Initializes random number generator.

Syntax

```
void randomize(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *randomize* initializes the random number generator with a random value.

Return value None.

See also *rand, random, srand*

_read — io.h, dos.h

Remarks Obsolete function. See *_rtl_read*.

read — io.h

Function Reads from file.

Syntax

```
int read(int handle, void *buf, unsigned len);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks

read attempts to read *len* bytes from the file associated with *handle* into the buffer pointed to by *buf*.

For a file opened in text mode, *read* removes carriage returns and reports end-of-file when it reaches a *Ctrl-Z*.

The file handle *handle* is obtained from a *creat*, *open*, *dup*, or *dup2* call.

On disk files, *read* begins reading at the current file pointer. When the reading is complete, it increments the file pointer by the number of bytes read. On devices, the bytes are read directly from the device.

The maximum number of bytes that *read* can read is UINT_MAX –1, because UINT_MAX is the same as –1, the error return indicator. UINT_MAX is defined in limits.h.

Return value

On successful completion, *read* returns an integer 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, *read* returns 0. On error, *read* returns –1 and sets the global variable *errno* to one of the following values:

EACCES	Permission denied
EBADF	Bad file number

See also *open, _rtl_read, write*

readdir — dirent.h

Function Reads the current entry from a directory stream.

Syntax

```
struct dirent *readdir(DIR *dirp);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks

readdir is available on POSIX-compliant UNIX systems.

The *readdir* function reads the current directory entry in the directory stream pointed to by *dirp*. The directory stream is advanced to the next entry.

The *readdir* function returns a pointer to a *dirent* structure that is overwritten by each call to the function on the same directory stream. The structure is not overwritten by a *readdir* call on a different directory stream.

The *dirent* structure corresponds to a single directory entry. It is defined in dirent.h, and contains (in addition to other non-accessible members) the following member:

```
char  d_name[];
```

where *d_name* is an array of characters containing the null-terminated file name for the current directory entry. The size of the array is indeterminate; use *strlen* to determine the length of the file name.

All valid directory entries are returned, including subdirectories, "." and ".." entries, system files, hidden files, and volume labels. Unused or deleted directory entries are skipped.

A directory entry can be created or deleted while a directory stream is being read, but *readdir* might or might not return the affected directory entry. Rewinding the directory with *rewinddir* or reopening it with *opendir* ensures that *readdir* will reflect the current state of the directory.

Return value If successful, *readdir* returns a pointer to the current directory entry for the directory stream. If the end of the directory has been reached, or *dirp* does not refer to an open directory stream, *readdir* returns NULL.

See also *closedir*, *opendir*, *rewinddir*

realloc — stdlib.h

Function Reallocates main memory.

Syntax

```
void *realloc(void *block, size_t size);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

realloc attempts to shrink or expand the previously allocated block to *size* bytes. If *size* is zero, the memory block is freed and NULL is returned. The *block* argument points to a memory block previously obtained by calling *malloc, calloc,* or *realloc.* If *block* is a NULL pointer, *realloc* works just like *malloc.*

realloc adjusts the size of the allocated block to *size,* copying the contents to a new location if necessary.

Return value

realloc returns the address of the reallocated block, which can be different than the address of the original block. If the block cannot be reallocated, *realloc* returns NULL.

If the value of *size* is 0, the memory block is freed and *realloc* returns NULL.

See also

calloc, free, malloc

remove — stdio.h

Function

Removes a file.

Syntax

```
int remove(const char *filename);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

remove deletes the file specified by *filename.* It is a macro that simply translates its call to a call to *unlink.* If your file is open, be sure to close it before removing it.

This function will fail (EACCES) if the file is currently open in any process.

➡ The *filename* string can include a full path.

Return value

On successful completion, *remove* returns 0. On error, it returns –1, and the global variable *errno* is set to one of the following values:

EACCES	Permission denied
ENOENT	No such file or directory

See also

unlink

rename — stdio.h

Function

Renames a file.

Syntax

```
int rename(const char *oldname, const char *newname);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■	■	■	■

Remarks

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 *oldname* and *newname* need not be the same, so *rename* can be used to move a file from one directory to another. Wildcards are not allowed.

Return value

On successfully renaming the file, *rename* returns 0. In the event of error, –1 is returned, and the global variable *errno* is set to one of the following values:

EACCES	Permission denied: filename already exists or has an invalid path, or is open
ENOENT	No such file or directory
ENOTSAM	Not same device

rewind — stdio.h

Q-R

Function

Repositions a file pointer to the beginning of a stream.

Syntax

```
void rewind(FILE *stream);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

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

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

Return value

None.

See also

fopen, fseek, ftell

rewinddir dirent.h

Function

Resets a directory stream to the first entry.

Syntax

```
void rewinddir(DIR *dirp);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks

rewinddir is available on POSIX-compliant UNIX systems.

The *rewinddir* function repositions the directory stream *dirp* at the first entry in the directory. It also ensures that the directory stream accurately reflects any directory entries that might have been created or deleted since the last *opendir* or *rewinddir* on that directory stream.

Return value

None.

See also

closedir, opendir, readdir

rmdir dir.h

Function

Removes a directory.

Syntax

```
int rmdir(const char *path);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks

rmdir deletes the directory whose path is given by *path*. The directory named by *path*

- Must be empty
- Must not be the current working directory
- Must not be the root directory

Return value

rmdir returns 0 if the directory is successfully deleted. A return value of –1 indicates an error, and the global variable *errno* is set to one of the following values:

EACCES	Permission denied
ENOENT	Path or file function not found

See also

chdir, getcurdir, getcwd, mkdir

rmtmp — stdio.h

Function Removes temporary files.

Syntax

```
int rmtmp(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks The *rmtmp* function closes and deletes all open temporary file streams, which were previously created with *tmpfile*. The current directory must the same as when the files were created, or the files will not be deleted.

Return value *rmtmp* returns the total number of temporary files it closed and deleted.

_rotl, _rotr — stdlib.h

Function Bit-rotates an **unsigned** short integer value to the left or right.

Syntax

```
unsigned short _rotl(unsigned short value, int count);
unsigned short _rotr(unsigned short value, int count);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *_rotl* rotates the given *value* to the left *count* bits.

_rotr rotates the given *value* to the right *count* bits.

Return value The functions return the rotated integer:

- *_rotl* returns the value of *value* left-rotated *count* bits.
- *_rotr* returns the value of *value* right-rotated *count* bits.

See also *_crotl, _crotr, _lrotl, _lrotr*

Q-R

_rtl_chmod — dos.h, io.h

Function Gets or sets file attributes.

Syntax

```
int _rtl_chmod(const char *path, int func [, int attrib]);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

_rtl_chmod can either fetch or set file attributes. If *func* is 0, *_rtl_chmod* returns the current attributes for the file. If *func* is 1, the attribute is set to *attrib*.

This function will fail (EACCES) if the file is currently open in any process.

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
FA_LABEL	Volume label
FA_DIREC	Directory
FA_ARCH	Archive

Return value

Upon successful completion, *_rtl_chmod* returns the file attribute word; otherwise, it returns a value of –1.

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

EACCES	Permission denied
ENOENT	Path or file name not found

See also

chmod, *_rtl_creat*

_rtl_close — io.h

Function

Closes a file.

Syntax

```
int _rtl_close(int handle);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

_rtl_close closes the file associated with *handle*, a file handle obtained from a *_rtl_creat*, *creat*, *creatnew*, *creattemp*, *dup*, *dup2*, *_rtl_open*, or *open* call.

The function does 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, *_rtl_close* returns 0. Otherwise, the function returns a value of –1.

_rtl_close fails if *handle* is not the handle of a valid, open file, and the global variable *errno* is set to

EBADF	Bad file number

See also *chsize, close, creatnew, dup, fclose, _rtl_creat, _rtl_open, sopen*

_rtl_creat — dos.h, io.h

Function Creates a new file or overwrites an existing one.

Syntax

```
int _rtl_creat(const char *path, int attrib);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
▪		▪	▪			▪

Remarks *_rtl_creat* opens the file specified by *path*. 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.

If the file already exists, its size is reset to 0. (This is essentially the same as deleting the file and creating a new file with the same name.)

The *attrib* argument is an ORed combination of one or more of the following constants (defined in dos.h):

FA_RDONLY	Read-only attribute
FA_HIDDEN	Hidden file
FA_SYSTEM	System file

Return value Upon successful completion, *_rtl_creat* returns the new file handle, a non-negative integer; otherwise, it returns –1.

In the event of error, the global variable *errno* is set to one of the following values:

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

See also *chsize, close, creat, creatnew, creattemp, _rtl_chmod, _rtl_close*

_rtl_heapwalk — malloc.h

Function Inspects the heap, node by node.

Syntax

```
int _rtl_heapwalk(_HEAPINFO *hi);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
			▪			▪

Q-R

Remarks

_rtl_heapwalk assumes the heap is correct. Use *_heapchk* to verify the heap before using *_rtl_heapwalk*. _HEAPOK is returned with the last block on the heap. _HEAPEND will be returned on the next call to *_rtl_heapwalk*.

_rtl_heapwalk receives a pointer to a structure of type *_HEAPINFO* (declared in malloc.h).

For the first call to *_rtl_heapwalk*, set the *hi._pentry* field to NULL. *_rtl_heapwalk* returns with *hi._pentry* containing the address of the first block.

hi._size holds the size of the block in bytes.

hi._useflag is a flag that is set to _USEDENTRY if the block is currently in use. If the block is free, *hi._useflag* is set to _FREEENTRY.

Return value

One of the following values:

_HEAPBADNODE	A corrupted heap block has been found
_HEAPBADPTR	The _pentry field does not point to a valid heap block
_HEAPEMPTY	No heap exists
_HEAPEND	The end of the heap has been reached
_HEAPOK	The _heapinfo block contains valid information about the next heap block

_rtl_open — fcntl.h, share.h, io.h

Function

Opens an existing file for reading or writing.

Syntax

```
int _rtl_open(const char *filename, int oflags);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

_rtl_open opens the file specified by *filename*, then prepares it for reading or writing, as determined by the value of *oflags*. The file is always opened in binary mode.

oflags uses the flags from the following two lists. Only one flag from the first list can be used (and one *must* be used); the remaining flags can be used in any logical combination.

List 1: Read/write flags

O_RDONLY	Open for reading.
O_WRONLY	Open for writing.

O_RDWR Open for reading and writing.

The following additional values can be included in *oflags* (using an OR operation):

These symbolic constants are defined in fcntl.h and share.h.

List 2: Other access flags

O_NOINHERIT	The file is not passed to child programs.
SH_COMPAT	Identical to SH_DENYNO.
SH_DENYRW	Only the current handle can have access to the file.
SH_DENWR	Allow only reads from any other open to the file.
SH_DENYRD	Allow only writes from any other open to the file.
SH_DENYNO	Allow other shared opens to the file.

Only one of the SH_DENY*xx* values can be included in a single *_rtl_open*. These file-sharing attributes are in addition to any locking performed on the files.

The maximum number of simultaneously open files is defined by HANDLE_MAX.

Return value

On successful completion, *_rtl_open* returns a nonnegative integer (the file handle). The file pointer, which marks the current position in the file, is set to the beginning of the file.

On error, *_rtl_open* returns –1. The global variable *errno* is set to one of the following:

EACCES	Permission denied
EINVACC	Invalid access code
EMFILE	Too many open files
ENOENT	Path or file not found

See also

open, *_rtl_read*, *sopen*

Q-R

_rtl_read io.h, dos.h

Function

Reads from file.

Syntax

```
int _rtl_read(int handle, void *buf, unsigned len);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■				■

Remarks

_rtl_read attempts to read *len* bytes from the file associated with *handle* into the buffer pointed to by *buf*.

When a file is opened in text mode, *_rtl_read* does not remove carriage returns.

The argument *handle* is a file handle obtained from a *creat*, *open*, *dup*, or *dup2* call.

On disk files *_rtl_read* begins reading at the current file pointer. When the reading is complete, the function increments the file pointer by the number of bytes read. On devices, the bytes are read directly from the device.

The maximum number of bytes that *_rtl_read* can read is UINT_MAX –1, because UINT_MAX is the same as –1, the error return indicator. UINT_MAX is defined in limits.h.

Return value

On successful completion, *_rtl_read* returns a positive integer indicating the number of bytes placed in the buffer. On end-of-file, *_rtl_read* returns zero. On error, it returns –1, and the global variable *errno* is set to one of the following values:

EACCES	Permission denied
EBADF	Bad file number

See also

read, *_rtl_open*, *_rtl_write*

_rtl_write — io.h

Function

Writes to a file.

Syntax

```
int _rtl_write(int handle, void *buf, unsigned len);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

_rtl_write attempts to write *len* bytes from the buffer pointed to by *buf* to the file associated with *handle*. The maximum number of bytes that *_rtl_write* can write is UINT_MAX –1, because UINT_MAX is the same as –1, which is the error return indicator for *_rtl_write*. UINT_MAX is defined in limits.h. *_rtl_write* does not translate a linefeed character (LF) to a CR/LF pair because all 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 files, writing always proceeds from the current file pointer. On devices, bytes are directly sent to the device.

For files opened with the O_APPEND option, the file pointer is not positioned to EOF by *_rtl_write* before writing the data.

Return value

_rtl_write returns the number of bytes written. In case of error, *_rtl_write* returns –1 and sets the global variable *errno* to one of the following values:

EACCES	Permission denied
EBADF	Bad file number

See also

lseek, _rtl_read, write

scanf **stdio.h**

Function

Scans and formats input from the stdin stream.

Syntax

```
int scanf(const char *format[, address, ...]);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■		■	■	■	■

Remarks

scanf scans a series of input fields, one character at a time, reading from the stdin stream. Then each field is formatted according to a format specifier passed to *scanf* in the format string pointed to by *format*. Finally, *scanf* stores the formatted input at an address passed to it as an argument following *format*. There must be the same number of format specifiers and addresses as there are input fields.

The specifiers **N** and **F** (discussed below) are provided only to ease porting code that was previously written for segmented architectures. In the OS/2 32-bit flat memory model, **near** and **far** pointers are not used.

This function should not be used in PM applications.

The format string

The format string present in *scanf* and the related functions *cscanf, fscanf, sscanf, vscanf, vfscanf,* and *vsscanf* controls how each function scans, converts, and stores its input fields. *There must be enough address arguments for the given format specifiers; if not, the results will be unpredictable and possibly disastrous.* Excess address arguments (more than required by the format) are ignored.

scanf often leads to unexpected results if you diverge from an expected pattern. You need to remember to teach *scanf* how to synchronize at the end of a line. The combination of *gets* or *fgets* followed by *sscanf* is safe and easy, and therefore preferred.

The format string is a character string that contains three types of objects: *whitespace characters, non-whitespace characters,* and *format specifiers.*

- The whitespace characters are blank, tab (\t) or newline (\n). If a *...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 *...scanf* function encounters a non-whitespace character in the format string, it will read, but not store, a matching non-whitespace character.
- The format specifiers direct the *...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 whitespace is left unread (including a newline), unless explicitly matched in the format string.

Format specifiers

...scanf format specifiers have the following form:

```
% [*] [width] [F|N] [h|l|L] type_character
```

Each format specifier begins with the percent character (%). After the % come the following, in this order:

- An optional assignment-suppression character, `[*]`
- An optional width specifier, `[width]`
- An optional pointer size modifier, `[F|N]`
- An optional argument-type modifier, `[h|l|L]`
- The type character

Optional format string components

These are the general aspects of input formatting controlled by the optional characters and specifiers in the *...scanf* format string:

The specifiers **N** and **F** are provided only for ease of code portability.

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 *...scanf* function encounters a whitespace or unconvertible character.
size	Overrides default size of address argument: *N* = **near** pointer *F* = **far** pointer
argument type	Overrides default type of address argument: *h* = **short int**

l = **long int** (if the type character specifies an integer conversion)
l = **double** (if the type character specifies a floating-point conversion)
L = **long double** (valid only with floating-point conversions)

...scanf type characters

The following table lists the *...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 specifier.

To see how the addition of the optional elements affects the *...scanf* input, refer to the tables following this one.

Type character	Expected input	Type of argument
Numerics		
d	Decimal integer	Pointer to **int** (**int** **arg*).
D	Decimal integer	Pointer to **long** (**long** **arg*).
o	Octal integer	Pointer to **int** (**int** **arg*).
O	Octal integer	Pointer to **long** (**long** **arg*).
i	Decimal, octal, or hexadecimal integer	Pointer to **int** (**int** **arg*).
I	Decimal, octal, or hexadecimal integer	Pointer to **long** (**long** **arg*).
u	Unsigned decimal integer	Pointer to **unsigned int** (**unsigned int** **arg*).
U	Unsigned decimal integer	Pointer to **unsigned long** (**unsigned long** **arg*).
x	Hexadecimal integer	Pointer to **int** (**int** **arg*).
X	Hexadecimal integer	Pointer to **int** (**int** **arg*).
e, E	Floating point	Pointer to **float** (**float** **arg*).
f	Floating point	Pointer to **float** (**float** **arg*).
g, G	Floating point	Pointer to **float** (**float** **arg*).
Characters		
s	Character string	Pointer to array of characters (**char** *arg[]*).
c	Character	Pointer to character (**char** **arg*) if a field width *W* is given along with the *c*-type character (such as %5*c*).
		Pointer to array of *W* characters (**char** *arg*[*W*]).
%	% character	No conversion done; % is stored.

S

Type character	Expected input	Type of argument
Pointers		
n		Pointer to **int** (**int** **arg*). The number of characters read successfully up to %*n* is stored in this **int**.
p	Hexadecimal form XXXXXXXX	Pointer to an object.

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 specifier (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 specifiers. The decimal-point character used in the output is determined by the current locale's LC_NUMERIC category. The conventions are 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 %1*s*.

%Wc 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* equals the length of string *s* (in characters). A space or newline terminates the input field; the terminator is not scanned or stored. 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. *...scanf* 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]`	Searches for any of the characters *a*, *b*, *c*, and *d* in the input field.
`%[^abcd]`	Searches 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 (numerals 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 alphanumeric characters, 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 hyphen (-) must be lexically less than the one after it.
- The hyphen must not be the first nor the last character in the set. (If it is first or last, it is considered to be the hyphen character, not a range definer.)
- The characters on either side of the hyphen must be the ends of the range and not part of some other range.

S

Here are some examples where the hyphen just means the hyphen character, not a range between two ends:

`%[-+*/]`	The four arithmetic operations.
`%[z-a]`	The characters *z*, –, and *a*.
`%[+0-9-A-Z]`	The characters + and – and the ranges 0-9 and *A-Z*.
`%[+0-9A-Z-]`	Also the characters + and – and the ranges 0-9 and *A-Z*.
`%[^-0-9+A-Z]`	All characters except + and – and those in the ranges 0-9 and *A-Z*.

%e, %E. %f, %g, and %G (floating-point) conversions

Floating-point numbers in the input field must conform to the following generic format:

```
[+/-] ddddddddd [.] dddd [E | e] [+/-] ddd
```

where [*item*] indicates that *item* is optional, and *ddd* represents decimal, octal, or hexadecimal digits.

INF = INFinity; NAN = Not-A-Number

In addition, +INF, –INF, +NAN, and –NAN are recognized as floating-point numbers. Note that the sign and capitalization are required.

%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 the asterisk follows the percent sign (%) in a format specifier, the next input field will be scanned but not 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 asterisk 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 fewer than *n* characters, *...scanf* reads all the characters in the field, then proceeds with the next field and format specifier.

If a whitespace or nonconvertible 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 specifier.

A nonconvertible 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).

Width specifier	How width of stored input is affected
n	Up to *n* characters are read, converted, and stored in the current address argument.

Input-size and argument-type modifiers

The input-size modifiers (*N* and *F*) and argument-type modifiers (*h*, *l*, and *L*) affect how the ...*scanf* functions interpret the corresponding address argument *arg[f]*.

F and *N* override the default or declared size of *arg*.

h, *l*, and *L* indicate which type (version) of the following input data is to be used (*h* = **short**, *l* = **long**, *L* = **long double**). 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**, and **long double** object for **%L**).

The specifiers **N** and **F** are provided only for ease of code portability.

Modifier	How conversion is affected
F	Overrides default or declared size; *arg* interpreted as **far** pointer.
N	Overrides default or declared size; *arg* interpreted as **near** pointer. Cannot be used with any conversion in **huge** model.
h	For *d, i, o, u, x* types, convert input to **short int**, store in **short** object.
	For *D, I, O, U, X* types, no effect.
	For *e, f, c, s, n, p* types, no effect.
l	For *d, i, o, u, x* types, convert input to **long int**, store in **long** object.
	For *e, f, g* types, convert input to **double**, store in **double** object.
	For *D, I, O, U, X* types, no effect.
	For *c, s, n, p* types, no effect.
L	For *e, f, g* types, convert input to a **long double**, store in **long double** object. **L** has no effect on other formats.

When scanf stops scanning

scanf might stop scanning a particular field before reaching the normal field-end character (whitespace), or might terminate entirely, for a variety of reasons.

scanf stops 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 specifier; the current input field is scanned but not stored.
- *width* characters have been read (*width* = width specification, a positive decimal integer in the format specifier).
- 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 *scanf* 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.

scanf 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 specifier occurs in the format string, it must match the current sequence of characters in the input field; *scanf* 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.

Return value

scanf returns the number of input fields successfully scanned, converted, and stored; the return value does not include scanned fields that were not stored. If *scanf* attempts to read at end-of-file, the return value is EOF. If no fields were stored, the return value is 0.

See also

atof, cscanf, fscanf, freopen, getc, printf, sscanf, vfscanf, vscanf, vsscanf

_searchenv — stdlib.h

Function

Searches an environment path for a file.

Syntax

```
void _searchenv(const char *file, const char *varname, char *buf);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

_searchenv attempts to locate *file*, searching along the path specified by the operating system environment variable *varname*. Typical environment variables that contain paths are PATH, LIB, and INCLUDE.

_searchenv searches for the file in the current directory of the current drive first. If the file is not found there, the environment variable *varname* is fetched, and each directory in the path it specifies is searched in turn until the file is found, or the path is exhausted.

When the file is located, the full path name is stored in the buffer pointed to by *buf*. This string can be used in a call to access the file (for example, with *fopen* or *exec...*). The buffer is assumed to be large enough to store any possible file name. If the file cannot be successfully located, an empty string (consisting of only a null character) will be stored at *buf*.

Return value None.

See also *_dos_findfirst*, *_dos_findnext*, *exec...*, *spawn...*, *system*

searchpath — dir.h

Function Searches the operating system path for a file.

Syntax

```
char *searchpath(const char *file);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *searchpath* attempts to locate *file*, searching along the operating system path, which is the PATH=... string in the environment. A pointer to the complete path-name string is returned as the function value.

searchpath searches for the file in the current directory of the current drive 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 access the file (for example, with *fopen* or *exec...*).

The string returned is located in a static buffer and is overwritten on each subsequent call to *searchpath*.

Return value *searchpath* returns a pointer to a file name string if the file is successfully located; otherwise, *searchpath* returns null.

See also *exec...*, *findfirst*, *findnext*, *spawn...*, *system*

S

_searchstr — stdlib.h

Function Searches a list of directories for a file.

Syntax

```
void _searchstr(const char *file, const char *ipath, char *buf);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

_searchstr attempt to locate *file*, searching along the path specified by the string *ipath*.

_searchstr searches for the file in the current directory of the current drive first. If the file is not found there, each directory in *ipath* is searched in turn until the file is found, or the path is exhausted. The directories in *ipath* must be separated by semicolons.

When the file is located, the full path name is stored in the buffer pointed by by *buf*. This string can be used in a call to access the file (for example, with *fopen* or *exec...*). The buffer is assumed to be large enough to store any possible file name. The constant _MAX_PATH, defined in stdlib.h, is the size of the largest file name. If the file cannot be successfully located, an empty string (consisting of only a null character) will be stored at *buf*.

Return value

None.

See also

_searchenv

setbuf — stdio.h

Function

Assigns buffering to a stream.

Syntax

```
void setbuf(FILE *stream, char *buf);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

setbuf causes the buffer *buf* to be used for I/O buffering instead of an automatically allocated buffer. It is used after *stream* has been opened.

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).

stdin and *stdout* are unbuffered if they are not redirected; otherwise, they are fully buffered. *setbuf* can be used to change the buffering style 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.

setbuf produces unpredictable results unless it is called immediately after opening *stream* or after a call to *fseek*. Calling *setbuf* after *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 None.

See also *fflush, fopen, fseek, setvbuf*

_setcursortype conio.h

Function Selects cursor appearance.

Syntax

```
void _setcursortype(int cur_t);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■			■			■

Remarks Sets the cursor type to

_NOCURSOR	Turns off the cursor
_NORMALCURSOR	Normal underscore cursor
_SOLIDCURSOR	Solid block cursor

This function should not be used in PM applications.

Return value None.

setdate

See *_dos_getdate* on page 45.

setdisk

See *getdisk*.

setjmp setjmp.h

Function Sets up for nonlocal goto.

Syntax

```
int setjmp(jmp_buf jmpb);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

setjmp captures the complete *task state* in *jmpb* and returns 0.

A later call to *longjmp* with *jmpb* restores the captured task state and returns in such a way that *setjmp* appears to have returned with the value *val*.

A task state includes:

- no segment registers are saved
- register variables (EBX, EDI, ESI)
- stack pointer (ESP)
- frame base pointer (EBP)
- flags are not saved

setjmp must be called before *longjmp*. The routine that calls *setjmp* and sets up *jmpb* must still be active and cannot have returned before the *longjmp* is called. If it has returned, the results are unpredictable.

setjmp is 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. If the return is from a call to *longjmp*, *setjmp* returns a nonzero value (as in the example).

See also

longjmp, *signal*

setlocale — locale.h

Function

Selects or queries a locale.

Syntax

```
char *setlocale(int category, const char *locale);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■	■	■	■

Remarks

Borland C++ supports the following locales at present:

Future releases of Borland C++ will increase the number of locales supported.

Module	Locale supported
de_DE	German
fr_FR	French
en_GB	English (Great Britain)
en_US	English (United States)

For each locale, the following character sets are supported:

DOS437	English
DOS850	Multilingual (Latin I)
WIN1252	Windows, Multilingual

For a description of DOS character sets, see *MS-DOS User's Guide and Reference*. See also *MS Windows 3.1 Programmer's Reference, Volume 4* for a discussion of the WIN1252 character set.

The possible values for the *category* argument are as follows:

Value	Description
LC_ALL	Affects all the following categories.
LC_COLLATE	Affects *strcoll* and *strxfrm*.
LC_CTYPE	Affects single-byte character handling functions. The *mbstowcs* and *mbtowc* functions are not affected.
LC_MONETARY	Affects monetary formatting by the *localeconv* function.
LC_NUMERIC	Affects the decimal point of non-monetary data formatting. This includes the *printf* family of functions, and the information returned by *localeconv*.
LC_TIME	Affects *strftime*.

The *locale* argument is a pointer to the name of the locale or named locale category. Passing a NULL pointer returns the current locale in effect. Passing a pointer that points to a null string requests *setlocale* to look for environment variables to determine which locale to set. The locale names are case sensitive.

The LOCALE.BLL file is installed in BCOS2\BIN directory.

If you specify a locale other than the default C locale, *setlocale* tries to access the locale library file named LOCALE.BLL to obtain the locale data. This file is located using the following strategies:

1. Searching the directory where the application's executable resides.
2. Searching in the current default directory.
3. Accessing the "PATH" environment variable and searching in each of the specified directories.

If the locale library is not found, *setlocale* terminates.

When *setlocale* is unable to honor a locale request, the preexisting locale in effect is unchanged and a null pointer is returned.

If the *locale* argument is a NULL pointer, the locale string for the category is returned. If *category* is LC_ALL, a complete locale string is returned. The structure of the complete locale string consists of the names of all the categories in the current locale concatenated and separated by semicolons. This string can be used as the locale parameter when calling *setlocale* with LC_ALL. This will reinstate all the locale categories that are named in the complete locale string, and allows saving and restoring of locale states. If the complete locale string is used with a single category, for example, LC_TIME, only that category will be restored from the locale string.

ANSI C states that if an empty string "" is used as the locale parameter an implementation defined locale is used. *setlocale* has been implemented to look for corresponding environment variables in this instance as POSIX suggests.

If the environment variable LC_ALL exists, the category will be set according to this variable. If the variable does not exist, the environment variable that has the same name as the requested category is looked for and the category is set accordingly.

If none of the above are satisfied, the environment variable named LANG is used. Otherwise, *setlocale* fails and returns a NULL pointer.

See the *Programmer's Guide*, Chapter 5, for information about defining options.

To take advantage of dynamically loadable locales in your application, define __USELOCALES__ for each module. If __USELOCALES__ is not defined, all locale-sensitive functions and macros will work only with the default C locale.

If a NULL pointer is used as the argument for the *locale* parameter, *setlocale* returns a string that specifies the current locale in effect. If the *category* parameter specifies a single category, such as LC_COLLATE, the string pointed to will be the name of that category. If LC_ALL is used as the *category* parameter then the string pointed to will be a full locale string that will indicate the name of each category in effect.

```
   ⋮
localenameptr = setlocale( LC_COLLATE, NULL );

if (localenameptr)
    printf( "%s\n", localenameptr );
   ⋮
```

The output here will be one of the module names together with the specified code page. For example, the output could be `fr_FR.DOS850@dbase`.

```
   ⋮
localenameptr = setlocale( LC_ALL, NULL );

if (localenameptr)
   printf( "%s\n", localenameptr );
   ⋮
```

An example of the output here could be the following:

```
fr_FR.DOS850@dbase;fr_FR.DOS850;fr_FR.DOS850;fr_FR.DOS850;
fr_FR.DOS850;fr_FR.DOS850;;
```

Each category in this full string is delimited by a semicolon. This string can be copied and saved by an application and then used again to restore the same locale categories at another time. Each delimited name corresponds to the locale category constants defined in locale.h. Therefore, the first name is the name of the LC_COLLATE category, the second is the LC_CTYPE category, and so on. Any other categories named in the locale.h header file are reserved for future implementation.

Here are some examples of setting locales by using *setlocale*:

Set all default categories for the specified French locale:

```
setlocale( LC_ALL, "fr_FR.DOS850" );
```

The default collation is named *dbase*. Therefore, whether you specify *dbase* or nothing at all, you get the same collation. However, *dbase* might not be the default in future releases.

Set French locale to named collation *dbase*:

```
setlocale( LC_COLLATE, "fr_FR.DOS850@dbase" )
```

When a category is loaded from the locale library, the default category is the one that will be loaded unless a modifier name is used. For example:

```
setlocale( LC_COLLATE, "fr_FR.DOS850" )
```

causes the default LC_COLLATE category to be loaded. It might or might not have a specific name.

```
setlocale( LC_COLLATE, "fr_FR.DOS850@dbase" )
```

specifies that the LC_COLLATE category named `dbase` to be loaded. This might or might not be the default.

setlocale updates the *lconv* locale structure when a request has been fulfilled.

When an application exits, any allocated memory used for the locale object is deallocated.

Return value

If selection is successful, *setlocale* returns a pointer to a string that is associated with the selected category (or possibly all categories) for the new locale.

S

On failure, a NULL pointer is returned and the locale is unchanged. All other possible returns are discussed in the Remarks section above.

See also

localeconv

setmode — fcntl.h

Function

Sets mode of an open file.

Syntax

```
int setmode(int handle, int amode);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
▪		▪	▪			▪

Remarks

setmode sets the mode of the open file associated with *handle* to either binary or text. The argument *amode* must have a value of either O_BINARY or O_TEXT, never both. (These symbolic constants are defined in fcntl.h.)

Return value

setmode returns the previous translation mode if successful. On error it returns –1 and sets the global variable *errno* to

EINVAL Invalid argument

See also

creat, open, _rtl_creat, _rtl_open

settime

See *gettime* on page 94.

setvbuf — stdio.h

Function

Assigns buffering to a stream.

Syntax

```
int setvbuf(FILE *stream, char *buf, int type, size_t size);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
▪	▪	▪	▪	▪	▪	▪

Remarks

setvbuf causes the buffer *buf* to be used for I/O buffering instead of an automatically allocated buffer. It is used after the given stream is opened.

If *buf* is null, a buffer will be allocated using *malloc;* the buffer will use *size* as the amount allocated. The buffer will be automatically freed on close. The *size* parameter specifies the buffer size and must be greater than zero.

The parameter *size* is limited by the constant UINT_MAX as defined in limits.h.

stdin and *stdout* are unbuffered if they are not redirected; otherwise, they are fully buffered. *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.

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.
- _IONBF — 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.

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 *setvbuf* returns 0 on success. It returns nonzero if an invalid value is given for *type* or *size*, or if there is not enough space to allocate a buffer.

See also *fflush, fopen, setbuf*

setverify — dos.h

Function Sets the state of the verify flag in the operating system.

Syntax

```
void setverify(int value);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■				■

Remarks *setverify* sets the current state of the verify flag to *value*, which can be either 0 (off) or 1 (on).

The verify flag controls output to the disk. When verify is off, writes are not verified; when verify is on, all disk writes are verified to ensure proper writing of the data.

Return value None.

See also *getverify*

signal — signal.h

Function Specifies signal-handling actions.

Syntax

```
void (_USERENTRY *signal(int sig, void (_USERENTRY *func)
                                 (int sig[, int subcode])))(int);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

signal determines how receipt of signal number *sig* will subsequently be treated. You can install a user-specified handler routine (specified by the argument *func*) or use one of the two predefined handlers, SIG_DFL and SIG_IGN, in signal.h. The function *func* must be used with the _USERENTRY calling convention.

Function pointer	Description
SIG_DFL	Terminates the program
SIG_ERR	Indicates an error return from *signal*
SIG_IGN	Ignore this type signal

The signal types and their defaults are as follows:

Signal type	Description
SIGBREAK	Control-Break interrupt. Keyboard must be in raw mode. Default action is to terminate the program.
SIGABRT	Abnormal termination. Default action is equivalent to printing `Abnormal program termination` to stderr and calling *_exit*(3).
SIGFPE	Arithmetic error caused by division by 0, invalid operation, and the like. Default action is program termination.
SIGILL	Illegal operation. Default action is program termination.
SIGINT	*Ctrl-C* interrupt. Default action is program termination.
SIGSEGV	Illegal storage access. Default action is program termination.
SIGTERM	Request for program termination. Default action is program termination.
SIGUSR1, SIGUSR2, SIGUSR3	User-defined signals that can be generated only by calling *raise*. Default action is to ignore the signal.

signal.h defines a type called *sig_atomic_t*, the largest integer type the processor can load or store atomically in the presence of asynchronous interrupts (for the 8086 family, this is a 16-bit word; for 80386 and higher number processors, it is a 32-bit word—a Borland C++ integer).

When a signal is generated by the *raise* function or by an external event, the following two things happen:

- If a user-specified handler has been installed for the signal, the action for that signal type is set to SIG_DFL.
- The user-specified function is called with the signal type as the parameter.

User-specified handler functions can terminate by a return or by a call to *abort*, *_exit*, *exit*, or *longjmp*. If your handler function is expected to continue to receive and handle more signals, you must have the handler function call *signal* again.

Borland C++ implements an extension to ANSI C when the signal type is SIGFPE, SIGSEGV, or SIGILL. The user-specified handler function is called with one or two extra parameters. If SIGFPE, SIGSEGV, or SIGILL has been raised as the result of an explicit call to the *raise* function, the user-specified handler is called with one extra parameter, an integer specifying that the handler is being explicitly invoked. The explicit activation values for SIGFPE, SIGSEGV and SIGILL are as follows (see declarations in float.h):

Signal	Meaning
SIGFPE	FPE_EXPLICITGEN
SIGSEGV	SEGV_EXPLICITGEN
SIGILL	ILL_EXPLICITGEN

If SIGFPE is raised because of a floating-point exception, or SIGSEGV, SIGILL, or the integer-related variants of SIGFPE signals (FPE_INTOVFLOW or FPE_INTDIV0) are raised as the result of a processor exception, the user handler is called with one of SIGFPE, SIGSEGV, or SIGILL exception type (see float.h for all these types). This first parameter is the usual ANSI signal type.

S

The following SIGFPE-type signals can occur (or be generated). They correspond to the exceptions that the 8087 family is capable of detecting, as well as the "INTEGER DIVIDE BY ZERO" and the "INTERRUPT ON OVERFLOW" on the main CPU. (The declarations for these are in float.h.)

SIGFPE signal	Meaning
FPE_INTOVFLOW	INTO executed with OF flag set
FPE_INTDIV0	Integer divide by zero
FPE_INVALID	Invalid operation

FPE_ZERODIVIDE	Division by zero
FPE_OVERFLOW	Numeric overflow
FPE_UNDERFLOW	Numeric underflow
FPE_INEXACT	Precision
FPE_EXPLICITGEN	User program executed *raise*(SIGFPE)
FPE_STACKFAULT	Floating-point stack overflow or underflow

The FPE_INTOVFLOW and FPE_INTDIV0 signals are generated by integer operations, and the others are generated by floating-point operations. Whether the floating-point exceptions are generated depends on the coprocessor control word, which can be modified with *_control87*. Denormal exceptions are handled by Borland C++ and not passed to a signal handler.

The following SIGSEGV-type signals can occur:

SEGV_BOUND	Bound constraint exception
SEGV_EXPLICITGEN	*raise*(SIGSEGV) was executed
SEGV_ACCESS	Access violation
SEGV_STACK	Unable to grow stack

Borland C++ doesn't generate bound instructions that can generate SEGV_BOUND-type signals, but they can be used in inline code and separately compiled assembler routines that are linked in.

The following SIGILL-type signals can occur:

ILL_EXECUTION	Illegal operation attempted
ILL_EXPLICITGEN	*raise*(SIGILL) was executed
ILL_PRIVILEGED	Attempted execution of privileged instruction

When the signal type is SIGFPE, SIGSEGV, or SIGILL, a return from a signal handler is generally not advisable if the state of the 8087 is corrupt, the results of an integer division are wrong, an operation that shouldn't have overflowed did, a bound instruction failed, or an illegal operation was attempted. The only time a return is reasonable is when the handler alters the registers so that a reasonable return context exists *or* the signal type indicates that the signal was generated explicitly (for example, FPE_EXPLICITGEN, SEGV_EXPLICITGEN, or ILL_EXPLICITGEN). Generally in this case you would print an error message and terminate the program using *_exit*, *exit*, or *abort*. If a return is executed under any other conditions, the program's action will probably be unpredictable upon resuming.

Special care must be taken when using the *signal* function in a multithread program. The SIGINT, SIGTERM, and SIGBREAK signals can be used only by the main thread (thread one) in a non-PM application. When one of these signals occurs, the currently executing thread is suspended, and control transfers to the signal handler (if any) set up by thread one. Other signals can be handled by any thread. A signal handler should not use C++ run-time library functions, because a semaphore deadlock might occur. Instead, the handler should simply set a flag or post a semaphore, and return immediately.

Return value If the call succeeds, *signal* returns a pointer to the previous handler routine for the specified signal type. If the call fails, *signal* returns SIG_ERR, and the external variable *errno* is set to EINVAL.

See also *abort, _control87, exit, longjmp, raise, setjmp*

sin, sinl — math.h

Function Calculates sine.

Syntax

```
double sin(double x);
long double sinl(long double x);
```

	DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
sin	■	■	■	■	■		■
sinl	■		■	■			■

Remarks *sin* computes the sine of the input value. Angles are specified in radians.

sinl is the **long double** version; it takes a **long double** argument and returns a **long double** result. Error handling for these functions can be modified through the functions *_matherr* and *_matherrl*.

This function can be used with *bcd* and *complex* types.

Return value *sin* and *sinl* return the sine of the input value.

See also *acos, asin, atan, atan2, bcd, complex, cos, tan*

S

sinh, sinhl — math.h

Function Calculates hyperbolic sine.

Syntax

```
double sinh(double x);
long double sinhl(long double x);
```

	DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
sinh	■	■	■	■	■		■
sinhl	■		■	■			■

Remarks *sinh* computes the hyperbolic sine, $(e^x - e^{-x})/2$.

sinl is the **long double** version; it takes a **long double** argument and returns a **long double** result. Error handling for *sinh* and *sinhl* can be modified through the functions *_matherr* and *_matherrl*.

This function can be used with *bcd* and *complex* types.

Return value *sinh* and *sinhl* return the hyperbolic sine of *x*.

When the correct value overflows, these functions return the value HUGE_VAL (*sinh*) or _LHUGE_VAL (*sinhl*) of appropriate sign. Also, the global variable *errno* is set to ERANGE.

See also *acos, asin, atan, atan2, bcd, complex, cos, cosh, sin, tan, tanh*

sleep — dos.h

Function Suspends execution for an interval (seconds).

Syntax

```
void sleep(unsigned seconds);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■		■			■

Remarks 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 accurate only to the nearest hundredth of a second or to the accuracy of the operating system clock, whichever is less accurate.

sleep might return before the specified time period elapses if a signal occurs.

Return value None.

sopen — fcntl.h, sys\stat.h, share.h, io.h

Function Opens a shared file.

Syntax

```
int sopen(char *path, int access, int shflag[, int mode]);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks *sopen* opens the file given by *path* and prepares it for shared reading or writing, as determined by *access*, *shflag*, and *mode*.

For *sopen*, *access* is constructed by ORing flags bitwise from the following two lists. Only one flag from the first list can be used; the remaining flags can 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 is 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 *mode* 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.
O_NOINHERIT	The file is not passed to child programs.

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 *mode* argument to *sopen* from the following symbolic constants defined in sys\stat.h.

Value of *mode*	Access permission
S_IWRITE	Permission to write
S_IREAD	Permission to read
S_IREAD|S_IWRITE	Permission to read/write

shflag specifies the type of file-sharing allowed on the file *path*. Symbolic constants for *shflag* are defined in share.h.

Value of *shflag*	What it does
SH_COMPAT	Identical to SH_DENYNONE
SH_DENYRW	Denies read/write access.

S

SH_DENYWR	Denies write access.
SH_DENYRD	Denies read access.
SH_DENYNONE	Permits read/write access.
SH_DENYNO	Permits read/write access.

Return value

On successful completion, *sopen* returns a nonnegative 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, it returns –1, and the global variable *errno* is set to

EACCES	Permission denied
EINVACC	Invalid access code
EMFILE	Too many open files
ENOENT	Path or file function not found

See also

chmod, close, creat, lock, lseek, _rtl_open, open, unlock, umask

spawnl, spawnle, spawnlp, spawnlpe, spawnv, spawnve, spawnvp, spawnvpe — process.h, stdio.h

Function

Creates and runs child processes.

Syntax

```
int spawnl(int mode, char *path, char *arg0, arg1, ..., argn, NULL);
int spawnle(int mode, char *path, char *arg0, arg1, ..., argn, NULL, char *envp[]);
int spawnlp(int mode, char *path, char *arg0, arg1, ..., argn, NULL);
int spawnlpe(int mode, char *path, char *arg0, arg1, ..., argn, NULL,
             char *envp[]);
int spawnv(int mode, char *path, char *argv[]);
int spawnve(int mode, char *path, char *argv[], char *envp[]);
int spawnvp(int mode, char *path, char *argv[]);
int spawnvpe(int mode, char *path, char *argv[], char *envp[]);
```

The last string must be NULL in functions spawnle, spawnlpe, spawnv, spawnve, spawnvp, and spawnvpe.

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■			■			■

Remarks

The functions in the *spawn...* family create child processes that run (execute) their own files. There must be sufficient memory available for loading and executing a child process.

The value of *mode* determines what action the calling function (the *parent process*) takes 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. The child process ID is returned, so that the parent can wait for completion using *cwait* or *wait*.
P_NOWAITO	Identical to P_NOWAIT except that the child process ID isn't saved by the operating system, so the parent process can't wait for it using *cwait* or *wait*.
P_DETACH	Identical to P_NOWAITO, except that the child process is executed in the background with no access to the keyboard or the display.
P_OVERLAY	Overlays child process in memory location formerly occupied by parent. Same as an *exec...* call.

path is the file name of the called child process. The *spawn...* function calls search for *path* using the standard operating system search algorithm:

- If no explicit extension is given, the functions search for the file as given. If the file is not found, they add .EXE and search again. If not found, they add .CMD and search again. If still not found, they add .BAT and search once more. The command processor (CMD.EXE) is used to run the executable file.
- If an extension is given, they search only for the exact file name.
- If only a period is given, they search only for the file name with no extension.
- If *path* does not contain an explicit directory, *spawn...* functions that have the ***p*** suffix search the current directory, then the directories set with the operating system PATH environment variable.

The suffixes *p*, *l*, and *v*, and *e* added to the *spawn...* "family name" specify that the named function operates with certain capabilities.

p The function searches for the file in those directories specified by the PATH environment variable. Without the *p* suffix, the function searches only the current working directory.

l 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 The argument pointers *argv[0], ..., arg[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 The argument *envp* can be passed to the child process, letting you 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* takes separate arguments, searches only the current directory for the child, and passes on the parent's environment to the child.
- *spawnvpe* 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 *path*. (Using a different value for this 0th argument won't produce an error.) If you want to pass an empty argument list to the child process, then *arg0* or *argv[0]* must be NULL.

When the *l* suffix is used, *arg0* usually points to *path*, 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 character pointers. 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* 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 < 256 bytes. Null-terminators are not counted.

When a *spawn...* function call is made, any open files remain open in the child process.

Return value

On a successful execution, the *spawn...* functions where *mode* is P_WAIT return the child process' exit status (0 for a normal termination). If the child specifically calls *exit* with a nonzero argument, its exit status can be set to a nonzero value. If *mode* is P_NOWAIT or P_NOWAITO, the spawn functions return the process ID of the child process. This ID can be passed to *cwait*.

On error, the *spawn...* functions return –1, and the global variable *errno* is set to one of the following:

EINVAL	Invalid argument
ENOENT	Path or file name not found
ENOEXEC	Exec format error
ENOMEM	Not enough memory

See also *abort, atexit, cwait, _exit, exit, exec..., _fpreset, searchpath, system, wait*

_splitpath — stdlib.h

Function Splits a full path name into its components.

Syntax

```
void _splitpath(const char *path, char *drive, char *dir, char *name, char *ext);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *_splitpath* takes a file's full path name (*path*) as a string in the form

```
X:\DIR\SUBDIR\NAME.EXT
```

and splits *path* into its four components. It then stores those components in the strings pointed to by *drive, dir, name,* and *ext.* (All five components must be passed, but any of them 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 _MAX_DRIVE _MAX_DIR _MAX_PATH _MAX_FNAME and _MAX_EXT) (defined in stdlib.h), and each size includes space for the null-terminator. These constants are defined in stdlib.h.

Constant	String
_MAX_PATH	*path*
_MAX_DRIVE	*drive*; includes colon (:)
_MAX_DIR	*dir*; includes leading and trailing backslashes (\)
_MAX_FNAME	*name*
_MAX_EXT	*ext*; includes leading dot (.)

_splitpath assumes that there is enough space to store each non-null component.

When *_splitpath* splits *path,* it treats the punctuation as follows:

- *drive* includes the colon (C:, A:, and so on).
- *dir* includes the leading and trailing backslashes (\BC\include\, \source\, and so on).
- *name* includes the file name.

S

■ *ext* includes the dot preceding the extension (.C, .EXE, and so on).

_makepath and *_splitpath* are invertible; if you split a given *path* with *_splitpath*, then merge the resultant components with *_makepath*, you end up with *path*.

Return value None.

See also *_fullpath, _makepath*

sprintf — stdio.h

Function Writes formatted output to a string.

Syntax

```
int sprintf(char *buffer, const char *format[, argument, ...]);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *sprintf* accepts a series of arguments, applies to each a format specifier contained in the format string pointed to by *format*, and outputs the formatted data to a string.

See *printf* for details on format specifiers.

sprintf applies the first format specifier to the first argument, the second to the second, and so on. There must be the same number of format specifiers as arguments.

Return value *sprintf* returns the number of bytes output. *sprintf* does not include the terminating null byte in the count. In the event of error, *sprintf* returns EOF.

See also *fprintf, printf*

sqrt, sqrtl — math.h

Function Calculates the positive square root.

Syntax

```
double sqrt(double x);
long double sqrtl(long double x);
```

	DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
sqrt	■	■	■	■	■		■
sqrtl	■		■	■			■

Remarks *sqrt* calculates the positive square root of the argument *x*.

sqrtl is the **long double** version; it takes a **long double** argument and returns a **long double** result. Error handling for these functions can be modified through the functions *_matherr* and *_matherrl*.

This function can be used with *bcd* and *complex* types.

Return value On success, *sqrt* and *sqrtl* return the value calculated, the square root of *x*. If *x* is real and positive, the result is positive. If *x* is real and negative, the global variable *errno* is set to

EDOM Domain error

See also *bcd, complex, exp, log, pow*

srand — stdlib.h

Function Initializes random number generator.

Syntax

```
void srand(unsigned seed);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks The random number 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.

Return value None.

See also *rand, random, randomize*

sscanf — stdio.h

S

Function Scans and formats input from a string.

Syntax

```
int sscanf(const char *buffer, const char *format[, address, ...]);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *sscanf* scans a series of input fields, one character at a time, reading from a string. Then each field is formatted according to a format specifier passed to *sscanf* in the format string pointed to by *format*. Finally, *sscanf* stores the formatted input at an address passed to it as an argument following *format*.

See scanf for details on format specifiers.

There must be the same number of format specifiers and addresses as there are input fields.

sscanf might stop scanning a particular field before it reaches the normal end-of-field (whitespace) character, or it might terminate entirely, for a number of reasons. See *scanf* for a discussion of possible causes.

This function should not be used in PM applications.

Return value

sscanf returns the number of input fields successfully scanned, converted, and stored; the return value does not include scanned fields that were not stored. If no fields were stored, the return value is 0.

If *sscanf* attempts to read at end-of-string, the return value is EOF.

See also

fscanf, *scanf*

stackavail — malloc.h

Function

Gets the amount of available stack memory.

Syntax

```
size_t stackavail(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

stackavail returns the number of bytes available on the stack. This is the amount of dynamic memory that *alloca* can access.

Return value

stackavail returns a *size_t* value indicating the number of bytes available.

See also

alloca

stat

See *fstat*.

_status87 — float.h

Function

Gets floating-point status.

Syntax

```
unsigned int _status87(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *_status87* gets the floating-point status word, which is a combination of the 80x87 status word and other conditions detected by the 80x87 exception handler.

Return value The bits in the return value give the floating-point status. See float.h for a complete definition of the bits returned by *_status87*.

stime — time.h

Function Sets system date and time.

Syntax

```
int stime(time_t *tp);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■				■

Remarks *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 *stime* returns a value of 0.

See also *asctime, ftime, gettime, gmtime, localtime, time, tzset*

stpcpy — string.h

Function Copies one string into another.

Syntax

```
char *stpcpy(char *dest, const char *src);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks *stpcpy* copies the string *src* to *dest*, stopping after the terminating null character of *src* has been reached.

Return value *stpcpy* returns *dest* + *strlen*(*src*).

See also *strcpy*

strcat string.h

Function Appends one string to another.

Syntax

```
char *strcat(char *dest, const char *src);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *strcat* appends a copy of *src* to the end of *dest*. The length of the resulting string is *strlen*(*dest*) + *strlen*(*src*).

Return value *strcat* returns a pointer to the concatenated strings.

strchr string.h

Function Scans a string for the first occurrence of a given character.

Syntax

```
char *strchr(const char *s, int c);                /* C only */

const char *strchr(const char *s, int c);          // C++ only
char *strchr( char *s, int c);                     // C++ only
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *strchr* scans a string in the forward direction, looking for a specific character. *strchr* finds the *first* occurrence of the character *c* in the string *s*. The null-terminator is considered to be part of the string, so that, for example,

```
strchr(strs,0)
```

returns a pointer to the terminating null character of the string *strs*.

Return value *strchr* returns a pointer to the first occurrence of the character *c* in *s*; if *c* does not occur in *s*, *strchr* returns null.

See also *strcspn*, *strrchr*

strcmp — string.h

Function

Compares one string to another.

Syntax

```
int strcmp(const char *s1, const char *s2);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

strcmp performs an unsigned comparison of *s1* to *s2*, starting with the first character in each string and continuing with subsequent characters until the corresponding characters differ or until the end of the strings is reached.

Return value

strcmp returns a value that is

- < 0 if *s1* is less than *s2*
- == 0 if *s1* is the same as *s2*
- > 0 if *s1* is greater than *s2*

See also

strcmpi, strcoll, stricmp, strncmp, strncmpi, strnicmp

strcmpi — string.h

Function

Compares one string to another, without case sensitivity.

Syntax

```
int strcmpi(const char *s1, const char *s2);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■		■			■

S

Remarks

strcmpi performs an unsigned comparison of *s1* to *s2*, without case sensitivity (same as *stricmp*—implemented as a macro).

It returns a value (< 0, 0, or > 0) based on the result of comparing *s1* (or part of it) to *s2* (or part of it).

The routine *strcmpi* is the same as *stricmp*. *strcmpi* is implemented through a macro in string.h and translates calls from *strcmpi* to *stricmp*. Therefore, to use *strcmpi*, you must include the header file string.h for the macro to be available. This macro is provided for compatibility with other C compilers.

Return value

strcmpi returns an **int** value that is

- < 0 if *s1* is less than *s2*
- == 0 if *s1* is the same as *s2*
- > 0 if *s1* is greater than *s2*

See also *strcmp, strcoll, stricmp, strncmp, strncmpi, strnicmp*

strcoll — string.h

Function Compares two strings.

Syntax

```
int strcoll(char *s1, char *s2);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■	■	■	■

Remarks *strcoll* compares the string pointed to by *s1* to the string pointed to by *s2*, according to the current locale's LC_COLLATE category.

Return value *strcoll* returns a value that is

- < 0 if *s1* is less than *s2*
- == 0 if *s1* is the same as *s2*
- > 0 if *s1* is greater than *s2*

See also *strcmp, strcmpi, stricmp, strncmp, strncmpi, strnicmp, strxfrm*

strcpy — string.h

Function Copies one string into another.

Syntax

```
char *strcpy(char *dest, const char *src);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks Copies string *src* to *dest*, stopping after the terminating null character has been moved.

Return value *strcpy* returns *dest*.

See also *stpcpy*

strcspn — string.h

Function

Scans a string for the initial segment not containing any subset of a given set of characters.

Syntax

```
size_t strcspn(const char *s1, const char *s2);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

The *strcspn* functions search *s2* until any one of the characters contained in *s1* is found. The number of characters which were read in *s2* is the return value. The string termination character is not counted. Neither string is altered during the search.

Return value

strcspn returns the length of the initial segment of string *s1* that consists entirely of characters *not* from string *s2*.

See also

strchr, strrchr

_strdate — time.h

Function

Converts current date to string.

Syntax

```
char *_strdate(char *buf);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

_strdate converts the current date to a string, storing the string in the buffer *buf*. The buffer must be at least 9 characters long.

The string has the form `MM/DD/YY` where MM, DD, and YY are all two-digit numbers representing the month, day, and year. The string is terminated by a null character.

Return value

_strdate returns *buf*, the address of the date string.

See also

asctime, ctime, localtime, strftime, _strtime, time

strdup — string.h

Function

Copies a string into a newly created location.

Syntax

```
char *strdup(const char *s);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks *strdup* makes a duplicate of string *s*, obtaining space with a call to *malloc*. The allocated space is (*strlen*(*s*) + 1) bytes long. The user is responsible for freeing the space allocated by *strdup* when it is no longer needed.

Return value *strdup* returns a pointer to the storage location containing the duplicated string, or returns null if space could not be allocated.

See also *free*

_strerror — string.h

Function Builds a customized error message.

Syntax

```
char  *_strerror(const char *s);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *_strerror* lets you generate customized error messages; it returns a pointer to a null-terminated string containing an error message.

- If *s* is null, the return value points to the most recent error message.
- If *s* is not null, the return value contains *s* (your customized error message), a colon, a space, the most-recently generated system error message, and a new line. *s* should be 94 characters or less.

Return value *_strerror* returns a pointer to a constructed error string. The error message string is constructed in a static buffer that is overwritten with each call to *_strerror*.

See also *perror*, *strerror*

strerror — string.h

Function Returns a pointer to an error message string.

Syntax

```
char *strerror(int errnum);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■	■	■	■

Remarks

strerror takes an **int** parameter *errnum,* an error number, and returns a pointer to an error message string associated with *errnum.*

Return value

strerror returns a pointer to a constructed error string. The error message string is constructed in a static buffer that is overwritten with each call to *strerror.*

See also

perror, _strerror

strftime — time.h

Function

Formats time for output.

Syntax

```
size_t strftime(char *s, size_t maxsize, const char *fmt, const struct tm *t);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■	■	■	■

Remarks

strftime formats the time in the argument *t* into the array pointed to by the argument *s* according to the *fmt* specifications. The format string consists of zero or more directives and ordinary characters. Like *printf,* a directive consists of the % character followed by a character that determines the substitution that is to take place. All ordinary characters are copied unchanged. No more than *maxsize* characters are placed in *s.*

The time is formatted according to the current locale's LC_TIME category.

The following table describes the ANSI-defined format specifiers.

Format specifier	Substitutes
%%	Character %
%a	Abbreviated weekday name
%A	Full weekday name
%b	Abbreviated month name
%B	Full month name
%c	Date and time
%d	Two-digit day of the month (01 to 31)
%H	Two-digit hour (00 to 23)
%I	Two-digit hour (01 to 12)
%j	Three-digit day of the year (001 to 366)
%m	Two-digit month as a decimal number (1 – 12)
%M	Two-digit minute (00 to 59)
%p	AM or PM
%S	Two-digit second (00 to 59)

%U	Two-digit week number where Sunday is the first day of the week (00 to 52)
%w	Weekday where 0 is Sunday (0 to 6)
%W	Two-digit week number where Monday is the first day of the week (00 to 52)
%x	Date
%X	Time
%y	Two-digit year without century (00 to 99)
%Y	Year with century
%Z	Time zone name, or no characters if no time zone

In addition to the ANSI C-defined format descriptors, the following POSIX-defined descriptors are also supported. Each format specifier begins with the percent character (%).

You must define __USELOCALES__ in order to use these descriptors.

Format specifier	Substitutes
%C	Century as a decimal number (00-99). For example, 1992 => 19
%D	Date in the format mm/dd/yy
%e	Day of the month as a decimal number in a two-digit field with leading space (1-31)
%h	A synonym for %b
%n	Newline character
%r	12-hour time (01-12) format with am/pm string i.e. "%I:%M:%S %p"
%t	Tab character
%T	24-hour time (00-23) in the format "HH:MM:SS"
%u	Weekday as a decimal number (1 Monday – 7 Sunday)

In addition to these descriptors, *strftime* also supports the descriptor modifiers as defined by POSIX on the following descriptors:

You must define __USELOCALES__ in order to use these descriptors.

Descriptor modifier	Substitutes
%Od	Day of the month using alternate numeric symbols
%Oe	Day of the month using alternate numeric symbols
%OH	Hour (24 hour) using alternate numeric symbols
%OI	Hour (12 hour) using alternate numeric symbols
%Om	Month using alternate numeric symbols
%OM	Minutes using alternate numeric symbols
%OS	Seconds using alternate numeric symbols
%Ou	Weekday as a number using alternate numeric symbols
%OU	Week number of the year using alternate numeric symbols
%Ow	Weekday as number using alternate numeric symbols
%OW	Week number of the year using alternate numeric symbols
%Oy	Year (offset from %C) using alternate numeric symbols

%O modifier – when this modifier is used before any of the above supported numeric format descriptors, for example %Od, the numeric value is converted to the corresponding ordinal string, if it exists. If an ordinal string does not exist then the basic format descriptor is used unmodified.

For example, on 8/20/88 a %d format descriptor would produce 20 but %Od on the same day would produce 20th.

Return value

strftime returns the number of characters placed into *s*. If the number of characters required is greater than *maxsize*, *strftime* returns 0.

See also

localtime, mktime, time

stricmp — string.h

Function

Compares one string to another, without case sensitivity.

Syntax

```
int stricmp(const char *s1, const char *s2);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

stricmp performs an unsigned comparison of *s1* to *s2*, starting with the first character in each string and continuing with subsequent characters until the corresponding characters differ or until the end of the strings is reached. The comparison is not case sensitive.

It returns a value (< 0, 0, or > 0) based on the result of comparing *s1* (or part of it) to *s2* (or part of it).

The routines *stricmp* and *strcmpi* are the same; *strcmpi* is implemented through a macro in string.h that translates calls from *strcmpi* to *stricmp*. Therefore, in order to use *strcmpi*, you must include the header file string.h for the macro to be available.

Return value

stricmp returns an **int** value that is

- < 0 if *s1* is less than *s2*
- == 0 if *s1* is the same as *s2*
- > 0 if *s1* is greater than *s2*

See also

strcmp, strcmpi, strcoll, strncmp, strncmpi, strnicmp

strlen — string.h

Function

Calculates the length of a string.

Syntax

```
size_t strlen(const char *s);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *strlen* calculates the length of *s*.

Return value *strlen* returns the number of characters in *s*, not counting the null-terminating character.

strlwr — string.h

Function Converts uppercase letters in a string to lowercase.

Syntax

```
char *strlwr(char *s);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *strlwr* converts uppercase letters in string *s* to lowercase according to the current locale's LC_CTYPE category. For the C locale, the conversion is from uppercase letters (*A* to *Z*) to lowercase letters (*a* to *z*). No other characters are changed.

Return value *strlwr* returns a pointer to the string *s*.

See also *strupr*

strncat — string.h

Function Appends a portion of one string to another.

Syntax

```
char *strncat(char *dest, const char *src, size_t maxlen);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *strncat* copies at most *maxlen* characters of *src* to the end of *dest* and then appends a null character. The maximum length of the resulting string is *strlen*(*dest*) + *maxlen*.

Return value *strncat* returns *dest*.

strncmp — string.h

Function Compares a portion of one string to a portion of another.

Syntax

```
int strncmp(const char *s1, const char *s2, size_t  maxlen);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *strncmp* makes the same unsigned comparison as *strcmp*, but looks at no more than *maxlen* characters. It starts with the first character in each string and continues with subsequent characters until the corresponding characters differ or until it has examined *maxlen* characters.

Return value *strncmp* returns an *int* value based on the result of comparing *s1* (or part of it) to *s2* (or part of it):

- < 0 if *s1* is less than *s2*
- == 0 if *s1* is the same as *s2*
- > 0 if *s1* is greater than *s2*

See also *strcmp, strcoll, stricmp, strncmpi, strnicmp*

strncmpi — string.h

Function Compares a portion of one string to a portion of another, without case sensitivity.

Syntax

```
int strncmpi(const char *s1, const char *s2, size_t n);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■				■

Remarks *strncmpi* performs a signed comparison of *s1* to *s2*, for a maximum length of *n* bytes, starting with the first character in each string and continuing with subsequent characters until the corresponding characters differ or until *n* characters have been examined. The comparison is not case sensitive. (*strncmpi* is the same as *strnicmp*—implemented as a macro). It returns a value (< 0, 0, or > 0) based on the result of comparing *s1* (or part of it) to *s2* (or part of it).

The routines *strnicmp* and *strncmpi* are the same; *strncmpi* is implemented through a macro in string.h that translates calls from *strncmpi* to *strnicmp*.

S

Therefore, in order to use *strncmpi*, you must include the header file string.h for the macro to be available. This macro is provided for compatibility with other C compilers.

Return value

strncmpi returns an **int** value that is

- < 0 if *s1* is less than *s2*
- == 0 if *s1* is the same as *s2*
- > 0 if *s1* is greater than *s2*

strncpy — string.h

Function

Copies a given number of bytes from one string into another, truncating or padding as necessary.

Syntax

```
char *strncpy(char *dest, const char *src, size_t maxlen);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

strncpy copies up to *maxlen* characters from *src* into *dest*, truncating or null-padding *dest*. The target string, *dest*, might not be null-terminated if the length of *src* is *maxlen* or more.

Return value

strncpy returns *dest*.

strnicmp — string.h

Function

Compares a portion of one string to a portion of another, without case sensitivity.

Syntax

```
int strnicmp(const char *s1, const char *s2, size_t maxlen);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

strnicmp performs a signed comparison of *s1* to *s2*, for a maximum length of *maxlen* bytes, starting with the first character in each string and continuing with subsequent characters until the corresponding characters differ or until the end of the strings is reached. The comparison is not case sensitive.

It returns a value (< 0, 0, or > 0) based on the result of comparing *s1* (or part of it) to *s2* (or part of it).

Return value

strnicmp returns an **int** value that is

- < 0 if *s1* is less than *s2*
- == 0 if *s1* is the same as *s2*
- > 0 if *s1* is greater than *s2*

strnset — string.h

Function Sets a specified number of characters in a string to a given character.

Syntax

```
char *strnset(char *s, int ch, size_t n);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *strnset* copies the character *ch* into the first *n* bytes of the string *s*. If *n* > *strlen*(*s*), then *strlen*(*s*) replaces *n*. It stops when *n* characters have been set, or when a null character is found.

Return value *strnset* returns *s*.

strpbrk — string.h

Function Scans a string for the first occurrence of any character from a given set.

Syntax

```
char *strpbrk(const char *s1, const char *s2);                  /* C only */

const char *strpbrk(const char *s1, const char *s2);            // C++ only
char *strpbrk(char *s1, const char *s2);                        // C++ only
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *strpbrk* scans a string, *s1*, for the first occurrence of any character appearing in *s2*.

Return value *strpbrk* returns a pointer to the first occurrence of any of the characters in *s2*. If none of the *s2* characters occur in *s1*, *strpbrk* returns null.

S

strrchr — string.h

Function Scans a string for the last occurrence of a given character.

Syntax

```
char *strrchr(const char *s, int c);                            /* C only */
```

```
const char *strrchr(const char *s, int c);            // C++ only
char *strrchr(char *s, int c);                        // C++ only
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *strrchr* scans a string in the reverse direction, looking for a specific character. *strrchr* finds the *last* occurrence of the character *c* in the string *s*. The null-terminator is considered to be part of the string.

Return value *strrchr* returns a pointer to the last occurrence of the character *c*. If *c* does not occur in *s*, *strrchr* returns null.

See also *strcspn, strchr*

strrev — string.h

Function Reverses a string.

Syntax

```
char *strrev(char *s);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *strrev* changes all characters in a string to reverse order, except the terminating null character. (For example, it would change *string\0* to *gnirts\0*.)

Return value *strrev* returns a pointer to the reversed string.

strset — string.h

Function Sets all characters in a string to a given character.

Syntax

```
char *strset(char *s, int ch);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *strset* sets all characters in the string *s* to the character *ch*. It quits when the terminating null character is found.

Return value *strset* returns *s*.

See also *setmem*

strspn string.h

Function Scans a string for the first segment that is a subset of a given set of characters.

Syntax

```
size_t strspn(const char *s1, const char *s2);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *strspn* finds the initial segment of string *s1* that consists entirely of characters from string *s2*.

Return value *strspn* returns the length of the initial segment of *s1* that consists entirely of characters from *s2*.

strstr string.h

Function Scans a string for the occurrence of a given substring.

Syntax

```
char *strstr(const char *s1, const char *s2);                /* C only */

const char *strstr(const char *s1, const char *s2);          // C++ only
char *strstr(char *s1, const char *s2);                      // C++ only
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *strstr* scans *s1* for the first occurrence of the substring *s2*.

Return value *strstr* returns a pointer to the element in *s1*, where *s2* begins (points to *s2* in *s1*). If *s2* does not occur in *s1*, *strstr* returns null.

S

_strtime time.h

Function Converts current time to string.

Syntax

```
char *_strtime(char *buf);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *_strtime* converts the current time to a string, storing the string in the buffer *buf*. The buffer must be at least 9 characters long.

The string has the following form:

```
HH:MM:SS
```

where HH, MM, and SS are all two-digit numbers representing the hour, minute, and second, respectively. The string is terminated by a null character.

Return value *_strtime* returns *buf*, the address of the time string.

See also *asctime, ctime, localtime, strftime, _strdate, time*

strtod, _strtold — stdlib.h

Function Convert a string to a **double** or **long double** value.

Syntax

```
double strtod(const char *s, char **endptr);
long double _strtold(const char *s, char **endptr);
```

	DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
strtod	■	■	■	■	■	■	■
_strtold	■		■	■			■

Remarks *strtod* converts a character string, *s*, to a **double** value. *s* is a sequence of characters that can be interpreted as a **double** value; the characters 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

strtod also recognizes +INF and –INF for plus and minus infinity, and +NAN and –NAN for Not-a-Number.

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*). *endptr* is useful for error detection.

_strtold is the **long double** version; it converts a string to a **long double** value.

Return value

These functions return the value of *s* as a **double** (*strtod*) or a **long double** (*_strtold*). In case of overflow, they return plus or minus HUGE_VAL (*strtod*) or _LHUGE_VAL (*_strtold*).

See also

atof

strtok — string.h

Function

Searches one string for tokens, which are separated by delimiters defined in a second string.

Syntax

```
char *strtok(char *s1, const char *s2);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

strtok considers the string *s1* to consist of a sequence of zero or more text tokens, separated by spans of one or more characters from the separator string *s2*.

The first call to *strtok* returns a pointer to the first character of the first token in *s1* and writes a null character into *s1* immediately following the returned token. Subsequent calls with null for the first argument will work through the string *s1* in this way, until no tokens remain.

The separator string, *s2*, can be different from call to call.

Return value

strtok returns a pointer to the token found in *s1*. A NULL pointer is returned when there are no more tokens.

S

strtol — stdlib.h

Function

Converts a string to a **long** value.

Syntax

```
long strtol(const char *s, char **endptr, int radix);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■	■	■	■

Remarks

strtol converts a character string, *s*, to a **long** integer value. *s* is a sequence of characters that can be interpreted as a **long** value; the characters 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 it doesn't recognize.

If *radix* is between 2 and 36, the long integer is expressed in base *radix*. If *radix* is 0, the first few characters of *s* determine the base of the value being converted.

First character	Second character	String interpreted as
0	1 – 7	Octal
0	*x* or *X*	Hexadecimal
1 – 9		Decimal

If *radix* is 1, it is considered to be an invalid value. If *radix* is less than 0 or greater than 36, it is considered to be an invalid value.

Any invalid value for *radix* causes the result to be 0 and sets the next character pointer **endptr* to the starting string pointer.

If the value in *s* is meant to be interpreted as octal, any character other than 0 to 7 will be unrecognized.

If the value in *s* is meant to be interpreted as decimal, any character other than 0 to 9 will be unrecognized.

If the value in *s* 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 will be recognized. (For example, if *radix* equals 5, only 0 to 4 will be recognized; if *radix* equals 20, only 0 to 9 and *A* to *J* will be recognized.)

If *endptr* is not null, *strtol* sets **endptr* to point to the character that stopped the scan (**endptr* = *&stopper*).

Return value

strtol returns the value of the converted string, or 0 on error.

See also

atoi, *atol*, *strtoul*

_strtold

See *strtod*.

strtoul — stdlib.h

Function Converts a string to an **unsigned long** in the given radix.

Syntax

```
unsigned long strtoul(const char *s, char **endptr, int radix);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
▪		▪	▪	▪	▪	▪

Remarks *strtoul* operates the same as *strtol*, except that it converts a string *str* to an **unsigned long** value (where *strtol* converts to a **long**). Refer to the entry for *strtol* for more information.

Return value *strtoul* returns the converted value, an **unsigned long**, or 0 on error.

See also *atol, strtol*

strupr — string.h

Function Converts lowercase letters in a string to uppercase.

Syntax

```
char *strupr(char *s);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
▪		▪	▪			▪

Remarks *strupr* converts lowercase letters in string *s* to uppercase according to the current locale's LC_CTYPE category. For the default C locale, the conversion is from lowercase letters (*a* to *z*) to uppercase letters (*A* to *Z*). No other characters are changed.

S

Return value *strupr* returns *s*.

See also *strlwr*

strxfrm — string.h

Function Transforms a portion of a string to a specified collation.

Syntax

```
size_t strxfrm(char *target, const char *source, size_t n);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■	■	■	■

Remarks

strxfrm transforms the string pointed to by *source* into the string *target* for no more than *n* characters. The transformation is such that if the *strcmp* function is applied to the resulting strings, its return corresponds with the return values of the *strcoll* function.

No more than *n* characters, including the terminating null character, are copied to *target*.

strxfrm transforms a character string into a special string according to the current locale's LC_COLLATE category. The special string that is built can be compared with another of the same type, byte for byte, to achieve a locale-correct collation result. These special strings, which can be thought of as keys or tokenized strings, are not compatible across the different locales.

The tokens in the tokenized strings are built from the collation weights used by *strcoll* from the active locale's collation tables.

Processing stops only after all levels have been processed for the character string or the length of the tokenized string is equal to the maxlen parameter.

All redundant tokens are removed from each level's set of tokens.

The tokenized string buffer must be large enough to contain the resulting tokenized string. The length of this buffer depends on the size of the character string, the number of collation levels, the rules for each level and whether there are any special characters in the character string. Certain special characters can cause extra character processing of the string resulting in more space requirements. For example, the French character "œ" will take double the space for itself because in some locales, it expands to two collation weights at each level. Substrings that have substitutions will also cause extra space requirements.

There is no safe formula to determine the required string buffer size, but at least (levels * string length) are required.

Return value

Number of characters copied not including the terminating null character. If the value returned is greater than or equal to *n*, the content of *target* is indeterminate.

See also

strcmp, strcoll, strncpy

swab — stdlib.h

Function

Swaps bytes.

Syntax

```
void swab(char *from, char *to, int nbytes);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
▪	▪	▪	▪			▪

Remarks

swab copies *nbytes* 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

None.

system — stdlib.h

Function

Issue an operating system command.

Syntax

```
int system(const char *command);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
▪	▪		▪			▪

Remarks

system invokes the operating system command processor to execute an operating system command, batch file, or other program named by the string *command*, from inside an executing C program.

To be located and executed, the program must be in the current directory or in one of the directories listed in the PATH string in the environment.

The COMSPEC environment variable is used to find the command processor program file, so that file need not be in the current directory.

S

Return value

If *command* is a NULL pointer, *system* returns nonzero if a command processor is available.

If *command* is not a NULL pointer, *system* returns 0 if the command processor was successfully started.

If an error occurred, a –1 is returned and *errno* is set to one of the following:

ENOENT	Path or file function not found
ENOEXEC	Exec format error
ENOMEM	Not enough memory

See also *exec..., _fpreset, searchpath, spawn...*

tan, tanl — math.h

Function Calculates the tangent.

Syntax

```
double tan(double x);
long double tanl(long double x);
```

	DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
tan	■	■	■	■	■	■	■
tanl	■		■	■			■

Remarks *tan* calculates the tangent. Angles are specified in radians.

tanl is the **long double** version; it takes a **long double** argument and returns a **long double** result. Error handling for these routines can be modified through the functions *_matherr* and *_matherrl.*

This function can be used with *bcd* and *complex* types.

Return value *tan* and *tanl* return the tangent of *x*, *sin*(*x*)/*cos*(*x*).

See also *acos, asin, atan, atan2, bcd, complex, cos, sin*

tanh, tanhl — math.h

Function Calculates the hyperbolic tangent.

Syntax

```
double tanh(double x);
long double tanhl(long double x);
```

	DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
tanh	■	■	■	■	■	■	■
tanhl	■		■	■			■

Remarks *tanh* computes the hyperbolic tangent, *sinh*(*x*)/*cosh*(*x*).

tanhl is the **long double** version; it takes a **long double** argument and returns a **long double** result. Error handling for these functions can be modified through the functions *_matherr* and *_matherrl.*

This function can be used with *bcd* and *complex* types.

Return value *tanh* and *tanhl* return the hyperbolic tangent of *x*.

See also *bcd, complex, cos, cosh, sin, sinh, tan*

tell — io.h

Function Gets the current position of a file pointer.

Syntax

```
long tell(int handle);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks *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 *tell* returns the current file pointer position. A return of –1 (**long**) indicates an error, and the global variable *errno* is set to

EBADF Bad file number

See also *fgetpos, fseek, ftell, lseek*

tempnam — stdio.h

Function Creates a unique file name in specified directory.

Syntax

```
char *tempnam(char *dir, char *prefix)
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks The *tempnam* function creates a unique file name in arbitrary directories. The unique file is not actually created; *tempnam* only verifies that it does not currently exist. It attempts to use the following directories, in the order shown, when creating the file name:

- The directory specified by the TMP environment variable.
- The *dir* argument to *tempnam.*
- The *P_tmpdir* definition in stdio.h. If you edit stdio.h and change this definition, *tempnam* will *not* use the new definition.
- The current working directory.

If any of these directories is NULL, or undefined, or does not exist, it is skipped.

The *prefix* argument specifies the first part of the file name; it cannot be longer than 5 characters, and cannot contain a period (.). A unique file name is created by concatenating the directory name, the *prefix*, and 6 unique characters. Space for the resulting file name is allocated with *malloc*; when this file name is no longer needed, the caller should call *free* to free it.

➡ If you do create a temporary file using the name constructed by *tempnam*, it is your responsibility to delete the file name (for example, with a call to *remove*). It is not deleted automatically. (*tmpfile does* delete the file name.)

Return value If *tempnam* is successful, it returns a pointer to the unique temporary file name, which the caller can pass to *free* when it is no longer needed. Otherwise, if *tempnam* cannot create a unique file name, it returns NULL.

See also *mktemp*, *tmpfile*, *tmpnam*

textattr — conio.h

Function Sets text attributes.

Syntax

```
void textattr(int newattr);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■			■			■

Remarks *textattr* lets you set both the foreground and background colors in a single call. (Normally, you set the attributes with *textcolor* and *textbackground*.)

This function does not affect any characters currently onscreen; it affects only those characters displayed by functions (such as *cprintf*) performing text mode, direct video output *after* this function is called.

The color information is encoded in the *newattr* parameter as follows:

7	6	5	4	3	2	1	0
B	b	b	b	f	f	f	f

In this 8-bit *newattr* parameter,

- *ffff* is the 4-bit foreground color (0 to 15).
- *bbb* is the 3-bit background color (0 to 7).

- *B* is the blink-enable bit.

If the blink-enable bit is on, the character blinks. This can be accomplished by adding the constant BLINK to the attribute.

If you use the symbolic color constants defined in conio.h for creating text attributes with *textattr*, note the following limitations on the color you select for the background:

- You can select only one of the first eight colors for the background.
- You must shift the selected background color left by 4 bits to move it into the correct bit positions.

These symbolic constants are listed in the following table:

Symbolic constant	Numeric value	Foreground or background?
BLACK	0	Both
BLUE	1	Both
GREEN	2	Both
CYAN	3	Both
RED	4	Both
MAGENTA	5	Both
BROWN	6	Both
LIGHTGRAY	7	Both
DARKGRAY	8	Foreground only
LIGHTBLUE	9	Foreground only
LIGHTGREEN	10	Foreground only
LIGHTCYAN	11	Foreground only
LIGHTRED	12	Foreground only
LIGHTMAGENTA	13	Foreground only
YELLOW	14	Foreground only
WHITE	15	Foreground only
BLINK	128	Foreground only

This function should not be used in PM applications.

Return value None.

See also *gettextinfo, highvideo, lowvideo, normvideo, textbackground, textcolor*

T-Z

textbackground conio.h

Function Selects new text background color.

Syntax

```
void textbackground(int newcolor);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■			■			■

Remarks

textbackground selects the background color. This function works for functions that produce output in text mode directly to the screen. *newcolor* selects the new background color. You can set *newcolor* to an integer from 0 to 7, or to one of the symbolic constants defined in conio.h. If you use symbolic constants, you must include conio.h.

Once you have called *textbackground*, all subsequent functions using direct video output (such as *cprintf*) will use *newcolor*. *textbackground* does not affect any characters currently onscreen.

The following table lists the symbolic constants and the numeric values of the allowable colors:

Symbolic constant	Numeric value
BLACK	0
BLUE	1
GREEN	2
CYAN	3
RED	4
MAGENTA	5
BROWN	6
LIGHTGRAY	7

This function should not be used in PM applications.

Return value None.

See also *gettextinfo, textattr, textcolor*

textcolor — conio.h

Function Selects new character color in text mode.

Syntax

```
void textcolor(int newcolor);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■			■			■

Remarks

textcolor selects the foreground character color. This function works for the console output functions. *newcolor* selects the new foreground color. You can set *newcolor* to an integer as given in the table below, or to one of the symbolic constants defined in conio.h. If you use symbolic constants, you must include conio.h.

Once you have called *textcolor*, all subsequent functions using direct video output (such as *cprintf*) will use *newcolor*. *textcolor* does not affect any characters currently onscreen.

The following table lists the allowable colors (as symbolic constants) and their numeric values:

Symbolic constant	Numeric value
BLACK	0
BLUE	1
GREEN	2
CYAN	3
RED	4
MAGENTA	5
BROWN	6
LIGHTGRAY	7
DARKGRAY	8
LIGHTBLUE	9
LIGHTGREEN	10
LIGHTCYAN	11
LIGHTRED	12
LIGHTMAGENTA	13
YELLOW	14
WHITE	15
BLINK	128

You can make the characters blink by adding 128 to the foreground color. The predefined constant BLINK exists for this purpose; for example,

```
textcolor(CYAN + BLINK);
```

Some monitors do not recognize the intensity signal used to create the eight "light" colors (8-15). On such monitors, the light colors are displayed as their "dark" equivalents (0-7). Also, systems that do not display in color can treat these numbers as shades of one color, special patterns, or special attributes (such as underlined, bold, italics, and so on). Exactly what you'll see on such systems depends on your hardware.

This function should not be used in PM applications.

Return value None.

See also *gettextinfo, highvideo, lowvideo, normvideo, textattr, textbackground*

textmode conio.h

Function Puts screen in text mode.

Syntax

```
void textmode(int newmode);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■			■			■

Remarks

textmode selects a specific text mode.

You can give the text mode (the argument *newmode*) by using a symbolic constant from the enumeration type *text_modes* (defined in conio.h).

The most commonly used *text_modes* type constants and the modes they specify are given in the following table. Some additional values are defined in conio.h.

Symbolic constant	Text mode
LASTMODE	Previous text mode
BW40	Black and white, 40 columns
C40	Color, 40 columns
BW80	Black and white, 80 columns
C80	Color, 80 columns
MONO	Monochrome, 80 columns
C4350	EGA 43-line and VGA 50-line modes

When *textmode* is called, the current window is reset to the entire screen, and the current text attributes are reset to normal, corresponding to a call to *normvideo*.

Specifying LASTMODE to *textmode* causes the most recently selected text mode to be reselected.

textmode should be used only when the screen or window is in text mode (presumably to change to a different text mode). This is the only context in which *textmode* should be used.

This function should not be used in PM applications.

Return value None.

See also *gettextinfo*, *window*

time — time.h

Function Gets time of day.

Syntax

typedef as long

```
time_t time(time_t *timer);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *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 *timer*, provided that *timer* is not a NULL pointer.

Return value *time* returns the elapsed time in seconds, as described.

See also *asctime, ctime, difftime, ftime, gettime, gmtime, localtime, settime, stime, tzset*

tmpfile — stdio.h

Function Opens a "scratch" file in binary mode.

Syntax

```
FILE *tmpfile(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *tmpfile* creates a temporary binary file and opens it for update (*w* + *b*). The file is automatically removed when it's closed or when your program terminates.

Return value *tmpfile* returns a pointer to the stream of the temporary file created. If the file can't be created, *tmpfile* returns NULL.

See also *fopen, tmpnam*

T-Z

tmpnam — stdio.h

Function Creates a unique file name.

Syntax

```
char *tmpnam(char *s);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

tmpnam creates a unique file name, which can safely be used as the name of a temporary file. *tmpnam* generates a different string each time you call it, up to TMP_MAX times. TMP_MAX is defined in stdio.h as 65,535.

The parameter to *tmpnam*, *s*, is either null or a pointer to an array of at least *L_tmpnam* characters. *L_tmpnam* is defined in stdio.h. If *s* is NULL, *tmpnam* leaves the generated temporary file name in an internal static object and returns a pointer to that object. If *s* is not NULL, *tmpnam* places its result in the pointed-to array, which must be at least *L_tmpnam* characters long, and returns *s*.

If you do create such a temporary file with *tmpnam*, it is your responsibility to delete the file name (for example, with a call to *remove*). It is not deleted automatically. (*tmpfile does* delete the file name.)

Return value

If *s* is null, *tmpnam* returns a pointer to an internal static object. Otherwise, *tmpnam* returns *s*.

See also

tmpfile

toascii — ctype.h

Function

Translates characters to ASCII format.

Syntax

```
int toascii(int c);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks

toascii is a macro that converts the integer *c* to ASCII by clearing all but the lower 7 bits; this gives a value in the range 0 to 127.

Return value

toascii returns the converted value of *c*.

_tolower — ctype.h

Function

Translates characters to lowercase.

Syntax

```
int _tolower(int ch);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks

_tolower is a macro that does the same conversion as *tolower*, except that it should be used only when *ch* is known to be uppercase (*A*-*Z*).

To use *_tolower*, you must include ctype.h.

Return value

_tolower returns the converted value of *ch* if it is uppercase; otherwise, the result is undefined.

tolower ctype.h

Function

Translates characters to lowercase.

Syntax

```
int tolower(int ch);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

tolower is a function that converts an integer *ch* (in the range EOF to 255) to its lowercase value. The function is affected by the current locale's LC_CTYPE category. For the default C locale, *ch* is converted to a lowercase letter (*a* to *z*, if it was uppercase, *A* to *Z*). All others are left unchanged.

Return value

tolower returns the converted value of *ch* if it is uppercase; it returns all others unchanged.

_toupper ctype.h

Function

Translates characters to uppercase.

Syntax

```
int _toupper(int ch);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

T-Z

Remarks

_toupper is a macro that does the same conversion as *toupper*, except that it should be used only when *ch* is known to be lowercase letter (*a* to *z*).

To use *_toupper*, you must include ctype.h.

Return value

_toupper returns the converted value of *ch* if it is lowercase; otherwise, the result is undefined.

toupper — ctype.h

Function Translates characters to uppercase.

Syntax

```
int toupper(int ch);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *toupper* is a function that converts an integer *ch* (in the range EOF to 255) to its uppercase value. The function is affected by the current locale's LC_CTYPE category. For the default C locale, *ch* is converted to an uppercase letter (*A* to *Z*; if it was lowercase, *a* to *z*). All others are left unchanged.

Return value *toupper* returns the converted value of *ch* if it is lowercase; it returns all others unchanged.

_truncate, _ftruncate — sys\types.h, io.h

Function Changes the file size.

Syntax

```
int _ftruncate(int handle, off_t size);
int _truncate(const char *path, off_t size);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *_truncate* changes the size of the file referred to by *path*. *_ftruncate* changes the size of the file referred to by *handle*, which must be opened for writing. These functions can truncate or extend the file, depending on the value of *size* compared to the file's original size. If the file is being extended, these functions will append null characters (\0). If the file is being truncated, all data beyond the new end-of-file is lost.

Return value These functions return 0 on success. On error, they return –1 and set *errno* to one of the following values:

EACCES	Permission denied
EADF	Bad file handle (*_ftruncate* only)
EINVAL	*size* is negative
ENOENT	File does not exist (*_truncate* only)

See also *chsize*

tzset — time.h

Function Sets value of global variables *_daylight*, *_timezone*, and *_tzname*.

Syntax

```
void tzset(void)
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks *tzset* is available on XENIX systems.

tzset sets the *_daylight*, *_timezone*, and *_tzname* global variables based on the environment variable *TZ*. The library functions *ftime* and *localtime* use these global variables to adjust Greenwich Mean Time (GMT) to the local time zone. The format of the *TZ* environment string is:

```
TZ = zzz[+/-]d[d][lll]
```

where *zzz* is a three-character string representing the name of the current time zone. All three characters are required. For example, the string "PST" could be used to represent pacific standard time.

[+/-]*d*[*d*] is a required field containing an optionally signed number with 1 or more digits. This number is the local time zone's difference from GMT in hours. Positive numbers adjust westward from GMT. Negative numbers adjust eastward from GMT. For example, the number 5 = EST, +8 = PST, and –1 = continental Europe. This number is used in the calculation of the global variable *_timezone*. *_timezone* is the difference in seconds between GMT and the local time zone.

lll is an optional three-character field that represents the local time zone daylight saving time. For example, the string "PDT" could be used to represent pacific daylight saving time. If this field is present, it causes the global variable *_daylight* to be set nonzero. If this field is absent, *_daylight* is set to zero.

If the *TZ* environment string isn't present or isn't in the preceding form, a default *TZ* = "EST5EDT" is presumed for the purposes of assigning values to the global variables *_daylight*, *_timezone*, and *_tzname*.

The global variable *_tzname*[0] points to a three-character string with the value of the time-zone name from the *TZ* environment string. *_tzname*[1] points to a three-character string with the value of the daylight saving time-zone name from the *TZ* environment string. If no daylight saving name is present, *_tzname*[1] points to a null string.

Return value None.

See also *asctime, ctime, ftime, gmtime, localtime, stime, time*

ultoa — stdlib.h

Function Converts an **unsigned long** to a string.

Syntax

```
char *ultoa(unsigned long value, char *string, int radix);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *ultoa* converts *value* to a null-terminated string and stores the result in *string*. *value* is an **unsigned long**.

radix specifies the base to be used in converting *value*; it must be between 2 and 36, inclusive. *ultoa* performs no overflow checking, and if *value* is negative and *radix* equals 10, it does not set the minus sign.

The space allocated for *string* must be large enough to hold the returned string, including the terminating null character (\0). *ultoa* can return up to 33 bytes.

Return value *ultoa* returns *string*.

See also *itoa, ltoa*

umask — io.h

Function Sets file read/write permission mask.

Syntax

```
unsigned umask(unsigned mode);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks The *umask* function sets the access permission mask used by *open* and *creat*. Bits that are set in *mode* will be cleared in the access permission of files subsequently created by *open* and *creat*.

The *mode* can have one of the following values, defined in sys\stat.h:

Value of *mode*	Access permission
S_IWRITE	Permission to write
S_IREAD	Permission to read
S_IREAD|S_IWRITE	Permission to read and write

Return value The previous value of the mask. There is no error return.

See also *creat, open*

ungetc stdio.h

Function Pushes a character back into input stream.

Syntax

```
int ungetc(int c, FILE *stream);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *ungetc* pushes the character *c* back onto the named input *stream*, which must be open for reading. This character will be returned on the next call to *getc* or *fread* for that *stream*. One character can be pushed back in all situations. A second call to *ungetc* without a call to *getc* will force the previous character to be forgotten. A call to *fflush*, *fseek*, *fsetpos*, or *rewind* erases all memory of any pushed-back characters.

Return value On success, *ungetc* returns the character pushed back; it returns EOF if the operation fails.

See also *fgetc, getc, getchar*

ungetch conio.h

Function Pushes a character back to the keyboard buffer.

Syntax

```
int ungetch(int ch);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■		■			■

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

T-Z

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

This function should not be used in PM applications.

See also *getch, getche*

unixtodos dos.h

Function Converts date and time from UNIX to DOS format.

Syntax

```
void unixtodos(long time, struct date *d, struct time *t);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *unixtodos* converts the UNIX-format time given in *time* to DOS format and fills in the *date* and *time* structures pointed to by *d* and *t*.

time must not represent a calendar time earlier than Jan. 1, 1980 00:00:00.

Return value None.

See also *dostounix*

unlink io.h

Function Deletes a file.

Syntax

```
int unlink(const char *filename);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks *unlink* deletes a file specified by *filename*. Any drive, path, and file name can 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 *_rtl_chmod* to change the read-only attribute.

This function will fail (EACCES) if the file is currently open in any process.

If your file is open, be sure to close it before unlinking it.

Return value On successful completion, *unlink* returns 0. On error, it returns –1 and the global variable *errno* is set to one of the following values:

EACCES	Permission denied
ENOENT	Path or file name not found

See also *chmod, remove*

unlock — io.h

Function Releases file-sharing locks.

Syntax

```
int unlock(int handle, long offset, long length);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *unlock* provides an interface to the operating system file-sharing mechanism. *unlock* removes a lock previously placed with a call to *lock*. To avoid error, all locks must be removed before a file is closed. A program must release all locks before completing.

Return value *unlock* returns 0 on success, –1 on error.

See also *lock, locking, sopen*

utime — utime.h

Function Sets file time and date.

Syntax

```
int utime(char *path, struct utimbuf *times);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks *utime* sets the modification time for the file *path*. The modification time is contained in the *utimbuf* structure pointed to by *times*. This structure is defined in utime.h, and has the following format:

```
struct utimbuf {
   time_t   actime;    /* access time */
   time_t   modtime;   /* modification time */
   };
```

The FAT file system supports only a modification time; therefore, on FAT file systems *utime* ignores *actime* and uses only *modtime* to set the file's modification time.

If *times* is NULL, the file's modification time is set to the current time.

T-Z

Return value

utime returns 0 if it is successful. Otherwise, it returns –1, and the global variable *errno* is set to one of the following:

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

See also

setftime, stat, time

va_arg, va_end, va_start — stdarg.h

Function

Implement a variable argument list.

Syntax

```
void va_start(va_list ap, lastfix);
type va_arg(va_list ap, type);
void va_end(va_list ap);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

Some C functions, such as *vfprintf* and *vprintf*, take variable argument lists in addition to taking a number of fixed (known) parameters. The *va_arg*, *va_end*, and *va_start* 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 *ap* of type ***va_list***.
- *va_start*: This routine (implemented as a macro) sets *ap* 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: *ap* and *lastfix*. (*ap* 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 *ap* to *va_arg* should be the same *ap* that *va_start* initialized.

Because of default promotions, you can't use **char**, **unsigned char**, or **float** types with *va_arg*.

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 dereferencing *ap*, and then incrementing *ap* to point to the following item. *va_arg* uses the *type* to both perform the dereference and to locate the following item. Each successive time *va_arg* is invoked, it modifies *ap* 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 *ap* in such a way that it cannot be used unless *va_start* is recalled. *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 *ap* is pointing to).

See also

v...printf, v...scanf

vfprintf — stdio.h

Function

Writes formatted output to a stream.

Syntax

```
int vfprintf(FILE *stream, const char *format, va_list arglist);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

The *v...printf* functions are known as *alternate entry points* for the *...printf* functions. They behave exactly like their *...printf* counterparts, but they accept a pointer to a list of arguments instead of an argument list.

See *printf* for details on format specifiers.

vfprintf accepts a pointer to a series of arguments, applies to each argument a format specifier contained in the format string pointed to by *format*, and outputs the formatted data to a stream. There must be the same number of format specifiers as arguments.

Return value

vfprintf returns the number of bytes output. In the event of error, *vfprintf* returns EOF.

See also

printf, va_arg, va_end, va_start

T-Z

vfscanf — stdio.h

Function

Scans and formats input from a stream.

Syntax

```
int vfscanf(FILE *stream, const char *format, va_list arglist);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks

The *v...scanf* functions are known as *alternate entry points* for the *...scanf* functions. They behave exactly like their *...scanf* counterparts, but they accept a pointer to a list of arguments instead of an argument list.

See *scanf* for details on format specifiers.

vfscanf scans a series of input fields, one character at a time, reading from a stream. Then each field is formatted according to a format specifier passed to *vfscanf* in the format string pointed to by *format*. Finally, *vfscanf* stores the formatted input at an address passed to it as an argument following *format*. There must be the same number of format specifiers and addresses as there are input fields.

vfscanf might stop scanning a particular field before it reaches the normal end-of-field (whitespace) character, or it might terminate entirely, for a number of reasons. See *scanf* for a discussion of possible causes.

Return value

vfscanf returns the number of input fields successfully scanned, converted, and stored; the return value does not include scanned fields that were not stored. If no fields were stored, the return value is 0.

If *vfscanf* attempts to read at end-of-file, the return value is EOF.

See also

fscanf, scanf, va_arg, va_end, va_start

vprintf — stdarg.h

Function

Writes formatted output to stdout.

Syntax

```
int vprintf(const char *format, va_list arglist);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■		■	■		■

Remarks

The *v...printf* functions are known as *alternate entry points* for the *...printf* functions. They behave exactly like their *...printf* counterparts, but they accept a pointer to a list of arguments instead of an argument list.

See *printf* for details on format specifiers.

vprintf accepts a pointer to a series of arguments, applies to each a format specifier contained in the format string pointed to by *format*, and outputs the formatted data to stdout. There must be the same number of format specifiers as arguments.

This function should not be used in PM applications.

Return value

vprint returns the number of bytes output. In the event of error, *vprint* returns EOF.

See also

freopen, printf, va_arg, va_end, va_start

vscanf — stdarg.h

Function

Scans and formats input from stdin.

Syntax

```
int vscanf(const char *format, va_list arglist);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks

The *v...scanf* functions are known as *alternate entry points* for the *...scanf* functions. They behave exactly like their *...scanf* counterparts, but they accept a pointer to a list of arguments instead of an argument list.

See *scanf* for details on format specifiers.

vscanf scans a series of input fields, one character at a time, reading from stdin. Then each field is formatted according to a format specifier passed to *vscanf* in the format string pointed to by *format*. Finally, *vscanf* stores the formatted input at an address passed to it as an argument following *format*. There must be the same number of format specifiers and addresses as there are input fields.

vscanf might stop scanning a particular field before it reaches the normal end-of-field (whitespace) character, or it might terminate entirely, for a number of reasons. See *scanf* for a discussion of possible causes.

This function should not be used in PM applications.

Return value

vscanf returns the number of input fields successfully scanned, converted, and stored; the return value does not include scanned fields that were not stored. If no fields were stored, the return value is 0.

If *vscanf* attempts to read at end-of-file, the return value is EOF.

See also

freopen, fscanf, scanf, va_arg, va_end, va_start

vsprintf — stdarg.h

Function

Writes formatted output to a string.

Syntax

```
int vsprintf(char *buffer, const char *format, va_list arglist);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks

The *v...printf* functions are known as *alternate entry points* for the *...printf* functions. They behave exactly like their *...printf* counterparts, but they accept a pointer to a list of arguments instead of an argument list.

See *printf* for details on format specifiers.

vsprintf accepts a pointer to a series of arguments, applies to each a format specifier contained in the format string pointed to by *format*, and outputs the formatted data to a string. There must be the same number of format specifiers as arguments.

Return value

vsprintf returns the number of bytes output. In the event of error, *vsprintf* returns EOF.

See also

printf, va_arg, va_end, va_start

vsscanf — stdarg.h

Function

Scans and formats input from a stream.

Syntax

```
int vsscanf(const char *buffer, const char *format, va_list arglist);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks

The *v...scanf* functions are known as *alternate entry points* for the *...scanf* functions. They behave exactly like their *...scanf* counterparts, but they accept a pointer to a list of arguments instead of an argument list.

See *scanf* for details on format specifiers.

vsscanf scans a series of input fields, one character at a time, reading from a stream. Then each field is formatted according to a format specifier passed to *vsscanf* in the format string pointed to by *format*. Finally, *vsscanf* stores the formatted input at an address passed to it as an argument following *format*. There must be the same number of format specifiers and addresses as there are input fields.

vsscanf might stop scanning a particular field before it reaches the normal end-of-field (whitespace) character, or it might terminate entirely, for a number of reasons. See *scanf* for a discussion of possible causes.

Return value

vsscanf returns the number of input fields successfully scanned, converted, and stored; the return value does not include scanned fields that were not stored. If no fields were stored, the return value is 0.

If *vsscanf* attempts to read at end-of-string, the return value is EOF.

See also

fscanf, scanf, sscanf, va_arg, va_end, va_start, vfscanf

wait — process.h

Function

Waits for one or more child processes to terminate.

Syntax

```
int wait(int *statloc);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
			■			■

Remarks

The *wait* function waits for one or more child processes to terminate. The child processes must be those created by the calling program; *wait* cannot wait for grandchildren (processes spawned by child processes). If *statloc* is not NULL, it points to location where *wait* will store the termination status.

If the child process terminated normally (by calling *exit*, or returning from *main*), the termination status word is defined as follows:

Bits 0-7 Zero.

Bits 8-15 The least significant byte of the return code from the child process. This is the value that is passed to *exit*, or is returned from *main*. If the child process simply exited from *main* without returning a value, this value will be unpredictable.

If the child process terminated abnormally, the termination status word is defined as follows:

Bits 0-7 Termination information about the child:

1 Critical error abort.
2 Execution fault, protection exception.
3 External termination signal.

Bits 8-15 Zero.

Return value

When *wait* returns after a normal child process termination it returns the process ID of the child.

When *wait* returns after an abnormal child termination it returns –1 to the parent and sets *errno* to EINTR.

T-Z

If *wait* returns without a child process completion it returns a –1 value and sets *errno* to

ECHILD   No child process exists

See also *cwait, spawn*

wcstombs — stdlib.h

Function Converts a wchar_t array into a multibyte string.

Syntax

```
size_t wcstombs(char *s, const wchar_t *pwcs, size_t n);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks *wcstombs* converts the type wchar_t elements contained in *pwcs* into a multibyte character string *s*. The process terminates if either a null character or an invalid multibyte character is encountered.

No more than *n* bytes are modified. If *n* number of bytes are processed before a null character is reached, the array *s* is not null terminated.

The behavior of *wcstombs* is affected by the setting of LC_CTYPE category of the current locale.

Return value If an invalid multibyte character is encountered, *wcstombs* returns (size_t) –1. Otherwise, the function returns the number of bytes modified, not including the terminating code, if any.

wctomb — stdlib.h

Function Converts wchar_t code to a multibyte character.

Syntax

```
int wctomb(char *s, wchar_t wc);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■	■	■	■

Remarks If *s* is not null, *wctomb* determines the number of bytes needed to represent the multibyte character corresponding to *wc* (including any change in shift state). The multibyte character is stored in *s*. At most *MB_CUR_MAX* characters are stored. If the value of *wc* is zero, *wctomb* is left in the initial state.

The behavior of *wctomb* is affected by the setting of LC_CTYPE category of the current locale.

Return value

If *s* is a NULL pointer, *wctomb* returns a nonzero value if multibyte character encodings do have state-dependent encodings, and a zero value if they do not.

If *s* is not a NULL pointer, *wctomb* returns –1 if the *wc* value does not represent a valid multibyte character. Otherwise, *wctomb* returns the number of bytes that are contained in the multibyte character corresponding to *wc*. In no case will the return value be greater than the value of *MB_CUR_MAX* macro.

wherex — conio.h

Function

Gives horizontal cursor position within window.

Syntax

```
int wherex(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

wherex returns the x-coordinate of the current cursor position (within the current text window).

This function should not be used in PM applications.

Return value

wherex returns an integer in the range 1 to the number of columns in the current video mode.

See also

gettextinfo, gotoxy, wherey

wherey — conio.h

T-Z

Function

Gives vertical cursor position within window.

Syntax

```
int wherey(void);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

wherey returns the y-coordinate of the current cursor position (within the current text window).

This function should not be used in PM applications.

Return value *wherey* returns an integer in the range 1 to the number of rows in the current video mode.

See also *gettextinfo, gotoxy, wherex*

window conio.h

Function Defines active text mode window.

Syntax

```
void window(int left, int top, int right, int bottom);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■			■			■

Remarks *window* defines a text window onscreen. If the coordinates are in any way invalid, the call to *window* is ignored.

left and *top* are the screen coordinates of the upper left corner of the window. *right* and *bottom* are the screen coordinates of the lower right corner.

The minimum size of the text window is one column by one line. The default window is full screen, with the coordinates:

1,1,C,R

where C is the number of columns in the current video mode, and R is the number of rows.

This function should not be used in PM applications.

Return value None.

See also *clreol, clrscr, delline, gettextinfo, gotoxy, insline, puttext, textmode*

_write io.h

Remarks Obsolete function. See *_rtl_write* on page 164.

write io.h

Function Writes to a file.

Syntax

```
int write(int handle, void *buf, unsigned len);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■	■	■	■			■

Remarks

write writes 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*, or *dup2* call.

This function attempts to write *len* bytes from the buffer pointed to by *buf* to the file associated with *handle*. Except when *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. The maximum number of bytes that *write* can write is UINT_MAX –1, because UINT_MAX is the same as –1, which is the error return indicator for *write*. On text files, when *write* sees a linefeed (LF) character, it outputs a CR/LF pair. UINT_MAX is defined in limits.h.

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 disks or disk files, writing always proceeds from the current file pointer. For devices, bytes are sent directly to the device. For files opened with the O_APPEND option, the file pointer is positioned to EOF by *write* before writing the data.

Return value

write returns the number of bytes written. A *write* to a text file does not count generated carriage returns. In case of error, *write* returns –1 and sets the global variable *errno* to one of the following values:

EACCES	Permission denied
EBADF	Bad file number

See also

creat, lseek, open, read, _rtl_write

T-Z

C H A P T E R 3

Global variables

Borland C++ provides you with predefined global variables for many common needs, such as dates, times, command-line arguments, and so on. This chapter defines and describes them.

_argc — dos.h

Function

Keeps a count of command-line arguments.

Syntax

```
extern int _argc;
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
▪		▪	▪			▪

Remarks

_argc has the value of *argc* passed to *main* when the program starts.

_argv — dos.h

Function

An array of pointers to command-line arguments.

Syntax

```
extern char **_argv;
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
▪		▪	▪			▪

Remarks

_argv points to an array containing the original command-line arguments (the elements of *argv[]*) passed to *main* when the program starts.

_ctype — ctype.h

Function

An array of character attribute information.

Syntax

```
extern char _ctype[];
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

_ctype is an array of character attribute information indexed by ASCII value + 1. Each entry is a set of bits describing the character.

This array is used only by routines affected by the C locale, such as *isdigit*, *isprint*, and so on.

_daylight — time.h

Function

Indicates whether daylight saving time adjustments will be made.

Syntax

```
extern int _daylight;
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

_daylight is used by the time and date functions. It is set by the *tzset, ftime*, and *localtime* functions to 1 for daylight saving time, 0 for standard time.

See also

_timezone

_environ — dos.h

Function

Accesses the operating system environment variables.

Syntax

```
extern char ** _environ;
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

_environ is an array of pointers to strings; it is used to access and alter the operating system environment variables. 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* can be empty.

When a program begins execution, the operating system environment settings are passed directly to the program. Note that *env*, 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.

See also *getenv, putenv*

errno, _doserrno, _sys_errlist, _sys_nerr — dos.h, errno.h

Function Enable *perror* to print error messages.

Syntax

```
extern int _doserrno;
extern int errno;
extern char **_sys_errlist;
extern int _sys_nerr;
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

errno, *_sys_errlist*, and *_sys_nerr* are used by *perror* to print error messages when certain library routines fail to accomplish their appointed tasks. *_doserrno* is a variable that maps many operating-system error codes to *errno*; however, *perror* does not use *_doserrno* directly. See the header files winbase.h and winerror.h for the list of operating-system errors.

- *errno*: When an error in a math or system call occurs, *errno* is set to indicate the type of error. Sometimes *errno* and *_doserrno* are equivalent. At other times, *errno* does not contain the actual operating system error code, which is contained in *_doserrno* instead. Still other errors might occur that set only *errno*, not *_doserrno*.
- *_doserrno*: When an operating-system call results in an error, *_doserrno* is set to the actual operating-system error code. *errno* is a parallel error variable inherited from UNIX.
- *_sys_errlist*: To provide more control over message formatting, the array of message strings is provided in *_sys_errlist*. You can use *errno* 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 and their meanings for the values stored in *_sys_errlist*. The list is alphabetically ordered for easier reading. For the numerical ordering, see the header file errno.h.

Mnemonic	Meaning
E2BIG	Arg list too long
EACCES	Permission denied
EBADF	Bad file number
ECHILD	No child process
ECONTR	Memory blocks destroyed
ECURDIR	Attempt to remove CurDir
EDEADLOCK	Locking violation
EDOM	Math argument
EEXIST	File already exists
EFAULT	Unknown error
EINTR	Interrupted function call
EINVACC	Invalid access code
EINVAL	Invalid argument
EINVDAT	Invalid data
EINVDRV	Invalid drive specified
EINVENV	Invalid environment
EINVFMT	Invalid format
EINVFNC	Invalid function number
EINVMEM	Invalid memory block address
EIO	Input/Output error
EMFILE	Too many open files
ENAMETOOLONG	File name too long
ENFILE	Too many open files
ENMFILE	No more files
ENODEV	No such device
ENOENT	No such file or directory
ENOEXEC	Exec format error
ENOFILE	File not found
ENOMEM	Not enough core
ENOPATH	Path not found
ENOSPC	No space left on device
ENOTSAM	Not same device
ENXIO	No such device or address
EPERM	Operation not permitted
EPIPE	Broken pipe
ERANGE	Result too large
EROFS	Read-only file system
ESPIPE	Illegal seek
EXDEV	Cross-device link
EZERO	Error 0

_fileinfo — stdlib.h

Function Passes file information to a child process.

Syntax

```
extern int _fileinfo;
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
			■			■

Remarks The value of *_fileinfo* determines whether information about open files is passed to a child process. By default, the value of *_fileinfo* is 0. If *_fileinfo* has a nonzero value, file information is passed to child processes.

Alternatively, child processes can inherit such information about open files by linking your program with the object file FILEINFO.OBJ. For example:

```
bcc test.c \BCOS2\lib\fileinfo.obj
```

The file information is passed in the environment variable *_C_FILE_INFO*. This variable contains encoded binary information, and your program should not attempt to read or modify its value. The child program must have been built with the C++ run-time library to inherit this information correctly. Other programs can ignore *_C_FILE_INFO*, and will not inherit file information.

_floatconvert — stdio.h

Function Links the floating-point formats.

Syntax

```
extern int _floatconvert;
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks Floating-point output requires linking of conversion routines used by *printf*, *scanf*, and any variants of these functions. To reduce executable size, the floating-point formats are not automatically linked. However, this linkage is done automatically whenever your program uses a mathematical routine or the address is taken of some floating-point number. If neither of these actions occur the missing floating-point formats can result in a run-time error.

_fmode fcntl.h

Function

Determines default file-translation mode.

Syntax

```
extern int _fmode;
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

_fmode 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, carriage-return/linefeed (CR/LF) combinations are translated to a single linefeed character (LF) on input. 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 functions *fopen*, *fdopen*, and *freopen*. Also, in the function *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.

_new_handler

Function

Traps new allocation miscues.

Syntax

```
typedef void (*pvf)();
pvf _new_handler;
```

As an alternative, you can set using the function *set_new_handler*, like this:

```
pvf set_new_handler(pvf p);
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

_new_handler contains a pointer to a function that takes no arguments and returns **void**. If **operator new()** is unable to allocate the space required, it will call the function pointed to by *_new_handler*; if that function returns it will try the allocation again. By default, the function pointed to by *_new_handler* terminates the application. The application can replace this handler, however, with a function that can try to free up some space. This is done by assigning directly to *_new_handler* or by calling the function *set_new_handler*, which returns a pointer to the former handler.

_new_handler is provided primarily for compatibility with C++ version 1.2. In most cases this functionality can be better provided by overloading **operator new()**.

_osmajor, _osminor, _osversion — dos.h

Function

Contain the major and minor operating-system version numbers.

Syntax

```
extern unsigned char _osmajor;
extern unsigned char _osminor;
extern unsigned _osversion;
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

The major and minor version numbers are available individually through *_osmajor* and *_osminor*. *_osmajor* is the major version number, and *_osminor* is the minor version number. For example, if you are running OS/2 version 2.0, *_osmajor* will be 3 and *_osminor* will be 20.

_osversion is functionally identical to *_version*. See the discussion of *_version*.

_threadid — stddef.h

Function

Pointer to thread ID.

Syntax

```
extern long _threadid;
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■			■			■

Remarks

_threadid is a long integer that contains the ID of the currently executing thread. It is implemented as a macro, and should be declared only by including stddef.h.

_ _throwExceptionName, _ _throwFileName, _ _throwLineNumber except.h

Function Generates information about a thrown exception.

Syntax

```
extern char * _ _throwExceptionName;
extern char * _ _throwFileName;
extern char * _ _throwLineNumber;
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks Use these global variables to get the name and location of a thrown exception. The output for each of the variables is a printable character string.

To get the file name and line number for a thrown exception with *_ _throwFileName* and *_ _throwLineNumber*, you must compile the module with the **–xp** compiler option.

_timezone time.h

Function Contains difference in seconds between local time and GMT.

Syntax

```
extern long _timezone;
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks *_timezone* is used by the time-and-date functions.

This variable is calculated by then *tzset* function; it is assigned a long value that is the difference, in seconds, between the current local time and Greenwich mean time.

See also *_daylight*

_tzname time.h

Function Array of pointers to time-zone names.

Syntax

```
extern char * _tzname[2]
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

The global variable *_tzname* is an array of pointers to strings containing abbreviations for time-zone names. *_tzname*[0] points to a three-character string with the value of the time-zone name from the *TZ* environment string. The global variable *_tzname*[1] points to a three-character string with the value of the daylight-saving time-zone name from the *TZ* environment string. If no daylight saving name is present, *_tzname*[1] points to a null string.

_version — dos.h

Function

Contains the operating-system version number.

Syntax

```
extern unsigned _version;
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

_version contains the operating-system version number, with the major version number in the high byte and the minor version number in the low byte. For a 32-bit application, this layout of the version number is in the low word. For OS/2 version 2.0, *_version* has the value 20 (twenty).

_wscroll — conio.h

Function

Enables or disables scrolling in console I/O functions.

Syntax

```
extern int _wscroll
```

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

Remarks

_wscroll is a console I/O flag. Its default value is 1. If you set *_wscroll* to 0, scrolling is disabled. This can be useful for drawing along the edges of a window without having your screen scroll.

C H A P T E R 4

The C++ iostreams

Online help provides sample programs for many iostream classes.

The stream class library in C++ consists of several classes distributed in two separate hierarchical trees. See the *Programmer's Guide,* Chapter 6, for an illustration of the class hierarchies. This reference presents some of the most useful details of these classes, in alphabetical order. The following cross-reference table tells which classes belong to which header files.

Table 4.1
The functions declared in constrea.h are not available for PM applications.

Header file	Classes
constrea.h	*conbuf, constream*
iostream.h	*ios, iostream, iostream_withassign, istream, istream_withassign, ostream, ostream_withassign, streambuf*
fstream.h	*filebuf, fstream, fstreambase, ifstream, ofstream*
strstrea.h	*istrstream, ostrstream, strstream, strstreambase, strstreambuf*

conbuf class — constrea.h

conbuf is not available for PM.

Specializes *streambuf* to handle console output.

Public constructor

Constructor

```
conbuf()
```

Makes an unattached *conbuf.*

Public member functions

clreol

```
void clreol()
```

Clears to end of line in text window.

clrscr

```
void clrscr()
```

Clears the defined screen.

delline `void delline()`

Deletes a line in the window.

gotoxy `void gotoxy(int x, int y)`

Positions the cursor in the window at the specified location.

highvideo `void highvideo()`

Selects high-intensity characters.

insline `void insline()`

Inserts a blank line.

lowvideo `void lowvideo()`

Selects low-intensity characters.

normvideo `void normvideo()`

Selects normal-intensity characters.

overflow `virtual int overflow( int = EOF )`

Flushes the conbuf to its destination.

setcursortype `void setcursortype(int cur_type)`

Selects the cursor appearance.

textattr `void textattr(int newattribute)`

Selects cursor appearance.

textbackground `void textbackground(int newcolor)`

Selects the text background color.

textcolor `void textcolor( int newcolor)`

Selects character color in text mode.

textmode `static void textmode(int newmode)`

Puts the screen in text mode.

wherex `int wherex()`

Gets the horizontal cursor position.

wherey `int wherey()`

Gets the vertical cursor position.

window `void window(int left, int top, int right, int bottom)`

Defines the active window.

constream class — constrea.h

constream is not available for PM.

Provides console output streams. This class is derived from *ostream*.

Public constructor

Constructor

```
constream()
```

Provides an unattached output stream to the console.

Public member functions

clrscr

```
void clrscr()
```

Clears the screen.

rdbuf

```
conbuf *rdbuf()
```

Returns a pointer to this constream's assigned conbuf.

textmode

```
void textmode(int newmode)
```

Puts the screen in text mode.

window

```
void window(int left, int top, int right, int bottom)
```

Defines the active window.

filebuf class — fstream.h

Specializes *streambuf* to use files for input and output of characters. The *filebuf* class manages buffer allocation and deletion, and seeking within a file. This class also permits unbuffered file I/O by using the appropriate constructor or the member function *filebuf*::*setbuf*. By default, files are opened in *openprot* mode to allow reading and writing. See page 261 for a list of file-opening modes.

The *filebuf* class only provides basic services for file I/O. Input and output to a filebuf can only be done with the low-level functions provided by *streambuf*. Higher level classes provide formatting services.

Public constructors

Constructor

```
filebuf();
```

Makes a *filebuf* that isn't attached to a file.

```
filebuf(int fd);
```

Makes a *filebuf* attached to a file as specified by file descriptor *fd*.

Constructor

```
filebuf(int fd, char *buf, int n);
```

Makes a *filebuf* attached to a file specified by the file descriptor *fd*, and uses *buf* as the storage area. The size of *buf* is sufficient to store *n* bytes. If *buf* is NULL or *n* is non-positive, the *filebuf* is unbuffered.

Public data members

openprot

```
static const int openprot
```

The default file protection. The exact value of *openprot* should not be of interest to the user. Its purpose is to set the file permissions to read and write.

Public member functions

attach

```
filebuf* attach(int fd)
```

Connects this closed *filebuf* to a file specified by the file descriptor *fd*. If the file buffer is already open, *attach* fails and returns NULL. Otherwise, the file buffer is connected to *fd*.

close

```
filebuf* close()
```

Flushes and closes the file. Generally, it is not necessary to make an explicit call to *close* at your program's end because proper file closing is ensured by the *filebuf* destructor. An explicit call to *close* is useful when you want to disconnect the *filebuf* from your program.

Returns 0 on error, for example, if the file was already closed. Otherwise, the function returns a reference to the *filebuf* (the **this** pointer).

fd

```
int fd()
```

Returns the file descriptor or EOF.

is_open

```
int is_open();
```

Returns nonzero if the file is open.

open

```
filebuf* open(const char *filename, int mode,
              int prot = filebuf::openprot);
```

Opens the file specified by *filename* and connects to it. The file-opening mode is specified by *mode*.

overflow

```
virtual int overflow(int c = EOF);
```

Flushes a buffer to its destination. Every derived class should define the actions to be taken.

seekoff

```
virtual streampos seekoff(streamoff offset, dir ios::seek_dir, int mode);
```

Moves the file get/put pointer an *offset* number of bytes. The pointer is moved in the direction specified by *dir* relative to the current position. *mode* can specify read (*ios::in*), write (*ios::out*), or both. If *mode* is *ios::in*, the get pointer is adjusted. If *mode* is *ios::out*, the put pointer is adjusted.

If successful, the *seekoff* function returns a *streampos*-type value that indicates the new file pointer position.

The function can fail if the file does not support repositioning or you request an illegal pointer repositioning, for example, beyond the end of the file. On failure, *seekoff* returns EOF. The file pointer position is undefined.

setbuf

```
virtual streambuf* setbuf(char *buf, int len);
```

Allocates *buf* of size *len* for use by the *filebuf*. If *buf* is NULL or *len* is a non-positive value, the *filebuf* is unbuffered.

On success, *setbuf* returns a pointer to the *filebuf*. A failure occurs if the file is open and a buffer has been allocated. On failure, *setbuf* returns NULL and no changes are made to the buffering status.

sync

```
virtual int sync();
```

Establishes consistency between internal data structures and the external stream representation.

underflow

```
virtual int underflow();
```

Makes input available. This is called when no more data exists in the input buffer. Every derived class should define the actions to be taken.

fstream class — fstream.h

This stream class, derived from *fstreambase* and *iostream*, provides for simultaneous input and output on a *filebuf*.

Public constructors

Constructor

```
fstream();
```

Makes an *fstream* that isn't attached to a file.

Constructor

```
fstream(const char *name, int mode, int prot = filebuf::openprot);
```

Makes an *fstream*, opens a file with access as specified by *mode*, and connects to it. See page 261 for access options provided by *ios::open_mode*.

Constructor

```
fstream(int fd);
```

Makes an *fstream* and connects to an open-file descriptor specified by *fd*.

Constructor

```
fstream(int fd, char *buf, int n);
```

Makes a *fstream* attached to a file specified by the file descriptor *fd*, and uses *buf* as the storage area. The size of *buf* is sufficient to store *n* bytes. If *buf* is NULL or *n* is non-positive, the *fstream* is unbuffered.

Public member functions

open

```
void open(const char *name, int mode, int prot = filebuf::openprot);
```

Opens a file specified by *name* for an *fstream*. The file-opening mode is specified by the variable *mode*.

rdbuf

```
filebuf* rdbuf();
```

Returns the *filebuf* used.

fstreambase class — fstream.h

This stream class, derived from *ios*, provides operations common to file streams. It serves as a base for *fstream*, *ifstream*, and *ofstream*.

Public constructors

Constructor

```
fstreambase();
```

Makes an *fstreambase* that isn't attached to a file.

Constructor

```
fstreambase(const char *name, int mode, int = filebuf::openprot);
```

Makes an *fstreambase,* opens a file specified by *name* in mode specified by *mode,* and connects to it.

Constructor

```
fstreambase(int fd);
```

Makes an *fstreambase* and connects to an open-file descriptor specified by *fd.*

Constructor

```
fstreambase(int fd, char *buf, int len);
```

Makes an *fstreambase* connected to an open-file descriptor specified by *fd.* The buffer is specified by *buf* and the buffer size is *len.*

Public member functions

attach

```
void attach(int fd);
```

Connects to an open-file descriptor.

close

```
void close();
```

Closes the associated *filebuf* and file.

open

```
void open(const char *name, int mode, int prot = filebuf::openprot);
```

Opens a file for an *fstreambase.* The file-opening mode is specified by *mode.*

rdbuf

```
filebuf* rdbuf();
```

Returns the filebuf used.

setbuf

```
void setbuf(char *buf, int len);
```

Reserves an area of memory pointed to by *buf.* The area is sufficiently large to store *len* number of bytes.

ifstream class — fstream.h

This stream class, derived from *fstreambase* and *istream,* provides input operations on a *filebuf.*

Public constructors

Constructor

```
ifstream();
```

Makes an *ifstream* that isn't attached to a file.

Constructor

```
ifstream(const char *name, int mode = ios::in,
        int prot = filebuf::openprot);
```

Makes an *ifstream*, opens a file for input in protected mode, and connects to it. By default, the file is not created if it does not already exist.

Constructor

```
ifstream(int fd);
```

Makes an *ifstream* and connects to an open-file descriptor *fd*.

Constructor

```
ifstream(int fd, char *buf, int buf_len);
```

Makes an *ifstream* connected to an open file. The file is specified by its descriptor, *fd*. The *ifstream* uses the buffer specified by *buf* of length *buf_len*.

Public member functions

open

```
void open(const char *name, int mode, int prot = filebuf::openprot);
```

Opens a file for an *ifstream*.

rdbuf

```
filebuf* rdbuf();
```

Returns the filebuf used.

ios class — iostream.h

Provides operations common to both input and output. Its derived classes (*istream, ostream, iostream*) specialize I/O with high-level formatting operations. The *ios* class is a base for *istream, ostream, fstreambase,* and *strstreambase.*

Public data members

The following three constants are used as the second parameter of the *setf* function:

```
static const long  adjustfield; // left | right | internal
static const long  basefield;   // dec | oct | hex
static const long  floatfield;  // scientific | fixed
```

Stream seek direction:

```
enum seek_dir { beg=0, cur=1, end=2 };
```

Stream operation mode. These can be logically ORed:

```
enum open_mode  {
   app,         Append data—always write at end of file.
   ate,         Seek to end of file upon original open.
   in,          Open for input (default for ifstreams).
   out,         Open for output (default for ofstreams).
   binary,      Open file in binary mode.
   trunc,       Discard contents if file exists (default if out is specified
                and neither ate nor app is specified).
   nocreate,    If file does not exist, open fails.
   noreplace,   If file exists, open for output fails unless ate or app is set.
};
```

Format flags used with *flags*, *setf*, and *unsetf* member functions:

```
enum {
   skipws,      Skip whitespace on input.
   left,        Left-adjust output.
   right,       Right-adjust output.
   internal,    Pad after sign or base indicator.
   dec,         Decimal conversion.
   oct,         Octal conversion.
   hex,         Hexadecimal conversion.
   showbase,    Show base indicator on output.
   showpoint,   Show decimal point for floating-point output.
   uppercase,   Uppercase hex output.
   showpos,     Show '+' with positive integers.
   scientific,  Suffix floating-point numbers with exponential (E)
                notation on output.
   fixed,       Use fixed decimal point for floating-point numbers.
   unitbuf,     Flush all streams after insertion.
   stdio,       Flush stdout, stderr after insertion.
};
```

Protected data members

```
streambuf   *bp;           // The associated streambuf
int          x_fill;       // Padding character of output
long         x_flags;      // Formatting flag bits
int          x_precision;  // Floating-point precision on output
```

```
int         state;      // Current state of the streambuf
ostream    *x_tie;      // The tied ostream, if any
int         x_width;    // Field width on output
```

Public constructor

Constructor

```
ios(streambuf *);
```

Associates a given *streambuf* with the stream.

Protected constructor

Constructor

```
ios();
```

Constructs an *ios* object that has no corresponding *streambuf.*

Public member functions

bad

```
int bad();
```

Nonzero if error occurred.

bitalloc

```
static long bitalloc();
```

Acquires a new flag bit set. The return value can be used to set, clear, and test the flag. This is for user-defined formatting flags.

clear

```
void clear(int = 0);
```

Sets the stream state to the given value.

eof

```
int eof();
```

Nonzero on end of file.

fail

```
int fail();
```

Nonzero if an operation failed.

fill

```
char fill()
```

Returns the current fill character.

fill

```
char fill(char);
```

Resets the fill character; returns the previous character.

flags

```
long flags();
```

Returns the current format flags.

flags

```
long flags(long);
```

Sets the format flags to be identical to the given **long**; returns previous flags. Use *flags(0)* to set the default format.

good

```
int good();
```

Nonzero if no state bits were set (that is, no errors appeared).

precision

```
int precision();
```

Returns the current floating-point precision.

precision

```
int precision(int);
```

Sets the floating-point precision; returns previous setting.

rdbuf

```
streambuf* rdbuf();
```

Returns a pointer to this stream's assigned streambuf.

rdstate

```
int rdstate();
```

setf

```
long setf(long);
```

Sets the flags corresponding to those marked in the given **long**; returns previous settings.

setf

```
long setf(long _setbits, long _field);
```

The bits corresponding to those marked in *_field* are cleared, and then reset to be those marked in *_setbits*.

sync_with_stdio

```
static void sync_with_stdio();
```

Mixes stdio files and iostreams. This should not be used for new code.

tie

```
ostream* tie();
```

Returns the *tied stream*, or NULL if there is none. Tied streams are those that are connected such that when one is used, the other is affected. For example, *cin* and *cout* are tied; when *cin* is used, it flushes *cout* first.

tie

```
ostream* tie(ostream *out);
```

Ties another stream to the output stream *out* and returns the previously tied stream. If the stream was not previously tied, *tie* returns NULL.

When an input stream has characters to be consumed, or if an output stream needs more characters, the tied stream is first flushed automatically. By default, *cin*, *cerr* and *clog* are tied to *cout*.

unsetf

```
long unsetf(long f);
```

Clears the bits corresponding to *f* and returns a **long** that represents the previous settings.

width

```
int width();
```

Returns the current width setting.

width

```
int width(int);
```

Sets the width as given; returns the previous width.

xalloc

```
static int xalloc();
```

Returns an array index of previously unused words that can be used as user-defined formatting flags.

Protected member functions

init

```
void init(streambuf *);
```

Provides the actual initialization.

setstate

```
void setstate(int);
```

Sets all status bits.

iostream class — iostream.h

This class, derived from *istream* and *ostream*, is a mixture of its base classes, allowing both input and output on a stream. It is a base for *fstream* and *strstream*.

Public constructor

Constructor

```
iostream(streambuf *);
```

Associates a given *streambuf* with the stream.

iostream_withassign class — iostream.h

This class is an *iostream* with an added assignment operator.

Public constructor

Constructor

```
iostream_withassign();
```

Default constructor (calls *iostream*'s constructor).

Public member functions

None (although the **=** operator is overloaded).

istream class — iostream.h

Provides formatted and unformatted input from a *streambuf*. The **>>** operator is overloaded for all fundamental types, as explained in the narrative at the beginning of the chapter. This *ios* class is a base for *ifstream, iostream, istrstream,* and *istream_withassign.*

Public constructor

Constructor

```
istream(streambuf *);
```

Associates a given *streambuf* with the stream.

Public member functions

gcount

```
int gcount();
```

Returns the number of characters last extracted.

get

```
int get();
```

Extracts the next character or EOF.

get

```
istream& get(char *buf, int len, char delim = '\n');
istream& get(signed char *buf, int len, char delim = '\n');
istream& get(unsigned char *buf, int len, char delim = '\n');
```

Extracts characters and stores them in *buf* until the delimiter, specified by *delim,* or end-of-file is encountered, or until (*len* – 1) bytes have been read. A terminating null is always placed in the output string; the delimiter never is. The delimiter remains in the stream. Fails only if no characters were extracted.

The *get* function fails if it encounters the end of file before any characters are stored. On failure, *get* sets *ios::failbit*.

get

```
istream& get(char &ch);
istream& get(signed char &ch);
istream& get(unsigned char &ch);
```

Extracts a single character into the *ch* reference.

get

```
istream& get(streambuf &sbuf, char delim = '\n');
```

Extracts characters into the given *sbuf* reference until *delim* is encountered.

getline

```
istream& getline(char *buf, int len, char);
istream& getline(signed char *buf, int len, char delim = '\n');
istream& getline(unsigned char *buf, int len, char delim = '\n');
```

Same as *get*, except the delimiter is also extracted. Generally, the specified *delim* is not copied to *buf*. However, if the delimiter is encountered exactly when *len* characters have been extracted, *delim* is not extracted.

ignore

```
istream& ignore(int n = 1, int delim = EOF);
```

Causes up to *n* characters in the input stream to be skipped; stops if *delim* is encountered.

ipfx

```
istream& ipfx(int n = 0);
```

The *ipfx* function is called by input functions prior to fetching from an input stream. Functions that perform formatted input call *ipfx(0)*; unformatted input functions call *ipfx(1)*.

peek

```
int peek();
```

Returns next char without extraction.

putback

```
istream& putback(char);
```

Pushes back a character into the stream.

read

```
istream& read(char*, int);
istream& read(signed char*, int);
istream& read(unsigned char*, int);
```

Extracts a given number of characters into an array. Use *gcount* for the number of characters actually extracted if an error occurred.

seekg

```
istream& seekg(streampos pos);
```

Moves to an absolute position in the input stream.

seekg

```
istream& seekg(streamoff offset, seek_dir dir);
```

Moves *offset* number of bytes relative to the current position for the input stream. The offset is in the direction specified by *dir* following the definition: **enum** *seek_dir {beg, cur, end};*

Use *ostream*::*seekp* for positioning in an output stream.

Use *seekpos* or *seekoff* for positioning in a stream buffer.

tellg

```
streampos tellg();
```

Returns the current stream position. On failure, *tellg* returns a negative number.

Use *ostream*::*tellp* to find the position in an output stream.

Protected member functions

eatwhite

```
void eatwhite();
```

Extract consecutive whitespace.

istream_withassign class — iostream.h

This class is an *istream* with an added assignment operator.

Public constructor

Constructor

```
istream_withassign();
```

Default constructor (calls *istream*'s constructor).

Public member functions

None (although the = operator is overloaded).

istrstream class — strstrea.h

Provides input operations on a *strstreambuf*. This class is derived from *strstreambase* and *istream*.

Public constructors

Constructor

```
istrstream(char *);
istrstream(signed char *);
istrstream(unsigned char *);
```

Each of the constructors above makes an *istrstream* with a specified string (a null character is never extracted). See "The three char types" in Chapter 1 of the *Programmer's Guide* for a discussion of character types.

Constructor

```
istrstream(char *str, int n);
istrsteam(signed char *str, int);
istrstream(unsigned char *str, int);
```

Each of the three constructors above makes an *istrstream* using up to *n* bytes of *str*. See "The three char types" in Chapter 1 of the *Programmer's Guide* for a discussion of character types.

ofstream class — fstream.h

Provides input operations on a *filebuf*. This class is derived from *fstreambase* and *ostream*.

Public constructors

Constructor

```
ofstream();
```

Makes an *ofstream* that isn't attached to a file.

Constructor

```
ofstream(const char *name, int mode = ios::out,
         int prot = filebuf::openprot);
```

Makes an *ofstream*, opens a file, and connects to it.

Constructor

```
ofstream(int fd);
```

Makes an *ofstream* and connects to an open-file descriptor specified by *fd*.

Constructor

```
ofstream(int fd, char *buf, int len);
```

Makes an *ofstream* connected to an open-file descriptor specified by *fd*. The buffer specified by *buf* of *len* is used by the *ofstream*.

Public member functions

open

```
void open(const char *name, int mode = ios::out,
        int prot = filebuf::openprot);
```

Opens a file for an *ofstream*.

rdbuf

```
filebuf* rdbuf();
```

Returns the *filebuf* used.

ostream class — iostream.h

Provides formatted and unformatted output to a *streambuf*. The **<<** operator is overloaded for all fundamental types. This *ios*-based class is a base for *constream*, *iostream*, *ofstream*, *ostrstream*, and *ostream_withassign*.

Public constructor

Constructor

```
ostream(streambuf *);
```

Associates a given *streambuf* with the stream.

Public member functions

flush

```
ostream& flush();
```

Flushes the stream.

opfx

```
int opfx();
```

The *opfx* function is called by output functions prior to inserting to an output stream. *opfx* returns 0 if the *ostream* has a nonzero error state. Otherwise, *opfx* returns a nonzero value.

osfx

```
void osfx();
```

The *osfx* function performs post output operations. If *ios::unitbuf* is on, *opfx* flushes the *ostream*. On failure, *opfx* sets *ios::*
failbit.

put

```
ostream& put(unsigned char ch);
ostream& put(char ch);
ostream& put(signed char ch);
```

Inserts the character.

seekp

```
ostream& seekp(streampos);
```

Moves to an absolute position (as returned from *tellp*).

seekp

```
ostream& seekp(streamoff, seek_dir);
```

Moves to a position relative to the current position, following the definition: **enum** *seek_dir {beg, cur, end};*

tellp

```
streampos tellp();
```

Returns the current stream position.

write

```
ostream& write(const signed char*, int n);
ostream& write(const unsigned char*, int n);
ostream& write(const char*, int n);
```

Inserts *n* characters (nulls included).

ostream_withassign class — iostream.h

This class is an *ostream* with an added assignment operator.

Public constructor

Constructor

```
ostream_withassign();
```

Default constructor (calls *ostream*'s constructor).

Public member functions

None (although the = operator is overloaded).

ostrstream class — strstrea.h

Provides output operations on a *strstreambuf*. This class is derived from *strstreambase* and *ostream*.

Public constructors

Constructor

```
ostrstream();
```

Makes a dynamic *ostrstream*.

Constructor

```
ostrstream(char *buf, int len, int mode = ios::out);
ostrstream(signed char *buf, int len, int mode = ios::out);
ostrstream(unsigned char *buf, int len, int mode = ios::out);
```

Each of the three constructors above makes a *ostrstream* with a specified *len*-byte buffer. If the file-opening mode is *ios::app* or *ios::ate,* the get/put pointer is positioned at the null character of the string. See "The three char types" in Chapter 1 of the *Programmer's Guide* for a discussion of character types.

Public member functions

pcount

```
int pcount();
```

Returns the number of bytes currently stored in the buffer.

str

```
char *str();
```

Returns and freezes the buffer. You must deallocate it if it was dynamic.

streambuf class — iostream.h

This is a base class for all other buffering classes. It provides a buffer interface between your data and storage areas such as memory or physical devices. The buffers created by *streambuf* are referred to as get, put, and reserve areas. The contents are accessed and manipulated by pointers that point between characters.

Buffering actions performed by *streambuf* are rather primitive. Normally, applications gain access to buffers and buffering functions through a pointer to *streambuf* that is set by *ios*. Class *ios* provides a pointer to *streambuf* that provides a transparent access to buffer services for high-level classes. The high-level classes provide I/O formatting.

Public constructors

Constructor

```
streambuf();
```

Creates an empty buffer object.

Constructor

```
streambuf(char *buf, int size);
```

Constructs an empty buffer *buf* and sets up a reserve area for *size* number of bytes.

Public member functions

in_avail

```
int in_avail();
```

Returns the number of characters remaining in the input buffer.

out_waiting

```
int out_waiting();
```

Returns the number of characters remaining in the output buffer.

sbumpc

```
int sbumpc();
```

Returns the current character from the input buffer, then advances.

seekoff

```
virtual streampos seekoff(streamoff, ios::seek_dir,
                          int = (ios::in | ios::out);
```

Moves the get and/or put pointer (the third argument determines which one or both) relative to the current position.

seekpos

```
virtual streampos seekpos(streampos, int = (ios::in | ios::out));
```

Moves the get or put pointer to an absolute position.

setbuf

```
virtual streambuf* setbuf(char *, int);
```

Connects to a given buffer.

sgetc

```
int sgetc();
```

Peeks at the next character in the input buffer.

sgetn

```
int sgetn(char*, int n);
```

Gets the next *n* characters from the input buffer.

snextc

```
int snextc();
```

Advances to and returns the next character from the input buffer.

sputbackc

```
int sputbackc(char);
```

Returns a character to input.

sputc

```
int sputc(int);
```

Puts one character into the output buffer.

sputn

```
int sputn(const char*, int n);
```

Puts *n* characters into the output buffer.

stossc

```
void stossc();
```

Advances to the next character in the input buffer.

Protected member functions

allocate

```
int allocate();
```

Sets up a buffer area.

base

```
char *base();
```

Returns the start of the buffer area.

blen

```
int blen();
```

Returns the length of the buffer area.

eback

```
char *eback();
```

Returns the base of the putback section of the get area.

ebuf

```
char *ebuf();
```

Returns the end+1 of the buffer area.

egptr

```
char *egptr();
```

Returns the end+1 of the get area.

epptr

```
char *epptr();
```

Returns the end+1 of the put area.

gbump

```
void gbump(int);
```

Advances the get pointer.

gptr

```
char *gptr();
```

Returns the next location in the get area.

pbase

```
char *pbase();
```

Returns the start of the put area.

pbump

```
void pbump(int);
```

Advances the put pointer.

pptr

```
char *pptr();
```

Returns the next location in the put area.

setb

```
void setb(char *, char *, int = 0 );
```

Sets the buffer area.

setg

```
void setg(char *, char *, char *);
```

Initializes the get pointers.

setp

```
void setp(char *, char *);
```

Initializes the put pointers.

unbuffered

```
void unbuffered(int);
```

Sets the buffering state.

unbuffered

```
int unbuffered();
```

Returns nonzero if not buffered.

strstreambase class — strstrea.h

Specializes *ios* to string streams. This class is entirely protected except for the member function *strstreambase::rdbuf*. This class is a base for *strstream*, *istrstream*, and *ostrstream*.

Public constructors

Constructor

```
strstreambase();
```

Makes an empty *strstreambase*.

Constructor

```
strstreambase(char *, int, char *start);
```

Makes an *strstreambase* with a specified buffer and starting position.

Public member functions

rdbuf

```
strstreambuf * rdbuf();
```

Returns a pointer to the *strstreambuf* associated with this object.

strstreambuf class — strstrea.h

Specializes *streambuf* for in-memory formatting.

Public constructors

Constructor

```
strstreambuf();
```

Makes a dynamic *strstreambuf*. Memory will be dynamically allocated as needed.

Constructor

```
strstreambuf(void * (*)(long), void (*)(void *));
```

Makes a dynamic buffer with specified allocation and free functions.

Constructor

```
strstreambuf(int n);
```

Makes a dynamic *strstreambuf*, initially allocating a buffer of at least *n* bytes.

Constructor

```
strstreambuf(char*, int, char *strt = 0);
strstreambuf(signed char *, int, signed char *strt = 0);
strstreambuf(unsigned char *, int, unsigned char *strt = 0);
```

Each of the three constructors above makes a static *strstreambuf* with a specified buffer. If *strt* is not null, it delimits the buffer. See "The three char types" in Chapter 1 of the *Programmer's Guide* for a discussion of character types.

Public member functions

doallocate

```
virtual int doallocate();
```

Performs low-level buffer allocation.

freeze

```
void freeze(int = 1);
```

If the input parameter is nonzero, disallows storing any characters in the buffer. Unfreeze by passing a zero.

overflow

```
virtual int overflow(int);
```

Flushes a buffer to its destination. Every derived class should define the actions to be taken.

seekoff

```
virtual streampos seekoff(streamoff, ios::seek_dir, int);
```

Moves the pointer relative to the current position.

setbuf

```
virtual streambuf* setbuf(char*, int);
```

Specifies the buffer to use.

str

```
char *str();
```

Returns a pointer to the buffer and freezes it.

sync

```
virtual int sync();
```

Establishes consistency between internal data structures and the external stream representation.

underflow

```
virtual int underflow();
```

Makes input available. This is called when a character is requested and the strstreambuf is empty. Every derived class should define the actions to be taken.

strstream class — strstrea.h

Provides for simultaneous input and output on a *strstreambuf*. This class is derived from *strstreambase* and *iostream*.

Public constructors

Constructor

```
strstream();
```

Makes a dynamic *strstream*.

Constructor

```
strstream(char *buf, int sz, int mode);
strstream(signed char *buf, int sz, int mode);
strstream(unsigned char *buf, int sz, int mode);
```

Each of the three constructors above makes a *strstream* with a specified *sz*-byte buffer. If *mode* is *ios::app* or *ios::ate,* the get/put pointer is positioned at the null character of the string. See "The three char types" in Chapter 1 of the *Programmer's Guide* for a discussion of character types.

Public member function

str

```
char *str();
```

Returns and freezes the buffer. The user must deallocate it if it was dynamic.

C H A P T E R 5

Persistent stream classes and macros

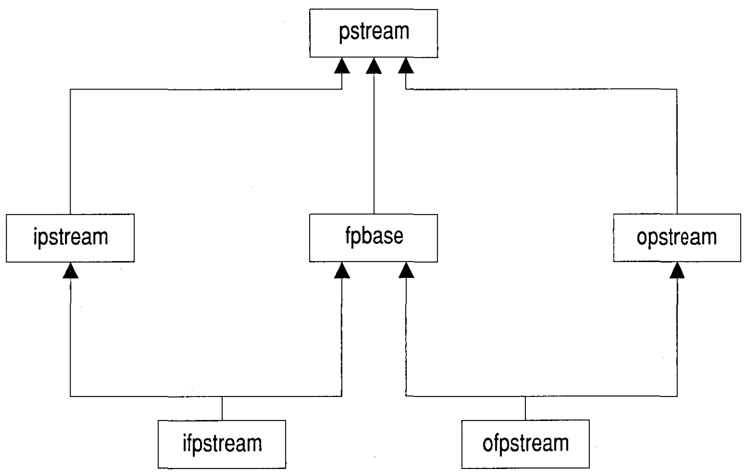
For a discussion on how to use the persistent streams library, see Chapter 7 in the *Programmer's Guide.*

Borland support for persistent streams consists of a class hierarchy and macros to help you develop streamable objects. This chapter is a reference for these classes and macros. It alphabetically lists and describes all the public classes that support persistent objects. The class descriptions are followed by descriptions of the _ _DELTA macro and the streaming macros. The streaming macros are provided to simplify the declaration and definition of streamable classes.

The persistent streams class hierarchy

The persistent streams class hierarchy is shown in the following figure:

Figure 5.1 Streamable class hierarchy



fpbase class objstm.h

Provides the basic operations common to all object file stream I/O.

Constructors

Constructor

```
fpbase();
fpbase(const char  *name, int omode, int prot = filebuf::openprot);
fpbase(int f);
fpbase(int f, char  *b, int len);
```

Creates a buffered *fpbase* object. You can set the size and location of the buffer with the *len* and *b* arguments. You can open a file and attach it to the stream by specifying the name, mode, and protection (*prot*) arguments, or by using the file descriptor, *f*.

Public member functions

attach

```
void attach(int f);
```

Attaches the file with descriptor *f* to this stream if possible. Sets *ios::state* accordingly.

close

```
void close();
```

Closes the stream and associated file.

open

```
void open(const char *name, int mode, int prot = filebuf::openprot);
```

Opens the named file in the given *mode* (*app, ate, in, out, binary, trunc, nocreate, noreplace*) and protection. The opened file is attached to this stream.

rdbuf

```
filebuf * rdbuf();
```

Returns a pointer to the current file buffer.

setbuf

```
void setbuf(char *buf, int len);
```

Sets the location the buffer to *buf* and the buffer size to *len*.

ifpstream class objstrm.h

Provides the base class for reading (extracting) streamable objects from file streams.

Public constructors

Constructor

```
ifpstream();
ifpstream(const char *name, int mode = ios::in,
        int prot = filebuf::openprot);
ifpstream(int f);
ifpstream(int f, char *b, int len);
```

Creates a buffered *ifpstream* object. You can set the size and location of the buffer with the *len* and *b* arguments. You can open a file and attach it to the stream by specifying the name, mode, and protection arguments, or via the file descriptor, *f*.

Public member functions

open

```
void open(const char *name, int mode = ios::in,
        int prot = filebuf::openprot);
```

Opens the named file in the given *mode* (*app, ate, in, out, binary, trunc, nocreate,* or *noreplace*) and protection. The default mode is *in* (input) with *openprot* protection. The opened file is attached to this stream.

rdbuf

```
filebuf * rdbuf();
```

Returns a pointer to the current file buffer.

ipstream class — objstrm.h

Provides the base class for reading (extracting) streamable objects.

Public constructors

Constructor

```
ipstream(streambuf *buf);
```

Creates a buffered *ipstream* with the given buffer. The state is set to 0.

Public member functions

find

```
TStreamableBase * find(P_id_type Id);
```

Returns a pointer to the object corresponding to *Id*.

freadBytes

```
void freadBytes( void *data, size_t sz );
```

Reads into the supplied buffer (*data*) the number of bytes specified by *sz*.

freadString

```
char *freadString();
```

Reads a string from the stream. Determines the length of the string and allocates a character array of the appropriate length. Reads the string into this array and returns a pointer to the string. The caller is expected to free the allocated memory block.

```
char *freadString( char *buf, unsigned maxLen );
```

Reads a string from the stream into the supplied buffer (*buf*). If the length of the string is greater than *maxLen*-1, reads nothing. Otherwise reads the string into the buffer and appends a null terminating byte.

getVersion

```
uint32 getVersion() const;
```

Returns the object version number.

readByte

```
uint8 readByte();
```

Returns the byte at the current stream position.

readBytes

```
void readBytes(void *data, size_t sz);
```

Reads *sz* bytes from current stream position, and writes them to *data*.

readString

```
char * readString();
char * readString(char *buf, unsigned maxLen);
```

readString() allocates a buffer large enough to contain the string at the current stream position. Reads the string from the stream into the buffer. The caller must free the buffer.

*readString(char *buf, unsigned maxLen)* reads the string at the current stream position into the buffer specified by *buf*. If the length of the string is greater than *maxLen*-1, reads nothing. Otherwise reads the string into the buffer and appends a null terminating byte.

readWord

```
uint32 readWord();
```

Returns the word at the current stream position.

readWord16

```
uint16 readWord16();
```

Returns the 16-bit word at the current stream position.

readWord32

```
uint32 readWord32();
```

Returns the 32-bit word at the current stream position.

registerObject

```
void registerObject(TStreamableBase * adr);
```

Registers the object pointed to by *adr*.

seekg

```
ipstream& seekg(streampos pos);
ipstream& seekg(streamoff off, ios::seek_dir);
```

The first form moves the stream position to the absolute position given by *pos*. The second form moves to a position relative to the current position by an offset *off* (+ or –) starting at *ios::seek_dir*. *ios::seek_dir* can be set to *beg* (start of stream), *cur* (current stream position), or *end* (end of stream).

tellg

```
streampos tellg();
```

Returns the (absolute) current stream position.

Protected constructors

Constructor

```
ipstream();
```

The protected form of the constructor does not initialize the buffer pointer *bp*. Use *init* to set the buffer and state.

Protected member functions

readData

```
void * readData(const ObjectBuilder * ,TStreamableBase *& mem);
```

Invokes the appropriate *read* function to read from the stream to the object pointed to by *mem*. If *mem* is 0, the appropriate *build* function is called first.

See also: *TStreamableClass*, and the *read* and *build* member functions of each streamable class

readPrefix

```
const ObjectBuilder * readPrefix();
```

Returns the *TStreamableClass* object corresponding to the class *name* stored at the current position.

readSuffix

```
void readSuffix();
```

Reads and checks the object's suffix.

See also: *ipstream::readPrefix*

readVersion

```
void readVersion();
```

Reads the version number of the input stream.

Friends

Operator >>

```
friend ipstream& operator >> (ipstream& ps, signed char & ch);
friend ipstream& operator >> (ipstream& ps, unsigned char & ch);
friend ipstream& operator >> (ipstream& ps, signed short & sh);
friend ipstream& operator >> (ipstream& ps, unsigned short & sh);
friend ipstream& operator >> (ipstream& ps, signed int & i);
friend ipstream& operator >> (ipstream& ps, unsigned int & i);
friend ipstream& operator >> (ipstream& ps, signed long & l);
friend ipstream& operator >> (ipstream& ps, unsigned long & l);
friend ipstream& operator >> (ipstream& ps, float & f);
friend ipstream& operator >> (ipstream& ps, double & d);
friend ipstream& operator >> (ipstream& ps, long double & d);
friend ipstream& operator >> (ipstream& ps, TStreamableBase t);
friend ipstream& operator >> (ipstream& ps, void *t);
```

Extracts (reads) from the *ipstream ps*, to the given argument. A reference to the stream is returned, letting you chain **>>** operations in the usual way. The data type of the argument determines how the read is performed. For example, reading a signed *char* is implemented using *readByte*.

ofpstream class — objstrm.h

Provides the base class for writing (inserting) streamable objects to file streams.

Public constructors

Constructor

```
ofpstream();
ofpstream(const char *name, int mode = ios::out,
          int prot = filebuf::openprot);
ofpstream(int f);
ofpstream(int f, char *b, int len);
```

Creates a buffered *ofpstream* object. You can set the size and address of the buffer with the *len* and *b* arguments. A file can be opened and attached to the stream by specifying the name, mode, and protection arguments, or by using the file descriptor, *f*.

Public member functions

open

```
void open(char *name, int mode = ios::out, int prot = filebuf::openprot);
```

Opens the named file in the given *mode* (*app, ate, in, out, binary, trunc, nocreate*, or *noreplace*) and protection. The default mode is *out* (output) with *openprot* protection. The opened file is attached to this stream.

rdbuf

```
filebuf * rdbuf();
```

Returns the current file buffer.

opstream class — objstrm.h

Provides the base class for writing (inserting) streamable objects.

Public constructors and destructor

Constructor

```
opstream(streambuf *buf);
```

This constructor creates a buffered *opstream* with the given buffer. The state is set to 0.

Destructor

```
~opstream();
```

Destroys the *opstream* object.

See also: *pstream::init*

Public member functions

findObject

```
P_id_type findObject(TStreamableBase *adr);
```

Returns the type ID for the object pointed to by *adr*.

findVB

```
P_id_type findVB(TStreamableBase *adr);
```

Returns a pointer to the virtual base.

flush

```
opstream& flush();
```

Flushes the stream.

fwriteBytes

```
void fwriteBytes( const void *data, size_t sz );
```

Writes the specified number of bytes (*sz*) from the supplied buffer (*data*) to the stream.

fwriteString

```
void fwriteString( const char *str );
```

Writes the specified character string (*str*) to the stream.

registerObject

```
void registerObject(TStreamableBase *adr);
```

Registers the class of the object pointed to by *adr*.

registerVB

```
void registerVB(TStreamableBase *adr);
```

Registers a virtual base class.

seekp

```
opstream& seekp(streampos pos);
opstream& seekp(streamoff off,ios::seek_dir);
```

The first form moves the stream's current position to the absolute position given by *pos*. The second form moves to a position relative to the current position by an offset *off* (+ or –) starting at *ios::seek_dir*. *ios::seek_dir* can be set to *beg* (start of stream), *cur* (current stream position), or *end* (end of stream).

tellp

```
streampos tellp();
```

Returns the (absolute) current stream position.

writeByte

```
void writeByte(uint8 ch);
```

Writes the byte *ch* to the stream.

writeBytes

```
void writeBytes(const void *data, size_t sz);
```

Writes *sz* bytes from *data* buffer to the stream.

writeObject

```
void writeObject( const TStreamableBase *t, int isPrt = 0,
                  ModuleId mid = GetModuleId() );
```

Writes the object that is pointed to by *t* to the output stream. The *isPtr* indicates whether the object was allocated from the heap.

writeString

```
void writeString(const char *str);
```

Writes *str* to the stream.

writeWord

```
void writeWord(uint32 us);
```

Writes the 32-bit word *us* to the stream.

writeWord16

```
void writeWord16(uint16 us);
```

Writes the 16-bit word *us* to the stream.

writeWord32

```
void writeWord32(uint32 us);
```

Writes the 32-bit word *us* to the stream.

Protected constructors

Constructor

```
opstream();
```

This protected form of the constructor does not initialize the buffer pointer *bp*. Use *init* to set the buffer and state.

Protected member functions

writeData

```
void writeData(TStreamableBase *t);
```

Writes data to the stream by calling the appropriate class's *write* member function for the object being written.

See also: *TStreamableBase* and the *write* functions in the streamable classes

writePrefix

```
void writePrefix(const TStreamableBase *t);
```

Writes the class name prefix to the stream. The **<<** operator uses this function to write a prefix and suffix around the data written with *writeData*. The prefix/suffix is used to ensure type-safe stream I/O.

See also: *ipstream:readPrefix*

writeSuffix

```
void writeSuffix(const TStreamableBase *t);
```

Writes the class name suffix to the stream. The **<<** operator uses this function to write a prefix and suffix around the data written with *writeData*. The prefix/suffix is used to ensure type-safe stream I/O.

See also: *ipstream:readPrefix*

Friends

Operator <<

```
friend opstream& operator << (opstream&  ps, signed char ch);
friend opstream& operator << (opstream&  ps, unsigned char ch);
friend opstream& operator << (opstream&  ps, signed short sh);
friend opstream& operator << (opstream&  ps, unsigned short sh);
friend opstream& operator << (opstream&  ps, signed int i);
friend opstream& operator << (opstream&  ps, unsigned int i);
friend opstream& operator << (opstream&  ps, signed long l);
friend opstream& operator << (opstream&  ps, unsigned long l);
friend opstream& operator << (opstream&  ps, float f);
friend opstream& operator << (opstream&  ps, double d);
friend opstream& operator << (opstream&  ps, long double d);
friend opstream& operator << (opstream&  ps, TStreamableBase& t);
```

Inserts (writes) the given argument to the given *ipstream* object. The data type of the argument determines the form of write operation employed.

pstream class — objstrm.h

pstream is the base class for handling streamable objects.

Type definitions

PointerTypes

```
enum PointerTypes{ptNull, ptIndexed, ptObject};
```

Enumerates object pointer types.

Public constructors and destructor

Constructor

```
pstream(streambuf *buf);
```

This constructor creates a buffered *pstream* with the given buffer. The state is set to 0.

Destructor

```
virtual ~pstream();
```

Destroys the *pstream* object.

Public member functions

bad

```
int bad() const;
```

Returns nonzero if an error occurred.

clear

```
void clear(int aState = 0);
```

Set the stream *state* to the given value (defaults to 0).

eof

```
int eof() const;
```

Returns nonzero after end of stream.

fail

```
int fail() const;
```

Returns nonzero if a stream operation failed.

good

```
int good() const;
```

Returns nonzero if no state bits are set (that is, if no errors occurred).

rdbuf

```
streambuf * rdbuf() const;
```

Returns a pointer to this stream's assigned buffer.

See also: *pstream::pb*

rdstate

```
int rdstate() const;
```

Returns the current *state* value.

Operators

Operator void *()

```
operator void *() const;
```

Converts to a **void** pointer.

See also: *pstream::fail*

Operator ! ()

```
int operator ! () const;
```

The NOT operator. Returns 0 if the operation has failed (that is, if *pstream::fail* returned nonzero); otherwise, returns nonzero.

See also: *pstream::fail*

Protected data members

bp

```
streambuf *bp;
```

Pointer to the stream buffer.

state

```
int state;
```

Format state flags. Use *rdstate* to access the current state.

See also: *pstream::rdstate*

Protected constructors

Constructor

```
pstream();
```

This form of the constructor does not initialize the buffer pointer *bp*. Use *init* and *setstate* to set the buffer and state.

Protected member functions

init

```
void init(streambuf *sbp);
```

Initializes the stream: sets *state* to 0 and *bp* to *sbp*.

setstate

```
void setstate(int b);
```

Updates the *state* data member with `state |= (b & 0xFF)`.

TStreamableBase class — objstrm.h

```
class TStreamableBase
```

Classes that inherit from *TStreamableBase* are known as streamable classes, meaning their objects can be written to and read from streams. If you want to develop your own streamable classes, you should make sure that *TStreamableBase* is somewhere in their ancestry. Using an existing streamable class as a base, of course, is an obvious way of achieving this. Use multiple inheritance to derive a class from *TStreamableBase* if your class must also fit into an existing class hierarchy.

Type definitions

Type_id

```
typedef const char *Type_id;
```

Describes type identifiers.

Public destructor

Destructor

```
virtual ~TStreamableBase() {};
```

Destroys the *TStreamableBase* object.

Public member functions

CastableID

```
virtual Type_id CastableID() const = 0;
```

Available only when the library is build without RTTI.

Provides support for typesafe downcasting. Returns a string containing the type name.

FindBase

```
virtual void *FindBase( Type_id id ) const;
```

Available only when the library is build without RTTI.

Returns a pointer to the base class.

MostDerived

```
virtual void *MostDerived() const = 0;
```

Available only when the library is build without RTTI.

Returns a **void** pointer to the actual streamed object.

TStreamableClass class — streambl.h

Used by the private database class and *pstream* in streamable class registration.

Public constructor

Constructor

```
TStreamableClass(const char *n, BUILDER b, int d=NoDelta,
                 ModuleId mid = GetModuleId());
```

Creates a *TStreamableClass* object with the given name (*n*) and the given builder function (*b*), then registers the type. Each streamable class, for example *TClassname*, has a *build* member function of type BUILDER. For type-safe object-stream I/O, the stream manager needs to access the names and the type information for each class. To ensure that the appropriate functions are linked into any application using the stream manager, you must provide a reference such as:

```
TStreamableClass RegClassName;
```

where *TClassName* is the name of the class for which objects need to be streamed. (Note that *RegClassName* is a single identifier.) This not only registers *TClassName* (telling the stream manager which *build* function to use), it also automatically registers any dependent classes. You can register a class more than once without any harm or overhead.

Invoke this function to provide raw memory of the correct size into which an object of the specified class can be read. Because the build procedure invokes a special constructor for the class, all virtual table pointers are initialized correctly.

The _ _DELTA macro is provided only for backward compatibility and should not be used in new code.

The distance, in bytes, between the base of the streamable object and the beginning of the *TStreamableBase* component of the object is *d*. Calculate *d* by using the _ _DELTA macro. For example,

```
TStreamableClass RegTClassName = TStreamableClass("TClassName",
TClassName::build, _ _DELTA(TClassName));
```

See also: *TStreamableBase, ipstream, opstream*

Friends

The classes *opstream* and *ipstream* are friends of *TStreamableClass*.

TStreamer class — objstrm.h

```
class TStreamer
```

Base class for all streamable objects.

Public member functions

GetObject

```
TStreamableBase *GetObject() const
```

Returns the address of the *TStreamableBase* component of the streamable object.

Protected constructors

Constructor

```
TStreamer( TStreamableBase *obj )
```

Constructs the *TStreamer* object, and initializes the streamable object pointer.

Protected member functions

Read

```
virtual void *Read( ipstream&, uint32 ) const = 0;
```

This pure virtual member function must be redefined for every streamable class. It must read the necessary data members for the streamable class from the supplied *ipstream*.

StreamableName

```
virtual const char *StreamableName() const = 0;
```

This pure virtual member function must be redefined for every streamable class. *StreamableName* returns the name of the streamable class, which is used by the stream manager to register the streamable class. The name returned must be a 0-terminated string.

Write

```
virtual void Write( opstream& ) const = 0;
```

This pure virtual function must be redefined for every streamable class. It must write the necessary streamable class data members to the supplied *opstream* object. *Write* is usually implemented by calling the base class's *Write* (if any), and then inserting any additional data members for the derived class.

_ _DELTA macro — streambl.h

```
#define _ _DELTA( d ) (FP_OFF((TStreamable *)(d *)1)-1)
```

Provided only for backward compatibility and should not be used in new code.

Calculates the distance, in bytes, between the base of the streamable object and the beginning of the *TStreamableBase* component of the object.

DECLARE_STREAMABLE macro — objstrm.h

```
DECLARE_STREAMABLE(exp, cls, ver)
```

The DECLARE_STREAMABLE macro is used within a class definition to add the members that are needed for streaming. Because it contains access specifiers, it should be followed by an access specifier or be used at the end of the class definition. The first parameter should be a macro, which in turn should conditionally expand to either **_ _import** or **_ _export**, depending on whether or not the class is to be imported or exported from a DLL. The second parameter is the streamable class name. The third parameter is the object version number.

See also: Chapter 8 in the *Programmer's Guide*

DECLARE_STREAMABLE_FROM_BASE macro — objstrm.h

```
DECLARE_STREAMABLE_FROM_BASE(exp, cls, ver)
```

DECLARE_STREAMABLE_FROM_BASE is used in the same way as DECLARE_STREAMABLE; it should be used when the class being defined can be written and read using *Read* and *Write* functions defined in its base class without change. This usually occurs when a derived class overrides virtual functions in its base or provides different constructors, but does not add any data members. (If you used DECLARE_STREAMABLE in this situation, you would have to write *Read* and *Write* functions that merely called the base's *Read* and *Write* functions. Using DECLARE_STREAMABLE_FROM_BASE prevents this.)

DECLARE_ABSTRACT_STREAMABLE macro — objstrm.h

```
DECLARE_ABSTRACT_STREAMABLE(exp, cls, ver)
```

This macro is used in an abstract class. DECLARE_STREAMABLE doesn't work with an abstract class because an abstract class can never be instantiated, and the code that attempts to instantiate the object (*Build*) causes compiler errors.

DECLARE_STREAMER macro — objstrm.h

```
DECLARE_STREAMER(exp, cls, ver )
```

This macro defines a nested class within your streamable class; it contains the core of the streaming code. DECLARE_STREAMER declares the *Read* and *Write* function declarations, whose definitions you must provide, and the *Build* function that calls the *TStreamableClass* constructor. See DECLARE_STREAMABLE for an explanation of the parameters.

DECLARE_STREAMER_FROM_BASE macro — objstrm.h

```
DECLARE_STREAMER_FROM_BASE( exp, cls, base )
```

This macro is used by DECLARE_STREAMABLE_FROM_BASE. It declares a nested *Streamer* class without the *Read* and *Write* functions. See DECLARE_STREAMABLE for a description of the parameters.

DECLARE_ABSTRACT_STREAMER macro — objstrm.h

```
define DECLARE_ABSTRACT_STREAMER( exp, cls, ver )
```

This macro is used by DECLARE_ABSTRACT_STREAMABLE. It declares a nested *Streamer* class without the *Build* function. See DECLARE_STREAMABLE for an explanation of the parameters.

DECLARE_CASTABLE macro — objstrm.h

```
DECLARE_CASTABLE
```

This macro provides declarations that provide a rudimentary typesafe downcast mechanism. This is useful for compilers that don't support run-time type information.

DECLARE_STREAMABLE_OPS macro — objstrm.h

```
DECLARE_STREAMABLE_OPS(cls)
```

Declares the inserters and extractors. For template classes, DECLARE_STREAMABLE_OPS must use `class<...>` as the macro argument; other DECLAREs take only the class name.

DECLARE_STREAMABLE_CTOR macro — objstrm.h

```
DECLARE_STREAMABLE_CTOR(cls)
```

Declares the constructor called by the *Streamer::Build* function.

IMPLEMENT_STREAMABLE macros — objstrm.h

```
IMPLEMENT_STREAMABLE(cls)
IMPLEMENT_STREAMABLE1(cls, base1)
IMPLEMENT_STREAMABLE2(cls, base1, base2)
IMPLEMENT_STREAMABLE3(cls, base1, base2, base3)
IMPLEMENT_STREAMABLE4(cls, base1, base2, base3, base4)
IMPLEMENT_STREAMABLE5(cls, base1, base2, base3, base4, base5)
```

The IMPLEMENT_STREAMABLE macros generate the registration object for the class via IMPLEMENT_STREAMABLE_CLASS, and generate the various member functions that are needed for a streamable class via IMPLEMENT_ABSTRACT_STREAMABLE.

IMPLEMENT_STREAMABLE is used when the class has no base classes other than TStreamableBase. Its only parameter is the name of the class. The numbered versions (IMPLEMENT_STREAMABLE1, IMPLEMENT_STREAMABLE2, and so on) are for classes that have bases.

Each base class, including all virtual bases, must be listed in the IMPLEMENT_STREAMABLE macro invocation.

The individual components comprising these macros can be used separately for special situations, such for as custom constructors.

IMPLEMENT_STREAMABLE_CLASS macro — objstrm.h

```
IMPLEMENT_STREAMABLE_CLASS(cls)
```

Constructs a *TStreamableClass* class instance.

IMPLEMENT_STREAMABLE_CTOR macros — objstrm.h

```
IMPLEMENT_STREAMABLE_CTOR(cls)
IMPLEMENT_STREAMABLE_CTOR1(cls, base1)
IMPLEMENT_STREAMABLE_CTOR2(cls, base1, base2)
IMPLEMENT_STREAMABLE_CTOR3(cls, base1, base2, base3)
IMPLEMENT_STREAMABLE_CTOR4(cls, base1, base2, base3, base4)
IMPLEMENT_STREAMABLE_CTOR5(cls, base1, base2, base3, base4, base5)
```

Defines the constructor called by the *Build* function. All base classes must be listed in the appropriate macro.

IMPLEMENT_STREAMABLE_POINTER macro — objstrm.h

```
IMPLEMENT_STREAMABLE_POINTER(cls)
```

Creates the instance pointer extraction operator (>>).

IMPLEMENT_CASTABLE_ID macro — objstrm.h

```
IMPLEMENT_CASTABLE_ID( cls )
```

Sets the typesafe downcast identifier.

IMPLEMENT_CASTABLE macros — objstrm.h

```
IMPLEMENT_CASTABLE( cls )
```

```
IMPLEMENT_CASTABLE1( cls )
IMPLEMENT_CASTABLE2( cls )
IMPLEMENT_CASTABLE3( cls )
IMPLEMENT_CASTABLE4( cls )
IMPLEMENT_CASTABLE5( cls )
```

These macros implement code that supports the typesafe downcast mechanism.

IMPLEMENT_STREAMER macro — objstrm.h

```
IMPLEMENT_STREAMER( cls )
```

Defines the *Streamer* constructor.

IMPLEMENT_ABSTRACT_STREAMABLE macros — objstrm.h

```
IMPLEMENT_ABSTRACT_STREAMABLE( cls )
IMPLEMENT_ABSTRACT_STREAMABLE1( cls )
IMPLEMENT_ABSTRACT_STREAMABLE2( cls )
IMPLEMENT_ABSTRACT_STREAMABLE3( cls )
IMPLEMENT_ABSTRACT_STREAMABLE4( cls )
IMPLEMENT_ABSTRACT_STREAMABLE5( cls )
```

This macro expands to IMPLEMENT_STREAMER (which defines the *Streamer* constructor), IMPLEMENT_STREAMABLE_CTOR (which defines the *TStreamableClass* constructor), and IMPLEMENT_STREAMABLE_POINTER (which defines the instance pointer extraction operator).

IMPLEMENT_STREAMABLE_FROM_BASE macro — objstrm.h

```
IMPLEMENT_STREAMABLE_FROM_BASE( cls, base1 )
```

This macro expands to IMPLEMENT_STREAMABLE_CLASS (which constructs a *TStreamableClass* instance), IMPLEMENT_STREAMABLE_CTOR1 (which defines a one base class constructor that is called by *Build*), and IMPLEMENT_STREAMABLE_POINTER (which defines the instance pointer extraction operator).

C H A P T E R 6

The C++ container classes

See Chapter 7 in the *Programmer's Guide* for information on using containers.

This chapter is a reference guide to the Borland C++ container classes. Each container class belongs to one of the following groups, which are listed here with their associated header-file names.

- Array (arrays.h)
- Association (assoc.h)
- Bag (bags.h)
- Binary tree (binimp.h)
- Dequeue (deques.h)
- Dictionary (dict.h)
- Double-linked list (dlistimp.h)
- Hash table (hashimp.h)
- List (listimp.h)
- Queue (queues.h)
- Set (sets.h)
- Stack (stacks.h)
- Vector (vectimp.h)

TMArrayAsVector template — arrays.h

```
template <class T, class Alloc> class TMArrayAsVector;
```

TMArrayAsVector implements a managed array of objects of type *T*, using a vector as the underlying implementation. It requires an operator **==** for type *T*. The memory manager *Alloc* provides class-specific **new** and **delete** operators.

Type definitions

CondFunc

```
typedef int ( *CondFunc)(const T &, void *);
```

Function type used as a parameter to *FirstThat* and *LastThat* member functions.

IterFunc

```
typedef void ( *IterFunc)(T &, void *);
```

Function type used as a parameter to the *ForEach* member function.

Public constructors

Constructor

```
TMArrayAsVector( int upper, int lower = 0, int delta = 0 )
```

Creates an array with an upper bound of *upper*, a lower bound of *lower*, and a growth delta of *delta*.

Public member functions

Add

```
int Add( const T& t )
```

Adds a *T* object at the next available index at the end of an array. Adding an element beyond the upper bound leads to an overflow condition. If overflow occurs and *delta* is nonzero, the array is expanded (by sufficient multiples of *delta* bytes) to accommodate the addition. If *delta* is zero, *Add* fails. *Add* returns 0 if it couldn't add the object.

AddAt

```
int AddAt( const T& t, int loc )
```

Adds a *T* object at the specified index. If that index is occupied, it moves the object up to make room for the added object. If *loc* is beyond the upper bound, the array is expanded if *delta* (see the constructor) is nonzero. If *delta* is zero, attempting to *AddAt* beyond the upper bound gives an error.

ArraySize

```
unsigned ArraySize() const;
```

Returns the current number of cells allocated.

BoundBase

```
int BoundBase( unsigned loc ) const;
```

Boundbase adjust vectors, which are zero-based, to arrays, which aren't zero-based. See *ZeroBase*.

Destroy

```
int Destroy( int i )
```

Removes the object at the given index. The object will be destroyed.

```
int Destroy( const T& t )
```

Removes the given object and destroys it.

Detach

```
int Detach( int loc )
```

```
int Detach( const T& t)
```

The first version removes the object at *loc*; the second version removes the first object that compares equal to the specified object.
See also: *TShouldDelete::ownsElements*

Find

```
int Find( const T& t ) const;
```

Finds the specified object and returns the object's index; otherwise returns INT_MAX.

FirstThat

```
T *FirstThat(CondFunc cond, void *args ) const;
```

Returns a pointer to the first object in the array that satisfies a given condition. You supply a test-function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the array meets the condition.

See also: *LastThat*

Flush

```
void Flush( );
```

Removes all elements from the array without destroying the array.

See also: *Detach*

ForEach

```
void ForEach(IterFunc iter, void *args )
```

ForEach executes the given function *iter* for each element in the array. The *args* argument lets you pass arbitrary data to this function.

GetItemsInContainer

```
unsigned GetItemsInContainer() const;
```

Returns the number of items in the array, as distinguished from *ArraySize*, which returns the size of the array.

Grow

```
void Grow( int loc )
```

Increases the size of the array, in either direction, so that *loc* is a valid index.

HasMember

```
int HasMember( const T& t ) const;
```

Returns 1 if the given object is found in the array; otherwise returns 0.

InsertEntry

```
void InsertEntry( int loc )
```

Creates an object and inserts it at *loc*, moving entries above *loc* up by one.

IsEmpty

```
int IsEmpty() const;
```

Returns 1 if the array contains no elements; otherwise returns 0.

IsFull

```
int IsFull() const;
```

Returns 1 if the array is full; otherwise returns 0. The array is full if *delta* is not equal to 0 and if the number of items in the container equals the value returned by *ArraySize*.

LastThat

```
T *LastThat( CondFunc cond, void *args ) const;
```

Returns a pointer to the last object in the array that satisfies a given condition. You supply a test function pointer *cond* that returns true for a

certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the array meets the condition.

See also: *FirstThat*, *ForEach*

LowerBound

```
int LowerBound() const;
```

Returns the array's *lowerbound*.

Reallocate

```
int Reallocate( unsigned sz, unsigned offset = 0 )
```

If *delta* (see the constructor) is zero, *reallocate* returns 0. Otherwise, *reallocate* tries to create a new array of size *sz* (adjusted upwards to the nearest multiple of *delta*). The existing array is copied to the expanded array and then deleted. In an array of pointers, the entries are zeroed for each unused element. In an array of objects, the default constructor is invoked for each unused element. *offset* is the location in the new vector where the first element of the old vector should be copied. This is needed when the array has to be extended downward.

RemoveEntry

```
void RemoveEntry( int loc )
```

Removes element at the *loc* index into the array, and reduces the array by one element. Elements from index (*loc* + 1) upward are copied to positions *loc*, (*loc* + 1), and so on. The original element at *loc* is lost.

SetData

```
void SetData( int loc, const T& t )
```

The given *t* replaces the existing element at the index *loc*.

UpperBound

```
int UpperBound() const;
```

Returns the array's current *upperbound*.

ZeroBase

```
unsigned ZeroBase( int loc ) const;
```

Returns the location relative to *lowerbound* (*loc* – *lowerbound*).

Protected member functions

ItemAt

```
T ItemAt( int i ) const;
```

Returns a copy of the object stored at location *i*.

Operators

operator [ ]

```
T& operator []( int loc )
```

```
T& operator []( int loc ) const;
```

Returns a reference to the element at the location specified by *loc*. the non-**const** version resizes the array if it's necessary to make *loc* a valid index. The **const** version throws an exception in the debugging version on an attempt to index out of bounds.

TMArrayAsVectorIterator template — arrays.h

```
template <class T, class Alloc> class TMArrayAsVectorIterator;
```

Implements an iterator object to traverse *TMArrayAsVector* objects.

Public constructors

Constructor

```
TMArrayAsVectorIterator( const TMArrayAsVector<T,Alloc> & a ) :
```

Creates an iterator object to traverse *TMArrayAsVector* objects.

Public member functions

Current

```
const T& Current();
```

Returns the current object.

Restart

```
void Restart();
void Restart( unsigned start, unsigned stop );
```

Restarts iteration from the beginning, or over the specified range.

Operators

operator ++

```
const T& operator ++(int);
```

Moves to the next object, and returns the object that was current before the move (post-increment).

```
const T& operator ++();
```

Moves to the next object, and returns the object that was current after the move (pre-increment).

operator int

```
operator int() const;
```

Converts the iterator to an integer value for testing if objects remain in the iterator. The iterator converts to 0 if nothing remains in the iterator.

TArrayAsVector template — arrays.h

```
template <class T> class TArrayAsVector;
```

TArrayAsVector implements an array of objects of type *T*, using a vector as the underlying implementation. *TStandardAllocator* is used to manage memory. See *TMArrayAsVector* on page 297 for members.

Public constructors

Constructor

```
TArrayAsVector( int upper, int lower = 0, int delta = 0 ) :
```

Creates an array with an upper bound of *upper*, a lower bound of *lower*, and a growth delta of *delta*.

TArrayAsVectorIterator template — arrays.h

```
template <class T> class TArrayAsVectorIterator;
```

Implements an iterator object to traverse *TArrayAsVector* objects. See *TMArrayAsVectorIterator* on page 301 for members.

Public constructors

Constructor

```
TArrayAsVectorIterator( const TArrayAsVector<T> & a )
```

Creates an iterator object to traverse *TArrayAsVector* objects.

TMIArrayAsVector template — arrays.h

```
template <class T, class Alloc> class TMIArrayAsVector;
```

Implements a managed, indirect array of objects of type *T*, using a vector as the underlying implementation.

Type definitions

CondFunc

```
typedef int ( *CondFunc)(const T &, void *);
```

Function type used as a parameter to *FirstThat* and *LastThat* member functions.

IterFunc

```
typedef void ( *IterFunc)(T &, void *);
```

Function type used as a parameter to *ForEach* member function.

Public constructors

Constructor

```
TMIArrayAsVector( int upper, int lower = 0, int delta = 0 );
```

Creates an indirect array with an upper bound of *upper*, a lower bound of *lower*, and a growth delta of *delta*.

Public member functions

Add

```
int Add( T *t );
```

Adds a pointer to a *T* object at the next available index at the end of an array. Adding an element beyond the upper bound leads to an overflow condition. If overflow occurs and *delta* is nonzero, the array is expanded (by sufficient multiples of *delta* bytes) to accommodate the addition. If *delta* is zero, *Add* fails. *Add* returns 0 if the object couldn't be added.

AddAt

```
int AddAt( T *t, int loc );
```

Adds a pointer to a *T* object at the specified index. If that index is occupied, it moves the object up to make room for the added object. If *loc* is beyond the upper bound, the array is expanded if *delta* (see the constructor) is nonzero. If *delta* is zero, attempting to *AddAt* beyond the upper bound returns 0. Otherwise it returns 1.

ArraySize

```
unsigned ArraySize() const;
```

Returns the current number of cells allocated.

Destroy

```
int Destroy( int i );
```

Removes the object at the given index. The object will be deleted.

```
int Destroy( T *t );
```

Removes the object pointed to by *t* and deletes it.

Detach

```
int Detach( int loc, DeleteType dt = NoDelete );
int Detach( T *t, DeleteType dt = NoDelete );
```

The first version removes the object pointer at *loc;* the second version removes the specified pointer. The value of *dt* and the current ownership setting determine whether the object itself will be deleted. *DeleteType* is defined in the base class *TShouldDelete* as `enum { NoDelete, DefDelete,`

`Delete }`. The default value of *dt*, *NoDelete*, means that the object will not be deleted regardless of ownership. With *dt* set to *Delete*, the object will be deleted regardless of ownership. If *dt* is set to *DefDelete*, the object will be deleted only if the array owns its elements.

See also: *TShouldDelete::ownsElements*

Find

```
int Find( const T *t ) const;
```

Finds the first specified object pointer and returns the index. Returns INT_MAX not found.

FirstThat

```
T *FirstThat( CondFunc cond, void *args ) const;
```

Returns a pointer to the first element in the array that satisfies a given condition. You supply a test-function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the container meets the condition.

See also: *LastThat*

Flush

```
void Flush( DeleteType dt = DefDelete )
```

Removes all elements from the array without destroying the array. The value of *dt* determines whether the elements themselves are destroyed. By default, the ownership status of the array determines their fate, as explained in the *Detach* member function. You can also set *dt* to *Delete* and *NoDelete*.

See also: *Detach*

ForEach

```
void ForEach(IterFunc iter, void *args )
```

ForEach executes the given function *iter* for each element in the container. The *args* argument lets you pass arbitrary data to this function.

GetItemsInContainer

```
unsigned GetItemsInContainer() const;
```

Returns the number of items in the array.

HasMember

```
int HasMember( const T& t ) const;
```

Returns 1 if the given object is found in the array; otherwise returns 0.

IsEmpty

```
int IsEmpty() const;
```

Returns 1 if the array contains no elements; otherwise returns 0.

IsFull

```
int IsFull() const;
```

Returns 1 if the array is full; otherwise returns 0.

LastThat

```
T *LastThat( CondFunc cond, void *args ) const;
```

Returns a pointer to the last element in the array that satisfies a given condition. You supply a test function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the container meets the condition.

See also: *FirstThat*, *ForEach*

LowerBound

```
int LowerBound() const;
```

Returns the array's *lowerbound*.

UpperBound

```
int UpperBound() const;
```

Returns the array's current *upperbound*.

Protected member functions

BoundBase

```
int BoundBase( unsigned loc ) const;
```

Boundbase adjusts vectors, which are zero-based, to arrays, which aren't zero-based. See *ZeroBase*.

Grow

```
void Grow( int loc )
```

Increases the size of the array, in either direction, so that *loc* is a valid index.

InsertEntry

```
void InsertEntry( int loc )
```

Creates an object and inserts it at *loc*.

ItemAt

```
T ItemAt( int i ) const;
```

Returns a copy of the object stored at location *i*.

Reallocate

```
int Reallocate( unsigned sz, unsigned offset = 0 )
```

If *delta* (see the constructor) is zero, *reallocate* returns 0. Otherwise, *reallocate* tries to create a new array of size *sz* (adjusted upward to the nearest multiple of *delta*). The existing array is copied to the expanded array and then deleted. In an array of pointers the entries are zeroed. In an array of objects the default constructor is invoked for each unused element. *offset* is the location in the new vector where the first element of the old vector should be copied. This is needed when the array has to be extended downward.

RemoveEntry

```
void RemoveEntry( int loc )
```

Removes element at *loc*, and reduces the array by one element. Elements from index (*loc* + 1) upward are copied to positions *loc*, (*loc* + 1), and so on. The original element at *loc* is lost.

SetData

```
void SetData( int loc, const T& t )
```

The given *t* replaces the existing element at the index *loc*.

SqueezeEntry

```
void SqueezeEntry( unsigned loc )
```

Removes element at *loc,* and reduces the array by one element. Elements from index (*loc* + 1) upward are copied to positions *loc,* (*loc* + 1), and so on. The original element at *loc* is lost.

ZeroBase

```
unsigned ZeroBase( int loc ) const;
```

Returns the location relative to *lowerbound* (*loc* – *lowerbound*).

Operators

operator [ ]

```
T * & operator []( int loc )
T * & operator []( int loc ) const;
```

Returns a reference to the element at the location specified by *loc*. the non-**const** version resizes the array if it's necessary to make *loc* a valid index. The **const** throws an exception in the debugging version on an attempt to index out of bounds.

TMIArrayAsVectorIterator template — arrays.h

```
template <class T, class Alloc> class TMIArrayAsVectorIterator;
```

Implements an iterator object to traverse *TMIArrayAsVector* objects. Based on *TMVectorIteratorImp*.

Public constructors

Constructor

```
TMIArrayAsVectorIterator( const TMIArrayAsVector<T,Alloc> &a )
```

Creates an iterator object to traverse *TMArrayAsVector* objects.

Public member functions

Current

```
T *Current();
```

Returns a pointer to the current object.

Restart

```
void Restart();
```

```
void Restart( unsigned start, unsigned stop );
```

Restarts iteration from the beginning, or over the specified range.

Operators

operator ++

```
const T& operator ++(int);
```

Moves to the next object, and returns the object that was current before the move (post-increment).

```
const T& operator ++();
```

Moves to the next object, and returns the object that was current after the move (pre-increment).

TIArrayAsVector template — arrays.h

```
template <class T> class TIArrayAsVector;
```

Implements an indirect array of objects of type *T*, using a vector as the underlying implementation. *TStandardAllocator* is used to manage memory. See *TMIArrayAsVector* on page 302 for members.

Public constructors

Constructor

```
TIArrayAsVector( int upper, int lower = 0, int delta = 0 )
```

Creates an array with an upper bound of *upper*, a lower bound of *lower*, and a growth delta of *delta*.

TIArrayAsVectorIterator template — arrays.h

```
template <class T> class TIArrayAsVectorIterator;
```

Implements an iterator object to traverse *TIArrayAsVector* objects. Uses *TStandardAllocator* for memory management. See *TMIArrayAsVectorIterator* on page 306 for member functions and operators.

Public constructors

Constructor

```
TIArrayAsVectorIterator( const TIArrayAsVector<T> &a ) :
TMIArrayAsVectorIterator<T,TStandardAllocator>(a)
```

Creates an iterator object to traverse *TIArrayAsVector* objects.

TMSArrayAsVector template — arrays.h

```
template <class T, class Alloc> class TMSArrayAsVector;
```

Implements a sorted array of objects of type *T*, using a vector as the underlying implementation. With the exception of the *AddAt* member function, *TMSArrayAsVector* inherits its member functions and operators from *TMArrayAsVector*. See *TMArrayAsVector* on page 297 for members.

Public constructors

Constructor

```
TMSArrayAsVector( int upper, int lower = 0, int delta = 0 )
```

Creates an array with an upper bound of *upper*, a lower bound of *lower*, and a growth delta of *delta*. It requires a **<** operator for type *T*.

TMSArrayAsVectorIterator template — arrays.h

```
template <class T, class Alloc> class TMSArrayAsVectorIterator;
```

Implements an iterator object to traverse *TMSArrayAsVector* objects. See *TMArrayAsVectorIterator* on page 301 for members.

Public constructors

Constructor

```
TMSArrayAsVectorIterator( const TMSArrayAsVector<T> & a )
```

Creates an iterator object to traverse *TSArrayAsVector* objects.

TSArray template — arrays.h

A simplified name for *TSArrayAsVector*.

TSArrayAsVector template — arrays.h

```
template <class T> class TSArrayAsVector;
```

Implements a sorted array of objects of type *T*, using a vector as the underlying implementation. With the exception of the *AddAt* member function, *TSArrayAsVector* inherits its member functions and operators from *TMArrayAsVector*. See *TMArrayAsVector* on page 297 for members.

Public constructors

Constructor

```
TSArrayAsVector( int upper, int lower = 0, int delta = 0 )
```

Creates an array with an upper bound of *upper*, a lower bound of *lower*, and a growth delta of *delta*. It requires a < operator for type *T*.

TSArrayAsVectorIterator template — arrays.h

```
template <class T> class TSArrayAsVectorIterator;
```

Implements an iterator object to traverse *TSArrayAsVector* objects. See *TMArrayAsVectorIterator* on page 301 for members.

Public constructors

Constructor

```
TSArrayAsVectorIterator( const TSArrayAsVector<T> & a ) :
```

Creates an iterator object to traverse *TSArrayAsVector* objects.

TSArrayIterator template — arrays.h

A simplified name for *TSArrayAsVectorIterator*.

TISArrayAsVector template — arrays.h

```
template <class T> class TISArrayAsVector;
```

Implements an indirect sorted array of objects of type *T*, using a vector as the underlying implementation. See *TMIArrayAsVector* on page 302 for members.

Public constructors

Constructor

```
TISArrayAsVector( int upper, int lower = 0, int delta = 0 )
```

Creates an indirect array with an upper bound of *upper*, a lower bound of *lower*, and a growth delta of *delta*.

TISArrayAsVectorIterator template — arrays.h

```
template <class T> class TISArrayAsVectorIterator;
```

Implements an iterator object to traverse *TISArrayAsVector* objects. See *TMArrayAsVectorIterator* on page 301 for members.

Public constructors

Constructor

```
TISArrayAsVectorIterator( const TISArrayAsVector<T> &a )
```

Creates an iterator object to traverse *TISArrayAsVector* objects.

TMISArrayAsVector template — arrays.h

```
template <class T, class Alloc> class TMISArrayAsVector;
```

Implements a managed, indirect sorted array of objects of type *T*, using a vector as the underlying implementation. See *TMIArrayAsVector* on page 302 for members.

Public constructors

Constructor

```
TMISArrayAsVector( int upper, int lower = 0, int delta = 0 )
```

Creates an indirect array with an upper bound of *upper*, a lower bound of *lower*, and a growth delta of *delta*.

TMDDAssociation template — assoc.h

```
template <class K, class V, class A> class TMDDAssociation;
```

Implements a managed association, binding a direct key (*K*) with a direct value (*V*) . Assumes that *K* has a *HashValue* member function, or that a global function with one of the following prototypes exists:

```
unsigned HashValue( K );
unsigned HashValue( K & );
unsigned HashValue( const K & );
```

K also must have a valid == operator. Class *A* represents the user-supplied storage manager.

Public constructors

Constructor

```
TMDDAssociation()
```

The default constructor.

Constructor

```
TMDDAssociation( const K &k, const V &v )
```

Constructs an object that associates a copy of key object *k* with a copy of value object *v*.

Public member functions

DeleteElements

```
void DeleteElements()
```

The dictionary containing the associations determines whether pointed-to objects should be deleted, and if so, calls *DeleteElements* for each of the associations it holds.

HashValue

```
unsigned HashValue()
```

Returns the hash value for the key.

Key

```
const K& Key()
```

Returns *KeyData*.

Value

```
const V& Value() const;
```

Returns *ValueData*.

Operators

operator ==

Tests equality between keys.

TDDAssociation template — assoc.h

```
template <class K,class V> class TDDAssociation;
```

Standard association (direct key, direct value). Implements an association, binding a direct key (*K*) with a direct value (*V*). Assumes that *K* has a *HashValue* member function, or that a global function with the following prototype exists:

```
unsigned HashValue( K & );
```

K also must have a valid == operator. See *TMDDAssociation* on page 310 for members.

Public constructors

Constructor

```
TDDAssociation()
```

The default constructor.

Constructor

```
TDDAssociation( const K &k, const V &v )
```

Constructs an object that associates key object *k* with value object *v*.

TMDIAssociation template — assoc.h

```
template <class K, class V, class A> class TMDIAssociation;
```

Implements a managed association, binding a direct key (*K*) with a indirect value (*V*) . Assumes that *K* has a *HashValue* member function, or that a global function with the following prototype exists:

```
unsigned HashValue( K & );
```

K also must have a valid == operator. Class *A* represents the user-supplied storage manager.

Public constructors

Constructor

```
TMDIAssociation()
```

The default constructor.

Constructor

```
TMDIAssociation( const K& k, V * v )
```

Constructs an object that associates key object *k* with value object *v*.

Public member functions

HashValue

```
unsigned HashValue()
```

Returns the hash value for the key.

Key

```
const K& Key()
```

Returns the key.

Value

```
const V * Value()
```

Returns a pointer to the data.

Operators

operator ==

```
int operator == (const TMDDAssociation<K,V,A> & a)
```

Tests the equality between keys.

TDIAssociation template — assoc.h

```
template <class K,class V> class TDIAssociation;
```

Implements an association, binding a direct key (*K*) with a indirect value (*V*). Assumes that *K* has a *HashValue* member function, or that a global function with the following prototype exists:

```
unsigned HashValue( K & );
```

K also must have a valid **==** operator. See *TMDIAssociation* on page 312 for members.

Public constructors

Constructor

```
TDIAssociation()
```

The default constructor.

Constructor

```
TDIAssociation( const K& k, V * v )
```

Constructs an object that associates key object *k* with value object *v*.

```
unsigned HashValue(int& i) { return i; }
TDIAssociation<int, int> assoc( 3, new int(4) ) /* Create an association */
TDictionaryAsHashTable<TDIAssociation<int, int> > dict; /* Creates a
                                                            dictionary */
```

```
dict.Add( assoc ); /* Copies assoc into the dictionary */
dict.OwnsElements(); /* Tell dict that it should delete pointed-to objects */
dict.Flush;  /* Deletes the int created by new in the first line */
```

TMIDAssociation template — assoc.h

```
template <class K, class V, class A> class TMIDAssociation;
```

Implements a managed association, binding an indirect key (*K*) with a direct value (*V*) . Assumes that *K* has a *HashValue* member function, or that a global function with the following prototype exists:

```
unsigned HashValue( K & );
```

K also must have a valid == operator. Class *A* represents the user-supplied storage manager.

Protected data members

KeyData

```
K KeyData;
```

The key class passed into the template by the user.

ValueData

```
V ValueData;
```

The value class passed into the template by the user.

Public constructors

Constructor

```
TMIDAssociation()
```

The default constructor.

Constructor

```
TMIDAssociation( K *k, const V& v )
```

Constructs an object that associates key object *k* with value object *v*.

Public member functions

DeleteElements

```
void DeleteElements()
```

The dictionary containing the associations determines whether pointed-to objects should be deleted, and if so, calls *DeleteElements* for each of the associations it holds.

HashValue

```
unsigned HashValue()
```

Returns the hash value for the key.

Key

```
const K * Key()
```

Returns a pointer to the key.

Value

```
const V& Value() const;
```

Returns a copy of the data.

Operators

operator ==

```
int operator == (const TMIDAssociation<K,V,A> & a)
```

Tests the equality between keys.

TIDAssociation template — assoc.h

```
template <class K, class V> class TIDAssociation;
```

Implements an association, binding an indirect key (*K*) with a direct value (*V*). Assumes that *K* has a *HashValue* member function, or that a global function with the following prototype exists:

```
unsigned HashValue( K & );
```

K also must have a valid == operator. See *TMIDAssociation* on page 314 for members.

Public constructors

Constructor

```
TIDAssociation()
```

The default constructor.

Constructor

```
TIDAssociation( K * k, const V& v )
```

Constructs an object that associates key object **k* with value object *v*.

TMIIAssociation template — assoc.h

```
template <class K, class V, class A> class TMIIAssociation;
```

Implements a managed association, binding an indirect key (*K*) with an indirect value (*V*). Assumes that *K* has a *HashValue* member function, or that a global function with the following prototype exists:

```
unsigned HashValue( K & );
```

K also must have a valid == operator. Class *A* represents the user-supplied storage manager.

Public constructors

Constructor

```
TMIIAssociation()
```

The default constructor.

Constructor

```
TMIIAssociation( K * k, V * v )
```

Constructs an object that associates key object **k* with value object **v*.

Public member functions

DeleteElements

```
void DeleteElements()
```

The dictionary containing the associations determines whether pointed-to objects should be deleted, and if so, calls *DeleteElements* for each of the associations it holds.

HashValue

```
unsigned HashValue()
```

Returns the hash value for the key.

Key

```
const K * Key()
```

Returns a pointer to the key.

Value

```
const V * Value()
```

Returns a pointer to the data.

Operators

operator ==

```
int operator == (const TMIIAssociation<K,V,A> & a)
```

Tests equality between keys.

TIIAssociation template — assoc.h

```
template <class K,class V> class TIIAssociation;
```

Standard association (indirect key, indirect value). Implements an association, binding an indirect key (*K*) with an indirect value (*V*) .

Assumes that *K* has a *HashValue* member function, or that a global function with the following prototype exists:

```
unsigned HashValue( K & );
```

K also must have a valid == operator. See *TMIIAssociation* on page 315 for members.

Public constructors

Constructor

```
TIIAssociation()
```

The default constructor.

Constructor

```
TIIAssociation( K *k, V * v )
```

Constructs an object that associates key object **k* with value object **v*.

TMBagAsVector template — bags.h

```
template <class T,class Alloc> class TMBagAsVector;
```

Implements a managed bag of objects of type *T*, using a vector as the underlying implementation. Bags, unlike sets, can contain duplicate objects.

Type definitions

CondFunc

```
typedef int ( *CondFunc)(const T &, void *);
```

Function type used as a parameter to *FirstThat* and *LastThat* member functions.

IterFunc

```
typedef void ( *IterFunc)(T &, void *);
```

Function type used as a parameter to *ForEach* member function.

Public constructors

Constructor

```
TMBagAsVector( unsigned sz = DEFAULT_BAG_SIZE )
```

Constructs a managed, empty bag. *sz* represents the number of items the bag can hold.

Public member functions

Add

```
int Add( const T& t )
```

Adds the given object to the bag.

Detach

```
int Detach( const T& t);
```

Removes the specified object.

See also: *TShouldDelete::ownsElements*

Find

```
T* Find( const T& t ) const;
```

Returns a pointer to the given object if found; otherwise returns 0.

Flush

```
void Flush()
```

Removes all the elements from the bag without destroying the bag.

See also: *Detach*

ForEach

```
void ForEach(IterFunc iter, void *args )
```

ForEach executes the given function *iter* for each element in the bag. The *args* argument lets you pass arbitrary data to this function.

GetItemsInContainer

```
int GetItemsInContainer() const;
```

Returns the number of objects in the bag.

HasMember

```
int HasMember( const T& t ) const;
```

Returns 1 if the given object is found; otherwise returns 0.

IsEmpty

```
int isEmpty() const;
```

Returns 1 if the bag is empty; otherwise returns 0.

IsFull

```
int isFull() const;
```

Returns 0.

TMBagAsVectorIterator template — bags.h

```
template <class T,class Alloc> class TMBagAsVectorIterator;
```

Implements an iterator object to traverse *TMBagAsVector* objects. See *TMArrayAsVectorIterator* on page 301 for members.

Public constructors

Constructor

```
TMBagAsVectorIterator( const TMBagAsVector<T,Alloc> & b )
```

Constructs an object that iterates on *TMBagAsVector* objects.

TBagAsVector template — bags.h

```
template <class T> class TBagAsVector;
```

Implements a bag of objects of type *T*, using a vector as the underlying implementation. *TStandardAllocator* is used to manage memory. See *TMBagAsVector* on page 317 for members.

Public constructors

Constructor

```
TBagAsVector( unsigned sz = DEFAULT_BAG_SIZE )
```

Constructs an empty bag. *sz* represents the number of items the bag can hold.

TBagAsVectorIterator template — bags.h

```
template <class T> class TBagAsVectorIterator;
```

Implements an iterator object to traverse *TBagAsVector* objects. *TStandardAllocator* is used to manage memory. See *TMArrayAsVectorIterator* on page 301 for members.

Public constructors

Constructor

```
TBagAsVectorIterator( const TBagAsVector<T> & b )
```

Constructs an object that iterates on *TBagAsVector* objects.

TMIBagAsVector template — bags.h

```
template <class T, class Alloc> class TMIBagAsVector;
```

Implements a managed bag of pointers to objects of type *T*, using a vector as the underlying implementation.

Type definitions

CondFunc

```
typedef int ( *CondFunc)(const T &, void *);
```

Function type used as a parameter to *FirstThat* and *LastThat* member functions.

IterFunc

```
typedef void ( *IterFunc)(T &, void *);
```

Function type used as a parameter to *ForEach* member function.

Public constructors

Constructor

```
TMIBagAsVector( unsigned sz = DEFAULT_BAG_SIZE )
```

Constructs an empty, managed, indirect bag. *sz* represents the initial number of slots allocated.

Public member functions

Add

```
int Add( T *t )
```

Adds the given object pointer to the bag.

Detach

```
int Detach( T *t, DeleteType dt = NoDelete )
```

Removes the specified object pointer. The value of *dt* and the current ownership setting determine whether the object itself will be deleted. *DeleteType* is defined in the base class *TShouldDelete* as `enum { NoDelete, DefDelete, Delete }`. The default value of *dt, NoDelete,* means that the object will not be deleted regardless of ownership. With *dt* set to *Delete,* the object will be deleted regardless of ownership. If *dt* is set to *DefDelete,* the object will only be deleted if the bag owns its elements.

See also: *TShouldDelete::ownsElements*

Find

```
T *Find( T *t ) const;
```

Returns a pointer to the object if found; otherwise returns 0.

FirstThat

```
T *FirstThat( CondFunc cond, void *args ) const;
```

See: *TMBagAsVector::FirstThat*

Flush

```
void Flush( TShouldDelete::DeleteType dt = TShouldDelete::DefDelete )
```

Removes all the elements from the bag without destroying the bag. The value of *dt* determines whether the elements themselves are destroyed. By default, the ownership status of the bag determines their fate, as explained in the *Detach* member function. You can also set *dt* to *Delete* and *NoDelete*.

See also: *Detach*

ForEach

```
void ForEach(IterFunc iter, void *args )
```

ForEach executes the given function *iter* for each element in the bag. The *args* argument lets you pass arbitrary data to this function.

GetItemsInContainer

```
int GetItemsInContainer() const;
```

Returns the number of objects in the bag.

HasMember

```
int HasMember( const T& t ) const;
```

Returns 1 if the given object is found; otherwise returns 0.

IsEmpty

```
int isEmpty() const;
```

Returns 1 if the bag is empty; otherwise returns 0.

IsFull

```
int isFull() const;
```

Returns 0.

LastThat

```
T *LastThat(CondFunc cond, void *args ) const;
```

Returns a pointer to the last object in the bag that satisfies a given condition. You supply a test function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the array meets the condition.

TMIBagAsVectorIterator template — bags.h

```
template <class T, class Alloc> class TMIBagAsVectorIterator;
```

Implements an iterator object to traverse *TMIBagAsVector* objects. See *TMArrayAsVectorIterator* on page 301 for members.

Public constructors

Constructor

```
TMIBagAsVectorIterator( const TMIBagAsVector<T,Alloc> & s )
```

Constructs an object that iterates on *TMIBagAsVector* objects.

TIBagAsVector template bags.h

```
template <class T> class TIBagAsVector;
```

Implements a bag of pointers to objects of type *T*, using a vector as the underlying implementation. *TStandardAllocator* is used to manage memory. See *TMIBagAsVector* on page 319 for members.

Public constructors

Constructor

```
TIBagAsVector( unsigned sz = DEFAULT_BAG_SIZE )
```

Constructs an empty, managed, indirect bag. *sz* represents the initial number of slots allocated.

TIBagAsVectorIterator template bags.h

```
template <class T> class TIBagAsVectorIterator;
```

Implements an iterator object to traverse *TIBagAsVector* objects. *TStandardAllocator* is used to manage memory. See *TMArrayAsVectorIterator* on page 301 for members.

Public constructors

Constructor

```
TIBagAsVectorIterator( const TIBagAsVector<T> & s )
```

Constructs an object that iterates on *TMIBagAsVector* objects.

TBinarySearchTreeImp template binimp.h

```
template <class T> class TBinarySearchTreeImp;
```

Implements an unbalanced binary tree. Class *T* must have **<** and **==** operators, and must have a default constructor.

Public member functions

Add

```
int Add( const T& t )
```

Creates a new binary-tree node and inserts a copy of object *t* into it.

Detach

```
int Detach( const T& t )
```

Removes the node containing item *t* from the tree.

Find

```
T * Find( const T& t ) const;
```

Returns a pointer to the node containing item *t*.

Flush

```
void Flush();
```

Removes all items from the tree.

ForEach

```
void ForEach( IterFunc iter, void * args, IteratorOrder order = InOrder )
```

Creates an internal iterator that executes the given function *iter* for each item in the container. The *args* argument lets you pass arbitrary data to this function.

GetItemsInContainer

```
unsigned GetItemsInContainer();
```

Returns the number of items in the tree.

Parent::IsEmpty

```
int IsEmpty();
```

Returns 1 if the tree is empty; otherwise returns 0.

Protected member functions

EqualTo

```
virtual int EqualTo( BinNode *n1, BinNode *n2 )
```

Tests the equality between two nodes.

LessThan

```
virtual int LessThan( BinNode *n1, BinNode *n2 )
```

Tests if node *n1* is less than node *n2*.

DeleteNode

```
virtual void DeleteNode( BinNode *node, int del)
```

Deletes *node*. The second parameter is ignored.

TBinarySearchTreeIteratorImp template — binimp.h

```
template <class T> class TBinarySearchTreeIteratorImp;
```

Implements an iterator that traverses *TBinarySearchTreeImp* objects.

Public constructors

Constructor

```
TBinarySearchTreeIteratorImp( TBinarySearchTreeImp<T>& tree,
                              TBinarySearchTreeBase::IteratorOrder
                              order = TBinarySearchTreeBase::InOrder )
```

Constructs an iterator object that traverses a *TBinarySearchTreeImp* container.

Public member functions

Current

```
const T& Current() const;
```

Returns the current object.

Restart

```
void Restart()
```

Restarts iteration from the beginning of the tree.

Operators

operator int

```
operator int() const;
```

Converts the iterator to an integer value for testing if objects remain in the iterator. The iterator converts to 0 if nothing remains in the iterator.

operator ++

```
const T& operator ++ ( int )
```

Moves to the next object in the tree, and returns the object that was current before the move (post-increment).

```
const T& operator ++ ()
```

Moves to the next object, and returns the object that was current after the move (pre-increment).

TIBinarySearchTreeImp template — binimp.h

```
template <class T> class TIBinarySearchTreeImp;
```

Implements an indirect unbalanced binary tree. Class *T* must have **<** and **==** operators, and must have a default constructor.

Public member functions

Add

```
int Add( T * t )
```

Creates a new binary-tree node and inserts a pointer to object *t* into the tree.

Detach

```
int Detach( T * t, int del = 0 )
```

Removes the node containing item *t* from the tree. The item is deleted if *del* is 1.

Find

```
T * Find( T * t ) const;
```

Returns a pointer to the node containing **t*.

Flush

```
void Flush(int del=0);
```

Removes all items from the tree. The are deleted if *del* is 1. If *del* is 0 the items are not deleted.

ForEach

```
void ForEach( IterFunc iter, void * args, IteratorOrder order = InOrder )
```

Creates an internal iterator that executes the given function *iter* for each item in the container. The *args* argument lets you pass arbitrary data to this function.

GetItemsInContainer

```
unsigned GetItemsInContainer();
```

Returns the number of items in the tree.

Parent::IsEmpty

```
int IsEmpty();
```

Returns 1 if the tree is empty; otherwise returns 0.

Protected member functions

EqualTo

```
virtual int EqualTo( BinNode *n1, BinNode *n2 )
```

Tests the equality between two nodes.

LessThan

```
virtual int LessThan( BinNode *n1, BinNode *n2 )
```

Tests if node *n1* is less than node *n2*.

DeleteNode

```
virtual void DeleteNode( BinNode *node, int del)
```

Deletes *node*. The second parameter is ignored.

TIBinarySearchTreeIteratorImp template binimp.h

```
template <class T> class TIBinarySearchTreeIteratorImp;
```

Implements an iterator that traverses *TIBinarySearchTreeImp* objects.

Public constructors

Constructor

```
TIBinarySearchTreeIteratorImp( TIBinarySearchTreeImp<T>& tree,
TBinarySearchTreeBase::IteratorOrder order =
TBinarySearchTreeBase::InOrder ) :
TBinarySearchTreeIteratorImp<TVoidPointer>(tree,order)
```

Constructs an iterator object that traverses a *TIBinarySearchTreeImp* container.

Public member functions

Current

```
T *Current() const;
```

Returns a pointer to the current object.

Restart

```
void Restart()
```

Restarts iteration from the beginning of the tree.

Operators

operator int

```
operator int() const;
```

Converts the iterator to an integer value for testing if objects remain in the iterator. The iterator converts to 0 if nothing remains in the iterator.

operator ++

```
T *operator ++ ( int i )
```

Moves to the next object in the tree, and returns a pointer to the object that was current before the move (post-increment).

```
T *operator ++ ()
```

Moves to the next object, and returns a pointer to the object that was current after the move (pre-increment).

TMDequeAsVector template — deques.h

```
template <class T, class Alloc> class TMDequeAsVector;
```

Implements a managed dequeue of *T* objects, using a vector as the underlying implementation.

Type definitions

CondFunc

```
typedef int ( *CondFunc)(const T &, void *);
```

Function type used as a parameter to *FirstThat* and *LastThat* member functions.

IterFunc

```
typedef void ( *IterFunc)(T &, void *);
```

Function type used as a parameter to *ForEach* member function.

Public constructors

Constructor

```
TMDequeAsVector( unsigned max = DEFAULT_DEQUE_SIZE )
```

Constructs a dequeue of *max* size.

Public member functions

FirstThat

```
T *FirstThat( CondFunc cond, void *args ) const;
```

Returns a pointer to the first object in the dequeue that satisfies a given condition. You supply a test-function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the array meets the condition.

See also: *LastThat*

Flush

```
void Flush()
```

Flushes the dequeue without destroying it.

See also: *TShouldDelete::ownsElements*

ForEach

```
void ForEach(IterFunc iter, void *args );
```

Executes function *iter* for each dequeue element. *ForEach* executes the given function *iter* for each element in the array. The *args* argument lets you pass arbitrary data to this function.

GetItemsInContainer

```
int GetItemsInContainer() const;
```

Returns the number of items in the dequeue.

GetLeft

```
T GetLeft();
```

Returns the object at the left end and removes it from the dequeue. The debuggable version throws an exception when the dequeue is empty.

See also: *PeekLeft*

GetRight

```
T GetRight();
```

Same as *GetLeft*, except that the right end of the dequeue is returned.

See also: *PeekRight*

IsEmpty

```
int IsEmpty() const;
```

Returns 1 if the dequeue has no elements; otherwise returns 0.

IsFull

```
int IsFull() const;
```

Returns 1 if the dequeue is full; otherwise returns 0.

LastThat

```
T *LastThat(CondFunc cond, void *args ) const;
```

Returns a pointer to the last object in the dequeue that satisfies a given condition. You supply a test function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the array meets the condition.

See also: *FirstThat*, *ForEach*

PeekLeft

```
const T& PeekLeft() const;
```

Returns the object at the left end (head) of the dequeue. The object stays in the dequeue.

See also: *GetLeft*

PeekRight

```
const T& PeekRight() const;
```

Returns the object at the right end (tail) of the dequeue. The object stays in the dequeue.

See also: *GetRight*

PutLeft

```
void PutLeft( const T& );
```

Adds (pushes) the given object at the left end (head) of the dequeue.

PutRight

```
void PutRight( const T& );
```

Adds (pushes) the given object at the right end (tail) of the dequeue.

Protected data members

Data

```
Vect Data;
```

The vector containing the dequeue's data.

Left

```
unsigned Left;
```

Index to the leftmost element of the dequeue.

Right

```
unsigned Right;
```

Index to the rightmost element of the dequeue.

Protected member functions

Next

```
unsigned Next( unsigned index ) const;
```

Returns *index* + 1. Wraps around to the head of the dequeue.

See also: *Prev*

Prev

```
unsigned Prev( unsigned index ) const;
```

Returns *index* – 1. Wraps around to the tail of the dequeue.

TMDequeAsVectorIterator template — deques.h

```
template <class T, class Alloc> class TMDequeAsVectorIterator;
```

Implements an iterator object for a managed, vector-based dequeue.

Public constructors

Constructor

```
TMDequeAsVectorIterator( const TMDequeAsVector<T,Alloc> &d )
```

Constructs an object that iterates on *TMDequeAsVector* objects.

Public member functions

Current

```
const T& Current();
```

Returns the current object.

Restart

```
void Restart();
```

Restarts iteration.

Operators

operator ++

```
const T& operator ++ ( int );
```

Moves to the next object, and returns the object that was current before the move (post-increment).

```
const T& operator ++ ();
```

Moves to the next object, and returns the object that was current after the move (pre-increment).

operator int

```
operator int();
```

Converts the iterator to an integer value for testing if objects remain in the iterator. Iterator converts to 0 if nothing remains in the iterator.

TDequeAsVector template — deques.h

```
template <class T> class TDequeAsVector;
```

Implements a dequeue of *T* objects, using a vector as the underlying implementation. *TStandardAllocator* is used to manage memory. See *TMDequeAsVector* on page 327 for members.

Public constructors

Constructor

```
TDequeAsVector( unsigned max = DEFAULT_DEQUE_SIZE )
```

Constructs a dequeue of *max* size.

TDequeAsVectorIterator template — deques.h

```
template <class T> class TDequeAsVectorIterator;
```

Implements an iterator object for a vector-based dequeue. See *TMDequeAsVectorIterator* on page 329 for members.

Public constructors

Constructor

```
TDequeAsVectorIterator( const TDequeAsVector<T> &d )
```

Constructs an object that iterates on *TMDequeAsVector* objects.

TMIDequeAsVector template — deques.h

```
template <class T, class Alloc> class TMIDequeAsVector;
```

Implements a managed, indirect dequeue of pointers to objects of type *T*, using a vector as the underlying implementation.

Type definitions

CondFunc

```
typedef int ( *CondFunc)(const T &, void *);
```

Function type used as a parameter to *FirstThat* and *LastThat* member functions.

IterFunc

```
typedef void ( *IterFunc)(T &, void *);
```

Function type used as a parameter to *ForEach* member function.

Public constructors

Constructor

```
TMIDequeAsVector( unsigned sz = DEFAULT_DEQUE_SIZE )
```

Constructs an indirect dequeue of *max* size.

Public member functions

FirstThat

```
T *FirstThat( CondFunc cond, void *args ) const;
```

Returns a pointer to the first object in the dequeue that satisfies a given condition. You supply a test-function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the array meets the condition.

See also: *LastThat*

Flush

```
void Flush( TShouldDelete::DeleteType = TShouldDelete::DefDelete );
```

Flushes the dequeue without destroying it. The fate of any objects removed depends on the current ownership status and the value of the *dt* argument.

ForEach

```
void ForEach(IterFunc iter, void *args );
```

Executes function *iter* for each dequeue element. *ForEach* executes the given function *iter* for each element in the array. The *args* argument lets you pass arbitrary data to this function.

GetItemsInContainer

```
int GetItemsInContainer() const;
```

Returns the number of items in the dequeue.

GetLeft

```
T *GetLeft()
```

Returns a pointer to the object at the left end and removes it from the dequeue. Returns 0 if the dequeue is empty.

See also: *PeekLeft*

GetRight

```
T *GetRight()
```

Same as *GetLeft*, except that the right end of the dequeue is returned.

See also: *PeekRight*

IsEmpty

```
int IsEmpty() const;
```

Returns 1 if a dequeue has no elements; otherwise returns 0.

IsFull

```
int isFull() const;
```

Returns 1 if a dequeue is full; otherwise returns 0.

LastThat

```
T *LastThat(CondFunc cond, void *args ) const;
```

Returns a pointer to the last object in the dequeue that satisfies a given condition. You supply a test function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the array meets the condition.

See also: *FirstThat, ForEach*

PeekLeft

```
T *PeekLeft() const;
```

Returns a pointer to the object at the left end (head) of the dequeue. The object stays in the dequeue.

See also: *GetLeft*

PeekRight

```
T *PeekRight() const;
```

Returns the object at the right end (tail) of the dequeue. The object stays in the dequeue.

See also: *GetRight*

PutLeft

```
void PutLeft( T *t )
```

Adds (pushes) the given object pointer at the left end (head) of the dequeue.

PutRight

```
void PutRight( T *t )
```

Adds (pushes) the given object pointer at the right end (tail) of the dequeue.

TMIDequeAsVectorIterator template — deques.h

```
template <class T, class Alloc> class TMIDequeAsVectorIterator;
```

Implements an iterator for the family of managed, indirect dequeues implemented as vectors. See *TMDequeAsVectorIterator* on page 329 for members.

Public constructors

Constructor

```
TMIDequeAsVectorIterator( const TMIDequeAsVector<T,Alloc> &d )
```

Creates an object that iterates on *TMIDequeAsVector* objects.

TIDequeAsVector template — deques.h

```
template <class T> class TIDequeAsVector;
```

Implements an indirect dequeue of pointers to objects of type *T*, using a vector as the underlying implementation. See *TMIDequeAsVector* on page 331 for members.

Public constructors

Constructor

```
TIDequeAsVector( unsigned sz = DEFAULT_DEQUE_SIZE ) :
TMIDequeAsVector<T,TStandardAllocator>(sz)
```

Constructs an indirect dequeue of *max* size.

TIDequeAsVectorIterator template — deques.h

```
template <class T> class TIDequeAsVectorIterator;
```

Implements an iterator for the family of indirect dequeues implemented as vectors. See *TMDequeAsVectorIterator* on page 329 for members.

Public constructors

Constructor

```
TIDequeAsVectorIterator( const TIDequeAsVector<T> &d )
```

Constructs an object that iterates on *TIDequeAsVector* objects.

TMDequeAsDoubleList template — deques.h

```
template <class T, class Alloc> class TMDequeAsDoubleList;
```

Implements a managed dequeue of objects of type *T*, using a double-linked list as the underlying implementation.

Type definitions

CondFunc

```
typedef int ( *CondFunc)(const T &, void *);
```

Function type used as a parameter to *FirstThat* and *LastThat* member functions.

IterFunc

```
typedef void ( *IterFunc)(T &, void *);
```

Function type used as a parameter to *ForEach* member function.

Public member functions

FirstThat

```
T *FirstThat( CondFunc cond, void *args ) const;
```

Returns a pointer to the first object in the dequeue that satisfies a given condition. You supply a test-function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the array meets the condition.

See also: *LastThat*

Flush

```
void Flush()
```

Flushes the dequeue without destroying it.

ForEach

```
void ForEach(IterFunc iter, void *args )
```

Executes function *iter* for each dequeue element. *ForEach* executes the given function *iter* for each element in the array. The *args* argument lets you pass arbitrary data to this function.

GetItemsInContainer

```
int GetItemsInContainer() const;
```

Returns the number of items in the dequeue.

GetLeft

```
T GetLeft()
```

Returns the object at the left end and removes it from the dequeue.

GetRight

```
T GetRight()
```

Same as *GetLeft*, except that the right end of the dequeue is returned.

See also: *PeekRight*

IsEmpty

```
int IsEmpty() const;
```

Returns 1 if a dequeue has no elements; otherwise returns 0.

IsFull

```
int IsFull() const;
```

Returns 1 if a dequeue is full; otherwise returns 0.

LastThat

```
T *LastThat(CondFunc cond, void *args ) const;
```

Returns a pointer to the last object in the dequeue that satisfies a given condition. You supply a test function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the array meets the condition.

See also: *FirstThat, ForEach*

PeekLeft

```
const T& PeekLeft() const;
```

Returns a reference to the object at the left end (head) of the dequeue. The object stays in the dequeue.

See also: *GetLeft*

PeekRight

```
const T& PeekRight() const;
```

Returns a reference to the object at the right end (tail) of the dequeue. The object stays in the dequeue.

See also: *GetRight*

PutLeft

```
void PutLeft( const T& t )
```

Adds (pushes) the given object at the left end (head) of the dequeue.

PutRight

```
void PutRight( const T& t )
```

Adds (pushes) the given object at the right end (tail) of the dequeue.

TMDequeAsDoubleListIterator template deques.h

```
template <class T, class Alloc> class TMDequeAsDoubleListIterator;
```

Implements an iterator object for a double-list based deques. See *TMDoubleListIteratorImp* on page 348 for members.

Public constructors

Constructor

```
TMDequeAsDoubleListIterator( const TMDequeAsDoubleList<T, Alloc> & s )
```

Constructs an object that iterates on *TMDequeAsDoubleList* objects.

TDequeAsDoubleList template deques.h

```
template <class T> class TDequeAsDoubleList;
```

Implements a dequeue of objects of type *T*, using a double-linked list as the underlying implementation, and *TStandardAllocator* as its memory manager. See *TMDequeAsDoubleList* on page 334 for members.

TDequeAsDoubleListIterator template deques.h

Implements an iterator object for a double-list based dequeue.

Public constructors

Constructor

```
TMDequeAsDoubleListIterator( const TMDequeAsDoubleList<T, Alloc> & s )
```

Constructs an object that iterates on *TDequeAsDoubleList* objects.

TMIDequeAsDoubleList template deques.h

```
template <class T, class Alloc> class TMIDequeAsDoubleList;
```

Implements a managed dequeue of pointers to objects of type *T*, using a double-linked list as the underlying implementation.

Type definitions

CondFunc

```
typedef int ( *CondFunc)(const T &, void *);
```

Function type used as a parameter to *FirstThat* and *LastThat* member functions.

IterFunc

```
typedef void ( *IterFunc)(T &, void *);
```

Function type used as a parameter to *ForEach* member function.

Public member functions

FirstThat

```
T *FirstThat( CondFunc cond, void *args ) const;
```

Returns a pointer to the first object in the dequeue that satisfies a given condition. You supply a test-function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the array meets the condition.

See also: *LastThat*

Flush

```
void Flush( TShouldDelete::DeleteType dt = TShouldDelete::DefDelete )
```

Flushes the dequeue without destroying it. The fate of any objects removed depends on the current ownership status and the value of the *dt* argument.

ForEach

```
void ForEach(IterFunc iter, void *args )
```

Executes function *iter* for each dequeue element. *ForEach* executes the given function *iter* for each element in the array. The *args* argument lets you pass arbitrary data to this function.

GetItemsInContainer

```
int GetItemsInContainer() const;
```

Returns the number of items in the dequeue.

GetLeft

```
T *GetLeft()
```

Returns a pointer to the object at the left end and removes it from the dequeue. Returns 0 if the dequeue is empty.

See also: *PeekLeft*

GetRight

```
T *GetRight()
```

Same as *GetLeft*, except that a pointer to the object at the right end of the dequeue is returned.

See also: *PeekRight*

IsEmpty

```
int IsEmpty() const;
```

Returns 1 if the dequeue has no elements; otherwise returns 0.

IsFull

```
int IsFull() const;
```

Returns 1 if the dequeue is full; otherwise returns 0.

LastThat

```
T *LastThat(CondFunc cond, void *args ) const;
```

Returns a pointer to the last object in the dequeue that satisfies a given condition. You supply a test function pointer, *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the array meets the condition.

See also: *FirstThat, ForEach*

PeekLeft

```
T *PeekLeft() const;
```

Returns a pointer to the object at the left end (head) of the dequeue. The object stays in the dequeue.

PeekRight

```
T *PeekRight() const;
```

Returns the object at the right end (tail) of the dequeue. The object stays in the dequeue.

PutLeft

```
void PutLeft( T *t )
```

Adds (pushes) the given object pointer at the left end (head) of the dequeue.

PutRight

```
void PutRight( T *t )
```

Adds (pushes) the given object pointer at the right end (tail) of the dequeue.

TMIDequeAsDoubleListIterator template — deques.h

```
template <class T, class Alloc> class TMIDequeAsDoubleListIterator;
```

Implements an iterator for the family of managed, indirect dequeues implemented as double lists. See *TMDoubleListIteratorImp* on page 348 for members.

Public constructors

Constructor

```
TMIDequeAsDoubleListIterator( const TMIDequeAsDoubleList<T,Alloc> s )
```

Constructs an object that iterates on *TMIDequeAsDoubleList* objects.

TIDequeAsDoubleList template — deques.h

```
template <class T> class TIDequeAsDoubleList;
```

Implements a dequeue of pointers to objects of type *T*, using a double-linked list as the underlying implementation. See *TMIDequeAsDoubleList* on page 336 for members.

TIDequeAsDoubleListIterator template — deques.h

```
template <class T> class TIDequeAsDoubleListIterator;
```

Implements an iterator for the family of indirect dequeues implemented as double lists. See *TMDoubleListIteratorImp* on page 348 for members.

Public constructors

Constructor

```
TIDequeAsDoubleListIterator( const TIDequeAsDoubleList<T> & s )
```

Constructs an object that iterates on *TIDequeAsDoubleList* objects.

TMDictionaryAsHashTable template — dict.h

```
template <class T, class A> class TMDictionaryAsHashTable;
```

Implements a managed dictionary using a hash table as the underlying FDS, and using the user-supplied storage allocator *A*. It assumes that *T* is one of the four types of associations, and that *T* has meaningful copy and == semantics as well as a default constructor.

Protected data members

HashTable

```
TMHashTableImp<T,A> HashTable;
```

Implements the underlying hash table.

Public constructors

Constructor

```
TMDictionaryAsHashTable( unsigned size = DEFAULT_HASH_TABLE_SIZE )
```

Constructs a dictionary with the specified *size*.

Public member functions

Add

```
int Add( const T& t )
```

Adds item *t* if not already in the dictionary.

Detach

```
int Detach( const T& t, DeleteType dt = DefDelete )
```

Removes item *t* from the dictionary. Calls *DeleteElements* on the association.

Find

```
T * Find( constT& t )
```

Returns a pointer to item *t*.

Flush

```
void Flush( DeleteType dt = DefDelete )
```

Removes all items from the dictionary. Calls *DeleteElements* on the association.

ForEach

```
void ForEach( IterFunc iter, void * args )
```

Creates an internal iterator that executes the given function *iter* for each item in the container. The *args* argument lets you pass arbitrary data to this function.

GetItemsInContainer

```
inline unsigned GetItemsInContainer()
```

Returns the number of items in the dictionary.

IsEmpty

```
inline int IsEmpty()
```

Returns 1 if the dictionary is empty; otherwise returns 0.

TMDictionaryAsHashTableIterator template — dict.h

```
template <class T, class A> class TMDictionaryAsHashTableIterator;
```

Implements an iterator that traverses *TMDictionaryAsHashTable* objects, using the user-supplied storage allocator *A*.

Public constructors

Constructor

```
TMDictionaryAsHashTableIterator(TMDictionaryAsHashTable<T,A> & t )
```

Constructs an iterator object that traverses a *TMDictionaryAsHashTable* container.

Public member functions

Current

```
const T& Current()
```

Returns the current object.

Restart

```
void Restart();
```

Restarts iteration from the beginning of the dictionary.

Operators

operator int

```
operator int()
```

Converts the iterator to an integer value for testing if objects remain in the iterator. The iterator converts to 0 if nothing remains in the iterator.

operator ++

```
const T& operator ++ (int)
```

Moves to the next object, and returns the object that was current before the move (post-increment).

```
const T& operator ++ ()
```

Moves to the next object, and returns the object that was current after the move (pre-increment).

TDictionaryAsHashTable template — dict.h

```
template <class T> class TDictionaryAsHashTable;
```

Implements a dictionary objects of type *T*, using the system storage allocator *TStandardAllocator*. It assumes that *T* is one of the four types of associations, and that *T* has meaningful copy and == semantics as well as a default constructor. See *TMDictionaryAsHashTable* on page 339 for members.

Public constructors

Constructor

```
TDictionaryAsHashTable( unsigned size = DEFAULT_HASH_TABLE_SIZE )
```

Constructs a dictionary with the specified *size*.

TDictionaryAsHashTableIterator template — dict.h

```
template <class T> class TDictionaryAsHashTableIterator;
```

Implements an iterator that traverses *TDictionaryAsHashTable* objects, using the system storage allocator *TStandardAllocator*.

Public constructors

Constructor

```
TDictionaryAsHashTableIterator( TDictionaryAsHashTable<T> & t )
```

Constructs an iterator object that traverses a *TDictionaryAsHashTable* container.

TMIDictionaryAsHashTable template — dict.h

```
template <class T, class A> class TMIDictionaryAsHashTable;
```

Implements a managed indirect dictionary using a hash table as the underlying FDS, and using the user-supplied storage allocator *A*. It assumes that *T* is of class *TAssociation*.

Public constructors

Constructor

```
TMIDictionaryAsHashTable( unsigned size = DEFAULT_HASH_TABLE_SIZE )
```

Constructs an indirect dictionary with the specified *size*.

Public member functions

Add

```
int Add( T * t )
```

Adds a pointer to item *t* if not already in the dictionary.

Detach

```
int Detach( T * t, int del = 0 )
```

Removes the pointer to item *t* from the dictionary, and deletes if *del* is 1. If *del* is 0 the item is not deleted.

Find

```
T * Find( T * t )
```

Returns a pointer to item *t*.

Flush

```
void Flush( int del = 0 )
```

Removes all items from the dictionary. The item is deleted if *del* is 1. If *del* is 0 the item is not deleted.

ForEach

```
void ForEach( IterFunc iter, void * args );
```

Creates an internal iterator that executes the given function *iter* for each item in the container. The *args* argument lets you pass arbitrary data to this function.

GetItemsInContainer

```
inline unsigned GetItemsInContainer()
```

Returns the number of items in the dictionary.

IsEmpty

```
inline int IsEmpty()
```

Returns 1 if the dictionary is empty; otherwise returns 0.

TMIDictionaryAsHashTableIterator template — dict.h

```
template <class T, class A> class TMIDictionaryAsHashTableIterator;
```

Implements an iterator that traverses *TMIDictionaryAsHashTable* objects, using the user-supplied storage allocator *A*.

Public constructors

Constructor

```
TMIDictionaryAsHashTableIterator( TMIDictionaryAsHashTable<T,A> & t )
```

Constructs an iterator object that traverses a *TMIDictionaryAsHashTable* container.

Public member functions

Current

```
T *Current()
```

Returns a pointer to the current object.

Restart

```
void Restart();
```

Restarts iteration from the beginning of the dictionary.

Operators

operator int

```
operator int()
```

Converts the iterator to an integer value for testing if objects remain in the iterator. The iterator converts to 0 if nothing remains in the iterator.

operator ++

```
T *operator ++ (int)
```

Moves to the next object, and returns a pointer to the object that was current before the move (post-increment).

```
T *operator ++ ()
```

Moves to the next object, and returns a pointer to the object that was current after the move (pre-increment).

TIDictionaryAsHashTable template — dict.h

```
template <class T> class TIDictionaryAsHashTable;
```

Implements an indirect dictionary using a hash table as the underlying FDS, and using the system storage allocator *TStandardAllocator*. It assumes that *T* is one of the four types of associations. See *TMIDictionaryAsHashTable* on page 342 for members.

Public constructors

Constructor

```
TIDictionaryAsHashTable( unsigned size = DEFAULT_HASH_TABLE_SIZE )
```

Constructs an indirect dictionary with the specified *size*.

TIDictionaryAsHashTableIterator template — dict.h

```
template <class T> class TIDictionaryAsHashTableIterator;
```

Implements an iterator that traverses *TIDictionaryAsHashTable* objects, using the user-supplied storage allocator *A*. See *TMIDictionaryAsHashTableIterator* on page 343 for members.

Public constructors

Constructor

```
TIDictionaryAsHashTableIterator( TIDictionaryAsHashTable<T> & t )
```

Constructs an iterator object that traverses a *TIDictionaryAsHashTable* container.

TDictionary template — dict.h

A simplified name for *TDictionaryAsHashTable*. See *TDictionaryAsHashTable* on page 341 for members.

TDictionaryIterator template — dict.h

A simplified name for *TDictionaryAsHashTableIterator*. See *TDictionaryAsHashTableIterator* on page 342 for members.

Public constructors

Constructor

```
TDictionaryIterator( const TDictionary<T> & a )
```

Constructs an iterator object that traverses a *TDictionary* container.

TMDoubleListElement template — dlistimp.h

```
template <class T, class Alloc> class TMDoubleListElement;
```

This class defines the nodes for double-list classes *TMDoubleListImp* and *TMIDoubleListImp*.

Public data members

data

```
T data;
```

Data object contained in the double list.

Next

```
TMDoubleListElement<T> *Next;
```

A pointer to the next element in the double list.

Prev

```
TMDoubleListElement<T> *Prev;
```

A pointer to the previous element in the double list.

Public constructors

Constructor

```
TMDoubleListElement();
```

Constructs a double-list element.

Constructor

```
TMDoubleListElement( T& t, TMDoubleListElement<T> *p )
```

Constructs a double-list element, and inserts after the object pointed to by *p*.

Operators

operator delete

```
void operator delete( void * );
```

Deletes an object.

operator new

```
void *operator new( size_t sz );
```

Allocates a memory block of *sz* amount, and returns a pointer to the memory block.

TMDoubleListImp template — dlistimp.h

```
template <class T, class Alloc> class TMDoubleListImp;
```

Implements a managed, double-linked list of objects of type *T*. Assumes that *T* has meaningful copy semantics, operator **==**, and a default constructor. The memory manager *Alloc* provides class-specific **new** and **delete** operators.

Type definitions

CondFunc

```
typedef int ( *CondFunc)(const T &, void *);
```

Function type used as a parameter to *FirstThat* and *LastThat* member functions.

IterFunc

```
typedef void ( *IterFunc)(T &, void *);
```

Function type used as a parameter to *ForEach* member function.

Public constructors

Constructor

```
TMDoubleListImp()
```

Constructs an empty, managed, double-linked list.

Public member functions

Add

```
int Add( const T& t );
```

Add the given object at the beginning of the list.

AddAtHead

```
int AddAtHead( const T& t );
```

Add the given object at the beginning of the list.

AddAtTail

```
int AddAtTail( const T& );
```

Adds the given object at the end (tail) the list.

Detach

```
int Detach( const T& );
```

Removes the first occurrence of the given object encountered by searching from the beginning of the list.

DetachAtHead

```
int DetachAtHead( );
```

Removes items from the head of a list without searching for a match.

FirstThat

```
T *FirstThat( CondFunc cond, void *args) const;
```

Returns a pointer to the first object in the double-list that satisfies a given condition. You supply a test-function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the array meets the condition.

Flush

```
void Flush();
```

Removes all elements from the list without destroying the list.

ForEach

```
void ForEach(IterFunc iter, void *args );
```

ForEach executes the given function *iter* for each element in the array. The *args* argument lets you pass arbitrary data to this function.

IsEmpty

```
int IsEmpty() const;
```

Returns 1 if array contains no elements; otherwise returns 0.

LastThat

```
T *LastThat( CondFunc cond, void *args ) const;
```

Returns a pointer to the last object in the double list that satisfies a given condition. You supply a test function pointer *cond* that returns true for a

certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the array meets the condition.

See also: *FirstThat, ForEach*

PeekHead

```
const T& PeekHead() const;
```

Returns a reference to the *Head* item in the double list, without removing it.

PeekTail

```
const T& PeekTail() const;
```

Returns a reference to the *Tail* item in the double list, without removing it.

Protected data members

Head,Tail

```
TMDoubleListElement<T> Head, Tail;
```

The head and tail items of the double list.

Protected member functions

FindDetach

```
virtual TMDoubleListElement<T> *FindDetach( const T& t )
```

Determines whether an object is in the list, and returns a pointer to its predecessor. Returns 0 if not found.

FindPred

```
virtual TMDoubleListElement<T> *FindPred( const T& );
```

Finds the element that would be followed by the parameter. The function does not check whether the parameter is actually there. This can be used for inserting (insert after returned element pointer).

TMDoubleListIteratorImp template — dlistimp.h

```
template <class T, class Alloc> class TMDoubleListIterator;
```

Implements a double list iterator. This iterator works with any direct double-linked list. For indirect lists, see *TMIDoubleListIteratorImp* on page 354.

Public constructors

Constructor

```
TMDoubleListIteratorImp( const TMDoubleListImp<T, Alloc> &l )
```

Constructs an iterator that traverses *TMDoubleListImp* objects.

```
TMDoubleListIteratorImp( const TMSDoubleListImp<T, Alloc> &l )
```

Constructs an iterator that traverses *TMDoubleListImp* objects.

Public member functions

Current

```
const T& Current()
```

Returns the current object.

Restart

```
void Restart()
```

Restarts iteration from the beginning of the list.

Operators

operator int

```
operator int()
```

Converts the iterator to an integer value for testing if objects remain in the iterator. The iterator converts to 0 if nothing remains in the iterator.

operator ++

```
const T& operator ++ ( int )
```

Moves to the next object, and returns the object that was current before the move (post-increment).

```
const T& operator ++ ()
```

Moves to the next object, and returns the object that was current after the move (pre-increment).

operator – –

```
const T& operator -- ( int )
```

Moves to the previous object, and returns the object that was current before the move (post-decrement).

```
const T& operator -- ()
```

Moves to the previous object, and returns the object that was current after the move (pre-decrement).

TDoubleListImp template — dlistimp.h

```
template <class T> class TDoubleListImp;
```

Implements a double-linked list of objects of type *T*, using *TStandardAllocator* for memory management. Assumes that *T* has meaningful copy semantics and a default constructor. See *TMDoubleListImp* on page 346 for members.

Public constructors

Constructor

```
TDoubleListImp()
```

Constructs an empty double-linked list.

TDoubleListIteratorImp template — dlistimp.h

```
template <class T> class TDoubleListIteratorImp;
```

Implements a double list iterator. This iterator works with any direct double-linked list. See *TMDoubleListIteratorImp* on page 348 for members.

Public constructors

Constructor

```
TDoubleListIteratorImp( const TDoubleListImp<T> &l )
```

Constructs an iterator that traverses *TDoubleListImp* objects.

TMSDoubleListImp template — dlistimp.h

```
template <class T, class Alloc> class TMSDoubleListImp;
```

Implements a managed, sorted, double-linked list of objects of type *T*. It assumes that *T* has meaningful copy semantics, a **==** operator, a **<** operator, and a default constructor. See *TMDoubleListImp* on page 346 for members.

Protected member functions

In addition to the following member functions, *TMSDoubleListImp* inherits member functions from *TMDoubleListImp* (see page 346).

FindDetach

```
virtual TMDoubleListElement<T> *FindDetach( const T& );
```

Determines whether an object is in the list, and returns a pointer to its predecessor. Returns 0 if not found.

FindPred

```
virtual TMDoubleListElement<T> *FindPred( const T& );
```

Finds the element that would be followed by the parameter. The function does not check whether the parameter is actually there. This can be used for inserting (insert after returned element pointer).

TMSDoubleListIteratorImp template dlistimp.h

```
template <class T, class Alloc> class TMSDoubleListIteratorImp;
```

Implements a double list iterator. This iterator works with any direct double-linked list. See *TMDoubleListIteratorImp* on page 348 for members.

Public constructors

Constructor

```
TMSDoubleListIteratorImp( const TMSDoubleListImp<T,Alloc> &l )
```

Constructs an iterator that traverses *TMSDoubleListImp* objects.

TSDoubleListImp template dlistimp.h

```
template <class T> class TSDoubleListImp;
```

Implements a sorted, double-linked list of objects of type *T*. It assumes that *T* has meaningful copy semantics, a meaningful < operator, and a default constructor. See *TMSDoubleListImp* on page 350 for members.

TSDoubleListIteratorImp template dlistimp.h

```
template <class T> class TSDoubleListIteratorImp;
```

Implements a double list iterator. This iterator works with any direct double-linked list. See *TMDoubleListIteratorImp* on page 348 for members.

Public constructors

Constructor

```
TSDoubleListIteratorImp( const TSDoubleListImp<T> &l )
```

Constructs an iterator that traverses *TSDoubleListImp* objects.

TMIDoubleListImp template — dlistimp.h

```
template <classT, class Alloc> class TMIDoubleListImp;
```

Implements a managed, double-linked list of pointers to objects of type *T*.The contained objects need a valid **==** operator. Because pointers always have meaningful copy semantics, this class can handle any type of object. The memory manager *Alloc* provides class-specific **new** and **delete** operators.

Type definitions

CondFunc

```
typedef int ( *CondFunc)(const T &, void *);
```

Function type used as a parameter to *FirstThat* and *LastThat* member functions.

IterFunc

```
typedef void ( *IterFunc)(T &, void *);
```

Function type used as a parameter to *ForEach* member function.

Public member functions

Add

```
int Add( T *t )
```

Adds an object pointer to the double list.

AddAtHead

```
int AddAtHead( T *t );
```

Add the given object at the beginning of the list.

AddAtTail

```
int AddAtTail( T *t )
```

Adds an object pointer to the tail of the double list.

Detach

```
int Detach( T *t, int del = 0 )
```

Removes the given object pointer from the list. The second argument specifies whether the object should be deleted.

DetachAtHead

```
int DetachAtHead( int del = 0 )
```

Deletes the object pointer from the head of the list.

DetachAtTail

```
int DetachAtTail( int del = 0 )
```

Deletes the object pointer from the tail of the list.

FirstThat

```
T *FirstThat( CondFunc cond, void *args ) const;
```

Returns a pointer to the first object in the double list that satisfies a given condition. You supply a test-function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the array meets the condition.

See also: *LastThat*

Flush

```
void Flush( int = 0 );
```

Removes all elements from the list without destroying the list.

ForEach

```
void ForEach(IterFunc iter, void * args );
```

Executes function *iter* for each double-list element. *ForEach* executes the given function *iter* for each element in the array. The *args* argument lets you pass arbitrary data to this function.

GetItemsInContainer

```
unsigned GetItemsInContainer() const;
```

Returns the number of items in the array.

IsEmpty

```
int IsEmpty() const;
```

Returns 1 if array contains no elements; otherwise returns 0.

LastThat

```
T *LastThat( CondFunc cond, void *args) const;
```

Returns a pointer to the last object in the list that satisfies a given condition. You supply a test function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the array meets the condition.

See also: *FirstThat, ForEach*

PeekHead

```
T *PeekHead() const;
```

Returns the object pointer at the *Head* of the list, without removing it.

PeekTail

```
T *PeekTail() const;
```

Returns the object pointer at the *Tail* of the list, without removing it.

Protected member functions

FindPred

```
virtual TDoubleListElement<void *> *FindPred( void * );
```

Finds the element that would be followed by the parameter. The function does not check whether the parameter is actually there. This can be used for inserting (insert after returned element pointer).

TMIDoubleListIteratorImp template — dlistimp.h

```
template <class T, class Alloc> class TMIDoubleListIteratorImp;
```

Implements a double list iterator. This iterator works with any indirect double list. For direct lists, see *TMDoubleListIteratorImp* on page 348.

Public constructors

Constructor

```
TMIDoubleListIteratorImp( const TMIDoubleListImp<T,Alloc> &l )
```

Constructs an object that iterates on *TIDoubleListImp* objects.

Public member functions

Current

```
T *Current()
```

Returns the current object pointer.

Restart

```
void Restart()
```

Restarts iteration from the beginning of the list.

Operators

operator ++

```
T *operator ++ (int)
```

Moves to the next object, and returns the object that was current before the move (post-increment).

```
T *operator ++ ()
```

Moves to the next object, and returns the object that was current after the move (pre-increment).

TIDoubleListImp template — dlistimp.h

```
template <class T> class TIDoubleListImp;
```

Implements a double-linked list of pointers to objects of type *T*, using *TStandardAllocator* for memory management. Because pointers always have meaningful copy semantics, this class can handle any type of object. See *TMIDoubleListImp* on page 352 for members.

TIDoubleListIteratorImp template — dlistimp.h

```
template <class T> class TIDoubleListIteratorImp;
```

Implements a double list iterator. This iterator works with any indirect double list. See *TMIDoubleListIteratorImp* on page 354 for members.

Public constructors

Constructor

```
TIDoubleListIteratorImp( const TIDoubleListImp<T> &l )
```

Constructs an object that iterates on *TIDoubleListImp* objects.

TMISDoubleListImp template — dlistimp.h

```
template <class T, class Alloc> class TMISDoubleListImp;
```

Implements a managed, sorted, double-linked list of pointers to objects of type *T*. Because pointers always have meaningful copy semantics, this class can handle any type of object.

Protected member functions

In addition to the member function described here, *TMISDoubleListImp* inherits member functions (see *TMIDoubleListImp* on page 352).

FindDetach

```
virtual TMDoubleListElement<void *> *FindDetach( void * );
```

Determines whether an object is in the list, and returns a pointer to its predecessor.

TMISDoubleListIteratorImp template — dlistimp.h

```
template <class T, class Alloc> class TMISDoubleListIteratorImp;
```

Implements a double list iterator. This iterator works with any indirect, sorted double list. See *TMIDoubleListIteratorImp* on page 354 for members.

Public constructors

Constructor

```
TMISDoubleListIteratorImp( const TMISDoubleListImp<T,Alloc> &l )
```

Constructs an object that iterates on *TMISDoubleListImp* objects.

TISDoubleListImp template — dlistimp.h

```
template <class T> class TISDoubleListImp;
```

Implements a sorted, double-linked list of pointers to objects of type *T*, using *TStandardAllocator* for memory management. Because pointers always have meaningful copy semantics, this class can handle any type of object. See *TMIDoubleListImp* on page 352 for members.

TISDoubleListIteratorImp template — dlistimp.h

```
template <class T> class TISDoubleListIteratorImp;
```

Implements a double list iterator. This iterator works with any indirect, sorted double list. See *TMIDoubleListIteratorImp* on page 354 for members.

Public constructors

Constructor

```
TISDoubleListIteratorImp( const TISDoubleListImp<T> &l )
```

Constructs an object that iterates on *TMISDoubleListImp* objects.

TMHashTableImp template — hashimp.h

```
template <class T, class Alloc> class TMHashTableImp;
```

Implements a managed hash table of objects of type *T*, using the user-supplied storage allocator *A*. It assumes that *T* has meaningful copy and == semantics, as well as a default constructor.

Public constructors and destructor

Constructor

```
TMHashTableImp( unsigned aPrime = DEFAULT_HASH_TABLE_SIZE )
```

Constructs a hash table.

Public member functions

Add

```
int Add( const T& t );
```

Adds item *t* to the hash table.

Detach

```
int Detach( const T& t, int del=0 );
```

Removes item *t* from the hash table. If *del* is set to 0, *t* is deleted; if *del* is set to 1, *t* is not deleted.

Find

```
T * Find( const T& t ) const;
```

Returns a pointer to item *t*.

Flush

```
void Flush()
```

Flushes all items in the hash table. The hash table is destroyed if *del* is nonzero.

ForEach

```
void ForEach( IterFunc iter, void *args);
```

Creates an internal iterator that executes the given function *iter* for each item in the container. The *args* argument lets you pass arbitrary data to this function.

GetItemsInContainer

```
unsigned GetItemsInContainer() const;
```

Returns the number of items in the hash table.

IsEmpty

```
int IsEmpty() const;
```

Returns 1 if the hash table is empty; otherwise returns 0.

TMHashTableIteratorImp template — hashimp.h

```
template <class T, class Alloc> class TMHashTableIteratorImp;
```

Implements an iterator for traversing *TMHashTableImp* containers, using the user-supplied storage allocator *Alloc*.

Public constructors and destructor

Constructor

```
TMHashTableIteratorImp( const TMHashTableImp<T,A> & h )
```

Constructs an iterator object that traverses a *TMHashTableImp* container.

Destructor

```
~TMHashTableIteratorImp()
```

Destroys the iterator.

Public member functions

Current

```
const T& Current()
```

Returns the current object.

Restart

```
void Restart();
```

Restarts iteration from the beginning of the hash table.

Operators

operator int

```
operator int()
```

Converts the iterator to an integer value for testing if objects remain in the iterator. The iterator converts to 0 if nothing remains in the iterator.

operator ++

```
const T& operator ++ (int)
```

Moves to the next object, and returns the object that was current before the move (post-increment).

```
const T& operator ++ ()
```

Moves to the next object, and returns the object that was current after the move (pre-increment).

THashTableImp template — hashimp.h

```
template <class T> class THashTableImp;
```

Implements a hash table of objects of type *T*, using the system storage allocator *TStandardAllocator*. It assumes that *T* has meaningful copy and == semantics as well as a default constructor. See *TMHashTableImp* on page 356 for members.

Public constructors

Constructor

```
THashTableImp( unsigned aPrime = DEFAULT_HASH_TABLE_SIZE )
```

Constructs a hash table that uses *TStandardAllocator* for memory management.

THashTableIteratorImp template — hashimp.h

```
template <class T> class THashTableIteratorImp;
```

Implements an iterator for traversing *THashTableImp* containers. See *TMHashTableIteratorImp* on page 357 for members.

Public constructors

Constructor

```
THashTableIteratorImp( const THashTableImp<T,A> & h )
```

Constructs an iterator object that traverses a *THashTableImp* container.

TMIHashTableImp template — hashimp.h

```
template <class T, class Alloc> class TMIHashTableImp;
```

Implements a managed hash table of pointers to objects of type *T*, using the user-supplied storage allocator *Alloc*.

Public constructors

Constructor

```
TMIHashTableImp( unsigned aPrime = DEFAULT_HASH_TABLE_SIZE )
```

Constructs an indirect hash table.

Public member functions

Add

```
int Add( T * t )
```

Adds a pointer to item *t* to the hash table.

Detach

```
int Detach( T * t, int del = 0 )
```

Removes a pointer to item *t* from the hash table. *t* is deleted if *del* is set 1, and not deleted if *del* is set to 0.

Find

```
T * Find( const T * t ) const;
```

Returns a pointer to item *t*.

Flush

```
void Flush( int del = 0 )
```

Flushes all items in the hash table. The hash table is destroyed if *del* is nonzero.

ForEach

```
void ForEach( IterFunc iter, void *args);
```

Creates an internal iterator that executes the given function *iter* for each item in the container. The *args* argument lets you pass arbitrary data to this function.

GetItemsInContainer

```
unsigned GetItemsInContainer() const;
```

Returns the number of items in the hash table.

IsEmpty

```
int IsEmpty() const;
```

Returns 1 if the hash table is empty; otherwise returns 0.

TMIHashTableIteratorImp template — hashimp.h

```
template <class T, class Alloc> class TMIHashTableIteratorImp;
```

Implements an iterator for traversing *TMIHashTableImp* containers.

Public constructors

Constructor

```
TMIHashTableIteratorImp( const TMIHashTableImp<T,A> & h )
```

Constructs an iterator object that traverses a *TMIHashTableImp* container.

Public member functions

Current

```
T *Current()
```

Returns a pointer to the current object.

Restart

```
void Restart();
```

Restarts iteration from the beginning of the hash table.

Operators

operator int

```
operator int()
```

Converts the iterator to an integer value for testing if objects remain in the iterator. The iterator converts to 0 if nothing remains in the iterator.

operator ++

```
T *operator ++ (int)
```

Moves to the next object, and returns the object pointer that was current before the move (post-increment).

```
T *operator ++ ()
```

Moves to the next object, and returns the object pointer that was current after the move (pre-increment).

TIHashTableImp template — hashimp.h

```
template <class T> class TIHashTableImp;
```

Implements a hash table of pointers to objects of type *T*, using the system storage allocator *TStandardAllocator*. See *TMIHashTableImp* on page 359 for members.

Public constructors

Constructor

```
TIHashTableImp( unsigned aPrime = DEFAULT_HASH_TABLE_SIZE )
```

Constructs an indirect hash table that uses the system storage allocator.

TIHashTableIteratorImp template — hashimp.h

```
template <class T> class TIHashTableIteratorImp;
```

Implements an iterator object that traverses *TIHashTableImp* containers, and uses the system memory allocator *TStandardAllocator*. See *TMIHashTableIteratorImp* on page 360 for members.

Public constructors

Constructor

```
TIHashTableIteratorImp( const TIHashTableImp<T> & h )
```

TMListElement template — listimp.h

```
template <class T, class Alloc> class TMListElement;
```

This class defines the nodes for *TMListImp* and *TMIListImp* and related classes.

Public data members

data

```
T Data;
```

Data object contained in the list.

Next

```
TMListElement<T,Alloc> *Next;
```

A pointer to the next element in the list.

Public constructors

Constructor

```
TMListElement();
```

Constructs a list element.

Constructor

```
TMListElement( T& t, TMListElement<T,Alloc> *p )
```

Constructs a list element, and places it after the object at location *p*.

Operators

operator delete

```
void operator delete( void * );
```

Deletes an object.

operator new

```
void *operator new( size_t sz );
```

Allocates a memory block of *sz* amount, and returns a pointer to the memory block.

TMListImp template — listimp.h

```
template <class T, class Alloc> class TMListImp;
```

Implements a managed list of objects of type *T*. *TMListImp* assumes that *T* has meaningful copy semantics, and a default constructor.

Type definitions

CondFunc

```
typedef int ( *CondFunc)(const T &, void *);
```

Function type used as a parameter to *FirstThat* and *LastThat* member functions.

IterFunc

```
typedef void ( *IterFunc)(T &, void *);
```

Function type used as a parameter to *ForEach* member function.

Public constructors

Constructor

```
TMListImp()
```

Constructs an empty list.

Example

```
TMListImp< MyObject, TStandardAllocator > list;  // Create list to hold
MyObjects
list.Add(MyObject() );     // Construct a MyObject, add to list
list.Add(MyObject() );     // Add a second MyObject
list.DetachAtHead() );     // Remove MyObject as head of list
```

Public member functions

Add

```
int Add( const T& t );
```

Adds an object to the list.

Detach

```
int Detach( const T&);
```

Removes the given object from the list. Returns 0 for failure, 1 for success in removing the object. See *TShouldDelete* on page 408.

DetachAtHead

```
int DetachAtHead( );
```

Removes items from the head of a list without searching for a match.

FirstThat

```
T *FirstThat( CondFunc cond, void *args ) const;
```

Returns a pointer to the first object in the list that satisfies a given condition. You supply a test-function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the array meets the condition.

See also: *LastThat*

Flush

```
void Flush();
```

Flushes the list without destroying it.

ForEach

```
void ForEach(IterFunc iter, void * args );
```

Executes function *iter* for list element. *ForEach* executes the given function *iter* for each element in the array. The *args* argument lets you pass arbitrary data to this function.

IsEmpty

```
int IsEmpty() const;
```

Returns 1 if the list has no elements; otherwise returns 0.

LastThat

```
T *LastThat( CondFunc cond, void *args) const;
```

Returns a pointer to the last object in the list that satisfies a given condition. You supply a test function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the list meets the condition.

See also: *FirstThat*, *ForEach*

PeekHead

```
const T& PeekHead() const;
```

Returns a reference to the *Head* item in the list, without removing it.

Protected data members

Head, Tail

```
TMListElement<T,Alloc> Head, Tail;
```

The elements before the first and after the last elements in the list.

Protected member functions

FindDetach

```
virtual TMListElement<T,Alloc> *FindDetach( const T& t )
```

Determines whether an object is in the list, and returns a pointer to its predecessor. Returns 0 if not found.

FindPred

```
virtual TMListElement<T,Alloc> *FindPred( const T& );
```

Finds the element that would be followed by the parameter. The function does not check whether the parameter is actually there. This can be used for inserting (insert after returned element pointer).

TMListIteratorImp template — listimp.h

```
template <class T, class Alloc> class TMListIteratorImp;
```

Implements a list iterator that works on direct, managed list. For indirect list iteration see *TMIListIteratorImp* on page 368.

Public constructors

Constructor

```
TMListIteratorImp(const TMListImp<T,Alloc> &l)
```

Constructs an iterator that traverses *TMListImp* objects.

Public member functions

Current

```
const T& Current()
```

Returns the current object.

Restart

```
void Restart()
```

Restarts iteration from the beginning of the list.

Operators

operator int

```
operator int();
```

Converts the iterator to an integer value for testing if objects remain in the iterator. The iterator converts to 0 if nothing remains in the iterator.

operator ++

```
const T& operator ++ ( int )
```

Moves to the next object, and returns the object that was current before the move (post-increment).

```
const T& operator ++ ()
```

Moves to the next object, and returns the object that was current after the move (pre-increment).

TListImp template — listimp.h

```
template <class T> class TListImp;
```

Implements a list of objects of type *T*. *TListImp* assumes that *T* has meaningful copy semantics, and a default constructor. See *TMListImp* on page 362 for members.

TListIteratorImp template — listimp.h

```
template <class T> class TListIteratorImp;
```

Implements a list iterator that works on direct, managed list. See *TMListIteratorImp* on page 364 for members.

Public constructors

Constructor

```
TListIteratorImp( const TMListImp<T, TStandardAllocator> &l )
```

Constructs an iterator that traverses *TListImp* objects.

TMSListImp template — listimp.h

```
template <class T, class Alloc> class TMSListImp;
```

Implements a managed, sorted list of objects of type *T*. *TMSListImp* assumes that T has meaningful copy semantics, a meaningful < operator, and a default constructor. See *TMListImp* on page 362 for members.

TMSListIteratorImp template — listimp.h

```
template <class T, class Alloc> class TMSListIteratorImp;
```

Implements a list iterator that works on direct, managed, sorted list. See *TMListIteratorImp* on page 364 for members.

Public constructors

Constructor

```
TMSListIteratorImp( const TMSListImp<T,Alloc> &l )
```

Constructs an iterator that traverses *TMSListImp* objects.

TSListImp template — listimp.h

```
template <class T> class TSListImp;
```

Implements a sorted list of objects of type *T*, using *TStandardAllocator* for memory management. *TSListImp* assumes that T has meaningful copy semantics, a meaningful < operator, and a default constructor. See *TMListImp* on page 362 for members.

TSListIteratorImp template — listimp.h

```
template <class T> class TSListIteratorImp;
```

Implements a list iterator that works on direct, sorted list. See *TMListIteratorImp* on page 364 for members.

TMIListImp template listimp.h

```
template <class T, class Alloc> class TMIListImp;
```

Implements a managed list of pointers to objects of type *T*. Because pointers always have meaningful copy semantics, this class can handle any type of object.

Type definitions

CondFunc

```
typedef int ( *CondFunc)(const T &, void *);
```

Function type used as a parameter to *FirstThat* and *LastThat* member functions.

IterFunc

```
typedef void ( *IterFunc)(T &, void *);
```

Function type used as a parameter to *ForEach* member function.

Public member functions

Add

```
int Add( T *t );
```

Adds an object pointer to the list.

Detach

```
int Detach( T *t, int del = 0 )
```

Removes the given object pointer from the list. The second argument specifies whether the object should be deleted. See *TShouldDelete* on page 408.

FirstThat

```
T *FirstThat( CondFunc cond, void *args ) const;
```

Returns a pointer to the first object in the list that satisfies a given condition. You supply a test-function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the array meets the condition.

See also: *LastThat*

ForEach

```
void ForEach( IterFunc iter, void *args )
```

Executes function *iter* for each list element. *ForEach* executes the given function *iter* for each element in the array. The *args* argument lets you pass arbitrary data to this function.

LastThat

```
T *LastThat( CondFunc cond, void *args ) const;
```

Returns a pointer to the last object in the list that satisfies a given condition. You supply a test function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the list meets the condition.

See also: *FirstThat, ForEach*

PeekHead

```
T *PeekHead() const;
```

Returns the object pointer at the *Head* of the list, without removing it.

Protected member functions

FindPred

```
virtual TMListElement<VoidPointer,Alloc> *FindPred( VoidPointer );
```

Finds the element that would be followed by the parameter. The function does not check whether the parameter is actually there. This can be used for inserting (insert after returned element pointer).

TMIListIteratorImp template — listimp.h

```
template <class T, class Alloc> class TMIListIteratorImp;
```

Implements a list iterator that works with any managed indirect list. For direct lists, see *TMListIteratorImp* on page 364.

Public constructors

Constructor

```
TMIListIteratorImp( const TMIListImp<VoidPointer,Alloc> &l )
```

Constructs an object that iterates on *TMIListImp* objects.

Public member functions

Current

```
T *Current()
```

Returns the current object pointer.

Restart

```
void Restart()
```

Restarts iteration from the beginning of the list.

Operators

operator ++

```
T *operator ++ (int)
```

Moves to the next object, and returns the object that was current before the move (post-increment).

```
T *operator ++ ()
```

Moves to the next object, and returns the object that was current after the move (pre-increment).

TIListImp template — listimp.h

```
template <class T> class TIListImp;
```

Implements a list of pointers to objects of type *T*. Because pointers always have meaningful copy semantics, this class can handle any type of object. See *TMIListImp* on page 367 for members.

TIListIteratorImp template — listimp.h

```
template <class T> class TIListIteratorImp;
```

Implements a list iterator that works with any indirect list. See *TMIListIteratorImp* on page 368 for members.

Public constructors

Constructor

```
TIListIteratorImp( const TIListImp<T> &l )
```

Constructs an object that iterates on *TMIListImp* objects.

TMISListImp template — listimp.h

```
template <class T, class Alloc> class TMISListImp;
```

Implements a managed sorted list of pointers to objects of type *T*. Because pointers always have meaningful copy semantics, this class can handle any type of object.

Public member functions

In addition to the member functions described here, *TMISListImp* inherits other member functions from *TMIListImp* (see page 367).

FindDetach

```
virtual TMListElement<TVoidPointer,Alloc> *FindDetach(TVoidPointer);
```

Determines whether an object is in the list, and returns a pointer to its predecessor. Returns 0 if not found.

FindPred

```
virtual TMListElement<TVoidPointer,Alloc> *FindPred( TVoidPointer );
```

Finds the element that would be followed by the parameter. The function does not check whether the parameter is actually there. This can be used for inserting (insert after returned element pointer).

TMISListIteratorImp template — listimp.h

```
template <class T, class Alloc> class TMISListIteratorImp;
```

Implements a list iterator that works with any managed indirect list. For direct lists, see *TMListIteratorImp* on page 364.

Public constructors

Constructor

```
TMISListIteratorImp( const TMISListImp<T,Alloc> &l ) :
```

Constructs an object that iterates on *TMISListImp* objects.

TISListImp template — listimp.h

```
template <class T> class TISListImp;
```

Implements a sorted list of pointers to objects of type *T*, using *TStandardAllocator* for memory management. Because pointers always have meaningful copy semantics, this class can handle any type of object. See *TMISListImp* on page 369 for members.

TISListIteratorImp template — listimp.h

```
template <class T> class TISListIteratorImp;
```

Implements a list iterator that works with any indirect list. See *TMIListIteratorImp* on page 368 for members.

Public constructors

Constructor

```
TISListIteratorImp( const TISListImp<T> &l )
```

Constructs an object that iterates on *TISListImp* objects.

TMQueueAsVector template — queues.h

```
template <class T, class Alloc> class TMQueueAsVector;
```

Implements a managed queue of objects of type *T*, using a vector as the underlying implementation. *TMQueueAsVector* assumes *T* has meaningful copy semantics, a **<** operator, and a default constructor. The memory manager *Alloc* provides class-specific **new** and **delete** operators.

Public constructors

Constructor

```
TMQueueAsVector( unsigned sz = DEFAULT_QUEUE_SIZE )
```

Constructs a managed, vector-implemented queue, of *sz* size.

Public member functions

FirstThat

```
T *FirstThat(CondFunc, void *args ) const;
```

Returns a pointer to the first object in the queue that satisfies a given condition. You supply a test-function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the array meets the condition.

See also: *LastThat*

Flush

```
void Flush()
```

Flushes the queue without destroying it. The fate of any objects removed depends on the current ownership status.

See also: *TShouldDelete::ownsElements*

ForEach

```
void ForEach( IterFunc iter, void *args );
```

Executes function *iter* for each queue element. *ForEach* executes the given function *iter* for each element in the array. The *args* argument lets you pass arbitrary data to this function.

Get

```
T Get()
```

Removes the object from the head of the queue. If the queue is empty, it returns 0. Otherwise the removed object is returned.

GetItemsInContainer

```
int GetItemsInContainer() const;
```

Returns the number of items in the queue.

IsEmpty

```
int IsEmpty() const;
```

Returns 1 if the queue has no elements; otherwise returns 0.

IsFull

```
int IsFull() const;
```

Returns 1 if the queue is full; otherwise returns 0.

LastThat

```
T *LastThat( CondFunc cond, void *args ) const;
```

Returns a pointer to the last object in the queue that satisfies a given condition. You supply a test function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the queue meets the condition.

See also: *FirstThat, ForEach*

Put

```
void Put( T t )
```

Adds an object to (the tail of) a queue.

TMQueueAsVectorIterator template — queues.h

```
template <class T, class Alloc> class TMQueueAsVectorIterator;
```

Implements an iterator object for managed, vector-based queues. See *TMDequeAsVectorIterator* on page 329 for members.

Public constructors

Constructor

```
TMQueueAsVectorIterator( const TMDequeAsVector<T,Alloc> &q )
```

Constructs an object that iterates on *TMQueueAsVector* objects.

TQueueAsVector template — queues.h

```
template <class T> class TQueueAsVector;
```

See *TMQueueAsVector* on page 371 for members.

Public constructors

Constructor

```
TQueueAsVector( unsigned sz = DEFAULT_QUEUE_SIZE )
```

Constructs a vector-implemented queue, of *sz* size.

TQueueAsVectorIterator template — queues.h

```
template <class T> class TQueueAsVectorIterator;
```

Implements an iterator object for vector-based queues. See *TMDequeAsVectorIterator* on page 329 for members.

Public constructors

Constructor

```
TQueueAsVectorIterator( const TQueueAsVector<T> &q )
```

Constructs an object that iterates on *TQueueAsVector* objects.

TMIQueueAsVector template — queues.h

```
template <class T, class Alloc> class TMIQueueAsVector;
```

Implements a managed queue of pointers to objects of type *T*, using a vector as the underlying implementation.

Public constructors

Constructor

```
TMIQueueAsVector( unsigned sz = DEFAULT_QUEUE_SIZE )
```

Constructs a managed, indirect queue, of *sz* size.

Public member functions

FirstThat

```
T *FirstThat( CondFunc, void *args ) const;
```

Returns a pointer to the first object in the queue that satisfies a given condition. You supply a test-function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the array meets the condition.

See also: *LastThat*

Flush

```
void Flush( TShouldDelete::DeleteType = TShouldDelete::DefDelete );
```

Flushes the queue without destroying it. The fate of any objects removed depends on the current ownership status and the value of the *dt* argument.

ForEach

```
void ForEach( IterFunc iter, void *args );
```

Executes function *iter* for each queue element. *ForEach* executes the given function *iter* for each element in the queue. The *args* argument lets you pass arbitrary data to this function.

Get

```
T *Get()
```

Removes and returns the object pointer from the queue. If the queue is empty, it returns 0.

GetItemsInContainer

```
int GetItemsInContainer() const;
```

Returns the number of items in the queue.

IsEmpty

```
int IsEmpty() const;
```

Returns 1 if a queue has no elements; otherwise returns 0.

IsFull

```
int isFull() const;
```

Returns 1 if a queue is full; otherwise returns 0.

LastThat

```
T *LastThat( CondFunc cond, void *args ) const;
```

Returns a pointer to the last object in the queue that satisfies a given condition. You supply a test function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the queue meets the condition.

See also: *FirstThat, ForEach*

Put

```
void Put( T *t )
```

Adds an object pointer to (the tail of) a queue.

TMIQueueAsVectorIterator template — queues.h

```
template <class T, class Alloc> class TMIQueueAsVectorIterator;
```

Implements an iterator object for managed, indirect, vector-based queues.

Public constructors

Constructor

```
TMIQueueAsVectorIterator( const TMIDequeAsVector<T,Alloc> &q )
```

Constructs an object that iterates on *TMIQueueAsVector* objects.

TIQueueAsVector template — queues.h

```
template <class T> class TIQueueAsVector;
```

Implements a queue of pointers to objects of type *T*, using a vector as the underlying implementation.

Public constructors

Constructor

```
TIQueueAsVector( unsigned sz = DEFAULT_QUEUE_SIZE )
```

Constructs a indirect queue, of *sz* size.

TIQueueAsVectorIterator template — queues.h

```
template <class T> class TIQueueAsVectorIterator;
```

Implements an iterator object for indirect, vector-based queues. See *TMDequeAsVectorIterator* on page 329 for members.

Public constructors

Constructor

```
TIQueueAsVectorIterator( const TIQueueAsVector<T> &q )
```

Constructs an object that iterates on *TIQueueAsVector* objects.

TMQueueAsDoubleList template — queues.h

```
template <class T, class Alloc> class TMQueueAsDoubleList;
```

Implements a managed queue of objects of type *T*, using a double-linked list as the underlying implementation.

Public member functions

FirstThat

```
T *FirstThat( CondFunc cond, void *args ) const;
```

Returns a pointer to the first object in the queue that satisfies a given condition. You supply a test-function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the queue meets the condition.

See also: *LastThat*

Flush

```
void Flush()
```

Flushes objects from the queue. Flushes the queue without destroying it.

ForEach

```
void ForEach( IterFunc iter, void *args )
```

Executes function *iter* for each queue element. *ForEach* executes the given function *iter* for each element in the array. The *args* argument lets you pass arbitrary data to this function.

Get

```
T Get()
```

Removes the object from the head of the queue. If the queue is empty, it throws the PRECONDITION exception in the debug version. In the non-debug version *Get* returns a meaningless object if the queue is empty.

GetItemsInContainer

```
int GetItemsInContainer() const;
```

Returns the number of items in the queue.

IsEmpty

```
int IsEmpty() const;
```

Returns 1 if a queue has no elements; otherwise returns 0.

IsFull

```
int IsFull() const;
```

Returns 1 if a queue is full; otherwise returns 0.

LastThat

```
T *LastThat( CondFunc cond, void *args ) const;
```

Returns a pointer to the last object in the queue that satisfies a given condition. You supply a test function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the array meets the condition.

See also: *FirstThat, ForEach*

Put

```
void Put( T t )
```

Adds an object to (the tail of) a queue. If the queue is full, it throws the PRECONDITION exception in the debug version. If the queue is full, the behavior of the non-debug version of *Put* is undefined.

TMQueueAsDoubleListIterator template queues.h

```
template <class T, class Alloc> class TMQueueAsDoubleListIterator;
```

Implements an iterator object for list-based queues. See *TMDequeAsDoubleListIterator* on page 336 for members.

Public constructors

Constructor

```
TMQueueAsDoubleListIterator( const TMQueueAsDoubleList<T,Alloc> & q )
```

Constructs an object that iterates on *TMQueueAsDoubleList* objects.

TQueueAsDoubleList template queues.h

```
template <class T> class TQueueAsDoubleList;
```

Implements a queue of objects of type *T*, using a double-linked list as the underlying implementation. See *TMQueueAsDoubleList* on page 375 for members.

TQueueAsDoubleListIterator template queues.h

```
template <class T> class TQueueAsDoubleListIterator;
```

Implements an iterator object for list-based queues. See *TMDequeAsDoubleListIterator* on page 336 for members.

Public constructors

Constructor

```
TQueueAsDoubleListIterator( const TQueueAsDoubleList<T> &q )
```

Constructs an object that iterates on *TQueueAsDoubleList* objects.

TMIQueueAsDoubleList template queues.h

```
template <class T, class Alloc> class TMIQueueAsDoubleList;
```

Implements a managed indirect queue of pointers to objects of type *T*, using a double-linked list as the underlying implementation.

Public member functions

FirstThat

`T *FirstThat( CondFunc cond, void *args ) const;`

Returns a pointer to the first object in the queue that satisfies a given condition. You supply a test-function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the queue meets the condition.

See also: *LastThat*

Flush

`void Flush( TShouldDelete::DeleteType dt = TShouldDelete::DefDelete )`

Flushes the queue without destroying it. The fate of any objects removed depends on the current ownership status and the value of the *dt* argument.

ForEach

`void ForEach( IterFunc iter, void *args )`

Executes function *iter* for each queue element. *ForEach* executes the given function *iter* for each element in the queue. The *args* argument lets you pass arbitrary data to this function.

Get

`T *Get()`

Removes and returns the object pointer from the queue. If the queue is empty, it throws the PRECONDITION exception in the debug version. In the non-debug version *Get* returns a meaningless object if the queue is empty.

GetItemsInContainer

`int GetItemsInContainer() const;`

Returns the number of items in the queue.

IsEmpty

`int IsEmpty() const;`

Returns 1 if the queue has no elements; otherwise returns 0.

IsFull

`int IsFull() const;`

Returns 1 if the queue is full; otherwise returns 0.

LastThat

`T *LastThat( CondFunc cond, void *args ) const;`

Returns a pointer to the last object in the dequeue that satisfies a given condition. You supply a test function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the queue meets the condition.

See also: *FirstThat, ForEach*

Put

`void Put( T *t )`

Adds an object pointer to (the tail of) a queue. If the queue is full, it throws the PRECONDITION exception in the debug version. If the queue is full, the behavior of the non-debug version of *Put* is undefined.

TMIQueueAsDoubleListIterator template — queues.h

```
template <class T, class Alloc> class TMIQueueAsDoubleListIterator;
```

Implements an iterator object for indirect, list-based queues. See *TMIDequeAsDoubleListIterator* on page 338 for members.

Public constructors

Constructor

```
TMIQueueAsDoubleListIterator( const TMIQueueAsDoubleList<T,Alloc> & q )
```

Constructs an object that iterates on *TMIQueueAsDoubleList* objects.

TIQueueAsDoubleList template — queues.h

Implements an indirect queue of pointers to objects of type *T*, using a double-linked list as the underlying implementation. See *TMIQueueAsDoubleList* on page 377 for members.

TIQueueAsDoubleListIterator template — queues.h

Implements an iterator object for indirect, list-based queues. See *TMIDequeAsDoubleListIterator* on page 338 for members.

Public constructors

Constructor

```
TIQueueAsDoubleListIterator( const TIQueueAsDoubleList<T> & q )
```

Constructs an object that iterates on *TIQueueAsDoubleList* objects.

TQueue template — queues.h

A simplified name for *TQueueAsVector*.

TQueueIterator template queues.h

A simplified name for *TQueueAsVectorIterator*.

TMSetAsVector template sets.h

```
template <class T, class Alloc> class TMSetAsVector;
```

Implements a managed set of objects of type *T*, using a vector as the underlying implementation. A set, unlike a bag, cannot contain duplicate items.

Public constructors

Constructor

```
TMSetAsVector( unsigned sz = DEFAULT_SET_SIZE ) :
```

Constructs an empty set. *sz* represents the number of items the set can hold.

Public member functions

In addition to the following member function, *TMSetAsVector* inherits member functions from *TMBagAsVector*. See *TMBagAsVector* on page 317 for members.

Add

```
int Add( const T& t );
```

Adds an object to the set.

TMSetAsVectorIterator template sets.h

```
template <class T, class Alloc> class TMSetAsVectorIterator;
```

Implements an iterator object to traverse *TMSetAsVector* objects. See *TMArrayAsVectorIterator* on page 301 for members.

Public constructors

Constructor

```
TMSetAsVectorIterator( const TMSetAsVector<T,Alloc> &s ) :
```

Constructs an object that iterates on *TMSetAsVector* objects.

TSetAsVector template sets.h

```
template <class T> class TSetAsVector;
```

Implements a set of objects of type *T*, using a vector as the underlying implementation. *TStandardAllocator* is used to manage memory. See *TMBagAsVector* on page 317 for members.

Public constructors

Constructor

```
TSetAsVector( unsigned sz = DEFAULT_SET_SIZE ) :
```

Constructs an empty set. *sz* represents the number of items the set can hold.

TSetAsVectorIterator template sets.h

```
template <class T> class TSetAsVectorIterator;
```

Implements an iterator object to traverse *TSetAsVector* objects. See *TMArrayAsVectorIterator* on page 301 for members.

Public constructors

Constructor

```
TSetAsVectorIterator( const TSetAsVector<T> &s )
```

Constructs an object that iterates on *TMSetAsVector* objects.

TMISetAsVector template sets.h

```
template <class T, class Alloc> class TMISetAsVector;
```

Implements a managed set of pointers to objects of type *T*, using a vector as the underlying implementation. See *TMIBagAsVector* on page 319 for members.

Public constructors

Constructor

```
TMISetAsVector( unsigned sz = DEFAULT_SET_SIZE ) :
```

Constructs an empty, managed, indirect set. *sz* represents the initial number of slots allocated.

Public member functions

In addition to the following member function, *TMISetAsVector* inherits member functions from *TMIBagAsVector*. See *TMIBagAsVector* on page 319.

Add

```
int Add( T * );
```

Adds an object pointer to the set.

TMISetAsVectorIterator template — sets.h

```
template <class T, class Alloc> class TMISetAsVectorIterator;
```

Implements an iterator object to traverse *TMISetAsVector* objects. See *TMIArrayAsVectorIterator* on page 306 for members.

Public constructors

Constructor

```
TMISetAsVectorIterator( const TMISetAsVector<T,Alloc> &s )
```

Constructs an object that iterates on *TMISetAsVector* objects.

TISetAsVector template — sets.h

```
template <class T> class TISetAsVector;
```

Implements a set of pointers to objects of type *T*, using a vector as the underlying implementation. See *TMIBagAsVector* on page 319 for members.

Public constructors

Constructor

```
TISetAsVector( unsigned sz = DEFAULT_SET_SIZE )
```

Constructs an empty, indirect bag. *sz* represents the initial number of slots allocated.

TISetAsVectorIterator template — sets.h

```
template <class T> class TISetAsVectorIterator;
```

Implements an iterator object to traverse *TISetAsVector* objects. See *TMIArrayAsVectorIterator* on page 306 for members.

Public constructors

Constructor

```
TISetAsVectorIterator( const TISetAsVector<T> &s )
```

Constructs an object that iterates on *TISetAsVector* objects.

TSet template — sets.h

A simplified name for *TSetAsVector*.

TSetIterator template — sets.h

A simplified name for *TSetAsVectorIterator*.

TMStackAsVector template — stacks.h

```
template <class T, class Alloc> class TMStackAsVector;
```

Implements a managed stack of objects of type *T*, using a vector as the underlying implementation.

Type definitions

CondFunc

```
typedef int ( *CondFunc)(const T &, void *);
```

Function type used as a parameter to *FirstThat* and *LastThat* member functions.

IterFunc

```
typedef void ( *IterFunc)(T &, void *);
```

Function type used as a parameter to *ForEach* member function.

Public constructors

Constructor

```
TMStackAsVector( unsigned max = DEFAULT_STACK_SIZE )
```

Constructs a managed, vector-implemented stack, with *max* indicating the maximum stack size.

Public member functions

FirstThat

```
T *FirstThat( CondFunc cond, void *args ) const;
```

Returns a pointer to the first object in the stack that satisfies a given condition. You supply a test-function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the array meets the condition.

See also: *LastThat*

Flush

```
void Flush( );
```

Flushes the stack without destroying it.

See also: *TShouldDelete::ownsElements*

ForEach

```
void ForEach( IterFunc iter, void *args )
```

Executes function *iter* for each stack element. *ForEach* executes the given function *iter* for each element in the array. The *args* argument lets you pass arbitrary data to this function.

GetItemsInContainer

```
int GetItemsInContainer() const;
```

Returns the number of items in the stack.

IsEmpty

```
int IsEmpty() const;
```

Returns 1 if the stack has no elements; otherwise returns 0.

IsFull

```
int IsFull() const;
```

Returns 1 if the stack is full; otherwise returns 0.

LastThat

```
T *LastThat( CondFunc cond, void *args ) const;
```

Returns a pointer to the last object in the stack that satisfies a given condition. You supply a test function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the array meets the condition.

See also: *FirstThat, ForEach*

Pop

```
T Pop()
```

Removes the object from the top of the stack and returns the object. The fate of the popped object is determined by ownership. See *TShouldDelete* on page 408.

Push

```
void Push( const T& t )
```

Pushes an object on the top of the stack.

Top

```
const T& Top() const;
```

Returns but does not remove the object at the top of the stack.

TMStackAsVectorIterator template — stacks.h

```
template <class T, class Alloc> class TMStackAsVectorIterator;
```

Implements an iterator object for managed, vector-based stacks. See *TMVectorIteratorImp* on page 393 for members.

Public constructors

Constructor

```
TMStackAsVectorIterator( const TMStackAsVector<T,Alloc> & s ) :
```

Constructs an object that iterates on *TMStackAsVector* objects.

TStackAsVector template — stacks.h

```
template <class T> class TStackAsVector;
```

Implements a stack of objects of type *T*, using a vector as the underlying implementation, and *TStandardAllocator* for memory management.

Public constructors

Constructor

```
TStackAsVector( unsigned max = DEFAULT_STACK_SIZE )
```

Constructs a vector-implemented stack, with *max* indicating the maximum stack size.

TStackAsVectorIterator template — stacks.h

```
template <class T> class TStackAsVectorIterator;
```

Implements an iterator object for managed, vector-based stacks. See *TMVectorIteratorImp* on page 393 for members.

Public constructors

Constructor

```
TStackAsVectorIterator( const TStackAsVector<T> & s ) :
```

Constructs an object that iterates on *TStackAsVector* objects.

TMIStackAsVector template — stacks.h

```
template <class T, class Alloc> class TMIStackAsVector;
```

TMIStackAsVector implements a managed stack of pointers to objects of type *T*, using a vector as the underlying implementation.

Type definitions

CondFunc

```
typedef int ( *CondFunc)(const T &, void *);
```

Function type used as a parameter to *FirstThat* and *LastThat* member functions.

IterFunc

```
typedef void ( *IterFunc)(T &, void *);
```

Function type used as a parameter to *ForEach* member function.

Public constructors

Constructor

```
TMIStackAsVector( unsigned max = DEFAULT_STACK_SIZE )
```

Constructs a managed, indirect, vector-implemented stack, with *max* indicating the maximum stack size.

Public member functions

FirstThat

```
T *FirstThat( CondFunc cond, void *args ) const;
```

Returns a pointer to the first object in the stack that satisfies a given condition. You supply a test-function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the array meets the condition.

See also: *LastThat*

Flush

```
void Flush( TShouldDelete::DeleteType = TShouldDelete::DefDelete )
```

Flushes the stack without destroying it. The fate of any objects removed depends on the current ownership status and the value of the *dt* argument.

See also: *TShouldDelete::ownsElements*

ForEach

```
void ForEach( IterFunc iter, void *args )
```

Executes function *iter* for each stack element. *ForEach* executes the given function *iter* for each element in the array. The *args* argument lets you pass arbitrary data to this function.

GetItemsInContainer

```
int GetItemsInContainer() const;
```

Returns the number of items in the stack.

IsEmpty

```
int IsEmpty() const;
```

Returns 1 if the stack has no elements; otherwise returns 0.

IsFull

```
int IsFull() const;
```

Returns 1 if the stack is full; otherwise returns 0.

LastThat

```
T *LastThat( CondFunc cond, void *args ) const;
```

Returns a pointer to the last object in the stack that satisfies a given condition. You supply a test function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the array meets the condition.

See also: *FirstThat, ForEach*

Pop

```
T *Pop()
```

Removes the object from the top of the stack and returns a pointer to the object. The fate of the popped object is determined by ownership. See *TShouldDelete* on page 408.

Push

```
void Push( T *t )
```

Pushes a pointer to an object on the top of the stack.

Top

```
T *Top() const;
```

Returns but does not remove the object pointer at the top of the stack.

TMIStackAsVectorIterator template — stacks.h

```
template <class T, class Alloc> class TMIStackAsVectorIterator;
```

Implements an iterator object for managed, indirect, vector-based stacks. See *TMVectorIteratorImp* on page 393 for members.

Public constructors

Constructor

```
TMIStackAsVectorIterator( const TMIStackAsVector<T,Alloc> & s )
```

Constructs an object that iterates on *TMIStackAsVector* objects.

TIStackAsVector template — stacks.h

```
template <class T> class TIStackAsVector;
```

Implements an indirect stack of pointers to objects of type *T*, using a vector as the underlying implementation. See *TMIStackAsVector* on page 386 for members.

Public constructors

Constructor

```
TIStackAsVector( unsigned max = DEFAULT_STACK_SIZE );
```

Constructs an indirect, vector-implemented stack, with *max* indicating the maximum stack size.

TIStackAsVectorIterator template — stacks.h

```
template <class T> class TIStackAsVectorIterator;
```

Implements an iterator object for indirect, vector-based stacks. See *TMIVectorIteratorImp* on page 402 for members.

Public constructors

Constructor

```
TMIStackAsVectorIterator( const TMIStackAsVector<T,Alloc> & s )
```

Constructs an object that iterates on *TIStackAsVector* objects.

TMStackAsList template — stacks.h

```
template <class T, class Alloc> class TMStackAsList;
```

Implements a managed stack of objects of type *T*, using a list as the underlying implementation. See *TMStackAsVector* on page 383 for members.

TMStackAsListIterator template stacks.h

```
template <class T, class Alloc> class TMStackAsListIterator;
```

Implements an iterator object for managed, list-based stacks. See *TMListIteratorImp* on page 364 for members.

Public constructors

Constructor

```
TMStackAsListIterator( const TMStackAsList<T,Alloc> & s ) :
TMListIteratorImp<T,Alloc>(s.Data)
```

Constructs an object that iterates on *TMStackAsList* objects.

TStackAsList template stacks.h

```
template <class T> class TStackAsList;
```

Implements a managed stack of objects of type *T*, using a list as the underlying implementation. See *TMStackAsVector* on page 383 for members.

TStackAsListIterator template stacks.h

```
template <class T> class TStackAsListIterator;
```

Implements an iterator object for list-based stacks. See *TMVectorIteratorImp* on page 393 for members.

Public constructors

Constructor

```
TStackAsListIterator( const TStackAsList<T> & s );
```

Constructs an object that iterates on *TIStackAsVector* objects.

TMIStackAsList template stacks.h

```
template <class T, class Alloc> class TMIStackAsList;
```

Implements a managed stack of pointers to objects of type *T*, using a linked list as the underlying implementation. See *TMIStackAsVector* on page 386 for members.

TMIStackAsListIterator template stacks.h

```
template <class T, class Alloc> class TMIStackAsListIterator;
```

Implements an iterator object for managed, indirect, list-based stacks. See *TMIListIteratorImp* on page 368 for members.

Public constructors

Constructor

```
TMIStackAsListIterator( const TMIStackAsList<T,Alloc> & s )
```

Constructs an object that iterates on *TMIStackAsList* objects.

TIStackAsList template stacks.h

```
template <class T> class TIStackAsList;
```

Implements *TMIStackAsList* with the standard allocator *TStandardAllocator*. See *TMIStackAsVector* on page 386 for members.

TIStackAsListIterator template stacks.h

```
template <class T> class TIStackAsListIterator;
```

Implements an iterator object for indirect, list-based stacks. See *TMIVectorIteratorImp* on page 402 for members.

Public constructors

Constructor

```
TIStackAsListIterator( const TIStackAsList<T> & s )
```

Constructs an object that iterates on *TIStackAsList* objects.

TStack template stacks.h

A simplified name for *TStackAsVector*.

TStackIterator template — stacks.h

A simplified name for *TStackAsVectorIterator*.

TMVectorImp template — vectimp.h

```
template <class T, class Alloc> class TMVectorImp;
```

Implements a managed vector of objects of type *T*. *TMVectorImp* assumes that *T* has meaningful copy semantics, and a default constructor.

Type definitions

CondFunc

```
typedef int ( *CondFunc)(const T &, void *);
```

Function type used as a parameter to *FirstThat* and *LastThat* member functions.

IterFunc

```
typedef void ( *IterFunc)(T &, void *);
```

Function type used as a parameter to *ForEach* member function.

Public constructors

Constructor

```
TMVectorImp();
```

Constructs a vector with no entries.

Constructor

```
TMVectorImp( unsigned sz, unsigned = 0 );
```

Constructs a vector of *sz* objects, initialized by default to 0.

Constructor

```
TMVectorImp( const TMVectorImp<T,Alloc> & );
```

Constructs a vector copy.

Public member functions

FirstThat

```
T *FirstThat( CondFunc cond, void *args ) const;
```

Returns a pointer to the first object in the vector that satisfies a given condition. You supply a test-function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the vector meets the condition.

```
T *FirstThat( CondFunc cond, void *args, unsigned start,
              unsigned stop) const;
```

This version of *FirstThat* allows you to specify a range to be searched. Returns a pointer to the first object in the vector that satisfies a given condition. You supply a test-function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the vector meets the condition.

See also: *LastThat*

Flush

```
void Flush( unsigned stop = UINT_MAX, unsigned start = 0 );
```

Flushes the vector without destroying it. The fate of any objects removed depends on the current ownership status and the value of the first argument.

See also: *TShouldDelete::ownsElements*

ForEach

```
void ForEach( IterFunc iter, void *args )
```

Returns a pointer to the first object in the vector that satisfies a given condition. *ForEach* executes the given function *iter* for each element in the array. The *args* argument lets you pass arbitrary data to this function.

```
void ForEach( IterFunc iter, void *, unsigned start, unsigned stop);
```

This version allows you to specify a range.

See also: *LastThat*

GetDelta

```
virtual unsigned GetDelta( ) const;
```

Returns the growth delta for the array.

LastThat

```
T *LastThat( CondFunc cond, void *args ) const;
```

Returns a pointer to the last object in the vector that satisfies a given condition. You supply a test function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the vector meets the condition.

```
T *LastThat( CondFunc cond, void *args, unsigned start,
             unsigned stop ) const;
```

This version allows you to specify a range.

See also: *FirstThat, ForEach*

Limit

```
unsigned Limit() const;
```

Returns the number of items that the vector can hold.

Resize

```
void Resize( unsigned sz, unsigned offset = 0 );
```

Creates a new vector of size *sz*. The existing vector is copied to the expanded vector, then deleted. In a vector of pointers the entries are zeroed. In an array of objects the default constructor is invoked for each unused element. *offset* is the location in the new vector where the first element of the old vector should be copied. This is needed when the vector has to be extended downward.

Top

```
virtual unsigned Top() const;
```

Returns the index of the current top element. For plain vectors *Top* returns *Lim*; for counted and sorted vectors *Top* returns the current insertion point.

Operators

operator [ ]

```
T & operator [] ( unsigned index ) const;
```

Returns a reference to the object at *index*.

operator =

```
const TMVectorImp<T,Alloc> & operator = ( const TMVectorImp<T,Alloc> & );
```

Provides the vector assignment operator.

Protected data members

Lim

```
unsigned Lim;
```

Lim stores the upper limit for indexes into the vector.

Protected member functions

Zero

```
virtual void Zero( unsigned, unsigned )
```

Provides for zeroing vector contents within the specified range.

TMVectorIteratorImp template — vectimp.h

```
template <class T, class Alloc> class TMVectorIteratorImp;
```

Implements a vector iterator that works with any direct, managed vector of objects of type *T*. For indirect vector iterators, see *TMIVectorIteratorImp* on page 402.

Public constructors

Constructor

```
TMVectorIteratorImp( const TMVectorImp<T,Alloc> &v )
```

Creates an iterator object to traverse *TMVectorImp* objects.

Constructor

```
TMVectorIteratorImp( const TMVectorImp<T,Alloc> &v, unsigned start,
unsigned stop )
```

Creates an iterator object to traverse *TMVectorImp* objects. A range can be specified.

Public member functions

Current

```
const T& Current();
```

Returns the current object.

Restart

```
void Restart();
```

Restarts iteration over the whole vector.

```
void Restart( unsigned start, unsigned stop );
```

Restarts iteration over the given range.

Operators

operator ++

```
const T& operator ++(int);
```

Moves to the next object, and returns the object that was current before the move (post-increment).

```
const T& operator ++();
```

Moves to the next object, and returns the object that was current after the move (pre-increment).

operator int

```
operator int();
```

Converts the iterator to an integer value for testing if objects remain in the iterator. The iterator converts to 0 if nothing remains in the iterator.

TVectorImp template — vectimp.h

```
template <class T> class TVectorImp;
```

Implements a vector of objects of type *T*. *TVectorImp* assumes that *T* has meaningful copy semantics, and a default constructor. See *TMVectorImp* on page 391 for members.

Public constructors

Constructor `TVectorImp()`

Constructs a vector with no entries.

Constructor `TVectorImp( unsigned sz, unsigned = 0 )`

Constructs a vector of *sz* objects, initialized by default to 0.

Constructor `TVectorImp( const TVectorImp<T> &v )`

Constructs a vector copy.

TVectorIteratorImp template — vectimp.h

```
template <class T> class TVectorIteratorImp;
```

Implements a vector iterator that works with any direct vector of objects of type *T*. See *TMVectorIteratorImp* on page 393 for members.

Public constructors

Constructor `TVectorIteratorImp( const TVectorImp<T> &v )`

Creates an iterator object to traverse *TVectorImp* objects.

Constructor `TVectorIteratorImp( const TVectorImp<T> &v, unsigned start, unsigned stop )`

Creates an iterator object to traverse *TVectorImp* objects. A range can be specified.

TMCVectorImp template — vectimp.h

```
template <class T, class Alloc> class TMCVectorImp;
```

Implements a managed, counted vector of objects of type *T*. *TMCVectorImp* assumes that *T* has meaningful copy semantics, and a default constructor.

Public constructors

Constructor

```
TMCVectorImp();
```

Constructs a vector with no entries.

Constructor

```
TMCVectorImp( unsigned sz, unsigned = 0 );
```

Constructs a vector of *sz* objects, initialized by default to 0.

Public member functions

In addition to the member functions described here, *TMCVectorImp* inherits member functions from *TMVectorImp* (see page 391).

Add

```
int Add( const T& t );
```

Adds an object to the vector and increments *Count_*.

AddAt

```
int AddAt( const T&, unsigned );
```

Adds an object to the vector at the specified location, and increments *Count_*.

Count

```
unsigned Count( ) const;
```

Returns *Count_*.

Detach

```
int Detach( unsigned loc );
int Detach( const T& loc );
```

Remove by specifying the object or its index.

Find

```
virtual unsigned Find( const T& ) const;
```

Finds the specified object and returns the object's index; otherwise returns INT_MAX.

GetDelta

```
virtual unsigned GetDelta( ) const;
```

Returns *Delta*.

Protected data members

In addition to the data members described here, *TMCVectorImp* inherits data members from *TMVectorImp* (see page 391).

Count_

```
unsigned Count_;
```

Maintains the number of objects in the vector.

Delta

```
unsigned Delta;
```

Specifies the size increment to be used when the vector grows.

Top

```
virtual unsigned Top( ) const;
```

Returns *Count_*.

TMCVectorIteratorImp template — vectimp.h

```
template <class T, class Alloc> class TMCVectorIteratorImp;
```

Implements a vector iterator that works with any direct, managed, counted vector of objects of type *T*. See *TMVectorIteratorImp* on page 393 for members.

Public constructors

Constructor

```
TMCVectorIteratorImp( const TMCVectorImp<T,Alloc> &v )
```

Creates an iterator object to traverse *TMCVectorImp* objects.

Constructor

```
TMVectorIteratorImp( const TMCVectorImp<T,Alloc> &v, unsigned start,
                     unsigned stop )
```

Creates an iterator object to traverse *TMCVectorImp* objects. A range can be specified.

TCVectorImp template — vectimp.h

```
template <class T> class TCVectorImp;
```

Implements a counted vector of objects of type *T*. *TCVectorImp* assumes that *T* has meaningful copy semantics, and a default constructor. See *TMCVectorImp* on page 395 for members.

Public constructors

Constructor

```
TCVectorImp();
```

Constructs a vector with no entries.

Constructor

```
MCVectorImp( unsigned sz, unsigned = 0 );
```

Constructs a vector of *sz* objects, initialized by default to 0.

TCVectorIteratorImp template — vectimp.h

```
template <class T> class TCVectorIteratorImp;
```

Implements a vector iterator that works with any direct, counted vector of objects of type *T*. See *TMCVectorIteratorImp* on page 397 for members.

Public constructors

Constructor

```
TCVectorIteratorImp( const TCVectorImp<T> &v )
```

Creates an iterator object to traverse *TCVectorImp* objects.

Constructor

```
TCVectorIteratorImp( const TCVectorImp<T> &v, unsigned start,
                     unsigned stop )
```

Creates an iterator object to traverse *TCVectorImp* objects. A range can be specified.

TMSVectorImp template — vectimp.h

```
template <class T, class Alloc> class TMSVectorImp;
```

Implements a managed, sorted vector of objects of type *T*. *TMSVectorImp* assumes that *T* has meaningful copy semantics, a meaningful **<** operator, and a default constructor. See *TMCVectorImp* on page 395 for members.

Public constructors

Constructor

```
TMSVectorImp()
```

Constructs a vector with no entries.

Constructor

```
TMSVectorImp( unsigned sz, unsigned d = 0 )
```

Constructs a vector of *sz* objects, initialized by default to 0.

TMSVectorIteratorImp template — vectimp.h

```
template <class T, class Alloc> class TMSVectorIteratorImp;
```

Implements a vector iterator that works with any direct, managed, sorted vector of objects of type *T*. See *TMVectorIteratorImp* on page 393 for members.

Public constructors

Constructor

```
TMSVectorIteratorImp( const TMSVectorImp<T,Alloc> &v )
```

Creates an iterator object to traverse *TMSVectorImp* objects.

Constructor

```
TMSVectorIteratorImp( const TMSVectorImp<T,Alloc> &v, unsigned start,
                      unsigned stop )
```

Creates an iterator object to traverse *TMSVectorImp* objects. A range can be specified.

TSVectorImp template — vectimp.h

```
template <class T> class TSVectorImp;
```

Implements a sorted vector of objects of type *T*. *TSVectorImp* assumes that *T* has meaningful copy semantics, a meaningful < operator, and a default constructor. See *TMCVectorImp* on page 395 for members.

Public constructors

Constructor

```
TSVectorImp()
```

Constructs a vector with no entries.

Constructor

```
TSVectorImp( unsigned sz, unsigned d = 0 )
```

Constructs a vector of *sz* objects, initialized by default to 0.

TSVectorIteratorImp template — vectimp.h

```
template <class T> class TSVectorIteratorImp;
```

Implements a vector iterator that works with any direct, sorted vector of objects of type *T*. See *TMVectorIteratorImp* on page 393 for members.

Public constructors

Constructor

```
TSVectorIteratorImp( const TSVectorImp<T> &v )
```

Creates an iterator object to traverse *TSVectorImp* objects.

Constructor

```
TSVectorIteratorImp( const TSVectorImp<T> &v, unsigned start,
                     unsigned stop )
```

Creates an iterator object to traverse *TSVectorImp* objects. A range can be specified.

TMIVectorImp template — vectimp.h

```
template <class T, class Alloc> class TMIVectorImp;
```

Implements a managed vector of pointers to objects of type *T*. Because pointers always have meaningful copy semantics, this class can handle any type of object.

Type definitions

CondFunc

```
typedef int ( *CondFunc)(const T &, void *);
```

Function type used as a parameter to *FirstThat* and *LastThat* member functions.

IterFunc

```
typedef void ( *IterFunc)(T &, void *);
```

Function type used as a parameter to *ForEach* member function.

Public constructors

Constructor

```
TMIVectorImp( unsigned sz );
```

Constructs a managed vector of pointers to objects. *sz* represents the vector size.

Public member functions

FirstThat

```
T *FirstThat( CondFunc cond, void *args ) const;
```

Returns a pointer to the first object in the vector that satisfies a given condition. You supply a test-function pointer *cond* that returns true for a

certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the array meets the condition.

```
T *FirstThat( CondFunc cond, void *args, unsigned, unsigned ) const;
```

This version allows specifying a range to be searched. You supply a test-function pointer *cond* that returns true for a certain condition. You can pass arbitrary arguments via *args*. Returns 0 if no object in the array meets the condition.

Flush

```
void Flush( unsigned = 0, unsigned stop = UINT_MAX, unsigned start = 0 );
```

Flushes the vector without destroying it. The fate of any objects removed depends on the current ownership status and the value of the first argument. A range to be flushed can be specified with the last two arguments.

ForEach

```
void ForEach( IterFunc iter, void *args )
```

Returns a pointer to the first object in the vector that satisfies a given condition. See *TMArrayAsVector::FirstThat*.

```
void ForEach( IterFunc iter, void *, unsigned, unsigned );
```

This version allows specifying a range.

GetDelta

```
virtual unsigned GetDelta( ) const;
```

Returns the growth delta for the array.

LastThat

```
T *LastThat( CondFunc cond, void *args ) const;
```

Returns a pointer to the last object in the vector that satisfies a given condition. See *TMArrayAsVector::LastThat*.

```
T *LastThat( CondFunc cond, void *args, unsigned, unsigned ) const;
```

This version allows specifying a range.

Limit

```
unsigned Limit() const;
```

Returns the number of items that the vector can hold.

Resize

```
void Resize( unsigned sz, unsigned offset = 0 );
```

Creates a new vector of size *sz*. The existing vector is copied to the expanded vector, then deleted. In a vector of pointers the entries are zeroed. In an array of objects the default constructor is invoked for each unused element. *offset* is the location in the new vector where the first element of the old vector should be copied. This is needed when the vector has to be extended downward.

Top

```
virtual unsigned Top() const;
```

Returns the index of the current top element. For plain vectors *Top* returns *Lim;* for counted and sorted vectors *Top* returns the current insertion point.

Zero

```
virtual void Zero( unsigned, unsigned );
```

Provides for zeroing vector contents within the specified range.

Operators

operator [ ]

```
T * & operator [] ( unsigned index )
T * & operator [] ( unsigned index ) const;
```

Returns a reference to the object at *index*.

TMIVectorIteratorImp template — vectimp.h

```
template <class T, class Alloc> class TMIVectorIteratorImp;
```

Implements a vector iterator that works with an indirect, managed vector.

Public constructors

Constructor

```
TMIVectorIteratorImp( const TMIVectorImp<T,Alloc> &v )
```

Creates an iterator object to traverse *TMIVectorImp* objects.

Constructor

```
TMIVectorIteratorImp( const TMIVectorImp<T,Alloc> &v, unsigned l, unsigned u )
```

Creates an iterator object to traverse *TMIVectorImp* objects. A range can be specified.

Public member functions

Current

```
T *Current();
```

Returns a pointer to the current object.

Restart

```
void Restart();
```

Restarts iteration over the whole vector.

```
void Restart( unsigned start, unsigned stop );
```

Restarts iteration over the given range.

Operators

operator ++

```
const T& operator ++(int);
```

Moves to the next object, and returns the object that was current before the move (post-increment).

```
const T& operator ++();
```

Moves to the next object, and returns the object that was current after the move (pre-increment).

operator int

```
operator int();
```

Converts the iterator to an integer value for testing if objects remain in the iterator. The iterator converts to 0 if nothing remains in the iterator.

TIVectorImp template — vectimp.h

```
template <class T> class TIVectorImp;
```

Implements a vector of pointers to objects of type *T*. Because pointers always have meaningful copy semantics, this class can handle any type of object. See *TMIVectorImp* on page 400 for members.

Public constructors

Constructor

```
TIVectorImp( unsigned sz, unsigned d = 0 )
```

Constructs an indirect vector of *sz* size, with default initialization of 0.

TIVectorIteratorImp template — vectimp.h

```
template <class T> class TIVectorIteratorImp;
```

Implements a vector iterator that works with an indirect, managed vector. See *TMIVectorIteratorImp* on page 402 for members.

Public constructors

Constructor

```
TIVectorIteratorImp( const TIVectorImp<T> &v )
```

Creates an iterator object to traverse *TIVectorImp* objects.

Constructor

```
TIVectorIteratorImp( const TIVectorImp<T> &v, unsigned l, unsigned u )
```

Creates an iterator object to traverse *TIVectorImp* objects. A range can be specified.

TMICVectorImp template — vectimp.h

```
template <class T, class Alloc> class TMICVectorImp;
```

Implements a managed, counted vector of pointers to objects of type *T*. Because pointers always have meaningful copy semantics, this class can handle any type of object.

Public constructors

Constructor

```
TMICVectorImp(unsigned sz, unsigned d = 0 )
```

Constructs a managed, counted vector of pointers to objects. *sz* represents the vector size. *d* represents the initialization value.

Public member functions

In addition to the following member functions, *TMICVectorImp* inherits other member functions and operators from *TMIVectorImp* (see page 400).

Add

```
int Add( T *t );
```

Adds an object to the vector.

Find

```
unsigned Find( T *t ) const;
```

Finds the specified object pointer, and returns its index.

Protected member functions

Find

```
virtual unsigned Find( void * ) const;
```

Finds the specified pointer and returns its index.

TMICVectorIteratorImp template — vectimp.h

```
template <class T, class Alloc> class TMICVectorIteratorImp;
```

Implements a vector iterator that works with an indirect, managed, counted vector. See *TMIVectorIteratorImp* on page 402 and *TMVectorIteratorImp* on page 393 for members.

Public constructors

Constructor

```
TMICVectorIteratorImp( const TMICVectorImp<T,Alloc> &v )
```

Creates an iterator object to traverse *TMCIVectorImp* objects.

Constructor

```
TMICVectorIteratorImp( const TMICVectorImp<T,Alloc> &v, unsigned l,
                       unsigned u )
```

Creates an iterator object to traverse *TMICVectorImp* objects. A range can be specified.

TICVectorImp template — vectimp.h

```
template <class T> class TICVectorImp;
```

Implements a counted vector of pointers to objects of type *T*. Because pointers always have meaningful copy semantics, this class can handle any type of object. See *TMICVectorImp* on page 404 for members.

Public constructors

Constructor

```
TICVectorImp( unsigned sz, unsigned d = 0 )
```

Constructs a counted vector of pointers to objects. *sz* represents the vector size. *d* represents the initialization value.

TICVectorIteratorImp template — vectimp.h

```
template <class T> class TICVectorIteratorImp;
```

Implements a vector iterator that works with an indirect, managed, counted vector. See *TMIVectorIteratorImp* on page 402 and *TMVectorIteratorImp* on page 393 for members.

Public constructors

Constructor

```
TICVectorIteratorImp( const TICVectorImp<T> &v )
```

Creates an iterator object to traverse *TICVectorImp* objects.

Constructor

```
TICVectorIteratorImp( const TICVectorImp<T> &v, unsigned l, unsigned u )
```

Creates an iterator object to traverse *TICVectorImp* objects. A range can be specified.

TMISVectorImp template — vectimp.h

```
template <class T, class Alloc> class TMISVectorImp;
```

Implements a managed, sorted vector of pointers to objects of type *T*. Because pointers always have meaningful copy semantics, this class can handle any type of object. See *TMICVectorImp* on page 404 for members.

Public constructors

Constructor

```
TMISVectorImp( unsigned sz, unsigned d = 0 );
```

Constructs a managed, sorted vector of pointers to objects. *sz* represents the vector size. *d* represents the initialization value.

TMISVectorIteratorImp template — vectimp.h

```
template <class T, class Alloc> class TMISVectorIteratorImp;
```

Implements a vector iterator that works with an indirect, managed, sorted vector. See *TMIVectorIteratorImp* on page 402 and *TMVectorIteratorImp* on page 393 for members.

Public constructors

Constructor

```
TMISVectorIteratorImp( const TMISVectorImp<T,Alloc> &v )
```

Creates an iterator object to traverse *TMIVectorImp* objects.

Constructor

```
TMISVectorIteratorImp( const TMISVectorImp<T,Alloc> &v, unsigned l,
                       unsigned u )
```

Creates an iterator object to traverse *TMIVectorImp* objects. A range can be specified.

TISVectorImp template — vectimp.h

```
template <class T> class TISVectorImp;
```

Implements a sorted vector of pointers to objects of type *T*. Because pointers always have meaningful copy semantics, this class can handle any type of object. See *TMICVectorImp* on page 404 for members.

Public constructors

Constructor

```
TISVectorImp( unsigned sz, unsigned d = 0 )
```

Constructs a managed, sorted vector of pointers to objects. *sz* represents the vector size. *d* represents the initialization value.

TISVectorIteratorImp template — vectimp.h

```
template <class T> class TISVectorIteratorImp;
```

Implements a vector iterator that works with an indirect, managed, sorted vector. See *TMIVectorIteratorImp* on page 402 and *TMVectorIteratorImp* on page 393 for members.

Public constructors

Constructor

```
TISVectorIteratorImp( const TISVectorImp<T> &v )
```

Creates an iterator object to traverse *TISVectorImp* objects.

Constructor

```
TISVectorIteratorImp( const TISVectorImp<T> &v, unsigned l, unsigned u )
```

Creates an iterator object to traverse *TISVectorImp* objects. A range can be specified.

TShouldDelete class — shddel.h

```
class TShouldDelete;
```

TShouldDelete maintains the ownership state of an indirect container. The fate of objects that are removed from a container can be made to depend on whether the container owns its elements or not. Similarly, when a container is destroyed, ownership can dictate the fate of contained objects that are still in scope. As a virtual base class, *TShouldDelete* provides ownership control for all containers classes. The member function *OwnsElements* can be used either to report or to change the ownership status of a container. The member function *DelObj* is used to determine if objects in containers should be deleted or not.

Public data members

```
enum DeleteType { NoDelete, DefDelete, Delete };
```

Enumerates values to determine whether or not an object should be deleted upon removal from a container.

Public constructors

Constructor

```
TShouldDelete( DeleteType dt = Delete )
```

Creates a *TShouldDelete* object. See member function *DelObj*.

Public member functions

OwnsElements

```
int OwnsElements()
```

Returns 1 if the container owns its elements; otherwise returns 0.

```
void OwnsElements( int del )
```

Changes the ownership status as follows: if *del* is 0, ownership is turned off; otherwise ownership is turned on.

Protected member functions

DelObj

```
int DelObj( DeleteType dt )
```

Tests the state of ownership and returns 1 if the contained objects should be deleted or 0 if the contained elements should not be deleted. The factors determining this are the current ownership state, and the value of *dt*, as shown in the following table.

	delObj	
ownsElements	**No**	**Yes**
NoDelete	No	No
DefDelete	No	Yes
Delete	Yes	Yes

delObj returns 1 if (*dt* is *Delete*) or (*dt* is *DefDelete* and the container currently owns its elements). Thus a *dt* of *NoDelete* returns 0 (don't delete) regardless of ownership; a *dt* of *Delete* return 1 (do delete) regardless of ownership; and a *dt* of *DefDelete* returns 1 (do delete) if the elements are owned, but a 0 (don't delete) if the objects are not owned.

C H A P T E R 7

The C++ mathematical classes

This chapter describes Borland C++ mathematics based on C++ classes. These mathematical operations are available only in C++ programs. However, a C++ program that uses any of these classes, the numerical types that the classes define, or any of the classes' **friend** and member functions can use any of ANSI C Standard mathematics routines.

There are two classes, *bcd* and *complex*, that construct numerical types. Along with these numerical types, each class defines the functions with which to carry out operations with their respective types (for example, converting to and from the *bcd* and *complex* type). Each class also overloads all necessary operators.

The mathematical classes are independent of any hierarchy. However, each class includes the iostream.h header file.

The portability for *bcd* and *complex* is as follows:

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■			■

bcd — bcd.h

The class constructors create binary coded decimals (BCD) from integers or floating-point numerical types. The **friend** function *real*, described on page 413, converts *bcd* numbers to **long double**.

Once you construct *bcd* numbers, you can freely mix them in expressions with **ints**, **doubles**, and other numeric types. You can also use *bcd* numbers in any of the ANSI C Standard mathematical functions.

The following ANSI C math functions are overloaded to operate with *bcd* types:

```
friend bcd  abs(bcd &);
friend bcd  acos(bcd &);
friend bcd  asin(bcd &);
```

```
friend bcd  atan(bcd &);
friend bcd  cos(bcd &);
friend bcd  cosh(bcd &);
friend bcd  exp(bcd &);
friend bcd  log(bcd &);
friend bcd  log10(bcd &);
friend bcd  pow(bcd & base, bcd & expon);
friend bcd  sin(bcd &);
friend bcd  sinh(bcd &);
friend bcd  sqrt(bcd &);
friend bcd  tan(bcd &);
friend bcd  tanh(bcd &);
```

See the documentation of these functions in Chapter 2.

The *bcd* class also overloads the operators **+**, **–**, *****, **/**, **+=**, **–=**, ***=**, **/=**, **=**, **==**, and **!=**. These operators provide *bcd* arithmetic manipulation in the usual sense.

The operators **<<** and **>>** are overloaded for stream input and output of *bcd* numbers, as they are for other data types in iostream.h.

bcd numbers have about 17 decimal digits precision, and a range of about 1×10^{-125} to 1×10^{125}.

The number is rounded according to the rules of banker's rounding, which means round to nearest whole number, with ties being rounded to an even digit.

Public constructors

Constructor

```
bcd();
```

The default constructor. You typically use this to declare a variable of type *bcd*.

```
bcd i;        // Construct a bcd-type number.
bcd j = 37;   // Construct and initialize a bcd-type number.
```

Constructor

```
bcd(int x);
```

This constructor defines a *bcd* variable from an **int** variable or directly from an integer.

```
int i = 15;
bcd j = bcd(i);    // Initialize j with a previously declared type.
bcd k = bcd(12);   // Construct k from the integer provided.
```

The above example provides these variables:

```
i = 15   j = 15    k = 12
```

Constructor

```
bcd(unsigned int x);
```

This constructor defines a *bcd* variable from a variable that was previously declared to be an **unsigned int** type. An unsigned integer can be provided directly to the constructor.

Constructor

```
bcd(long x);
```

This constructor defines a *bcd* variable from an **long** variable or directly from a **long** value.

Constructor

```
bcd(unsigned long x);
```

This constructor defines a *bcd* variable from a variable that was previously declared to be an **unsigned long** type.

Constructor

```
bcd(double x, int decimals = Max);
```

This constructor defines a *bcd* variable from a variable that was previously declared to be a floating point **double** type. The constructor also creates a variable directly from a **double** value.

To specify a precision level (that is, the number of digits after the decimal point) that is different from the default, use the variable *decimals*; for example,

```
double x = 1.2345;  // Declare and initialize in the usual manner.
bcd y = bcd(x, 2);  // Create a bcd numerical type from x.
```

The precision level for *y* is set to 2. Therefore, *y* is initialized with 1.23.

Constructor

```
bcd(long double x, int decimals = Max);
```

This constructor defines a *bcd* variable from a variable that was previously declared to be a floating point **long double** type. Alternately, you can supply a **long double** value directly in the place of *x*.

To specify a precision level (that is, the number of digits after the decimal point) that is different from the default, use the variable *decimals*.

Friend functions

real

```
long double real(bcd number)
```

You can use the *real* function to convert a binary coded decimal number back to a **long double**. See the *Programmer's Guide*, Chapter 2, for a discussion about arithmetic conversions.

complex — complex.h

Creates *complex* numbers. Once you construct *complex* numbers, you can freely mix them in expressions with **int**s, **double**s, and other numeric types. You can also use *complex* numbers in any of the ANSI C Standard mathematical functions. The ANSI math functions are documented in Chapter 2.

The *complex* class also overloads the operators **+**, **–**, *****, **/**, **+=**, **–=**, ***=**, **/=**, **=**, **==**, and **!=**. These operators provide complex arithmetic manipulation in the usual sense.

The operators **<<** and **>>** are overloaded for stream input and output of *complex* numbers, as they are for other data types in iostream.h.

If you don't want to program in C++, but instead want to program in C, the only constructs available to you are **struct** *complex* and *cabs*, which give the absolute value of a complex number. Both of these alternates are defined in math.h.

Public constructors

Constructor

```
complex();
```

The default constructor. You typically use this to declare a variable of type *complex.*

```
complex i;      // Construct a complex-type number.
complex j = 37; // Construct and initialize a complex-type number.
```

Constructor

```
complex(double real, double imag = 0);
```

Creates a *complex* numerical type out of a **double**. Upon construction, a real and an imaginary part are provided. The imaginary part is considered to be zero if *imag* is omitted.

Friend functions

abs

```
friend double abs(complex& val);
```

Returns the absolute value of a complex number.

The complex version of *abs* returns a **double**. All other math functions return a *complex* type when *val* is *complex* type.

acos

```
friend complex acos(complex& z);
```

Calculates the arc cosine.

The complex inverse cosine is defined by

```
acos(z) = -i * log(z + i sqrt(1 - z²))
```

arg

```
double arg(complex x);
```

arg gives the angle, in radians, of the number in the complex plane.

The positive real axis has angle 0, and the positive imaginary axis has angle *pi*/2. If the argument passed to *arg* is *complex* 0 (zero), *arg* returns zero.

arg(*x*) returns *atan2*(*imag*(*x*), *real*(*x*)).

asin

```
friend complex asin(complex& z);
```

Calculates the arc sine.

The complex inverse sine is defined by

```
asin(z) = -i * log(i * z + sqrt(1 - z²))
```

atan

```
friend complex atan(complex& z);
```

Calculates the arc tangent.

The complex inverse tangent is defined by

```
atan(z) = -0.5 i log((1 + i z)/(1 - i z))
```

conj

```
complex conj(complex z);
```

Returns the complex conjugate of a complex number.
`conj(z)` is the same as `complex(real(z), -imag(z))`.

cos

```
friend complex cos(complex& z);
```

Calculates the cosine of a value.

The complex cosine is defined by

```
cos(z) = ( exp(i * z) + exp(-i * z) ) / 2
```

cosh

```
friend complex cosh(complex& z);
```

Calculates the hyperbolic cosine of a value.

The complex hyperbolic cosine is defined by

```
cosh(z) = ( exp(z) + exp(-z) ) / 2
```

exp

```
friend complex exp(complex& y);
```

Calculates the exponential *e* to the *y*.

The complex exponential function is defined by

```
exp(x + y * i) = exp(x) (cos(y) + i * sin(y) )
```

imag

```
double imag(complex x);
```

Returns the imaginary part of a *complex* number.

The data associated to a complex number consists of two floating-point (**double**) numbers. *imag* returns the one considered to be the imaginary part.

log

```
friend complex log(complex& z);
```

Calculates the natural logarithm of z.

The complex natural logarithm is defined by

```
log(z) = log( abs(z) ) + i * arg(z)
```

log10

```
friend complex log10(complex& z);
```

Calculates $\log_{10}(z)$.

The complex common logarithm is defined by

```
log10(z) = log(z) / log(10)
```

norm

```
double norm(complex x);
```

Returns the square of the absolute value. *norm*(*x*) returns the magnitude *real*(*x*) * *real*(*x*) + *imag*(*x*) * *imag*(*x*).

norm can overflow if either the real or imaginary part is sufficiently large.

polar

```
complex polar(double mag, double angle = 0);
```

Returns a *complex* number with a given magnitude (absolute value) and angle.

polar(*mag*, *angle*) is the same as *complex*(*mag* * *cos*(*angle*), *mag* * *sin*(*angle*)).

pow

```
friend complex pow(complex& base, double expon);
friend complex pow(double base, complex& expon);
friend complex pow(complex& base, complex& expon);
```

Calculates *base* to the power of *expon*.

The complex *pow* is defined by

```
pow(base, expon) = exp(expon * log(base))
```

real

```
double real(complex x);
```

You can use the *real* function to convert a *complex* number back to a **long double**. The **friend** function returns the real part of a complex number or converts a *complex* number back to **double**. The data associated to a complex number consists of two floating-point numbers. *real* returns the number considered to be the real part.

See the *Programmer's Guide*, Chapter 2, for a discussion about arithmetic conversions.

sin

```
friend complex sin(complex& z);
```

Calculates the trigonometric sine.

The complex sine is defined by

```
sin(z) = ( exp(i * z) - exp(-i * z) ) / (2 * i)
```

sinh

```
friend complex sinh(complex& z);
```

Calculates the hyperbolic sine.

The complex hyperbolic sine is defined by

```
sinh(z) = ( exp(z) - exp(-z) ) / 2
```

sqrt

```
friend complex sqrt(complex& x);
```

Calculates the positive square root.

For any *complex* number *x*, *sqrt*(*x*) gives the *complex* root whose *arg* is *arg*(*x*)/2.

The complex square root is defined by

```
sqrt(x) = sqrt(abs(x)) (cos( arg(x) / 2) + i * sin(arg(x)/2))
```

tan

```
friend complex tan(complex& z);
```

Calculates the trigonometric tangent.

The complex tangent is defined by

```
tan(z) = sin(z) / cos(z)
```

tanh

```
friend complex tanh(complex& z);
```

Calculates the hyperbolic tangent.

The complex hyperbolic tangent is defined by

```
tanh(z) = sinh(z) / cosh(z)
```

C H A P T E R 8

Class diagnostic macros

Borland provides a set of macros for debugging C++ code. These macros are located in checks.h. There are two types of macros, default and extended. The default macros are

- CHECK
- PRECONDITION
- TRACE
- WARN

The extended macros are

- CHECKX
- PRECONDITIONX
- TRACEX
- WARNX

The default macros provide straightforward value checking and message output. The extended macros let you create macro groups that you can selectively enable or disable. Extended macros also let you selectively enable or disable macros within a group based on a numeric threshold level.

To use __DEBUG, you must link with the diagnostic libraries.

Three preprocessor symbols control diagnostic macro expansion: __DEBUG, __TRACE, and __WARN. If one of these symbols is defined when compiling, then the corresponding macros expand and diagnostic code is generated. If none of these symbols is defined, then the macros do not expand and no diagnostic code is generated. These symbols can be defined on the command line using the **-D** switch, or by using `#define` statements within your code.

The diagnostic macros are enabled according to the following table:

	__DEBUG=1	__DEBUG=2	__TRACE	__WARN
PRECONDITION	X	X		
PRECONDITIONX	X	X		
CHECK		X		
CHECKX		X		
TRACE			X	
TRACEX			X	
WARN				X
WARNX				X

To create a diagnostic version of an executable, place the diagnostic macros at strategic points within the program code and compile with the appropriate preprocessor symbols defined. Diagnostic versions of the Borland class libraries are built in a similar manner.

The following sections describe the default and extended diagnostic macros, give examples of their use, and explain message output and run-time control.

Default diagnostic macros — checks.h

CHECK

```
CHECK(<cond>)
```

Throws an exception containing the string *<msg>* if *<cond>* equals 0. Use CHECK to perform value checking within a function.

PRECONDITION

```
PRECONDITION(<cond>)
```

Throws an exception containing the string *<msg>* if *<cond>* equals 0. Use PRECONDITION on entry to a function to check the validity of the arguments and to do any other checking to determine if the function has been invoked correctly.

TRACE

```
TRACE(<msg>)
```

Outputs *<msg>*. TRACE is used to output general messages that are not dependent on a particular condition.

WARN

```
WARN(<cond>,<msg>)
```

Outputs *<msg>* if *<cond>* is nonzero. It is used to output conditional messages.

Example The following program illustrates the use of the default TRACE and WARN macros:

```
#include <checks.h>

int main()
{
   TRACE( "Hello World" );
   WARN( 5 != 5, "Math is broken!" );
   WARN( 5 != 7, "Math still works!" );

   return 0;
}
```

When the above code is compiled with __TRACE and __WARN defined, it produces the following output when run:

```
Trace PROG.C 5: [Def] Hello World
Warning PROG.C 7: [Def] Math still works!
```

The above output indicates that the message "Hello World" was output by the default TRACE macro on line 5 of PROG.C, and the message "Math still works!" was output by the default WARN macro on line 7 of PROG.C.

Default diagnostic macros expand to extended diagnostic macros with the group set to "Def" and the level set to 0. This "Def" group controls the behavior of the default macros and is initially enabled with a threshold level of 0.

Extended diagnostic macros — checks.h

The extended macros CHECKX and PRECONDITIONX augment CHECK and PRECONDITION by letting you provide a message to be output when the condition fails.

The extended macros TRACEX and WARNX augment TRACE and WARN by providing a way to specify macro groups that can be independently enabled or disabled. TRACEX and WARNX require additional arguments that specify the group to which the macros belongs, and the threshold level at which the macro should be executed. The macro is executed only if the specified group is enabled and has a threshold level that is greater than or equal to the threshold-level argument used in the macro.

The following sections describe the extended diagnostic macros.

CHECKX

`CHECKX(<cond>,<msg>)`

Throws an exception containing the string <*msg*> if <*cond*> equals 0. Use CHECKX to perform value checking within a function.

PRECONDITIONX

`PRECONDITIONX(<cond>,<msg>)`

Throws an exception containing the string <*msg*> if <*cond*> equals 0. Use PRECONDITIONX on entry to a function to check the validity of the arguments and to do any other checking to determine if the function has been invoked correctly.

TRACEX

`TRACEX(<group>,<level>,<msg>)`

Trace only if <*group*> and <*level*> are enabled.

WARNX

`WARNX(<group>,<cond>,<level>,<msg>)`

Warn only if <*group*> and <*level*> are enabled.

When using TRACEX and WARNX you need to be able to create groups. The following three macros create diagnostic macro groups:

DIAG_DECLARE_GROUP

```
DIAG_DECLARE_GROUP(<name>)
```

Declare a group named <*name*>. You cannot use DIAG_DEFINE_GROUP and DIAG_DECLARE_GROUP in the same compilation unit. Multiple group declarations in the same compilation unit are allowed.

If a header file uses DIAG_DECLARE_GROUP (so that the group declaration is automatically available to files that include the header), the source file that contains the DIAG_DECLARE_GROUP invocation for that group then generates a redefinition error. The solution is to conditionalize the header file so that the declaration goes away when the source file with the DIAG_DECLARE_GROUP invocation is built.

For example, in myheader.h

```
#if !defined( BUILD_MY_GROUP )
DIAG_DECLARE_GROUP
#endif
```

And in the source file my_prog.cpp:

```
#define BUILD_MY_GROUP
#include "myheader.h"
```

DIAG_DEFINE_GROUP

```
DIAG_DEFINE_GROUP(<name>,<enabled>,<level>)
```

Define a group named <*name*>. You cannot use DIAG_DEFINE_GROUP and DIAG_DECLARE_GROUP in the same compilation unit.

The following two macros manipulate groups:

DIAG_ENABLE

```
DIAG_ENABLE(<group>,<state>)
```

Sets <*group*>'s enable flag to <state>.

DIAG_ISENABLED

```
DIAG_ISENABLED(<group>)
```

Returns nonzero if <*group*> is enabled.

The following two macros manipulate levels:

DIAG_SETLEVEL

```
DIAG_SETLEVEL(<group>,<level>)
```

Sets <*group*>'s threshold level to <*level*>.

DIAG_GETLEVEL

```
DIAG_GETLEVEL(<group>)
```

Gets <*group*>'s threshold level.

Threshold levels are arbitrary numeric values that establish a threshold for enabling macros. A macro with a level greater than the group threshold level its test will be performed, but it won't display anything. For example, if a group has a threshold level of 0 (the default value), all macros that belong to that group and have levels of 1 or greater are ignored.

Example The following PROG.C example defines two diagnostic groups, *Group1* and *Group2*, which are used as arguments to extended diagnostic macros:

```
#include <checks.h>

DIAG_DEFINE_GROUP(Group1, 1, 0);
DIAG_DEFINE_GROUP(Group2, 1, 0);

int main( int argc, char **argv )
{
   TRACE( "Always works, argc=" << argc );
   TRACEX( Group1, 0, "Hello" );
   TRACEX( Group2, 0, "Hello" );

   DIAG_ENABLE(Group1, 0);

   TRACEX( Group1, 0, "Won't execute - group is disabled!" );
   TRACEX( Group2, 3, "Won't execute - level is too high!" );

   return 0;
}
```

When the above code is compiled with __TRACE defined and run, it produces the following output:

```
Trace PROG.C 8: [Def] Always works, argc=1
Trace PROG.C 10: [Group1] Hello
Trace PROG.C 11: [Group2] Hello
```

Note that the last two macros are not executed. In the first case, the group *Group1* is disabled. In the second case, the macro level exceeds *Group2*'s threshold level (set by default to 0).

Macro message output

The TRACE, TRACEX, WARN, and WARNX macros take a *<msg>* argument that is conditionally inserted into an output stream. This means a sequence of objects can be inserted in the output stream (for example `TRACE( "Mouse @ " << x << "," << y );`). The use of streams is extensible to different object types and allows for parameters within trace messages.

Run-time macro control

Diagnostic groups can be controlled at run time by using the control macros described above within your program or by directly modifying the group information within the debugger.

This group information is contained in a class named *TDiagGroup< TDiagGroupClass##Group* >, where *##Group* is the name of the group. This class contains a static structure *Flags*, which in turn contains the enabled flag and the threshold level. For example, to enable the group *Group1*, you would set the variable *TDiagGroup<TDiagGroupClassGroup1>::Flags.Enabled* to 1.

C H A P T E R 9

Run-time support

This chapter provides a detailed description, in alphabetical order, of functions and classes that provide run-time support. Any class operators or member functions are listed immediately after the class constructor. See the *Programmer's Guide*, Chapter 4, for a discussion of how to use exception-handling keywords.

The portability for all classes and functions in this chapter is as follows:

DOS	UNIX	Win 16	Win 32	ANSI C	ANSI C++	OS/2
■		■	■		■	

Bad_cast class — typeinfo.h

When **dynamic_cast** fails to make a cast to reference, the expression can throw *Bad_cast*. Note that when **dynamic_cast** fails to make a cast to pointer type, the result is the null pointer.

Bad_typeid class — typeinfo.h

When the operand of **typeid** is a dereferenced 0 pointer, the **typeid** operator can throw *Bad_typeid*.

set_new_handler function — new.h

```
typedef void (new * new_handler)() throw(xalloc);
new_handler set_new_handler(new_handler my_handler);
```

set_new_handler installs the function to be called when the global **operator new**() or **operator new**[]() cannot allocate the requested memory. By default the **new** operators throw an *xalloc* exception if memory cannot be allocated. You can change this default behavior by calling *set_new_handler* to set a new handler. To retain the traditional version of **new**, which does not throw exceptions, you can use *set_new_handler*(0).

If **new** cannot allocate the requested memory, it calls the handler that was set by a previous call to *set_new_handler*. If there is no handler installed by *set_new_handler*, **new** returns 0. *my_handler* should specify the actions to be taken when **new** cannot satisfy a request for memory allocation. The *new_handler* type, defined in new.h, is a function that takes no arguments and returns **void**. A *new_handler* can throw an *xalloc* exception.

The user-defined *my_handler* should do one of the following:

- Return after freeing memory
- Throw an *xalloc* exception or an exception derived from *xalloc*
- Call *abort* or *exit* functions

If *my_handler* returns, then **new** will again attempt to satisfy the request.

Ideally, *my_handler* frees up memory and returns; **new** can then satisfy the request and the program can continue. However, if *my_handler* cannot provide memory for **new**, *my_handler* must throw an exception or terminate the program. Otherwise, an infinite loop will be created.

Preferably, you should overload **operator new()** and **operator new[]()** to take appropriate actions for your applications.

set_new_handler returns the old handler, if one has been registered.

The user-defined argument function, *my_handler*, should not return a value.

See also the description of *abort*, *exit*, and *_new_handler* (global variable).

set_terminate function — except.h

```
typedef void (*terminate_function)();
terminate_function set_terminate(terminate_function t_func);
```

set_terminate lets you install a function that defines the program's termination behavior when a handler for the exception cannot be found. The actions are defined in *t_func*, which is declared to be a function of type *terminate_function*. A *terminate_function* type, defined in except.h, is a function that takes no arguments, and returns **void**.

By default, an exception for which no handler can be found results in the program calling the *terminate* function. This will normally result in a call to *abort*. The program then ends with the message `Abnormal program termination`. If you want some function other than *abort* to be called by the *terminate* function, you should define your own *t_func* function. Your *t_func* function is installed by *set_terminate* as the termination function. The installation of *t_func* lets you implement any actions that are not taken by *abort*.

The previous function given to *set_terminate* will be the return value.

The definition of *t_func* must terminate the program. Such a user-defined function must not return to its caller, the *terminate* function. An attempt to return to the caller results in undefined program behavior. It is also an error for *t_func* to throw an exception.

See also the description of *abort*, *set_unexpected*, and *terminate*.

set_unexpected function — except.h

```
typedef void ( * unexpected_function )();
unexpected_function set_unexpected(unexpected_function unexpected_func);
```

set_unexpected lets you install a function that defines the program's behavior when a function throws an exception not listed in its exception specification. The actions are defined in *unexpected_func*, which is declared to be a function of type *unexpected_function*. An *unexpected_function* type, defined in except.h, is a function that takes no arguments, and returns **void**.

By default, an unexpected exception causes *unexpected* to be called. If *unexpected_func* is defined, it is subsequently called by *unexpected*. Program control is then turned over to the user-defined *unexpected_func*. Otherwise, *terminate* is called.

The previous function given to *set_unexpected* will be the return value.

The definition of *unexpected_func* must not return to its caller, the *unexpected* function. An attempt to return to the caller results in undefined program behavior.

unexpected_func can also call *abort*, *exit*, or *terminate*.

See also the description of *abort*, *exit*, *set_terminate*, and *terminate*.

terminate function — except.h

```
void terminate();
```

The function *terminate* can be called by *unexpected* or by the program when a handler for an exception cannot be found. The default action by *terminate* is to call *abort*. Such a default action causes immediate program termination.

You can modify the way your program terminates when an exception is generated that is not listed in the exception specification. If you don't want the program to terminate with a call to *abort*, you can instead define a function to be called. Such a function (called a *terminate_function*) will be called by *terminate* if it is registered with *set_terminate*.

The function does not return.

See also the description of *abort* and *set_terminate*.

Type_info class — typeinfo.h

Provides information about a type.

Public constructor

Constructor

None.

Only a private constructor is provided. You cannot create *Type_info* objects. By declaring your objects to be **__rtti** types, or by using the **–RT** compiler switch, the compiler provides your objects with the elements of *Type_info*.

Type_info references are generated by the **typeid** operator. See Chapter 2 in the *Programmer's Guide* for a discussion of **typeid**.

Operators

operator ==

```
int operator==(const Type_info &) const;
```

Provides comparison of *Typeinfo*s.

operator !=

```
int operator!=(const Type_info &) const;
```

Provides comparison of *Typeinfo*s.

Public member functions

before

```
int before(const Type_info &);
```

Use this function to compare the lexical order of types. For example, to compare two types, ***T1*** and ***T2***, use the following syntax:

```
typeid( T1 ).before(typeid( T2 ));
```

The *before* function returns 0 or 1.

name

```
const char* name() const;
```

The *name* function returns a printable string that identifies the type name of the operand to **typeid**. The space for the character string is overwritten on each call.

unexpected function — except.h

```
void unexpected();
```

The *unexpected* function is called when a function throws an exception not listed in its exception specification. The program calls *unexpected,* which by default calls any user-defined function registered by *set_unexpected*. If no function is registered with *set_unexpected,* the *unexpected* function then calls *terminate.*

The *unexpected* function does not return. However, the function can throw an exception.

See also the description of *set_unexpected* and *terminate.*

xalloc class — except.h

Reports an error on allocation request.

Public constructors

Constructor

```
xalloc(const string &msg, size_t size);
```

The *xalloc* class has no default constructor. Every use of *xalloc* must define the message to be reported when a *size* allocation cannot be fulfilled. The *string* type is defined in cstring.h header file.

Public member functions

raise

```
void raise() throw(xalloc);
```

Calling *raise* causes an *xalloc* to be thrown. In particular, it throws ***this.**

requested

```
size_t requested() const;
```

Returns the number of bytes that were requested for allocation.

xmsg class — except.h

Reports a message related to an exception.

Public constructor

Constructor

```
xmsg(string msg);
```

There is no default constructor for *xmsg*. Every *xmsg* object must have a *string* message explicitly defined. The *string* type is defined in cstring.h header file.

Public member functions

raise

```
void raise() throw(xmsg);
```

Calling *raise* causes an *xmsg* to be thrown. In particular, it throws ***this**.

why

```
string why() const;
```

Reports the string used to construct an *xmsg*. Because every *xmsg* must have its message explicitly defined, every instance should have a unique message.

C H A P T E R 10

C++ utility classes

This chapter is a reference guide for the following classes, which are listed here with their associated header-file names:

■ Date class	BCOS2\INCLUDE\CLASSLIB\date.h
■ File classes	BCOS2\INCLUDE\CLASSLIB\file.h
■ String classes	BCOS2\INCLUDE\cstring.h
■ Threading classes	BCOS2\INCLUDE\CLASSLIB\thread.h
■ Time classes	BCOS2\INCLUDE\CLASSLIB\time.h

TDate class — date.h

```
class  TDate
```

Class *TDate* represents a date. It has members that read, write, and store dates, and that convert dates to Gregorian calendar dates.

Type definitions

DayTy

```
typedef unsigned DayTy;
```

Day type.

HowToPrint

```
enum HowToPrint{ Normal, Terse, Numbers, EuropeanNumbers, European };
```

Lists different print formats.

JulTy

```
typedef unsigned long JulTy;
```

Julian calendar type.

MonthTy

```
typedef unsigned MonthTy;
```

Month type.

YearTy

```
typedef unsigned YearTy;
```

Year type.

Public constructors

Constructor

```
TDate();
```

Constructs a *TDate* object with the current date.

Constructor

```
TDate( DayTy day, YearTy year );
```

Constructs a *TDate* object with the given *day* and *year*. The base date for this computation is Dec. 31 of the previous year. If year == 0, it constructs a *TDate* with Jan. 1, 1901 as "day zero." For example, TDate(-1,0) = Dec. 31, 1900 and TDate(1,0) = Jan. 2, 1901.

Constructor

```
TDate( DayTy day, const char* month, YearTy year);
TDate( DayTy day, MonthTy month, YearTy year);
```

Constructs a *TDate* object for the given *day*, *month*, and *year*.

Constructor

```
TDate( istream& is );
```

Constructs a *TDate* object, reading the date from input stream *is*.

Constructor

```
TDate( const TTime& time);
```

Constructs a *TDate* object from *TTime* object *time*.

Public member functions

AsString

```
string AsString() const;
```

Converts the *TDate* object to a *string* object.

Between

```
int Between( const TDate& d1, const TDate& d2 ) const;
```

Returns 1 if this *TDate* object is between *d1* and *d2*, inclusive.

CompareTo

```
int CompareTo( const TDate & ) const;
```

Returns 1 if the target *TDate* is greater than parameter *TDate*, –1 if the target is less than the parameter, and 0 if the dates are equal.

Day

```
DayTy Day() const;
```

Returns the day of the year (1-365).

DayName

```
const char *DayName( DayTy weekDayNumber );
```

Returns a string name for the day of the week, where Monday is 1 and Sunday is 7.

DayOfMonth

```
DayTy DayOfMonth() const;
```

Returns the day of the month (1-31).

DayOfWeek

```
DayTy DayOfWeek( const char* dayName );
```

Returns the number associated with a string naming the day of the week, where Monday is 1 and Sunday is 7.

DaysInYear

```
DayTy DaysInYear( YearTy );
```

Returns the number of days in the specified year (365 or 366).

DayWithinMonth

```
int DayWithinMonth( MonthTy, DayTy, YearTy );
```

Returns 1 if the given day is within the given month for the given year.

FirstDayOfMonth

```
DayTy FirstDayOfMonth() const;
```

Returns the number of the first day of the month for this *TDate*.

```
DayTy FirstDayOfMonth( MonthTy month) const;
```

Returns the number of the first day of a given month. Returns 0 if *month* is outside the range 1 through 12.

Hash

```
unsigned Hash() const;
```

Returns a hash value for the date.

IndexOfMonth

```
MonthTy IndexOfMonth( const char *monthName );
```

Returns the number (1-12) of the month *monthname*.

IsValid

```
int IsValid() const;
```

Returns 1 if this *TDate* is valid, 0 otherwise.

Jday

```
JulTy Jday( MonthTy, DayTy, YearTy );
```

Converts the given Gregorian calendar date to the corresponding Julian day number. Gregorian calendar started on Sep. 14, 1752. This function not valid before that date. Returns 0 if the date is invalid.

Leap

```
int Leap() const;
```

Returns 1 if this *TDate*'s year is a leap year, 0 otherwise.

Max

```
TDate Max( const TDate& dt ) const;
```

Compares this *TDate* with *dt* and returns the date with the greater Julian number.

Min

```
TDate Min( const TDate& dt ) const;
```

Compares this *TDate* with *dt* and returns the date with the lesser Julian number.

Month

```
MonthTy Month() const;
```

Returns the month number for this *TDate*.

MonthName

```
const char *MonthName( MonthTy monthNumber );
```

Returns the string name for the given *monthNumber* (1-12). Returns 0 for an invalid *monthNumber.*

NameOfDay

```
const char *NameOfDay() const;
```

Returns this *TDate*'s day string name.

NameOfMonth

```
const char *NameOfMonth() const;
```

Returns this *TDate*'s month string name.

Previous

```
TDate Previous( const char *dayName ) const;
```

Returns the *TDate* of the previous *dayName*.

```
TDate Previous( DayTy day ) const;
```

Returns the *TDate* of the previous *day*.

SetPrintOption

```
HowToPrint SetPrintOption( HowToPrint h );
```

Sets the print option for all *TDate* objects and returns the old setting. See *HowToPrint* in the "Type definition" section for this class.

WeekDay

```
DayTy WeekDay() const;
```

Returns 1 (Monday) through 7 (Sunday).

Year

```
YearTy Year() const;
```

Returns the year of this *TDate*.

Protected member functions

AssertIndexOfMonth

```
static int AssertIndexOfMonth( MonthTy m );
```

Returns 1 if *m* is between 1 and 12 inclusive, otherwise returns 0.

AssertWeekDayNumber

```
static int AssertWeekDayNumber( DayTy d);
```

Returns 1 if *d* is between 1 and 7 inclusive, otherwise returns 0.

Operators

Operator <

```
int operator < ( const TDate& date ) const;
```

Returns 1 if this *TDate* precedes *date*, otherwise returns 0.

Operator <=

```
int operator <= ( const TDate& date ) const;
```

Returns 1 if this *TDate* is less than or equal to *date,* otherwise returns 0.

Operator >

```
int operator >  ( const TDate& date ) const;
```

Returns 1 if this *TDate* is greater than *date,* otherwise returns 0.

Operator >=

```
int operator >= ( const TDate& date ) const;
```

Returns 1 if this *TDate* is greater than or equal to *date,* otherwise returns 0.

Operator ==

```
int operator == ( const TDate& date ) const;
```

Returns 1 if this *TDate* is equal to *date,* otherwise returns 0.

Operator !=

```
int operator != ( const TDate& date ) const;
```

Returns 1 if this *TDate* is not equal to *date,* otherwise returns 0.

Operator –

```
JulTy operator - ( const TDate& dt ) const;
```

Subtracts *dt* from this *TDate* and returns the difference.

Operator +

```
friend TDate operator + ( const TDate& dt, int dd );
friend TDate operator + ( int dd, const TDate& dt );
```

Returns a new *TDate* containing the sum of this *TDate* and *dd.*

Operator –

```
friend TDate operator - ( const TDate& dt, int dd );
```

Subtracts *dd* from this *TDate* and returns the difference.

Operator ++

```
void operator ++ ();
```

Increments this *TDate* by 1.

Operator – –

```
void operator -- ();
```

Decrements this *TDate* by 1.

Operator +=

```
void operator += ( int dd );
```

Adds *dd* to this *TDate.*

Operator –=

```
void operator -= ( int dd );
```

Subtracts *dd* from this *TDate.*

Operator <<

```
friend ostream& operator << ( ostream& os, const TDate& date );
```

Inserts *date* into output stream *os.*

Operator >>

```
friend istream& operator >> ( istream& is, TDate& date );
```

Extracts *date* from input stream *is.*

TFileStatus structure file.h

```
struct TFileStatus
{
   TTime createTime;
   TTime modifyTime;
   TTime accessTime;
   long size;
   uint8 attribute;
   char fullName[_MAX_PATH];
};
```

Describes a file record containing creation, modification, and access times; also provides the file size, attributes, and name.

See also: *TTime* class

TFile class file.h

```
class  TFile
```

Class *TFile* encapsulates standard file characteristics and operations.

Public data members

FileNull

```
enum { FileNull };
```

Represents a null file handle.

File flags

```
enum{
   ReadOnly    = O_RDONLY,
   ReadWrite   = O_RDWR,
   WriteOnly   = O_WRONLY,
   Create      = O_CREAT | O_TRUNC,
   CreateExcl  = O_CREAT | O_EXCL,
   Append      = O_APPEND,
   Compat      = SH_COMPAT,
   DenyNone    = SH_DENYNONE,
   DenyRdWr    = SH_DENYRW,
   NoInherit   = O_NOINHERIT
   };
```

Enumerates file-translation modes and sharing capabilities. See the *open* and *sopen* functions in Chapter 2.

```
enum{
   PermRead    = S_IREAD,
   PermWrite   = S_IWRITE,
   PermRdWr    = S_IREAD | S_IWRITE
   };
```

Enumerates file read and write permissions. See the *creat* function in Chapter 2.

```
enum{
   Normal      = 0x00,
   RdOnly      = 0x01,
   Hidden      = 0x02,
   System      = 0x04,
   Volume      = 0x08,
   Directory   = 0x10,
   Archive     = 0x20
  };
```

Enumerates file types.

```
enum seek_dir
   {
   beg = 0,
   cur = 1,
   end = 2
   };
```

Enumerates file-pointer seek direction.

Public constructors

Constructor

```
TFile();
```

Creates a *TFile* object with a file handle of *FileNull*.

Constructor

```
TFile( int handle );
```

Creates a *TFile* object with a file handle of *handle*.

Constructor

```
TFile( const TFile& file );
```

Creates a *TFile* object with the same file handle *file*.

Constructor

```
TFile( const char* name, uint16 access=ReadOnly,
       uint16 permission=PermRdWr );
```

Creates a *TFile* object and opens file *name* with the given attributes. The file is created if it doesn't exist.

Public member functions

Close

```
int Close();
```

Closes the file. Returns nonzero if successful, 0 otherwise.

Flush

```
void Flush();
```

Performs any pending I/O functions.

GetHandle

```
int GetHandle() const;
```

Returns the file handle.

GetStatus

```
int GetStatus( TFileStatus& status ) const;
```

Fills *status* with the current file status. Returns nonzero if successful, 0 otherwise.

```
int GetStatus( const char *name, TFileStatus& status );
```

Fills *status* with the status for file *name*. Returns nonzero if successful, 0 otherwise.

IsOpen

```
int IsOpen() const;
```

Returns 1 if the file is open, 0 otherwise.

Length

```
long Length() const;
```

Returns the file length.

```
void Length( long newLen );
```

Resizes file to *newLen*.

LockRange

```
void LockRange( long position, uint32 count );
```

Locks *count* bytes, beginning at *position* of the associated file.

See also: *UnlockRange*

Open

```
int Open( const char* name, uint16 access, uint16 permission );
```

Opens file *name* with the given attributes. The file will be created if it doesn't exist. Returns 1 if successful, 0 otherwise.

Position

```
long Position() const;
```

Returns the current position of the file pointer. Returns –1 to indicate an error.

Read

```
int Read( void *buffer, int numBytes );
```

Reads *numBytes* from the file into *buffer*.

Remove

```
static void Remove( const char *name );
```

Removes file *name*. Returns 0 if successful, –1 if unsuccessful.

Rename

```
static void Rename( const char *oldName, const char *newName );
```

Renames file *oldName* to *newName*.

Seek

```
long Seek( long offset, int origin = beg );
```

Repositions the file pointer to *offset* bytes from the specified *origin*.

SeekToBegin

```
long SeekToBegin();
```

Repositions the file pointer to the beginning of the file.

SeekToEnd

```
long SeekToEnd();
```

Repositions the file pointer to the end of the file.

SetStatus

```
static int SetStatus( const char *name, const TFileStatus& status );
```

Sets file *name*'s status to *status*.

UnlockRange

```
void UnlockRange(long Position, uint32 count );
```

Unlocks the range at the given *Position*.

See also: *LockRange*

Write

```
int Write( const void *buffer, int numBytes );
```

Writes *numbytes* of *buffer* to the file.

string class — cstring.h

```
class  string
```

This class uses a technique called "copy-on-write." Multiple instances of a string can refer to the same piece of data so long as it is in a "read-only" situation. If a string writes to the data, a copy is automatically made if more than one string is referring to it.

Type definitions

StripType

```
enum StripType { Leading, Trailing, Both };
```

Enumerates type of stripping. See *strip* in the "Public member functions" section for this class.

Public constructors and destructor

Constructor

```
string();
```

The default constructor. Creates a string of length zero.

Constructor

```
string(const string &s);
```

Copy constructor. Creates a string that contains a copy of the contents of string *s*.

Constructor

```
string( const string &s, size_t start, size_t n = NPOS )
```

Creates a string containing a copy of the *n* bytes beginning at position *start* of string *s*.

Constructor

```
string(const char *cp);
```

Creates a string containing a copy of the bytes from the location pointed to by *cp* through the first 0 byte (conversion from *char**).

Constructor

```
string( const char *cp, size_t start, size_t n = NPOS );
```

Creates a string containing a copy of the *n* bytes beginning at the position *start* in the buffer pointed to by *cp*.

```
// Construct a string object from a char buffer.
#include <cstring.h>
#include <iostream.h>

int main(void) {
   const char *cp = "0123456789";
   string s1(cp, 3, 5);

   cout << "s1 = " << s1;
   return 0;
   }
```

Program output:

```
s1 = 34567
```

Constructor

```
string( char c )
```

Constructs a string containing the character c.

Constructor

```
string( char c, size_t n )
```

Constructs a string containing the character c repeated *n* times.

Constructor

```
string( signed char c )
```

Constructs a string containing the character c.

Constructor

```
string( signed char c, size_t n )
```

Constructs a string containing the character c repeated *n* times.

Constructor

```
string( unsigned char c )
```

Constructs a string containing the character c.

Constructor

```
string( unsigned char c, size_t n )
```

Constructs a string containing the character c repeated *n* times.

Constructor

```
string(const TSubString &ss);
```

Constructs a string from the substring *ss*.

Destructor

```
~string();
```

Frees all resources allocated to this object.

Public member functions

append

```
string & append( const string &s )
```

Appends string *s* to the target string.

```
string  & append( const string  &s, size_t start, size_t n = NPOS)
```

Beginning from the *start* position in *s*, the *append* function appends the next *n* characters of string *s* to the target string.

```
string  & append( const char  *cp, size_t start, size_t n = NPOS )
```

Beginning from the *start* position of the character array *cp*, the *append* function appends the next *n* characters to the target string.

assign

```
string & assign( const string  &s );
```

Assigns string *s* to target string.

See also: *operator =*

```
string & assign( const string  &s, size_t start, size_t n = NPOS );
```

Beginning from the *start* position in *s*, the *assign* function copies *n* characters to target string. For example:

```
string s1 = "abcdef";
string s2;
s2.assign( s1, 2, 3 );
```

Results in *s2* set to `cde`.

See also: *operator =*

compare

```
int compare(const string  &s);
```

Compares the target string to the string *s*. *compare* returns an integer less than, equal to, or greater than 0, depending on whether the target string is less than, equal to, or greater than *s*.

```
int compare( const string  &s, size_t start, size_t n = NPOS );
```

Beginning as position *start* in *s*, the *compare* function compares not more than *n* characters from the target string to the string *s*. The *compare* function returns a negative value if the string compares less than the argument, 0 if they compare equal, and positive if greater than.

contains

```
int contains(const char  * pat) const;
```

Returns 1 if *pat* is found in the target string, 0 otherwise.

```
int contains(const string  & s) const;
```

Returns 1 if string *s* is found in the target string, 0 otherwise.

copy

```
size_t copy( char  *cb, size_t n )
```

Copies at most *n* characters from the target string into the *char* array pointed to by *cb*. *copy* returns the number of characters copied.

```
size_t copy( char  *cb, size_t n, size_t pos )
```

Copies at most *n* characters beginning at position *pos* from the target string into the *char* array pointed to by *cb*. *copy* returns the number of characters copied.

```
string copy() const throw( xalloc ).
```

Returns a distinct copy of the string.

c_str

```
const char  *c_str() const;
```

Returns a pointer to a zero-terminated character array that holds the same characters contained in the string. The returned pointer might point to the actual contents of the string, or it might point to an array that the string allocates for this function call. The effects of any direct modification to the contents of this array are undefined, and the results of accessing this array after the execution of any non-**const** member function on the target string are undefined.

Conversions from a string object to a *char** are inherently dangerous, because they violate the class boundary and can lead to dangling pointers. For this reason class string does not have an implicit conversion to *char**, but provides *c_str* for use when this conversion is needed.

find

```
size_t find( const string  &s )
```

Locates the first occurrence of the string *s* in the target string. If the string is found, it returns the position of the beginning of *s* within the target string. If the string *s* is not found, it returns *NPOS*.

```
size_t find( const string  &s, size_t pos )
```

Locates the first occurrence of the string *s* in the target string, beginning at the position *pos*. If the string is found, it returns the position of the beginning of *s* within the target string. If the *s* is not found, it returns *NPOS* and does not change *pos*.

```
size_t find( const TRegexp  &pat, size_t i = 0 )
```

Searches the string for patterns matching regular expression *pat* beginning at location *i*. It returns the position of the beginning of *pat* within the target string. If the *pat* is not found, it returns *NPOS* and does not change *pos*.

```
size_t find( const TRegexp  &pat, size_t  *ext, size_t i = 0 ) const;
```

Searches the string for patterns matching regular expression *pat* beginning at location *i*. Parameter *ext* returns the length of the matching string if found. It returns the position of the beginning of *pat* within the target string. If the *pat* is not found, it returns *NPOS* and does not change *pos*.

See also: *rfind*

find_first_of

```
size_t find_first_of( const string  &s ) const;
```

Locates the first occurrence in the target string of any character contained in string *s*. If the search is successful *find_first_of* returns the character location. If the search fails *find_first_of* returns NPOS.

```
size_t find_first_of( const string  &s, size_t pos ) const;
```

Locates the first occurrence in the target string of any character contained in string *s* after position *pos*. If the search is successful, the function returns the character position within the target string. If the search fails or if `pos > length()`, *find_first_of* returns NPOS.

find_first_not_of

```
size_t find_first_not_of( const string  &s) const;
```

Locates the first occurrence in the target string of any character not contained in string *s*. If the search is successful, find_first_not_of returns the character position within the target string. If the search fails it returns NPOS.

```
size_t find_first_not_of( const string  &s, size_t pos ) const;
```

Locates the first occurrence in the target string of any character not contained in string *s* after position *pos*. If the search is successful *find_first_not_of* returns the character position within the target string. If the search fails or if *pos* > *length()*, *find_first_not_of* returns NPOS.

find_last_of

```
size_t find_last_of( const string  &s ) const;
```

Locates the last occurrence in the target string of any character contained in string *s*. If the search is successful *find_last_of* returns the character position within the target string. If the search fails it returns 0.

```
size_t find_last_of( const string  &s, size_t pos ) const;
```

Locates the last occurrence in the target string of any character contained in string *s* after position *pos*. If the search is successful *find_last_of* returns the character position within the target string. If the search fails or if *pos* > *length()*, *find_last_of* returns NPOS.

find_last_not_of

```
size_t find_last_not_of( const string  &s ) const;
```

Locates the last occurrence in the target string of any character not contained in string *s*. If the search is successful *find_last_not_of* returns the character position within the target string. If the search fails it returns NPOS.

```
size_t find_last_not_of( const string  &s, size_t pos ) const;
```

Locates the last occurrence in the target string of any character not contained in string *s* after position *pos*. If the search is successful *find_last_not_of* returns the character position within the target string. If the search fails or if *pos* > *length()*, *find_last_not_of* returns NPOS.

get_at

```
char get_at( size_t pos ) const throw( outofrange );
```

Returns the character at the specified position. If `pos > length()-1`, an *outofrange* exception is thrown.

See also: *put_at*

get_case_sensitive_flag

```
static int get_case_sensitiveFlag()
```

Returns 0 if string comparisons are case sensitive, 1 if not.

get_initial_capacity

```
static unsigned get_initial_capacity()
```

Returns the number of characters that will fit in the string without resizing.

get_max_waste

```
static unsigned get_max_waste()
```

After a string is resized, returns the amount of free space available.

get_paranoid_check

```
static int get_paranoid_check();
```

Returns 1 if paranoid checking is enabled, 0 if not.

get_resize_increment

```
static unsigned get_resize_increment()
```

Returns the string resizing increment.

get_skipwhitespace_flag `static int get_skipwhitespace_flag()`

Returns 1 if whitespace is skipped, 0 if not.

hash

```
unsigned hash() const;
```

Returns a hash value.

initial_capacity

```
static size_t initial_capacity(size_t ic = 63);
```

Sets initial string allocation capacity.

insert

```
string  &insert( size_t pos, const string  &s )
```

Inserts string *s* at position *pos* in the target string. *insert* returns a reference to the resulting string.

```
string  &insert( size_t pos, const string  &s, size_t start,
                 size_t n = NPOS )
```

Beginning as position *start* in *s*, the *insert* function inserts not more than *n* characters from the target string to the string *s* at position *pos*. *insert* returns a reference to the resulting string. If *pos* is invalid, *insert* throws the *outofrange* exception.

is_null

```
int is_null() const;
```

Returns 1 if the string is empty, 0 otherwise.

length

```
unsigned length() const;
```

Returns the number of characters in the target string. Since null characters can be stored in a string, `length()` might be greater than `strlen(c_str())`.

max_waste

```
static size_t MaxWaste(size_t mw = 63);
```

Sets the maximum empty space size and resizes the string.

prepend

```
string  &prepend( const string  &s )
```

Prepends string *s* to the target string.

```
string  &prepend( const string  &s, size_t start, size_t n = NPOS )
```

Beginning from the *start* position in *s*, the *prepend* function prefixes the target string with *n* characters taken from string *s*.

```
string s1 = "abcdef";
string s2 = "0123";
s2.prepend( s1, 2, 3 );
```

Results in *s2* set to `cde0123`.

```
string  &prepend( const char  *cp )
```

Prepends the character array *cp* to the target string.

```
string  &prepend( const char  *cp, sizes_t start, size_t n = NPOS )
```

Beginning from the *start* position in *cp*, the *prepend* function prefixes the target string with *n* characters taken from character array *cp*.

put_at

```
void put_at( size_t pos, char c ) throw( outofrange );
```

Replaces the character at *pos* with *c*. If `pos == length()`, *putAt* appends *c* to the target string. If `pos > length()` an *outofrange* exception is thrown.

read_file

```
istream  &read_file(istream  &is);
```

Reads from input stream *is* until an EOF or a null terminator is reached.

read_line

```
istream  &read_line(istream  &is);
```

Reads from input stream *is* until an EOF or a newline is reached.

read_string

```
istream  &read_string(istream  &is);
```

Reads from input stream *is* until an EOF or a null terminator is reached.

read_to_delim

```
istream  &read_to_delim(istream  &is, char delim = '\n');
```

Reads from input stream *is* until an EOF or a *delim* is reached.

read_token

```
istream  &read_token(istream  &is);
```

Reads from input stream *is* until whitespace is reached. Note that this function skips any initial whitespace.

rfind

```
size_t rfind( const string  &s )
```

Locates the last occurrence of the string *s* in the target string. If the string is found, it returns the position of the beginning of the string *s* within the target string. If *s* is not found, it returns *NPOS*.

```
size_t rfind( const string  &s, size_t pos )
```

Locates the last occurrence of the string *s* that is not beyond the position *pos* in the target string. If the string is found, it returns the position of the beginning of *s* within the target string. If *s* is not found, it returns *NPOS* and does not change *pos*.

See also: *find*

remove

```
string  &remove( size_t pos );
```

Removes the characters from *pos* to the end of the target string and returns a reference to the resulting string.

```
string  &remove( size_t pos, size_t n )
```

Removes at most *n* characters from the target string beginning at *pos* and returns a reference to the resulting string.

replace

```
string  &replace( size_t pos, size_t n, const string  &s )
```

Removes at most *n* characters from the target string beginning at *pos*, and replaces them with a copy of the string *s*. *replace* returns a reference to the resulting string.

```
string  &replace( size_t pos, size_t n1, const string  &s, size_t start,
                  size_t n2 = NPOS )
```

Removes at most *n1* characters from the target string beginning at *pos*, and replaces them with *n2* characters of string *s* beginning at *start*. *replace* returns a reference to the resulting string.

reserve

```
size_t reserve() const;
```

Returns an implementation-dependent value that indicates the current internal storage size. The returned value is always greater than or equal to `length()`.

```
void reserve( size_t ic )
```

Suggests to the implementation that the target string might eventually require *ic* bytes of storage.

resize

```
void resize(size_t m);
```

Resizes the string to *m* characters, truncating or adding blanks as necessary.

resize_increment

```
static size_t resize_increment(size_t ri = 64);
```

Sets the resize increment for automatic resizing.

set_case_sensitive

```
static int set_case_sensitive(int tf = 1);
```

Sets case sensitivity. 1 is case sensitive; 0 is not case sensitive.

set_paranoid_check

```
static int set_paranoid_check(int ck = 1);
```

String searches use a hash value scheme to find the strings. There is a possibility that more than one string could hash to the same value. Calling *set_paranoid_check* with *ck* set to 1 forces checking the string found against the desired string with the C library function *strcmp*. When *set_paranoid_check* is called with *ck* set to 0, this final check isn't made.

skip_whitespace

```
static int skip_whitespace(int sk = 1);
```

Set to 1 to skip whitespace after a token read, 0 otherwise.

strip

```
TSubString strip( StripType s = Trailing, char c = ' ');
```

Strips away *c* characters from the beginning, end, or both (beginning and end) of string *s*, depending on *StripType*.

substr

```
string substr( size_t pos ) const;
```

Creates a string containing a copy of the characters from *pos* to the end of the target string.

```
string substr( size_t pos, size_t n ) const;
```

Creates a string containing a copy of not more than *n* characters from *pos* to the end of the target string.

substring

```
TSubString substring( const char  *cp )
```

Creates a *TSubString* object containing a copy of the characters pointed to by **cp*.

```
const TSubString substring( const char  *cp ) const;
```

Creates a *TSubString* object containing a copy of the characters pointed to by **cp*.

```
TSubString substring( const char  *cp, size_t start )
```

Creates a *TSubString* object containing a copy of the characters pointed to by **cp*, starting at character *start*.

```
const TSubString substring( const char  *cp, size_t start ) const;
```

Creates a *TSubString* object containing a copy of the characters pointed to by **cp*, starting at character *start*.

to_lower

```
void to_lower();
```

Changes the string to lowercase.

to_upper

```
void to_upper();
```

Changes target string to uppercase.

Protected member functions

assert_element

```
void assert_element( size_t pos ) const;
```

Throws an *outofrange* exception if an invalid element is given.

assert_index

```
void assert_index( size_t pos ) const;
```

Throws an *outofrange* exception if an invalid index is given.

cow

```
void cow();
```

Copy on write. Multiple instances of a string can refer to the same piece of data as long as it is in a read-only situation. If a string writes to the data, then *cow* (copy on write) is called to make a copy if more than one string is referring to it.

valid_element

```
int valid_element( size_t pos ) const;
```

Returns 1 if *pos* is an element of the string, 0 otherwise.

valid_index

```
int valid_index( size_t pos ) const;
```

Returns 1 if *pos* is a valid index of the string, 0 otherwise.

Operators

Operator =

```
string  & operator=(const string  &s);
```

If the target string is the same object as the parameter passed to the assignment, the assignment operator does nothing. Otherwise it performs any actions necessary to free up resources allocated to the target string, then copies *s* into the target string.

Operator +=

```
string  & operator += (const string &s)
```

Appends the contents of the string *s* to the target string.

```
string  & operator += (const char *cp);
```

Appends the contents of *cp* to the target string.

Operator +

```
friend string operator + (const string &s, const char *cp);
```

Concatenates string *s* and *cp*.

Operator []

```
char & operator [] (size_t pos);
```

Returns a reference to the character at position *pos*.

```
char operator [] (size_t pos) const;
```

Returns the character at position *pos*.

Operator ()

```
char & operator () (size_t pos);
```

Returns a reference to the character at position *pos*.

```
TSubString operator () (size_t start, size_t len);
```

Returns the substring beginning at location *start* and spanning *len* bytes.

```
TSubString operator () (const TRegexp & re);
```

Returns the first occurrence of a substring matching regular expression *re*.

```
TSubString operator () (const TRegexp  & re, size_t start);
```

Returns the first occurrence of a substring matching regular expression *re*, beginning at location *start*.

```
char operator () (size_t pos) const;
```

Returns the character at position *pos*.

```
const TSubString operator () (size_t start, size_t len) const;
```

Returns the substring beginning at location *start* and spanning *len* bytes.

```
const TSubString operator () (const TRegexp  & pat) const;
```

Returns the first occurrence of a substring matching regular expression *re*.

```
const TSubString operator () (const TRegexp & pat, size_t start) const;
```

Returns the first occurrence of a substring matching regular expression *re*, beginning at location *start*.

Operator ==

```
friend int operator == ( const string &s1, const string &s2 );
```

Tests for equality of string *s1* and string *s2*. Two strings are equal if they have the same length, and if the same location in each string contains characters that compare equally. Operator **==** returns a 1 to indicate that the strings are equal, and a 0 to indicate that they are not equal.

```
friend int operator == ( const string  &s1, const char  *cp );
friend int operator == ( const char  *cp, const string  &s );
```

Tests for equality of string *s1* and *char *cp*. The two are equal if they have the same length, and if the same location in each string contains characters that compare equally. Operator **==** returns a 1 to indicate that the strings are equal, and a 0 to indicate that they are not equal.

Operator !=

```
friend int operator != ( const string &s1, const string &s2 );
```

Tests for inequality of strings *s1* and *s2*. Two strings are equal if they have the same length, and if the same location in each string contains characters that compare equally. Operator **!=** returns a 1 to indicate that the strings are not equal, and a 0 to indicate that they are equal.

```
friend int operator != ( const string &s, const char *cp );
friend int operator != ( const char  *cp, const string  &s );
```

Tests for inequality between string *s* and *char *cp*. The two are equal if they have the same length, and if the same location in each string contains the same character. Operator **!=** returns a 1 to indicate that the strings are not equal, and a 0 to indicate that they are equal.

Operator <

```
friend int operator < ( const string  &s1, const string  &s2 );
```

Compares string *s1* to string *s2*. Returns 1 if string *s1* is less than *s2*, 0 otherwise.

```
friend int operator < ( const string  &s, const char  *cp );
friend int operator < ( const char  *cp, const string  &s );
```

Compares string *s1* to **cp2*. Returns 1 if the left side of the expression is less than the right side, 0 otherwise.

Operator <=

```
friend int operator <= ( const string  &s1, const string  &s2 );
```

Compares string *s1* to string *s2*. Returns 1 if string *s1* is less than or equal to *s2*, 0 otherwise.

```
friend int operator <= ( const string  &s, const char  *cp );
friend int operator <= ( const char  *cp, const string  &s );
```

Compares string *s1* to **cp*. Returns 1 if the left side of the expression is less than or equal to the right side, 0 otherwise.

Operator >

```
friend int operator > ( const string  &s1, const string  &s2 );
```

Compares string *s1* to string *s2*. Returns 1 if string *s1* is greater than *s2*, 0 otherwise.

```
friend int operator > ( const string  &s, const char  *cp );
friend int operator > ( const char  *cp, const string  &s );
```

Compares string *s1* to **cp2*. Returns 1 if the left side of the expression is greater than the right side, 0 otherwise.

Operator >=

```
friend int operator >= ( const string  &s1, const string _FR &s2 );
```

Compares string *s1* to string *s2*. Returns 1 if string *s1* is greater than or equal to *s2*, 0 otherwise.

```
friend int operator >= ( const string  &s, const char  *cp );
friend int operator >= ( const char  *cp, const string  &s );
```

Compares string *s1* to **cp*. Returns 1 if the left side of the expression is greater than or equal to the right side, 0 otherwise.

Operator >>

```
friend ipstream  & operator >> ( ipstream  & is, string  & str );
```

Extracts string *str* from input stream *is*.

Related global operators and functions

Operator >>

```
istream  & operator >> (istream  &is, string  &s);
```

Behaves the same as `operator >> (istream&, char *)` (see Chapter 4), and returns a reference to *is*.

Operator <<

```
ostream  & operator << (ostream  &os, const string  & s);
```

Behaves the same as `operator << (ostream&, const char *)` (see Chapter 4) except that it does not terminate when it encounters a null character in the string. Returns a reference to *os*.

```
opstream & operator << ( opstream  & os, const string  & str );
```

Inserts string *str* into persistent output stream *os*.

Operator +

```
string operator + ( const char  *cp, const string  & s);
```

Concatenates **cp* and string *s*.

```
string operator + ( const string  &s1, const string  &s2 );
```

Concatenates string *s1* and *s2*.

getline

```
istream  & getline( istream  &is, string  &s );
```

Behaves the same as `istream::getline(chptr, NPOS)`, except that instead of storing into a *char* array, it stores into a *string*. *getline* returns a reference to *is*.

```
istream  & getline( istream  &is, string  &s, char c );
```

Behaves the same as `istream::getline(cb, NPOS, c)`, except that instead of storing into a *char* array, it stores into a *string*. *getline* returns a reference to *is*.

to_lower

```
string  to_lower(const string  &s);
```

Changes string *s* to lowercase.

to_upper

```
string  to_upper(const string  &s);
```

Changes string *s* to uppercase.

TSubString class — cstring.h

```
class  TSubString
```

Addresses selected substrings.

Public member functions

get_at

```
char get_at( size_t pos ) const;
```

Returns the character at the specified position. If `pos > length()-1`, an exception is thrown.

See also: *put_at*

is_null

```
int is_null() const;
```

Returns 1 if the string is empty, 0 otherwise.

length

```
size_t length() const;
```

Returns the substring length.

put_at

```
void put_at( size_t pos, char c )
```

Replaces the character at *pos* with *c*. If `pos == length()`, *putAt* appends *c* to the target string. If `pos > length()`, an exception is thrown.

start

```
int start() const;
```

Returns the index of the starting character.

to_lower

```
void to_lower();
```

Changes the substring to lowercase.

to_upper

```
void to_upper();
```

Changes the substring to uppercase.

Protected member functions

assert_element

```
int assert_element(size_t pos) const;
```

Returns 1 if *pos* represents a valid index into the substring, 0 otherwise.

Operators

Operator =

```
TSubString  & operator = (const string  &s);
```

Copies *s* into the target substring.

Operator ==

```
int operator == (const char  * cp) const;
```

Tests for equality between the target substring and **cp*. The two are equal if they have the same length, and if the same location in each string contains the same character. Operator **==** returns a 1 to indicate that the strings are equal, and a 0 to indicate that they are not equal.

```
int operator == (const string  & s) const;
```

Tests for equality between the target substring and string *s*. Two are equal if they have the same length, and if the same location in each string contains the same character. Operator **==** returns a 1 to indicate that the strings are equal, and a 0 to indicate that they are not equal.

Operator !=

```
int operator != (const char  * cp) const;
```

Tests for inequality between the target string and **cp*. Two strings are equal if they have the same length, and if the same location in each string contains the same character. Operator **!=** returns a 1 to indicate that the strings are not equal, and a 0 to indicate that they are equal.

```
int operator != (const string  & s) const;
```

Tests for inequality between the target string and string *s*. Two strings are equal if they have the same length, and if the same location in each string contains the same character. Operator **!=** returns a 1 to indicate that the strings are not equal, and a 0 to indicate that they are equal.

Operator ()

```
char  & operator () (size_t pos);
```

Returns a reference to the character at position *pos*.

```
char operator () (size_t pos) const;
```

Returns the character at position *pos*.

Operator []

```
char  & operator [] (size_t pos);
```

Returns a reference to the character at position *pos*.

```
char operator [] (size_t pos) const;
```

Returns the character at position *pos*.

Operator !

```
int operator !() const;
```

Detects null substrings. Returns 1 if the substring is not null.

TCriticalSection class — thread.h

```
class TCriticalSection
```

TCriticalSection provides a system-independent interface to critical sections in threads. *TCriticalSection* objects can be used in conjunction with *TCriticalSection::Lock* objects to guarantee that only one thread can be executing any of the code sections protected by the lock at any given time.

See also: *TCriticalSection::Lock*

Constructors and destructor

Constructor

```
TCriticalSection();
```

Constructs a *TCriticalSection* object.

Destructor

```
~TCriticalSection();
```

Destroys a *TCriticalSection* object.

TCriticalSection::Lock class — thread.h

```
class Lock
```

This nested class handles locking and unlocking critical sections. Here's an example:

```
TCriticalSection LockF;
void f()
{
   TCriticalSection::Lock(LockF);

   // critical processing here
}
```

Only one thread of execution will be allowed to execute the critical code inside function *f* at any one time.

Public constructors and destructor

Constructor

```
Lock( const TCriticalSection& );
```

Requests a lock on the *TCriticalSection* object. If no *Lock* object in another thread holds a lock on that *TCriticalSection* object, the lock is allowed and execution continues. If a Lock object in another thread holds a lock on that object, the requesting thread is blocked until the lock is released.

Destructor

```
~Lock();
```

Releases the lock.

TMutex class — thread.h

TMutex provides a system-independent interface to critical sections in threads. *TMutex* objects can be used in conjunction with TMutex::Lock objects to guarantee that only one thread can be executing any of the code sections protected by the lock at any given time.

The differences between the classes *TCriticalSection* and *TMutex* are that a timeout can be specified when creating a *Lock* on a *TMutex* object, and that a *TMutex* object has an HMTX handle that can be used outside the class. This mirrors the distinction made in Windows NT between a CRITICALSECTION and a Mutex. Under NT a *TCriticalSection* object is much faster than a *TMutex* object. Under operating systems that don't make this distinction a *TCriticalSection* object can use the same underlying implementation as a *TMutex*, losing the speed advantage that it has under NT.

Public constructors and destructor

Constructor

```
TMutex();
```

Constructs a *TMutex* object.

Destructor

```
~TMutex();
```

Destroys a *TMutex* object.

Operators

HMTX

```
operator HMTX() const;
```

Returns a handle to the underlying TMutex object, for use in operating system calls that require it.

TMutex::Lock class — thread.h

This nested class handles locking and unlocking *TMutex* objects.

Public constructors

Constructor

```
Lock( const TMutex&, unsigned long timeOut = NoLimit );
```

Requests a lock on the *TMutex* object. If no *Lock* object in another thread holds a lock on that *TMutex* object, the lock is allowed and execution continues. If a *Lock* object in another thread holds a lock on that object, the requesting thread is blocked until the lock is released.

Public member functions

Release

```
void Release();
```

Releases the lock on the *TMutex* object.

TSync class — thread.h

TSync provides a system-independent interface for building classes that act like monitors—classes in which only one member function can execute on a particular instance at any one time. *TSync* uses *TCriticalSection,* has no public members, and can only be used as a base class. Here is an example of *TSync* in use:

```
class ThreadSafe : private TSync
{
public:
   void f();
   void g();
private:
   int i;
};

void ThreadSafe::f()
{
   Lock(this);
   if( i == 2 )
     i = 3;
}

void ThreadSafe::g()
{
   Lock(this);
   if( i == 3 )
     i = 2;
}
```

See also: class *TSync::Lock*

Protected constructors

Constructor

```
TSync();
```

Default constructor.

Constructor

```
TSync( const TSync& );
```

Copy constructor. Does not copy the *TCriticalSection* object.

Protected operators

Operator =

```
const TSync& operator = ( const TSync& s )
```

Assigns *s* to the target, and does not copy the *TCriticalSection* object.

TSync::Lock class — thread.h

```
class Lock : private TCriticalSection::Lock
```

This nested class handles locking and unlocking critical sections.

Public constructors and destructor

Constructor

```
Lock( const TSync *s );
```

Requests a lock on the critical section of the *TSync* object pointed to by *s*. If no other *Lock* object holds a lock on that *TCriticalSection* object, the lock is allowed and execution continues. If another Lock object holds a lock on that object, the requesting thread is blocked until the lock is released.

Destructor

```
~Lock();
```

Releases the lock.

TThread class — thread.h

```
class TThread
```

TThread provides a system-independent interface to threads. Here is an example:

```
class TimerThread : private TThread
{
public:
   TimerThread() : Count(0) {}
private:
   unsigned long Run();
   int Count;
};

unsigned long TimerThread::Run()
{
```

```
    // loop 10 times
    while( Count++ < 10 )
    {
       Sleep(1000);    // delay 1 second
       cout << "Iteration " << Count << endl;
    }
    return 0L;
}

int main()
{
    TimerThread timer;
    timer.Start();
    Sleep( 20000 );     // delay 20 seconds
    return 0;
}
```

Type definitions

Status

```
enum Status { Created, Running, Suspended, Finished, Invalid };
```

Describes the state of the thread, as follows:

- *Created*. The object has been created but its thread has not been started. The only valid transition from this state is to *Running*, which happens on a call to *Start*. In particular, a call to *Suspend* or *Resume* when the object is in this state is an error and will throw an exception.
- *Running*. The thread has been started successfully. There are two transitions from this state:
    - When the user calls *Suspend*, the object moves into the *Suspended* state.
    - When the thread exits, the object moves into the *Finished* state.

  Calling *Resume* on an object that is in the *Running* state is an error and will throw an exception.
- *Suspended*. The thread has been suspended by the user. Subsequent calls to *Suspend* nest, so there must be as many calls to *Resume* as there were to *Suspend* before the thread resumes execution.
- *Finished*. The thread has finished executing. There are no valid transitions out of this state. This is the only state from which it is legal to invoke the destructor for the object. Invoking the destructor when the object is in any other state is an error and will throw an exception.

Protected constructors and destructor

Constructor

```
TThread();
```

Constructs an object of type *TThread*.

Constructor

```
TThread( const TThread& );
```

Copy constructor. Puts the target object into the *Created* state.

Destructor

```
virtual ~TThread();
```

Destroys the *TThread* object.

Public member functions

GetPriority

```
int GetPriority() const;
```

Gets the thread priority.

See also: *SetPriority*

GetStatus

```
Status GetStatus() const;
```

Returns the current status of the thread. See data member *Status* for possible values.

Resume

```
unsigned long Resume();
```

Resumes execution of a suspended thread.

SetPriority

```
int SetPriority(int);
```

Sets the thread priority.

See also: *GetPriority*

Start

```
THANDLE Start();
```

Begins execution of the thread, and returns the thread handle.

Suspend

```
unsigned long Suspend();
```

Suspends execution of the thread.

Terminate

```
void Terminate();
```

Sets an internal flag that indicates that the thread should exit. The derived class can check the state of this flag by calling *ShouldTerminate*.

TerminateAndWait

```
void TerminateAndWait( unsigned long timeout = NoLimit );
```

Combines the behavior of *Terminate* and *WaitForExit*. Sets an internal flag that indicates that the thread should exit and blocks the calling thread until the internal thread exits or until the time specified by *timeout*, in milliseconds, expires. A *timeout* of –1 says to wait indefinitely.

WaitForExit

```
void WaitForExit( unsigned long timeout = NoLimit );
```

Blocks the calling thread until the internal thread exits or until the time specified by *timeout*, in milliseconds, expires. A *timeout* of –1 says wait indefinitely.

Protected member functions

ShouldTerminate

```
int ShouldTerminate() const;
```

Returns a nonzero value to indicate that *Terminate* or *TerminateAndWait* has been called and that the thread will finish its processing and exit.

Protected operators

Operator =

```
const TThread& operator = ( const TThread& );
```

The *TThread* assignment operator. The target object must be in either the *Created* or *Finished* state. If so, assignment puts the target object into the *Created* state. If the object is not in either state an exception will be thrown.

TThread::TThreadError class — thread.h

```
class TThreadError
```

TThreadError defines the exceptions thrown when a threading error occurs.

Type definitions

ErrorType

```
enum ErrorType
   {
   SuspendBeforeRun,
   ResumeBeforeRun,
   ResumeDuringRun,
   SuspendAfterExit,
   ResumeAfterExit,
   CreationFailure,
   DestroyBeforeExit,
   AssignError
   };
```

Identifies the type of error that occurred. The following list explains each error type:

- *SuspendBeforeRun*. The user called *Suspend* on an object before calling *Start*.
- *ResumeBeforeRun*. The user called *Resume* on an object before calling *Start*.
- *ResumeDuringRun*. The user called *Resume* on a thread that was not suspended.
- *SuspendAfterExit*. The user called *Suspend* on an object whose thread had already exited.
- *ResumeAfterExit*. The user called *Resume* on an object whose thread had already exited.
- *CreationFailure*. The operating system was unable to create the thread.
- *DestroyBeforeExit*. The object's destructor was invoked before its thread had exited.
- *AssignError*. An attempt was made to assign to an object that was not in either the *Created* or *Finished* state.

Public member functions

GetErrorType

```
ErrorType GetErrorType() const;
```

Returns the *ErrorType* for the error that occurred.

TTime type definitions — time.h

```
typedef unsigned HourTy;
typedef unsigned MinuteTy;
typedef unsigned SecondTy;
typedef unsigned long ClockTy;
```

Type definitions for hours, minutes, seconds, and seconds since January 1, 1901.

TTime class — time.h

```
class  TTime
```

Class *TTime* encapsulates time functions and characteristics.

Public constructors

Constructor

```
TTime();
```

Constructs a *TTime* object with the current time.

Constructor

```
TTime( ClockTy s );
```

Constructs a *TTime* object with the given *s* (seconds since January 1, 1901).

Constructor

```
TTime( HourTy h, MinuteTy m, SecondTy s = 0 );
```

Constructs a *TTime* object with the given time and today's date.

Constructor

```
TTime( const TDate&, HourTy h=0, MinuteTy m=0, SecondTy s=0 );
```

Constructs a *TTime* object with the given time and date.

Public member functions

AsString

```
string AsString() const;
```

Returns a *string* object containing the time.

BeginDST

```
static TTime BeginDST( unsigned year );
```

Returns the start of daylight savings time for the given year.

Between

```
int Between( const TTime& a, const TTime& b ) const;
```

Returns 1 if the target date is between *TTime*s *a* and *b*, 0 otherwise.

CompareTo

```
int CompareTo( const TTime & ) const;
```

Compares *t* to this *TTime* object and returns 0 if the times are equal, 1 if *t* is earlier, and –1 if *t* is later.

EndDST

```
static TTime EndDST( unsigned year );
```

Returns the time when daylight savings time ends for the given year.

Hash

```
unsigned Hash() const;
```

Returns seconds since January 1, 1901.

Hour

```
HourTy Hour() const;
```

Returns the hour in local time.

HourGMT

```
HourTy HourGMT() const;
```

Returns the hour in Greenwich Mean Time.

IsDST

```
int IsDST() const;
```

Returns 1 if the time is in daylight savings time, 0 otherwise.

IsValid

```
int IsValid() const;
```

Returns 1 if this *TTime* object contains a valid time, 0 otherwise.

Max

```
TTime Max( const TTime& t ) const;
```

Returns either this *TTime* object or *t*, whichever is greater.

Min

```
TTime Min( const TTime& t ) const;
```

Returns either this *TTime* object or *t*, whichever is lesser.

Minute

```
MinuteTy Minute() const;
```

Returns the minute in local time.

MinuteGMT

```
MinuteTy MinuteGMT() const;
```

Returns the minute in Greenwich Mean Time.

PrintDate

```
static int PrintDate( int flag);
```

Set *flag* to 1 to print the date along with the time; set to 0 to not print the date. Returns the old setting.

Second

```
SecondTy Second() const;
```

Returns seconds.

Seconds

```
ClockTy Seconds() const;
```

Returns seconds since January 1, 1901.

Protected member functions

AssertDate

```
static int AssertDate( const TDate& d );
```

Returns 1 if *d* is between the earliest valid date (*RefDate)* and the latest valid date (*MaxDate)*.

Protected data members

RefDate

```
static const TDate RefDate;
```

The minimum valid date for *TTime* objects: January 1, 1901.

MaxDate

```
static const TDate MaxDate;
```

The maximum valid date for *TTime* objects.

Operators

Operator <

```
int operator <  ( const TTime& t ) const;
```

Returns 1 if the target time is less than time *t*, 0 otherwise.

Operator <=

```
int operator <= ( const TTime& t ) const;
```

Returns 1 if the target time is less than or equal to time *t*, 0 otherwise.

Operator >

```
int operator > ( const TTime& t ) const;
```

Returns 1 if the target time is greater than time *t*, 0 otherwise.

Operator >=

```
int operator >= ( const TTime& t ) const;
```

Returns 1 if the target time is greater than or equal to time *t*, 0 otherwise.

Operator ==

```
int operator == ( const TTime& t ) const;
```

Returns 1 if the target time is equal to time *t*, 0 otherwise.

Operator !=

```
int operator != ( const TTime& t ) const;
```

Returns 1 if the target time is not equal to time *t*, 0 otherwise.

Operator ++

```
void operator ++ ();
```

Increments time by 1 second.

Operator – –

```
void operator -- ();
```

Decrements time by 1 second.

Operator +=

```
void operator += (long s);
```

Adds *s* seconds to the time.

Operator –=

```
void operator -= (long s);
```

Subtracts *s* seconds from the time.

Operator +

```
friend TTime operator + ( const TTime& t, long s );
friend TTime operator + ( long s, const TTime& t );
```

Adds *s* seconds to time *t*.

Operator –

```
friend TTime operator - ( const TTime& t, long s );
friend TTime operator - ( long s, const TTime& t );
```

Performs subtraction, in seconds, between *s* and *t*.

Operator <<

```
friend ostream& operator << ( ostream& os, const TTime& t);
```

Inserts time *t* into output stream *os*.

```
friend opstream& operator << ( opstream& s, const TTime& d );
```

Inserts time *t* into persistent stream *s*.

Operator >>

```
friend ipstream& operator >> ( ipstream& s, TTime& d );
```

Extracts time *t* from persistent stream *s*.

A P P E N D I X A

Run-time library cross-reference

This appendix is an overview of the Borland C++ library routines and include files.

This appendix

- Names the object libraries and other files found the LIB directory, and describe their uses.
- Explains why you might want to obtain the source code for the Borland C++ run-time library.
- Lists and describes the header files.
- Summarizes the different categories of tasks performed by the library routines.

Borland C++ has several hundred functions and macros that you call from within your C and 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. These functions and macros, collectively referred to as *library routines*, are documented in Chapter 2 of this book.

The run-time libraries

The following table lists the OS/2 libraries names and uses.

File name	Use
BPMCC.LIB	Static-link implementation of the Borland Presentation Manager custom controls.
BPMCC.DLL	Dynamic-link implementation of the Borland Presentation Manager custom controls.
C02.OBJ	Startup code for EXE files (must be first .OBJ)
C02D.OBJ	Startup code for DLL files (must be first .OBJ)
OS2.LIB	Import library for OS/2 API
C2.LIB	Single-threaded static-link run-time library

C2MT.LIB	Multi-threaded static-link run-time library
C2.DLL	Single-threaded dynamic-link run-time library
C2I.LIB	Import library for single-threaded dynamic-link run-time library. Link with this to use C2.DLL
C2MT.DLL	Multi-threaded dynamic-link run-time library
C2MTI.LIB	Import library for multi-threaded dynamic-link run-time library. Link with this to use C2MT.DLL
FILEINFO.OBJ	Link with this file to allow file handle information to be passed to child processes started with *execl* and *spawn* functions.
LOCALE.BLL	Provides locale-specific data.
OBSOLETE.LIB	Provides obsolete global variables
POPUP.OBJ	Link with this file to cause runtime messages (such as those printed by the *abort* and *assert* functions) to be displayed in a pop-up character-mode screen.
WILDARGS.OBJ	Link with this file for automatic expansion of wildcard file names on the command line.

The following table lists the container libraries:

BIDS2.LIB	Static library
BIDSDB2.LIB	Static library, diagnostic version
BIDS2I.LIB	Import static library
BIDS402.DLL	Dynamic link library
BIDS40D2.DLL	Dynamic link library, diagnostic version

Here is an example of how you create an EXE that uses the single-threaded static run-time library:

```
TLINK /TOE C02.OBJ <OBJS>, <EXE>, <MAP>, OS2.LIB C2.LIB
```

For these examples you must provide your own file names in place of OBJS, EXE, and MAP.

This example creates an EXE that uses the dynamic link library C2.DLL:

```
TLINK /TOE C02.OBJ <OBJS>, <EXE>, <MAP>, OS2.LIB C2I.LIB
```

This example creates a DLL that uses the multi-threaded static run-time library:

```
TLINK /TOE C02D.OBJ <OBJS>, <EXE>, <MAP>, OS2.LIB C2MT.LIB
```

See also the *Programmer's Guide,* Chapter 9, for additional information and examples on how to use the various libraries.

Reasons to access the run-time library source code

There are several good reasons why you might want to obtain the source code for the run-time library routines:

- You might find that a particular function you want to write is similar to, but not the same as, a Borland C++ function. With access to the run-time library source code, you could tailor the library function to your own needs, and avoid having to write a separate function of your own.
- Sometimes, when you are debugging code, you might want to know more about the internals of a library function. Having the source code to the run-time library would be of great help in this situation.
- You might want to delete the leading underscores on C symbols. Access to the run-time library source code will let you delete them.
- You can 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 Borland C++ run-time library source code. Because Borland believes strongly in the concept of "open architecture," we have made the Borland C++ run-time library source code available for licensing. All you have to do is fill out the order form distributed with your Borland C++ package, include your payment, and we'll ship you the Borland C++ run-time library source code.

The Borland C++ header files

C++ header files, and header files defined by ANSI C, are marked in the margin.

Header files, also called include files, provide function prototype declarations for library functions. Data types and symbolic constants used with the library functions are also defined in them, along with global variables defined by Borland C++ and by the library functions. The Borland C++ library follows the ANSI C standard on names of header files and their contents.

	alloc.h	Declares memory management functions (allocation, deallocation, and so on).
ANSI C	assert.h	Defines the *assert* debugging macro.
	bcd.h	Declares the C++ class *bcd* and the overloaded operators for *bcd* and *bcd* math functions.
	checks.h	Defines PRECONDITION, WARN, and TRACE diagnostic macros.

	complex.h	Declares the C++ complex math functions.
	conio.h	Declares various functions used in calling the operating system console I/O routines. The functions defined in this header file cannot be used in PM applications.
	constrea.h	Declares C++ classes and methods to support console output.
	cstring.h	Declares the ANSI C++ string class support.
ANSI C	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.
	direct.h	Defines structures, macros, and functions for dealing with directories and path names.
	dirent.h	Declares functions and structures for POSIX directory operations.
	dos.h	Defines various constants and gives declarations needed for DOS and 8086-specific calls.
ANSI C	errno.h	Defines constant mnemonics for the error codes.
	except.h	Declares routines that provide support for ANSI C++ exceptions.
	excpt.h	Declares routines and keywords that provide support for C-based structured exceptions.
	fcntl.h	Defines symbolic constants used in connection with the library routine *open*.
ANSI C	float.h	Contains parameters for floating-point routines.
	fstream.h	Declares the C++ stream classes that support file input and output.
	generic.h	Contains macros for generic class declarations.
	io.h	Contains structures and declarations for low-level input/output routines.
	iomanip.h	Declares the C++ streams I/O manipulators and contains templates for creating parameterized manipulators.
	iostream.h	Declares the basic C++ streams (I/O) routines.

ANSI C	limits.h	Contains environmental parameters, information about compile-time limitations, and ranges of integral quantities.
ANSI C	locale.h	Declares functions that provide country- and language-specific information.
	sys\locking.h	Definitions for *mode* parameter of *locking* function.
	malloc.h	Memory management functions and variables.
ANSI C	math.h	Declares prototypes for the math functions and math error handlers.
	mem.h	Declares the memory-manipulation functions. (Many of these are also defined in string.h.)
	memory.h	Memory manipulation functions.
C++	new.h	Access to *_new_handler* and *_set_new_handler*.
	process.h	Contains structures and declarations for the *spawn...* and *exec...* functions.
	search.h	Declares functions for searching and sorting.
ANSI C	setjmp.h	Defines a type *jmp_buf* used by the *longjmp* and *setjmp* functions and declares the functions *longjmp* and *setjmp*.
	share.h	Defines parameters used in functions that make use of file-sharing.
ANSI C	signal.h	Defines constants and declarations for use by the *signal* and *raise* functions.
ANSI C	stdarg.h	Defines macros used for reading the argument list in functions declared to accept a variable number of arguments (such as *vprintf, vscanf,* and so on).
ANSI C	stddef.h	Defines several common data types and macros.
ANSI C	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.
C++	stdiostr.h	Declares the C++ (version 2.0) stream classes for use with stdio FILE structures. You should use iostream.h for new code.

ANSI C	stdlib.h	Declares several commonly used routines: conversion routines, search/sort routines, and other miscellany.
ANSI C	string.h	Declares several string-manipulation and memory-manipulation routines.
C++	strstrea.h	Declares the C++ stream classes for use with byte arrays in memory.
	sys\stat.h	Defines symbolic constants used for opening and creating files.
ANSI C	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.
	sys\timeb.h	Declares the function *ftime* and the structure *timeb* that *ftime* returns.
	sys\types.h	Declares the type *time_t* used with time functions.
C++	typeinfo.h	Provides declarations for ANSI C++ run-time type identification (RTTI).
	utime.h	Declares the *utime* function and the *utimbuf* struct that it returns.
	values.h	Defines important constants, including machine dependencies; provided for UNIX System V compatibility.
	varargs.h	Definitions for accessing parameters in functions that accept a variable number of arguments. Provided for UNIX compatibility; you should use stdarg.h for new code.

Library routines by category

The Borland C++ library routines perform a variety of tasks. In this section, we list the routines, along with the include files in which they are declared, under several general categories of task performed. Chapter 2 contains complete information about the functions.

C++ prototyped routines

Certain routines described in this book have multiple declarations. You must choose the prototype appropriate for your program. In general, the multiple prototypes are required to support the original C implementation and the stricter and sometimes different C++ function declaration syntax.

For example, some string-handling routines have multiple prototypes because in addition to the ANSI-C specified prototype, Borland C++ provides prototypes that are consistent with the ANSI C++ draft.

getvect	(dos.h)	*strchr*	(string.h)
max	(stdlib.h)	*strpbrk*	(string.h)
memchr	(string.h)	*strrchr*	(string.h)
min	(stdlib.h)	*strstr*	(string.h)
setvect	(dos.h)		

Classification routines

These routines classify ASCII characters as letters, control characters, punctuation, uppercase, and so on.

isalnum	(ctype.h)	*islower*	(ctype.h)
isalpha	(ctype.h)	*isprint*	(ctype.h)
isascii	(ctype.h)	*ispunct*	(ctype.h)
iscntrl	(ctype.h)	*isspace*	(ctype.h)
isdigit	(ctype.h)	*isupper*	(ctype.h)
isgraph	(ctype.h)	*isxdigit*	(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.

atof	(stdlib.h)	*strtol*	(stdlib.h)
atoi	(stdlib.h)	*_strtold*	(stdlib.h)
atol	(stdlib.h)	*strtoul*	(stdlib.h)
ecvt	(stdlib.h)	*toascii*	(ctype.h)
fcvt	(stdlib.h)	*_tolower*	(ctype.h)
gcvt	(stdlib.h)	*tolower*	(ctype.h)
itoa	(stdlib.h)	*_toupper*	(ctype.h)
ltoa	(stdlib.h)	*toupper*	(ctype.h)
strtod	(stdlib.h)	*ultoa*	(stdlib.h)

Directory control routines

These routines manipulate directories and path names.

chdir	(dir.h)	*fnmerge*	(dir.h)
_chdrive	(direct.h)	*fnsplit*	(dir.h)
closedir	(dirent.h)	*_fullpath*	(stdlib.h)
_dos_findfirst	(dos.h)	*getcurdir*	(dir.h)
_dos_findnext	(dos.h)	*getcwd*	(dir.h)
_dos_getdiskfree	(dos.h)	*_getdcwd*	(direct.h)
_dos_getdrive	(dos.h)	*getdisk*	(dir.h)
_dos_setdrive	(dos.h)	*_getdrive*	(direct.h)
findfirst	(dir.h)	*_makepath*	(stdlib.h)
findnext	(dir.h)	*mkdir*	(dir.h)

mktemp	(dir.h)	*_searchenv*	(stdlib.h)
opendir	(dirent.h)	*searchpath*	(dir.h)
readdir	(dirent.h)	*_searchstr*	(stdlib.h)
rewinddir	(dirent.h)	*setdisk*	(dir.h)
rmdir	(dir.h)	*_splitpath*	(stdlib.h)

Diagnostic routines

These routines provide built-in troubleshooting capability.

assert	(assert.h)	*perror*	(errno.h)
CHECK	(checks.h)	*PRECONDITION*	(checks.h)
_matherr	(math.h)	*TRACE*	(checks.h)
_matherrl	(math.h)	*WARN*	(checks.h)

Inline routines

These routines have inline versions. The compiler will generate code for the inline versions when you use #**pragma intrinsic** or if you specify program optimization. See the *User's Guide*, Appendix A, "The optimizer," for more details.

abs	(math.h)	*stpcpy*	(string.h)
alloca	(malloc.h)	*strcat*	(string.h)
_crotl	(stdlib.h)	*strchr*	(string.h)
_crotr	(stdlib.h)	*strcmp*	(string.h)
_lrotl	(stdlib.h)	*strcpy*	(string.h)
_lrotr	(stdlib.h)	*strlen*	(string.h)
memchr	(mem.h)	*strncat*	(string.h)
memcmp	(mem.h)	*strncmp*	(string.h)
memcpy	(mem.h)	*strncpy*	(string.h)
memset	(mem.h)	*strnset*	(string.h)
_rotl	(stdlib.h)	*strrchr*	(string.h)
_rotr	(stdlib.h)	*strset*	(string.h)

Input/output routines

These routines provide stream- and operating-system level I/O capability.

access	(io.h)	*_dos_close*	(dos.h)
_chmod	(io.h)	*_dos_creat*	(dos.h)
chmod	(io.h)	*_dos_creatnew*	(dos.h)
chsize	(io.h)	*_dos_getfileattr*	(dos.h)
clearerr	(stdio.h)	*_dos_getftime*	(dos.h)
_close	(io.h)	*_dos_open*	(dos.h)
close	(io.h)	*_dos_read*	(dos.h)
_creat	(io.h)	*_dos_setfileattr*	(dos.h)
creat	(io.h)	*_dos_setftime*	(dos.h)
creatnew	(io.h)	*_dos_write*	(dos.h)
creattemp	(io.h)	*dup*	(io.h)
cscanf	(conio.h)	*dup2*	(io.h)

eof	(io.h)
fclose	(stdio.h)
fcloseall	(stdio.h)
fdopen	(stdio.h)
feof	(stdio.h)
ferror	(stdio.h)
fflush	(stdio.h)
fgetc	(stdio.h)
fgetchar	(stdio.h)
fgetpos	(stdio.h)
fgets	(stdio.h)
filelength	(io.h)
fileno	(stdio.h)
flushall	(stdio.h)
fopen	(stdio.h)
fprintf	(stdio.h)
fputc	(stdio.h)
fputchar	(stdio.h)
fputs	(stdio.h)
fread	(stdio.h)
freopen	(stdio.h)
fscanf	(stdio.h)
fseek	(stdio.h)
fsetpos	(stdio.h)
_fsopen	(stdio.h)
fstat	(sys\stat.h)
ftell	(stdio.h)
_ftruncate	(io.h)
fwrite	(stdio.h)
getc	(stdio.h)
getch	(conio.h)
getchar	(stdio.h)
getche	(conio.h)
getftime	(io.h)
gets	(stdio.h)
getw	(stdio.h)
isatty	(io.h)
kbhit	(conio.h)
lock	(io.h)
locking	(io.h)
lseek	(io.h)
_open	(io.h)
open	(io.h)
perror	(stdio.h)
_pipe	(io.h)
printf	(stdio.h)
putc	(stdio.h)
putchar	(stdio.h)
puts	(stdio.h)
putw	(stdio.h)
_read	(io.h)
read	(io.h)
remove	(stdio.h)
rename	(stdio.h)
rewind	(stdio.h)
rmtmp	(stdio.h)
scanf	(stdio.h)
setbuf	(stdio.h)
_setcursortype	(conio.h)
setftime	(io.h)
setmode	(io.h)
setvbuf	(stdio.h)
sopen	(io.h)
sprintf	(stdio.h)
sscanf	(stdio.h)
stat	(sys\stat.h)
_strerror	(string.h, stdio.h)
strerror	(stdio.h)
tell	(io.h)
tempnam	(stdio.h)
tmpfile	(stdio.h)
tmpnam	(stdio.h)
_truncate	(io.h)
umask	(io.h)
ungetch	(conio.h)
unlink	(dos.h)
unlock	(io.h)
utime	(utime.h)
vfprintf	(stdio.h)
vfscanf	(stdio.h)
vprintf	(stdio.h)
vscanf	(stdio.h)
vsprintf	(stdio.h)
vsscanf	(io.h)
_write	(io.h)

Interface routines

These routines provide operating system and machine-specific capabilities.

country	(dos.h)	*setverify*	(dos.h)
getdfree	(dos.h)	*sleep*	(dos.h)
getverify	(dos.h)		

International locale API routines

These routines are affected by the current locale. The current locale is specified by the *setlocale* function and is enabled by defining __USELOCALES__ with **-D** command line option. When you define __USELOCALES__, only function versions of the following routines are used in the run-time library rather than macros. See online Help for a discussion of the International API.

cprintf	(stdio.h)	*scanf*	(stdio.h)
cscanf	(stdio.h)	*setlocale*	(locale.h)
fprintf	(stdio.h)	*sprintf*	(stdio.h)
fscanf	(stdio.h)	*sscanf*	(stdio.h)
isalnum	(ctype.h)	*strcoll*	(string.h)
isalpha	(ctype.h)	*strftime*	(time.h)
iscntrl	(ctype.h)	*strlwr*	(string.h)
isdigit	(ctype.h)	*strupr*	(string.h)
isgraph	(ctype.h)	*strxfrm*	(string.h)
islower	(ctype.h)	*tolower*	(ctype.h)
isprint	(ctype.h)	*toupper*	(ctype.h)
ispunct	(ctype.h)	*vfprintf*	(stdio.h)
isspace	(ctype.h)	*vfscanf*	(stdio.h)
isupper	(ctype.h)	*vprintf*	(stdio.h)
isxdigit	(ctype.h)	*vscanf*	(stdio.h)
localeconv	(locale.h)	*vsprintf*	(stdio.h)
printf	(stdio.h)	*vsscanf*	(stdio.h)

Manipulation routines

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

mblen	(stdlib.h)	*strchr*	(string.h)
mbstowcs	(stdlib.h)	*strcmp*	(string.h)
mbtowc	(stdlib.h)	*strcoll*	(string.h)
memccpy	(mem.h, string.h)	*strcpy*	(string.h)
memchr	(mem.h, string.h)	*strcspn*	(string.h)
memcmp	(mem.h, string.h)	*strdup*	(string.h)
memcpy	(mem.h, string.h)	*strerror*	(string.h)
memicmp	(mem.h, string.h)	*stricmp*	(string.h)
memmove	(mem.h, string.h)	*strcmpi*	(string.h)
memset	(mem.h, string.h)	*strlen*	(string.h)
stpcpy	(string.h)	*strlwr*	(string.h)
strcat	(string.h)	*strncat*	(string.h)

strncmp	(string.h)	*strset*	(string.h)
strncmpi	(string.h)	*strspn*	(string.h)
strncpy	(string.h)	*strstr*	(string.h)
strnicmp	(string.h)	*strtok*	(string.h)
strnset	(string.h)	*strupr*	(string.h)
strpbrk	(string.h)	*strxfrm*	(string.h)
strrchr	(string.h)	*wcstombs*	(stdlib.h)
strrev	(string.h)	*wctomb*	(stdlib.h)

Math routines

These routines perform mathematical calculations and conversions.

abs	(complex.h, stdlib.h)	*cosh*	(complex.h, math.h)
acos	(complex.h, math.h)	*coshl*	(math.h)
acosl	(math.h)	*cosl*	(math.h)
arg	(complex.h)	*div*	(math.h)
asin	(complex.h, math.h)	*ecvt*	(stdlib.h)
asinl	(math.h)	*exp*	(complex.h, math.h)
atan	(complex.h, math.h)	*expl*	(math.h)
atan2	(complex.h, math.h)	*fabs*	(math.h)
atan2l	(math.h)	*fabsl*	(math.h)
atanl	(math.h)	*fcvt*	(stdlib.h)
atof	(stdlib.h, math.h)	*floor*	(math.h)
atoi	(stdlib.h)	*floorl*	(math.h)
atol	(stdlib.h)	*fmod*	(math.h)
_atold	(math.h)	*fmodl*	(math.h)
bcd	(bcd.h)	*_fpreset*	(float.h)
cabs	(math.h)	*frexp*	(math.h)
cabsl	(math.h)	*frexpl*	(math.h)
ceil	(math.h)	*gcvt*	(stdlib.h)
ceill	(math.h)	*hypot*	(math.h)
_clear87	(float.h)	*hypotl*	(math.h)
complex	(complex.h)	*imag*	(complex.h)
conj	(complex.h)	*itoa*	(stdlib.h)
_control87	(float.h)	*labs*	(stdlib.h)
cos	(complex.h, math.h)	*ldexp*	(math.h)
ldexpl	(math.h)	*modfl*	(math.h)
ldiv	(math.h)	*norm*	(complex.h)
log	(complex.h, math.h)	*polar*	(complex.h)
logl	(math.h)	*poly*	(math.h)
log10	(complex.h, math.h)	*polyl*	(math.h)
log10l	(math.h)	*pow*	(complex.h, math.h)
_lrotl	(stdlib.h)	*pow10*	(math.h)
_lrotr	(stdlib.h)	*pow10l*	(math.h)
ltoa	(stdlib.h)	*powl*	(math.h)
_matherr	(math.h)	*rand*	(stdlib.h)
_matherrl	(math.h)	*random*	(stdlib.h)
modf	(math.h)	*randomize*	(stdlib.h)

real	(complex.h)	*_status87*	(float.h)
_rotl	(stdlib.h)	*strtod*	(stdlib.h)
_rotr	(stdlib.h)	*strtol*	(stdlib.h)
sin	(complex.h, math.h)	*_strtold*	(stdlib.h)
sinh	(complex.h, math.h)	*strtoul*	(stdlib.h)
sinhl	(math.h)	*tan*	(complex.h, math.h)
sinl	(math.h).h, math.h)	*tanh*	(complex.h, math.h)
sqrt	(complex.h, math.h)	*tanhl*	(complex.h, math.h)
sqrtl	(math.h)	*tanl*	(math.h)
srand	(stdlib.h)	*ultoa*	(stdlib.h)

Memory routines

These routines provide dynamic memory allocation.

alloca	(malloc.h)	*_heapmin*	(malloc.h)
calloc	(alloc.h, stdlib.h)	*heapwalk*	(alloc.h)
free	(alloc.h, stdlib.h)	*_heapwalk*	(malloc.h)
_heapadd	(malloc.h)	*malloc*	(alloc.h, stdlib.h)
heapcheck	(alloc.h)	*realloc*	(alloc.h, stdlib.h)
heapcheckfree	(alloc.h)	*_set_new_handler*	(new.h)
heapchecknode	(alloc.h)	*stackavail*	(malloc.h)

Miscellaneous routines

These routines provide nonlocal goto capabilities and locale.

localeconv	(locale.h)	*setjmp*	(setjmp.h)
longjmp	(setjmp.h)	*setlocale*	(locale.h)

Obsolete definitions

The following global variables have been renamed to comply with ANSI naming requirements. You should always use the new names. If you link with libraries that were compiled with Borland C++ 3.1 (or earlier) header files, you will get the message

```
Error: undefined external varname in module LIBNAME.LIB
```

A library module that results in such an error should be recompiled. However, if you cannot recompile the code for such libraries, you can link with OBSOLETE.LIB to resolve the external variable names.

The following global variables have been renamed:

Table A.1 Obsolete global variables

Old name	New name	Header file
daylight	*_daylight*	time.h
directvideo	*_directvideo*	conio.h
environ	*_environ*	stdlib.h

Table A.1: Obsolete global variables (continued)

sys_errlist	*_sys_errlist*	errno.h
sys_nerr	*_sys_nerr*	errno.h
timezone	*_timezone*	time.h
tzname	*_tzname*	time.h

The old names of the following functions are available. However, the compiler will generate a warning that you are using an obsolete name. Future versions of Borland C++ might not provide support for the old function names.

The following function names have been changed:

Table A.2 Obsolete function names

Old name	New name	Header file
_chmod	*_rtl_chmod*	io.h
_close	*_rtl_close*	io.h
_creat	*_rtl_creat*	io.h
_heapwalk	*_rtl_heapwalk*	malloc.h
_open	*_rtl_open*	io.h
_read	*_rtl_read*	io.h
_write	*_rtl_write*	io.h

Process control routines

These routines invoke and terminate new processes from within another.

abort	(process.h)	*exit*	(process.h)
_beginthread	(process.h)	*_expand*	(process.h)
_c_exit	(process.h)	*getpid*	(process.h)
_cexit	(process.h)	*_pclose*	(stdio.h)
cwait	(process.h)	*_popen*	(stdio.h)
_endthread	(process.h)	*raise*	(signal.h)
execl	(process.h)	*signal*	(signal.h)
execle	(process.h)	*spawnl*	(process.h)
execlp	(process.h)	*spawnle*	(process.h)
execlpe	(process.h)	*spawnlp*	(process.h)
execv	(process.h)	*spawnlpe*	(process.h)
execve	(process.h)	*spawnv*	(process.h)
execvp	(process.h)	*spawnve*	(process.h)
execvpe	(process.h)	*spawnvp*	(process.h)
_exit	(process.h)	*spawnvpe*	(process.h)

Console I/O routines

These routines output text to the screen or read from the keyboard. They cannot be used in a PM application.

cgets	(conio.h)	*movetext*	(conio.h)
clreol	(conio.h)	*normvideo*	(conio.h)
clrscr	(conio.h)	*putch*	(conio.h)
cprintf	(conio.h)	*puttext*	(conio.h)
cputs	(conio.h)	*_setcursortype*	(conio.h)
delline	(conio.h)	*textattr*	(conio.h)
getpass	(conio.h)	*textbackground*	(conio.h)
gettext	(conio.h)	*textcolor*	(conio.h)
gettextinfo	(conio.h)	*textmode*	(conio.h)
gotoxy	(conio.h)	*ungetc*	(stdio.h)
highvideo	(conio.h)	*wherex*	(conio.h)
insline	(conio.h)	*wherey*	(conio.h)
lowvideo	(conio.h)	*window*	(conio.h)

Time and date routines

These are time conversion and time manipulation routines.

asctime	(time.h)	*mktime*	(time.h)
ctime	(time.h)	*setdate*	(dos.h)
difftime	(time.h)	*settime*	(dos.h)
_dos_getdate	(dos.h)	*stime*	(time.h)
_dos_gettime	(dos.h)	*_strdate*	(time.h)
_dos_setdate	(dos.h)	*strftime*	(time.h)
_dos_settime	(dos.h)	*_strtime*	(time.h)
dostounix	(dos.h)	*TDate*	(date.h)
ftime	(sys\timeb.h)	*time*	(time.h)
getdate	(dos.h)	*TTime*	(time.h)
gettime	(dos.h)	*tzset*	(time.h)
gmtime	(time.h)	*unixtodos*	(dos.h)
localtime	(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_start*	(stdarg.h)
va_end	(stdarg.h)		

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