MATLAB® Compiler

The Language of Technical Computing

Computation

Visualization

Programming

User's Guide

Version 2.1

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MATLAB Compiler User's Guide

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Introducing the MATLAB Compiler

Introduction

This book describes version 2.1 of the MATLAB® Compiler. The MATLAB Compiler takes M-files as input and generates C or C++ source code or P-code as output. The MATLAB Compiler can generate these kinds of source code:

- C source code for building MEX-files.
- C or C++ source code for combining with other modules to form stand-alone applications. Stand-alone applications do not require MATLAB at run time; they can run even if MATLAB is not installed on the system. The MATLAB Compiler *does* require the MATLAB C/C++ Math Library to create stand-alone applications that rely on the core math and data analysis capabilities of MATLAB. The MATLAB Compiler also requires the MATLAB C/C++ Graphics Library in order to create stand-alone applications that make use of Handle Graphics® functions.
- C code S-functions for use with Simulink®.
- C shared libraries (dynamically linked libraries, or DLLs, on Microsoft Windows 95/98/2000/NT) and C++ static libraries. These can be used without MATLAB on the system, but they do require the MATLAB C/C++ Math Library.

This chapter takes a closer look at these categories of C and C++ source code and explains the value of compiled code.

Before You Begin

Before reading this book, you should already be comfortable writing M-files. If you are not, see "Programming and Data Types" in *Using MATLAB*.

Note The phrase *MATLAB interpreter* refers to the application that accepts MATLAB commands, executes M-files and MEX-files, and behaves as described in *Using MATLAB*. When you use MATLAB, you are using the MATLAB interpreter. The phrase *MATLAB Compiler* refers to this product that translates M-files to C or C++ source code. This book distinguishes references to the MATLAB Compiler by using the word 'Compiler' with a capital C. References to 'compiler' with a lowercase c refer to your C or C++ compiler.

New Features

MATLAB Compiler 2.1 supports much of the functionality of MATLAB 6. The new features of the Compiler are:

- Optimizations
- `mlib` files
- Additional data type support
- Improved support for `load` and `save`
- Dynamically linking in MEX-files in the stand-alone environment
- MATLAB add-in for Visual Studio
- Faster C/C++ Math Library applications
- Additional language support

Note The MATLAB Compiler 2.1 does *not* support user-defined classes (MATLAB objects), scripts, or calls to the MATLAB Java interface.

Optimizations

Compiler 2.1 provides a series of optimizations that can help speed up your compiled code. These optimizations are on by default unless you are building a debuggable version.

Folding Array Constants. Folds scalar and nonscalar valued array constants.

One- and Two-Dimensional Array Indexing. Uses faster routines that are optimized for simple indexing.

for-loops. Optimizes `for-` loops with integer starts and increments.

Conditional Expressions. Reduces the MATLAB conditional operators to scalar C conditional operators when both operands are known to be integer scalars.

For more information on these optimizations, see Chapter 6, "Optimizing Performance."

mlib Files

`mlib` files make it possible to produce a shared library out of a toolbox and then compile M-files that make calls into that toolbox. Specifying an `mlib` file tells the MATLAB Compiler to link against the `mlib` file's corresponding shared library whenever it needs to use any of the functions found in that library. The `mlib` file and its corresponding shared library file must be located within the same directory. For more information about `mlib` files, see "mlib Files" on page 5-25.

Additional Data Type Support

Integer Data Types. The signed and unsigned integer arrays `int8`, `int16`, `int32`, `uint8`, `uint16`, and `uint32` are now supported, which provides improved support for the Image Processing Toolbox.

Function Handles. A function handle is a new MATLAB data type that captures all the information about a function that MATLAB needs to evaluate it. Compiler 2.1 supports function handles. For more information on function handles, see the `function handle` reference page.

Improved Support for load and save

`load` and `save` are now supported when they do not list the variables to be loaded or saved. They work by loading or saving all variables that are defined or used within the function.

Dynamically Linking in MEX-Files in the Stand-Alone Environment

Specifying `-h` or providing the name of a function on the command line will automatically link in any referenced MEX-files.

MATLAB Add-In for Visual Studio®

This add-in integrates the MATLAB Compiler 2.1 into Visual C/C++ Version 5 or 6. To learn more about the MATLAB add-in for Visual Studio, see "Using an IDE" on page 4-24.

Faster C/C++ Math Library Applications

The improved performance of the C/C++ Math Library is due in part to the added scalar accelerated versions of many of the library functions.

Additional Language Support

pause and continue. These commands are now supported.

eval and input. `eval` and `input` are supported for strings that do not contain workspace variables.

Note As of Compiler 2.1, Compiler 1.2 is no longer available due to the evolution of internal data structures. The `-V1.2` option is no longer supported, along with any options recognized by Compiler 1.2.

Compiler Licensing Changes

Starting with Compiler 1.2.1, a new licensing scheme has been employed that enables the product to be simpler and more user friendly.

In versions prior to 1.2.1, you could not run the MATLAB Compiler unless you were running MATLAB. On networked systems, this meant that one user would be holding the license for one copy of MATLAB and the Compiler, simultaneously. In effect, one user required both products and tied up both licenses until the user exited MATLAB. Although you can still run the Compiler from within MATLAB, it is not required. One user could be running the Compiler while another user could be using MATLAB.

The licensing model is based on how you run the Compiler:

- From the MATLAB command prompt
- From a DOS/UNIX shell

Running Compiler from MATLAB

When you run the Compiler from "inside" of MATLAB, that is, you run `mcc` from the MATLAB command prompt, you hold the Compiler license as long as MATLAB remains open. To give up the Compiler license, exit MATLAB.

Running Compiler from DOS/UNIX Shell

If you run the Compiler from a DOS or UNIX shell, you are running from "outside" of MATLAB. In this case, the Compiler:

- Does not require MATLAB to be running on the system where the Compiler is running
- Gives the user a dedicated 30 minute time allotment during which the user has complete ownership over a license to the Compiler

Each time a user requests the Compiler, the user begins a 30 minute time period as the sole owner of the Compiler license. Anytime during the 30 minute segment, if the same user requests the Compiler, the user gets a new 30 minute allotment. When the 30-minute time interval has elapsed, if a different user requests the Compiler, the new user gets the next 30 minute interval.

When a user requests the Compiler and a license is not available, the user receives the message

```
Error: Could not check out a Compiler License.
```

This message is given when no licenses are available. As long as licenses are available, the user gets the license and no message is displayed. The best way to guarantee that all MATLAB Compiler users have constant access to the Compiler is to have an adequate supply of licenses for your users.

Uses of the Compiler

The MATLAB Compiler (`mcc`) can translate M-files into C files. The resultant C files can be used in any of the supported executable types including MEX, executable, or library by generating an appropriate *wrapper* file. A wrapper file contains the required interface between the Compiler-generated code and a supported executable type. For example, a MEX wrapper contains the MEX gateway routine that sets up the left- and right-hand arguments for invoking the Compiler-generated code.

The code produced by the MATLAB Compiler is independent of the final target type — MEX, executable, or library. The wrapper file provides the necessary interface to the target type.

Note MEX-files generated by the MATLAB Compiler 2.1 are not backward compatible. They require MATLAB 6/Release 12 or greater.

Creating MEX-Files

The MATLAB Compiler, when invoked with the `-x` macro option, produces a MEX-file from M-files. The Compiler:

1. Translates your M code to C code.
2. Generates a MEX wrapper.
3. Invokes the `mex` utility which builds the C MEX-file source into a MEX-file by linking the MEX-file with the MEX version of the math libraries (`libmatlbmx`).

This figure illustrates the process of producing a MEX-file. The MATLAB interpreter dynamically loads MEX-files as they are needed. Some MEX-files run significantly faster than their M-file equivalents, which is explained in “Faster Execution” on page 1-14.

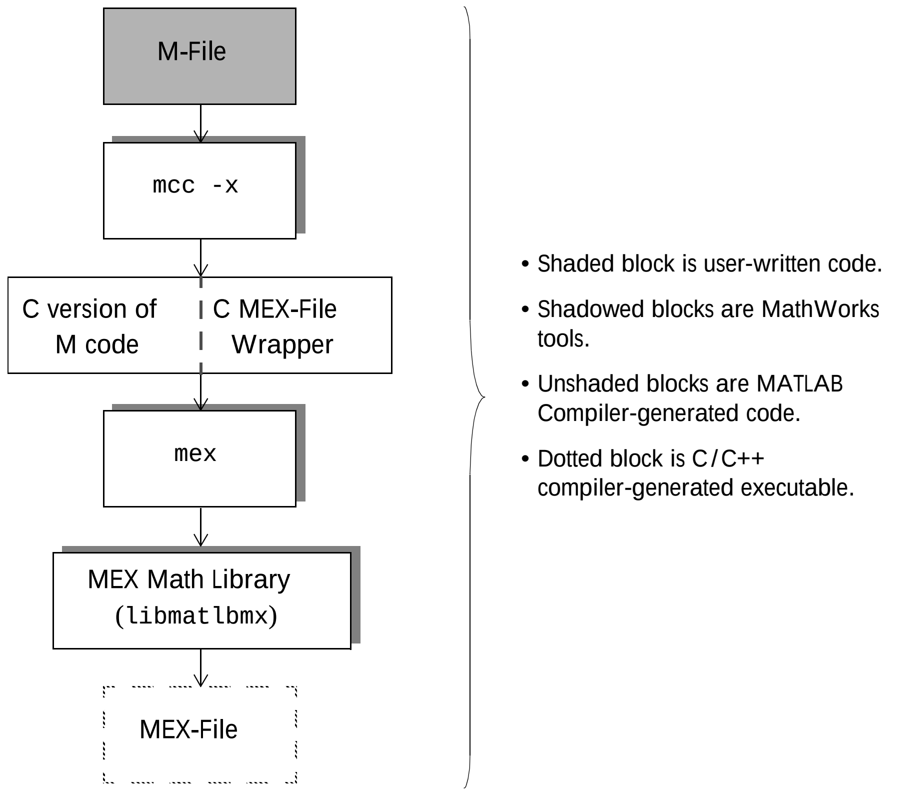


Figure 1-1: Developing MEX-Files

MATLAB users who do not have the MATLAB Compiler must write the source code for MEX-files in either Fortran or C. "External Interfaces/API" explains the fundamentals of this process. To write MEX-files, you have to know how MATLAB represents its supported data types and the MATLAB external interface (i.e., the application program interface, or API.)

If you are comfortable writing M-files and have the MATLAB Compiler, then you do not have to learn all the details involved in writing MEX-file source code.

Creating Stand-Alone Applications

C Stand-Alone Applications

The MATLAB Compiler, when invoked with the `-m` macro option, translates input M-files into C source code that is usable in any of the supported executable types. The Compiler also produces the required wrapper file suitable for a stand-alone application. Then, your ANSI C compiler compiles these C source code files and the resulting object files are linked against the MATLAB C/C++ Math Library, which you must have in order to create C or C++ stand-alone applications. For more information about which libraries must be included when you distribute a C application, see "Distributing Stand-Alone UNIX Applications" on page 4-14 or "Distributing Stand-Alone Windows Applications" on page 4-26.

Note If you do *not* have the MATLAB C/C++ Graphics Library (`libsgl`), and your application calls a Handle Graphics function, a run-time error occurs.

C++ Stand-Alone Applications

The MATLAB Compiler, when invoked with the `-p` macro option, translates input M-files into C++ source code that is usable in any of the executable types except MEX. The Compiler also produces the required wrapper file suitable for a stand-alone application. Then, your C++ compiler compiles this C++ source code and the resulting object files are linked against the MATLAB C/C++ Math Library. For more information about which libraries must be included when you distribute a C++ application, see "Distributing Stand-Alone UNIX Applications" on page 4-14 or "Distributing Stand-Alone Windows Applications" on page 4-26.

Developing a Stand-Alone Application

Suppose you want to create an application that calculates the rank of a large magic square. One way to create this application is to code the whole application in C or C++; however, this would require writing your own magic square, rank, and singular value routines.

An easier way to create this application is to write it as one or more M-files. This figure outlines this development process.

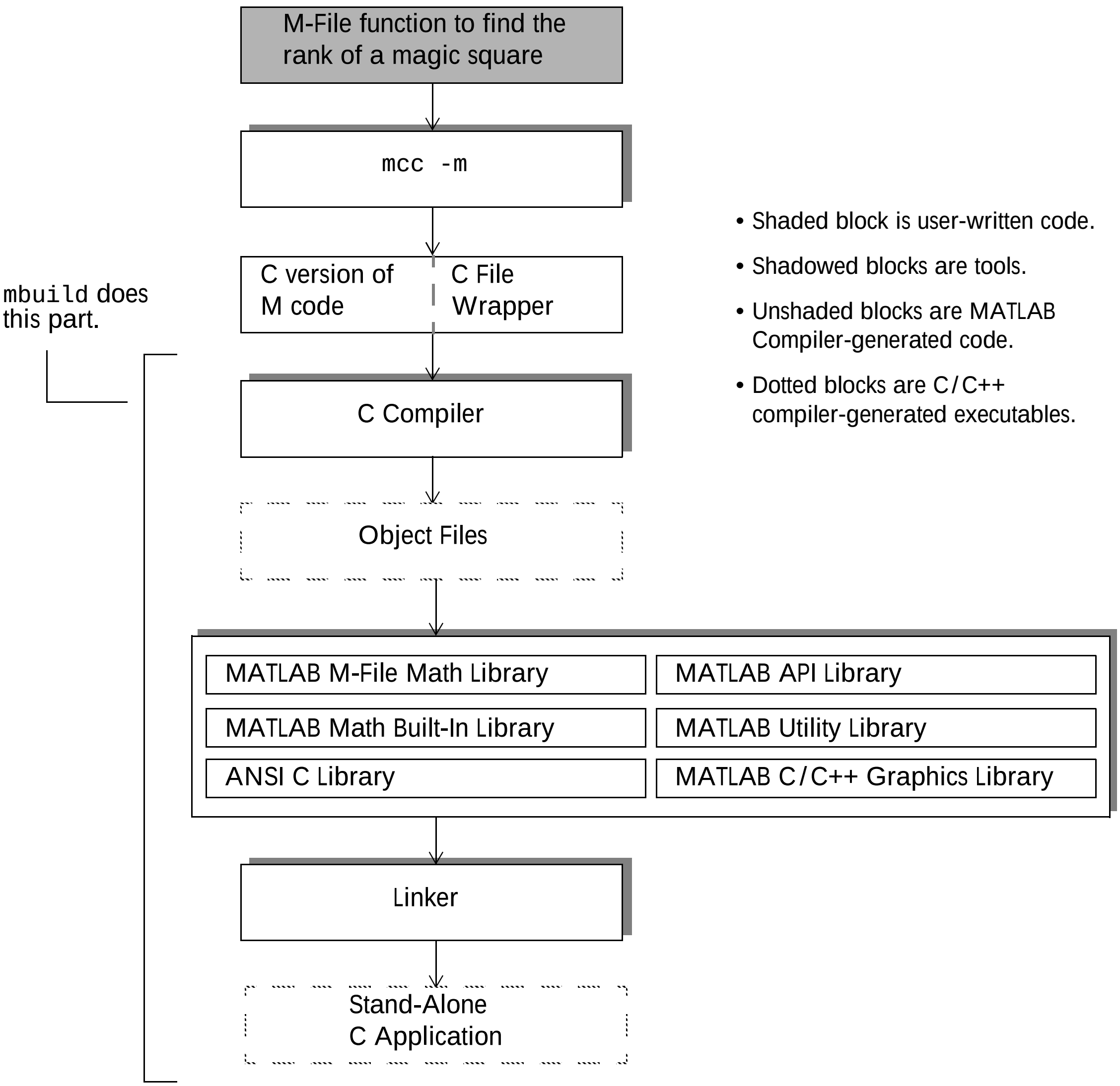


Figure 1-2: Developing a Typical Stand-Alone C Application

See “Stand-Alone Applications” for complete details regarding stand-alone applications.

Figure 1-2 illustrates the process of developing a typical stand-alone C application. Use the same basic process for developing stand-alone C++ applications, but use the `-p` option instead of the `-m` option with the MATLAB Compiler, a C++ compiler instead of a C compiler, and the MATLAB C/C++ Math Library.

Note The MATLAB Compiler contains a tool, `mbuild`, which simplifies much of this process. Chapter 4, “Stand-Alone Applications,” describes the `mbuild` tool.

`-p` and `-m` are examples of options that you use to control how the Compiler works. The “Reference” chapter includes a complete description of the Compiler 2.1 options in the section, “mcc.” Throughout this book you will see numerous examples of how these options are used with the Compiler to perform various tasks.

The MATLAB Compiler Family

This figure illustrates the various ways you can use the MATLAB Compiler. The shaded blocks represent user-written code; the unshaded blocks represent Compiler-generated code; the remaining blocks (drop shadow) represent MathWorks or other vendor tools.

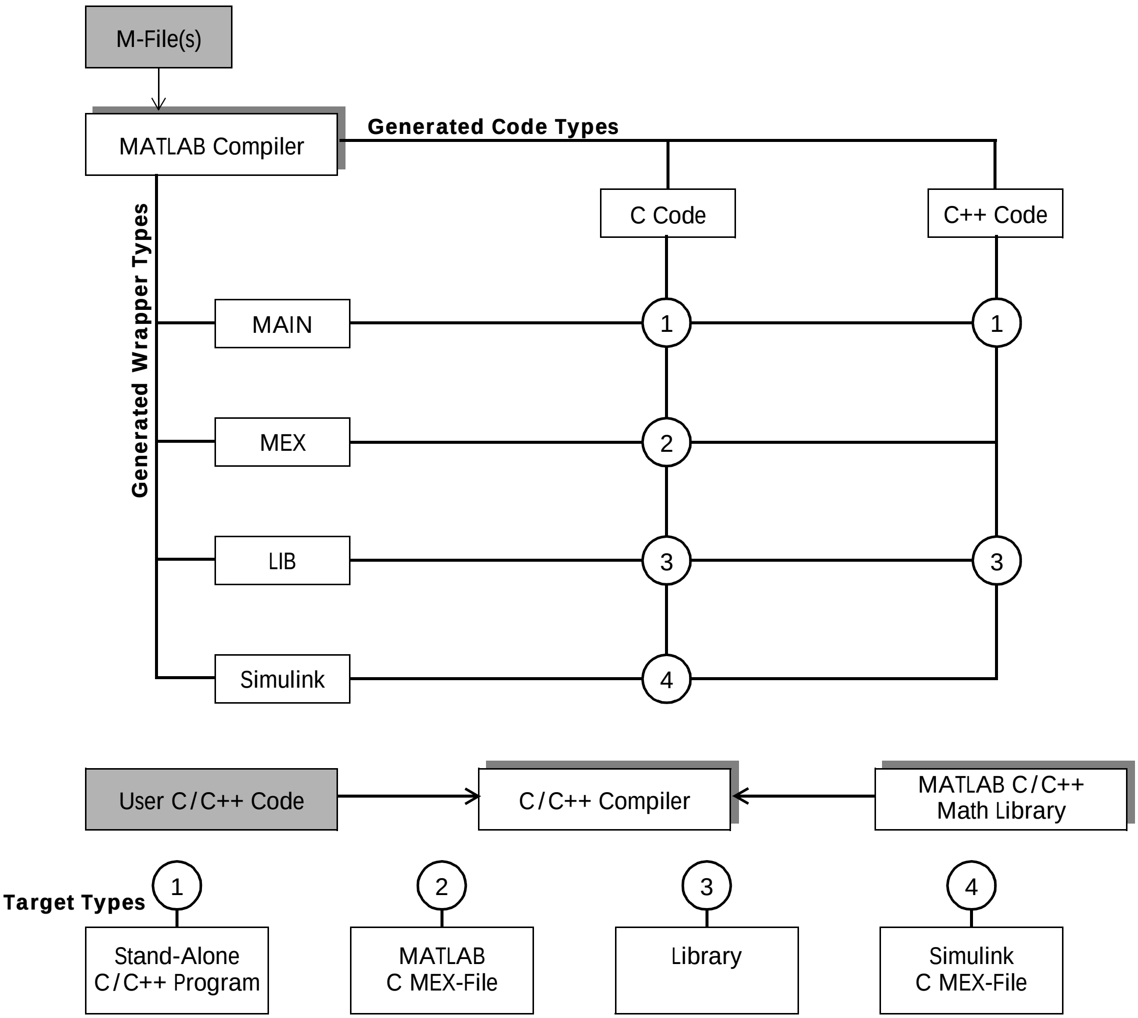


Figure 1-3: MATLAB Compiler Uses

The Compiler takes your M-file(s) and can generate C or C++ code. It can also generate one of four wrapper files depending on your specified target. This table shows the wrapper files the Compiler can generate, their associated targets, and the corresponding `-W` option (wrapper).

Table 1-1: Compiler 2.1 Wrappers and Targets

Wrapper File	Target	-W Setting
Main	Stand-alone C or C++ program	`-W main`
MEX	MATLAB C MEX-file	`-W mex`
Library	C shared library or C++ static library	`-W lib:`*libname*
Simulink S-function	Simulink C MEX-file	`-W simulink`

Each numbered node in Figure 1-3, MATLAB Compiler Uses, indicates a combination of C/C++ code and a wrapper that generates a specific target type. The file(s) formed by combining the C/C++ code (denoted by “User C/C++ Code”) and the wrapper are then passed to the C/C++ compiler, which combines them with any user-defined C/C++ programs, and eventually links them against the appropriate libraries. The end result of this sequence is the target as described in the table above.

Why Compile M-Files?

There are three main reasons to compile M-files:

- To create stand-alone applications or C shared libraries (DLLs on Windows) or C++ static libraries
- To hide proprietary algorithms
- To speed them up

Stand-Alone Applications and Libraries

You can create MATLAB applications that take advantage of the mathematical functions of MATLAB, yet do not require that the user owns MATLAB. Stand-alone applications are a convenient way to package the power of MATLAB and to distribute a customized application to your users.

You can develop an algorithm in MATLAB to perform specialized calculations and use the Compiler to create a C shared library (DLL on Windows) or a C++ static library. You can then integrate the algorithm into a C/C++ application. After you compile the C/C++ application, you can use the MATLAB algorithm to perform specialized calculations from your program.

Hiding Proprietary Algorithms

MATLAB M-files are ASCII text files that anyone can view and modify. MEX-files are binary files. Shipping MEX-files or stand-alone applications instead of M-files hides proprietary algorithms and prevents modification of your M-files.

Faster Execution

Compiled C or C++ code typically runs faster than its M-file equivalents because:

- Compiled code usually runs faster than interpreted code.
- C or C++ can avoid unnecessary memory allocation overhead that the MATLAB interpreter performs.

Cases When Performance Does Not Improve. Compilation is not likely to speed up M-file functions that:

- Are heavily vectorized
- Spend most of their time in MATLAB's built-in indexing, math, or graphics functions

Cases When Performance Does Improve. Compilation is most likely to speed up M-file functions that contain loops.

Upgrading from Previous Versions

MATLAB Compiler 2.0

The MATLAB Compiler 2.1 does not support the `-V1.2` option that was available in Compiler 2.0.

MATLAB Compiler 1.2

Compatibility

The MATLAB Compiler 2.1 is fully compatible with previous releases of the Compiler. If you have M-files that were compiled with a previous version of the Compiler and compile them with the new version, you will get the same results.

Installation

The MATLAB 6 (Release 12) installer automatically installs Compiler 2.1. Once you install and configure Compiler 2.1, you can compile your M-files from either the MATLAB prompt or the DOS or UNIX command line. For more information about installation, see Chapter 2, "Installation and Configuration."

MATLAB Compiler 1.0/1.1

In many cases, M-code that was written and compiled in MATLAB 4.2 will work as is in MATLAB 6 as well as the MATLAB 5 series. There are, however, certain changes that could impact your work, especially if you integrated Compiler-generated code into a larger application.

Changed Library Name

Beginning with MATLAB 5.0, the name of the shared library that contains compiled versions of most MATLAB M-file math routines, `libtbx`, has changed. The new library is now called `libmmfile`.

Changed Data Type Names

In C, beginning with MATLAB 5.0, the name of the basic MATLAB data type, `Matrix`, has changed. The new name for the data type is `mxArray`.

In C++, beginning with MATLAB 5.0, the name of the basic MATLAB data type, `mwMatrix`, has changed. The new name for the data type is `mwArray`.

Limitations and Restrictions

MATLAB Code

This version of the MATLAB Compiler supports almost all of the functionality of MATLAB. However, there are some limitations and restrictions that you should be aware of. Although this version of the MATLAB Compiler cannot compile the following, a future version will be able to compile them:

- Script M-files (See "Converting Script M-Files to Function M-Files" in Chapter 3 for further details.)
- M-files that use objects
- M-files that use `input` or `eval` to manipulate workspace variables.

Note `input` and `eval` calls that do *not* use workspace variables will compile and execute properly.

The Compiler cannot compile built-in MATLAB functions (functions such as `eig` have no M-file, so they can't be compiled). Note, however, that most of these functions are available to you because they are in the MATLAB Math Built-in Library (`libmatlb`).

In addition, the Compiler does not honor conditional global and persistent declarations. It treats global and persistent as declarations. For example,

```
if (y==3)
   persistent x
else
   x = 3;
end
```

Stand-Alone Applications

The restrictions and limitations noted in the previous section also apply to stand-alone applications. The functions in this table are supported in MEX-mode, but are not supported in stand-alone mode.

Note You cannot call any Handle Graphics functions unless you have the optional Graphics Library installed. In addition, stand-alone applications cannot access Simulink functions. Although the MATLAB Compiler *can* compile M-files that call these functions, the MATLAB C/C++ Math library does not support them. Therefore, unless you write your own versions of the unsupported routines in a MEX-file or as C-code, when you run the executable, you will get a run-time error.

Table 1-2: Unsupported Functions in Stand-Alone Mode

add_block	add_line	applescript	assignin
callstats	close_system	cputime	dbclear
dbcont	dbdown	dbquit	dbstack
dbstatus	dbstep	dbstop	dbtype
dbup	delete_block	delete_line	diary
echo	edt	errorstat	errortrap
evalin	fields	fschange	functionscalled
get_param	hcreate	help	home
hregister	inferiorto	inmem	isglobal
isjava	isruntime	java	javaArray
javaMethod	javaObject	keyboard	linmod
lookfor	macprint	mactools	methods
mislocked	mlock	more	munlock
new_system	open_system	pack	pfile

Table 1-2: Unsupported Functions in Stand-Alone Mode (Continued)

rehash	runtime	set_param	sim
simget	simset	sldebug	str2func
superiorto	system_dependent	trmginput	type
vms	what	which	who
whos			

2

Installation and Configuration

This chapter explains:

- The system requirements you need to use the MATLAB Compiler
- How to install the MATLAB Compiler
- How to configure the MATLAB Compiler after you have installed it

This chapter includes information for both MATLAB Compiler platforms — UNIX and Microsoft Windows.

For information about the MATLAB Compiler not available at print time, see the *MATLAB Compiler 2.1 Release Notes*.

When you install your ANSI C or C++ compiler, you may be required to provide specific configuration details regarding your system. This chapter contains information for each platform that can help you during this phase of the installation process. The sections, "Things to Be Aware of," provide this information for each platform.

Note If you encounter problems relating to the installation or use of your ANSI C or C++ compiler, consult the documentation or customer support organization of your C or C++ compiler vendor.

System Configuration for MEX-Files

This section outlines the steps necessary to configure your system to create MEX-files.

The sequence of steps to install and configure the MATLAB Compiler so that it can generate MEX-files is:

1 Install the MATLAB Compiler.

2 Install an ANSI C or C++ compiler, if you don't already have one installed.

3 Verify that `mex` can generate MEX-files.

4 Verify that the MATLAB Compiler can generate MEX-files from the MATLAB command line and from the UNIX or DOS command line.

This figure shows the Compiler installation sequence for creating MEX-files on both platforms. The sections following the flowchart provide more specific details for the individual platforms. Additional steps may be necessary if you plan to create stand-alone applications or libraries, however, you still must perform the steps given in this chapter first. Chapter 4, "Stand-Alone Applications" provides the details about the additional installation and configuration steps necessary for creating stand-alone applications and libraries.

Note This flowchart assumes that MATLAB is properly installed on your system.

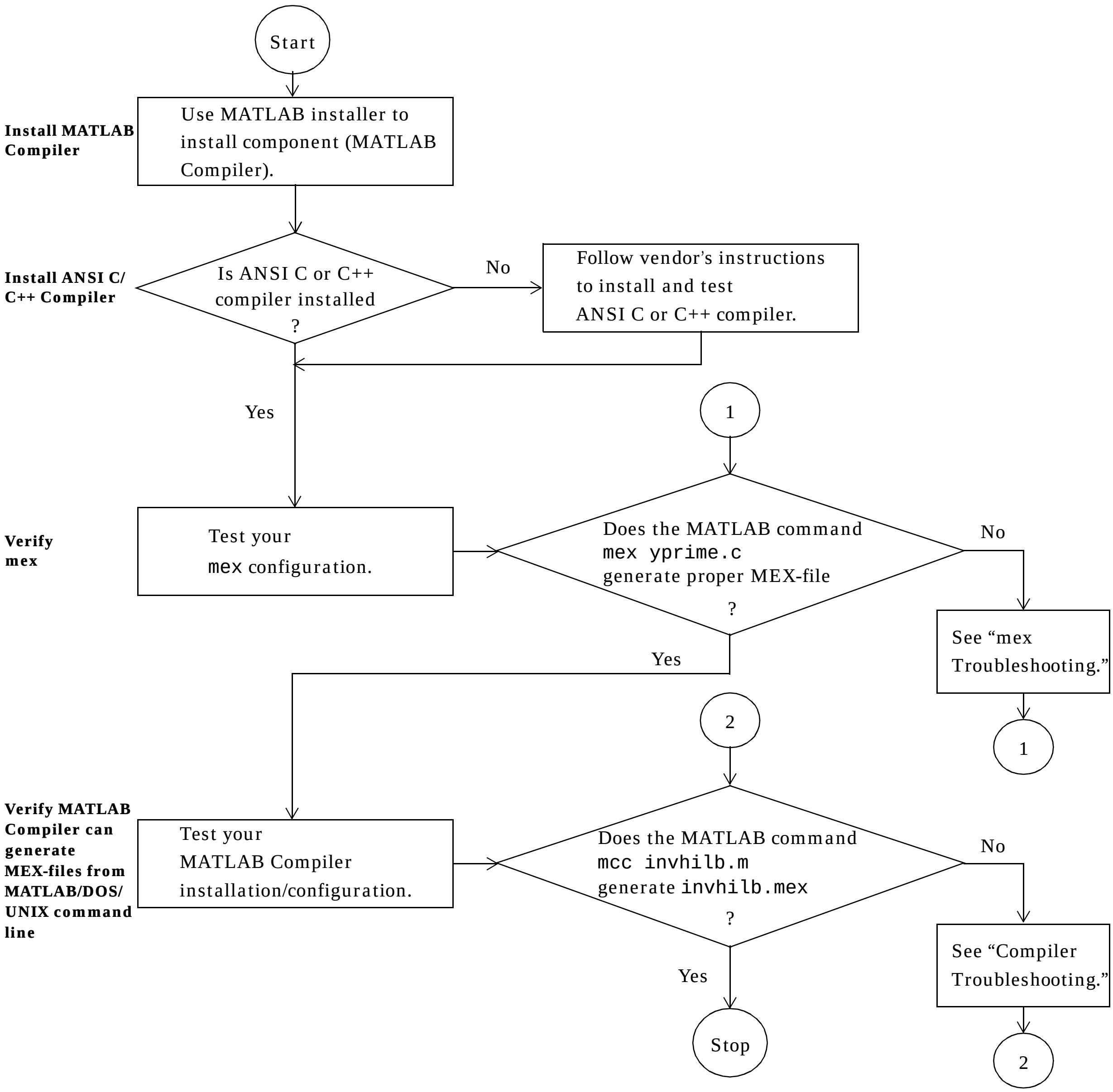


Figure 2-1: MATLAB Compiler Installation Sequence for Creating MEX-Files

UNIX Workstation

This section examines the system requirements, installation procedures, and configuration procedures for the MATLAB Compiler on UNIX systems.

System Requirements

You cannot install the MATLAB Compiler unless MATLAB 6/Release 12 is already installed on the system. The MATLAB Compiler imposes no operating system or memory requirements beyond those that are necessary to run MATLAB. The MATLAB Compiler consumes a small amount of disk space.

This table shows the requirements for creating UNIX applications with the MATLAB Compiler.

Table 2-1: Requirements for Creating UNIX Applications

To create...	You need...
MEX-files	ANSI C compiler MATLAB Compiler
Stand-alone C applications	ANSI C compiler MATLAB Compiler MATLAB C/C++ Math Library
Stand-alone C++ applications	C++ compiler MATLAB Compiler MATLAB C/C++ Math Library

The MATLAB C/C++ Math Library is a separately sold product.

Note If your application uses Handle Graphics, you will need the MATLAB C/C++ Graphics Library to develop stand-alone applications. The MATLAB C/C++ Graphics Library is a separately sold product.

Note Although the MATLAB Compiler supports the creation of stand-alone C++ applications, it does not support the creation of C++ MEX-files.

Supported ANSI C and C++ UNIX Compilers

The MATLAB Compiler supports:

- The GNU C compiler, `gcc`, (except on HP and SGI64)
- The system's native ANSI C compiler on all UNIX platforms
- The system's native C++ compiler on all UNIX platforms (except Linux)
- The GNU C++ compiler, `g++`, on Linux.

Note For a list of all the compilers supported by MATLAB, see the MathWorks Technical Support Department's Technical Notes at:

`http://www.mathworks.com/support/tech-notes/v5/1600/1601.shtml`

Known Compiler Limitations. There are several known restrictions regarding the use of supported compilers:

- The SGI C compiler does not handle denormalized floating-point values correctly. Denormalized floating-point numbers are numbers that are greater than 0 and less than the value of `DBL_MIN` in the compiler's `float.h` file.
- Due to a limitation of the GNU C++ compiler (`g++`) on Linux, `try...catch...end` blocks do not work.
- The `-A debugline:on` option does not work on the GNU C++ compiler (`g++`) on Linux because it uses `try...catch...end`.

Compiler Options Files

The MathWorks provides options files for every supported C or C++ compiler. These files contain the necessary flags and settings for the compiler. This table shows the preconfigured options files that are included with MATLAB for UNIX.

Compiler	Options File
System native ANSI compiler	`mexopts.sh`
`gcc` (GNU C compiler)	`gccopts.sh`

Information on the options files is provided for those users who may need to modify them to suit their own needs. Many users never have to be concerned with the inner workings of the options files.

Locating Options Files

To locate your options file, the `mex` script searches the following:

- The current directory
- `$HOME/.matlab/R12`
- `<matlab>/bin`

`mex` uses the first occurrence of the options file it finds. If no options file is found, `mex` displays an error message.

Installation

MATLAB Compiler

To install the MATLAB Compiler on UNIX systems, follow the instructions in the *MATLAB Installation Guide for UNIX*. If you have a license to install the MATLAB Compiler, it appears as one of the installation choices that you can select as you proceed through the installation process. If the MATLAB Compiler does not appear as one of the installation choices, contact The MathWorks to get an updated license file (`license.dat`):

- Via the Web at `www.mathworks.com`. On the MathWorks home page, click on the MATLAB Access option, log in to the Access home page, and follow the instructions.
- Via e-mail at `service@mathworks.com`

ANSI C or C++ Compiler

To install your ANSI C or C++ compiler, follow the vendor's instructions that accompany your C or C++ compiler. Be sure to test the C or C++ compiler to make sure it is installed and configured properly. Typically, the compiler vendor provides some test procedures. The following section, "Things to Be Aware of," contains several UNIX-specific details regarding the installation and configuration of your ANSI C or C++ compiler.

Note On some UNIX platforms, a C or C++ compiler may already be installed. Check with your system administrator for more information.

Things to Be Aware of

This table provides information regarding the installation and configuration of a C or C++ compiler on your system.

Description	Comment
Determine which C or C++ compiler is installed on your system.	See your system administrator.
Determine the path to your C or C++ compiler.	See your system administrator.

mex Verification

Choosing a Compiler

Using the System Compiler. If the MATLAB Compiler and your supported C or C++ compiler are installed on your system, you are ready to create C MEX-files. To create a MEX-file, you can simply enter

```
mex filename.c
```

This simple method of creating MEX-files works for the majority of users. It uses the system's compiler as your default compiler for creating C MEX-files.

If you do not need to change C or C++ compilers, or you do not need to modify your compiler options files, you can skip ahead in this section to "Creating MEX-Files" on page 2-10. If you need to know how to change the options file, continue with this section.

Changing Compilers

Changing the Default Compiler. To change your default C or C++ compiler, you select a different options file. You can do this at anytime by using the command

```
mex -setup

 Using the 'mex -setup' command selects an options file that is
 placed in ~/.matlab/R12 and used by default for 'mex'. An options
 file in the current working directory or specified on the
 command line overrides the default options file in ~/.matlab/R12.

 Options files control which compiler to use, the compiler and
 link command options, and the runtime libraries to link against.

 To override the default options file, use the 'mex -f' command
 (see 'mex -help' for more information).

The options files available for mex are:

  1: <matlab>/bin/gccopts.sh :
        Template Options file for building gcc MEX-files
  2: <matlab>/bin/mexopts.sh :
        Template Options file for building MEX-files via the
        system ANSI compiler

Enter the number of the options file to use as your default options
file:
```

Select the proper options file for your system by entering its number and pressing **Return**. If an options file doesn't exist in your MATLAB directory, the system displays a message stating that the options file is being copied to your user-specific `matlab` directory. If an options file already exists in your MATLAB directory, the system prompts you to overwrite it.

Note The `setup` option creates a user-specific, `matlab` directory in your individual home directory and copies the appropriate options file to the directory. (If the directory already exists, a new one is not created.) This `matlab` directory is used for your individual options files only; each user can have his or her own default options files (other MATLAB products may place options files in this directory). Do not confuse these user-specific `matlab` directories with the system `matlab` directory, where MATLAB is installed.

Using the `setup` option resets your default compiler so that the new compiler is used every time you use the `mex` script.

Modifying the Options File. Another use of the `setup` option is if you want to change your options file settings. For example, if you want to make a change to the current linker settings, or you want to disable a particular set of warnings, you should use the `setup` option.

As the previous note says, `setup` copies the appropriate options file to your individual directory. To make your user-specific changes to the options file, you then edit your copy of the options file to correspond to your specific needs and save the modified file. This sets your default compiler's options file to your specific version.

Temporarily Changing the Compiler. To temporarily change your C or C++ compiler, use the `-f` option, as in

```
mex -f <file> …
```

The `-f` option tells the `mex` script to use the options file, `<file>`. If `<file>` is not in the current directory, then `<file>` must be the full pathname to the desired options file. Using the `-f` option tells the `mex` script to use the specified options file for the current execution of `mex` only; it does not reset the default compiler.

Creating MEX-Files

To create MEX-files on UNIX, first copy the source file(s) to a local directory, and then change directory (`cd`) to that local directory.

On UNIX, MEX-files are created with platform-specific extensions, as shown in this table.

Table 2-2: MEX-File Extensions for UNIX

Platform	MEX-File Extension
DEC Alpha	`mexaxp`
HP 9000 PA-RISC	`mexhp7`
HP-UX	`mexhpux`
IBM RS/6000	`mexrs6`
Linux	`mexglx`
SGI	`mexsg`
Solaris	`mexsol`

The `<matlab>/extern/examples/mex` directory contains C source code for the example `yprime.c`. After you copy the source file (`yprime.c`) to a local directory and `cd` to that directory, enter at the MATLAB prompt

```
mex yprime.c
```

This should create the MEX-file called `yprime` with the appropriate extension corresponding to your UNIX platform. For example, if you create the MEX-file on Solaris, its name is `yprime.mexsol`.

You can now call `yprime` from the MATLAB prompt as if it were an M-function. For example,

```
yprime(1,1:4)
ans =
     2.0000   8.9685   4.0000    -1.0947
```

If you encounter problems generating the MEX-file or getting the correct results, refer to “External Interfaces/API” for additional information about MEX-files.

MATLAB Compiler Verification

Verifying from MATLAB

Once you have verified that you can generate MEX-files on your system, you are ready to verify that the MATLAB Compiler is correctly installed. Type the following at the MATLAB prompt.

```
mcc -x invhilb
```

After a short delay, this command should complete and display the MATLAB prompt. Next, at the MATLAB prompt, type

```
which invhilb
```

The `which` command should indicate that `invhilb` is now a MEX-file by listing the filename followed by the appropriate UNIX MEX-file extension. For example, if you run the Compiler on Solaris, the Compiler creates the file `invhilb.mexsol`. Finally, at the MATLAB prompt, type

```
invhilb(10)
```

Note that this tests only the Compiler's ability to make MEX-files. If you want to create stand-alone applications, refer to Chapter 4, "Stand-Alone Applications" for additional details.

Verifying from UNIX Command Prompt

To verify that the Compiler can generate MEX-files from the UNIX command prompt, you follow a similar procedure as that used in the previous section.

Note Before you test to see if the Compiler can generate MEX-files from the UNIX command prompt, you may want to delete the MEX-file you created in the previous section, `invhilb.mexsol`, or whatever the extension is on your system. That way, you can be sure your newly generated MEX-file is the result of using the Compiler from the UNIX prompt.

Copy `invhilb.m` from the `<matlab>/toolbox/matlab/elmat` directory to a local directory and then type the following at the UNIX prompt.

```
mcc -x invhilb
```

Next, verify that `invhilb` is now a MEX-file by listing the `invhilb` files.

```
ls invhilb.*
```

You will see a list similar to this.

```
invhilb.c        invhilb.m        invhilb_mex.c
invhilb.h        invhilb.mexsol
```

These are the various files that the Compiler generates from the M-file. The Compiler-generated MEX-file appears in the list as the filename followed by the appropriate UNIX MEX-file extension. In this example, the Compiler was executed on Solaris, so the Compiler creates the file `invhilb.mexsol`. For more information on which files the Compiler creates for a compilation, see Chapter 5, “Controlling Code Generation.”

To test the newly created MEX-file, start MATLAB and, at the MATLAB prompt, type

```
invhilb(10)
```

Microsoft Windows on PCs

This section examines the system requirements, installation procedures, and configuration procedures for the MATLAB Compiler on PCs running Windows 95/98/2000 or Windows NT.

System Requirements

You cannot install the MATLAB Compiler unless MATLAB 6/Release 12 is already installed on the system. The MATLAB Compiler imposes no operating system or memory requirements beyond what is necessary to run MATLAB. The MATLAB Compiler consumes a small amount of disk space.

This table shows the requirements for creating PC applications with the MATLAB Compiler.

Table 2-3: Requirements for Creating PC Applications

To create...	You need...
MEX-files	ANSI C compiler (see following note) MATLAB Compiler
Stand-alone C applications	ANSI C compiler (see following note) MATLAB Compiler MATLAB C/C++ Math Library
Stand-alone C++ applications	C++ compiler MATLAB Compiler MATLAB C/C++ Math Library

Note MATLAB includes an ANSI C compiler (Lcc) that is suitable for use with the MATLAB Compiler.

The MATLAB C/C++ Math Library is a separately sold product; the MATLAB C/C++ Graphics Library is a separately sold product. If your application uses Handle Graphics, you will need the MATLAB C/C++ Graphics Library to develop stand-alone applications.

Note Although the MATLAB Compiler supports the creation of stand-alone C++ applications, it does not support the creation of C++ MEX-files.

Supported ANSI C and C++ PC Compilers

To create C MEX-files, stand-alone C/C++ applications, or dynamically linked libraries (DLLs) with the MATLAB Compiler, you must install and configure a supported C/C++ compiler. Use one of the following 32-bit C/C++ compilers that create 32-bit Windows dynamically linked libraries (DLLs) or Windows NT applications:

- Lcc C version 2.4 (included with MATLAB)
- Watcom C/C++ versions 10.6 & 11.0
- Borland C++ versions 5.0, 5.2, 5.3, 5.4, & 5.5
- Microsoft Visual C++ (MSVC) versions 5.0 & 6.0

Note For a list of all the compilers supported by MATLAB, see the MathWorks Technical Support Department's Technical Notes at:

`http://www.mathworks.com/support/tech-notes/v5/1600/1601.shtml`

To create stand-alone applications or DLLs, you also need the MATLAB C/C++ Math Library, which is sold separately. Also, if your applications use Handle Graphics, you will need the MATLAB C/C++ Graphics Library, which is sold separately.

Applications generated by the MATLAB Compiler are 32-bit applications and only run on Windows 95/98/2000 and Windows NT systems.

Known Compiler Limitations. There are several known restrictions regarding the use of supported compilers:

- Some compilers, e.g., Watcom, do not handle denormalized floating-point values correctly. Denormalized floating-point numbers are numbers that are greater than 0 and less than the value of `DBL_MIN` in your compiler's `float.h` file.

- The MATLAB Compiler 2.1 sometimes will generate `goto` statements for complicated `if` conditions. The Borland C++ Compiler prohibits the `goto` statement within a `try…catch` block. This error can occur if you use the `-A debugline:on` option, because its implementation uses `try…catch`. To work around this limitation, simplify the `if` conditions.
- There is a limitation with the Borland C++ Compiler. In your M-code, if you use a constant number that includes a leading zero and contains the digit '8' or '9' before the decimal point, the Borland compiler will display the error message

```
Error <file>.c <line>: Illegal octal digit in function
                       <functionname>
```

  For example, the Borland compiler considers `009.0` an illegal octal integer as opposed to a legal floating-point constant, which is how it is defined in the ANSI C standard.

  As an aside, if all the digits are in the legal range for octal numbers (0-7), then the compiler will incorrectly treat the number as a floating-point value. So, if you have code such as

```
x = [007 06 10];
```

  and want to use the Borland compiler, you should edit the M-code to remove the leading zeros and write it as

```
x = [7 6 10];
```

- The MATLAB Compiler's `-d` option (place output in specified directory) does not work properly with the Borland 5.0 and 5.2 compilers if there are spaces in the pathname due to limitations in the compiler.

Compiler Options Files

The MathWorks provides options files for every supported C or C++ compiler. These files contain the necessary flags and settings for the compiler. This table shows the preconfigured PC options files that are included with MATLAB.

Compiler	Options File
Lcc C, Version 2.4 (included with MATLAB)	`lccopts.bat`
Microsoft C/C++, Version 5.0 Microsoft C/C++, Version 6.0	`msvc50opts.bat` `msvc60opts.bat`
Watcom C/C++, Version 10.6 Watcom C/C++, Version 11.0	`watcopts.bat` (supported for `mex` only, not for `mbuild`) `wat11copts.bat` (supported for `mex` only, not for `mbuild`)

Borland C++, Version 5.0
Borland C++, Version 5.2
Borland C++ Builder 3
Borland C++ Builder 4
Borland C++ Builder 5
	`bccopts.bat`
	`bccopts.bat`
	`bcc53opts.bat`
	`bcc54opts.bat`
	`bcc55opts.bat`

Locating Options Files

To locate your options file, the `mex` script searches the following:

- The current directory
- The `user profile` directory (see the following section, "The User Profile Directory Under Windows," for more information about this directory)

`mex` uses the first occurrence of the options file it finds. If no options file is found, `mex` searches your machine for a supported C compiler and uses the factory default options file for that compiler. If multiple compilers are found, you are prompted to select one.

The User Profile Directory Under Windows. The Windows `user profile` directory is a directory that contains user-specific information such as desktop appearance, recently used files, and **Start** menu items. The `mex` and `mbuild` utilities store their respective options files, `mexopts.bat` and `compopts.bat`, which are created during the `-setup` process, in a subdirectory of your `user profile` directory, named `Application Data\MathWorks\MATLAB\R12`. Under Windows NT and Windows 95/98/2000 with user profiles enabled, your `user profile` directory is `%windir%\Profiles\username`. Under Windows 95/98/2000 with user profiles disabled, your `user profile` directory is `%windir%`. Under Windows 95/98/2000, you can determine whether or not user profiles are enabled by using the **Passwords** control panel.

Installation

MATLAB Compiler

To install the MATLAB Compiler on a PC, follow the instructions in the *MATLAB Installation Guide for PC*. If you have a license to install the MATLAB Compiler, it will appear as one of the installation choices that you can select as you proceed through the installation process.

If the Compiler does not appear in your list of choices, contact The MathWorks to obtain an updated License File (`license.dat`) for multiuser network installations, or an updated Personal License Password (PLP) for single-user, standard installations:

- Via the Web at `www.mathworks.com`. On the MathWorks home page, click on the MATLAB Access option, log in to the Access home page, and follow the instructions.
- Via e-mail at `service@mathworks.com`

ANSI C or C++ Compiler

To install your ANSI C or C++ compiler, follow the vendor's instructions that accompany your compiler. Be sure to test the C/C++ compiler to make sure it is installed and configured properly. The following section, "Things to Be Aware of," contains some Windows-specific details regarding the installation and configuration of your C/C++ compiler.

Things to Be Aware of

This table provides information regarding the installation and configuration of a C/C++ compiler on your system.

Description	Comment
Installation options	We recommend that you do a full installation of your compiler. If you do a partial installation, you may omit a component that the MATLAB Compiler relies on.
Installing debugger files	For the purposes of the MATLAB Compiler, it is not necessary to install debugger (DBG) files. However, you may need them for other purposes.
Microsoft Foundation Classes	Microsoft Foundation Classes (MFC) are not required.
16-bit DLL/executables	This is not required.
ActiveX	This is not required.
Running from the command line	Make sure you select all relevant options for running your compiler from the command line.
Updating the registry	If your installer gives you the option of updating the registry, you should do it.
Installing Microsoft Visual C++ Version 6.0	If you need to change the location where this compiler is installed, you must change the location of the `Common` directory. Do not change the location of the `VC98` directory from its default setting.

mex Verification

Choosing a Compiler

Systems with Exactly One C/C++ Compiler. If you have properly installed the MATLAB Compiler and your supported C or C++ compiler, you can now create C MEX-files. On systems where there is exactly one C or C++ compiler available to you, the `mex` utility automatically configures itself for the appropriate compiler. So, for many users, to create a C MEX-file, you can simply enter

```
mex filename.c
```

This simple method of creating MEX-files works for the majority of users. It uses your installed C or C++ compiler as your default compiler for creating your MEX-files.

If you are a user who does not need to change compilers, or you do not need to modify your compiler options files, you can skip ahead in this section to "Creating MEX-Files" on page 2-23.

Note On Windows 95 and Windows 98 systems, if you get the error, `out of environment space`, see "Out of Environment Space Running mex or mbuild" on page 2-26 for more information.

Systems with More than One C/C++ Compiler. On systems where there is more than one C or C++ compiler, the `mex` utility lets you select which of the compilers you want to use. Once you choose your C or C++ compiler, that compiler becomes your default compiler and you no longer have to select one when you compile MEX-files.

For example, if your system has both the Borland and Watcom compilers, when you enter for the first time

```
mex filename.c
```

you are asked to select which compiler to use.

```
mex has detected the following compilers on your machine:
```

```
[1] : Borland compiler in T:\Borland\BC.500
[2] : WATCOM compiler in T:\watcom\c.106

[0] : None
```

```
Please select a compiler. This compiler will become the default:
```

Select the desired compiler by entering its number and pressing **Return**. You are then asked to verify the information.

Changing Compilers

Changing the Default Compiler. To change your default C or C++ compiler, you select a different options file. You can do this at any time by using the `mex -setup` option.

This example shows the process of changing your default compiler to the Microsoft Visual C/C++ Version 6.0 compiler.

```
mex -setup

Please choose your compiler for building external interface (MEX)
files.

Would you like mex to locate installed compilers [y]/n? n

Select a compiler:
[1] Borland C++Builder version 5.0
[2] Borland C++Builder version 4.0
[3] Borland C++Builder version 3.0
[4] Borland C/C++ version 5.02
[5] Borland C/C++ version 5.0
[6] Borland C/C++ (free command line tools) version 5.5
[7] Compaq Visual Fortran version 6.1
[8] Digital Visual Fortran version 6.0
[9] Digital Visual Fortran version 5.0
[10] Lcc C version 2.4
[11] Microsoft Visual C/C++ version 6.0
[12] Microsoft Visual C/C++ version 5.0
[13] WATCOM C/C++ version 11
[14] WATCOM C/C++ version 10.6
```

```
[0] None

Compiler: 11

Your machine has a Microsoft Visual C/C++ compiler located at
D:\Applications\Microsoft Visual Studio. Do you want to use this
compiler [y]/n? y

Please verify your choices:

Compiler: Microsoft Visual C/C++ 6.0
Location: D:\Applications\Microsoft Visual Studio

Are these correct?([y]/n): y

The default options file:
"C:\WINNT\Profiles\username
\Application Data\MathWorks\MATLAB\R12\mexopts.bat" is being
updated...

Installing the MATLAB Visual Studio add-in ...

  Updated ...
```

If the specified compiler cannot be located, you are given the message:

```
The default location for compiler-name is directory-name,
but that directory does not exist on this machine.
Use directory-name anyway [y]/n?
```

Using the `setup` option sets your default compiler so that the new compiler is used everytime you use the `mex` script.

Modifying the Options File. Another use of the `setup` option is if you want to change your options file settings. For example, if you want to make a change to the current linker settings, or you want to disable a particular set of warnings, you should use the `setup` option.

The `setup` option copies the appropriate options file to your `user profile` directory. To make your user-specific changes to the options file, you edit your copy of the options file in your `user profile` directory to correspond to your specific needs and save the modified file. After completing this process, the `mex` script will use the new options file everytime with your modified settings.

Temporarily Changing the Compiler. To temporarily change your C or C++ compiler, use the `-f` option, as in

```
mex -f <file> …
```

The `-f` option tells the `mex` script to use the options file, `<file>`. If `<file>` is not in the current directory, then `<file>` must be the full pathname to the desired options file. Using the `-f` option tells the `mex` script to use the specified options file for the current execution of `mex` only; it does not reset the default compiler.

Creating MEX-Files

The `<matlab>\extern\examples\mex` directory contains C source code for the example `yprime.c`. To verify that your system can create MEX-files, enter at the MATLAB prompt

```
cd([matlabroot '\extern\examples\mex'])
mex yprime.c
```

This should create the `yprime.dll` MEX-file. MEX-files created on Windows 95/98/2000 or NT always have the extension `dll`.

You can now call `yprime` as if it were an M-function. For example,

```
yprime(1,1:4)
ans =
     2.0000   8.9685   4.0000    -1.0947
```

If you encounter problems generating the MEX-file or getting the correct results, refer to "External Interfaces/API" for additional information about MEX-files.

Using an IDE

The MathWorks provides a MATLAB add-in for the Visual Studio development system that lets you work easily within Microsoft Visual C/C++ (MSVC) environment to create and debug MEX-files. The MATLAB add-in for Visual Studio is included with MATLAB and is automatically installed when you run `mex -setup` and select Microsoft Visual C/C++ version 5 or 6. For more information about the add-in, see “Using an IDE” in Chapter 4, “Stand-Alone Applications.”

MATLAB Compiler Verification

Verifying from MATLAB

Once you have verified that you can generate MEX-files on your system, you are ready to verify that the MATLAB Compiler is correctly installed. Type the following at the MATLAB prompt.

```
mcc -x invhilb
```

After a short delay, this command should complete and display the MATLAB prompt. Next, at the MATLAB prompt, type

```
which invhilb
```

The `which` command should indicate that `invhilb` is now a MEX-file; it should have created the file `invhilb.dll`. Finally, at the MATLAB prompt, type

```
invhilb(10)
```

Note that this tests only the Compiler’s ability to make MEX-files. If you want to create stand-alone applications or DLLs, refer to Chapter 4, “Stand-Alone Applications,” for additional details.

Verifying from DOS Command Prompt

To verify that the Compiler can generate C MEX-files from the DOS command prompt, you follow a similar procedure as that used in the previous section.

Note Before you test to see if the Compiler can generate MEX-files from the DOS command prompt, you may want to delete the MEX-file you created in the previous section, `invhilb.dll`. That way, you can be sure your newly generated MEX-file is the result of using the Compiler from the DOS prompt. To delete this file, you must clear the MEX-file or quit MATLAB; otherwise the deletion will fail.

Copy `invhilb.m` from the `<matlab>\toolbox\matlab\elmat` directory to a local directory and then type the following at the DOS prompt.

```
mcc -x invhilb
```

Next, verify that `invhilb` is now a MEX-file by listing the `invhilb` files.

```
dir invhilb*
```

You will see a list containing

```
invhilb.c
invhilb.dll
invhilb.h
invhilb.m
invhilb_mex.c
```

These are the files that the Compiler generates from the M-file, in addition to the original M-file, `invhilb.m`. The Compiler-generated MEX-file appears in the list as the filename followed by the extension, `dll`. In this example, the Compiler creates the file `invhilb.dll`. For more information on which files the Compiler creates for a compilation, see Chapter 5, "Controlling Code Generation."

To test the newly created MEX-file, you would start MATLAB and, at the MATLAB prompt, you could type

```
invhilb(10)
```

Troubleshooting

This section identifies some of the more common problems that can occur when installing and configuring the MATLAB Compiler.

mex Troubleshooting

Out of Environment Space Running mex or mbuild. On Windows 95 and Windows 98 systems, the `mex` and `mbuild` scripts require more than the default amount of environment space. If you get the error, `out of environment space`, add this line to your `config.sys` file.

```
shell=c:\command.com /e:32768 /p
```

Non-ANSI C Compiler on UNIX. A common configuration problem in creating C MEX-files on UNIX involves using a non-ANSI C compiler. You must use an ANSI C compiler.

DLLs Not on Path on Windows. MATLAB will fail to load MEX-files if it cannot find all DLLs referenced by the MEX-file; the DLLs must be on the DOS path or in the same directory as the MEX-file. This is also true for third-party DLLs.

Segmentation Violation or Bus Error. If your MEX-file causes a segmentation violation or bus error, there is most likely a problem with the MATLAB Compiler. Contact Technical Support at The MathWorks (`support@mathworks.com`).

Generates Wrong Answers. If your program generates the wrong answer(s), there are several possible causes. There could be an error in the computational logic or there may be a defect in the MATLAB Compiler. Run your original M-file with a set of sample data and record the results. Then run the associated MEX-file with the sample data and compare the results with those from the original M-file. If the results are the same, there may be a logic problem in your original M-file. If the results differ, there may be a defect in the MATLAB Compiler. In this case, send the pertinent information via e-mail to `support@mathworks.com`.

mex Works from Shell But Not from MATLAB (UNIX). If the command

```
mex -x yprime.c
```

works from the UNIX shell prompt but does not work from the MATLAB prompt, you may have a problem with your `.cshrc` file. When MATLAB launches a new C shell to perform compilations, it executes the `.cshrc` script. If this script causes unexpected changes to the `PATH`, an error may occur. You can test whether this is true by performing a

```
set SHELL=/bin/sh
```

prior to launching MATLAB. If this works correctly, then you should check your `.cshrc` file for problems setting the `PATH`.

Cannot Locate Your Compiler (PC). If `mex` has difficulty locating your installed compilers, it is useful to know how it goes about finding compilers. `mex` automatically detects your installed compilers by first searching for locations specified in the following environment variables.

- `BORLAND` for Borland C++ Compiler, Version 5.0, 5.2, or 5.3
- `WATCOM` for the Watcom C/C++ Compiler
- `MSVCDIR` for Microsoft Visual C/C++, Version 5.0 or 6.0
- `MSDEVDIR` for Microsoft Visual C/C++, Version 4.2

Next, `mex` searches the Windows Registry for compiler entries. Note that Watcom does not add an entry to the registry. Digital Fortran does not use an environment variable; `mex` only looks for it in the registry.

Internal Error When Using mex -setup (PC). Some antivirus software packages such as Cheyenne AntiVirus and Dr. Solomon may conflict with the `mex -setup` process. If you get an error message during `mex -setup` of the following form

```
mex.bat: internal error in sub get_compiler_info(): don't
recognize <string>
```

then you need to disable your antivirus software temporarily and rerun `mex -setup`. After you have successfully run the `setup` option, you can re-enable your antivirus software.

Verification of mex Fails. If none of the previous solutions addresses your difficulty with `mex`, contact Technical Support at The MathWorks at `support@mathworks.com`.

Troubleshooting the Compiler

One problem that might occur when you try to use the Compiler involves licensing.

Licensing Problem. If you do not have a valid license for the MATLAB Compiler, you will get an error message similar to the following when you try to access the Compiler.

```
Error: Could not check out a Compiler License:
No such feature exists.
```

If you have a licensing problem, contact The MathWorks. A list of contacts at The MathWorks is provided at the beginning of this manual.

MATLAB Compiler Does Not Generate MEX-File. If you experience other problems with the MATLAB Compiler, contact Technical Support at The MathWorks at `support@mathworks.com`.

3

Getting Started with MEX-Files

This chapter gets you started compiling M-files with the MATLAB Compiler. By the end of this chapter, you should know how to:

- Compile M-files into MEX-files
- Invoke MEX-files
- Generate Simulink S-functions

This chapter also lists the limitations and restrictions of the MATLAB Compiler.

A Simple Example - The Sierpinski Gasket

Consider an M-file function called gasket.m.

```
function theImage = gasket(numPoints)
%GASKET An image of a Sierpinski Gasket.
%   IM = GASKET(NUMPOINTS)
%
%   Example:
%   x = gasket(50000);
%   imagesc(x);colormap([1 1 1;0 0 0]);
%   axis equal tight

%   Copyright (c) 1984-98 by The MathWorks, Inc
%   $Revision: 1.1 $  $Date: 1998/09/11 20:05:06 $

theImage = zeros(1000,1000);

corners = [866 1;1 500;866 1000];
startPoint = [866 1];
theRand = rand(numPoints,1);
theRand = ceil(theRand*3);

for i=1:numPoints
   startPoint = floor((corners(theRand(i),:)+startPoint)/2);
   theImage(startPoint(1),startPoint(2)) = 1;
end
```

How the Function Works

This function determines the coordinates of a Sierpinski Gasket using an Iterated Function System algorithm. The function starts with three points that define a triangle, and starting at one of these points, chooses one of the remaining points at random. A dot is placed at the midpoint of these two points. From the new point, a dot is placed at the midpoint between the new point and a point randomly selected from the original points. This process continues and eventually leads to an approximation of a curve.

The curve can be graphed in many ways. Sierpinski's method is:

- Start with a triangle and from it remove a triangle that is one-half the height of the original and inverted. This leaves three triangles.
- From each of the remaining three triangles, remove a triangle that is one-fourth the height of these new triangles and inverted. This leaves nine triangles.
- The process continues and at infinity the surface area becomes zero and the length of the curve is infinite.

`gasket.m` is a good candidate for compilation because it contains a loop. The overhead of the `for` loop command is relatively high compared to the cost of the loop body. M-file programmers usually try to avoid loops containing scalar operations because loops run relatively slowly under the MATLAB interpreter.

To achieve a reasonable approximation of the Sierpinski Gasket, set the number of points to 50,000. To compute the coordinates and time the computation, you can use

```
tic; x = gasket(50000); toc
```

To display the figure, you can use

```
imagesc(x); colormap([1 1 1;0 0 0]);
axis equal tight
```

Invoking the M-File

To get a baseline reading, you can determine how long it takes the MATLAB interpreter to run `gasket.m`. The built-in MATLAB functions `tic` and `toc` are useful tools for measuring time.

```
tic; x = gasket(50000); toc
elapsed_time =
7.9620
```

On the Pentium Pro 200, the M-file took about 10 seconds of CPU time to calculate the first 50,000 points on the Sierpinski Gasket.

Note The timings listed in this book were recorded on a Pentium Pro 200 MHz PC running Microsoft Windows NT. In each case, the code was executed two times and the results of the second execution were captured for this book. All of the timings listed throughout this book are for reference purposes only. They are not absolute; if you execute the same example under the same conditions, your times will probably differ from these values. Use these values as a frame of reference only.

Compiling the M-File into a MEX-File

To create a MEX-file from this M-file, enter the `mcc` command at the MATLAB interpreter prompt.

```
mcc -x gasket
```

This `mcc` command generates:

- A file named `gasket.c` containing MEX-file C source code.
- A file named `gasket.h` containing the public information.
- A file named `gasket_mex.c` containing the MEX-function interface (MEX wrapper).
- A MEX-file named `gasket.mex`. (The actual filename extension of the executable MEX-file varies depending on your platform, e.g., on the PC the file is named `gasket.dll`.)

`mcc` automatically invokes `mex` to create `gasket.mex` from `gasket.c` and `gasket_mex.c`. The `mex` utility encapsulates the appropriate C compiler and linker options for your system.

This example uses the `-x` macro option to create the MEX-file. For more information on this Compiler option as well as the other options, see the `mcc` reference page. For more information on the files that the Compiler generates, see Chapter 5, “Controlling Code Generation.”

Invoking the MEX-File

Invoke the MEX-file version of `gasket` from the MATLAB interpreter the same way you invoke the M-file version.

```
tic; x = gasket(50000); toc
```

MATLAB runs the MEX-file version (`gasket.mex`) rather than the M-file version (`gasket.m`). Given an M-file and a MEX-file with the same root name (`gasket`) in the same directory, the MEX-file takes precedence.

This produces

```
elapsed_time =
   5.2880
```

The MEX-file runs about 33% faster than the M-file version.

Note These are optimized times.

To display the Sierpinski Gasket, use

```
imagesc(x); colormap([1 1 1;0 0 0]);
axis equal tight
```

This figure shows the results.

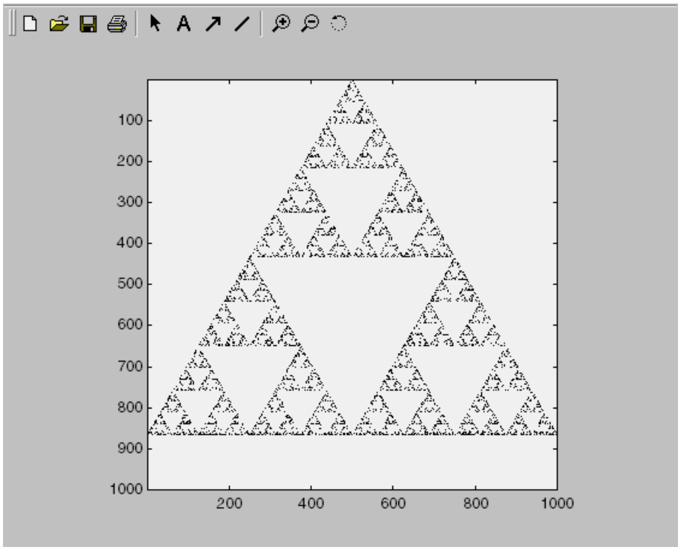


Figure 3-1: The Sierpinski Gasket for 50,000 Points

Compiler Options and Macros

The MATLAB Compiler uses a family of options, also called option flags, to control the functionality of the Compiler. The `mcc` reference page includes a complete description of the Compiler 2.1 options. Throughout this book you will see how these options are used with the Compiler to perform various tasks.

One particular set of Compiler options, macros, are particularly useful for performing straightforward compilations.

Macro options provide a simplified approach to compilation. Instead of manually grouping several options together to perform a particular type of compilation, you can use one simple option to quickly accomplish basic compilation tasks.

Note Macro options are intended to simplify the more common compilation tasks. You can always use individual options to customize the compilation process to satisfy your particular needs.

For detailed information about the macros included with the MATLAB Compiler, as well complete information on all the other available Compiler options, see the `mcc` reference page.

Generating Simulink S-Functions

You can use the MATLAB Compiler to generate Simulink C MEX S-functions. This allows you to speed up Simulink models that contain MATLAB M-code that is referenced from a MATLAB `Fcn` block.

Note Only the MATLAB Fcn block is supported.

For more information about Simulink in general, see *Using Simulink*. For more information about Simulink S-functions, see *Writing S-Functions*.

Simulink-Specific Options

By using Simulink-specific options with the MATLAB Compiler, you can generate an S-function that is compatible with the S-Function block. The Simulink-specific options are `-S`, `-u`, and `-y`. Using any of these options with the MATLAB Compiler causes it to generate code that is compatible with Simulink.

Using the -S Option

The simplest S-function that the MATLAB Compiler can generate is one with a dynamically sized number of inputs and outputs. That is, you can pass any number of inputs and outputs in or out of the S-function. Both the MATLAB Fcn block and the S-Function block are single-input, single-output blocks. Only one line can be connected to the input or output of these blocks. However, each line may be a vector signal, essentially giving these blocks multi-input, multi-output capability. To generate a C language S-function of this type from an M-file, use the `-S` option

```
mcc -S mfilename
```

Note The MATLAB Compiler option that generates a C language S-function is a capital S (`-S`).

The result is an S-function described in the following files.

```
mfilename.c
mfilename.h
mfilename_simulink.c
mfilename.ext          (where ext is the MEX-file extension for your
                        platform, e.g., dll for Windows)
```

Using the -u and -y Options

Using the `-S` option by itself will generate code suitable for most general applications. However, if you would like to exert more control over the number of valid inputs or outputs for your function, you should use the `-u` and/or `-y` options. These options specifically set the number of inputs (u) and the number of outputs (y) for your function. If either `-u` or `-y` is omitted, the respective input or output will be dynamically sized.

```
mcc -S -u 1 -y 2 mfilename
```

In the above line, the S-function will be generated with an input vector whose width is 1 and an output vector whose with is 2. If you were to connect the referencing S-function block to signals that do not correspond to the correct number of inputs or outputs, Simulink will generate an error when the simulation starts.

Note The MATLAB Compiler `-S` option does *not* support the passing of parameters that is normally available with Simulink S-functions.

Specifying S-Function Characteristics

Sample Time

Similar to the MATLAB Fcn block, the automatically generated S-function has an inherited sample time.

Data Type

The input and output vectors for the Simulink S-function must be double-precision vectors or scalars. You must ensure that the variables you use in the M-code for input and output are also double-precision values.

Note Simulink S-functions that are generated via the `-S` option of the Compiler are not currently compatible with Real-Time Workshop®. They can, however, be used to rapidly prototype code in Simulink.

Converting Script M-Files to Function M-Files

MATLAB provides two ways to package sequences of MATLAB commands:

- Function M-files
- Script M-files

These two categories of M-files differ in two important respects:

- You can pass arguments to function M-files but not to script M-files.
- Variables used inside function M-files are local to that function; you cannot access these variables from the MATLAB interpreter's workspace unless they are passed back by the function. By contrast, variables used inside script M-files are shared with the caller's workspace; you can access these variables from the MATLAB interpreter command line.

The MATLAB Compiler cannot compile script M-files nor can it compile a function M-file that calls a script.

Converting a script into a function is usually fairly simple. To convert a script to a function, simply add a `function` line at the top of the M-file.

For example, consider the script M-file `houdini.m`.

```
m = magic(4); % Assign 4x4 matrix to m.
t = m .^ 3;   % Cube each element of m.
disp(t);      % Display the value of t.
```

Running this script M-file from a MATLAB session creates variables `m` and `t` in your MATLAB workspace.

The MATLAB Compiler cannot compile `houdini.m` because `houdini.m` is a script. Convert this script M-file into a function M-file by simply adding a `function` header line.

```
function [m,t] = houdini(sz)
m = magic(sz); % Assign matrix to m.
t = m .^ 3;    % Cube each element of m.
disp(t)        % Display the value of t.
```

The MATLAB Compiler can now compile `houdini.m`. However, because this makes `houdini` a function, running `houdini.mex` no longer creates variable `m` in the MATLAB workspace. If it is important to have m accessible from the MATLAB workspace, you can change the beginning of the function to

```
function [m,t] = houdini
```

4

Stand-Alone Applications

This chapter explains how to use the MATLAB Compiler to code and build stand-alone applications. The first part of the chapter concentrates on using the `mbuild` script to build stand-alone applications and the second part concentrates on the coding of the applications. Stand-alone applications run without the help of the MATLAB interpreter. In fact, stand-alone applications *run* even if MATLAB is not installed on the system. However, stand-alone applications *do* require the run-time shared libraries. The specific shared libraries required for each platform are listed within the following sections.

Note You must have the optional MATLAB C/C++ Math Library installed on your system if you want to create stand-alone applications. If your application uses Handle Graphics, you must have the optional MATLAB C/C++ Graphics Library installed on your system.

Differences Between MEX-Files and Stand-Alone Applications

MEX-files and stand-alone applications differ in these respects:

- MEX-files run in the same process space as the MATLAB interpreter. When you invoke a MEX-file, the MATLAB interpreter dynamically links in the MEX-file.
- Stand-alone C or C++ applications run independently of MATLAB.

MEX-Files

It is now possible to call MEX-files from Compiler-generated stand-alone applications. The Compiler will compile MEX-files whenever they are specified on the command line or are located using the `-h` option to find helper functions. The MEX-files will then be loaded and called by the stand-alone code.

If an M-file and a MEX-file appear in the same directory and the M-file contains at least one function, the Compiler will compile the M-file instead of the MEX-file. If the MEX-file is desired instead, you must use the `%#mex` pragma. For more information on this pragma, see "%#mex" in Chapter 7.

Note The Compiler-generated code cannot invoke Compiler-generated MEX-files. Specify the M-file(s) source instead and the Compiler will compile those into the stand-alone application.

Stand-Alone C Applications

To build stand-alone C applications as described in this chapter, MATLAB, the MATLAB Compiler, a C compiler, and the MATLAB C/C++ Math Library must be installed on your system.

The source code for a stand-alone C application consists either entirely of M-files or some combination of M-files, MEX-files, and C or C++ source code files.

The MATLAB Compiler translates input M-files into C source code suitable for your own stand-alone applications. After compiling this C source code, the resulting object file is linked with the object libraries.

For more information about which libraries must be included when you distribute a C application, see "Distributing Stand-Alone UNIX Applications" on page 4-14 or "Distributing Stand-Alone Windows Applications" on page 4-26.

Note If you attempt to compile M-files to produce stand-alone applications and you do not have the MATLAB C/C++ Math Library installed, the system will not be able to find the appropriate libraries and the linking will fail. Also, if you do not have the MATLAB C/C++ Graphics Library installed, the MATLAB Compiler will generate run-time errors if the graphics functions are called.

Stand-Alone C++ Applications

To build stand-alone C++ applications, MATLAB, the MATLAB Compiler, a C++ compiler, and the MATLAB C/C++ Math Library must be installed on your system.

The source code for a stand-alone C++ application consists either entirely of M-files or some combination of M-files, MEX-files, and C or C++ source code files.

The MATLAB Compiler, when invoked with the appropriate option flag (`-p` or `-L Cpp`), translates input M-files into C++ source code suitable for your own stand-alone applications. After compiling this C++ source code, the resulting object files are linked against the MATLAB C/C++ Math Library. For more information about which libraries must be included when you distribute a C++ application, see "Distributing Stand-Alone UNIX Applications" on page 4-14 or "Distributing Stand-Alone Windows Applications" on page 4-26.

Note On the PC, the MATLAB C++ Math Library is static because the different PC compiler vendors use different C++ name mangling algorithms.

Building Stand-Alone C/C++ Applications

This section explains how to build stand-alone C and C++ applications on UNIX systems and PCs running Microsoft Windows.

This section begins with a summary of the steps involved in building stand-alone C/C++ applications, including the `mbuild` script, which helps automate the build process, and then describes platform-specific issues for both supported platforms.

Note This chapter assumes that you have installed and configured the MATLAB Compiler.

Overview

On both operating systems, the steps you use to build stand-alone C and C++ applications are:

1. Verify that `mbuild` can create stand-alone applications.
2. Verify that the MATLAB Compiler can link object files with the proper libraries to form a stand-alone application.

This figure shows the sequence on both platforms. The sections following the flowchart provide more specific details for the individual platforms.

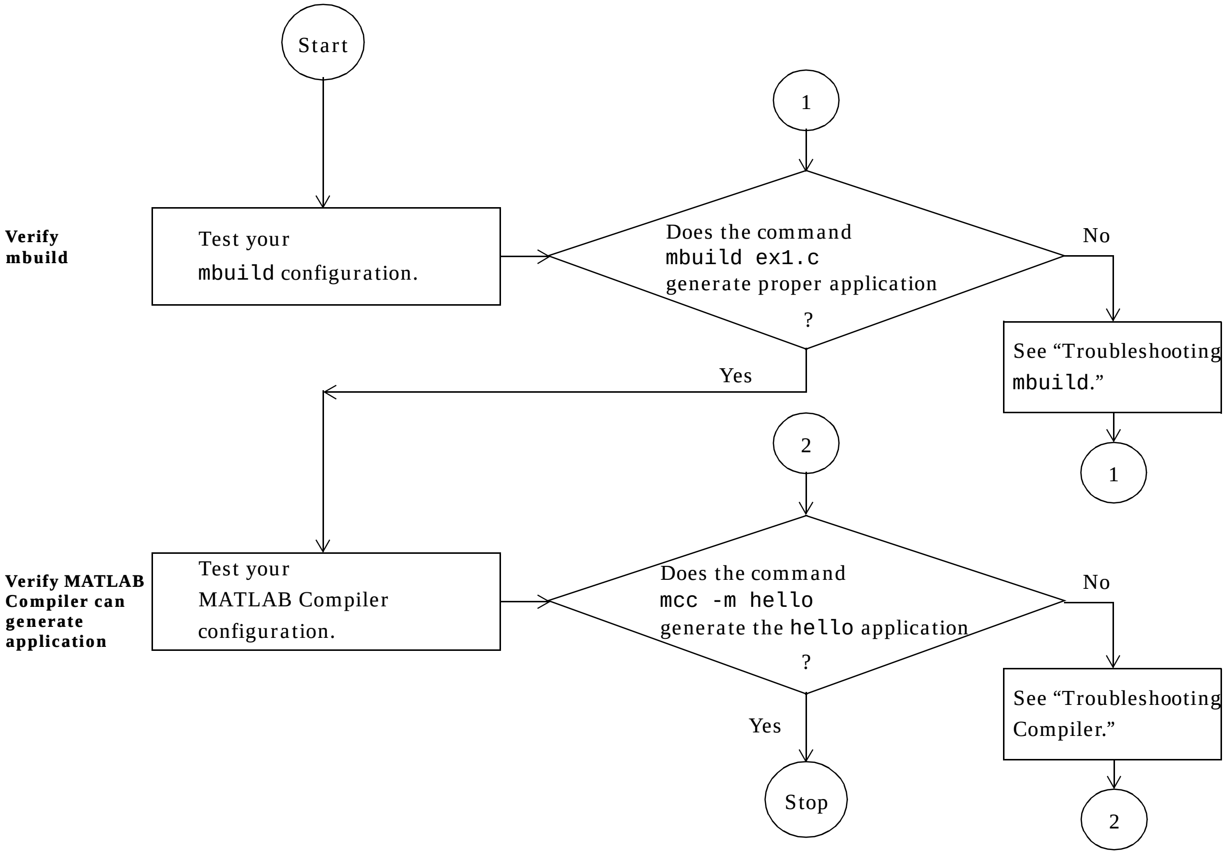


Figure 4-1: Sequence for Creating Stand-Alone C/C++ Applications

Packaging Stand-Alone Applications

To distribute a stand-alone application, you must include the application's executable as well as the shared libraries with which the application was linked. The necessary shared libraries vary by platform. The individual UNIX and Windows sections that follow provide more information about packaging applications.

Getting Started

Introducing mbuild

The MathWorks utility, `mbuild`, lets you customize the configuration and build process. The `mbuild` script provides an easy way for you to specify an options file that lets you:

- Set your compiler and linker settings
- Change compilers or compiler settings
- Switch between C and C++ development
- Build your application

The MATLAB Compiler (`mcc`) automatically invokes `mbuild` under certain conditions. In particular, `mcc -m` or `mcc -p` invokes `mbuild` to perform compilation and linking. See the `mcc` reference page for complete details on which Compiler options you should use in order to use the `mbuild` script.

If you do not want `mcc` to invoke `mbuild` automatically, you can use the `-c` option. For example, `mcc -mc filename`.

Compiler Options Files

Options files contain the required compiler and linker settings for your particular C or C++ compiler. The MathWorks provides options files for every supported C or C++ compiler. The options file for UNIX is `mbuildopts.sh`; The Compiler Options Files on the PC table contains the PC options files.

Much of the information on options files in this chapter is provided for those users who may need to modify an options file to suit their specific needs. Many users never have to be concerned with how the options files work.

Note If you are developing C++ applications, make sure your C++ compiler supports the templates features of the C++ language. If it does not, you may be unable to use the MATLAB C/C++ Math Library.

Building Stand-Alone Applications on UNIX

This section explains how to compile and link C or C++ source code into a stand-alone UNIX application. This section includes:

- Configuring for C or C++
- Preparing to Compile
- Verifying mbuild
- Verifying the MATLAB Compiler
- Distributing Stand-Alone UNIX Applications
- About the mbuild Script

Configuring for C or C++

The `mbuild` script deduces the type of files you are compiling by the file extension. If you include both C and C++ files, `mbuild` uses the C++ compiler and the MATLAB C++ Math Library. If `mbuild` cannot deduce from the file extensions whether to compile C or C++, `mbuild` invokes the C compiler. The MATLAB Compiler generates only `.c` and `.cpp` files. This table shows the supported file extensions.

Table 4-1: UNIX File Extensions for mbuild

Language	Extension(s)
C	`.c`

C++	`.cpp`
	`.C`
	`.cxx`
	`.cc`

Note You can override the language choice that is determined from the extension by using the `-lang` option of `mbuild`. For more information about this option, as well as all of the other `mbuild` options, see the `mbuild` reference page.

Locating Options Files

`mbuild` locates your options file by searching the following:

- The current directory
- `$HOME/.matlab/R12`
- `<matlab>/bin`

`mbuild` uses the first occurrence of the options file it finds. If no options file is found, `mbuild` displays an error message.

Preparing to Compile

Note Refer to "Supported ANSI C and C++ UNIX Compilers" in Chapter 2 for information about supported compilers and important limitations.

Using the System Compiler

If the MATLAB Compiler and your supported C or C++ compiler are installed on your system, you are ready to create C or C++ stand-alone applications. To create a stand-alone C application, you can simply enter

```
mbuild filename.c
```

This simple method works for the majority of users. Assuming `filename.c` contains a `main` function, this example uses the system's compiler as your default compiler for creating your stand-alone application. If you are a user who does not need to change C or C++ compilers, or you do not need to modify your compiler options files, you can skip ahead in this section to "Verifying mbuild" on page 4-12. If you need to know how to change the options file or select a different compiler, continue with this section.

Changing Compilers

Changing the Default Compiler. You need to use the `setup` option if you want to change any options or link against different libraries. At the UNIX prompt type

```
mbuild -setup
```

The setup option creates a user-specific options file for your ANSI C or C++ compiler. Executing mbuild -setup presents a list of options files currently included in the bin subdirectory of MATLAB.

```
mbuild -setup

Using the 'mbuild -setup' command selects an options file that is
placed in ~/.matlab/R12 and used by default for 'mbuild'. An
options file in the current working directory or specified on the
command line overrides the default options file in ~/.matlab/R12.

Options files control which compiler to use, the compiler and link
command options, and the runtime libraries to link against.

To override the default options file, use the 'mbuild -f' command
(see 'mbuild -help' for more information).

The options files available for mbuild are:

  1: /matlab/bin/mbuildopts.sh :
        Build and link with MATLAB C/C++ Math Library
  2: /matlab/bin/mbuildsglopts.sh :
        Build and link with MATLAB C/C++ Graphics Library

Enter the number of the options file to use as your default options
file:
```

If there is more than one options file, you can select the one you want by entering its number and pressing **Return**. If there is only one options file available, it is automatically copied to your MATLAB directory if you do not already have an mbuild options file. If you already have an mbuild options file, you are prompted to overwrite the existing one.

Note The options file is stored in the .matlab/R12 subdirectory of your home directory. This allows each user to have a separate mbuild configuration.

Using the setup option sets your default compiler so that the new compiler is used everytime you use the mbuild script.

Modifying the Options File. Another use of the `setup` option is if you want to change your options file settings. For example, if you want to make a change to the current linker settings, or you want to disable a particular set of warnings, you should use the `setup` option.

If you need to change the options that `mbuild` passes to your compiler or linker, you must first run

```
mbuild -setup
```

which copies a master options file to your local MATLAB directory, typically `$HOME/.matlab/R12/mbuildopts.sh`.

If you need to see which options `mbuild` passes to your compiler and linker, use the verbose option, `-v`, as in

```
mbuild -v filename1 [filename2 …]
```

to generate a list of all the current compiler settings. To change the options, use an editor to make changes to your options file, which is in your local `matlab` directory. Your local `matlab` directory is a user-specific, MATLAB directory in your individual home directory that is used specifically for your individual options files. You can also embed the settings obtained from the verbose option of `mbuild` into an integrated development environment (IDE) or makefile that you need to maintain outside of MATLAB. Often, however, it is easier to call `mbuild` from your makefile. See your system documentation for information on writing makefiles.

Note Any changes made to the local options file will be overwritten if you execute `mbuild -setup`. To make the changes persist through repeated uses of `mbuild -setup`, you must edit the master file itself, `<matlab>/bin/mbuildopts.sh`.

Temporarily Changing the Compiler. To temporarily change your C or C++ compiler, use the `-f` option, as in

```
mbuild -f <file> …
```

The `-f` option tells the `mbuild` script to use the options file, `<file>`. If `<file>` is not in the current directory, then `<file>` must be the full pathname to the desired options file. Using the `-f` option tells the `mbuild` script to use the specified options file for the current execution of mbuild only; it does not reset the default compiler.

Verifying mbuild

There is C source code for an example ex1.c included in the <matlab>/extern/examples/cmath directory, where <matlab> represents the top-level directory where MATLAB is installed on your system. To verify that mbuild is properly configured on your system to create stand-alone applications, copy ex1.c to your local directory and type cd to change to that directory. Then, at the MATLAB prompt, enter

```
mbuild ex1.c
```

This creates the file called ex1. Stand-alone applications created on UNIX systems do not have any extensions.

Locating Shared Libraries

Before you can run your stand-alone application, you must tell the system where the API and C shared libraries reside. This table provides the necessary UNIX commands depending on your system's architecture.

Architecture	Command
HP700/HP-UX	setenv SHLIB_PATH <matlab>/extern/lib/<arch>:$SHLIB_PATH
IBM RS/6000	setenv LIBPATH <matlab>/extern/lib/ibm_rs:$LIBPATH
All others	setenv LD_LIBRARY_PATH <matlab>/extern/lib/<arch>:$LD_LIBRARY_PATH

where:
<matlab> is the MATLAB root directory
<arch> is your architecture (i.e., alpha, hp700, hpux, lnx86, sgi, sgi64, or sol2)

It is convenient to place this command in a startup script such as ~/.cshrc. Then the system will be able to locate these shared libraries automatically, and you will not have to re-issue the command at the start of each login session.

Note On all UNIX platforms, the Compiler library is shipped as a shared object (.so) file or shared library (.sl). Any Compiler-generated, stand-alone application must be able to locate the C/C++ libraries along the library path environment variable (SHLIB_PATH, LIBPATH, or LD_LIBRARY_PATH) in order to be found and loaded. Consequently, to share a Compiler-generated, stand-alone application with another user, you must provide all of the required shared libraries. For more information about the required shared libraries for UNIX, see "Distributing Stand-Alone UNIX Applications" on page 4-14.

Running Your Application

To launch your application, enter its name on the command line. For example,

```
ex1
ans =

     1     3     5
     2     4     6


ans =

   1.0000 + 7.0000i   4.0000 +10.0000i
   2.0000 + 8.0000i   5.0000 +11.0000i
   3.0000 + 9.0000i   6.0000 +12.0000i
```

Verifying the MATLAB Compiler

There is MATLAB code for an example, hello.m, included in the <matlab>/extern/examples/compiler directory. To verify that the MATLAB Compiler can generate stand-alone applications on your system, type the following at the MATLAB prompt.

```
mcc -m hello.m
```

This command should complete without errors. To run the stand-alone application, hello, invoke it as you would any other UNIX application, typically by typing its name at the UNIX prompt. The application should run and display the message

```
Hello, World
```

When you execute the `mcc` command to link files and libraries, `mcc` actually calls the `mbuild` script to perform the functions.

Distributing Stand-Alone UNIX Applications

To distribute a stand-alone application, you must create a package containing these files:

- Your application executable.
- The contents, if any, of a directory named `bin`, created by `mbuild` in the same directory as your application executable. Note: `mbuild` does not create a `bin` directory for every stand-alone application.
- Any custom MEX-files your application uses.
- All the MATLAB Math run-time libraries.

For specific information about packaging these files, see “Distributing Stand-Alone Applications” in the *MATLAB C Math Library User's Guide*.

Note There is no support for the MATLAB C/C++ Graphics Library on the IBM_RS platform.

Remember to locate the shared libraries along the `LD_LIBRARY_PATH` (`SHLIB_PATH` on HP) environment variable so that they can be found and loaded.

Installing C++ and Fortran Support

MATLAB users require access to both the C++ and Fortran run-time shared libraries. These are usually provided as part of the operating system installation. For Digital UNIX, however, the C++ shared libraries are part of the base installation package, but the Fortran shared libraries are on a separate disk called the “Associated Products CD.” MATLAB users running under Digital UNIX should install both the C++ and Fortran run-time shared libraries.

Note If you distribute an application created with the math libraries on Digital UNIX, your users must have both the C++ and Fortran run-time shared libraries installed on their systems.

About the mbuild Script

The `mbuild` script supports various options that allow you to customize the building and linking of your code. Many users do not need to know any additional details of the `mbuild` script; they use it in its simplest form. For complete information about the mbuild script and its options, see `mbuild` on page 7-25.

Building Stand-Alone Applications on PCs

This section explains how to compile and link the C/C++ code generated from the MATLAB Compiler into a stand-alone Windows application. This section includes:

- Configuring for C or C++
- Preparing to Compile
- Verifying mbuild
- Verifying the MATLAB Compiler
- About the mbuild Script
- Using an IDE
- Distributing Stand-Alone Windows Applications

Configuring for C or C++

`mbuild` determines whether to compile in C or C++ by examining the type of files you are compiling. This table shows the file extensions that `mbuild` interprets as indicating C or C++ files.

Table 4-2: Windows File Extensions for mbuild

Language	Extension(s)
C	`.c`

C++	`.cpp`
	`.cxx`
	`.cc`

- If you include both C and C++ files, `mbuild` uses the C++ compiler and the MATLAB C++ Math Library.
- If `mbuild` cannot deduce from the file extensions whether to compile in C or C++, `mbuild` invokes the C compiler.

Note You can override the language choice that is determined from the extension by using the `-lang` option of `mbuild`. For more information about this option, as well as all of the other `mbuild` options, see the `mbuild` reference page.

Locating Options Files

To locate your options file, the `mbuild` script searches the following:

- The current directory
- The `user profile` directory (For more information about this directory, see the section, "The User Profile Directory Under Windows," in Chapter 2.)

`mbuild` uses the first occurrence of the options file it finds. If no options file is found, `mbuild` searches your machine for a supported C compiler and uses the factory default options file for that compiler. If multiple compilers are found, you are prompted to select one.

Preparing to Compile

Note Refer to "Supported ANSI C and C++ PC Compilers" on page 2-15 for information about supported compilers and important limitations. Watcom 10.6 and 11 are not supported for building stand-alone applications.

Choosing a Compiler

Systems with Exactly One C/C++ Compiler. If the MATLAB Compiler and your supported C or C++ compiler are installed on your system, you are ready to create C or C++ stand-alone applications. On systems where there is exactly one C or C++ compiler available to you, the `mbuild` utility automatically configures itself for the appropriate compiler. So, for many users, to create a C or C++ stand-alone applications, you can simply enter

```
mbuild filename.c
```

This simple method works for the majority of users. Assuming `filename.c` contains a `main` function, this example uses your installed C or C++ compiler as your default compiler for creating your stand-alone application. If you are a user who does not need to change compilers, or you do not need to modify your compiler options files, you can skip ahead in this section to “Verifying mbuild” on page 4-22. If you need to know how to change the options file or select a different compiler, continue with this section.

Note On Windows 95 and Windows 98 systems, if you get the error, `out of environment space`, see “Out of Environment Space Running mex or mbuild” on page 4-28 for more information.

Systems with More than One C/C++ Compiler. On systems where there is more than one C or C++ compiler, the `mbuild` utility lets you select which of the compilers you want to use. Once you choose your C or C++ compiler, that compiler becomes your default compiler and you no longer have to select one when you compile your stand-alone applications.

For example, if your system has both the Lcc and Microsoft Visual C/C++ compilers, when you enter for the first time

```
mbuild filename.c
```

you are asked to select which compiler to use.

```
Please choose your compiler for building stand-alone MATLAB
applications:

Select a compiler:
[1] Lcc C version 2.4 in D:Applications\Mathworks\sys\lcc
[2] Microsoft Visual C/C++ version 6.0 in
D:\Applications\Microsoft Visual Studio

[0] None

Compiler:
```

Select the desired compiler by entering its number and pressing **Return**. You are then asked to verify your information.

Changing Compilers

Changing the Default Compiler. To change your default C or C++ compiler, you select a different options file. You can do this at anytime by using the `setup` command.

This example shows the process of changing your default compiler to the Microsoft Visual C/C++ Version 6.0 compiler.

```
mbuild -setup

Please choose your compiler for building stand-alone MATLAB
applications.

Would you like mbuild to locate installed compilers [y]/n? n

Select a compiler:
[1] Borland C++Builder version 5.0
[2] Borland C++Builder version 4.0
[3] Borland C++Builder version 3.0
[4] Borland C/C++ version 5.02
[5] Borland C/C++ version 5.0
[6] Borland C/C++ (free command line tools) version 5.5
[7] Lcc C version 2.4
[8] Microsoft Visual C/C++ version 6.0
[9] Microsoft Visual C/C++ version 5.0
[10] Microsoft Visual C/C++ version 4.2

[0] None

Compiler: 8

Your machine has a Microsoft Visual C/C++ compiler located at
D:\Applications\Microsoft Visual Studio. Do you want to use this
compiler [y]/n? y
Would you like to link with the C/C++ Graphics Library?([y]/n): y

Please verify your choices:

Compiler: Microsoft Visual C/C++ 6.0
Location: D:\Applications\Microsoft Visual Studio
```

```
Linking against the C/C++ Graphics Library

Are these correct?([y]/n): y

The default options file:
"C:\WINNT\Profiles\username\
Application Data\MathWorks\MATLAB\R12\compopts.bat"
is being updated...

Installing the MATLAB Visual Studio add-in ...

  Updated ...
```

If the specified compiler cannot be located, you are given the message:

```
The default location for <compiler-name> is <directory-name>,
but that directory does not exist on this machine.

Use <directory-name> anyway [y]/n?
```

Using the `setup` option sets your default compiler so that the new compiler is used everytime you use the `mbuild` script.

Modifying the Options File. Another use of the `setup` option is if you want to change your options file settings. For example, if you want to make a change to the current linker settings, or you want to disable a particular set of warnings, you should use the `setup` option.

The `setup` option copies the appropriate options file to your `user profile` directory. To make your user-specific changes to the options file, you edit your copy of the options file in your `user profile` directory to correspond to your specific needs and save the modified file. This sets your default compiler's options file to your specific version. Table 4-3, Compiler Options Files on the PC, lists the names of the PC options files included in this release of MATLAB.

If you need to see which options `mbuild` passes to your compiler and linker, use the verbose option, `-v`, as in

```
mbuild -v filename1 [filename2 …]
```

to generate a list of all the current compiler settings used by `mbuild`. To change the options, use an editor to make changes to your options file that corresponds to your compiler. You can also embed the settings obtained from the verbose option into an integrated development environment (IDE) or makefile that you need to maintain outside of MATLAB. Often, however, it is easier to call `mbuild` from your makefile. See your system documentation for information on writing makefiles.

Note Any changes that you make to the local options file `compopts.bat` will be overwritten the next time you run `mbuild -setup`. If you want to make your edits persist through repeated uses of `mbuild -setup`, you must edit the master file itself. The master options files are also located in `<matlab>\bin`.

Table 4-3: Compiler Options Files on the PC

Compiler	Master Options File
Borland C/C++, Version 5.0	`bcccompp.bat`
Borland C/C++, Version 5.2	`bcc52compp.bat`
Borland C/C++, Version 5.3	`bcc53compp.bat`
Microsoft Visual C/C++, Version 4.2	`msvccompp.bat`
Microsoft Visual C/C++, Version 5.0	`msvc50compp.bat`
Microsoft Visual C/C++, Version 6.0	`msvc60compp.bat`

Combining Customized C and C++ Options Files. The options files for `mbuild` have changed as of MATLAB 5.3 (Release 11) so that the same options file can be used to create both C and C++ stand-alone applications. If you have modified your own separate options files to create C and C++ applications, you can combine them into one options file.

To combine your existing options files into one universal C and C++ options file:

1. Copy from the C++ options file to the C options file all lines that set the variables `COMPFLAGS`, `OPTIMFLAGS`, `DEBUGFLAGS`, and `LINKFLAGS`.

2 In the C options file, within just those copied lines from step 1, replace all occurrences of:

- `COMPFLAGS` with `CPPCOMPFLAGS`
- `OPTIMFLAGS` with `CPPOPTIMFLAGS`
- `DEBUGFLAGS` with `CPPDEBUGFLAGS`
- `LINKFLAGS` with `CPPLINKFLAGS`.

This process modifies your C options file to be a universal C/C++ options file.

Temporarily Changing the Compiler. To temporarily change your C or C++ compiler, use the `-f` option, as in

```
mbuild -f <file> …
```

The `-f` option tells the `mbuild` script to use the options file, `<file>`. If `<file>` is not in the current directory, then `<file>` must be the full pathname to the desired options file. Using the `-f` option tells the `mbuild` script to use the specified options file for the current execution of `mbuild` only; it does not reset the default compiler.

Verifying mbuild

There is C source code for an example, `ex1.c`, included in the `<matlab>\extern\examples\cmath` directory, where `<matlab>` represents the top-level directory where MATLAB is installed on your system. To verify that `mbuild` is properly configured on your system to create stand-alone applications, enter at the MATLAB prompt

```
mbuild ex1.c
```

This creates the file called `ex1.exe`. Stand-alone applications created on Windows 95/98/2000 or Windows NT always have the extension `exe`. The created application is a 32-bit MS-DOS console application.

Shared Libraries

All the libraries (WIN32 Dynamic Link Libraries, or DLLs) for MATLAB, the MATLAB Compiler, and the MATLAB Math Library are in the directory

```
<matlab>\bin\win32
```

The `.DEF` files for the Microsoft and Borland compilers are in the `<matlab>\extern\include` directory. All of the relevant libraries for building stand-alone applications are WIN32 Dynamic Link Libraries. Before running a stand-alone application, you must ensure that the directory containing the DLLs is on your path. The directory must be on your operating system `$PATH` environment variable. On Windows 95, set the value in your `AUTOEXEC.BAT` file; on Windows NT, use the Control Panel to set it.

Running Your Application

You can now run your stand-alone application by launching it from the DOS command line. For example,

```
ex1
ans =

     1     3     5
     2     4     6


ans =

   1.0000 + 7.0000i   4.0000 +10.0000i
   2.0000 + 8.0000i   5.0000 +11.0000i
   3.0000 + 9.0000i   6.0000 +12.0000i
```

Verifying the MATLAB Compiler

There is MATLAB code for an example, `hello.m`, included in the `<matlab>\extern\examples\compiler` directory. To verify that the MATLAB Compiler can generate stand-alone applications on your system, type the following at the MATLAB prompt.

```
mcc -m hello.m
```

This command should complete without errors. To run the stand-alone application, `hello`, invoke it as you would any other Windows console application, by typing its name on the MS-DOS command line. The application should run and display the message `Hello, World`.

When you execute the `mcc` command to link files and libraries, `mcc` actually calls the `mbuild` script to perform the functions.

About the mbuild Script

The `mbuild` script supports various options that allow you to customize the building and linking of your code. Many users do not need to know any additional details of the `mbuild` script; they use it in its simplest form. For complete information about the mbuild script and its options, see `mbuild` on page 7-25.

Using an IDE

The MathWorks provides a MATLAB add-in for the Visual Studio development system that lets you work easily within Microsoft Visual C/C++ (MSVC). The MATLAB add-in for Visual Studio greatly simplifies using M-files in the MSVC environment. The add-in automates the integration of M-files into Visual C++ projects. It is fully integrated with the MSVC environment.

The add-in for Visual Studio is automatically installed on your system when you run either `mbuild -setup` or `mex -setup` and select Microsoft Visual C/C++ version 5 or 6. However, there are several steps you must follow in order to use the add-in:

1. To build MEX-files with the add-in for Visual Studio, run the following command at the MATLAB command prompt.

   ```
   mex -setup
   ```

   Follow the menus and choose either Microsoft Visual C/C++ 5.0 or 6.0. This configures `mex` to use the selected Microsoft compiler and also installs the necessary add-in files in your Microsoft Visual C/C++ directories.

2. To build stand-alone applications with the MATLAB add-in for Visual Studio (requires the MATLAB Compiler and the MATLAB C/C++ Math Libraries), run the following command at the MATLAB command prompt.

   ```
   mbuild -setup
   ```

   Follow the menus and choose either Microsoft Visual C/C++ 5.0 or 6.0. This configures `mbuild` to use the selected Microsoft compiler and also installs the necessary add-in files into your Microsoft Visual C/C++ directories. (It is not a problem if these overlap with the files installed by the `mex -setup` command.)

3 For either `mex` or stand-alone support, you should also run the following commands at the MATLAB prompt.

```
cd(prefdir); mccsavepath;
```

These commands save your current MATLAB path to a file named `mccpath` in your `user preferences` directory. (Type `prefdir` to see the name of your `user preferences` directory.)

This step is necessary because the MATLAB add-in for Visual Studio runs outside of the MATLAB environment, so it would have no way to determine your MATLAB path. If you add directories to your MATLAB path and want them to be visible to the MATLAB add-in, rerun the `cd` and `mccsavepath` commands shown in this step and replace `prefdir` with the desired pathname.

4 To configure the MATLAB add-in for Visual Studio to work with Microsoft Visual C/C++:

a Select **Tools** -> **Customize** from the MSVC menu.

b Click on the **Add-ins and Macro Files** tab.

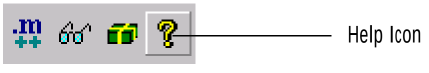
c Check **MATLAB for Visual Studio** on the **Add-ins and Macro Files** list and click **Close**. The floating MATLAB add-in for Visual Studio toolbar appears. The checkmark directs MSVC to automatically load the add-in when you start MSVC again.

Note To run the MATLAB add-in for Visual Studio on Windows 95 or Windows 98 systems, add this line to your `config.sys` file.

```
shell=c:\command.com /e:32768 /p
```

For additional information on the MATLAB add-in for Visual Studio:

- See the `MATLABAddin.hlp` file in the `<matlab>\bin\win32` directory, or
- Click on the Help icon in the MATLAB add-in for Visual Studio toolbar



Distributing Stand-Alone Windows Applications

To distribute a stand-alone application, you must create a package containing these files:

- Your application executable.
- The contents, if any, of a directory named `bin`, created by `mbuild` in the same directory as your application executable. Note: `mbuild` does not create a `bin` directory for every stand-alone application.
- Any custom MEX-files your application uses.
- All the MATLAB Math run-time libraries.

For specific information about packaging these files, see “Distributing Stand-Alone Applications” in the *MATLAB C Math Library User's Guide*.

Building Shared Libraries

You can use mbuild to build C shared libraries on both UNIX and the PC. All of the mbuild options that pertain to creating stand-alone applications also pertain to creating C shared libraries. To create a C shared library, specify one or more files with the .exports extension. The .exports files are text files that contain the names of the functions to export from the shared library, one per line. You can include comments in your code by beginning a line (first column) with # or a *. mbuild treats these lines as comments and ignores them. mbuild merges multiple .exports files into one master exports list.

For example, given file1.exports as

```
times2
times3
```

and file1.c as

```
int times2(int x)
{
   return 2 * x;
}

int times3(int x)
{
   return 3 * x;
}
```

The command

```
mbuild file1.c file1.exports
```

creates a shared library named file1.*ext*, where *ext* is the platform-dependent shared library extension. For example, on the PC, it would be called file1.dll. The shared library exports the symbols times2 and times3.

Troubleshooting

Troubleshooting mbuild

This section identifies some of the more common problems that might occur when configuring `mbuild` to create stand-alone applications.

Options File Not Writeable. When you run `mbuild -setup`, `mbuild` makes a copy of the appropriate options file and writes some information to it. If the options file is not writeable, you are asked if you want to overwrite the existing options file. If you choose to do so, the existing options file is copied to a new location and a new options file is created.

Out of Environment Space Running mex or mbuild. On Windows 95 and Windows 98 systems, the `mex` and `mbuild` scripts require more than the default amount of environment space. If you get the error, `out of environment space`, add this line to your `config.sys` file.

```
shell=c:\command.com /e:32768 /p
```

Directory or File Not Writeable. If a destination directory or file is not writeable, ensure that the permissions are properly set. In certain cases, make sure that the file is not in use.

mbuild Generates Errors. On UNIX, if you run `mbuild` *filename* and get errors, it may be because you are not using the proper options file. Run `mbuild -setup` to ensure proper compiler and linker settings.

Compiler and/or Linker Not Found. On PCs running Windows, if you get errors such as `unrecognized command` or `file not found`, make sure the command line tools are installed and the path and other environment variables are set correctly in the options file.

mbuild Not a Recognized Command. If `mbuild` is not recognized, verify that `<MATLAB>\bin` is on your path. On UNIX, it may be necessary to rehash.

mbuild Works from Shell but Not from MATLAB (UNIX). If the command

```
mbuild ex1.c
```

works from the UNIX command prompt but does not work from the MATLAB prompt, you may have a problem with your `.cshrc` file. When MATLAB launches a new C shell to perform compilations, it executes the `.cshrc` script. If this script causes unexpected changes to the `PATH` environment variable, an error may occur. You can test this by performing a

```
set SHELL=/bin/sh
```

prior to launching MATLAB. If this works correctly, then you should check your `.cshrc` file for problems setting the `PATH` environment variable.

Cannot Locate Your Compiler (PC). If `mbuild` has difficulty locating your installed compilers, it is useful to know how it goes about finding compilers. `mbuild` automatically detects your installed compilers by first searching for locations specified in the following environment variables:

- `BORLAND` for Borland C/C++, Version 5.0, 5.2, or 5.3
- `MSVCDIR` for Microsoft Visual C/C++, Version 5.0 or 6.0

Next, `mbuild` searches the Windows registry for compiler entries.

Internal Error When Using mbuild -setup (PC). Some antivirus software packages such as Cheyenne AntiVirus and Dr. Solomon may conflict with the `mbuild -setup` process. If you get an error message during `mbuild -setup` of the following form

```
mex.bat: internal error in sub get_compiler_info(): don't
recognize <string>
```

then you need to disable your antivirus software temporarily and rerun `mbuild -setup`. After you have successfully run the `setup` option, you can re-enable your antivirus software.

Verification of mbuild Fails. If none of the previous solutions addresses your difficulty with `mbuild`, contact Technical Support at The MathWorks at `support@mathworks.com`.

Troubleshooting the Compiler

Typically, problems that occur when building stand-alone C and C++ applications involve `mbuild`. However, it is possible that you may run into some difficulty with the MATLAB Compiler. One problem that might occur when you try to generate a stand-alone application involves licensing.

Licensing Problem. If you do not have a valid license for the MATLAB Compiler, you will get an error message similar to the following when you try to access the Compiler.

```
Error: Could not check out a Compiler License:
No such feature exists.
```

If you have a licensing problem, contact The MathWorks. A list of contacts at The MathWorks is provided at the beginning of this manual.

MATLAB Compiler Does Not Generate Application. If you experience other problems with the MATLAB Compiler, contact Technical Support at The MathWorks at `support@mathworks.com`.

Coding with M-Files Only

One way to create a stand-alone application is to write all the source code in one or more M-files or MEX-files. Coding an application in M-files allows you to take advantage of MATLAB's interpretive development environment. Then, after getting the M-file version of your program working properly, compile the code and build it into a stand-alone application.

Note It is good practice to avoid manually modifying the C or C++ code that the MATLAB Compiler generates. If the generated C or C++ code is not to your liking, modify the M-file (and/or the compiler options) and then recompile. If you do edit the generated C or C++ code, remember that your changes will be erased the next time you recompile the M-file. For more information, see "Compiling MATLAB Provided M-Files Separately" on page 4-35 and "Interfacing M-Code to C/C++ Code" in Chapter 5.

Consider a very simple application whose source code consists of two M-files, `mrank.m` and `main.m`. This example involves C code; you use a similar process (described below) for C++ code. In this example, the line `r = zeros(n,1)` preallocates memory to help the performance of the Compiler.

`mrank.m` returns a vector of integers, `r`. Each element of `r` represents the rank of a magic square. For example, after the function completes, `r(3)` contains the rank of a 3-by-3 magic square.

```
function r = mrank(n)
r = zeros(n,1);
for k = 1:n
   r(k) = rank(magic(k));
end
```

`main.m` contains a "main routine" that calls `mrank` and then prints the results

```
function main
r = mrank(5)
```

To compile these into code that can be built into a stand-alone application, invoke the MATLAB Compiler.

```
mcc -mc main mrank
```

The `-m` option flag causes the MATLAB Compiler to generate C source code suitable for stand-alone applications. For example, the MATLAB Compiler generates C source code files `main.c`, `main_main.c`, and `mrank.c`. `main_main.c` contains a C function named `main`; `main.c` and `mrank.c` contain a C functions named `mlfMain` and `mlfMrank`. (The `-c` option flag inhibits invocation of `mbuild`.)

To build an executable application, you can use `mbuild` to compile and link these files. Or, you can automate the entire build process (invoke the MATLAB Compiler twice, use `mbuild` to compile the files with your ANSI C compiler, and link the code) by using the command

```
mcc -m main mrank
```

This figure illustrates the process of building a stand-alone C application from two M-files. The commands to compile and link depend on the operating system being used. See “Building Stand-Alone C/C++ Applications” on page 4-5 for details.

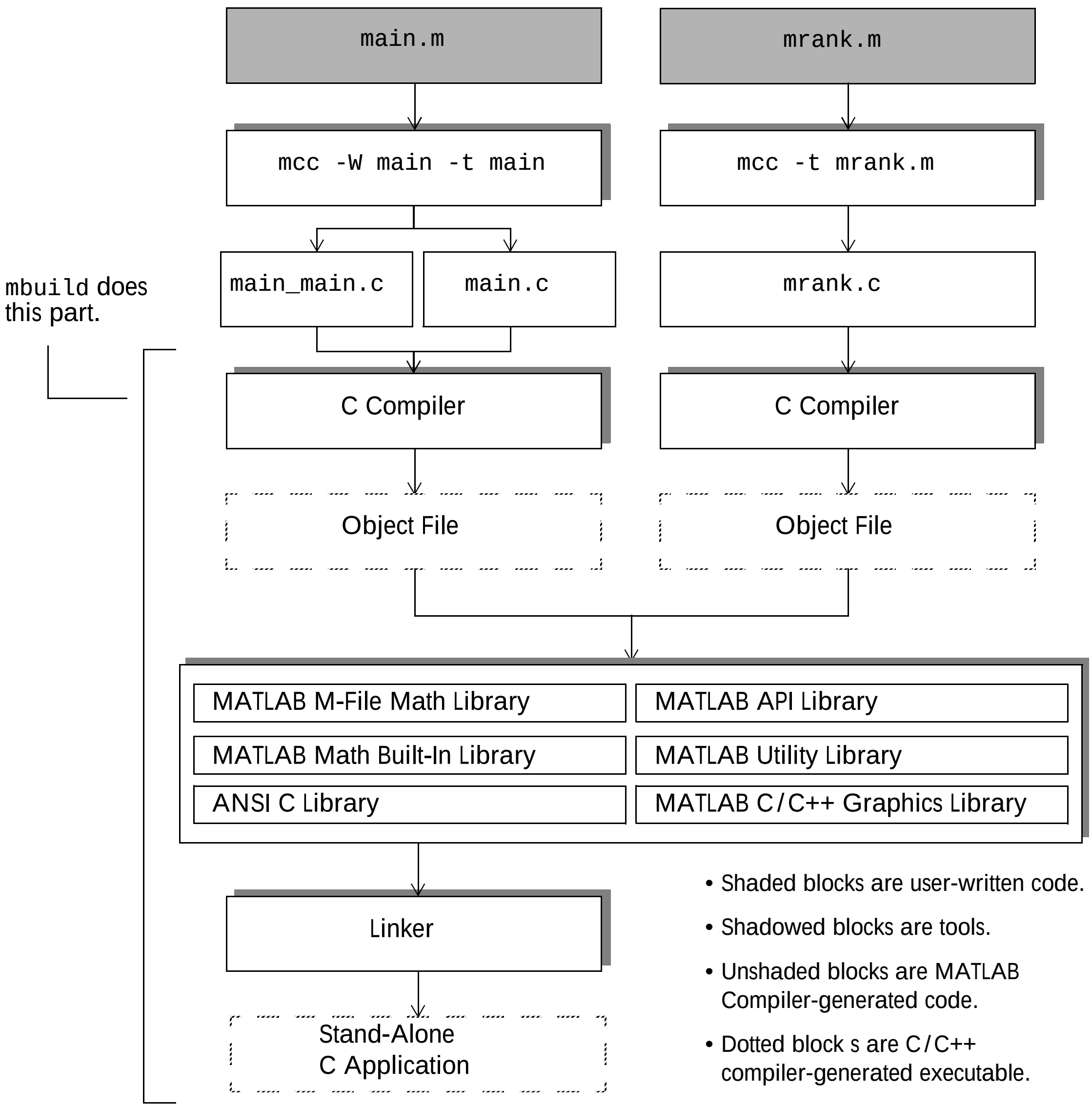


Figure 4-2: Building Two M-Files into a Stand-Alone C Application

For C++ code, add `-L cpp` to the previous commands, use a C++ compiler instead of a C compiler, and use the MATLAB C/C++ Math Library. See the *MATLAB C++ Math Library User's Guide* for details.

Alternative Ways of Compiling M-Files

The previous section showed how to compile `main.m` and `mrank.m` separately. This section explores two other ways of compiling M-files.

Note These two alternative ways of compiling M-files apply to C++ as well as to C code; the only difference is that you add `-L cpp` for C++.

Compiling MATLAB Provided M-Files Separately

The M-file `mrank.m` contains a call to `rank`. The MATLAB Compiler translates the call to `rank` into a C call to `mlfRank`. The `mlfRank` routine is part of the MATLAB M-File Math Library. The `mlfRank` routine behaves in stand-alone applications exactly as the `rank` function behaves in the MATLAB interpreter. However, if this default behavior is not desirable, you can create your own version of `rank` or `mlfRank`.

One way to create a new version of `rank` is to copy MATLAB's own source code for `rank` and then to edit this copy. MATLAB implements `rank` as the M-file `rank.m` rather than as a built-in command. To see MATLAB's code for `rank.m`, enter

```
type rank
```

Copy this code into a file named `rank.m` located in the same directory as `mrank.m` and `main.m`. Then, modify your version of `rank.m`. After completing the modifications, compile `rank.m`.

```
mcc -t rank
```

Compiling `rank.m` generates file `rank.c`, which contains a function named `mlfRank`. Then, compile the other M-files composing the stand-alone application.

```
mcc -t main.m                          (produces main.c)
mcc -t mrank.m                         (produces mrank.c)
mcc -W main main mrank rank.m          (produces main_main.c)
```

To compile and link all four C source code files (main.c, rank.c, mrank.c, and main_main.c) into a stand-alone application, use

```
mcc -m main_main.c main.c rank.c mrank.c
```

The resulting stand-alone application uses your customized version of mlfRank rather than the default version of mlfRank stored in the MATLAB Toolbox Library.

Note On PCs running Windows, as well as SGI, SGI64, and IBM, if a function in the MATLAB Toolbox Library calls mlfRank, it will call the one found in the Library and *not* your customized version. We recommend that you call your version of rank something else, for example, myrank.m.

Compiling mrank.m and rank.m as Helper Functions

Another way of building the mrank stand-alone application is to compile rank.m and mrank.m as helper functions to main.m. In other words, instead of invoking the MATLAB Compiler three separate times, invoke the MATLAB Compiler only once. For C

```
mcc -m main rank
```

For C++

```
mcc -p main rank
```

These commands create files containing the C or C++ source code. The macro options -m and -p automatically compile all helper functions.

Mixing M-Files and C or C++

The examples in this section illustrate how to mix M-files and C or C++ source code files:

- The first example is a simple application that mixes M-files and C code.
- The second example illustrates how to write C code that calls a compiled M-file.

One way to create a stand-alone application is to code some of it as one or more function M-files and to code other parts directly in C or C++. To write a stand-alone application this way, you must know how to:

- Call the external C or C++ functions generated by the MATLAB Compiler.
- Handle the results these C or C++ functions return.

Note If you include compiled M code into a larger application, you must produce a library wrapper file even if you do not actually create a separate library. For more information on creating libraries, see the library sections in "Supported Executable Types" in Chapter 5.

Simple Example

This example involves mixing M-files and C code. Consider a simple application whose source code consists of `mrank.m` and `mrankp.c`.

mrank.m

`mrank.m` contains a function that returns a vector of the ranks of the magic squares from 1 to `n`.

```
function r = mrank(n)
r = zeros(n,1);
for k = 1:n
   r(k) = rank(magic(k));
end
```

The Build Process

The steps needed to build this stand-alone application are:

1 Compile the M-code.

2 Generate the library wrapper file.

To perform these steps, use

```
mcc -t -W lib:Pkg -T link:exe -h mrank mrankp.c libmmfile.mlib
```

The MATLAB Compiler generates C source code files named `mrank.c`, `Pkg.c`, and `Pkg.h`. This command invokes `mbuild` to compile the resulting Compiler-generated source files (`mrank.c`, `Pkg.c`, `Pkg.h`) with the existing C source file (`mrankp.c`) and links against the required libraries. For details, see “Building Stand-Alone C/C++ Applications” on page 4-5.

The MATLAB Compiler provides two different versions of `mrankp.c` in the `<matlab>/extern/examples/compiler` directory:

- `mrankp.c` contains a POSIX-compliant `main` function. `mrankp.c` sends its output to the standard output stream and gathers its input from the standard input stream.
- `mrankwin.c` contains a Windows version of `mrankp.c`.

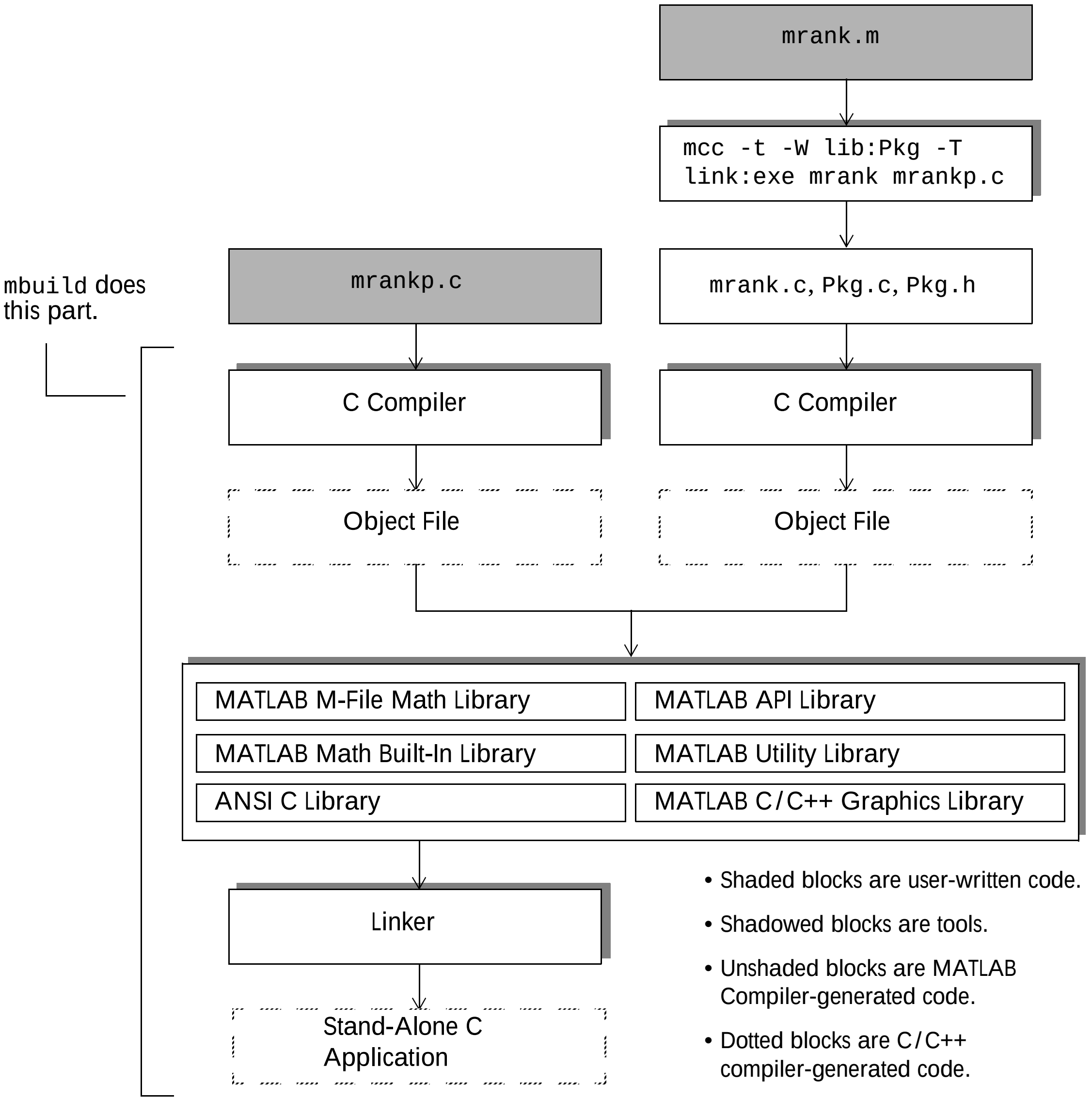


Figure 4-3: Mixing M-Files and C Code to Form a Stand-Alone Application

mrankp.c

The code in `mrankp.c` calls `mrank` and outputs the values that `mrank` returns.

```
/*
 * MRANKP.C
 * "Posix" C main program illustrating the use of the MATLAB Math
 * Library.
 * Calls mlfMrank, obtained by using MCC to compile mrank.m.
 *
 * $Revision: 1.3 $
 *
 */

#include <stdio.h>
#include <math.h>
#include "matlab.h"

/* Prototype for mlfMrank */
extern mxArray *mlfMrank( mxArray * );

main( int argc, char **argv )
{
    mxArray *N;    /* Matrix containing n. */
    mxArray *R;    /* Result matrix. */
    int      n;    /* Integer parameter from command line. */

    /* Get any command line parameter. */
    if (argc >= 2) {
        n = atoi(argv[1]);
    } else {
        n = 12;
    }
    PkgInitialize();  /* Initialize the library of M-Functions */

    /* Create a 1-by-1 matrix containing n. */
    N = mlfScalar(n);

    /* Call mlfMrank, the compiled version of mrank.m. */
    R = mlfMrank(N);
```

```
    /* Print the results. */
    mlfPrintMatrix(R);

    /* Free the matrices allocated during this computation. */
    mxDestroyArray(N);
    mxDestroyArray(R);

    PkgTerminate();    /* Terminate the library of M-functions */
}
```

An Explanation of mrankp.c

The heart of `mrankp.c` is a call to the `mlfMrank` function. Most of what comes before this call is code that creates an input argument to `mlfMrank`. Most of what comes after this call is code that displays the vector that `mlfMrank` returns. First, the code must call the Compiler-generated library initialization function.

```
PkgInitialize();/* Initialize the library of M-Functions */
```

To understand how to call `mlfMrank`, examine its C function header, which is

```
mxArray *mlfMrank(mxArray *n_rhs_)
```

According to the function header, `mlfMrank` expects one input parameter and returns one value. All input and output parameters are pointers to the `mxArray` data type. (See "External Interfaces/API" for details on the `mxArray` data type.) To create and manipulate `mxArray *` variables in your C code, you can call the `mx` routines described in the "External Interfaces/API" or any routine in the MATLAB C/C++ Math Library. For example, to create a 1-by-1 `mxArray *` variable named `N` with real data, `mrankp` calls `mlfScalar`.

```
N = mlfScalar(n);
```

`mrankp` can now call `mlfMrank`, passing the initialized `N` as the sole input argument.

```
R = mlfMrank(N);
```

`mlfMrank` returns a pointer to an `mxArray *` variable named `R`. The easiest way to display the contents of `R` is to call the `mlfPrintMatrix` convenience function.

```
mlfPrintMatrix(R);
```

mlfPrintMatrix is one of the many routines in the MATLAB Math Built-In Library, which is part of the MATLAB Math Library product.

Finally, mrankp must free the heap memory allocated to hold matrices and call the Compiler-generated termination function.

```
mxDestroyArray(N);
mxDestroyArray(R);
PkgTerminate();/* Terminate the library of M-functions */
```

Advanced C Example

This section illustrates an advanced example of how to write C code that calls a compiled M-file. Consider a stand-alone application whose source code consists of two files:

- multarg.m, which contains a function named multarg.
- multargp.c, which contains a C function named main.

multarg.m specifies two input parameters and returns two output parameters.

```
function [a,b] = multarg(x,y)
a = (x + y) * pi;
b = svd(svd(a));
```

The code in multargp.c calls mlfMultarg and then displays the two values that mlfMultarg returns.

```
#include <stdio.h>
#include <string.h>
#include <math.h>
#include "matlab.h"
#include "multpkg.h"/* Include Compiler-generated header file */

static void PrintHandler( const char *text )
{
    printf(text);
}

int main( )   /* Programmer written coded to call mlfMultarg */
{
#define ROWS  3
#define COLS  3
```

```
    mxArray *a, *b, *x, *y;
    double  x_pr[ROWS * COLS] = {1, 2, 3, 4, 5, 6, 7, 8, 9};
    double  x_pi[ROWS * COLS] = {9, 2, 3, 4, 5, 6, 7, 8, 1};
    double  y_pr[ROWS * COLS] = {1, 2, 3, 4, 5, 6, 7, 8, 9};
    double  y_pi[ROWS * COLS] = {2, 9, 3, 4, 5, 6, 7, 1, 8};
    double *a_pr, *a_pi, value_of_scalar_b;

    multpkgInitialize();/* Call multpkg initialization */

    /* Install a print handler to tell mlfPrintMatrix how to
     * display its output.
     */
    mlfSetPrintHandler(PrintHandler);

    /* Create input matrix "x" */
    x = mxCreateDoubleMatrix(ROWS, COLS, mxCOMPLEX);
    memcpy(mxGetPr(x), x_pr, ROWS * COLS * sizeof(double));
    memcpy(mxGetPi(x), x_pi, ROWS * COLS * sizeof(double));

    /* Create input matrix "y" */
    y = mxCreateDoubleMatrix(ROWS, COLS, mxCOMPLEX);
    memcpy(mxGetPr(y), y_pr, ROWS * COLS * sizeof(double));
    memcpy(mxGetPi(y), y_pi, ROWS * COLS * sizeof(double));

    /* Call the mlfMultarg function. */
    a = (mxArray *)mlfMultarg(&b, x, y);

    /* Display the entire contents of output matrix "a". */
    mlfPrintMatrix(a);

    /* Display the entire contents of output scalar "b" */
    mlfPrintMatrix(b);

    /* Deallocate temporary matrices. */
    mxDestroyArray(a);
    mxDestroyArray(b);
    multpkgTerminate();/* Call multpkg termination */
    return(0);
}
```

You can build this program into a stand-alone application by using the command:

```
mcc -t -W lib:multpkg -T link:exe multarg multargp.c libmmfile.mlib
```

The program first displays the contents of a 3-by-3 matrix a and then displays the contents of scalar b:

```
 6.2832 +34.5575i  25.1327 +25.1327i  43.9823 +43.9823i
12.5664 +34.5575i  31.4159 +31.4159i  50.2655 +28.2743i
18.8496 +18.8496i  37.6991 +37.6991i  56.5487 +28.2743i

143.4164
```

An Explanation of This C Code

Invoking the MATLAB Compiler on multarg.m generates the C function prototype.

```
extern mxArray * mlfMultarg(mxArray * * b, mxArray * x,
    mxArray * y);
extern void mlxMultarg(int nlhs, mxArray * plhs[], int nrhs,
    mxArray * prhs[]);
```

This C function header shows two input arguments (mxArray *x and mxArray *y) and two output arguments (the return value and mxArray **b).

Use mxCreateDoubleMatrix to create the two input matrices (x and y). Both x and y contain real and imaginary components. The memcpy function initializes the components, for example,

```
x = mxCreateDoubleMatrix(ROWS, COLS, COMPLEX);
memcpy(mxGetPr(x), x_pr, ROWS * COLS * sizeof(double));
memcpy(mxGetPi(y), y_pi, ROWS * COLS * sizeof(double));
```

The code in this example initializes variable x from two arrays (x_pr and x_pi) of predefined constants. A more realistic example would read the array values from a data file or a database.

After creating the input matrices, main calls mlfMultarg.

```
a = (mxArray *)mlfMultarg(&b, x, y);
```

The `mlfMultarg` function returns matrices `a` and `b`. `a` has both real and imaginary components; `b` is a scalar having only a real component. The program uses `mlfPrintMatrix` to output the matrices, for example,

```
mlfPrintMatrix(a);
```

5

Controlling Code Generation

This chapter describes the code generated by the MATLAB Compiler and the options that you can use to control code generation. In particular, it discusses:

- Compiling private and method functions
- The generated header files
- Internal interface functions
- Supported executable types
- Formatting Compiler-generated code
- Including M-file information in Compiler output
- Interfacing M-code to C/C++ code
- Print handlers

Code Generation Overview

Example M-Files

To generate the various files created by the Compiler, this chapter uses several different M-files — `gasket.m`, `foo.m`, `fun.m`, and `sample.m`.

Sierpinski Gasket M-File

```
function theImage = gasket(numPoints)
%GASKET An image of a Sierpinski Gasket.
%   IM = GASKET(NUMPOINTS)
%
%   Example:
%   x = gasket(50000);
%   imagesc(x);colormap([0 0 0;1 1 1]);
%   axis equal tight

%   Copyright (c) 1984-98 by The MathWorks, Inc
%   $Revision: 1.1 $  $Date: 1998/09/11 20:05:06 $

theImage = zeros(1000,1000);

corners = [866 1;1 500;866 1000];
startPoint = [866 1];
theRand = rand(numPoints,1);
theRand = ceil(theRand*3);

for i=1:numPoints
    startPoint = floor((corners(theRand(i),:)+startPoint)/2);
    theImage(startPoint(1),startPoint(2)) = 1;
end
```

foo M-File

```
function [a, b] = foo(x, y)
if nargout == 0
elseif nargout == 1
    a = x;
elseif nargout == 2
    a = x;
    b = y;
end
```

fun M-File

```
function a = fun(b)
a(1) = b(1) .* b(1);
a(2) = b(1) + b(2);
a(3) = b(2) / 4;
```

sample M-File

```
function y = sample( varargin )
varargin{:}
y = 0;
```

Generated Code

This chapter investigates the generated header files, interface functions, and wrapper functions for the C MEX, stand-alone C and C++ targets, and C and C++ libraries.

When you use the MATLAB Compiler to compile an M-file, it generates these files:

- C or C++ code, depending on your target language (`-L`) specification
- Header file
- Wrapper file, depending on the `-W` option

The C or C++ code that is generated by the Compiler and the header file are independent of the final target type and target platform. That is, the C or C++ code and header file are identical no matter what the desired final output. The wrapper file provides the code necessary to support the output executable type. So, the wrapper file is different for each executable type.

This table shows the names of the files generated when you compile a generic M-file (`file.m`) for the MEX and stand-alone targets. The table also shows the files generated when you compile a set of files (`filelist`) for the library target.

Table 5-1: Compiler-Generated Files

	C	C++
Header	`file.h`	`file.hpp`
Code	`file.c`	`file.cpp`
Main Wrapper (-W main)	`file_main.c`	`file_main.cpp`
MEX Wrapper (-W mex)	`file_mex.c`	N/A (C++ MEX-files are not supported.)
Simulink Wrapper (-W simulink)	`file_simulink.c`	N/A (C++ MEX-files are not supported.)

Library (-W lib:filelist)	`filelist.c`
	`filelist.h`
	`filelist.exports`
	`filelist.mlib`
		`filelist.cpp`
		`filelist.hpp`
		`filelist.mlib`

Note Many of the code snippets generated by the MATLAB Compiler that are used in this chapter use the `-F page-width` option to produce readable code that fits nicely on the book's printed page. For more information about the `page-width` option, see "Formatting Compiler-Generated Code" on page 5-29.

Compiling Private and Method Functions

Private functions are functions that reside in subdirectories with the special name `private`, and are visible only to functions in the parent directory. Since private functions are invisible outside of the parent directory, they can use the same names as functions in other directories. Because MATLAB looks for private functions before standard M-file functions, it will find a private function before a nonprivate one.

Method functions are implementations specific to a particular MATLAB type or user-defined object. Method functions are only invoked when the argument list contains an object of the correct class.

In order to compile a method function, you must specify the name of the method along with the classname so that the Compiler can differentiate the method function from a nonmethod (normal) function.

Note Although Compiler 2.1 can currently compile method functions, it does not support overloading of methods as implemented in MATLAB. This feature is provided in anticipation of support of overloaded methods being added.

Method directories can contain private directories. Private functions are found only when executing a method from the parent method directory. Taking all of this into account, the Compiler command line needs to be able to differentiate between these various functions that have the same name. A file called `foo.m` that contains a function called `foo` can appear in all of these locations at the same time. The conventions used on the Compiler command line are as documented in this table.

Name	Description
`foo.m`	Default version of `foo.m`
`xxx/private/foo.m`	`foo.m` private to the `xxx` directory
`@cell/foo.m`	`foo.m` method to operate on cell arrays
`@cell/private/foo.m`	`foo.m` private to methods that operate on cell arrays

This table lists the functions you can specify on the command line and their corresponding function and filenames.

Function	C Function	C++ Function	Filename
foo	mlfFoo mlxFoo mlNFoo mlfNFoo mlfVFoo	foo Nfoo Vfoo mlxFoo	foo.c foo.h foo.cpp foo.hpp
@cell/foo	mlf_cell_foo mlx_cell_foo mlN_cell_foo mlfN_cell_foo mlfV_cell_foo	_cell_foo N_cell_foo V_cell_foo mlx_cell_foo	_cell_foo.c _cell_foo.h _cell_foo.cpp _cell_foo.hpp
xxx/private/foo	mlfXXX_private_foo mlxXXX_private_foo mlNXXX_private_foo mlfNXXX_private_foo mlfVXXX_private_foo	XXX_private_foo NXXX_private_foo VXXX_private_foo mlxXXX_private_foo	_XXX_private_foo.c _XXX_private_foo.h _XXX_private_foo.cpp _XXX_private_foo.hpp
@cell/private/foo	mlfcell_private_foo mlxcell_private_Foo mlNcell_private_Foo mlfNcell_private_Foo mlfVcell_private_Foo	_cell_private_foo N_cell_private_foo V_cell_private_foo mlx_cell_private_foo	_cell_private_foo.c _cell_private_foo.h _cell_private_foo.cpp _cell_private_foo.hpp

For private functions, the name given in the table above may be ambiguous. The MATLAB Compiler generates a warning when it cannot distinguish which private function to use. For example, given these two `foo.m` private functions and their locations

```
/Z/X/private/foo.m
/Y/X/private/foo.m
```

the Compiler searches up only one level and determines the path to the file as

```
X/private/foo.m
```

Since it is ambiguous which `foo.m` you are requesting, it generates the warning

```
Warning: The specified private directory is not unique. Both
/Z/X/private and /Y/X/private are found on the path for this
private directory.
```

The Generated Header Files

This section highlights the two header files that the Compiler can generate for the Sierpinski Gasket (gasket.m) example.

C Header File

If the target language is C, the Compiler generates the header file, gasket.h. This example uses the Compiler command

```
mcc -t -L C -T codegen -F page-width:60 gasket
```

to generate the associated files. The C header file, gasket.h, is

```
/*
 * MATLAB Compiler: 2.1
 * Date: Thu Aug 24 08:43:31 2000
 * Arguments: "-B" "macro_default" "-O" "all" "-O"
 * "fold_scalar_mxarrays:on" "-O"
 * "fold_non_scalar_mxarrays:on" "-O"
 * "optimize_integer_for_loops:on" "-O" "array_indexing:on"
 * "-O" "optimize_conditionals:on" "-t" "-L" "C" "-T"
 * "codegen" "-F" "page-width:60" "gasket"
 */

#ifndef MLF_V2
#define MLF_V2 1
#endif

#ifndef __gasket_h
#define __gasket_h 1

#ifdef __cplusplus
extern "C" {
#endif

#include "libmatlb.h"

extern void InitializeModule_gasket(void);
extern void TerminateModule_gasket(void);
extern mxArray * mlfGasket(mxArray * numPoints);
```

```
extern void mlxGasket(int nlhs,
                      mxArray * plhs[],
                      int nrhs,
                      mxArray * prhs[]);

#ifdef __cplusplus
}
#endif

#endif
```

C++ Header File

If the target language is C++, the Compiler generates the header file, `gasket.hpp`. This example uses the Compiler command

```
mcc -t -L Cpp -T codegen -F page-width:60 gasket
```

to generate the associated files. The C++ header file, `gasket.hpp`, is

```
//
// MATLAB Compiler: 2.1
// Date: Thu Aug 24 08:45:03 2000
// Arguments: "-B" "macro_default" "-O" "all" "-O"
// "fold_scalar_mxarrays:on" "-O"
// "fold_non_scalar_mxarrays:on" "-O"
// "optimize_integer_for_loops:on" "-O" "array_indexing:on"
// "-O" "optimize_conditionals:on" "-t" "-L" "Cpp" "-T"
// "codegen" "-F" "page-width:60" "gasket"
//
#ifndef __gasket_hpp
#define __gasket_hpp 1

#include "matlab.hpp"

extern void InitializeModule_gasket();
extern void TerminateModule_gasket();
extern mwArray gasket(mwArray numPoints = mwArray::DIN);
#ifdef __cplusplus
extern "C"
#endif
```

```
void mlxGasket(int nlhs,
               mxArray * plhs[],
               int nrhs,
               mxArray * prhs[]);

#endif
```

Internal Interface Functions

This section uses the Sierpinski Gasket example (`gasket.m`) to show several of the generated interface functions for the C and C++ cases. The remaining interface functions are generated by the example `foo.m` as described earlier in this chapter.

Interface functions perform argument translation between the standard calling conventions and the Compiler-generated code.

C Interface Functions

The C interface functions process any input arguments and pass them to the implementation version of the function, `M`*f*.

mlx*F* Interface Function

The Compiler always generates the `mlx`*F* interface function, which is used by `feval`. At times, the Compiler needs to use `feval` to perform argument matching even if the user does not specifically call `feval`. For example,

```
x = cell(1,5);
y = {1 2 3 4 5};
[x{:}] = deal(y{:});
```

would use the `feval` interface. The following C code is the corresponding `feval` interface (`mlxGasket`) from the Sierpinski Gasket example. This function calls the C `Mgasket` function.

```
/*
 * The function "mlxGasket" contains the feval interface
 * for the "gasket" M-function from file
 * "<matlab>\extern\examples\compiler\gasket.m" (lines 1-23).
 * The feval function calls the implementation version of
 * gasket through this function. This function processes
 * any input arguments and passes them to the
 * implementation version of the function, appearing above.
 */
void mlxGasket(int nlhs,
               mxArray * plhs[],
               int nrhs,
               mxArray * prhs[]) {
```

```
        mxArray * mprhs[1];
        mxArray * mplhs[1];
        int i;
```

Input argument processing

```
        if (nlhs > 1) {
            mlfError(_mxarray0_);
        }
        if (nrhs > 1) {
            mlfError(_mxarray2_);
        }
        for (i = 0; i < 1; ++i) {
            mplhs[i] = mclGetUninitializedArray();
        }
        for (i = 0; i < 1 && i < nrhs; ++i) {
            mprhs[i] = prhs[i];
        }
        for (; i < 1; ++i) {
            mprhs[i] = NULL;
        }
        mlfEnterNewContext(0, 1, mprhs[0]);
```

Call to C implementation function

```
        mplhs[0] = Mgasket(nlhs, mprhs[0]);
```

Output argument processing

```
        mlfRestorePreviousContext(0, 1, mprhs[0]);
        plhs[0] = mplhs[0];
    }
```

mlf*F* Interface Function

The Compiler always generates the mlf*F* interface function, which contains the “normal” C interface to the function. This code is the corresponding C interface function (`mlfGasket`) from the Sierpinski Gasket example. This function calls the C `mgasket` function.

```
/*
 * The function "mlfGasket" contains the normal interface
 * for the "gasket" M-function from file
 * "<matlab>\extern\examples\compiler\gasket.m" (lines 1-23).
 * This function processes any input arguments and passes
 * them to the implementation version of the function,
 * appearing above.
 */
mxArray * mlfGasket(mxArray * numPoints) {
    int nargout = 1;
```

Input argument processing

```
    mxArray * theImage = mclGetUninitializedArray();
    mlfEnterNewContext(0, 1, numPoints);
```

Call M-function

```
    theImage = Mgasket(nargout, numPoints);
```

Output argument processing

```
    mlfRestorePreviousContext(0, 1, numPoints);
    return mlfReturnValue(theImage);
}
```

mlfN*F* Interface Function

The Compiler produces this interface function only when the M-function uses the variable `nargout`.The `nargout` interface allows you to specify the number of requested outputs via the `int nargout` argument, as opposed to the normal interface that dynamically calculates the number of outputs based on the number of non-null inputs it receives.

This is the corresponding `mlfN`*F* interface function (`mlfNFoo`) for the `foo.m` example described earlier in this chapter. This function calls the `Mfoo` function that appears in `foo.c`.

```
/*
 * The function "mlfNFoo" contains the nargout interface
 * for the "foo" M-function from file
 * "<matlab>\extern\examples\compiler\foo.m" (lines 1-8).
 * This interface is only produced if the M-function uses
 * the special variable "nargout". The nargout interface
 * allows the number of requested outputs to be specified
 * via the nargout argument, as opposed to the normal
 * interface which dynamically calculates the number of
```

```
 * outputs based on the number of non-NULL inputs it
 * receives. This function processes any input arguments
 * and passes them to the implementation version of the
 * function, appearing above.
 */
mxArray * mlfNFoo(int nargout,
                  mxArray * * b,
                  mxArray * x,
                  mxArray * y) {
```

Input argument processing

```
    mxArray * a = mclGetUninitializedArray();
    mxArray * b__ = mclGetUninitializedArray();
    mlfEnterNewContext(1, 2, b, x, y);
```

Call M-function

```
    a = Mfoo(&b__, nargout, x, y);
```

Output argument processing

```
    mlfRestorePreviousContext(1, 2, b, x, y);
    if (b != NULL) {
        mclCopyOutputArg(b, b__);
    } else {
        mxDestroyArray(b__);
    }
    return mlfReturnValue(a);
}
```

mlfV*F* Interface Function

The Compiler produces this interface function only when the M-function uses the variable `nargout` and has at least one output. This `void` interface function specifies zero output arguments to the implementation version of the function, and in the event that the implementation version still returns an output (which, in MATLAB, would be assigned to the `ans` variable), it deallocates the output.

This is the corresponding `mlfV`*F* interface function (`mlfVFoo`) for the `foo.m` example described at the beginning of this section. This function calls the C `Mfoo` implementation function that appears in `foo.c`.

```
/*
 * The function "mlfVFoo" contains the void interface for
 * the "foo" M-function from file
 * "<matlab>\extern\examples\compiler\foo.m" (lines 1-8). The
 * void interface is only produced if the M-function uses
 * the special variable "nargout", and has at least one
```

```
 * output. The void interface function specifies zero
 * output arguments to the implementation version of the
 * function, and in the event that the implementation
 * version still returns an output (which, in MATLAB, would
 * be assigned to the "ans" variable), it deallocates the
 * output. This function processes any input arguments and
 * passes them to the implementation version of the
 * function, appearing above.
 */
void mlfVFoo(mxArray * x, mxArray * y) {
```

Input argument processing

```
    mxArray * a = NULL;
    mxArray * b = NULL;
    mlfEnterNewContext(0, 2, x, y);
```

Call M-function

```
    a = Mfoo(&b, 0, x, y);
```

Output argument processing

```
    mlfRestorePreviousContext(0, 2, x, y);
    mxDestroyArray(a);
    mxDestroyArray(b);
}
```

C++ Interface Functions

The C++ interface functions process any input arguments and pass them to the implementation version of the function.

Note In C++, the `mlx`*F* interface functions are also C functions in order to allow the `feval` interface to be uniform between C and C++.

---

mlx*F* Interface Function

The Compiler always generates the `mlx`*F* interface function, which is used by `feval`. At times, the Compiler needs to use `feval` to perform argument matching even if the user does not specifically call `feval`. For example,

```
x = cell(1,5);
y = {1 2 3 4 5};
[x{:}] = deal(y{:});
```

would use the `feval` interface. The following C++ code is the corresponding `feval` interface (`mlxGasket`) from the Sierpinski Gasket example. This function calls the C++ `Mgasket` function.

```
//
// The function "mlxGasket" contains the feval interface
// for the "gasket" M-function from file
// "<matlab>\extern\examples\compiler\gasket.m" (lines 1-23).
// The feval function calls the implementation version of
// gasket through this function. This function processes
// any input arguments and passes them to the
// implementation version of the function, appearing above.
//
void mlxGasket(int nlhs,
               mxArray * plhs[],
               int nrhs,
               mxArray * prhs[]) {
    MW_BEGIN_MLX();
    {
        mwArray mprhs[1];
        mwArray mplhs[1];
        int i;
        mclCppUninitializeArrays(1, mplhs);
        if (nlhs > 1) {
            error(_mxarray0_);
        }
        if (nrhs > 1) {
            error(_mxarray2_);
        }
        for (i = 0; i < 1 && i < nrhs; ++i) {
            mprhs[i] = mwArray(prhs[i], 0);
        }
        for (; i < 1; ++i) {
            mprhs[i].MakeDIN();
        }
        mplhs[0] = Mgasket(nlhs, mprhs[0]);
        plhs[0] = mplhs[0].FreezeData();
    }
    MW_END_MLX();
}
```

Input argument processing

Call M-function

Output argument processing

F Interface Function

The Compiler always generates the *F* interface function, which contains the "normal" C++ interface to the function. This code is the corresponding C++ interface function (gasket) from the Sierpinski Gasket example. This function calls the C++ code.

Call M-function

Output argument processing

```
//
// The function "gasket" contains the normal interface for
// the "gasket" M-function from file
// "<matlab>\extern\examples\compiler\gasket.m" (lines 1-23).
// This function processes any input arguments and passes
// them to the implementation version of the function,
// appearing above.
//
mwArray gasket(mwArray numPoints) {
    int nargout(1);
    mwArray theImage(mclGetUninitializedArray());
    theImage = Mgasket(nargout, numPoints);
    return theImage;
}
```

N*F* Interface Function

The Compiler produces this interface function only when the M-function uses the variable nargout. The nargout interface allows the number of requested outputs to be specified via the nargout argument, as opposed to the normal interface that dynamically calculates the number of outputs based on the number of non-null inputs it receives.

This is the corresponding N*F* interface function (NFoo) for the foo.m example described earlier in this chapter. This function calls the Mfoo function appearing in foo.cpp.

```
//
// The function "Nfoo" contains the nargout interface for
// the "foo" M-function from file
// "<matlab>\extern\examples\compiler\foo.m" (lines 1-8).
// This interface is only produced if the M-function uses
// the special variable "nargout". The nargout interface
// allows the number of requested outputs to be specified
// via the nargout argument, as opposed to the normal
```

```
// interface which dynamically calculates the number of
// outputs based on the number of non-NULL inputs it
// receives. This function processes any input arguments
// and passes them to the implementation version of the
// function, appearing above.
//
mwArray Nfoo(int nargout,
             mwArray * b,
             mwArray x,
             mwArray y) {
```

Input argument processing

```
    mwArray a(mclGetUninitializedArray());
    mwArray b__(mclGetUninitializedArray());
```

Call M-function

```
    a = Mfoo(&b__, nargout, x, y);
```

Input argument processing

```
    if (b != NULL) {
        *b = b__;
    }
```

Output argument processing

```
    return a;
}
```

V*F* Interface Function

The Compiler produces this interface function only when the M-function uses the variable `nargout` and has at least one output. The `void` interface function specifies zero output arguments to the implementation version of the function, and in the event that the implementation version still returns an output (which, in MATLAB, would be assigned to the `ans` variable), it deallocates the output.

This is the corresponding V*F* interface function (`VFoo`) for the `foo.m` example described earlier in this chapter. This function calls the `Mfoo` function appearing in `foo.cpp`.

```
//
// The function "Vfoo" contains the void interface for the
// "foo" M-function from file
// "<matlab>\extern\examples\compiler\foo.m" (lines 1-8).
// The void interface is only produced if the M-function
// uses the special variable "nargout", and has at least
// one output. The void interface function specifies zero
// output arguments to the implementation version of the
// function, and in the event that the implementation
```

```
// version still returns an output (which, in MATLAB, would
// be assigned to the "ans" variable), it deallocates the
// output. This function processes any input arguments and
// passes them to the implementation version of the
// function, appearing above.
//
void Vfoo(mwArray x, mwArray y) {
    mwArray a(mwArray::UNDEFINED);
    mwArray b(mwArray::UNDEFINED);
    a = Mfoo(&b, 0, x, y);
}
```

Input argument processing

Call M-function

Supported Executable Types

Wrapper functions create a link between the Compiler-generated code and a supported executable type by providing the required interface that allows the code to operate in the desired execution environment.

The wrapper functions differ depending on the execution environment, whereas the C and C++ header files and code that are generated by the Compiler are the same for MEX-functions, stand-alone applications, and libraries.

To provide the required interface, the wrapper:

- Defines persistent/global variables
- Initializes the `feval` function table for run-time `feval` support
- Performs wrapper-specific initialization and termination
- Initializes the constant pools generated by optimization

This section discusses the various wrappers that can be generated using the MATLAB Compiler.

Note When the Compiler generates a wrapper function, it must examine all of the `.m` files that will be included into the executable. If you do not include all the files, the Compiler may not define all of the global variables. Optimized code will not run at all without initialization.

Generating Files

You can use the `-t` option of the Compiler to generate source files in addition to wrapper files. For example,

```
mcc -W main -h x.m
```

examines `x.m` and all M-files referenced by `x.m`, but generates only the `x_main.c` wrapper file. However, including the `-t` option in

```
mcc -W main -h -t x.m
```

generates `x_main.c`, `x.c`, and all M-files referenced by `x.m`.

MEX-Files

The `-W mex -L C` options produce the MEX-file wrapper, which includes the `mexFunction` interface that is standard to all MATLAB plug-ins. For more information about the requirements of the `mex` interface, see "External Interfaces/API."

In addition to declaring globals and initializing the `feval` function table, the MEX-file wrapper function includes interface and definition functions for all M-files not included into the set of compiled files. These functions are implemented as callbacks to MATLAB.

Note By default, the `-x` option does not include any functions that do not appear on the command line. Functions that do not appear on the command line would generate a callback to MATLAB. Specify `-h` if you want all functions called to be compiled into your MEX-file.

Main Files

You can generate C or C++ application wrappers that are suitable for building C or C++ stand-alone applications, respectively. These POSIX-compliant main wrappers accept strings from the POSIX shell and return a status code. They are meant to translate "command-like" M-files into POSIX main applications.

POSIX Main Wrapper

The POSIX `main()` function wrapper behaves exactly the same as the command/function duality mode of MATLAB. That is, any command of the form

```
command argument
```

can also be written in the functional form

```
command('argument')
```

If you write a function that accepts strings in MATLAB, that function will compile to a POSIX main wrapper in such a way that it behaves the same from the DOS/UNIX command line as it does from within MATLAB.

The Compiler processes the string arguments passed to the `main()` function and sends them into the compiled M-function as strings.

For example, consider this M-file, `sample.m`.

```
function y = sample( varargin )
varargin{:}
y = 0;
```

You can compile `sample.m` into a POSIX main application. If you call `sample` from MATLAB, you get

```
sample hello world

ans =
hello

ans =
world

ans =
     0
```

If you compile `sample.m` and call it from the DOS shell, you get

```
C:\> sample hello world

ans =
hello

ans =
world

C:\>
```

The difference between the MATLAB and DOS/UNIX environments is the handling of the return value. In MATLAB, the return value is handled by printing its value; in the DOS/UNIX shell, the return value is handled as the return status code. When you compile a function into a POSIX main application, the first return value from the function is coerced to a scalar and is returned to the POSIX shell.

Simulink S-Functions

The `-W simulink -L C` options produce a Simulink S-function wrapper. Simulink S-function wrappers conform to the Simulink C S-function conventions. The wrappers initialize:

- The `sizes` structure
- The S-function's sample times array
- The S-function's states and work vectors
- The global variables and constant pool

For more information about Simulink S-function requirements, see *Writing S-Functions*.

Note By default, the `-S` command does not include any functions that do not appear on the command line. Functions that do not appear on the command line would generate a callback to MATLAB. Specify `-h` if you want all functions called to be compiled into your MEX-file.

C Libraries

The intent of the C library wrapper files is to allow the inclusion of an arbitrary set of M-files into a static library or shared library. The header file contains all of the entry points for all of the compiled M functions. The export list contains the set of symbols that are exported from a C shared library.

Another benefit of creating a library is that you can compile a common set of functions once. You can then compile other M-functions that depend on them without recompiling the original functions. You can accomplish this using `mlib` files, which are automatically generated when you generate the library. For more information about `mlib` files, see "mlib Files" on page 5-25.

Note Even if you are not producing a shared library, you must generate a library wrapper file when including any Compiler-generated code into a larger application.

This example uses several functions from the `toolbox\matlab\timefun` directory (`weekday`, `date`, `tic`, `calendar`, `toc`) to create a library wrapper. The `-W lib:libtimefun -L C` options produce the files shown in this table.

File	Description
`libtimefun.c`	C wrapper file
`libtimefun.h`	C header file
`libtimefun.exports`	C export list
`libtimefun.mlib`	M-file library

libtimefun.c

The C wrapper file (`libtimefun.c`) contains the initialization (`libtimefunInitialize`) and termination (`libtimefunTerminate`) functions for the library. You must call `libtimefunInitialize` before you call any Compiler-generated code. This function initializes the state of Compiler-generated functions so that those functions can be called from C code not generated by the Compiler. You must also call `libtimefunTerminate` before you unload the library.

The library files in this example are produced from the command

```
mcc -W lib:libtimefun -L C weekday date tic calendar toc
```

C Shared Library

The MATLAB Compiler allows you to build a shared library from the files created in the previous section, "C Libraries." To build the shared library, `libtimefun.`*ext*, in one step, use

```
mcc -W lib:libtimefun -L C -t -T link:lib -h weekday date tic calendar toc
```

The `-t` option tells the Compiler to generate C code from each of the listed M-files. The `-T link:lib` option tells the Compiler to compile and link a shared library. The `-h` option tells the Compiler to include any other M-functions called from those listed on the `mcc` command line, i.e., helper functions.

mlib Files

Shared libraries, like libraries, let you compile a common set of functions once and then compile other M-functions that depend on them without compiling them again.You accomplish this using `mlib` files, which are automatically generated when you generate the shared library.

Creating an mlib File. When you create a library wrapper file, you also get a `.mlib` file with the same base name. For example,

```
mcc -W lib:libtimefun -L C -t -T link:lib -h weekday date tic calendar toc
```

creates

```
libtimefun.c
libtimefun.h
libtimefun.exports
libtimefun.mlib
libtimefun.ext
```

The last file, `libtimefun.`*ext*, is the shared library file for your platform. For example, on the PC, the shared library is

```
libtimefun.dll
```

Using an mlib File. This example uses two function, `tic` and `toc`, that are in the shared library. Consider a new function, timer, defined as

```
function timer
    tic
         x = fft(1:1000);
    toc
```

Prior to `mlib` files, if you compiled `timer` using

```
mcc -m timer
```

both `tic` and `toc` would be recompiled due to the implicit `-h` option included in the `-m` macro. Using `mlib` files, you would use

```
mcc -m timer libtimefun.mlib
```

At compile time, function definitions for `tic` and `toc` are located in the `libtimefun.mlib` file, indicating that all future references to `tic` and `toc` should come from the `mlib` files's corresponding shared library. When the executable is created, it is linked against the shared library. For example on the PC, the executable `timer.exe` is created and it is linked against `libtimefun.dll`.

An advantage of using `mlib` files is that the generated code is smaller because some of the code is now located in the shared library.

Note On the `mcc` command line, you can access any `mlib` file by including the full path to the file. For example,

```
mcc -m timer /pathname/libtimefun.mlib
```

Restrictions.

- (UNIX) The first three characters of the filename must be `lib`.
- (PC and UNIX) You cannot rename the file.
- (PC and UNIX) Both the shared library and the `mlib` file must be in the same directory at compile time.
- (PC and UNIX) At run time, the path to the shared library must be on the system's search path. For more information about setting the path on the PC, see "Shared Libraries" on page 4-22. For UNIX information, see "Locating Shared Libraries" on page 4-12. You do not need the `mlib` file present when running the executable that links to the shared library.

C++ Libraries

The intent of the C++ library wrapper files is to allow the inclusion of an arbitrary set of M-files into a library. The header file contains all of the entry points for all of the compiled M functions.

Note Even if you are not producing a separate library, you must generate a library wrapper file when including any Compiler-generated code into a larger application.

This example uses several functions from the `toolbox\matlab\timefun` directory (`weekday`, `date`, `tic`, `calendar`, `toc`) to create a C++ library called `libtimefun`. The `-W lib:libtimefun -L Cpp` options produce the C++ library files shown in this table.

File	Description
`libtimefun.cpp`	C++ wrapper file
`libtimefun.hpp`	C++ header file

Note On some platforms, including Microsoft Windows NT, support for C++ shared libraries is limited and the C++ mangled function names must be exported. Refer to your vendor-supplied documentation for details on creating C++ shared libraries.

libtimefun.cpp

The C++ wrapper file (`libtimefun.cpp`) initializes the state of Compiler-generated functions so that those functions can be called from C++ code not generated by the Compiler. These files are produced from the command

```
mcc -W lib:libtimefun -L Cpp weekday date tic calendar toc
```

Porting Generated Code to a Different Platform

The code generated by the MATLAB Compiler is portable among platforms. However, if you build an executable from `foo.m` on a PC running Windows, that same file will not run on a UNIX system.

For example, you cannot simply copy `foo.`*mex* (where the *mex* extension varies by platform) from a PC to a Sun system and expect the code to work, because binary formats are different on different platforms (all supported executable types are binary). However, you could copy either all of the generated C code or `foo.m` from the PC to the Sun system. Then, on the Sun platform you could use `mex` or `mcc` to produce a `foo.`*mex* that would work on the Sun system.

Note Stand-alone applications require that the MATLAB C/C++ Math Library be purchased for each platform where the Compiler-generated code will be executed. For more information, see the MATLAB C/C++ Math Library documentation.

Formatting Compiler-Generated Code

The formatting options allow you to control the look of the Compiler-generated C or C++ code. These options let you set the width of the generated code and the indentation levels for statements and expressions. To control code formatting, use

```
-F <option>
```

The remaining sections focus on the different choices you can use.

Listing All Formatting Options

To view a list of all available formatting options, use

```
mcc -F list …
```

Setting Page Width

Use the `page-width:`*n* option to set the maximum width of the generated code to *n*, an integer. The default is 80 columns wide, so not selecting any page width formatting option will automatically limit your columns to 80 characters.

Setting the page width to a desired value does not guarantee that all generated lines of code will not exceed that value. There are cases where, due to indentation perhaps, a variable name may not fit within the width limit. Since variable names cannot be split, they may extend beyond the set limit. Also, to maintain the syntactic integrity of the original M source, annotations included from the M source file are not wrapped.

Note When using `-A line:on`, which is the default with the MATLAB add-in for Visual Studio, the page width is set as large as possible to support source-level debugging and this setting is ignored.

Default Width

Not specifying a page width formatting option uses the default of 80. Using

```
mcc -x gasket
```

generates this code segment.

```
0         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

for (mclForStart(
               &viter__, mlfScalar(1), mclVa(numPoints, "numPoints"), NULL);
             mclForNext(&viter__, &i);
             ) {
            /*
             * startPoint = floor((corners(theRand(i),:)+startPoint)/2);
             */
            mlfAssign(
              &startPoint,
              mlfFloor(
                mclMrdivide(
                  mclPlus(
                    mclVe(
                      mlfIndexRef(
                        mclVsv(corners, "corners"),
                        "(?,?)",
                        mlfIndexRef(
                          mclVsv(theRand, "theRand"), "(?)", mclVsv(i, "i")),
                        mlfCreateColonIndex())),
                    mclVv(startPoint, "startPoint")),
                  mlfScalar(2))));
             .
             .
             .
```

Page Width = 40

This example specifies a page width of 40.

```
mcc -x -F page-width:40 gasket
```

The segment of generated code is

```
0         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

mlfAssign(
      &theImage,
      mlfZeros(
        mlfScalar(1000),
        mlfScalar(1000),
        NULL));
    /*
     *
     * corners = [866 1;1 500;866 1000];
     */
    mlfAssign(
```

```
    &corners,
    mlfDoubleMatrix(
      3,
      2,
      _array0_,
      (double *)NULL));
  /*
   * startPoint = [866 1];
   */
  mlfAssign(
    &startPoint,
    mlfDoubleMatrix(
      1,
      2,
      _array1_,
      (double *)NULL));
  /*
   * theRand = rand(numPoints,1);
   */
  mlfAssign(
    &theRand,
    mlfNRand(
      1,
      mclVa(numPoints, "numPoints"),
      mlfScalar(1),
      NULL));
  /*
   * theRand = ceil(theRand*3);
   */
  mlfAssign(
    &theRand,
    mlfCeil(
      mclMtimes(
        mclVv(theRand, "theRand"),
        mlfScalar(3))));

     .
     .
     .
```

Setting Indentation Spacing

Use the `statement-indent:n` option to set the indentation of all statements to `n`, an integer. The default is 4 spaces of indentation. To set the indentation for expressions, use `expression-indent:n`. This sets the number of spaces of indentation to `n`, an integer, and defaults to two spaces of indentation.

Default Indentation

Not specifying indent formatting options uses the default of four spaces for statements and two spaces for expressions. For example, using

```
mcc -x gasket
```

generates the following code segment.

```
0         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

void mlxGasket(int nlhs, mxArray * plhs[], int nrhs, mxArray * prhs[]) {
    mxArray * mprhs[1];
    mxArray * mplhs[1];
    int i;
    if (nlhs > 1) {
        mlfError(
          mxCreateString(
            "Run-time Error: File: gasket Line: 1 Column: "
            "1 The function \"gasket\" was called with mor"
            "e than the declared number of outputs (1)."));
    }
    if (nrhs > 1) {
        mlfError(
          mxCreateString(
            "Run-time Error: File: gasket Line: 1 Column: "
            "1 The function \"gasket\" was called with mor"
            "e than the declared number of inputs (1)."));
    }
    for (i = 0; i < 1; ++i) {
        mplhs[i] = mclGetUninitializedArray();
    }
    for (i = 0; i < 1 && i < nrhs; ++i) {
        mprhs[i] = prhs[i];
    }
    for (; i < 1; ++i) {
        mprhs[i] = NULL;
    }
    mlfEnterNewContext(0, 1, mprhs[0]);
    mplhs[0] = Mgasket(nlhs, mprhs[0]);
    mlfRestorePreviousContext(0, 1, mprhs[0]);
    plhs[0] = mplhs[0];
}
```

Modified Indentation

This example shows the same segment of code using a statement indentation of two and an expression indentation of one.

```
mcc -F statement-indent:2 -F expression-indent:1 -x gasket
```

generates the following code segment.

```
0         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

void mlxGasket(int nlhs, mxArray * plhs[], int nrhs, mxArray * prhs[]) {
  mxArray * mprhs[1];
  mxArray * mplhs[1];
  int i;
  if (nlhs > 1) {
    mlfError(
     mxCreateString(
      "Run-time Error: File: gasket Line: 1 Column: 1 The function \"gasket"
      "\" was called with more than the declared number of outputs (1)."));
  }
  if (nrhs > 1) {
    mlfError(
     mxCreateString(
      "Run-time Error: File: gasket Line: 1 Column: 1 The function \"gaske"
      "t\" was called with more than the declared number of inputs (1)."));
  }
  for (i = 0; i < 1; ++i) {
    mplhs[i] = mclGetUninitializedArray();
  }
  for (i = 0; i < 1 && i < nrhs; ++i) {
    mprhs[i] = prhs[i];
  }
  for (; i < 1; ++i) {
    mprhs[i] = NULL;
  }
  mlfEnterNewContext(0, 1, mprhs[0]);
  mplhs[0] = Mgasket(nlhs, mprhs[0]);
  mlfRestorePreviousContext(0, 1, mprhs[0]);
  plhs[0] = mplhs[0];
}
```

Including M-File Information in Compiler Output

The annotation options allow you to control the type of annotation in the Compiler-generated C or C++ code. These options let you include the comments and/or source code from the initial M-file(s) as well as `#line` preprocessor directives. You can also use an annotation option to generate source file and line number information when you receive run-time error messages. To control code annotation, use

```
-A <option>
```

You can combine annotation options, for example selecting both comments and `#line` directives. The remaining sections focus on the different choices you can use.

Controlling Comments in Output Code

Use the `annotation:type` option to include your initial M-file comments and code in your generated C or C++ output. The possible values for `type` are:

- `all`
- `comments`
- `none`

Not specifying any annotation type uses the default of `all`, which includes the complete source of the M-file (comments and code) interleaved with the generated C/C++ source.

The following sections show segments of the generated code from this simple Hello, World example.

```
function hello
% This is the hello, world function written in M code
        fprintf(1,'Hello, World\n' );
```

Comments Annotation

To include only comments from the source M-file in the generated output, use

```
mcc -A annotation:comments …
```

This code snippet shows the generated code containing only the comments.

Comments

```
static void Mhello(void) {
    mxArray * ans = mclGetUninitializedArray();
    /*
     * This is the hello, world function written in M code
     * $Revision: 1.1 $
     *
     */
    mclAssignAns(
      &ans,
      mlfNFprintf(0, mlfScalar(1), mxCreateString("Hello, World\\n"), NULL));
    mxDestroyArray(ans);
}
       .
       .
       .
```

All Annotation

To include both comments and source code from the source M-file in the generated output, use

```
mcc -A annotation:all …
```

or do not stipulate the annotation option, thus using the default of `all`.

The code snippet contains both comments and source code.

Comments

Code

```
static void Mhello(void) {
    mxArray * ans = mclGetUninitializedArray();
    /*
     * % This is the hello, world function written in M code
     * % $Revision: 1.1 $
     * %
     * fprintf(1,'Hello, World\n' );
     */
    mclAssignAns(
      &ans,
      mlfNFprintf(0, mlfScalar(1), mxCreateString("Hello, World\\n"), NULL));
    mxDestroyArray(ans);
}
       .
       .
       .
```

No Annotation

To include no source from the initial M-file in the generated output, use

```
mcc -A annotation:none …
```

This code snippet shows the generated code without comments and source code.

```
static void Mhello(void) {
    mxArray * ans = mclGetUninitializedArray();
    mclAssignAns(
      &ans,
      mlfNFprintf(0, mlfScalar(1), mxCreateString("Hello, World\\n"), NULL));
    mxDestroyArray(ans);
}
       .
       .
       .
```

Controlling #line Directives in Output Code

`#line` preprocessing directives inform a C/C++ compiler that the C/C++ code was generated by another tool (MATLAB Compiler) and they identify the correspondence between the generated code and the original source code (M-file). You can use the `#line` directives to help debug your M-file(s). Most C language debuggers can display your M-file source code. These debuggers allow you to set breakpoints, single step, and so on at the M-file code level when you use the `#line` directives.

Use the `line:setting` option to include `#line` preprocessor directives in your generated C or C++ output. The possible values for `setting` are:

- `on`
- `off`

Not specifying any `line` setting uses the default of `off`, which does not include any `#line` preprocessor directives in the generated C/C++ source.

Note When using the `#line` directive, the `page-width` directive is disabled in order to make the code work properly with the C debugger.

Include #line Directives

To include `#line` directives in your generated C or C++ code, use

```
mcc -A line:on …
```

The Hello, World example produces the following code segment when this option is selected.

```
.
Line 1  →   #line 1 "<matlab>\\extern\\examples\\compiler\\hello.m"
            static void Mhello(void) {
Line 1  →       #line 1 "<matlab>\\extern\\examples\\compiler\\hello.m"
                mxArray * ans = mclGetUninitializedArray();
                /*
                 * % This is the hello, world function written in M code
                 * % $Revision: 1.1 $
                 * %
                 * fprintf(1,'Hello, World\n' );
                 */
Line 5  →       #line 5 "<matlab>\\extern\\examples\\compiler\\hello.m"
                mclAssignAns(
Line 5  →         #line 5 "<matlab>\\extern\\examples\\compiler\\hello.m"
                  &ans,
Line 5  →         #line 5 "<matlab>\\extern\\examples\\compiler\\hello.m"
                  mlfNFprintf(0, mlfScalar(1), mxCreateString("Hello, World\\n"), NULL));
Line 5  →       #line 5 "<matlab>\\extern\\examples\\compiler\\hello.m"
                mxDestroyArray(ans);
Line 5  →       #line 5 "<matlab>\\extern\\examples\\compiler\\hello.m"
            }
                  .
                  .
                  .
```

In this example, Line 1 points to lines in the generated C code that were produced by line 1 from the M-file, that is

```
function hello
```

Line 5 points to lines in the C code that were produced by line 5 of the M-file, or

```
fprintf(1,'Hello, World\n' );
```

Controlling Information in Run-Time Errors

Use the `debugline:setting` option to include source filenames and line numbers in run-time error messages. The possible values for `setting` are:

- `on`
- `off`

Not specifying any `debugline` setting uses the default of `off`, which does not include filenames and line numbers in the generated run-time error messages.

For example, given the M-file, `tmmult.m`, which in MATLAB would produce the error message `Inner matrix dimensions must agree`

```
function tmmult
        a = ones(2,3);
        b = ones(4,5);

        y = mmult(a,b)

function y = mmult(a,b)
        y = a*b;
```

If you create a Compiler-generated MEX-file with the command

```
mcc -x tmmult
```

and run it, your results are

```
tmmult
??? Inner matrix dimensions must agree.

Error in ==> <matlab>\toolbox\compiler\tmmult.dll
```

The information about where the error occurred is not available. However, if you compile `tmmult.m` and use the `-A debugline:on` option as in

```
mcc -x -A debugline:on tmmult
```

your results are

File/line #

```
tmmult
Inner matrix dimensions must agree.
Error in File: "<matlab>\extern\examples\compiler\tmmult.m",
Function: "tmmult", Line: 5.

Error in ==> <matlab>\extern\examples\compiler\tmmult.dll
```

Note When using the `-A debugline:on` option, the `lasterr` function returns a string that includes the line number information. If, in your M-code, you compare against the string value of `lasterr`, you will get different behavior when using this option.

Since `try…catch…end` is not available in `g++`, do not use the `-A debugline:on` option on Linux when generating a C++ application.

Interfacing M-Code to C/C++ Code

The MATLAB Compiler 2.1 supports calling arbitrary C/C++ functions from your M-code. You simply provide an M-function stub that determines how the code will behave in M, and then provide an implementation of the body of the function in C or C++.

C Example

Suppose you have a C function that reads data from a measurement device. In M-code, you want to simulate the device by providing a sine wave output. In production, you want to provide a function that returns the measurement obtained from the device. You have a C function called `measure_from_device()` that returns a `double`, which is the current measurement.

`collect.m` contains the M-code for the simulation of your application.

```
function collect

y = zeros(1, 100); %Pre-allocate the matrix
for i = 1:100
   y(i) = collect_one;
end

function y = collect_one

persistent t;
if (isempty(t))
   t = 0;
end
t = t + 0.05;
y = sin(t);
```

The next step is to replace the implementation of the `collect_one` function with a C implementation that provides the correct value from the device each time it is requested. This is accomplished by using the `%#external` pragma.

The `%#external` pragma informs the MATLAB Compiler that the implementation version of the function (`M`*f*) will be hand written and will not be generated from the M-code. This pragma affects only the single function in which it appears. Any M-function may contain this pragma (local, global, private, or method). When using this pragma, the Compiler will generate an additional header file called *file*_external.h or *file*_external.hpp, where *file* is the name of the initial M-file containing the %#external pragma. This header file will contain the extern declaration of the function that the user must provide. This function must conform to the same interface as the Compiler-generated code.

The Compiler will still generate a .c or .cpp file from the .m file in question. The Compiler will generate the feval table, which includes the function and all of the required interface functions for the M-function, but the body of M-code from that function will be ignored. It will be replaced by the hand-written code. The Compiler will generate the interface for any functions that contain the %#external pragma into a separate file called *file*_external.h or *file*_external.hpp. The Compiler-generated C or C++ file will include this header file to get the declaration of the function being provided.

In this example, place the pragma in the collect_one local function.

```
function collect

y = zeros(1, 100); % pre-allocate the matrix
for i = 1:100
   y(i) = collect_one;
end

function y = collect_one

%#external
persistent t;
if (isempty(t))
   t = 0;
end
t = t + 0.05;
end
y = sin(t);
```

When this file is compiled, the Compiler creates the additional header file collect_external.h, which contains the interface between the Compiler-generated code and your code. In this example, it would contain

```
extern mxArray *Mcollect_collect_one( int nargout_ );
```

We recommend that you include this header file when defining the function. This function could be implemented in this C file, `measure.c`, using the `measure_from_device()` function.

```
#include "matlab.h"
#include "collect_external.h"
#include <math.h>

extern double measure_from_device(void);

mxArray *Mcollect_collect_one( int nargout_ )
{
   return( mlfScalar( measure_from_device() ));
}
double measure_from_device(void)
{
   static double t = 0.0;
   t = t + 0.05;
   return sin(t);
}
```

In general, the Compiler will use the same interface for this function as it would generate. To generate the C code and header file, use

```
mcc -c collect.m
```

By examining the Compiler-generated C code, you should easily be able to determine how to implement this interface. To compile `collect.m` to a MEX-file, use

```
mcc -x collect.m measure.c
```

Using Pragmas

Using feval

In stand-alone C and C++ modes, the pragma

```
%#function <function_name-list>
```

informs the MATLAB Compiler that the specified function(s) will be called through an `feval` call or through a MATLAB function that accepts a function to `feval` as an argument or contains an `eval` string or Handle Graphics callback that references the specified function. Without this pragma, the `-h` option will not be able to locate and compile all M-files used in your application.

If you are using the `%#function` pragma to define functions that are not available in M-code, you must write a dummy M-function that identifies the number of input and output parameters to the M-file function with the same name used on the `%#function` line. For example,

```
%#function myfunctionwritteninc
```

This implies that `myfunctionwritteninc` is an M-function that will be called using `feval`. The Compiler will look up this function to determine the correct number of input and output variables. Therefore, you need to provide a dummy M-function that contains a function line, such as

```
function y = myfunctionwritteninc( a, b, c );
```

and includes the `%#external` pragma. This statement indicates that the function takes three inputs (`a`, `b`, `c`) and returns a single output variable (`y`). No other lines need to be present in the M-function.

Compiling MEX-Files

If the Compiler finds both a function M-file and a `.mex` file in the same directory, it will assume that the `.mex` file is the compiled version of the M-file. In those cases, if the M-file version is not desired, use the `%#mex` pragma to force the Compiler to use the MEX-file. For example,

```
function y = gamma(x)
    %#mex
    error('gamma MEX-file is missing');
```

Print Handlers

A print handler is a routine that controls how your application displays the output generated by calls to `mlf` routines.

The system provides a default print handler for your application. The default print handler writes output to the standard output stream. If this print handler is suitable for your application, you do not need to write and register another print handler.

However, you can override the default behavior by writing and registering an alternative print handler. In fact, if you are coding a stand-alone application with a GUI, then you *must* register another print handler to display application output inside a GUI mechanism, such as a Windows message box or a Motif Label widget.

You write an alternative print handler routine in C or C++ and register its name at the beginning of your stand-alone application.

The way you register a print handler depends on whether or not “the `main` routine” (or first routine called) for your application is written in C or in M.

Note The print handlers and registration functions discussed in this section are written for C applications. Although they will work in C++ applications, we recommend that you use a C++ print handler and the C++ registration routine `mwSetPrintHandler()` for C++ applications. See the *MATLAB C++ Math Library User's Guide* for details about C++ print handlers.

Main Routine Written in C

If your main routine is coded in C (as opposed to being written as an M-file), you must:

- Register a print handler in your main routine.
- Write the print handler.

This section references source code from a sample stand-alone application written for Microsoft Windows. The main routine `WinMain` is written in C. The source code illustrates how to register and write a print handler.

The application is built from two files:

- `mrankwin.c`, which contains `WinMain`, `WinPrint` (the print handler), and a related function `WinFlush`
- The MATLAB Compiler C translation of `mrank.m`

Both `mrankwin.c` and `mrank.m` are located in the `<matlab>/extern/examples/compiler/` directory of your installation.

The `WinMain` routine in `mrankwin.c` is straightforward:

- It registers a print handler.
- It assigns an integer input from the command line to a scalar array, or defaults the contents of the array to 12.
- It passes that array to `mlfMrank`, which determines the rank of the magic squares from 1 to n.
- It prints the array returned by `mlfMrank`.

The first and last items in this list refer to print handlers.

Registering a Print Handler

To register a print handler routine, call the MATLAB C Math Library routine `mlfSetPrintHandler` as the first executable line in `WinMain` (or `main`). `mlfSetPrintHander` takes a single argument, a pointer to a print handler function.

For example, the first line of `WinMain` in `mrankwin.c` registers the print handler routine named `WinPrint` by calling `mlfSetPrintHandler`.

```
mlfSetPrintHandler(WinPrint);
```

Writing a Print Handler

Whenever an `mlf` function within a stand-alone application makes a request to write data, the application automatically intercepts the request and calls the registered print handler, passing the text to be displayed. In fact, the application calls the print handler once for *every* line of data to be output.

The print handler that you write must:

- Take a single argument of type `const char *` that points to the text to be displayed.
- Return `void`.

The print handler routine `WinPrint` in the example program illustrates one possible approach to writing a print handler for a Windows program.

When the example `WinMain` routine prints the array returned by `mlfMrank`,

```
mlfPrintMatrix(R);
```

the registered print handler, `WinPrint`, is called. If array `R` contains a 12-row result from the call to `mlfMrank`, the application calls `WinPrint` 12 times, each time passing the next line of data. The print handler `WinPrint` dynamically allocates a buffer to hold the printable contents of array `R` and appends each text string passed to it to the buffer.

In this design, the print handler prints to a buffer rather than the screen. A companion function `WinFlush` actually displays the 12 lines of data in a Windows message box.

In the example, `WinMain` calls `WinFlush` immediately following the call to `mlfPrintMatrix`.

```
mlfPrintMatrix(R);
WinFlush();
```

Though `WinFlush` is not part of the print handler, this implementation of a print handler requires that you call `WinFlush` after any `mlf` function that causes a series of calls to the print handler. For this short program, this design is appropriate.

Here is the source code from `mrankwin.c` for `WinPrint` and `WinFlush`. It includes:

- The static, global variables used by the two routines

```
static int totalcnt  = 0;
static int upperlim  = 0;
static int firsttime = 1;
char *OutputBuffer;
```

- The print handler routine itself that deposits the text passed to it in an output buffer

```
void WinPrint( char *text)
{
        int cnt;

        /* Allocate a buffer for the output */
        if (firsttime) {
                OutputBuffer = (char *)mxCalloc(1028, 1);
                upperlim += 1028;
                firsttime = 0;
        }

        /* Make sure there’s enough room in the buffer */
        cnt = strlen(text);
        while (totalcnt + cnt >= upperlim) {
                char *TmpOut;
                upperlim += 1028;
              TmpOut = (char *)mxRealloc(OutputBuffer, upperlim);
                if (TmpOut != NULL)
                    OutputBuffer = TmpOut;
        }

        /* Concatenate the next line of text */
        strncat(OutputBuffer, text, cnt);

       /* Update the number of characters stored in the buffer */
        totalcnt += cnt;
}
```

- The related function `WinFlush` that actually displays the text from the output buffer in a Windows message box.

```
void WinFlush(void)
{
        MessageBox(NULL, OutputBuffer, "MRANK", MB_OK);
        mxFree(OutputBuffer);
}
```

For more details on `mlfPrintMatrix`, see the *MATLAB C Math Library User's Guide.*

Main Routine Written in M-Code

If your main routine is an M-file, you must:

- Write a print handler in C.
- Register the print handler in your main M-file.

Registering the print handler requires several steps, some performed in C and some in M-code. To register a print handler from your main M-file, you call a dummy print handler initialization function written in M-code. The MATLAB Compiler translates that call into a call to the actual print handler initialization function written in C or C++.

To set up for this translation, you must write two print handler initialization functions:

- A print handler initialization function in C or C++ that registers the print handler
- A dummy print handler initialization routine in M-code that does nothing (the body of the function is empty) except enable the MATLAB Compiler to make the proper translation

You call the dummy print handler initialization function from your main M-file. The MATLAB Compiler translates that call into a call to your print handler initialization function written in C or C++.

Example Files

In this example, two M-files and one C file are built into a stand-alone application. The main routine is `mr.m`.

- `mr.m` contains the main M routine.

```
function mr(m)
initprnt
m=str2num(m);
r=mrank(m);
r

function initprnt
%#external
```

- `mrank.m` determines the rank of the magic squares from 1 to `n`.

```
function r = mrank(n)
r = zeros(n, 1);
for k = 1:n
   r(k) = rank(magic(k));
end
```

- `myph.c` contains the print handler and the print handler initialization routine, in that order. In the example, this C file is written by the user.

```
#include "matlab.h"
#include “mr_external.h”
static void myPrintHandler(const char *s)
{
   printf("%s\n",s);
}

void Mmr_initprnt(void)
{
   mlfSetPrintHandler(myPrintHandler);
}
```

Writing the Print Handler in C/C++

First, write a print handler in C following the standard rules for a print handler: it must take one argument of type `const char *s` and return `void`.

The print handler in this example is very simple.

```
static void myPrintHandler(const char *s)
{
   printf("%s\n",s);
}
```

The file `myph.c` contains this code.

Registering the Print Handler

Registering the print handler requires several steps, some performed in C and some in M. Be careful to name your C and M print handler initialization functions according to the rules presented below. Otherwise, the correspondence between the two is missing.

Naming the Print Handler Initialization Routine in C. When you write the print handler initialization routine in C, you must follow the naming convention used by the MATLAB C Math Library. This name will appear in a header file that is generated by the MATLAB Compiler when it compiles the stub M-function, `initprnt` in this example. See the earlier section, "Interfacing M-Code to C/C++ Code," for more information.

You should include this Compiler-generated header file when you define the C function. For example, the print handler initialization routine developed here is called `MInitprnt` and is found in `mr_external.h`.

Naming the Dummy Print Handler Initialization Routine in M-Code. When you name the dummy print handler initialization routine in M-code, you must name it after the base part of the actual print handler initialization routine (the one written in C or C++).

For example, the dummy print handler initialization routine shown here is called `initprnt`.

Writing the Initialization Routine in C. First, write the print handler initialization routine in C. All print handler initialization functions register the name of the print handler function by calling `mlfSetPrintHandler`, passing a pointer to the print handler (the function name) as an argument.

Your initialization function must take no arguments and return `void`. For example,

```
void Mmr_initprnt(void)
{
   mlfSetPrintHandler(myPrintHandler);
}
```

The file `myph.c` contains this code.

Writing a Dummy Initialization Function in M-Code. Next, write the dummy print handler initialization routine in M-code. The body of this function is empty, but without the function declaration, the MATLAB Compiler can't successfully translate the call to `initprnt` in M-code into a call to `MInitprnt()` in C.

The function can be placed in the same M-file that defines the main `mr.m` in this example. It is declared as `function initprnt` and contains the `%#external` pragma.

Initializing the Print Handler in Your Main M-File. Call the dummy print handler initialization routine in the first executable line of your main M-file. For example, in `mr.m` the call to `initprnt` immediately follows the function declaration.

```
function mr(m)
initprnt;          % Call print handler initialization routine

m=str2num(m);

r=mrank(m)

function initprnt
%#external
```

Building the Executable

You must compile `myph.c` with one of the supported C compilers, and you must ensure that the resulting object file is linked into the stand-alone application. To build the C stand-alone executable, at the DOS/UNIX prompt type

```
mcc -t -L C -W main -T link:exe mr.m mrank.m myph.c
```

Testing the Executable

Run the executable by typing at the MATLAB prompt

```
mr 5
```

The output displays as

```
r =

     1

     2

     3

     3

     5
```

6

Optimizing Performance

The MATLAB Compiler can perform several different optimizations on your M-file source code that can make the performance of the generated C/C++ code much faster than the performance of the M-code in the MATLAB interpreter.

Compiler 2.1 provides a series of optimizations that can help speed up your compiled code. The optimizations improve performance when:

- Your code manipulates scalar or nonscalar arrays.
- Your code contains simple one- and two-dimensional array indexing.
- Your code contains loops that start and increment with integers.
- Your code contains conditional expressions where bother operands are integers.

The only times you would choose not to optimize are if you are debugging your code or you want to maintain the readability of your code.

Optimization Bundles

All optimizations are controlled separately, and you can enable or disable any of the optimizations. To simplify the process, you can use the provided bundles of Compiler settings that allow you to select the most common optimization options. For more information on bundles, see "-B <filename> (Bundle of Compiler Settings)" on page 7-43.

Turn On All Optimizations

To turn on all optimizations, use

```
-O all
```

This bundle is stored in `<matlab>/toolbox/compiler/bundles/opt_bundle_all`. By default, all optimizations are on unless you specifically disable them or use the `-g` option for debugging. The `-g` option disables all optimizations.

Turn Off All Optimizations

To turn off all optimizations, use

```
-O none
```

This bundle is stored in `<matlab>/toolbox/compiler/bundles/opt_bundle_none`. This optimization setting is used whenever you use `-g` for debugging.

Turn On Individual Optimizations

You can enable or disable each individual optimization. To enable/disable an optimization, use

```
-O <optimization option>:[on|off]
```

where `<optimization option>` is:

- `fold_scalar_mxarrays`
- `fold_non_scalar_mxarrays`
- `array_indexing`
- `optimize_integer_for_loops`
- `optimize_conditionals`

List All Optimizations

To list all available optimizations, use

```
-O list
```

Optimizing Arrays

Scalar Arrays

(`fold_scalar_mxarrays`) When this optimization is enabled, all constant, scalar-valued array operations are *folded* at compile time and are stored in a constant pool that is created once at program initialization time. Folding reduces the number of computations that are performed at runtime, thus improving runtime performance.

Scalar folding can dramatically improve the performance of code that is manipulating scalar arrays, but it makes the code less readable. For example,

```
function y = foo(x)
y = 2*pi*x;
```

If you compile this with the `-O none` option, you get

```
...
mlfAssign(&y, mclMtimes(mlfScalar(6.283185307179586),
          mclVa(x, "x")));
...
```

Compiling with `-O none -O fold_scalar_mxarrays:on`, gives

```
...
mlfAssign(&y, mclMtimes(_mxarray0_, mclVa(x, "x")));
...
```

In the optimized case, this code uses `_mxarray0_`, which is initialized at program start-up to hold the correct value. All constants with the same value use the same `mxArray` variable in the constant pool.

Nonscalar Arrays

(`fold_non_scalar_mxarrays`) This optimization is very similar to `fold_scalar_mxarrays`. It folds nonscalar `mxArray` values into compile-time arrays that are initialized at program start-up. This can have a large performance impact if you are constructing arrays that use `[]` or `{}` within a loop. This optimization makes the code less readable. For example,

```
function y = test
y = [ 1 0; 0 1] * [ pi pi/2; -pi -pi/2 ];
```

If you compile this with the `-O none` option, you get

```
...
mlfAssign(
  &y,
  mclMtimes(
    mlfDoubleMatrix(2, 2, _array0_, (double *)NULL),
    mlfDoubleMatrix(2, 2, _array1_, (double *)NULL)));
...
```

Compiling with `-O none -O fold_non_scalar_mxarrays:on` gives

```
...
mlfAssign(&y, _mxarray0_);
...
```

Optimizing Loops

Simple Indexing

(array_indexing) This optimization improves the performance of simple one- and two-dimensional array index expressions. Without this optimization, all array indexing uses the fully general array indexing function, which is not optimized for one- and two-dimensional indexing. With this optimization enabled, indexing uses faster routines that are optimized for simple indexing. For example,

```
function y = test(x,i1,i2);
y = x(i1,i2);
```

If you compile this with the -O none option, you get

```
...
mlfAssign(
  &y,
  mlfIndexRef(mclVsa(x, "x"), "(?,?)", mclVsa(i1, "i1"),
              mclVsa(i2, "i2")));
...
```

Compiling with -O none -O array_indexing:on gives

```
...
mlfAssign(
  &y, mclArrayRef2(mclVsa(x, "x"), mclVsa(i1, "i1"),
                   mclVsa(i2,"i2")));
...
```

The mclArrayRef2 function is optimized for two-dimensional indexing. mclArrayRef1 is used for one-dimensional indexing.

Loop Simplification

(optimize_integer_for_loops) This optimization detects when a loop starts and increments with integers and replaces the loop with a much simpler loop that uses C integer variables instead of array valued variables. The performance improvements with this optimization can be dramatic.

Note This optimization causes the variable names in the resulting C program to differ from those in the M-file. Therefore, it is recommended that you do not use this option when debugging.

For example,

```
function test(x)
for i = 1:length(x)-1
   x(i) = x(i) + x(i+1)
end
```

If you compile this with the `-O none` option, you get

```
...
{
    mclForLoopIterator viter__;
    for (mclForStart(
           &viter__,
           mlfScalar(1),
           mclMinus(mclVe(mlfLength(mclVa(x, "x"))),
           mlfScalar(1)), NULL);
         mclForNext(&viter__, &i);
         ) {
         ...
    }
    mclDestroyForLoopIterator(viter__);
}
...
```

Compiling with `-O none -O optimize_integer_for_loops:on` gives

```
...
{
    int v_ = mclForIntStart(1);
    int e_ = mclForIntEnd(mlfScalar(mclLengthInt(mclVa(x, "x"))
             - 1));
    if (v_ > e_) {
        mlfAssign(&i, _mxarray0_);
    } else {
```

```
...
        for (; ; ) {
          ...
            if (v_ == e_) {
                break;
            }
            ++v_;
        }
        mlfAssign(&i, mlfScalar(v_));
    }
...
```

Optimizing Conditionals

(optimize_conditionals) This optimization reduces the MATLAB conditional operators to scalar C conditional operators when both operands are known to be integer scalars. The Compiler "knows" that nargin, nargout, and for loop control variables (when using the above optimization) are integer scalars. For example,

```
function test(a,b,c,d)
   if (nargin < 4)
       d = 0.0;
end
```

If you compile this with the -O none option, you get

```
...
if (mlfTobool(mclLt(mlfScalar(nargin_), mlfScalar(4)))) {
...
```

Compiling with -O none -O optimize_conditionals:on gives

```
...
if (nargin_ < 4) {
...
```

7

Reference

This chapter provides reference information for the MATLAB Compiler pragmas, functions, and command line tools.

Pragmas	
`%#external`	Call arbitrary C/C++ functions.
`%#function`	`feval` pragma.
`%#mex`	Prefer the MEX-file over an existing M-file.

Functions	
`mbchar`	Impute `char` matrix.
`mbcharscalar`	Impute character scalar.
`mbcharvector`	Impute `char` vector.
`mbint`	Impute integer.
`mbintscalar`	Impute integer scalar.
`mbintvector`	Impute integer vector.
`mbreal`	Impute real.
`mbrealscalar`	Impute real scalar.
`mbrealvector`	Impute real vector.
`mbscalar`	Impute scalar.
`mbvector`	Impute vector.
`reallog`	Natural log.
`realpow`	Array power function.
`realsqrt`	Square root.

Command Line Tools	
`mbuild`	Customize building and linking.
`mcc`	Invoke MATLAB Compiler.
MATLAB Compiler Options Flags	Introduces Compiler options.
Macro Options	Simplify basic compilation tasks.
Code Generation Options	Control Compiler output.
Optimization Options	Improves the performance of the generated C/C++ code.
Compiler and Environment Options	Control Compiler behavior.
`mbuild`/`mex` Options	Control `mbuild` and `mex`.

Pragmas

Pragmas are compiler-specific commands that provide special information to the Compiler. This section contains the reference pages for the MATLAB Compiler pragmas, `%#external`, `%#function`, and `%#mex`.

Purpose Pragma to call arbitrary C/C++ functions from your M-code.

Syntax `%#external`

Description The `%#external` pragma informs the Compiler that the implementation version of the function (`M`*f*) will be hand written and will not be generated from the M-code. This pragma affects only the single function in which it appears, and any M-function may contain this pragma (local, global, private, or method).

When using this pragma, the Compiler will generate an additional header file called *file*`_external.h` or *file*`_external.hpp`, where *file* is the name of the initial M-file containing the `%#external` pragma. This header file will contain the `extern` declaration of the function that the user must provide. This function must conform to the same interface as the Compiler-generated code. For more information on the `%#external` pragma, see “Interfacing M-Code to C/C++ Code” in Chapter 5.

%#function

Purpose `feval` pragma.

Syntax `%#function <function_name-list>`

Description This pragma informs the MATLAB Compiler that the specified function(s) will be called through an `feval`, `eval`, or handle graphics callback. You need to specify this pragma only to assist the Compiler in locating and automatically compiling the set of functions when using the `-h` option.

If you are using the `%#function` pragma to define functions that are not available in M-code, you should use the `%#external` pragma to define the function. For example,

```
%#function myfunctionwritteninc
```

This implies that `myfunctionwritteninc` is an M-function that will be called using `feval`. The Compiler will look up this function to determine the correct number of input and output variables. Therefore, you need to provide a dummy M-function that contains a function line and a `%#external` pragma, such as

```
function y = myfunctionwritteninc( a, b, c );
%#external
```

The `function` statement indicates that the function takes three inputs (`a`, `b`, `c`) and returns a single output variable (`y`). No additional lines need to be present in the M-file.

Purpose `mex` pragma.

Syntax `%#mex`

Description This pragma informs the MATLAB Compiler to select the MEX-file over an existing M-file.

If you are using the `%#function` pragma to define functions that are not available in M-code, you should use the `%#external` pragma to define the function. For example,

```
function y = gamma(x)
   %#mex
   error('gamma MEX-file is missing');
```

Functions

This section contains the reference pages for the Compiler functions. Many of these functions are included to maintain backward compatibility with previous versions of the Compiler.

Note In Compiler 2.1, the functions `mbchar`, `mbcharscalar`, `mbcharvector`, `mbint`, `mbintscalar`, `mbintvector`, `mbreal`, `mbrealscalar`, `mbrealvector`, `mbscalar`, and `mbvector` are not used for type imputation, but rather to test if values are a specific data type.

Purpose

Assert variable is a MATLAB character string.

Syntax

```
mbchar(x)
```

Description

The statement

```
mbchar(x)
```

causes the MATLAB Compiler to impute that `x` is a `char` matrix. At runtime, if `mbchar` determines that `x` does not hold a `char` matrix, `mbchar` issues an error message and halts execution of the MEX-file.

`mbchar` tells the MATLAB interpreter to check whether `x` holds a `char` matrix. If `x` does not, `mbchar` issues an error message and halts execution of the M-file. The MATLAB interpreter does not use `mbchar` to impute `x`.

Note that `mbchar` only tests `x` at the point in an M-file or MEX-file where an `mbchar` call appears. In other words, an `mbchar` call tests the value of `x` only once. If `x` becomes something other than a `char` matrix after the `mbchar` test, `mbchar` cannot issue an error message.

A `char` matrix is any scalar, vector, or matrix that contains only the `char` data type.

Example

This code in MATLAB causes `mbchar` to generate an error message because `n` does not contain a `char` matrix.

```
n = 17;
mbchar(n);
??? Error using ==> mbchar
Argument to mbchar must be of class 'char'.
```

See Also

`mbcharvector`, `mbcharscalar`, `mbreal`, `mbscalar`, `mbvector`, `mbintscalar`, `mbintvector`, `mcc`

Purpose

Assert variable is a character scalar.

Syntax

```
mbcharscalar(x)
```

Description

The statement

```
mbcharscalar(x)
```

causes the MATLAB Compiler to impute that `x` is a character scalar, i.e., an unsigned short variable. At runtime, if `mbcharscalar` determines that `x` holds a value other than a character scalar, `mbcharscalar` issues an error message and halts execution of the MEX-file.

`mbcharscalar` tells the MATLAB interpreter to check whether `x` holds a character scalar value. If `x` does not, `mbcharscalar` issues an error message and halts execution of the M-file. The MATLAB interpreter does not use `mbcharscalar` to impute `x`.

Note that `mbcharscalar` only tests `x` at the point in an M-file or MEX-file where an `mbcharscalar` call appears. In other words, an `mbcharscalar` call tests the value of `x` only once. If `x` becomes a vector after the `mbcharscalar` test, `mbcharscalar` cannot issue an error message.

`mbcharscalar` defines a character scalar as any value that meets the criteria of both `mbchar` and `mbscalar`.

Example

This code in MATLAB generates an error message.

```
n = ['hello' 'world'];
mbcharscalar(n)
??? Error using ==> mbscalar
Argument of mbscalar must be scalar.
```

See Also

`mbchar`, `mbcharvector`, `mbreal`, `mbscalar`, `mbvector`, `mbintscalar`, `mbintvector`, `mcc`

Purpose Assert variable is a character vector, i.e., a MATLAB string.

Syntax

```
mbcharvector(x)
```

Description The statement

```
mbcharvector(x)
```

causes the MATLAB Compiler to impute that x is a char vector. At runtime, if mbcharvector determines that x holds a value other than a char vector, mbcharvector issues an error message and halts execution of the MEX-file.

mbcharvector tells the MATLAB interpreter to check whether x holds a char vector value. If x does not, mbcharvector issues an error message and halts execution of the M-file. The MATLAB interpreter does not use mbcharvector to impute x.

Note that mbcharvector only tests x at the point in an M-file or MEX-file where an mbcharvector call appears. In other words, an mbcharvector call tests the value of x only once. If x becomes something other than a char vector after the mbcharvector test, mbcharvector cannot issue an error message.

mbcharvector defines a char vector as any value that meets the criteria of both mbchar and mbvector. Note that mbcharvector considers char scalars as char vectors as well.

Example This code in MATLAB causes mbcharvector to generate an error message because, although n is a vector, n contains one value that is not a char.

```
n = [1:5];
mbcharvector(n)
??? Error using ==> mbchar
Argument to mbchar must be of class 'char'.
```

See Also mbchar, mbcharscalar, mbreal, mbscalar, mbvector, mbintscalar, mbintvector, mcc

mbint

Purpose Assert variable is integer.

Syntax `mbint(n)`

Description The statement

```
mbint(x)
```

causes the MATLAB Compiler to impute that `x` is an integer. At runtime, if `mbint` determines that `x` holds a noninteger value, the generated code issues an error message and halts execution of the MEX-file.

`mbint` tells the MATLAB interpreter to check whether `x` holds an integer value. If `x` does not, `mbint` issues an error message and halts execution of the M-file. The MATLAB interpreter does not use `mbint` to impute a data type to `x`.

Note that `mbint` only tests `x` at the point in an M-file or MEX-file where an `mbint` call appears. In other words, an `mbint` call tests the value of `x` only once. If `x` becomes a noninteger after the `mbint` test, `mbint` cannot issue an error message.

`mbint` defines an integer as any scalar, vector, or matrix that contains only integer or string values. For example, `mbint` considers `n` to be an integer because all elements in `n` are integers.

```
n = [5 7 9];
```

If even one element of `n` contains a fractional component, for example,

```
n = [5 7 9.2];
```

then `mbint` assumes that `n` is not an integer.

`mbint` considers all strings to be integers.

If `n` is a complex number, then `mbint` considers `n` to be an integer if both its real and imaginary parts are integers. For example, `mbint` considers the value of `n` an integer.

```
n = 4 + 7i
```

`mbint` does not consider the value of `x` an integer because one of the parts (the imaginary) has a fractional component.

```
x = 4 + 7.5i;
```

Example

This code in MATLAB causes `mbint` to generate an error message because `n` does not hold an integer value.

```
n = 17.4;
mbint(n);
??? Error using ==> mbint
Argument to mbint must be integer.
```

See Also

`mbintscalar`, `mbintvector`, `mcc`

mbintscalar

Purpose Assert variable is integer scalar.

Syntax `mbintscalar(n)`

Description The statement

```
mbintscalar(x)
```

causes the MATLAB Compiler to impute that `x` is an integer scalar. At runtime, if `mbintscalar` determines that `x` holds a value other than an integer scalar, `mbintscalar` issues an error message and halts execution of the MEX-file.

`mbintscalar` tells the MATLAB interpreter to check whether `x` holds an integer scalar value. If `x` does not, `mbintscalar` issues an error message and halts execution of the M-file. The MATLAB interpreter does not use `mbintscalar` to impute `x`.

Note that `mbintscalar` only tests `x` at the point in an M-file or MEX-file where an `mbintscalar` call appears. In other words, an `mbintscalar` call tests the value of `x` only once. If `x` becomes a vector after the `mbintscalar` test, `mbintscalar` cannot issue an error message.

`mbintscalar` defines an integer scalar as any value that meets the criteria of both `mbint` and `mbscalar`.

Example This code in MATLAB causes `mbintscalar` to generate an error message because, although `n` is a scalar, `n` does not hold an integer value.

```
n = 4.2;
mbintscalar(n)
??? Error using ==> mbint
Argument to mbint must be integer.
```

See Also `mbint`, `mbscalar`, `mcc`

Purpose

Assert variable is integer vector.

Syntax

`mbintvector(n)`

Description

The statement

```
mbintvector(x)
```

causes the MATLAB Compiler to impute that `x` is an integer vector. At runtime, if `mbintvector` determines that `x` holds a value other than an integer vector, `mbintvector` issues an error message and halts execution of the MEX-file.

`mbintvector` tells the MATLAB interpreter to check whether `x` holds an integer vector value. If `x` does not, `mbintvector` issues an error message and halts execution of the M-file. The MATLAB interpreter does not use `mbintvector` to impute `x`.

Note that `mbintvector` only tests `x` at the point in an M-file or MEX-file where an `mbintvector` call appears. In other words, an `mbintvector` call tests the value of `x` only once. If `x` becomes a two-dimensional matrix after the `mbintvector` test, `mbintvector` cannot issue an error message.

`mbintvector` defines an integer vector as any value that meets the criteria of both `mbint` and `mbvector`. Note that `mbintvector` considers integer scalars to be integer vectors as well.

Example

This code in MATLAB causes `mbintvector` to generate an error message because, although all the values of `n` are integers, `n` is a matrix rather than a vector.

```
n = magic(2)
n =
     1     3
     4     2
mbintvector(n)
??? Error using ==> mbvector
Argument to mbvector must be a vector.
```

See Also

`mbint`, `mbvector`, `mbintscalar`, `mcc`

mbreal

Purpose Assert variable is real.

Syntax `mbreal(n)`

Description The statement

```
mbreal(x)
```

causes the MATLAB Compiler to impute that `x` is real (not complex). At runtime, if `mbreal` determines that `x` holds a complex value, `mbreal` issues an error message and halts execution of the MEX-file.

`mbreal` tells the MATLAB interpreter to check whether `x` holds a real value. If `x` does not, `mbreal` issues an error message and halts execution of the M-file. The MATLAB interpreter does not use `mbreal` to impute `x`.

Note that `mbreal` only tests `x` at the point in an M-file or MEX-file where an `mbreal` call appears. In other words, an `mbreal` call tests the value of `x` only once. If `x` becomes complex after the `mbreal` test, `mbreal` cannot issue an error message.

A real value is any scalar, vector, or matrix that contains no imaginary components.

Example This code in MATLAB causes `mbreal` to generate an error message because `n` contains an imaginary component.

```
n = 17 + 5i;
mbreal(n);
??? Error using ==> mbreal
Argument to mbreal must be real.
```

See Also `mbrealscalar`, `mbrealvector`, `mcc`

Purpose Assert variable is real scalar.

Syntax `mbrealscalar(n)`

Description The statement

```
mbrealscalar(x)
```

causes the MATLAB Compiler to impute that `x` is a real scalar. At runtime, if `mbrealscalar` determines that `x` holds a value other than a real scalar, `mbrealscalar` issues an error message and halts execution of the MEX-file.

`mbrealscalar` tells the MATLAB interpreter to check whether `x` holds a real scalar value. If `x` does not, `mbrealscalar` issues an error message and halts execution of the M-file. The MATLAB interpreter does not use `mbrealscalar` to impute `x`.

Note that `mbrealscalar` only tests `x` at the point in an M-file or MEX-file where an `mbrealscalar` call appears. In other words, an `mbrealscalar` call tests the value of `x` only once. If `x` becomes a vector after the `mbrealscalar` test, `mbrealscalar` cannot issue an error message.

`mbrealscalar` defines a real scalar as any value that meets the criteria of both `mbreal` and `mbscalar`.

Example This code in MATLAB causes `mbrealscalar` to generate an error message because, although `n` contains only real numbers, `n` is not a scalar.

```
n = [17.2 15.3];
mbrealscalar(n)
??? Error using ==> mbscalar
Argument of mbscalar must be scalar.
```

See Also `mbreal`, `mbscalar`, `mbrealvector`, `mcc`

mbrealvector

Purpose Assert variable is a real vector.

Syntax `mbrealvector(n)`

Description The statement

```
mbrealvector(x)
```

causes the MATLAB Compiler to impute that `x` is a real vector. At runtime, if `mbrealvector` determines that `x` holds a value other than a real vector, `mbrealvector` issues an error message and halts execution of the MEX-file.

`mbrealvector` tells the MATLAB interpreter to check whether `x` holds a real vector value. If `x` does not, `mbrealvector` issues an error message and halts execution of the M-file. The MATLAB interpreter does not use `mbrealvector` to impute `x`.

Note that `mbrealvector` only tests `x` at the point in an M-file or MEX-file where an `mbrealvector` call appears. In other words, an `mbrealvector` call tests the value of `x` only once. If `x` becomes complex after the `mbrealvector` test, `mbrealvector` cannot issue an error message.

`mbrealvector` defines a real vector as any value that meets the criteria of both `mbreal` and `mbvector`. Note that `mbrealvector` considers real scalars to be real vectors as well.

Example This code in MATLAB causes `mbrealvector` to generate an error message because, although `n` is a vector, `n` contains one imaginary number.

```
n = [5 2+3i];
mbrealvector(n)
??? Error using ==> mbreal
Argument to mbreal must be real.
```

See Also `mbreal`, `mbrealscalar`, `mbvector`, `mcc`

mbscalar

Purpose Assert variable is scalar.

Syntax `mbscalar(n)`

Description The statement

```
mbscalar(x)
```

causes the MATLAB Compiler to impute that `x` is a scalar. At runtime, if `mbscalar` determines that `x` holds a nonscalar value, `mbscalar` issues an error message and halts execution of the MEX-file.

mbscalar tells the MATLAB interpreter to check whether `x` holds a scalar value. If `x` does not, `mbscalar` issues an error message and halts execution of the M-file. The MATLAB interpreter does not use `mbscalar` to impute `x`.

Note that `mbscalar` only tests `x` at the point in an M-file or MEX-file where an `mbscalar` call appears. In other words, an `mbscalar` call tests the value of `x` only once. If `x` becomes nonscalar after the `mbscalar` test, `mbscalar` cannot issue an error message.

`mbscalar` defines a scalar as a matrix whose dimensions are 1-by-1.

Example This code in MATLAB causes `mbscalar` to generate an error message because `n` does not hold a scalar.

```
n = [1 2 3];
mbscalar(n);
??? Error using ==> mbscalar
Argument of mbscalar must be scalar.
```

See Also `mbint`, `mbintscalar`, `mbintvector`, `mbreal`, `mbrealscalar`, `mbrealvector`, `mbvector`, `mcc`

mbvector

Purpose Assert variable is vector.

Syntax

```
mbvector(n)
```

Description The statement

```
mbvector(x)
```

causes the MATLAB Compiler to impute that `x` is a vector. At runtime, if `mbvector` determines that `x` holds a nonvector value, `mbvector` issues an error message and halts execution of the MEX-file.

`mbvector` causes the MATLAB interpreter to check whether `x` holds a vector value. If `x` does not, `mbvector` issues an error message and halts execution of the M-file. The MATLAB interpreter does not use `mbvector` to impute `x`.

Note that `mbvector` only tests `x` at the point in an M-file or MEX-file where an `mbvector` call appears. In other words, an `mbvector` call tests the value of `x` only once. If `x` becomes a nonvector after the `mbvector` test, `mbvector` cannot issue an error message.

`mbvector` defines a vector as any matrix whose dimensions are 1-by-n or n-by-1. All scalars are also vectors (though most vectors are not scalars).

Example This code in MATLAB causes `mbvector` to generate an error message because the dimensions of `n` are 2-by-2.

```
n = magic(2)
n =
     1     3
     4     2
mbvector(n)
??? Error using ==> mbvector
Argument to mbvector must be a vector.
```

See Also `mbint`, `mbintscalar`, `mbintvector`, `mbreal`, `mbrealscalar`, `mbscalar`, `mbrealvector`, `mcc`

Purpose Natural logarithm for nonnegative real inputs.

Syntax

```
Y = reallog(X)
```

Description `reallog` is an elementary function that operates element-wise on matrices. `reallog` returns the natural logarithm of `X`. The domain of `reallog` is the set of all nonnegative real numbers. If `X` is negative or complex, `reallog` issues an error message.

`reallog` is similar to the MATLAB `log` function; however, the domain of `log` is much broader than the domain of `reallog`. The domain of `log` includes all real and all complex numbers. If `Y` is real, you should use `reallog` rather than `log` for two reasons.

First, subsequent access of `Y` may execute more efficiently if `Y` is calculated with `reallog` rather than with `log`. Using `reallog` forces the MATLAB Compiler to impute a real type to `X` and `Y`. Using `log` typically forces the MATLAB Compiler to impute a complex type to `Y`.

Second, the compiled version of `reallog` may run somewhat faster than the compiled version of `log`. (However, the interpreted version of `reallog` may run somewhat slower than the interpreted version of `log`.)

See Also `exp`, `log`, `log2`, `logm`, `log10`, `realpow`, `realsqrt`

realpow

Purpose Array power function for real-only output.

Syntax

```
Z = realpow(X,Y)
```

Description `realpow` returns `X` raised to the `Y` power. `realpow` operates element-wise on matrices. The range of `realpow` is the set of all real numbers. In other words, if `X` raised to the `Y` power yields a complex answer, then `realpow` does not return an answer. Instead, `realpow` signals an error.

If `X` is negative and `Y` is not an integer, the resulting power is complex and `realpow` signals an error.

`realpow` is similar to the array power operator (`.^`) of MATLAB. However, the range of `.^` is much broader than the range of `realpow`. (The range of `.^` includes all real and all imaginary numbers.) If `X` raised to the `Y` power yields a complex answer, then you must use `.^` instead of `realpow`. However, if `X` raised to the `Y` power yields a real answer, then you should use `realpow` for two reasons.

First, subsequent access of `Z` may execute more efficiently if `Z` is calculated with `realpow` rather than `.^`. Using `realpow` forces the MATLAB Compiler to impute that `Z`, `X`, and `Y` are real. Using `.^` typically forces the MATLAB Compiler to impute the complex type to `Z`.

Second, the compiled version of `realpow` may run somewhat faster than the compiled version of `.^`. (However, the interpreted version of `realpow` may run somewhat slower than the interpreted version of `.^`.)

See Also `exp`, `log`, `log2`, `logm`, `log10`, `reallog`, `realsqrt`

Purpose Square root for nonnegative real inputs.

Syntax

```
Y = realsqrt(X)
```

Description

`realsqrt(X)` returns the square root of the elements of `X`. The domain of `realsqrt` is the set of all nonnegative real numbers. If `X` is negative or complex, `realsqrt` issues an error message.

`realsqrt` is similar to `sqrt`; however, `sqrt`'s domain is much broader than `realsqrt`'s. The domain of `sqrt` includes all real and all complex numbers. Despite this larger domain, if `Y` is real, then you should use `realsqrt` rather than `sqrt` for two reasons.

First, subsequent access of `Y` may execute more efficiently if `Y` is calculated with `realsqrt` rather than with `sqrt`. Using `realsqrt` forces the MATLAB Compiler to impute a real type to `X` and `Y`. Using `sqrt` typically forces the MATLAB Compiler to impute a complex type to `Y`.

Second, the compiled version of `realsqrt` may run somewhat faster than the compiled version of `sqrt`. (However, the interpreted version of `realsqrt` may run somewhat slower than the interpreted version of `sqrt`.)

See Also `exp`, `log`, `log2`, `logm`, `log10`, `reallog`, `realpow`

Command Line Tools

This section contains the reference pages for the Compiler command line tools, namely, `mbuild` and `mcc`. This section describes the command line tool options. Appendix A contains a summary of the options in a convenient table form.

Purpose

Compile and link source files that call functions in the MATLAB C/C++ Math Library or MATLAB C/C++ Graphics Library into a stand-alone executable or shared library.

Syntax

```
mbuild [option1 ... optionN] sourcefile1 [... sourcefileN]
      [objectfile1 ... objectfileN] [libraryfile1 ... libraryfileN]
       [exportfile1 ... exportfileN]
```

Description

`mbuild` is a script that supports various options that allow you to customize the building and linking of your code. This table lists the `mbuild` options. If no platform is listed, the option is available on both UNIX and Microsoft Windows.

Option	Description
`-<arch>`	(UNIX) Assume local host has architecture `<arch>`. Possible values for `<arch>` include `sol2`, `hpux`, `hp700`, `alpha`, `ibm_rs`, `sgi`, and `glnx86`.
`@<response_file>`	(Windows) Replace `@<response_file>` on the `mbuild` command line with the contents of the text file, `response_file`.
`-c`	Compile only. Do not link. Creates an object file but not an executable.
`-D<name>`	Define a symbol name to the C/C++ preprocessor. Equivalent to a `#define <name>` directive in the source.
`-D<name>#<value>`	Define a symbol name and value to the C/C++ preprocessor. Equivalent to a `#define <name> <value>` directive in the source.
`-D<name>=<value>`	(UNIX) Define a symbol name and value to the C preprocessor. Equivalent to a `#define <name> <value>` directive in the source.

Option	Description
`-f <<optionsfile>>`	Specify location and name of options file to use. Overrides the `mbuild` default options file search mechanism.
`-g`	Create a debuggable executable. If this option is specified, `mbuild` appends the value of options file variables ending in `DEBUGFLAGS` with their corresponding base variable. This option also disables the `mbuild` default behavior of optimizing built object code.
`-h[elp]`	Help; prints a description of `mbuild` and the list of options.
`-I<pathname>`	Add `<pathname>` to the list of directories to search for `#include` files.
`-inline`	Inline matrix accessor functions (`mx*`). The generated executable may not be compatible with future versions of the MATLAB C/C++ Math Library or MATLAB C/C++ Graphics Library.
`-l<name>`	(UNIX) Link with object library `lib<name>`.
`-L<directory>`	(UNIX) Add `<directory>` to the list of directories containing object-library routines.

Option	Description
`-lang <language>`	Specify compiler language. `<language>` can be `c` or `cpp`. By default, `mbuild` determines which compiler (C or C++) to use by inspection of the source file's extension. This option overrides that mechanism. This option is necessary when you use an unsupported file extension, or when you pass in all `.o` files and libraries.
`-n`	No execute mode. Print out any commands that `mbuild` would execute, but do not actually execute any of them.
`-O`	Optimize the object code by including the optimization flags listed in the options file. If this option is specified, `mbuild` appends the value of options file variables ending in `OPTIMFLAGS` with their corresponding base variable. Note that optimizations are enabled by default, are disabled by the `-g` option, but are reenabled by `-O`.
`-outdir <dirname>`	Place any generated object, resource, or executable files in the directory `<dirname>`. Do not combine this option with `-output` if the `-output` option gives a full pathname.
`-output <resultname>`	Create an executable named `<resultname>`. An appropriate executable extension is automatically appended. Overrides the `mbuild` default executable naming mechanism.

Option	Description
`-setup`	Interactively specify the compiler options file to use as default for future invocations of `mbuild` by placing it in `<UserProfile>\Application Data\MathWorks\MATLAB\R12` (Windows) or `$HOME/.matlab/R12` (UNIX). When this option is specified, no other command line input is accepted.
`-U<name>`	Remove any initial definition of the C preprocessor symbol `<name>`. (Inverse of the `-D` option.)
`-v`	Verbose; Print the values for important internal variables after the options file is processed and all command line arguments are considered. Prints each compile step and final link step fully evaluated to see which options and files were used. Very useful for debugging.
`<name>=<value>`	(UNIX) Override an options file variable for variable `<name>`. If `<value>` contains spaces, enclose it in single quotes, e.g., `CFLAGS='opt1 opt2'`. The definition, `<def>`, can reference other variables defined in the options file. To reference a variable in the options file, prepend the variable name with a `$`, e.g., `CFLAGS='$CFLAGS opt2'`.

Option	Description
`<name>#<value>`	Override an options file variable for variable `<name>`. If `<def>` contains spaces, enclose it in single quotes, e.g., `CFLAGS='opt1 opt2'`. The definition, `<def>`, can reference other variables defined in the options file. To reference a variable in the options file, prepend the variable name with a `$`, e.g., `CFLAGS='$CFLAGS opt2'`.

Note Some of these options (`-f`, `-g`, and `-v`) are available on the `mcc` command line and are passed along to `mbuild`. Others can be passed along using the `-M` option to `mcc`. For details on the `-M` option, see the `mcc` reference page.

Purpose

Invoke MATLAB Compiler.

Syntax

```
mcc [-options] mfile1   [mfile2 ... mfileN]
                        [C/C++file1 ... C/C++fileN]
```

Description

`mcc` is the MATLAB command that invokes the MATLAB Compiler. You can issue the `mcc` command either from the MATLAB command prompt (MATLAB mode) or the DOS or UNIX command line (stand-alone mode).

Command Line Syntax

You may specify one or more MATLAB Compiler option flags to `mcc`. Most option flags have a one-letter name. You can list options separately on the command line, for example,

```
mcc -m -g myfun
```

You can group options that do not take arguments by preceding the list of option flags with a single dash (-), for example,

```
mcc -mg myfun
```

Options that take arguments cannot be combined unless you place the option with its arguments last in the list. For example, these formats are valid.

```
mcc -m -A full myfun       % Options listed separately
mcc -mA full myfun         % Options combined, A option last
```

This format is *not* valid.

```
mcc -Am full myfun         % Options combined, A option not last
```

In cases where you have more than one option that takes arguments, you can only include one of those options in a combined list and that option must be last. You can place multiple combined lists on the `mcc` command line.

If you include any C or C++ filenames on the `mcc` command line, the files are passed directly to `mex` or `mbuild`, along with any Compiler-generated C or C++ files.

Using Macros to Simplify Compilation

The MATLAB Compiler, through its exhaustive set of options, gives you access to the tools you need to do your job. If you want a simplified approach to compilation, you can use one simple option, i.e., *macro*, that allows you to quickly accomplish basic compilation tasks. If you want to take advantage of the power of the Compiler, you can do whatever you desire to do by choosing various Compiler options.

This table shows the relationship between the macro approach to accomplish a standard compilation and the multioption alternative.

Table 7-1: Macro Options

```
Translate M to C/C++
 | Function Wrapper
 |  |         Target Language
 |  |           |     Output Stage
 |  |           |      |          Helper Functions
 |  |           |      |           |
 |  |           |      |           |  M-File Library
 |  |           |      |           |     |
```

Macro Option	Bundle File	Creates	Option Equivalence
-m	macro_option_m	Stand-alone C application	-t -W main -L C -T link:exe -h libmmfile.mlib
-p	macro_option_p	Stand-alone C++ application	-t -W main -L Cpp -T link:exe -h libmmfile.mlib
-x	macro_option_x	MEX-function	-t -W mex -L C -T link:mexlibrary libmatlbmx.mlib
-S	macro_option_S	Simulink S-function	-t -W simulink -L C -T link:mex libmatlbmx.mlib
-B sgl	sgl	Stand-alone C graphics library application	-m -W mainhg libmwsglm.mlib
-B sglcpp	sglcpp	Stand-alone C++ graphics library application	-p -W mainhg libmwsglm.mlib
-B pcode	pcode	MATLAB P-code	-t -L P
-g	macro_option_g	Enable debug	-G -A debugline:on -O none

Understanding a Macro Option. The -m option tells the Compiler to produce a stand-alone C application. The -m macro is equivalent to the series of options

```
-t -W main -L C -T link:exe -h libmmfile.mlib
```

This table shows the five options that compose the -m macro and the information that they provide to the Compiler.

Table 7-2: The -m Macro

Option	Function
-t	Translate M code to C/C++ code.
-W main	Produce a wrapper file suitable for a stand-alone application.
-L C	Generate C code as the target language.
-T link:exe	Create an executable as the output.
-h	Automatically, find and compile helper functions included in the source M-file.
libmmfile.mlib	Link to this shared library whenever necessary.

Changing Macro Options. You can change the meaning of a macro option by editing the corresponding macro_option file bundle file in <matlab>/toolbox/compiler/bundles. For example, to change the -x macro, edit the file macro_option_x in the bundles directory.

Setting Up Default Options

If you have some command line options that you wish always to pass to mcc, you can do so by setting up an mccstartup file. Create a text file containing the desired command line options and name the file mccstartup. Place this file in one of two directories:

1. The current working directory, or
2. Your preferences directory ($HOME/.matlab/R12 on UNIX, <system root>\profiles\<user>\application data\mathworks\matlab\R12 on PC)

mcc searches for the mccstartup file in these two directories in the order shown above. If it finds an mccstartup file, it reads it and processes the options within the file as if they had appeared on the mcc command line before any actual command line options. Both the mccstartup file and the -B option are processed the same way.

Note If you need to change the meaning of a macro to satisfy your individual requirements, you should create or modify your mccstartup file in the preferences directory. Changing the file macro_option_x in the bundles directory changes the option for all Compiler users. To see the name of your preferences directory, type prefdir at the command prompt.

Setting a MATLAB Path in the Stand-Alone MATLAB Compiler

Unlike the MATLAB version of the Compiler, which inherits a MATLAB path from MATLAB, the stand-alone version has no initial path. If you want to set up a default path, you can do so by making an mccpath file. To do this:

1. Create a text file containing the text -I <your_directory_here> for each directory you want on the default path, and name this file mccpath. (Alternately, you can call the MCCSAVEPATH M-function from MATLAB to create an mccpath file.)

2. Place this file in your preferences directory. To do so, run the following commands at the MATLAB prompt.

   ```
   cd(prefdir); mccsavepath;
   ```

   These commands save your current MATLAB path to a file named mccpath in your user preferences directory. (Type prefdir to see the name of your preferences directory.)

The stand-alone version of the MATLAB Compiler searches for the mccpath file in your current directory and then your preferences directory. If it finds an mccpath file, it processes the directories specified within the file and uses them to initialize its search path. Note that you may still use the -I option on the command line or in mccstartup files to add other directories to the search path. Directories specified this way are searched after those directories specified in the mccpath file.

Conflicting Options on Command Line

If you use conflicting options, the Compiler resolves them from left to right, with the rightmost option taking precedence. For example, using the equivalencies in Table 7-1, Macro Options, on page 7-31,

```
mcc -m -W none test.m
```

is equivalent to

```
mcc -t -W main -L C -T link:exe -h -W none test.m
```

In this example, there are two conflicting `-W` options. After working from left to right, the Compiler determines that the rightmost option takes precedence, namely, `-W none`, and the Compiler does not generate a wrapper.

Note Macros and regular options may both affect the same settings and may therefore override each other depending on their order in the command line.

Handling Full Pathnames

If you specify a full pathname to an M-file on the `mcc` command line, the Compiler:

1. Breaks the full name into the corresponding path- and filenames (`<path>` and `<file>`).
2. Replaces the full pathname in the argument list with "`-I <path> <file>`". For example,

   ```
   mcc -m /home/user/myfile.m
   ```

   would be treated as

   ```
   mcc -m -I /home/user myfile.m
   ```

In rare situations, this behavior can lead to a potential source of confusion. For example, suppose you have two different M-files that are both named `myfile.m` and they reside in `/home/user/dir1` and `/home/user/dir2`. The command

```
mcc -m -I /home/user/dir1 /home/user/dir2/myfile.m
```

would be equivalent to

```
mcc -m -I /home/user/dir1 -I /home/user/dir2 myfile.m
```

The Compiler finds the `myfile.m` in `dir1` and compiles it instead of the one in `dir2` because of the behavior of the `-I` option. If you are concerned that this might be happening, you can specify the `-v` option and then see which M-file the Compiler parses. The `-v` option prints the full pathname to the M-file.

Note The Compiler produces a warning (`specified_file_mismatch`) if a file with a full pathname is included on the command line and it finds it somewhere else.

Compiling Embedded M-Files

If the M-file you are compiling calls other M-files, you can list the called M-files on the command line. Doing so causes the MATLAB Compiler to build all the M-files into a single MEX-file, which usually executes faster than separate MEX-files. Note, however, that the single MEX-file has only one entry point regardless of the number of input M-files. The entry point is the first M-file on the command line. For example, suppose that `bell.m` calls `watson.m`. Compiling with

```
mcc -x bell watson
```

creates `bell.mex`. The entry point of `bell.mex` is the compiled code from `bell.m`. The compiled version of `bell.m` can call the compiled version of `watson.m`. However, compiling as

```
mcc -x watson bell
```

creates `watson.mex`. The entry point of `watson.mex` is the compiled code from `watson.m`. The code from `bell.m` never gets executed.

As another example, suppose that `x.m` calls `y.m` and that `y.m` calls `z.m`. In this case, make sure that `x.m` is the first M-file on the command line. After `x.m`, it does not matter which order you specify `y.m` and `z.m`.

MATLAB Compiler Option Flags

The MATLAB Compiler option flags perform various functions that affect the generated code and how the Compiler behaves. This table shows the categories of the Compiler options.

Table 7-3: Compiler Option Categories

Category	Purpose
Macros	The macro options simplify the compilation process by combining the most common compilation tasks into single options.
Code Generation	These options affect the actual code that the Compiler generates. For example, `-L` specifies the target language as either C or C++.
Compiler and Environment	These options provide information to the Compiler such as where to put (`-d`) and find (`-I`) particular files.
mbuild/mex	These options provide information for the `mbuild` and/or `mex` scripts.

The remainder of this reference page is subdivided into sections that correspond to the Compiler option categories. Each section provides a full description of all of the options in the category.

Macro Options

The macro options provide a simplified way to accomplish basic compilation tasks.

-m (Stand-Alone C). Produce a stand-alone C application. It includes helper functions by default (`-h`), and then generates a stand-alone C wrapper (`-W main`). In the final stage, this option compiles your code into a stand-alone executable and links it to the MATLAB C/C++ Math Library (`-T link:exe`).

For example, to translate an M-file named `mymfile.m` into C and to create a stand-alone executable that can be run without MATLAB, use

```
mcc -m mymfile
```

The `-m` option is equivalent to the series of options

```
-W main -L C -t -T link:exe -h libmmfile.mlib
```

-p (Stand-Alone C++). Produce a stand-alone C++ application. It includes helper functions by default (`-h`), and then generates a stand-alone C++ wrapper (`-W main`). In the final stage, this option compiles your code into a stand-alone executable and links it to the MATLAB C/C++ Math Library (`-T link:exe`). For example, to translate an M-file named `mymfile.m` into C++ and to create a stand-alone executable that can be run without MATLAB, use

```
mcc -p mymfile
```

The `-p` option is equivalent to the series of options

```
-W main -L Cpp -t -T link:exe -h libmmfile.mlib
```

-S (Simulink S-Function). Produce a Simulink S-function that is compatible with the Simulink S-function block. For example, to translate an M-file named `mymfile.m` into C and to create the corresponding Simulink S-function using dynamically sized inputs and outputs, use

```
mcc -S mymfile
```

The `-S` option is equivalent to the series of options

```
-W simulink -L C -t -T link:mex libmatlbmx.mlib
```

-x (MEX-Function). Produce a MEX-function. For example, to translate an M-file named `mymfile.m` into C and to create the corresponding MEX-file that can be called directly from MATLAB, use

```
mcc -x mymfile
```

The `-x` option is equivalent to the series of options

```
-W mex -L C -t -T link:mexlibrary libmatlbmx.mlib
```

-B sgl (Stand-Alone C Graphics Library). Produce a stand-alone C application that uses Handle Graphics.

The `-B sgl` option is equivalent to the series of options

```
-m -W mainhg libmwsglm.mlib
```

-B sglcpp (Stand-Alone C++ Graphics Library). Produce a stand-alone C++ application that uses Handle Graphics.

The `-B sglcpp` option is equivalent to the series of options

```
-p -W mainhg libmwsglm.mlib
```

-B pcode (MATLAB P-Code). Produce MATLAB P-code.

The `-B pcode` option is equivalent to the series of options

```
-t -L P
```

Code Generation Options

-A (Annotation Control for Output Source). Control the type of annotation in the resulting C/C++ source file. The types of annotation you can control are:

- M-file code and/or comment inclusion (`annotation`)
- `#line` preprocessor directive inclusion (`line`)
- Whether error messages report the source file and line number (`debugline`)

To control the M-file code that is included in the generated C/C++ source, use

```
mcc -A annotation:type …
```

This table shows the available types of code and comment annotation options.

Table 7-4: Code/Comment Annotation Options

type	Description
`all`	Provides the complete source of the M-file interleaved with the generated C/C++ source. The default is `all`.
`comments`	Provides all of the comments from the M-file interleaved with the generated C/C++ source.
`none`	No comments or code from the M-file are added to code.

To control the `#line` preprocessor directives that are included in the generated C/C++ source, use

```
mcc -A line:setting …
```

The table shows the available `#line` directive settings.

Table 7-5: Line Annotation Options

Setting	Description
`on`	Adds `#line` preprocessor directives to the generated C/C++ source code to enable source M-file debugging. **Note:** The page width option is ignored when this is on.
`off`	Adds no `#line` preprocessor directives to the generated C/C++ source code. The default is `off`.

To control if run-time error messages report the source file and line number, use

```
mcc -A debugline:on …
```

This table shows the available `debugline` directive settings.

Table 7-6: Run-Time Error Annotation Options

Setting	Description
`on`	Specifies the presence of source file and line number information in run-time error messages.
`off`	Specifies no source file and line number information in run-time error messages. The default is `off`.

For example:

To include all of your M-code, including comments, in the generated file and the standard #line preprocessor directives, use

```
mcc -A annotation:all -A line:on …
```
or
`mcc -A line:on …` (The default is all for code/comment inclusion.)

To include none of your M-code and no `#line` preprocessor directives, use

```
mcc -A annotation:none -A line:off …
```

To include the standard `#line` preprocessor directives in your generated C/C++ source code as well as source file and line number information in your run-time error messages, use

```
mcc -A line:on -A debugline:on …
```

-F <option> (Formatting). Control the formatting of the generated code. This table shows the available options.

Table 7-7: Formatting Options

<Option>	Description
`list`	Generates a table of all the available formatting options.
`expression-indent:n`	Sets the number of spaces of indentation for all expressions to `n`, where `n` is an integer. The default indent is 4.
`page-width:n`	Sets maximum width of generated code to `n`, where `n` is an integer. The default width is 80.
`statement-indent:n`	Sets the number of spaces of indentation for all statements to `n`, where `n` is an integer. The default indent is 2.

-g (Debug). This option is a macro that is equivalent to

```
-G -A debugline:on -O none
```

In addition to the `-G` option, the `-g` option includes the `-A debugline:on` option. This will have an impact on performance of the generated code. If you wish to have debugging information, but do not want the performance degradation associated with the debug line information, use `-g -A debugline:off`. The `-g` option also includes the `-O none` option, causing all compiler optimizations to be turned off. If you wish to have some optimizations on, you may specify them after the debug option.

-l (Line Numbers) . Generate C/C++ code that prints filename and line numbers on run-time errors. This option flag is useful for debugging, but causes the executable to run slightly slower. This option is equivalent to

```
mcc -A debugline:on …
```

-L <language> (Target Language). Specify the target language of the compilation. Possible values for language are `C` or `Cpp`. The default is `C`. Note that these values are case insensitive.

-O <option> (Optimization Options). Optimizes your M-file source code so that the performance of the generated C/C++ code may be faster than the performance of the M-code in the MATLAB interpreter. This table shows the available options.

Table 7-8: Optimization Options

<Option>	Description
`-O list`	Lists all available optimizations.
`-O all`	Turns on all optimizations; `all` is the default.
`-O none`	Turns off all optimizations.
`-O <opt option>:[on|off]`	Enables or disables individual optimizations, where: `<opt option>` is: • `fold_scalar_mxarrays` • `fold_non_scalar_mxarrays` • `array_indexing` • `optimize_integer_for_loops` • `optimize_conditionals`

-u (Number of Inputs). Provide more control over the number of valid inputs for your Simulink S-function. This option specifically sets the number of inputs (u) for your function. If `-u` is omitted, the input will be dynamically sized. (Used with `-S` option.)

-W <type> (Function Wrapper). Control the generation of function wrappers for a collection of Compiler-generated M-files. You provide a list of functions and the Compiler generates the wrapper functions and any appropriate global variable definitions. This table shows the valid type options.

Table 7-9: Function Wrapper Types

<Type>	Description
`mex`	Produces a `mexFunction()` interface.
`main`	Produces a POSIX shell `main()` function.
`simulink`	Produces a Simulink C MEX S-function interface.
`lib:<string>`	Produces an initialization and termination function for use when compiling this Compiler-generated code into a larger application. This option also produces a header file containing prototypes for all public functions in all M-files specified. `<string>` becomes the base (file) name for the generated C/C++ and header file. Creates a `.exports` file that contains all nonstatic function names.
`none`	Does not produce a wrapper file. `none` is the default.

Caution When generating function wrappers, you *must* specify all M-files that are being linked together on the command line. These files are used to produce the initialization and termination functions as well as global variable definitions. If the functions are not specified in this manner, undefined symbols will be produced at link time or run-time crashes may occur.

-y (Number of Outputs). Provides more control over the number of valid outputs for your Simulink S-function. This option specifically sets the number of outputs (y) for your function. If `-y` is omitted, the output will be dynamically sized. (Used with `-S` option.)

Compiler and Environment Options

-B <filename> (Bundle of Compiler Settings). Replace `-B <filename>` on the `mcc` command line with the contents of the specified file. The file should contain only `mcc` command line options and corresponding arguments and/or other filenames. The file may contain other `-B` options.You can place options that you always set in an `mccstartup` file. For more information, see ““Setting Up Default Options” on page 7-32.

-c (C Code Only). Generate C code but do not invoke `mex` or `mbuild`, i.e., do not produce a MEX-file or stand-alone application. This is equivalent to `-T codegen` placed at the end of the `mcc` command line.

-d <directory> (Output Directory). Place the output files from the compilation in the directory specified by the `-d` option.

-h (Helper Functions). Compile helper functions. Any helper functions that are called will be compiled into the resulting MEX or stand-alone application. The `-m` option automatically compiles all helper functions, so `-m` effectively calls `-h`.

Using the `-h` option is equivalent to listing the M-files explicitly on the `mcc` command line.

The `-h` option purposely does not include built-in functions or functions that appear in the MATLAB M-File Math Library portion of the C/C++ Math Libraries. This prevents compiling functions that are already part of the C/C++ Math Libraries. If you want to compile these functions as helper functions, you should specify them explicitly on the command line. For example, use

```
mcc -m minimize_it fminsearch
```

instead of

```
mcc -m -h minimize_it
```

-I <directory> (Directory Path). Add a new directory path to the list of included directories. Each `-I` option adds a directory to the *end* of the current search path. For example,

```
-I <directory1> -I <directory2>
```

would set up the search path so that `directory1` is searched first for M-files, followed by `directory2`. This option is important for stand-alone compilation where the MATLAB path is not available.

-o <outputfile>. Specify the basename of the final executable output (MEX-file or application) of the Compiler. A suitable, possibly platform-dependent, extension is added to the specified basename (e.g., `.exe` for PC stand-alone applications, `.mexsol` for Solaris MEX-files).

-t (Translate M to C/C++). Translate M-files specified on the command line to C/C++ files.

-T <target> (Output Stage). Specify the desired output stage. This table gives the possible values of `target`.

Table 7-10: Output Stage Options

<Target>	Description
`codegen`	Translates M-files to C/C++ files. The default is `codegen`.
`compile:<bin>`	Translates M-files to C/C++ files; compiles to object form.
`link:<bin>`	Translates M-files to C/C++ files; compiles to object form; links to executable form (MEX or stand-alone application.)

where `<bin>` can be `mexlibrary`, `mex`, `exe`, or `lib`. `mex` and `mexlibrary` use the `mex` script to build a MEX-file; `exe` uses the `mbuild` script to build an executable; `lib` uses `mbuild` to build a shared library.

-v (Verbose). Display the steps in compilation, including:

- The Compiler version number
- The source filenames as they are processed
- The names of the generated output files as they are created
- The invocation of `mex` or `mbuild`

The `-v` option passes the `-v` option to `mex` or `mbuild` and displays information about `mex` or `mbuild`.

-w (Warning). Display warning messages. This table shows the various ways you can use the -w option.

Table 7-11: Warning Option

Syntax	Description
(no `-w` option)	Default; displays only serious warnings.
`-w list`	Generates a table that maps `<string>` to warning message for use with `enable`, `disable`, and `error`. The "Error and Warning Messages" appendix lists the same information.
`-w`	Enables complete warnings.
`-w disable`*[:<string>]*	Disables specific warning associated with *<string>*. The "Error and Warning Messages" appendix lists the valid *<string>* values. Leave off the optional *:<string>* to apply the `disable` action to all warnings.
`-w enable`*[:<string>]*	Enables specific warning associated with *<string>*. The "Error and Warning Messages" appendix lists the valid *<string>* values. Leave off the optional *:<string>* to apply the `enable` action to all warnings.
`-w error`*[:<string>]*	Treats specific warning associated with *<string>* as error. Leave off the optional *:<string>* to apply the `error` action to all warnings.

-Y <license.dat File>. Use license information in `license.dat` file when checking out a Compiler license.

mbuild/mex Options

-f <filename> (Specifying Options File). Use the specified options file when calling `mex` or `mbuild`. This option allows you to use different compilers for different invocations of the MATLAB Compiler. This option is a direct pass-through to the `mex` or `mbuild` script. See “External Interfaces/API” for more information about using this option with the `mex` script.

Note Although this option works as documented, it is suggested that you use `mex -setup` or `mbuild -setup` to switch compilers.

-g (Debug Only). Cause `mex` or `mbuild` to invoke the C/C++ compiler with the appropriate C/C++ compiler options for debugging. You should specify `-g` if you want to debug the MEX-file or stand-alone application with a debugger.

-M "string" (Direct Pass Through). Pass `string` directly to the `mex` or `mbuild` script. This provides a useful mechanism for defining compile-time options, e.g., `-M "-Dmacro=value"`.

Note Multiple `-M` options do not accumulate; only the last `-M` option is used.

-z <path> (Specifying Library Paths). Specify the path to use for library and include files. This option uses the specified path for compiler libraries instead of the path returned by `matlabroot`.

Examples

Make a C translation and a MEX-file for `myfun.m`.

```
mcc -x myfun
```

Make a C translation and a stand-alone executable for `myfun.m`.

```
mcc -m myfun
```

Make a C++ translation and a stand-alone executable for `myfun.m`.

```
mcc -p myfun
```

Make a C translation and a Simulink S-function for `myfun.m` (using dynamically sized inputs and outputs).

```
mcc -S myfun
```

Make a C translation and a Simulink S-function for `myfun.m` (explicitly calling for one input and two outputs).

```
mcc -S -u 1 -y 2 myfun
```

Make a C translation and stand-alone executable for `myfun.m`. Look for `myfun.m` in the `/files/source` directory, and put the resulting C files and executable in the `/files/target` directory.

```
mcc -m -I /files/source -d /files/target myfun
```

Make a C translation and a MEX-file for `myfun.m`. Also translate and include all M-functions called directly or indirectly by `myfun.m`. Incorporate the full text of the original M-files into their corresponding C files as C comments.

```
mcc -x -h -A annotation:all myfun
```

Make a generic C translation of `myfun.m`.

```
mcc -t -L C myfun
```

Make a generic C++ translation of `myfun.m`.

```
mcc -t -L Cpp myfun
```

Make a C MEX wrapper file from `myfun1.m` and `myfun2.m`.

```
mcc -W mex -L C myfun1 myfun2
```

Make a C translation and a stand-alone executable from `myfun1.m` and `myfun2.m` (using one `mcc` call).

```
mcc -m myfun1 myfun2
```

Make a C translation and a stand-alone executable from `myfun1.m` and `myfun2.m` (by generating each output file with a separate `mcc` call).

```
mcc -t -L C myfun1                  % Yields myfun1.c
mcc -t -L C myfun2                  % Yields myfun2.c
mcc -W main -L C myfun1 myfun2      % Yields myfun1_main.c
mcc -T compile:exe myfun1.c         % Yields myfun1.o
mcc -T compile:exe myfun2.c         % Yields myfun2.o
mcc -T compile:exe myfun1_main.c    % Yields myfun1_main.o
mcc -T link:exe myfun1.o myfun2.o myfun1_main.o
```

Note On PCs, filenames ending with `.o` above would actually end with `.obj`.

MATLAB Compiler Quick Reference

Common Uses of the Compiler

This section summarizes how to use the MATLAB Compiler to generate some of its more standard results. The first four examples take advantage of the macro options.

Create a MEX-File. To translate an M-file named `mymfile.m` into C and to create the corresponding C MEX-file that can be called directly from MATLAB, use

```
mcc -x mymfile
```

Create a Simulink S-Function. To translate an M-file named `mymfile.m` into C and to create the corresponding Simulink S-function using dynamically sized inputs and outputs, use

```
mcc -S mymfile
```

Create a Stand-Alone C Application. To translate an M-file named `mymfile.m` into C and to create a stand-alone executable that can be run without MATLAB, use

```
mcc -m mymfile
```

Create a Stand-Alone C++ Application. To translate an M-file named `mymfile.m` into C++ and to create a stand-alone executable that can be run without MATLAB, use

```
mcc -p mymfile
```

Create a Stand-Alone C Graphics Library Application. To translate an M-file named `mymfile.m` that contains Handle Graphics functions into C and to create a stand-alone executable that can be run without MATLAB, use

```
mcc -B sgl mymfile
```

Create a Stand-Alone C++ Graphics Library Application. To translate an M-file named `mymfile.m` that contains Handle Graphics functions into C++ and to create a stand-alone executable that can be run without MATLAB, use

```
mcc -B sglcpp mymfile
```

Create a C Library. To create a C library, use

```
mcc -m -W lib:libfoo -T link:lib foo.m
```

Create a C++ Library. To create a C++ library, use

```
mcc -p -W lib:libfoo -T compile:lib foo.m
```

Create a C Shared Library. To create a C shared library that performs specialized calculations that you can call from your own programs, use

```
mcc -W lib:mylib -L C -t -T link:lib -h Function1 Function2 …
```

Create MATLAB P-Code. To translate an M-file named `mymfile.m` into MATLAB P-code, use

```
mcc -B pcode mymfile
```

Note You can add the `-g` option to any of these for debugging purposes.

---

mcc

Bold entries in the Comment/Options column indicate default values.

Option	Description	Comment/Options

`A annotation:`*type*	Controls M-file code/ comment inclusion in generated C/C++ source	*type* = **`all`**
		`comments`
		`none`

`A debugline:`*setting*	Controls the inclusion of source filename and line numbers in run-time error messages	*setting* = `on` **`off`**
`A line:`*setting*	Controls the `#line` preprocessor directives included in the generated C/C++ source	*setting* = `on` **`off`**
`B filename`	Replaces `-B filename` on the `mcc` command line with the contents of `filename`	The file should contain only `mcc` command line options.
`c`	Generates C code only	Overrides `-T` option; equivalent to `-T codegen`
`d directory`	Places output in specified `directory`	
`f filename`	Uses the specified options file, `filename`	`mex -setup` and `mbuild -setup` are recommended.
`F` *option*	Specifies format parameters	*option* = `list` `expression-indent:`*n* `page-width:`*n* `statement-indent:`*n*
`g`	Generates debugging information	

Option	Description	Comment/Options
`h`	Compiles helper functions	
`I directory`	Adds new `directory` to path	
`l`	Generates code that reports file and line numbers on run-time errors	Equivalent to: `-A debugline:on`
`L` *language*	Specifies output target language	*language* = **C** `Cpp`
`m`	Macro to generate a C stand-alone application	Equivalent to: `-W main -L C -t -T link:exe -h libmmfile.mlib`
`M string`	Passes `string` to `mex` or `mbuild`	Use to define compile-time options.
`o outputfile`	Specifies name/location of final executable	

`O` *option*`:[on|off]`
`O` **`all`**
`O none`
`O list`
	Build an optimized executable.	*option* =
		`fold_scalar_mxarrays`
		`fold_non_scalar_mxarrays`
		`array_indexing`
		`optimize_integer_for_loops`
		`optimize_conditionals`

`p`	Macro to generate a C++ stand-alone application	Equivalent to: `-W main -L Cpp -t -T link:exe -h libmmfile.mlib`
`S`	Macro to generate Simulink S-function	Equivalent to: `-W simulink -L C -t -T link:mex libmatlbmx.mlib`
`t`	Translates M code to C/C++ code	

Option	Description	Comment/Options

`T` *target*	Specifies output stage	*target* = **codegen**
		`compile:`*bin*
		`link:`*bin*
		where *bin* = `mex`
		`exe`
		`lib`

`u number`	Specifies number of inputs for Simulink S-function	
`v`	Verbose; Displays compilation steps	

`w` *option*	Displays warning messages	*option* = `list`
		level
		level`:`*string*
		where *level* = `disable`
		`enable`
		`error`
		No `w` option displays only serious warnings (default).

`W` *type*	Controls the generation of function wrappers	*type* = `mex`
		`main`
		`simulink`
		`lib:`*string*
		none

`x`	Macro to generate MEX-function	Equivalent to: `-W mex -L C -t -T link:mexlibrary libmatlbmx.mlib`
`y number`	Specifies number of outputs for Simulink S-function	
`Y licensefile`	Uses `licensefile` when checking out a Compiler license	

Option	Description	Comment/Options
`z path`	Specifies `path` for library and include files	
`?`	Displays help message	

B

Error and Warning Messages

This appendix lists and describes error messages and warnings generated by the MATLAB Compiler. Compile-time messages are generated during the compile or link phase. It is useful to note that most of these compile-time error messages should not occur if MATLAB can successfully execute the corresponding M-file. Run-time messages are generated when the executable program runs.

The sections in this appendix are:

- "Compile-Time Errors"
- "Warning Messages"
- "Run-Time Errors"

Use this reference to:

- Confirm that an error has been reported
- Determine possible causes for an error
- Determine possible ways to correct an error

Note When using the MATLAB Compiler, if you receive an Internal Error message, record the specific message and report it to Technical Support at The MathWorks at `support@mathworks.com`.

Compile-Time Errors

Error: An error occurred while shelling out to *mex/mbuild* (error code = *errorno*). Unable to build executable (specify the -v option for more information). The Compiler reports this error if `mbuild` or `mex` generates an error.

Error: An error occurred writing to file "*filename*": *reason*. The file could not be written. The reason is provided by the operating system. For example, you may not have sufficient disk space available to write the file.

Error: Cannot recompile M-file "*filename*" because it is already in library "*libraryname*". There already exists a procedure in a library that has the same name as the M-file that is being compiled. For example,

```
mcc -x sin.m                    % Incorrect
```

Error: Cannot write file "*filename*" because MCC has already created a file with that name, or a file with that name was specified as a command line argument. The Compiler has been instructed to generate two files with the same name. For example,

```
mcc -W lib:liba liba -t         % Incorrect
```

Error: Could not check out a Compiler license. No additional Compiler licenses are available for your workgroup.

Error: Could not find license file "*filename*". (*Windows only*) The `license.dat` file could not be found in `<MATLAB>\bin`.

Error: Could not run mbuild. The MATLAB C/C++ Math Library must be installed in order to build stand-alone applications. Install the MATLAB C/C++ Math Library.

Error: File: "*filename*" not found. A specified file could not be found on the path. Verify that the file exists and that the path includes the file's location. You can use the `-I` option to add a directory to the search path

Error: File: "*filename*" is a script M-file which cannot be compiled with the current Compiler. The MATLAB Compiler cannot compile script M-files. To learn how to convert script M-files to function M-files, see "Converting Script M-Files to Function M-Files" in Chapter 3.

Error: File: *filename* Line: # Column: # != is not a MATLAB operator. Use ~= instead. Use the MATLAB relational operator ~= (not equal).

Error: File: *filename* Line: # Column: # () indexing must appear last in an index expression. If you use ordinary array indexing `()` to index into an expression, it must be last in the index expression. For example, you can use `X(1).value` and `X{2}(1)`, but you cannot use `X.value(1)` or `X(1){2}`.

Error: File: *filename* Line: # Column: # A CONTINUE may only be used within a FOR or WHILE loop. Use `CONTINUE` to pass control to the next iteration of a `FOR` or `WHILE` loop.

Error: File: *filename* Line: # Column: # A function declaration cannot appear within a script M-file. There is a function declaration in the file to be compiled, but it is not at the beginning of the file. Scripts cannot have any function declarations; function M-files must start with a function.

Error: File: *filename* Line: # Column: # Assignment statements cannot produce a result. An assignment statement cannot be used in a place where an expression, but not a statement, is expected. In particular, this message often identifies errors where an assignment was used, but an equality test was intended. For example,

```
if x == y, z = w; end        % Correct
if x = y, z = w; end         % Incorrect
```

Error: File: *filename* Line: # Column: # A variable cannot be made *storageclass1* after being used as a *storageclass2*. You cannot change a variable's storage class (global/local/persistent). Even though MATLAB allows this type of change in scope, the Compiler does not.

Error: File: *filename* Line: # Column: # An array for multiple LHS assignment must be a vector. If the left-hand side of a statement is a multiple assignment, the list of left-hand side variables must be a vector. For example,

```
[p1, p2, p3] = myfunc(a)     % Correct
[p1; p2; p3] = myfunc(a)     % Incorrect
```

Error: File: *filename* Line: # Column: # An array for multiple LHS assignment cannot be empty. If the left-hand side of a statement is a multiple assignment, the list of left-hand side variables cannot be empty. For example,

```
[p1, p2, p3] = myfunc(a)     % Correct
[ ] = myfunc(a)              % Incorrect
```

Error: File: *filename* Line: # Column: # An array for multiple LHS assignment cannot contain *token*. If the left-hand side of a statement is a multiple assignment, the vector cannot contain this token. For example, you cannot assign to constants.

```
[p1] = myfunc(a)                 % Correct
[3] = myfunc(a)                  % Incorrect
```

Error: File: *filename* Line: # Column: # Expected a variable, function, or constant, found "*string*". There is a syntax error in the specified line. See the online MATLAB Function Reference pages accessible from the Help browser.

Error: File: *filename* Line: # Column: # Expected one of , ; % or EOL, got "*string*". There is a syntax error in the specified line. See the online MATLAB Function Reference pages accessible from Help.

Error: File: *filename* Line: # Column: # Functions cannot be indexed using {} or . indexing. You cannot use the cell array constructor, `{}`, or the structure field access operator, `.`, to index into a function.

Error: File: *filename* Line: # Column: # Indexing expressions cannot return multiple results. There is an assignment in which the left-hand side takes multiple values, but the right-hand side is not a function call but rather a structure access. For example,

```
[x, y] = f(z)                    % Correct
[x, y] = f.z                     % Incorrect
```

Error: File: *filename* Line: # Column: # Invalid multiple left-hand-side assignment. For example, you try to assign to constants

```
[] = sin(1);                     % Incorrect
```

Error: File: *filename* Line: # Column: # MATLAB assignment cannot be nested. You cannot use a syntax such as `x = y = 2`. Use `y = 2, x = y` instead.

Error: File: *filename* Line: # Column: # Missing operator, comma, or semicolon. There is a syntax error in the file. Syntactically, an operator, a comma, or a semicolon is expected, but is missing. For example,

```
if x == y, z = w; end            % Correct
if x == y, z = w end             % Incorrect
```

Error: File: *filename* Line: # Column: # Missing variable or function. An illegal name was used for a variable or function. For example,

```
x                              % Correct
_x                             % Incorrect
```

Error: File: *filename* Line: # Column: # Only functions can return multiple values. In this example, `foo` must be a function, it cannot be a variable.

```
[a, b] = foo;
```

Error: File: *filename* Line: # Column: # "*string1*" expected, "*string2*" found. There is a syntax error in the specified line. See the online MATLAB Function Reference pages accessible from the online Help.

Error: File: *filename* Line: # Column: # The end operator can only be used within an array index expression. You can use the `end` operator in an array index expression such as `sum(A(:, end))`. You cannot use the `end` operator outside of such an expression, for example, `y = 1 + end`.

Error: File: *filename* Line: # Column: # The name "*parametername*" occurs twice as an input parameter. The variable names specified on the function declaration line must be unique. For example,

```
function foo(bar1, bar2)     % Correct
function foo(bar, bar)       % Incorrect
```

Error: File: *filename* Line: # Column: # The name "*parametername*" occurs twice as an output parameter. The variable names specified on the function declaration line must be unique. For example,

```
function [bar1, bar2] = foo  % Correct
function [bar, bar] = foo    % Incorrect
```

Error: File: *filename* Line: # Column: # The '*operatorname*' operator may only produce a single output. The primitive operator produces only a single output. For example,

```
x = 1:10;                    % is correct
[x, y] = 1:10;               % is incorrect
```

Error: File: *filename* Line: # Column: # The PERSISTENT declaration must precede any use of the variable *variablename*. In the text of the function, there is a reference to the variable before the persistent declaration.

Error: File: *filename* Line: # Column: # The single colon operator (:) can only be used within an array index expression. You can only use the `:` operator by itself as an array index. For example, `A(:) = 5;` is okay, but `y = :;` is not.

Error: File: *filename* Line: # Column: # The variable *variablename* was mentioned more than once as an input. The argument list has a repeated variable. For example,

```
function y = myfun(x, x)     % Incorrect
```

Error: File: *filename* Line: # Column: # The variable *variablename* was mentioned more than once as an output. The return value vector has a repeated variable. For example,

```
function [x, x] = myfun(y)   % Incorrect
```

Error: File: *filename* Line: # Column: # This statement is incomplete. Variable arguments cannot be made global or persistent. The variables `varargin` and `varargout` are not like other variables. They cannot be declared either global or persistent. For example,

```
global varargin              % Incorrect
```

Error: File: *filename* Line: # Column: # Variable argument (varargin) must be last in input argument list. The function call must specify the required arguments first followed by `varargin`. For example,

```
function [out1, out2] = example1(a, b, varargin)   % Correct
function [out1, out2] = example1(a, varargin, b)   % Incorrect
```

Error: File: *filename* Line: # Column: # Variable argument (varargout) must be last in output argument list. The function call must specify the required arguments first followed by `varargout`. For example,

```
function [i, j, varargout]= ex2(x1, y1, x2, y2, val)% Correct
function [i, varargout, j]= ex2(x1, y1, x2, y2, val)% Incorrect
```

Error: File: *filename* Line: # Column: # *variablename* has been declared both as GLOBAL and PERSISTENT. Declare variables as either `GLOBAL` or `PERSISTENT`.

Error: Found illegal whitespace character in command line option: "*string*". The strings on the left and right side of the space should be separate arguments to MCC. For example,

```
mcc('-A', 'none')            % Correct
mcc('-A none')               % Incorrect
```

Error: Improper usage of option *-optionname*. Type "mcc -?" for usage information. You have incorrectly used a Compiler option. For more information about Compiler options, see the section, "MATLAB Compiler Option Flags," in Chapter 7 or type `mcc -?` at the command prompt.

Error: "*languagename*" is not a known language. The dialect option was given a language argument for which there is no support yet. For example,

```
mcc -m -D japanese sample.m  % Correct
mcc -m -D german sample.m    % Incorrect
```

Error: *libraryname* library not found. MATLAB has been installed incorrectly.

Error: MEX-File "*mexfilename*" cannot be compiled into P-Code. Only M-files can be compiled into P-code; MEX-files cannot be compiled into P-code.

Error: No source files were specified (-? for help). You must provide the Compiler with the name of the source file(s) to compile.

Error: On UNIX, the name of an MLIB-file must begin with the letters "lib". '*filename*' does not adhere to this rule. The `mlib` file specified on the command line does not start with the letters "lib" and the file being compiled uses procedures in that library.

Error: "*optionname*" is not a valid *-option* option argument. You must use an argument that corresponds to the option. For example,

```
mcc -L Cpp …                 % Correct
mcc -L COBOL …               % Incorrect
```

Error: Out of memory. Typically, this message occurs because the Compiler requests a larger segment of memory from the operating system than is currently available. Adding additional memory to your system could alleviate this problem.

Error: Previous warning treated as error. When you use the `-w error` option, this error displays immediately after a warning message.

Error: The argument after the *-option* option must contain a colon. The format for this argument requires a colon. For more information, see "MATLAB Compiler Option Flags," in Chapter 7 or type `mcc -?` at the command prompt.

Error: The environment variable MATLAB must be set to the MATLAB root directory. On UNIX, the `MATLAB` and `LM_LICENSE_FILE` variables must be set. The `mcc` shell script does this automatically when it is called the first time.

Error: The file *filename* cannot be written. When generating an `mlib` file, the Compiler cannot write out the `mlib` file.

Error: The license manager failed to initialize (error code is *errornumber*). You do not have a valid Compiler license or no additional Compiler licenses are available.

Error: The option -*option* is invalid in *modename* mode (specify -? for help). The specified option is not available.

Error: The option -*option* must be immediately followed by whitespace (e.g. "*proper_example_usage*"). These options require additional information, so they cannot be combined.
`-A`, `-B`, `-d`, `-f`, `-F`, `-I`, `-L`, `-M`, `-o`, `-T`, `-u`, `-W`, `-x`, `-y`, `-Y`, `-z`.

For example, you can use `mcc -vc`, but you cannot use
`mcc -Ac annotation:all`.

Error: The options specified will not generate any output files.
Please use one of the following options to generate an executable output file:
-x (generates a MEX-file executable using C)
-m (generates a stand-alone executable using C)
-p (generates a stand-alone executable using C++)
-S (generates a Simulink MEX S-function using C)
-B sgl (generates a stand-alone graphics library executable using C (requires the SGL))
-B sglcpp (generates a stand-alone graphics library executable using C++ (requires the SGL))
-B pcode (generates a MATLAB P-code file)
Or type mcc -? for more usage information. Use one of these options or another option that generates output file(s). See the section, "MATLAB Compiler Option Flags," in Chapter 7 or type `mcc -?` at the command prompt for more information.

Error: The specified file "*filename*" cannot be read. There is a problem with your specified file. For example, the file is not readable because there is no read permission.

Error: The -*option* option cannot be combined with other options. The `-V2.0` option must appear separate from other options on the command line. For example,

```
mcc -V2.0 -L Cpp …          % Correct
mcc -V2.0L Cpp …            % Incorrect
```

Error: The -*optionname* option requires an argument (e.g. "*proper_example_usage*"). You have incorrectly used a Compiler option. For more information about Compiler options, see the section, “MATLAB Compiler Option Flags,” in Chapter 7 or type `mcc -?` at the command prompt.

Error: This version of MCC does not support the creation of C++ MEX code. You cannot create C++ MEX functions with the current Compiler.

Error: Unable to open file "*filename*":<string>. There is a problem with your specified file. For example, there is no write permission to the output directory, or the disk is full.

Error: Unable to set license linger interval (error code is *errornumber*). A license manager failure has occurred. Contact Technical Support at The MathWorks with the full text of the error message.

Error: Uninterpretable number of inputs set on command line "*commandline*". When generating a simulink S-function, the inputs specified on the command line was not a number. For example,

```
mcc -S -u 2 sample.m        % Correct
mcc -S -u a sample.m        % Incorrect
```

Error: Uninterpretable number of outputs set on command line "*commandline*". When generating a simulink S-function, the outputs specified on the command line was not a number. For example,

```
mcc -S -y 2 sample.m        % Correct
mcc -S -y a sample.m        % Incorrect
```

Error: Uninterpretable width set on command line "*commandline*". The argument to the page width option was not interpretable as a number.

Error: Unknown annotation option: *optionname*. An invalid string was specified after the `-A` option. For a complete list of the valid annotation options, see “MATLAB Compiler Option Flags,” in Chapter 7 or type `mcc -?` at the command prompt.

Error: Unknown typesetting option: *optionname*. The valid typesetting options available with `-F` are `expression-indent:n`, `list`, `page-width`, and `statement-indent:n`.

Error: Unknown warning enable/disable string: *warningstring*. `-w enable:`, `-w disable:`, and `-w error:` require you to use one of the warning string identifiers listed in the "Warning Messages" on page B-12.

Error: Unrecognized option: *-option*. The option is not one of the valid options for this version of the Compiler. See the section, "MATLAB Compiler Option Flags," in Chapter 7 for a complete list of valid options for Compiler 2.1 or type `mcc -?` at the command prompt.

Error: Use "-V2.0" to specify desired version. You specified `-V` without a version number. You must use `-V2.0` if you specify a version number.

Error: *versionnumber* is not a valid version number. Use "-V2.0". If you specify a Compiler version number, it must be `-V2.0`. The default is `-V2.0`.

Warning Messages

This section lists the warning messages that the MATLAB Compiler 2.1 can generate. Using the `-w` option for `mcc`, you can control which messages are displayed. Each warning message contains a description and the warning message identifier string (in parentheses) that you can enable or disable with the `-w` option. For example, to enable the display of warnings related to undefined variables, you can use

```
mcc -w enable:undefined_variable …
```

To enable all warnings except those generated by the `save` command, use

```
mcc -w enable -w disable:save_options …
```

To display a list of all the warning message identifier strings, use

```
mcc -w list
```

For additional information about the `-w` option, see “MATLAB Compiler Option Flags” in Chapter 7.

Warning: (PM) Warning: *message*. *(path_manager_warning)* The path manager can experience file I/O problems when reading the directory structure (permissions).

Warning: (PMI): *message*. *(path_manager_inform)* This is an informational path manager message.

Warning: A line has *number* characters, violating the maximum page width *width*. *(max_page_width_violation)* To increase the maximum page width, use the `-F page-width:n` option and set `n` to a larger value.

Warning: File: *filename* Line: # Column: # A BREAK statement appeared outside of a loop. This BREAK is interpreted as a RETURN. *(break_without_loop)* The `break` statement should be used in conjunction with the `for` or `while` statements. When not used in conjunction with these statements, the `break` statement acts as a `return` from a function.

Warning: File: ***filename*** **Line: # Column: # The call to function "*functionname*" on this line could not be bound to a function that is known at compile time. A run-time error will occur if this code is executed.** *(no_matching_function)* The called function was not found on the search path.

Warning: File: ***filename*** **Line: # Column: # Attempt to clear *value* when it has not been previously defined.** *(clear_undefined_value)* The variable was cleared with the `clear` command prior to being defined.

Warning: File: ***filename*** **Line: # Column: # Future versions of MATLAB will require that whitespace, a comma, or a semicolon separate elements of a matrix. Please type "help matrix_element_separators" at the MATLAB prompt for more information.** *(separator_needed)* It is still possible to leave out all separators when constructing a matrix. For example, `[5.5.5]` has no separators. It is equivalent to [5.5, 0.5].

Warning: File: ***filename*** **Line: # Column: # References to "*functionname*" require the C/C++ Graphics Library when executing in stand-alone mode. You must specify -B sgl or -B sglcpp in order to use the C/C++ Graphics Library. A run-time error will occur if the C/C++ Graphics Library is not present.** *(using_graphics_function)* This warning is produced when a Graphics Library call is present in the code. It is only generated when producing the main or library wrapper and not during normal compilation, unless it is specifically enabled.

Warning: File: ***filename*** **Line: # Column: # References to "*variablename*" will produce a run-time error because it is an undefined function or variable.** *(undefined_variable_or_unknown_function)* This warning appears if you refer to a variable but never provide it with a value. The most likely cause of this warning is when you call a function that is not on the path or it is a method function. **Note** Inline objects are not supported in this release and will produce this warning when used.

Warning: File: ***filename*** **Line: # Column: # The #function pragma expects a list of function names.** *(pragma_function_missing_names)* This pragma informs the MATLAB Compiler that the specified function(s) provided in the list of function names will be called through an `feval` call. This is used so that the `-h` option will automatically compile the selected functions.

Warning: File: *filename* Line: # Column: # The call to function "*functionname*" on this line passed *quantity1* inputs and the function is declared with *quantity2*. A run-time error will occur if this code is executed. *(too_many_inputs)* There is an inconsistency between the number of formal and actual inputs to the function.

Warning: File: *filename* Line: # Column: # The call to function "*functionname*" on this line requested *quantity1* outputs and the function is declared with *quantity2*. A run-time error will occur if this code is executed. *(too_many_outputs)* There is an inconsistency between the number of formal and actual outputs for the function.

Warning: File: *filename* Line: # Column: # The clear function cannot process the "*optionname*" argument in compiled code. *(clear_cannot_handle_flag)* You cannot use `clear variables`, `clear mex`, `clear functions`, or `clear all` in compiled M-code.

Warning: File: *filename* Line: # Column: # The clear statement did not specifically list the names of variables to be cleared as constant strings. A run-time error will be reported if this code is executed. *(clear_non_constant_strings)* Use one of the forms of the `clear` command that contains the names of the variables to be cleared. Use `clear name` or `clear('name')`; do not use `clear(name)`.

Warning: File: *filename* Line: # Column: # The Compiler does not support the *optionname* option to save. This option is ignored. *(save_option_ignored)* You cannot use `-ascii`, `-double`, or `-tabs` with the `save` command in compiled M-code.

Warning: File: *filename* Line: # Column: # The filename provided to load (save) was a cell array or structure index that could possibly expand into a comma separated list. An error will occur at run-time if a comma list is present for the filename. *(load_save_filename)* The Compiler needs to know statically the number of variables that are involved in a `load` or `save`. If a cell array is involved, the Compiler cannot make that determination, and the generated code may behave differently from MATLAB.

Warning: File: *filename* Line: # Column: # The "*functionname*" function is only available in MEX mode. A run-time error will occur if this code is executed in stand-alone mode. *(using_mex_only_function)* This warning is produced if you call any built-in function that is only available in `mex` mode. It is only generated when producing the main or lib wrapper and not during normal compilation, unless specifically enabled.

Warning: File: ***filename*** **Line: # Column: # The load statement cannot be translated unless it specifically lists the names of variables to be loaded as constant strings.** *(load_without_constant_strings)* Use one of the forms of the `load` command that contains the names of the variables to be loaded, for example, `load filename num` or `y = load('filename')`

Warning: File: ***filename*** **Line: # Column: # The logical expression(s) involving OR and AND operators may have returned a different result in previous versions of MATLAB due to a change in logical operator precedence. Use parentheses to make your code insensitive to this change. Please type "help precedence" for more information.** *(and_or_precedence)* Starting in MATLAB 6.0, the precedence of the logical AND (`&`) and logical OR (`|`) operators now obeys the standard relationship (AND being higher precedence than OR) and the formal rules of boolean algebra as implemented in most other programming languages, as well as Simulink and Stateflow.

Previously, MATLAB would incorrectly treat the expression

```
y = a&b | c&d
```

as

```
y = (((a&b) |c) &d);
```

It now correctly treats it as

```
y = (a&b) | (c&d);
```

The form, `y = a&b | c&d`, will not elicit the warning message from the Compiler. We recommend that you use parentheses to get the same behavior now and in the future.

Warning: File: ***filename*** **Line: # Column: # The MATLAB Compiler does not currently support MATLAB object-oriented programming. References to the method "*methodname*" will produce a run-time error.** *(matlab_method_used)* This warning occurs if the file being compiled references a function that has only a method definition.

Warning: File: ***filename*** **Line: # Column: # The save statement cannot be translated unless it specifically lists the names of variables to be saved as constant strings.** *(save_without_constant_strings)* Use one of the forms of the `save` command that contains the names of the variables to be saved, for example, `save filename num`

Warning: File: *filename* Line: # Column: # The second output argument from the "*functionname*" function is only available in MEX mode. A run-time error will occur if this code is executed in stand-alone mode. *(unix_dos_second_argument)* The DOS command can be called with two output arguments. That form cannot be compiled in stand-alone mode. This warning occurs if the DOS command was called with two output arguments in a file that is being compiled in stand-alone mode. For example,

```
[r, s] = dos('ls'); % causes a warning when compiling stand-alone
```

Warning: File: *filename* Line: # Column: # This load (save) statement referred to variable "*variablename*" that was not referenced in the function. *(load_save_unreferenced)* This warning occurs if a variable is loaded (saved) via a load (save) command, but then does not occur elsewhere in scope.

Warning: File: *filename* Line: # Column: # Unmatched "end". *(end_without_block)* The `end` statement does not have a corresponding `for`, `while`, `switch`, `try`, or `if` statement.

Warning: File: *filename* Line: # Column: # Unrecognized Compiler pragma "*pragmaname*". *(unrecognized_pragma)* Use one of the Compiler pragmas as described in Chapter 7, "Reference."

Warning: File: *filename* Line: # Column: # *name* has been used as both a function and a variable, the variable is ignored. *(inconsistent_variable)* When a name represents both a function and a variable, it is used as the function only.

Warning: File: *filename* Line: # Column: # "*variablename*" has not been defined prior to use on this line. *(undefined_variable)* Variables should be defined prior to use.

Warning: Line: # Column: # Function with duplicate name "*functionname*" cannot be called. *(duplicate_function_name)* This warning occurs when an M-file contains more than one function with the same name.

Warning: *filename* is a P-file being referenced from "*filename*". NOTE: A link error will be produced if a call to this function is made from stand-alone mode. *(mex_or_p_file)* The Compiler cannot generate a call to a function in a P-file for stand-alone code. The warning occurs if a call to a function that is defined in a P-file is detected.

Warning: M-file "*filename*" was specified on the command line with full path of "*pathname*", but was found on the search path in directory "*directoryname*" first.
(specified_file_mismatch) The Compiler detected an inconsistency between the location of the M-file as given on the command line and in the search path. The Compiler uses the location in the search path. This warning occurs when you specify a full pathname on the `mcc` command line and a file with the same base name (filename) is found earlier on the search path. This warning is issued in the following example if the file `afile.m` exists in both `dir1` and `dir2`.

```
mcc -x -I /dir1 /dir2/afile.m
```

Warning: No M-function source available for "*functionname*", assuming function [varargout] = *functionname*(varargin) NOTE: This will produce a link error in stand-alone code unless you provide a handwritten definition for this function.
(using_stub_function) The Compiler found a `.p` or `.mex` version of the function and is substituting a generic function declaration in its place.

Warning: Overriding the -F page-width setting to *width* due to presence of -A line:on setting.
(page_width_override) The `-A line:on` setting overrides the page width. This warning reminds you that the `-F` setting, although present, has no effect.

Warning: The function "*functionname*" is an intrinsic MATLAB function. The signature of the function found in file "*filename*" does not match the known signature for this function:
known number of inputs = *quant1*,found number of inputs = *quant2*
known number of outputs = *quant1*found number of outputs = *quant2*
known varargin used = *quant1*,found varargin used = *quant2*
known varargout used = *quant1*,found varargout used = *quant2*
known nargout used = *quant1*,found nargout used = *quant2*.
(*builtin_signature_mismatch*) When compiling an M-file that is contained in The MathWorks libraries, the number of inputs/outputs and the signatures to the function must match exactly.

Warning: The file *filename* was repeated on the Compiler command line. *(repeated_file)* This warning occurs when the same filename appears more than once on the compiler command line. For example,

```
mcc -x sample.m sample.m % will generate the warning
```

Warning: The name of a shared library should begin with the letters "lib". "*libraryname*" doesn't. *(missing_lib_sentinel)* This warning is generated if the name of the specified library does not begin with the letters "lib". This warning is specific to UNIX and does not occur on Windows. For example,

```
mcc -t -W lib:liba -T link:lib a0 a1 % no warning
mcc -t -W lib:a -T link:lib a0 a1    % will generate a warning
```

Warning: The option *optionname* is ignored in *modename* mode (specify -? for help). (*switch_ignored*) *Modename* = 1.2 or 2.0. Certain options only have meaning in one or the other mode. For example, if you use the `-e` option, you can't use the `-V2.0` option. For more information about Compiler options, see the section, "MATLAB Compiler Option Flags," in Chapter 7.

Warning: The specified private directory is not unique. Both "*directoryname1*" and "*directoryname2*" are found on the path for this private directory. *(duplicate_private_directories)* The Compiler cannot distinguish which private function to use. For more information, see "Compiling Private and Method Functions" in Chapter 5.

Run-Time Errors

Note The error messages described in this section are generated by the Compiler into the code exactly as they are written, but are not the only source of run-time errors. You also can receive run-time errors can from the C/C++ Math Libraries; these errors are not documented in this book. Math Library errors do not include the source file and line number information. If you receive such an error and are not certain if it is coming from the C/C++ Math Libraries or your M-code, compile with the `-A debugline:on` option to get additional information about which part of the M source code is causing the error. For more information about `-A` (the annotation option), see "Code Generation Options" in Chapter 7.

Run-time Error: File: *filename* Line: # Column: # The call to function "*functionname*" that appeared on this line was not a known function at compile time. The function was not found at compile time.

Run-time Error: File: *filename* Line: # Column: # The call to function "*functionname*" on this line passed *quantity1* inputs and the function is declared with *quantity2*. There is an inconsistency between the formal and actual number of inputs to a function.

Run-time Error: File: *filename* Line: # Column: # The call to function "*functionname*" on this line requested *quantity1* outputs and the function is declared with *quantity2*. There is an inconsistency between the formal and actual number of outputs from a function.

Run-time Error: File: *filename* Line: # Column: # The clear statement did not specifically list the names of variables to be cleared as constant strings. Use one of the forms of the `clear` command that contains the names of the variables to be cleared, for example, `clear name`.

Run-time Error: File: *filename* Line: # Column: # The Compiler does not support EVAL or INPUT functions. Currently, these are unsupported functions.

Run-time Error: File: *filename* Line: # Column: # The function "*functionname*" was called with more than the declared number of inputs (*quantity1*). There is an inconsistency between the declared number of formal inputs and the actual number of inputs.

Run-time Error: File: *filename* Line: # Column: # The function "*functionname*" was called with more than the declared number of outputs (*quantity1*). There is an inconsistency between the declared number of formal outputs and the actual number of outputs.

Run-time Error: File: *filename* Line: # Column: # The load statement did not specifically list the names of variables to be loaded as constant strings. Use one of the forms of the `load` command that contains the names of the variables to be loaded, for example, `load filename num value`.

Run-time Error: File: *filename* Line: # Column: # The save statement did not specifically list the names of variables to be saved as constant strings. Use one of the forms of the `save` command that contains the names of the variables to be saved, for example, `save testdata num value`.

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