

# MATLAB<sup>®</sup> Compiler

## The Language of Technical Computing

- Computation
- Visualization
- Programming

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### *MATLAB Compiler User's Guide*

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# Getting Started

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This chapter introduces the MATLAB® Compiler and its uses. It also provides a quick start section that highlights the steps needed to create and deploy applications and components.

Introduction (p. 1-2)	A brief overview
Upgrading from Previous Compiler Releases (p. 1-4)	Compatibility between releases
Uses of the MATLAB Compiler (p. 1-5)	High-level descriptions of what the MATLAB Compiler can do
Quick Start (p. 1-8)	Summarizes the basic steps to create and deploy stand-alone applications and libraries
Limitations and Restrictions (p. 1-15)	Restrictions regarding what can be compiled
MATLAB Compiler Licensing (p. 1-21)	How the MATLAB Compiler license model works

## Introduction

MATLAB Compiler Version 4 takes M-files as input and generates redistributable, stand-alone applications or software components. These resulting applications and components are platform specific. The MATLAB Compiler can generate these kinds of applications or components:

- Stand-alone applications. Stand-alone applications do not require MATLAB at run-time; they can run even if MATLAB is not installed on the end-user's system.
- C and C++ shared libraries (dynamically linked libraries, or DLLs, on Microsoft Windows). These can be used without MATLAB on the end-user's system.
- Excel add-ins; requires MATLAB Builder for Excel
- COM objects; requires MATLAB Builder for COM

The MATLAB Compiler supports all the functionality of MATLAB, including objects. In addition, no special considerations are necessary for private and method functions; they are handled by the Compiler.

---

**Note** Some toolboxes will not compile with MATLAB Compiler 4. Particular functionality of some toolboxes will also not compile. For more information regarding the compilability of toolboxes, see the MATLAB Compiler product page on the Web.

---

## Before You Begin

Before reading this book, you should already be comfortable writing M-files. If you are not, see Programming in the MATLAB documentation.

It is useful to note the distinction between the MATLAB Compiler and the MATLAB interpreter. The *MATLAB interpreter* refers to the application that accepts MATLAB commands, executes M-files and MEX-files, and behaves as described in the MATLAB documentation. When you use MATLAB, you are using the MATLAB interpreter. The *MATLAB Compiler* refers to this product, which takes M-files as input and generates stand-alone applications or software components. The MATLAB Compiler is invoked with the `mcc` command.

---

**Note** 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.

---

## Upgrading from Previous Compiler Releases

MATLAB Compiler 4 is compatible with previous releases of the Compiler. M-files that you compiled with a previous version of the MATLAB Compiler should compile with this version.

You can recompile any of your existing M-files that are compatible with MATLAB Release 14 products. There are no restrictions on the contents of your M-files other than compatibility with Release 14.

In MATLAB Compiler 4, the generated API is different from previous versions of the Compiler. If you develop software components, you will need to adjust to the new API. See Appendix D, “C++ Utility Library Reference,” for more information.

### Differences Between Compiler Releases

MATLAB Compiler 4 is significantly different from previous versions of the Compiler. These differences are described in the MATLAB Compiler Release Notes. The Release Notes also include enhancements, bug fixes, and known software and documentation problems for each release of the MATLAB Compiler subsequent to MATLAB Compiler 4 (Release 14).



## Uses of the MATLAB Compiler

This section introduces the various targets that the MATLAB Compiler can generate. You can find complete information about these targets and how to generate them in the corresponding sections throughout this book.

- Stand-Alone Applications
- Libraries
- COM Objects
- Excel Add-ins

### Wrapper Files

The MATLAB Compiler (`mcc`) generates redistributable, stand-alone applications or software components from M-files. The specific final target can be any of the supported component types including stand-alone executable, library, or component. The Compiler generates the appropriate *wrapper* file based on the desired target. A wrapper file contains the required interface between the compiled application and the supported executable type.

Wrapper files differ depending on the execution environment. To provide the required interface, the wrapper

- Performs wrapper-specific initialization and termination.
- Defines data arrays containing path information, encryption keys, and other information needed by the MATLAB Component Runtime (MCR).
- Provides the necessary code to forward calls from the interface functions to the MATLAB functions in the MCR.

For example, the wrapper for a stand-alone executable contains the main function. The wrapper for a library contains the entry points for each public M-file function. You can find additional details specific to each wrapper type in each target's chapter throughout this book.

The Component Technology File (CTF) produced by the MATLAB Compiler is independent of the final target type — executable or library, but the CTF archive is platform specific. The wrapper file provides the necessary interface to the target type.

## Stand-Alone Applications

The MATLAB Compiler, when invoked with the `-m` macro option, takes the input M-files and produces the required wrapper file suitable for a stand-alone application. Then, your C or C++ compiler compiles this code and links against the MCR, which is a stand-alone set of shared libraries that enable the execution of M-files. For example, to generate a stand-alone executable from the file `example.m`, use

```
mcc -m example
```

For overview information on creating stand-alone applications and deploying them, see “Quick Start” on page 1-8. For detailed information on stand-alone applications, see Chapter 6, “Stand-Alone Applications.”

## Libraries

### C Shared Library

You can use the `-l` option to create a C shared library from a set of M-files. For example

```
mcc -l file1.m file2.m file3.m
```

The `-l` option is a bundle option that expands into

```
-W lib -T link:lib
```

The `-W lib` option tells the MATLAB Compiler to generate a function wrapper for a shared library and call it `libfile1`. The `-T link:lib` option specifies the target output as a shared library. For overview information on creating shared libraries and deploying them, see “Quick Start” on page 1-8. For detailed information on creating libraries, see Chapter 7, “Libraries.”

### C++ Shared Library

The procedure for creating a C++ shared library from M-files is identical to the procedure for creating a C shared library, except you use the `cpplib` wrapper. For example

```
-W cpplib -T link:lib
```

## Builder Products

### MATLAB Builder for COM

With the optional MATLAB Builder for COM, you can create COM components that can be used in any application that works with COM objects.

MATLAB Builder for COM lets you convert MATLAB M-files to Common Object Model (COM) objects that are accessible from Visual Basic, C/C++, Microsoft Excel, or any other COM client. The collection of M-files is translated into a single COM class. MATLAB Builder for COM supports multiple classes per component.

For more information on MATLAB Builder for COM, see the MathWorks Web site (<http://www.mathworks.com/products/combuilder/>).

### MATLAB Builder for Excel

With the optional MATLAB Builder for Excel, you can automatically generate a Visual Basic Application file (.bas) and a plug-in DLL from your MATLAB model that can be imported into Excel as a stand-alone function. Users can then call or use their MATLAB based algorithms the same way as other Excel add-ins.

MATLAB Builder for Excel compiles MATLAB M-files into a COM object that can be used as an Excel plug-in. The collection of M-files is translated into a single Excel plug-in. MATLAB Builder for Excel supports one class per component.

For more information on MATLAB Builder for Excel, see the MathWorks Web site (<http://www.mathworks.com/products/matlabxl/>).

---

**Note** MATLAB Builder for COM and MATLAB Builder for Excel are available only on Windows.

---

## Quick Start

---

**Note** From time to time, additional Compiler examples may be added to the File Exchange section of MATLAB Central on the MathWorks Web site. You can check for these examples at the File Exchange.

---

This section provides the basic steps of how to use the MATLAB Compiler to create components (applications and libraries) from MATLAB M-files. These components can then be deployed to machines that do not have MATLAB installed on them.

This quick start is for users who only want to know the basic steps to follow to create components. If your needs are more advanced or you want background information on the process, you will need to browse through the book and locate what you need.

---

**Note** Before you can use the Compiler, you must have it installed and configured properly on your system. Refer to Chapter 2, “Installation and Configuration” for more information. At a minimum, you must run `mbuild -setup` once after installing a new version of the MATLAB Compiler.

---

### Compiling a Stand-Alone Application

To create a stand-alone application from the M-file `mymfunction`, use the command

```
gcc -m mymfunction.m
```

This creates a stand-alone executable named `mymfunction.exe` on Windows and `mymfunction` on UNIX.

### Compiling a Shared Library

To create a shared library from the M-file `mymfunction`, use the command

```
gcc -l mymfunction.m
```

---

This creates a shared library named `mymfunction.dll` on Windows and `mymfunction.so` on UNIX.

---

**Note** The extension for a shared library on HP-UX is `.sl`, so this shared library is named `mymfunction.sl` on HP-UX machines. This book uses `.so` as the extension for UNIX shared libraries, so HP-UX users need to use the proper extension.

---

### Stand-Alone Application That Calls a Library

To create a stand-alone (driver) application from a user-written source file named `mydrivercode` that calls the above library `mymfunction`, use the command

```
mbuild mydrivercode.c mymfunction.lib           (On Windows)
mbuild mydrivercode.c mymfunction.so           (On UNIX)
```

---

**Note** You must call `mclInitializeApplication` once at the beginning of your driver application. You must make this call before calling any other MathWorks functions. You must also call your library's initialization routine before calling any functions in your library. See "Calling a Shared Library" on page 7-9 for more information.

---

### Testing Components on Development Machine

To test components on your development machine, make sure you have your path set properly. The following sections show how to set the path for each supported platform.

---

**Note** `<matlabroot>` refers to the complete path where MATLAB is installed on your machine.

---

## Windows

Add the following directory to your system PATH environment variable.

```
<matlabroot>\bin\win32
```

## UNIX

Add the following platform-specific directories to your dynamic library path.

---

**Note** For readability, the following commands appear on separate lines, but you must enter each setenv command on one line.

---

### Linux.

```
setenv LD_LIBRARY_PATH
<matlabroot>/sys/os/glnx86:
<matlabroot>/bin/glnx86:
<matlabroot>/sys/java/jre/glnx86/jre1.5.0/lib/i386/native_threads:
<matlabroot>/sys/java/jre/glnx86/jre1.5.0/lib/i386/client:
<matlabroot>/sys/java/jre/glnx86/jre1.5.0/lib/i386:

setenv XAPPLRESDIR <matlabroot>/X11/app-defaults
```

### Solaris.

```
setenv LD_LIBRARY_PATH
/usr/lib/lwp:
<matlabroot>/sys/os/sol2:
<matlabroot>/bin/sol2:
<matlabroot>/sys/java/jre/sol2/jre1.5.0/lib/sparc/native_threads:
<matlabroot>/sys/java/jre/sol2/jre1.5.0/lib/sparc/client:
<matlabroot>/sys/java/jre/sol2/jre1.5.0/lib/sparc:

setenv XAPPLRESDIR <matlabroot>/X11/app-defaults
```

### Linux x86-64.

```
setenv LD_LIBRARY_PATH
<matlabroot>/sys/os/glnxa64:
<matlabroot>/bin/glnxa64:
<matlabroot>/sys/java/jre/glnxa64/jre1.4.2/lib/amd64/native_threads:
<matlabroot>/sys/java/jre/glnxa64/jre1.4.2/lib/amd64/client:
<matlabroot>/sys/java/jre/glnxa64/jre1.4.2/lib/amd64:

setenv XAPPLRESDIR <matlabroot>/X11/app-defaults
```

## HP-UX.

```
setenv SHLIB_PATH
<matlabroot>/sys/os/hpux:
<matlabroot>/bin/hpux:
<matlabroot>/sys/java/jre/hpux/jre1.4.1/lib/PA_RISC2.0/server:
<matlabroot>/sys/java/jre/hpux/jre1.4.1/lib/PA_RISC2.0

setenv LD_PRELOAD
<matlabroot>/sys/java/jre/hpux/jre1.4.1/lib/PA_RISC2.0/server/libjvm.sl

setenv XAPPLRESDIR <matlabroot>/X11/app-defaults
```

You can then run the compiled applications on your development machine to test them.

## Deploying Components to Other Machines

To deploy your component to a target machine that does not have the same version of MATLAB installed as your development machine (or any version of MATLAB for that matter), you need to package the components and configure the target machines as follows.

---

**Note** <mcr\_root> refers to the complete path where the MCR library archive files are installed on your machine. Since <mcr\_root> is version specific, you also need to include <ver>, which you can determine after you install the MCR.

---

## Windows

- Your component, i.e., the stand-alone executable or shared library
- The CTF archive that the Compiler creates for your component (<component\_name>.ctf)
- MCRInstaller.exe (This file is located in the <matlabroot>\toolbox\compiler\deploy\win32 directory.)

On the target machine, do the following:

- 1 Install the MCR by running `MCRInstaller.exe`. During the installation process, you will be prompted for a directory in which to install the MCR, for example, `C:\MCR`.
- 2 Copy the component and CTF archive to your application root directory, for example, `C:\approot`.
- 3 Add the following directory to your system path:

```
<mcr_root>\<ver>\runtime\win32
```

---

**Note** On Windows XP, this directory is automatically added to your path.

---

- 4 Test the component.

## UNIX

- Your component, i.e., the stand-alone executable or shared library
- The CTF archive that the Compiler creates for your component (`<component_name>.ctf`)
- `MCRInstaller.zip`

To create `MCRInstaller.zip`, execute the following command at the MATLAB command prompt.

```
buildmcr
```

This command puts `MCRInstaller.zip` in the directory `<matlabroot>/toolbox/compiler/deploy/<ARCH>`, where `<ARCH>` is your system architecture, Linux = `glnx86`, Solaris = `sol2`, x86-64 = `glnxa64`, and HP = `hpux`. If you do not have write access to this directory, you can specify the destination directory as an input to `buildmcr`.



On the target machine, do the following:

- 1 Install the MCR by unzipping `MCRInstaller.zip` in a directory, for example, `/home/<user>/MCR`. You may choose any directory except `<matlabroot>` or any directory below `<matlabroot>`.
- 2 Copy the component and CTF archive to your application root directory, for example, `/home/<user>/approot`.
- 3 Add the following platform-specific directories to your dynamic library path.

---

**Note** For readability, the following commands appear on separate lines, but you must enter each `setenv` command on one line.

---

#### Linux.

```
setenv LD_LIBRARY_PATH
  <mcr_root>/<ver>/runtime/glnx86:
  <mcr_root>/<ver>/sys/os/glnx86:
  <mcr_root>/<ver>/sys/java/jre/glnx86/jre1.5.0/lib/i386/native_threads:
  <mcr_root>/<ver>/sys/java/jre/glnx86/jre1.5.0/lib/i386/client:
  <mcr_root>/<ver>/sys/java/jre/glnx86/jre1.5.0/lib/i386:
setenv XAPPLRESDIR <mcr_root>/<ver>/X11/app-defaults
```

#### Solaris.

```
setenv LD_LIBRARY_PATH
  /usr/lib/lwp:
  <mcr_root>/<ver>/runtime/sol2:
  <mcr_root>/<ver>/sys/os/sol2:
  <mcr_root>/<ver>/sys/java/jre/sol2/jre1.5.0/lib/sparc/native_threads:
  <mcr_root>/<ver>/sys/java/jre/sol2/jre1.5.0/lib/sparc/client:
  <mcr_root>/<ver>/sys/java/jre/sol2/jre1.5.0/lib/sparc:
setenv XAPPLRESDIR <mcr_root>/<ver>/X11/app-defaults
```

#### Linux x86-64.

```
setenv LD_LIBRARY_PATH
  <mcr_root>/<ver>/runtime/glnxa64:
  <mcr_root>/<ver>/sys/os/glnxa64:
  <mcr_root>/<ver>/sys/java/jre/glnxa64/jre1.4.2/lib/amd64/native_threads:
  <mcr_root>/<ver>/sys/java/jre/glnxa64/jre1.4.2/lib/amd64/client:
  <mcr_root>/<ver>/sys/java/jre/glnxa64/jre1.4.2/lib/amd64:
setenv XAPPLRESDIR <mcr_root>/<ver>/X11/app-defaults
```

## HP-UX.

```
setenv SHLIB_PATH
<mcr_root>/<ver>/runtime/hpux:
<mcr_root>/<ver>/sys/os/hpux:
<mcr_root>/<ver>/bin/hpux:
<mcr_root>/<ver>/sys/java/jre/hpux/jre1.4.1/lib/PA_RISC2.0/server:
<mcr_root>/<ver>/sys/java/jre/hpux/jre1.4.1/lib/PA_RISC2.0

setenv LD_PRELOAD
<mcr_root>/<ver>/sys/java/jre/hpux/jre1.4.1/lib/PA_RISC2.0/server/libjvm.sl

setenv XAPPLRESDIR <mcr_root>/<ver>/X11/app-defaults
```

## 4 Test the component.

## Limitations and Restrictions

### Compiling MATLAB and Toolboxes

The MATLAB Compiler supports the full MATLAB language and almost all MATLAB based toolboxes. However, some limited MATLAB and toolbox functionality is not licensed for compilation.

- Most of the prebuilt graphical user interfaces included in MATLAB and its companion toolboxes will not compile.
- Functionality that cannot be called directly from the command line will not compile.
- Some toolboxes, such as the Symbolic Math Toolbox, will not compile.

The code generated by the MATLAB Compiler is not suitable for embedded applications.

To see a full list of MATLAB Compiler limitations, visit

[http://www.mathworks.com/products/compiler/compiler\\_support.html](http://www.mathworks.com/products/compiler/compiler_support.html).

### MATLAB Code

MATLAB Compiler 4 supports much of the functionality of MATLAB.

However, there are some limitations and restrictions that you should be aware of. This version of the Compiler cannot create interfaces for script M-files (See “Converting Script M-Files to Function M-Files” on page 5-16 for further details.)

### Incorporating Updated M-Files into an Application

From time to time, MathWorks Technical Support distributes new versions of M-files to correct bugs via the Web. To incorporate these changes into your deployed applications, you must first apply the patch and then rerun `buildmcr` to generate an up-to-date version of the `MCRInstaller`. To deploy the bug fixes to your customers, you must ship this new `MCRInstaller` with your new applications and make the installer available to current customers so they may update their installation.

---

**Note** On Windows, rerunning `buildmcr` will only regenerate the `MCRInstaller.zip` ZIP file. It will not regenerate the `MCRInstaller.exe` program. If you run `buildmcr` on Windows, you will need to distribute `MCRInstaller.zip` to your users instead of `MCRInstaller.exe`.

---

## Stand-Alone Applications

There is a set of functions that is not supported in stand-alone mode. These functions fall into these categories:

- Functions that print or report MATLAB code from a function, for example, the MATLAB `help` function or debug functions, will not work.
- Simulink functions, in general, will not work.
- Functions that require a command line, for example, the MATLAB `lookfor` function, will not work.
- `clc`, `home`, and `savepath` will not do anything in deployed mode.

Returned values from stand-alone applications will be 0 for successful completion or a nonzero value otherwise.

In addition, there are functions that have been identified as nondeployable due to licensing restrictions.

**Table 1-1: Unsupported Functions**

add_block	add_line	applescript	close_system
dbclear	dbcont	dbdown	dbquit
dbstack	dbstatus	dbstep	dbstop
dbtype	dbup	delete_block	delete_line
echo	edit	fields	get_param
help	home	inmem	keyboard
linmod	mislocked	mlock	more
munlock	new_system	open_system	pack
rehash	set_param	sim	simget
simset	sldebug	type	

## Fixing Callback Problems: Missing Functions

When the Compiler creates a stand-alone application, it compiles the M-file(s) you specify on the command line and, in addition, it compiles any other M-files that your M-file(s) calls. The Compiler uses a dependency analysis, which determines all the functions on which the supplied M-files, MEX-files, and P-files depend. The dependency analysis may not locate a function if the only place the function is called in your M-file is a call to the function either

- In a callback string, or
- In a string passed as an argument to the `feval` function or an ODE solver.

The Compiler does not look in these text strings for the names of functions to compile.

### Symptom

Your application runs, but an interactive user interface element, such as a push button, does not work. The compiled application issues this error message.

```
An error occurred in the callback : change_colormap
The error message caught was      : Reference to unknown function
change_colormap from FEVAL in stand-alone mode.
```

## Workaround

There are several ways to eliminate this error.

- Using the `##function` pragma and specifying callbacks as strings
- Specifying callbacks with function handles
- Using the `-a` option

**Specifying Callbacks as Strings.** Create a list of all the functions that are specified only in callback strings and pass these functions using separate `##function` pragma statements. (See “Finding Missing Functions in an M-File” on page 1-19 for suggestions about finding functions in callback strings.) This overrides the Compiler’s dependency analysis and instructs it to explicitly include the functions listed in the `##function` pragmas.

For example, the call to the `change_colormap` function in the sample application, `my_test`, illustrates this problem. To make sure the Compiler processes the `change_colormap` M-file, list the function name in the `##function` pragma.

```
function my_test()
% Graphics library callback test application

##function change_colormap

peaks;

p_btn = uicontrol(gcf,...
                'Style', 'pushbutton',...
                'Position',[10 10 133 25 ],...
                'String', 'Make Black & White',...
                'CallBack','change_colormap');
```

**Specifying Callbacks with Function Handles.** To specify the callbacks with function handles, use the same code as in the example above and replace the last line with

```
'CallBack',@change_colormap);
```

For more information on specifying the value of a callback, see [Specifying the Value of Callback Function Properties in the MATLAB Programming documentation](#).

**Using the `-a` Option.** Instead of using the  `%#function` pragma, you can specify the name of the missing M-file on the Compiler command line using the `-a` option.

## Finding Missing Functions in an M-File

To find functions in your application that may need to be listed in a  `%#function` pragma, search your M-file source code for text strings specified as callback strings or as arguments to the  `feval`,  `fminbnd`,  `fminsearch`,  `funm`, and  `fzero` functions or any ODE solvers.

To find text strings used as callback strings, search for the characters “Callback” or “fcn” in your M-file. This will find all the  `Callback` properties defined by Handle Graphics objects, such as  `uicontrol` and  `uimenu`. In addition, this will find the properties of figures and axes that end in  `Fcn`, such as  `CloseRequestFcn`, that also support callbacks.

## Suppressing Warnings on UNIX

Several warnings may appear when you run a stand-alone application on UNIX. This section describes how to suppress these warnings.

- To suppress the  `app-defaults` warnings, set  `XAPPLRESDIR` to point to  `<mcr_root>/<ver>/X11/app-defaults`.
- To suppress the  `libjvm.so` warning, make sure you set the dynamic library path properly for your platform as described in Step 3 of the UNIX section of “Deploying Components to Other Machines” on page 1-11.

You can also use the MATLAB Compiler option  `-R -nojvm` to set your application’s  `nojvm` run-time option, if the application is capable of running without Java.

## No MCR Versioning on HP-UX

The feature that allows you to install multiple versions of the MCR on the same machine is currently not supported on HP-UX. When you receive a new version of MATLAB, you must recompile and redeploy all of your applications and components. Also, when you install a new MCR onto a target machine, you

must delete the old version of the MCR and install the new one. You can only have one version of the MCR on the target machine.



# MATLAB Compiler Licensing

## Deployed Applications

Before you deploy applications or components to your users, you should be aware of the license conditions. Consult the Deployment Addendum in The MathWorks License Agreement at [www.mathworks.com/license](http://www.mathworks.com/license) for terms and conditions of deployment.

## Using MATLAB Compiler Licenses for Development

You can run the MATLAB Compiler from the MATLAB command prompt (MATLAB mode) or the DOS/UNIX prompt (stand-alone mode).

### Running the Compiler in MATLAB Mode

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 the Compiler in Stand-Alone Mode

If you run the Compiler from a DOS or UNIX prompt, 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.

# Installation and Configuration

---

This chapter describes the system requirements for the MATLAB Compiler. It also contains installation and configuration information for both Microsoft Windows and Linux.

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.

System Requirements (p. 2-2)	Software requirements for the MATLAB Compiler and a supported C/C++ compiler
Installation (p. 2-4)	Steps to install the MATLAB Compiler and a supported C/C++ compiler
Configuration (p. 2-7)	Configuring a supported C/C++ compiler to work with the MATLAB Compiler
Special Compiler Notes (p. 2-11)	Known limitations of the supported C/C++ compilers
Options Files (p. 2-12)	More detailed information on MATLAB Compiler options files for users who need to know more about how they work

# System Requirements

To install the MATLAB Compiler, you must have the proper version of MATLAB installed on your system. The MATLAB Compiler Platform & Requirements page, which is accessible from our Web site, provides this information. 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.

The MATLAB Compiler requires that a supported ANSI C or C++ compiler be installed on your system. Certain output targets require particular compilers.

---

**Note** Before you use the MATLAB Compiler for the first time, you must run `mbuild -setup` to configure your C/C++ compiler to work with the MATLAB Compiler.

---

In general, the MATLAB Compiler supports the current release of a third-party compiler and its previous release. Since new versions of compilers are released on a regular basis, it is important to check our Web site for the latest supported compilers.

## Supported Third-Party Compilers

For an up-to-date list of all the compilers supported by MATLAB and the MATLAB Compiler, see the MathWorks Technical Support Department's Technical Notes at

<http://www.mathworks.com/support/tech-notes/1600/1601.shtml>

## Supported ANSI C and C++ Windows Compilers

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). This is a C only compiler; it does *not* work with C++.
- Borland C++ versions 5.3, 5.4, 5.5, 5.6, and free 5.5. (You may see references to these compilers as Borland C++Builder versions 3.0, 4.0, 5.0, and 6.0.) For

more information on the free Borland compiler and its associated command line tools, see <http://community.borland.com>.

- Microsoft Visual C/C++ (MSVC) versions 6.0, 7.0, and 7.1.

---

**Note** The only compiler that supports the building of COM objects and Excel plug-ins is Microsoft Visual C/C++ (versions 6.0, 7.0, and 7.1).

---

### **Supported ANSI C and C++ UNIX Compilers**

The MATLAB Compiler supports the native system compilers on Solaris and HP-UX. On Linux and Linux x86-64, the MATLAB Compiler supports gcc and g++.

# Installation

The MATLAB Compiler requires a supported ANSI C or C++ compiler installed on your system. This section describes the installation of the MATLAB Compiler and an ANSI C or C++ compiler.

## Installing the MATLAB Compiler

### Windows

To install the MATLAB Compiler on Windows, follow the instructions in the Installation Guide for Windows. 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.

You can contact the MathWorks:

- Via the Web at [www.mathworks.com](http://www.mathworks.com). On the MathWorks home page, click on Support, then click on the Access Login, and follow the instructions.
- Via e-mail at [service@mathworks.com](mailto:service@mathworks.com)

### UNIX

To install the MATLAB Compiler on UNIX workstations, follow the instructions in the 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`).

## Installing an 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.

---

**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.

---

When you install your C or C++ compiler, you might encounter configuration questions that require you to provide particular details. These tables provide information on some of the more common issues.

### Windows

Issue	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 (MFC)	This is 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.

### Windows (Continued)

Issue	Comment
Updating the registry	If your installer gives you the option of updating the registry, you should do it.
Installing Microsoft Visual C/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.

### UNIX

Issue	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.



---

## Configuration

This section describes how to configure a C or C++ compiler to work with the MATLAB Compiler. There is a MATLAB utility called `mbuild` that simplifies the process of setting up a C or C++ compiler. Typically, you only need to use the `mbuild` utility's `setup` option to initially specify which third-party compiler you want to use. For more information on the `mbuild` utility, see the `mbuild` reference page.

---

**Note** In many cases, especially if you have the latest release of a third-party C/C++ compiler installed in its default location, you do not need to run `mbuild -setup`. However, there is no harm in doing so.

---

### Introducing the `mbuild` Utility

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
- Build your application

The MATLAB Compiler (`mcc`) automatically invokes `mbuild` under certain conditions. In particular, `mcc -m` or `mcc -l` invokes `mbuild` to perform compilation and linking.

### Configuring an ANSI C or C++ Compiler

#### Compiler Options Files

Options files contain flags and settings that control the operation of your installed C and C++ compiler. Options files are compiler-specific, i.e., there is a unique options file for each supported C/C++ compiler, which The MathWorks provides.

When you select a compiler to use with the MATLAB Compiler, the corresponding options file is activated on your system. To select a default compiler, use

```
mbuild -setup
```

Additional information on the options files is provided in this chapter 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 and only need the setup option to initially designate a C or C++ compiler. If you need more information on options files, see “Options Files” on page 2-12.

**Windows.** Executing the command on Windows gives

```
mbuild -setup
```

```
Please choose your compiler for building standalone MATLAB
applications:
```

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

```
Select a compiler:
```

```
[1] Borland C++Builder version 6.0
[2] Borland C++Builder version 5.0
[3] Borland C++Builder version 4.0
[4] Borland C++Builder version 3.0
[5] Borland C/C++ version 5.02
[6] Borland C/C++ version 5.0
[7] Borland C/C++ (free command line tools) version 5.5
[8] Lcc C version 2.4
[9] Microsoft Visual C/C++ version 7.1
[10] Microsoft Visual C/C++ version 7.0
[11] Microsoft Visual C/C++ version 6.0
```

```
[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

Try to update options file:  
 C:\WINNT\Profiles\username\Application  
 Data\MathWorks\MATLAB\R14\compopts.bat  
 From template:  
 \sys\MATLAB\BIN\WIN32\mbuildopts\msvc60compp.bat

Done . . .

.

.

Updated ...

The preconfigured options files that are included with MATLAB for Windows are shown below.

<b>Options File</b>	<b>Compiler</b>
lcccompp.bat	Lcc C, Version 2.4 (included with MATLAB)
msvc60compp.bat	Microsoft Visual C/C++, Version 6.0
msvc70compp.bat	Microsoft Visual C/C++, Version 7.0
msvc71compp.bat	Microsoft Visual C/C++, Version 7.1
bcc53compp.bat	Borland C++ Builder 3
bcc54compp.bat	Borland C++ Builder 4
bcc55compp.bat	Borland C++ Builder 5
bcc56compp.bat	Borland C++ Builder 6

**UNIX.** Executing the command on UNIX gives

```
mbuild -setup
```

Using the 'mbuild -setup' command selects an options file that is placed in ~/.matlab/R14 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/R14.

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: <matlabroot>/bin/mbuildopts.sh :  
Build and link with MATLAB C-API or MATLAB Compiler-generated  
library via the system ANSI C/C++ compiler
```

```
<matlabroot>/bin/mbuildopts.sh is being copied to  
/home/user/.matlab/R14/mbuildopts.sh
```

The preconfigured options file that is included with MATLAB for UNIX is mbuildopts.sh, which uses the system native ANSI compiler.

## Special Compiler Notes

There are several known restrictions regarding the use of supported compilers on Windows:

- The Lcc C compiler does not support C++.
- The only compiler that supports the building of COM objects and Excel plug-ins is Microsoft Visual C/C++ (versions 6.0, 7.0, and 7.1).

# Options Files

This information is provided for users who need to know more about how options files work.

## Locating the Options File

### Windows

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

- Current directory
- The user profile directory (see the following section for more information about this directory)

`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.

**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 `mbuild` utility stores its options files, `comopts.bat`, which is created during the `-setup` process, in a subdirectory of your user profile directory, named `Application Data\MathWorks\MATLAB\R14`. Under Windows with user profiles enabled, your user profile directory is `%windir%\Profiles\username`. Under Windows with user profiles disabled, your user profile directory is `%windir%`. You can determine whether or not user profiles are enabled by using the **Passwords** control panel.

### UNIX

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

- Current directory
- `$HOME/.matlab/R14`
- `<matlabroot>/bin`

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

## Changing the Options File

Although it is common to use one options file for all of your Compiler-related work, you can change your options file at anytime. The `setup` option resets your default compiler so that the new compiler is used every time. Use

```
mbuild -setup
```

to reset your C or C++ compiler for future sessions.

## Windows

**Modifying the Options File.** You can use of the `setup` option to change your options file settings on Windows. The `setup` option copies the appropriate options file to your `user profile` directory.

To modify your options file on Windows:

- 1 Use `mbuild -setup` to make a copy of the appropriate options file in your local area.
- 2 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 `mbuild` script will use the new options file every time with your modified settings.

## UNIX

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.

**Modifying the Options File.** You can use the `setup` option to change your options file settings on UNIX. 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.

To modify your options file on Linux:

- 1** Use `mbuild -setup` to make a copy of the appropriate options file in your local area.
- 2** 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.



# Compilation Process

---

This chapter provides an overview of how the MATLAB Compiler works. In addition, it lists the various sets of input and output files used by the Compiler.

Overview of the MATLAB Compiler Technology (p. 3-2)	Describes the build process
Input and Output Files (p. 3-6)	Lists the files generated by the MATLAB Compiler

## Overview of the MATLAB Compiler Technology

### **MATLAB Component Runtime**

MATLAB Compiler 4 uses the MATLAB Component Runtime (MCR), which is a stand-alone set of shared libraries that enable the execution of M-files. The MCR provides complete support for all features of the MATLAB language.

---

**Note** Since the MCR technology provides full support for the MATLAB language, including Java, starting a compiled application takes roughly the same amount of time as starting MATLAB.

---

### **Component Technology File**

Compiler 4 also uses a Component Technology File (CTF) archive to house the deployable package. All M-files are encrypted in the CTF archive using the Advanced Encryption Standard (AES) cryptosystem where symmetric keys are protected by 1024-bit RSA keys.

Each application or shared library produced by the MATLAB Compiler has an associated CTF archive. The archive contains all the MATLAB based executable content (M-files, MEX-files, etc.) associated with the component. When the CTF archive is extracted on a user's system, the files remain encrypted.

### **Additional Details**

Multiple CTF archives, such as COM or Excel components, can coexist in the same user application, but you cannot mix and match the M-files they contain. You cannot combine encrypted and compressed M-files from multiple CTF archives into another CTF archive and distribute them.

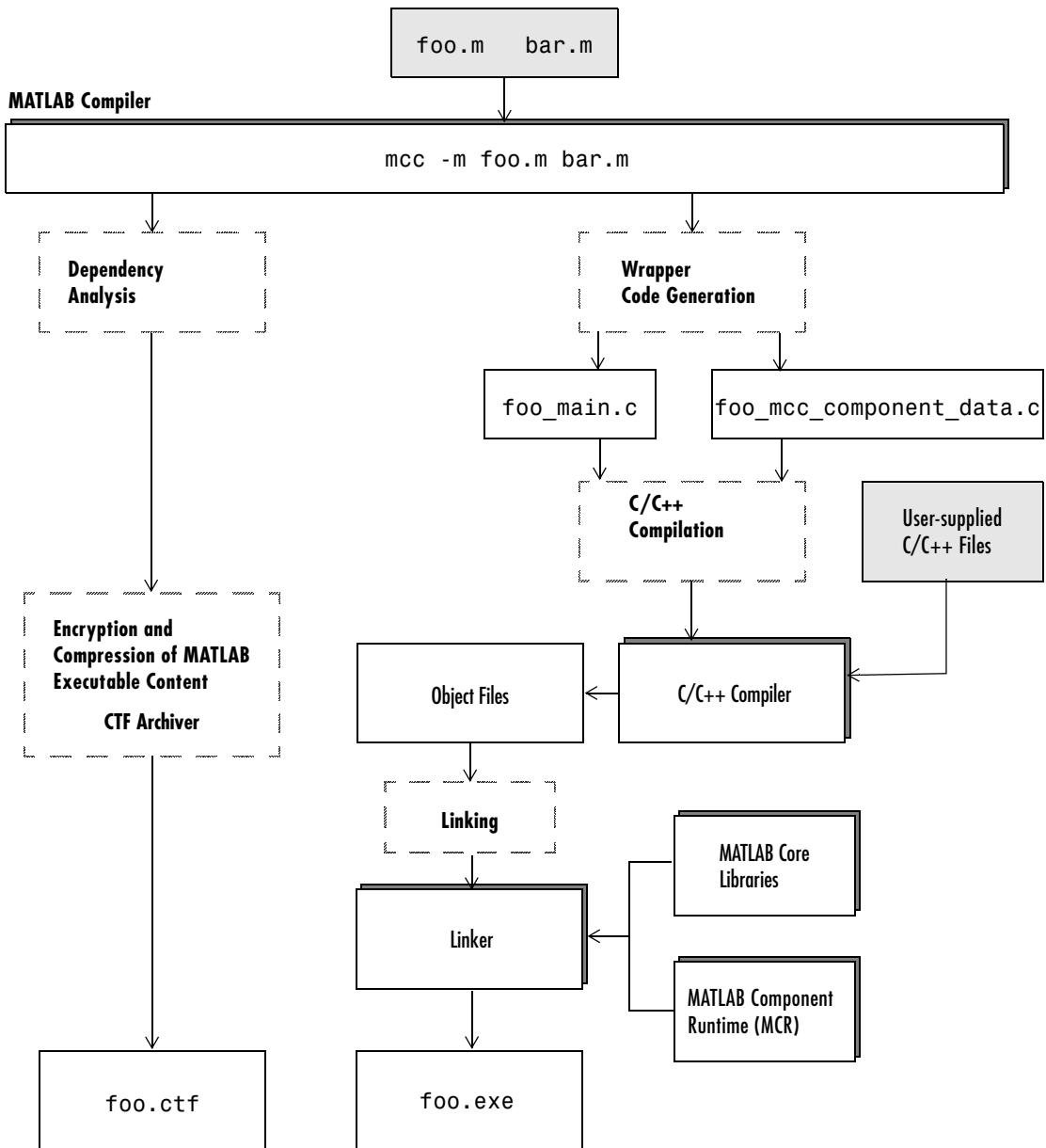
All the M-files from a given CTF archive are locked together with a unique cryptographic key. M-files with different keys will not execute if placed in the same CTF archive. If you want to generate another application with a different mix of M-files, you must recompile these M-files into a new CTF archive.

## Build Process

The process of creating software components with the MATLAB Compiler are completely automatic. For example, to create a stand-alone MATLAB application, you supply the list of M-files that make up the application. The Compiler then performs the following operations:

- Dependency analysis
- Code generation
- Archive creation
- Compilation
- Linking

This figure illustrates how the Compiler takes user code and generates a stand-alone executable.



## Dependency Analysis

The first step determines all the functions on which the supplied M-files, MEX-files, and P-files depend. This list includes all the M-files called by the given files as well as files that they call, and so on. Also included are all built-in functions and MATLAB objects.

## Wrapper Code Generation

This step generates all the source code needed to create the target component, including

- The C/C++ interface code to those M-functions supplied on the command line (`foo_main.c`). For libraries and components, this file includes all of the generated interface functions.
- A component data file that contains information needed to execute the M-code at run-time. This data includes path information and encryption keys needed to load the M-code stored in the component's CTF archive.

## Archive Creation

The list of MATLAB executable files (M-files and MEX-files) created during dependency analysis is used to create a CTF archive that contains the files needed by the component to properly execute at run-time. The files are encrypted and compressed into a single file for deployment. Directory information is also included so that the content is properly installed on the target machine.

## C/C++ Compilation

This step compiles the generated C/C++ files from wrapper code generation into object code. For targets that support the inclusion of user-supplied C/C++ code on the `mcc` command line, this code is also compiled at this stage.

## Linking

The final step links the generated object files with the necessary MATLAB libraries to create the finished component.

The C/C++ compilation and linking steps use the `mbuild` utility that is included with the MATLAB Compiler.

## Input and Output Files

This section describes the files created during the compilation process.

### Stand-Alone Executable

In this example, the MATLAB Compiler takes the M-files `foo.m` and `bar.m` as input and generates a stand-alone executable called `foo`.

```
mcc -m foo.m bar.m
```

File	Description
<code>foo_main.c</code>	The main-wrapper C source file containing the program's main function. The main function takes the input arguments that are passed on the command line and passes them as strings to the <code>foo</code> function.
<code>foo_mcc_component_data.c</code>	C source file containing data needed by the MCR to run the application. This data includes path information, encryption keys, and other initialization information for the MCR.
<code>foo.ctf</code>	The CTF archive. This file contains a compressed and encrypted archive of the M-files that make up the application ( <code>foo.m</code> and <code>bar.m</code> ). It also contains other files called by the two main M-files as well as any other executable content and data files needed at run-time.
<code>foo</code>	The main executable file of the application. This file reads and executes the content stored in the CTF archive. On Windows, this file is <code>foo.exe</code> .

## C Shared Library

In this example, the Compiler takes the M-files `foo.m` and `bar.m` as input and generates a C shared library called `libfoo`.

```
mcc -W lib:libfoo -T link:lib foo.m bar.m
```

File	Description
<code>libfoo.c</code>	The library wrapper C source file containing the exported functions of the library representing the C interface to the the two M-functions ( <code>foo.m</code> and <code>bar.m</code> ) as well as library initialization code.
<code>libfoo.h</code>	The library wrapper header file. This file is included by applications that call the exported functions of <code>libfoo</code> .
<code>libfoo_mcc_component_data.c</code>	C source file containing data needed by the MCR to initialize and use the library. This data includes path information, encryption keys, and other initialization for the MCR.
<code>libfoo.exports</code>	The exports file used by <code>mbuild</code> to link the library.
<code>libfoo.ctf</code>	The CTF archive. This file contains a compressed and encrypted archive of the M-files that make up the library ( <code>foo.m</code> and <code>bar.m</code> ). This file also contains other files called by the two main M-files as well as any other executable content and data files needed at run-time.
<code>libfoo</code>	The shared library binary file. On Windows, this file is <code>libfoo.dll</code> . On Solaris, this file is <code>libfoo.so</code> . (Note: UNIX extensions vary depending on the platform. See the External Interfaces documentation for additional information.)

## C++ Shared Library

In this example, the Compiler takes the M-files `foo.m` and `bar.m` as input and generates a C++ shared library called `libfoo`.

```
mcc -W cpplib:libfoo -T link:lib foo.m bar.m
```

File	Description
<code>libfoo.cpp</code>	The library wrapper C++ source file containing the exported functions of the library representing the C++ interface to the two M-functions ( <code>foo.m</code> and <code>bar.m</code> ) as well as library initialization code.
<code>libfoo.h</code>	The library wrapper header file. This file is included by applications that call the exported functions of <code>libfoo</code> .
<code>libfoo_mcc_component_data.c</code>	C++ source file containing data needed by the MCR to initialize and use the library. This data includes path information, encryption keys, and other initialization for the MCR.
<code>libfoo.exports</code>	The exports file used by <code>mbuild</code> to link the library.
<code>libfoo.ctf</code>	The CTF archive. This file contains a compressed and encrypted archive of the M-files that make up the library ( <code>foo.m</code> and <code>bar.m</code> ). This file also contains other files called by the two main M-files as well as any other executable content and data files needed at run-time.
<code>libfoo</code>	The shared library binary file. On Windows, this file is <code>libfoo.dll</code> . On Solaris, this file is <code>libfoo.so</code> . (Note: UNIX extensions vary depending on the platform. See the External Interfaces documentation for additional information.)



# Deployment Process

---

This chapter provides an overview of how to deploy a product to end users and what they must do to use the product.

Overview (p. 4-2)

Describes the general steps used to deploy a product

Working with the MCR (p. 4-6)

Describes the steps end users must follow to run  
Compiler-generated applications and components

Deploying a Stand-Alone Application  
on a Network Drive (p. 4-11)

Describes the steps you must follow to run  
Compiler-generated applications from a network drive

### Overview

After creating your component with the MATLAB Compiler, you can distribute, or deploy, it to others so that they can use it on their machines, independent of MATLAB.

The deployment process requires that you

- 1 Package the necessary components depending on the type of generated application.
- 2 Distribute them to your end user.
- 3 Have the end users install them on their systems. During this phase of the installation process, the end users run `MCRInstaller` *once* on their target machine, that is, the machine where they will run the application or library. On Windows, `MCRInstaller` is a self-extracting executable that installs the necessary components to run your application. On UNIX, `MCRInstaller` is a ZIP file. See “Installing the MCR on a Deployment Machine” on page 4-6 for additional details on `MCRInstaller`.

There are specific examples of how to deploy each target in their corresponding chapters in this book.

### Porting Generated Code to a Different Platform

Since binary formats are different on each platform, the various components generated by the MATLAB Compiler cannot be moved from platform to platform as is. You can distribute a MATLAB Compiler-generated application to any target machine that has the same operating system as the machine on which the application was compiled. For example, if you want to deploy an application to a Windows machine, you must use the Windows version of the MATLAB Compiler to build the application on a Windows machine.

To deploy an application to a machine whose operating system is different than the machine used to develop the application requires recompiling. You must recompile the application on the desired targeted platform. For example, if you want to deploy the previous application that was developed on a Windows machine to a Linux machine, you must use the MATLAB Compiler on a Linux machine and completely rebuild the application. Consequently, you must have

a valid MATLAB Compiler license on both platforms in order to be able to do this.

## Extracting a CTF Archive without Executing the Component

CTF archives contain executable content (M-files and MEX-files) that need to be extracted from the archive before they can be executed. The CTF archive automatically expands the first time you run the MATLAB Compiler-based component (a MATLAB Compiler-based stand-alone application or an application that calls a MATLAB Compiler-based shared library or COM component).

To expand an archive without running the application, you can use the `extractCTF` (.exe on Windows) stand-alone utility provided in the `<matlabroot>/toolbox/compiler/deploy/<ARCH>` directory, where `<ARCH>` is your system architecture, Windows = win32, Linux = glnx86, Solaris = sol2, x86-64 = glnxa64, and HP = hpux. This utility takes the name of the CTF archive as input and expands the archive into the current working directory. For example, this command expands `hello.ctf` into the current working directory.

```
extractCTF hello.ctf
```

The archive expands into a directory called `hello_mcr`. In general, the name of the directory containing the expanded archive is `<componentname>_mcr`, where `componentname` is the name of the CTF archive without the extension.

---

**Note** To run `extractCTF` from any directory, you must add `<matlabroot>/toolbox/compiler/deploy/<ARCH>` to your PATH environment variable.

---

## User Interaction with the Compilation Path

The MATLAB Compiler uses a dependency analysis function (`depfun`) to determine the list of necessary files to include in the CTF package. In some cases, this process includes an excessive number of files, for example, when MATLAB OOPS classes are included in the compilation and it cannot resolve overloaded methods at compile time. The dependency analysis is an iterative

process that also processes include/exclude information on each pass. Consequently, this process can lead to very large CTF archives resulting in long compilation times for relatively small applications.

The most effective way to reduce the number of files is to constrain the MATLAB path that depfun uses at compile time. The Compiler includes features that enable you to manipulate the path. Currently, there are three ways to interact with the compilation path:

- `addpath` and `rmpath` in MATLAB
- Passing `-I <directory>` on the `mcc` command line
- Passing `-N` and `-p` directories on the `mcc` command line (new feature)

### **addpath and rmpath in MATLAB**

If you run the Compiler from the MATLAB prompt, you can use the `addpath` and `rmpath` commands to modify the MATLAB path before doing a compilation. There are two disadvantages:

- The path is modified for the current MATLAB session only.
- If the Compiler is run outside of MATLAB, this doesn't work unless a `savepath` is done in MATLAB.

---

**Note** The path is also modified for any interactive work you are doing in MATLAB as well.

---

### **Passing `-I< directory>` on the Command Line**

You can use the `-I` option to add a directory to the head of the path used by the current compilation. This feature is useful when you are compiling files that are in directories currently not on the MATLAB path.

### **Passing `-N` and `-p <directory>` on the Command Line**

There are now two new Compiler options that provide more detailed manipulation of the path. This new feature acts like a “filter” applied to the MATLAB path for a given compilation. The first new option is `-N`. Passing `-N` on the `mcc` command line effectively clears the path of all directories except the following core directories (this list is subject to change over time):

- `<matlabroot>/toolbox/matlab`
- `<matlabroot>/toolbox/local`
- `<matlabroot>/toolbox/compiler`

It also retains all subdirectories of the above list that appear on the MATLAB path at compile time. Including `-N` on the command line also allows you to replace directories from the original path, while retaining the relative ordering of the included directories. All subdirectories of the included directories that appear on the original path are also included.

Use the `-p` option to add a directory to the compilation path in an order-sensitive context, i.e., the same order in which they are found on your MATLAB path. The syntax is

```
p <directory>
```

where `<directory>` is the directory to be included. If `<directory>` is not an absolute path, it is assumed to be under the current working directory. The rules for how these directories are included are

- If a directory is included with `-p` that is on the original MATLAB path, the directory and all its subdirectories that appear on the original path are added to the compilation path in an order-sensitive context.
- If a directory is included with `-p` that is not on the original MATLAB path, that directory is not included in the compilation. (You can use `-I` to add it.)
- If a path is added with the `-I` option while this feature is active (`-N` has been passed) and it is already on the MATLAB path, it is added in the order-sensitive context as if it were included with `-p`. Otherwise, the directory is added to the head of the path, as it normally would be with `-I`.

---

**Note** The `-p` option requires the `-N` option on the `mcc` command line.

---

# Working with the MCR

## Installing the MCR on a Deployment Machine

Before end users can run MATLAB Compiler-generated components on their machines, they need to install the MCR, if it is not already present. You only need to install the MCR one time on a deployment machine.

---

**Note** The MCR is version specific, so you must ensure that your end users have the proper version of the MCR installed on their machines.

---

To prepare the deployment machine on Windows, Windows users simply need to install the MCR by using the MCRInstaller utility (MCRInstaller.exe).

To prepare the deployment machine on UNIX, UNIX users need to

- Install the MCR
- Set the path properly
- Set the necessary environment variables

UNIX users must execute the MCRInstaller, which is a ZIP file, and then manually set the path and environment variables as required.

---

**Note** If the UNIX MCRInstaller.zip file is not present on your machine, you can generate it using the `buildmcr` function in MATLAB. For more information on using `buildmcr`, see “Deploying the Application” on page 6-5.

---

## Windows

- 1 Locate the MCRInstaller utility in the `<matlabroot>\toolbox\compiler\deploy\win32` directory and copy it to a new directory on your machine. Run the utility to start the installation.

```
MCRInstaller.exe
```

The MCRInstaller opens a command window and begins preparation for the installation.

---

**Note** On Windows, if you run MCRInstaller in a directory that does not have write permission, you get a series of errors beginning with

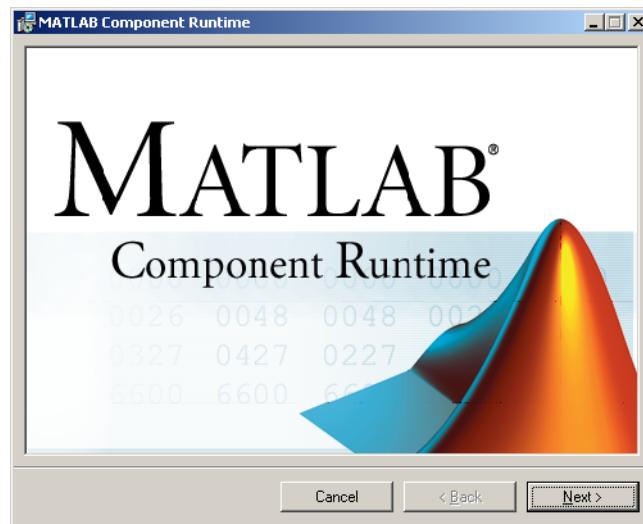
```
error: cannot create Setup.exe
```

To work around this, use the `-d` option to specify a directory that does have write permission. For example,

```
MCRInstaller.exe -d D:\MCRInstall
```

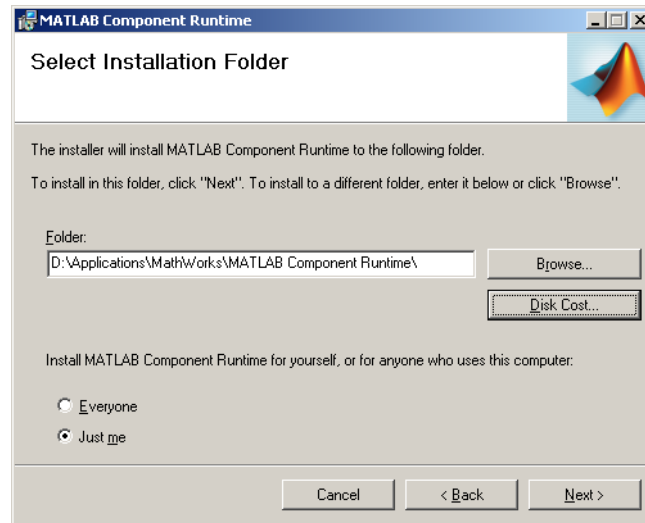
---

- 2 When the **MATLAB Component Runtime** startup screen appears, click **Next** to begin the installation.



- 3 The setup wizard starts. Click **Next** to continue.

- 4 The **Select Installation Folder** dialog lets you choose where you want to install the MCR. This dialog also lets you view available and required disk space on your system. You can also choose whether you want to install the MCR for just yourself or others. Select your options, and then click **Next** to continue.



- 5 Confirm your selections by clicking **Next**.

The installation begins. The process takes some time due to the quantity of files that are installed.

- 6 When the installation completes, click **Close** on the **Installation Completed** dialog to exit.

---

**Note** The **Install MATLAB Component Runtime for yourself, or for anyone who uses this computer** option is not implemented for this release. The current default is **Everyone**.

---



## UNIX

- 1 Locate the `MCRInstaller.zip` file and copy it to a new directory on your machine. This new directory will become the installation directory for your Compiler-generated components. To install the MCR, unzip `MCRInstaller.zip`.
- 2 Update your dynamic library path.

---

**Note** For readability, the following commands appear on separate lines, but you must enter each `setenv` command on one line.

---

### Linux.

```
setenv LD_LIBRARY_PATH
  <mcr_root>/<ver>/runtime/glnx86:
  <mcr_root>/<ver>/sys/os/glnx86:
  <mcr_root>/<ver>/sys/java/jre/glnx86/jre1.5.0/lib/i386/native_threads:
  <mcr_root>/<ver>/sys/java/jre/glnx86/jre1.5.0/lib/i386/client:
  <mcr_root>/<ver>/sys/java/jre/glnx86/jre1.5.0/lib/i386:
setenv XAPPLRESDIR <mcr_root>/<ver>/X11/app-defaults
```

### Solaris.

```
setenv LD_LIBRARY_PATH
  /usr/lib/lwp:
  <mcr_root>/<ver>/runtime/sol2:
  <mcr_root>/<ver>/sys/os/sol2:
  <mcr_root>/<ver>/sys/java/jre/sol2/jre1.5.0/lib/sparc/native_threads:
  <mcr_root>/<ver>/sys/java/jre/sol2/jre1.5.0/lib/sparc/client:
  <mcr_root>/<ver>/sys/java/jre/sol2/jre1.5.0/lib/sparc:
setenv XAPPLRESDIR <mcr_root>/<ver>/X11/app-defaults
```

### Linux x86-64.

```
setenv LD_LIBRARY_PATH
  <mcr_root>/<ver>/runtime/glnxa64:
  <mcr_root>/<ver>/sys/os/glnxa64:
  <mcr_root>/<ver>/sys/java/jre/glnxa64/jre1.4.2/lib/amd64/native_threads:
  <mcr_root>/<ver>/sys/java/jre/glnxa64/jre1.4.2/lib/amd64/client:
  <mcr_root>/<ver>/sys/java/jre/glnxa64/jre1.4.2/lib/amd64:
setenv XAPPLRESDIR <mcr_root>/<ver>/X11/app-defaults
```

### HP-UX.

```
setenv SHLIB_PATH
<mcr_root>/<ver>/runtime/hpux:
<mcr_root>/<ver>/sys/os/hpux:
<mcr_root>/<ver>/bin/hpux:
<mcr_root>/<ver>/sys/java/jre/hpux/jre1.4.1/lib/PA_RISC2.0/server:
<mcr_root>/<ver>/sys/java/jre/hpux/jre1.4.1/lib/PA_RISC2.0

setenv LD_PRELOAD
<mcr_root>/<ver>/sys/java/jre/hpux/jre1.4.1/lib/PA_RISC2.0/server/libjvm.sl

setenv XAPPLRESDIR <mcr_root>/<ver>/X11/app-defaults
```

## Installing the MCR and MATLAB on the Same Machine

You do not need to install the MCR on your machine if your machine has MATLAB installed on it and that version of MATLAB is the same as the version of MATLAB that was used to create the deployed component.

### Modifying the Path

If you do install the MCR on a machine that already has MATLAB on it, you must adjust the path according to your needs. To run the deployed component, the MCR run-time directory must appear prior to the MATLAB run-time directory on the path. To run MATLAB, the MATLAB run-time directory must appear prior to the MCR run-time directory.

**Windows.** To run deployed components, <mcr\_root>\<ver>\runtime\win32 must appear on your system path before <matlabroot>\bin\win32. To run MATLAB, <matlabroot>\bin\win32 must appear on your system path before <mcr\_root>\<ver>\runtime\win32.

**UNIX.** To run deployed components, the setenv LD\_LIBRARY\_PATH and setenv XAPPLRESDIR commands for your UNIX platform must appear on your library path before <matlabroot>/bin/<arch>. See Step 2 of the UNIX section of “Installing the MCR on a Deployment Machine” on page 4-6. for the platform-specific commands.

To run MATLAB, <matlabroot>/bin/<arch> must appear on your library path before the setenv LD\_LIBRARY\_PATH and setenv XAPPLRESDIR commands for your UNIX platform.

## Deploying a Stand-Alone Application on a Network Drive

You can deploy a compiled stand-alone application to a network drive so that it can be accessed by all network users without having them install the MCR on their individual machines.

- 1** On any Windows machine, execute `MCRInstaller.exe` to install the MATLAB Component Runtime (MCR). See “Installing the MCR on a Deployment Machine” on page 4-6 for instructions.
- 2** Copy the entire MCR directory (the directory where MCR is installed) onto a network drive.
- 3** Copy the compiled application into a separate directory in the network drive and add the path `<mcr_root>\<ver>\runtime\<arch>` to all client machines. All network users can then execute the application.

If you are using either MATLAB Builder for COM or MATLAB Builder for Excel, you need to register the following DLLs on every client machine:

```
mwcommgr.dll  
mwcomutil.dll
```

To register the DLLs, at the DOS prompt enter

```
regsvr32 <dllname>
```

These DLLs are located in `<mcr_root>\<ver>\runtime\<arch>`.



# Working with mcc

---

This chapter describes `mcc`, which is the command that invokes the MATLAB Compiler.

Command Overview (p. 5-2)	Details on using the <code>mcc</code> command
Using Macros to Simplify Compilation (p. 5-4)	Information on macros and how they can simplify your work
Using Pathnames (p. 5-6)	Specifying pathnames
Using Bundle Files (p. 5-7)	How to use bundle files to replace sequences of commands
Using Wrapper Files (p. 5-9)	Details on wrapper files
Interfacing M-Code to C/C++ Code (p. 5-12)	Calling C/C++ functions from M-code
Using Pragmas (p. 5-15)	Using <code>%#function</code>
Script Files (p. 5-16)	Using scripts in applications
Compiler Tips (p. 5-18)	Useful information for creating applications

## Command Overview

`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).

### Compiler Options

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
```

Macros are MathWorks supplied Compiler options that simplify the more common compilation tasks. Instead of manually grouping several options together to perform a particular type of compilation, you can use a simple macro option. You can always use individual options to customize the compilation process to satisfy your particular needs. For more information on macros, see “Using Macros to Simplify Compilation” on page 5-4.

### Combining Options

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 -v -W main -T link:exe myfun    % Options listed separately  
mcc -vW main -T link:exe myfun    % Options combined
```

This format is *not* valid.

```
mcc -Wv main -T link:exe myfun
```

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 `mbuild`, along with any Compiler-generated C or C++ files.

## 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 5-1, Macro Options, on page 5-4,

```
mcc -m -W none test.m
```

is equivalent to

```
mcc -W main -T link:exe -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.

---

## 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:

- The current working directory, or
- Your preferences directory (`$HOME/.matlab/R14` on UNIX,  
<system root>\profiles\R14 on Windows)

`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.

## 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. Macros let you group several options together to perform a particular type of compilation.

This table shows the relationship between the macro approach to accomplish a standard compilation and the multioption alternative.

**Table 5-1: Macro Options**

Macro Option	Bundle File	Creates	Option Equivalence	
			Function Wrapper	Output Stage
-l	macro_option_l	Library	-W lib	-T link:lib
-m	macro_option_m	Stand-alone C application	-W main	-T link:exe

### 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

```
-W main -T link:exe
```

This table shows the options that compose the `-m` macro and the information that they provide to the Compiler.

**Table 5-2: The -m Macro**

Option	Function
-W main	Produce a wrapper file suitable for a stand-alone application.
-T link:exe	Create an executable as the output.



## Changing Macro Options

You can change the meaning of a macro option by editing the corresponding `macro_option` file bundle file in `<matlabroot>/toolbox/compiler/bundles`. For example, to change the `-m` macro, edit the file `macro_option_m` in the `bundles` directory.

---

**Note** This changes the meaning of `-m` for all users of this MATLAB installation.

---

## Using Pathnames

If you specify a full pathname to an M-file on the mcc command line, the MATLAB Compiler

- 1 Breaks the full name into the corresponding pathname 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 during the dependency analysis phase.

---

**Note** The Compiler produces a warning (`specified_file_mismatch`) if a file with a full pathname is included on the command line and the Compiler finds it somewhere else.

---

## Using Bundle Files

Bundle files provide a convenient way to group sets of MATLAB Compiler options and recall them as needed. The syntax of the bundle file option is

```
-B <filename>[:<a1>,<a2>,...,<an>]
```

When used on the `mcc` command line, the bundle option `-B` replaces the entire string 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.

A bundle file can include replacement parameters for Compiler options that accept names and version numbers. For example, there is a bundle file for C shared libraries, `csharedlib`, that consists of

```
-W lib:%1% -T link:lib
```

To invoke the Compiler to produce a C shared library using this bundle, you could use

```
mcc -B csharedlib:mysharedlib myfile.m myfile2.m
```

In general, each `%n%` in the bundle file will be replaced with the corresponding option specified to the bundle file. Use `%%` to include a `%` character. It is an error to pass too many or too few options to the bundle file.

You can place options that you always set in an `mccstartup` file. For more information, see “Setting Up Default Options” on page 5-3.

---

**Note** You can use the -B option with a replacement expression as is at the DOS or UNIX prompt. To use -B with a replacement expression at the MATLAB prompt, you must enclose the expression that follows the -B in single quotes when there is more than one parameter passed. For example,

```
>>mcc -B csharedlib:libtimefun weekday data tic calendar toc
```

can be used as is at the MATLAB prompt because libtimefun is the only parameter being passed. If the example had two or more parameters, then the quotes would be necessary as in

```
>>mcc -B 'cexcel:component,class,1.0' weekday data tic calendar toc
```

---

This table shows the available bundle files.

<b>Bundle File Name</b>	<b>Creates</b>	<b>Contents</b>
ccom	COM Object	-W com:<component_name>,<class_name>,<version> -T link:lib
cexcel	Excel COM Object	-W excel:<component_name>,<class_name>,<version> -T link:lib -b
cppcom	COM Object (same as ccom)	-B ccom:<component_name>,<class_name>,<version>
cppexcel	Excel COM Object (same as cexcel)	-B cexcel:<component_name>,<class_name>,<version>
cpplib	C++ Library	-W cpplib:<shared_library_name> -T link:lib
csharedlib	C Shared Library	-W lib:<shared_library_name> -T link:lib

## Using Wrapper Files

Wrapper files encapsulate, or ‘wrap,’ the M-files in your application with an interface that enables the M-files to operate in a given target environment.

To provide the required interface, the wrapper

- Performs wrapper-specific initialization and termination
- Provides the dispatching of function calls to the MCR

To specify the type of wrapper to generate, use the syntax

```
-W <type>
```

The following sections detail the available wrapper types.

### Main File Wrapper

The `-W main` option generates wrappers that are suitable for building stand-alone applications. These POSIX-compliant main wrappers accept strings from the POSIX shell and return a status code. They pass these command line strings to the M-file function(s) as MATLAB strings. They are meant to translate “command-like” M-files into POSIX main applications.

### POSIX Main Wrapper

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 returned to the POSIX shell.

## C Library Wrapper

The `-l` option, or its equivalent `-W lib:libname`, produces a C library wrapper file. This option produces a shared library from an arbitrary set of M-files. The generated header file contains a C function declaration for each of the compiled M-functions. The export list contains the set of symbols that are exported from a C shared library.

---

**Note** You must generate a library wrapper file when calling any Compiler-generated code from a larger application.

---

## **C++ Library Wrapper**

The `-W cplib:libname` option produces the C++ library wrapper file. This option allows the inclusion of an arbitrary set of M-files into a library. The generated header file contains all of the entry points for all of the compiled M-functions.

---

**Note** You must generate a library wrapper file when calling any Compiler-generated code from a larger application.

---

## Interfacing M-Code to C/C++ Code

The MATLAB Compiler 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); %Preallocate 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 function 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 `fcn_external.h`, where `fcn` is the name of the initial M-function containing the `extern` pragma. This header file will contain the `extern` declaration of the function that you must provide. This function must conform to the same interface as the Compiler-generated code.

The Compiler will generate the interface for any functions that contain the `extern` pragma into a separate file called `fcn_external.h`. 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); % preallocate the matrix
for i = 1:100
    y(i) = collect_one;
end

function y = collect_one

extern
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_one_external.h`, which contains the interface between the Compiler-generated code and your code. In this example, it would contain

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

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 "collect_one_external.h"
#include <math.h>

extern double measure_from_device(void);

void collect_one(int nlhs, mxArray *plhs[],
                int nrhs, mxArray *prhs[])
{
    plhs[0] = mxCreateDoubleMatrix(1,1,mxREAL);
    *(mxGetPr(plhs[0])) = 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 application, use

```
mcc -m 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) should be included in the compilation, whether or not the Compiler's dependency analysis detects it. Without this pragma, the Compiler's dependency analysis will not be able to locate and compile all M-files used in your application.

You cannot use the ##function pragma to refer to functions that are not available in M-code.

### Example - Using ##function

A good coding technique involves using ##function in your code wherever you use feval statements. This example shows how to use this technique to help the Compiler find the appropriate files during compile time, eliminating the need to include all the files on the command line.

```
function ret = mywindow(data,filterName)
%MYWINDOW Applies the window specified on the data.
%
% Get the length of the data.
N= length(data);
% List all the possible windows.
##function bartlett, barthannwin, blackman, blackmanharris, ...
bohmanwin, chebwin, flattopwin, gausswin, hamming, hann,...
kaiser, nuttallwin, parzenwin, rectwin, tukeywin, ...
triang window = feval(filterName,N);
% Apply the window to the data.
ret = data.*window;
```

## Script Files

### 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, however, it can compile function M-files that call scripts. You may not specify a script M-file explicitly on the `mcc` command line, but you may specify function M-files that include scripts themselves.

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 magic square 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 houdini(sz)
m = magic(sz); % Assign magic square 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.m` no longer creates variables `m` and `t` in the MATLAB workspace. If it is important to have `m` and `t` accessible from the MATLAB workspace, you can change the beginning of the function to

```
function [m,t] = houdini(sz)
```

The function now returns the values of `m` and `t` to its caller.

## Including Script Files in Deployed Applications

Compiled applications consist of two layers of M-files. The top layer is the interface layer and consists of those functions that are directly accessible from C or C++.

In stand-alone applications, the interface layer consists of only the main M-file. In libraries, the interface layer consists of the M-files specified on the `mcc` command line.

The second layer of M-files in compiled applications includes those M-files that are called by the functions in the top layer. You can include scripts in the second layer, but not in the top layer.

For example, you could produce an application from the `houdini.m` script M-file by writing a new M-function that calls the `houdini.m` script, rather than converting the `houdini.m` script M-file into a function.

```
function houdini_fcn  
    houdini;
```

To produce the `houdini_fcn` executable, which will call the `houdini.m` script M-file, use

```
mcc -m houdini_fcn
```

## Compiler Tips

### Calling Built-In Functions from C or C++

To enable a C or C++ program to call a built-in function directly, you must write an M-file wrapper around each built-in function you wish to access outside of MATLAB. This is necessary because there are no C callable interfaces to built-in functions. For example, to use the magic function in a deployed application, you can use this M-file.

```
function magicsquare(n)
%MAGICSQUARE generates a magic square matrix of the size specified
%   by the input parameter n.

% Copyright 2003 The MathWorks, Inc.

if (ischar(n))
    n=str2num(n);
end
magic(n)
```

### Calling a Function from the Command Line

You can make a MATLAB function into a stand-alone executable that is directly callable from the system command line. All the arguments passed to the MATLAB function from the system command line are strings. Two techniques to work with these functions are

- Modify the original MATLAB function to test each argument and convert the strings to numbers.
- Write a wrapper MATLAB function that does this test and then calls the original MATLAB function.

For example:

```
function x=foo(a, b)
    if (isstr(a)), a = str2num(a), end;
    if (isstr(b)), b = str2num(b), end;
```

```
% The rest of your M-code here...
```

You only do this if your function expects numeric input. If your function expects strings, there is nothing to do because that's the default from the command line.

## Using MAT-Files in Deployed Applications

To use a MAT-file in a deployed application, use the MATLAB Compiler `-a` option to include the file in the CTF archive. For more information on the `-a` option, see “`-a Add to Archive`” on page 8-14.

## Running Deployed Applications

If you use a relative path to start a deployed application from a directory that is not your working directory, it may fail. For example, if you execute your application using

```
..\myProgram.exe
```

you may see the error

```
Cannot find the directory containing the 'myProgram' component,  
which is required by this application. Make sure the directory  
containing 'myProgram.ctf' is on your dynamic load library path  
(PATH on Windows, or LD_LIBRARY_PATH on Linux, for example), or  
your application search path (PATH on both Windows and Linux).  
Error initializing CTF Archive.
```

Using a relative path is not supported directly. When you start a program from a directory using a relative path, your actual working directory is not the directory of the executable. The working directory must be the same as the executable for the CTF file to be found or else the directory containing your CTF file must be on your system path. Therefore, you must start your application from its directory or else modify your system path.

## Compiling a GUI That Contains an ActiveX Control

When you save a GUI that contains ActiveX components, GUIDE creates a file in the current directory for each such component. The filename consists of the name of the GUI followed by an underscore (`_`) and `activexn`, where `n` is a sequence number. For example, if the GUI is named `ActiveXcontrol` then the

filename would be `ActiveXcontrol_activex1`. The filename does not have an extension.

If you use the MATLAB Compiler `mcc` command to compile a GUI that contains an ActiveX component, you must use the `-a` option to add the ActiveX control files that GUIDE saved in the current directory to the CTF archive. Your command should be similar to

```
mcc -m mygui -a mygui_activex1
```

where `mygui_activex1` is the name of the file. If you have more than one such file, use a separate `-a` option for each file.

### **Debugging MATLAB Compiler-Generated Executables**

As of MATLAB Compiler 4, it is no longer possible to debug your entire program using a C/C++ debugger; most of the application is M-code, which can only be debugged in MATLAB. Instead, run your code in MATLAB and verify that it produces the desired results. Then you can compile it. The compiled code will produce the same results.



# Stand-Alone Applications

---

This chapter describes how to use the MATLAB Compiler to code and build stand-alone applications. You can distribute stand-alone applications to users who do not have MATLAB on their systems.

Introduction (p. 6-2)

Overview of using the MATLAB Compiler to build stand-alone applications

C Stand-Alone Application Target (p. 6-3)

Examples of using the MATLAB Compiler to generate and deploy stand-alone C applications

Coding with M-Files Only (p. 6-11)

Creating stand-alone applications from M-files

Mixing M-Files and C or C++ (p. 6-13)

Creating applications from M-files and C/C++ code

## Introduction

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, taking advantage of the power of MATLAB and its tools.

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

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

The MATLAB Compiler takes your M-files and generates C source code functions that allow your M-files to be invoked from outside of interactive MATLAB. After compiling this C source code, the resulting object file is linked with the run-time libraries. A similar process is used to create C++ stand-alone applications.

You can call MEX-files from Compiler-generated stand-alone applications. The MEX-files will then be loaded and called by the stand-alone code.

## C Stand-Alone Application Target

This section provides an example that illustrates the complete cycle of compiling an application and deploying it to a user's machine.

This example takes an M-file, `magicsquare.m`, and creates a stand-alone C application, `magicsquare`.

### Compiling the Application

**1** Copy the file `magicsquare.m` from  
`<matlabroot>/extern/examples/compiler`  
to your work directory.

**2** To compile the M-code, use  
`mcc -mv magicsquare.m`

The `-m` option tells the MATLAB Compiler (`mcc`) to generate a C stand-alone application. The `-v` option (verbose) displays the compilation steps throughout the process and helps identify other useful information such as which third-party compiler is used and what environment variables are referenced.

This command creates the stand-alone application called `magicsquare` and additional files. The Windows platform appends the `.exe` extension to the name. See the table in “Stand-Alone Executable” on page 3-6 for the complete list of files created.

### Testing the Application

These steps test your stand-alone application on your development machine.

---

**Note** Testing your application on your development machine is an important step to help ensure that your application is compilable. To verify that your application compiled properly, you must test all functionality that is available with the application. If you receive an error message similar to `Undefined`

function or Attempt to execute script *script\_name* as a function, it is likely that the application will not run properly on deployment machines. Most likely, your CTF archive is missing some necessary functions. Use `-a` to add the missing functions to the archive and recompile your code.

---

**1** Update your path as follows:

**Windows.** Add the following directory to your path.

```
<matlabroot>\bin\win32
```

**UNIX.** Add the following platform-specific directories to your dynamic library path.

---

**Note** For readability, the following commands appear on separate lines, but you must enter each `setenv` command on one line.

---

**Linux.**

```
setenv LD_LIBRARY_PATH
<matlabroot>/sys/os/glnx86:
<matlabroot>/bin/glnx86:
<matlabroot>/sys/java/jre/glnx86/jre1.5.0/lib/i386/native_threads:
<matlabroot>/sys/java/jre/glnx86/jre1.5.0/lib/i386/client:
<matlabroot>/sys/java/jre/glnx86/jre1.5.0/lib/i386:
setenv XAPPLRESDIR <matlabroot>/X11/app-defaults
```

**Solaris.**

```
setenv LD_LIBRARY_PATH
/usr/lib/lwp:
<matlabroot>/sys/os/sol2:
<matlabroot>/bin/sol2:
<matlabroot>/sys/java/jre/sol2/jre1.5.0/lib/sparc/native_threads:
<matlabroot>/sys/java/jre/sol2/jre1.5.0/lib/sparc/client:
<matlabroot>/sys/java/jre/sol2/jre1.5.0/lib/sparc:
setenv XAPPLRESDIR <matlabroot>/X11/app-defaults
```

**Linux x86-64.**

```

setenv LD_LIBRARY_PATH
<matlabroot>/sys/os/glnxa64:
<matlabroot>/bin/glnxa64:
<matlabroot>/sys/java/jre/glnxa64/jre1.4.2/lib/amd64/native_threads:
<matlabroot>/sys/java/jre/glnxa64/jre1.4.2/lib/amd64/client:
<matlabroot>/sys/java/jre/glnxa64/jre1.4.2/lib/amd64:

setenv XAPPLRESDIR <matlabroot>/X11/app-defaults

```

**HP-UX.**

```

setenv SHLIB_PATH
<matlabroot>/sys/os/hpux:
<matlabroot>/bin/hpux:
<matlabroot>/sys/java/jre/hpux/jre1.4.1/lib/PA_RISC2.0/server:
<matlabroot>/sys/java/jre/hpux/jre1.4.1/lib/PA_RISC2.0

setenv LD_PRELOAD
<matlabroot>/sys/java/jre/hpux/jre1.4.1/lib/PA_RISC2.0/server/libjvm.sl

setenv XAPPLRESDIR <matlabroot>/X11/app-defaults

```

- 2** Run the stand-alone application from the system prompt (shell prompt on UNIX, DOS prompt on Windows) by typing the application name.

```

magicsquare.exe 4          (On Windows)
magicsquare 4            (On UNIX)

```

The results are displayed as

```

ans =
    16     2     3    13
     5    11    10     8
     9     7     6    12
     4    14    15     1

```

**Deploying the Application**

You can distribute a MATLAB Compiler-generated stand-alone to any target machine that has the same operating system as the machine on which the application was compiled. For example, if you want to deploy an application to a Windows machine, you must use the MATLAB Compiler to build the application on a Windows machine. If you want to deploy the same application to a UNIX machine, you must use the MATLAB Compiler on the same UNIX platform and completely rebuild the application. To deploy an application to

multiple platforms requires MATLAB and MATLAB Compiler licenses on all the desired platforms.

### Windows

Gather and package the following files and distribute them to the deployment machine.

Component	Description
MCRInstaller.exe	Self-extracting MATLAB Component Runtime library utility; Platform-dependent file that must correspond to the end-user's platform; This file is located in the <matlabroot>\toolbox\compiler\deploy\win32 directory.
magicsquare.ctf	Component Technology File archive; Platform-dependent file that must correspond to the end-user's platform
magicsquare	Application; magicsquare.exe for Windows

### UNIX

These steps describe how to distribute a stand-alone application.

- 1 Generate the MATLAB Component Runtime (MCR) library archive on the development machine. You only need to do this step once per platform. To generate the MCR library archive, run

```
buildmcr;
```

This places the MCRInstaller archive MCRInstaller.zip in the <matlabroot>/toolbox/compiler/deploy/<arch> directory.

Alternatively, to build the MCRInstaller archive as filename in the path directory, you can use

```
buildmcr(path, filename);
```

To return the full path to the file `zipfile`, use

```
zipfile = buildmcr(path, filename);
```

To build the MCRInstaller archive in the current directory, use

```
zipfile = buildmcr('.');
```

- 2 Gather and package the following files and distribute them to the deployment machine.

Component	Description
MCRInstaller.zip	MATLAB Component Runtime library archive; Platform-dependent file that must correspond to the end-user's platform
unzip	Utility to unzip MCRInstaller.zip (optional). The target machine must have an unzip utility installed.
magicsquare.ctf	Component Technology File archive; Platform-dependent file that must correspond to the end-user's platform
magicsquare	Application

## Running the Application

These steps describe the process that end users must follow to install and run the application on their machines.

### Preparing Windows Machines

- 1 Install the MCR by running the MCR Installer in a directory. For example, run `MCRInstaller.exe` in `C:\MCR`. For more information on running the MCR Installer utility, see “Installing the MCR on a Deployment Machine” on page 4-6.

- 2 Copy the executable and CTF archive to your application root directory, for example, `C:\approot`.
- 3 Add the following directory to your system path.

```
<mcr_root>\<ver>\runtime\win32
```

---

**Note** On Windows XP, this directory is automatically added to your path.

---

### Preparing UNIX Machines

- 1 Install the MCR by unzipping `MCRInstaller.zip` in a directory, for example, `/home/<user>/MCR`. You may choose any directory except `<matlabroot>` or any directory below `<matlabroot>`.

---

**Note** This book uses `<mcr_root>` to refer to the directory where these MCR library archive files are installed on your machine.

---

- 2 Copy the executable and CTF archive to your application root directory, for example, `/home/<user>/approot`.
- 3 Add the following platform-specific directories to your dynamic library path.

---

**Note** For readability, the following commands appear on separate lines, but you must enter each `setenv` command on one line.

---

#### Linux.

```
setenv LD_LIBRARY_PATH
<mcr_root>/<ver>/runtime/glnx86:
<mcr_root>/<ver>/sys/os/glnx86:
<mcr_root>/<ver>/sys/java/jre/glnx86/jre1.5.0/lib/i386/native_threads:
<mcr_root>/<ver>/sys/java/jre/glnx86/jre1.5.0/lib/i386/client:
<mcr_root>/<ver>/sys/java/jre/glnx86/jre1.5.0/lib/i386:
setenv XAPPLRESDIR <mcr_root>/<ver>/X11/app-defaults
```



**Solaris.**

```

setenv LD_LIBRARY_PATH
/usr/lib/lwp:
<mcr_root>/<ver>/runtime/sol2:
<mcr_root>/<ver>/sys/os/sol2:
<mcr_root>/<ver>/sys/java/jre/sol2/jre1.5.0/lib/sparc/native_threads:
<mcr_root>/<ver>/sys/java/jre/sol2/jre1.5.0/lib/sparc/client:
<mcr_root>/<ver>/sys/java/jre/sol2/jre1.5.0/lib/sparc:
setenv XAPPLRESDIR <mcr_root>/<ver>/X11/app-defaults

```

**Linux x86-64.**

```

setenv LD_LIBRARY_PATH
<mcr_root>/<ver>/runtime/glnxa64:
<mcr_root>/<ver>/sys/os/glnxa64:
<mcr_root>/<ver>/sys/java/jre/glnxa64/jre1.4.2/lib/amd64/native_threads:
<mcr_root>/<ver>/sys/java/jre/glnxa64/jre1.4.2/lib/amd64/client:
<mcr_root>/<ver>/sys/java/jre/glnxa64/jre1.4.2/lib/amd64:
setenv XAPPLRESDIR <mcr_root>/<ver>/X11/app-defaults

```

**HP-UX.**

```

setenv SHLIB_PATH
<mcr_root>/<ver>/runtime/hpux:
<mcr_root>/<ver>/sys/os/hpux:
<mcr_root>/<ver>/bin/hpux:
<mcr_root>/<ver>/sys/java/jre/hpux/jre1.4.1/lib/PA_RISC2.0/server:
<mcr_root>/<ver>/sys/java/jre/hpux/jre1.4.1/lib/PA_RISC2.0
setenv LD_PRELOAD
<mcr_root>/<ver>/sys/java/jre/hpux/jre1.4.1/lib/PA_RISC2.0/server/libjvm.sl
setenv XAPPLRESDIR <mcr_root>/<ver>/X11/app-defaults

```

---

**Note** There is a limitation regarding directories on your path. If the target machine has a MATLAB installation, the <mcr\_root> directories must be first on the path in order to run the deployed application. To run MATLAB, the matlabroot directories must be first on the path. This restriction only applies to configurations involving an installed MCR and an installed MATLAB on the same machine.

---

**Executing the Application**

Run the magic square stand-alone application from the system prompt and provide a number representing the size of the desired magic square, for example, 4.

```
magicsquare 4
```

The results are displayed as:

```
ans =  
 16     2     3    13  
  5    11    10     8  
  9     7     6    12  
  4    14    15     1
```

## 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 as in the previous magic square example. Coding an application in M-files allows you to take advantage of the MATLAB interactive development environment. Once the M-file version of your program works properly, compile the code and build it into a stand-alone application.

### Example

Consider a simple application whose source code consists of two M-files, `mrank.m` and `main.m`. This example generates C code from your M-files.

#### `mrank.m`

`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
```

In this example, the line `r = zeros(n,1)` preallocates memory to help the performance of the MATLAB Compiler.

#### `main.m`

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

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

### Compiling the Example

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

```
mcc -m main mrank
```

The `-m` option 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 C functions named `m1fMain` and `m1fMrank`.

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 on both M-files, use `mbuild` to compile the files with your ANSI C compiler, and link the code) by using the command

```
mcc -m main mrank
```

If you need to combine other code with your application (Fortran, for example, a language not supported by the MATLAB Compiler), or if you want to build a makefile that compiles your application, you can use the command

```
mcc -mc main mrank
```

The `-c` option inhibits invocation of `mbuild`. You will probably need to examine the verbose output of `mbuild` to determine how to set the compiler options in your makefile. Run

```
mcc -mv main mrank
```

to see the switches and options that `mbuild` uses on your platform.

## 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 Chapter 7, “Libraries.”

---

### 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.
- 3 Create the binary executable.

To perform these steps, use

```
mcc -W lib:libPkg -T link:exe mrank printmatrix mrankp.c
```

The MATLAB Compiler generates the following C source code files:

- libPkg.c
- libPkg.ctf
- libPkg.h
- libPkg\_mcc\_component\_data.c

This command invokes `mbuild` to compile the resulting Compiler-generated source files with the existing C source file (`mrankp.c`) and link against the required libraries.

The MATLAB Compiler provides two different versions of `mrankp.c` in the `<matlabroot>/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`.

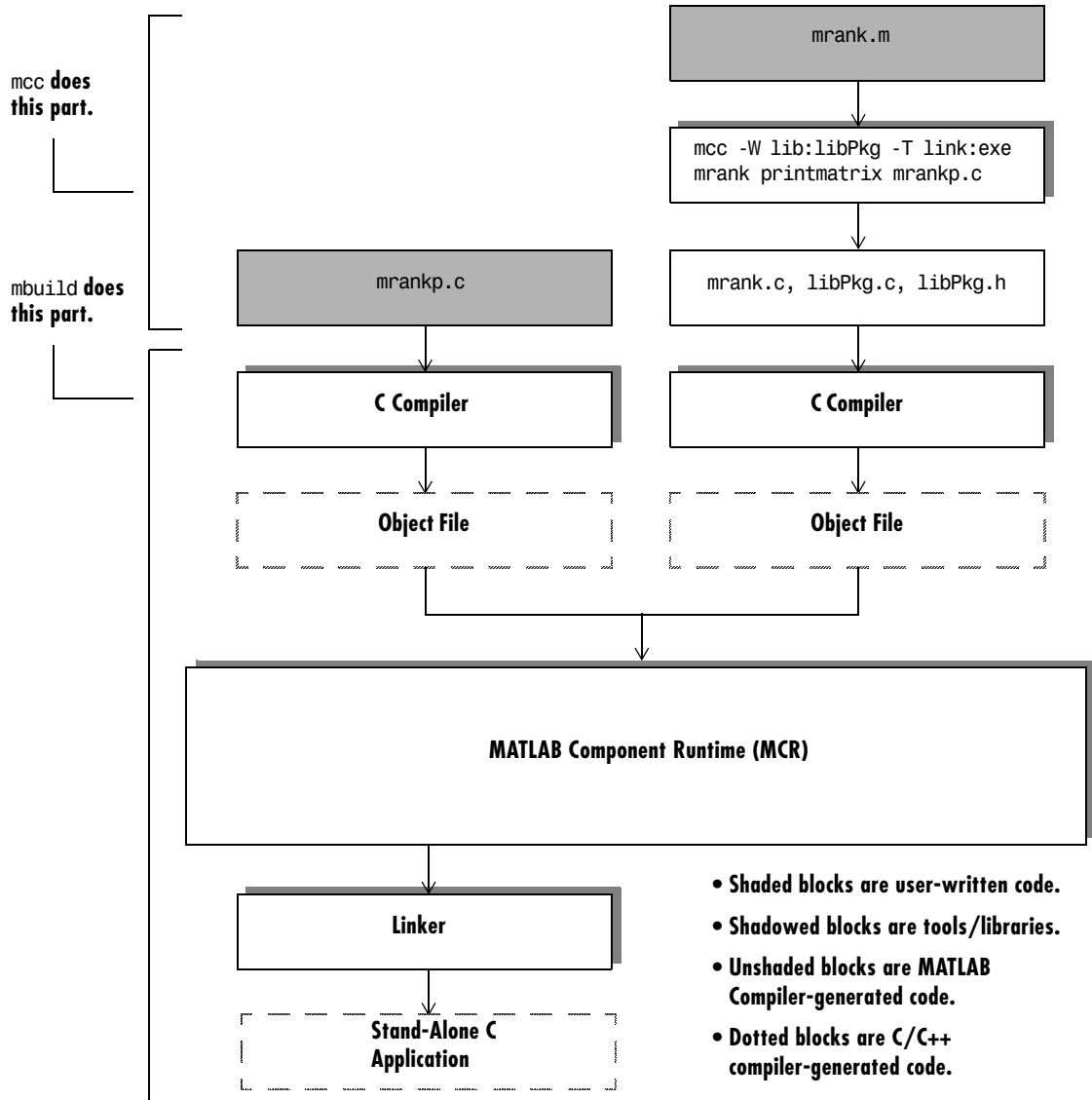


Figure 6-1: Mixing M-Files and C Code to Form a Stand-Alone Application

**mrnkp.c**

The code in `mrnkp.c` calls `mrnk` and outputs the values that `mrnk` returns.

```
/*
 * MRANKP.C
 * "Posix" C main program
 * Calls mlfMrnk, obtained by using MCC to compile mrnk.m.
 *
 * $Revision: 1.3.16.2 $
 *
 */

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

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

    /* Get any command line parameter. */
    if (argc >= 2) {
        n = atoi(argv[1]);
    } else {
        n = 12;
    }
    mclInitializeApplication(NULL,0);
    libPkgInitialize(); /* Initialize the library of M-Functions */

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

    /* Call mlfMrnk, the compiled version of mrnk.m. */
    mlfMrnk(1, &R, N);

    /* Print the results. */
    mlfPrintmatrix(R);
}
```



```

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

    libPkgTerminate(); /* Terminate the library of M-functions */
    mclTerminateApplication();
}

```

### An Explanation of mrankp.c

The heart of `mrnkp.c` is a call to the `m1fMrank` function. Most of what comes before this call is code that creates an input argument to `m1fMrank`. Most of what comes after this call is code that displays the vector that `m1fMrank` returns. First, the code must initialize the MCR and the generated `libPkg` library.

```

mclInitializeApplication(NULL,0);
libPkgInitialize(); /* Initialize the library of M-Functions */

```

To understand how to call `m1fMrank`, examine its C function header, which is

```

void m1fMrank(int nargout, mxArray** r, mxArray* n);

```

According to the function header, `m1fMrank` expects one input parameter and returns one value. All input and output parameters are pointers to the `mxArray` data type. (See the [External Interfaces](#) documentation 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](#) documentation. For example, to create a 1-by-1 `mxArray *` variable named `N` with real data, `mrnkp` calls `mxCreateScalarDouble`.

```

N = mxCreateScalarDouble(n);

```

`mrnkp` can now call `m1fMrank`, passing the initialized `N` as the sole input argument.

```

R = m1fMrank(1,&R,N);

```

`m1fMrank` returns its output in a newly allocated `mxArray *` variable named `R`. The variable `R` is initialized to `NULL`. Output variables that have not been assigned to a valid `mxArray` should be set to `NULL`. The easiest way to display the contents of `R` is to call the `m1fPrintmatrix` function.

```
mlfPrintmatrix(R);
```

This function is defined in `Printmatrix.m`.

Finally, `mrnkp` must free the heap memory allocated to hold matrices and call the termination functions.

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

## 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 "libMultpkg.h"  
  
/*  
 * Function prototype; the MATLAB Compiler creates mlfMultarg  
 * from multarg.m  
 */  
  
void PrintHandler( const char *text )  
{  
    printf(text);
```

```

}

int main( ) /* Programmer written coded to call mlfMultarg */
{
#define ROWS 3
#define COLS 3
    mclOutputHandlerFcn PrintHandler;
    mxArray *a = NULL, *b = NULL, *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;

    /* Initialize with a print handler to tell mlfPrintMatrix
     * how to display its output.
     */
    mclInitializeApplication(NULL,0);
    libMultpkgInitializeWithHandlers(PrintHandler, 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. */
    mlfMultarg(2, &a, &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);
        libMultpkgTerminate();
        mclTerminateApplication();
        return(0);
    }
}
```

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

```
mcc -W lib:libMultpkg -T link:exe multarg printmatrix multargp.c
```

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 void mlfMultarg(int nargout, mxArray** a, mxArray** b,
    mxArray* x, mxArray* y);
```

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, mxCOMPLEX);
    memcpy(mxGetPr(x), x_pr, ROWS * COLS * sizeof(double));
    memcpy(mxGetPi(y), x_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`.

```
mlfMultarg(2, &a, &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);
```



# Libraries

---

This chapter describes how to use the MATLAB Compiler to create libraries.

Introduction (p. 7-2)

Overview of shared libraries

C Shared Library Target (p. 7-3)

Creating and distributing C shared libraries

C++ Shared Library Target (p. 7-14)

Creating and distributing C++ shared libraries

MATLAB Compiler-Generated

Interface functions

Interface Functions (p. 7-19)

## Introduction

You can use the MATLAB Compiler to create C or C++ shared libraries (DLLs on Windows) from your MATLAB algorithms. You can then write C or C++ programs that can call the MATLAB functions in the shared library, much like calling the functions from the MATLAB command line.



## C Shared Library Target

You can use the MATLAB Compiler to build C or C++ shared libraries on both Windows and UNIX. Many of the `mcc` options that pertain to creating stand-alone applications also pertain to creating C and C++ shared libraries.

### C Shared Library Wrapper

The C library wrapper option allows you to create a shared library from an arbitrary set of M-files. The MATLAB Compiler generates a wrapper file, a header file, and an export list. 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.

---

**Note** Even if you are not producing a shared library, you must use `-W lib` or `-W cplib` when including any Compiler-generated code into a larger application. For more information, refer to “Mixing M-Files and C or C++” on page 6-13.

---

### C Shared Library Example

This example takes several M-files and creates a C shared library. It also includes a stand-alone driver application to call the shared library.

#### Building the Shared Library

- 1 Copy the following files from `<matlabroot>/extern/examples/compiler` to your work directory.

```
<matlabroot>/extern/examples/compiler/addmatrix.m
<matlabroot>/extern/examples/compiler/multiplymatrix.m
<matlabroot>/extern/examples/compiler/eigmatrix.m
<matlabroot>/extern/examples/compiler/matrixdriver.c
```

---

**Note** `matrixdriver.c` contains the stand-alone application’s main function.

---

- 2 To create the shared library, use

```
mcc -B csharedlib:libmatrix addmatrix.m multiplymatrix.m  
eigmatrix.m -v
```

The `-B csharedlib` option is a bundle option that expands into

```
-W lib:<libname> -T link:lib
```

The `-W lib:<libname>` option tells the MATLAB Compiler to generate a function wrapper for a shared library and call it `libname`. The `-T link:lib` option specifies the target output as a shared library. Note the directory where the Compiler puts the shared library because you will need it later on.

### Writing the Driver Application

All programs that call MATLAB Compiler-generated shared libraries have roughly the same structure:

- 1 Declare variables and process/validate input arguments.
- 2 Call `mclInitializeApplication`, and test for success. This function sets up the global MCR state and enables the construction of MCR instances.
- 3 Call, once for each library, `<libraryname>Initialize`, to create the MCR instance required by the library.
- 4 Invoke functions in the library, and process the results. (This is the main body of the program.)

---

**Note** If your driver application displays MATLAB figure windows, you should include a call to `mclWaitForFiguresToDie(NULL)` prior to calling the `Terminate` functions and `mclTerminateApplication` in the following two steps.

---

- 5 Call, once for each library, `<libraryname>Terminate`, to destroy the associated MCR.
- 6 Call `mclTerminateApplication` to free resources associated with the global MCR state.

## 7 Clean up variables, close files, etc., and exit.

This example uses `matrixdriver.c` as the driver application.

---

**Note** You must call `mclInitializeApplication` once at the beginning of your driver application. You must make this call before calling any other MathWorks functions. See “Calling a Shared Library” on page 7-9 for complete details on using a Compiler-generated library in your application.

---

### Compiling the Driver Application

To compile the driver code, `matrixdriver.c`, you use your C/C++ compiler. Execute the following `mbuild` command that corresponds to your development platform. This command uses your C/C++ compiler to compile the code.

```
mbuild matrixdriver.c libmatrix.lib    (Windows)
mbuild matrixdriver.c -L. -lmatrix -I. (UNIX)
```

---

**Note** This command assumes that the shared library and the corresponding header file created from step 2 are in the current working directory.

On UNIX, if this is not the case, replace the “.” (dot) following the `-L` and `-I` options with the name of the directory that contains these files, respectively.

On Windows, if this is not the case, specify the full path to `libmatrix.lib`, and use a `-I` option to specify the directory containing the header file.

---

This generates a stand-alone application, `matrixdriver.exe`, on Windows, and `matrixdriver`, on UNIX.

**Difference in the Exported Function Signature.** The interface to the `m1f` functions generated by the Compiler from your M-file routines has changed from earlier versions of the Compiler. The generic signature of the exported `m1f` functions is

- M-functions with no return values

```
void m1f<function-name>(<list_of_input_variables>);
```

- M-functions with at least one return value

```
void mlf<function-name>(int number_of_return_values,  
    <list_of_pointers_to_return_variables>,  
    <list_of_input_variables>);
```

Refer to the header file generated for your library for the exact signature of the exported function. For example, in the library created in the previous section, the signature of the exported `addmatrix` function is

```
void mlfAddmatrix(int nlhs,mxArray **a,mxArray *a1,mxArray *a2);
```

### Testing the Driver Application

These steps test your stand-alone driver application and shared library on your development machine.

---

**Note** Testing your application on your development machine is an important step to help ensure that your application is compilable. To verify that your application compiled properly, you must test all functionality that is available with the application. If you receive an error message similar to `Undefined function or Attempt to execute script script_name` as a function, it is likely that the application will not run properly on deployment machines. Most likely, your CTF archive is missing some necessary functions. Use `-a` to add the missing functions to the archive and recompile your code.

---

- 1 To run the stand-alone application, add the directory containing the shared library that was created in step 2 in “Building the Shared Library” on page 7-3 to your dynamic library path.
- 2 Update the path for your platform by following the instructions in “Testing Components on Development Machine” on page 1-9.
- 3 Run the driver application from the prompt (DOS prompt on Windows, shell prompt on UNIX) by typing the application name.

```
matrixdriver.exe          (On Windows)  
matrixdriver              (On UNIX)
```

The results are displayed as:

The value of the added matrix is:

```
2.00  4.00  6.00
8.00  10.00  12.00
14.00  16.00  18.00
```

The value of the multiplied matrix is:

```
30.00  36.00  42.00
66.00  81.00  96.00
102.00 126.00  150.00
```

The eigenvalue of the first matrix is:

```
16.12  -1.12  -0.00
```

## Deploying Stand-Alone Applications That Call MATLAB Compiler-Based Shared Libraries

Gather and package the following files and distribute them to the deployment machine.

Component	Description
MCRInstaller.zip	(UNIX) MATLAB Component Runtime library archive; platform-dependent file that must correspond to the end-user's platform
MCRInstaller.exe	(Windows) Self-extracting MATLAB Component Runtime library utility; platform-dependent file that must correspond to the end-user's platform
unzip	(UNIX) Utility to unzip MCRInstaller.zip (optional). The target machine must have an unzip utility installed.
matrixdriver	Application; matrixdriver.exe for Windows
libmatrix	Shared library; extension varies by platform, for example, DLL on Windows

---

**Note** You can distribute a MATLAB Compiler-generated stand-alone application to any target machine that has the same operating system as the machine on which the application was compiled. If you want to deploy the same application to a different platform, you must use the MATLAB Compiler on the different platform and completely rebuild the application.

---

### Deploying Shared Libraries to be Used with Other Projects

To distribute the shared library for use with an external application, you need to distribute the following.

Component	Description
MCRInstaller.zip	(UNIX) MATLAB Component Runtime library archive; platform-dependent file that must correspond to the end-user's platform
MCRInstaller.exe	(Windows) Self-extracting MATLAB Component Runtime library utility; platform-dependent file that must correspond to the end-user's platform
unzip	(UNIX) Utility to unzip MCRInstaller.zip (optional). The target machine must have an unzip utility installed.
libmatrix.ctf	Component Technology File archive; platform-dependent file that must correspond to the end-user's platform
libmatrix	Shared library; extension varies by platform, for example, DLL on Windows
libmatrix.h	Library header file

## Calling a Shared Library

At run-time, there is an MCR instance associated with each individual shared library. Consequently, if an application links against two MATLAB Compiler-generated shared libraries, there will be two MCR instances created at run-time.

You can control the behavior of each MCR instance by using MCR options. The two classes of MCR options are global and local. Global MCR options are identical for each MCR instance in an application. Local MCR options may differ for MCR instances.

To use a shared library, you must use these functions:

- `mclInitializeApplication`
- `mclTerminateApplication`

`mclInitializeApplication` allows you to set the global MCR options. They apply equally to all MCR instances. You must set these options before creating your first MCR instance.

These functions are necessary because some MCR options such as whether or not to start Java, the location of the MCR itself, whether or not to use the MATLAB JIT feature, and so on, are set when the first MCR instance starts and cannot be changed by subsequent instances of the MCR.

---

**Note** You must call `mclInitializeApplication` once at the beginning of your driver application. You must make this call before calling any other MathWorks functions.

---

### Function Signatures

The function signatures are

```
bool mclInitializeApplication(const char **options, int count);
bool mclTerminateApplication(void);
```

**mclInitializeApplication.** Takes an array of strings of user-settable options (these are the very same options that can be provided to `mcc` via the `-R` option) and a count of the number of options (the length of the option array). Returns true for success and false for failure.

**mclTerminateApplication.** Takes no arguments and can *only* be called after all MCR instances have been destroyed. Returns true for success and false for failure.

---

**Note** After you call `mclTerminateApplication`, you may not call `mclInitializeApplication` again. No MathWorks functions may be called after `mclTerminateApplication`.

---

This C example shows typical usage of the functions.

```
int main(){

    mxArray *in1, *in2; /* Define input parameters */
    mxArray *out = NULL; /* and output parameters to be passed to
                           the library functions */

    double data[] = {1,2,3,4,5,6,7,8,9};

    /* Call the library initialization routine and make sure that
       the library was initialized properly */
    mclInitializeApplication(NULL,0);
    if (!libmatrixInitialize()){
        fprintf(stderr,"could not initialize the library
                    properly\n");
        return -1;
    }

    /* Create the input data */
    in1 = mxCreateDoubleMatrix(3,3,mxREAL);
    in2 = mxCreateDoubleMatrix(3,3,mxREAL);
    memcpy(mxGetPr(in1), data, 9*sizeof(double));
    memcpy(mxGetPr(in2), data, 9*sizeof(double));

    /* Call the library function */
    mlfAddmatrix(1, &out, in1, in2);
    /* Display the return value of the library function */
    printf("The value of added matrix is:\n");
    display(out);
}
```



```

/* Destroy the return value since this variable will be reused
   in the next function call. Since we are going to reuse the
   variable, we have to set it to NULL. Refer to MATLAB
   Compiler documentation for more information on this. */
mxDestroyArray(out); out=0;
mlfMultiplmatrix(1, &out, in1, in2);
printf("The value of the multiplied matrix is:\n");
display(out);
mxDestroyArray(out); out=0;
mlfEigmatrix(1, &out, in1);
printf("The Eigen value of the first matrix is:\n");
display(out);
mxDestroyArray(out); out=0;

/* Call the library termination routine */
libmatrixTerminate();

/* Free the memory created */
mxDestroyArray(in1); in1=0;
mxDestroyArray(in2); in2 = 0;
mclTerminateApplication();
return 0;
}

```

---

**Note** `mclInitializeApplication` can only be called *once* per application. Calling it a second time is an error, and will cause the function to return false. This function must be called before calling any C MX-function or MAT-file API function.

---

## Steps to Use a Shared Library

To use a MATLAB Compiler-generated shared library in your application, you must perform the following steps:

- 1 Include the generated header file for each library in your application. Each MATLAB Compiler-generated shared library has an associated header file named `<libname>.h`, where `<libname>` is the library's name that was passed in on the command line when the library was compiled.

- 2** Initialize the MATLAB libraries by calling the `mclInitializeApplication` API function. You must call this function once per application, and it must be called before calling any other MATLAB API functions, such as C MX-functions or C MAT-file functions. `mclInitializeApplication` must be called before calling any functions in a MATLAB Compiler-generated shared library. You may optionally pass in application-level options to this function. `mclInitializeApplication` returns a Boolean status code. A return value of `true` indicates successful initialization, and `false` indicates failure.
- 3** For each MATLAB Compiler-generated shared library that you include in your application, call the library's initialization function. This function performs several library-local initializations, such as unpacking the CTF archive, and starting an MCR instance with the necessary information to execute the code in that archive. The library initialization function will be named `<libname>Initialize()`, where `<libname>` is the library's name that was passed in on the command line when the library was compiled. This function returns a Boolean status code. A return value of `true` indicates successful initialization, and `false` indicates failure.

---

**Note** On Windows, if you want to have your shared library call a MATLAB shared library (as generated by the MATLAB Compiler), the MATLAB library initialization function (e.g., `<libname>Initialize`) cannot be called from your shared library during the `DllMain(DLL_ATTACH_PROCESS)` call. This applies whether the intermediate shared library is implicitly or explicitly loaded. You must place the call somewhere after `DllMain()`.

---

- 4** Call the exported functions of each library as needed. Use the C MX API to process input and output arguments for these functions.
- 5** When your application no longer needs a given library, call the library's termination function. This function frees the resources associated with its MCR instance. The library termination function will be named `<libname>Terminate()`, where `<libname>` is the library's name that was passed in on the command line when the library was compiled. Once a library has been terminated, that library's exported functions should not be called again in the application.

- 6 When your application no longer needs to call any MATLAB Compiler-generated libraries, call the `mclTerminateApplication` API function. This function frees application-level resources used by the MCR. Once you call this function, no further calls can be made to MATLAB Compiler-generated libraries in the application.

## C++ Shared Library Target

### C++ Shared Library Wrapper

The C++ library wrapper option allows you to create a shared library from an arbitrary set of M-files. The MATLAB Compiler generates a wrapper file and a header file. The header file contains all of the entry points for all of the compiled M-functions.

---

**Note** Even if you are not producing a shared library, you must use `-W lib` or `-W cpplib` when including any Compiler-generated code into a larger application. For more information, refer to “Mixing M-Files and C or C++” on page 6-13.

---

### C++ Shared Library Example

This example rewrites the previous C shared library example using C++. The procedure for creating a C++ shared library from M-files is identical to the procedure for creating a C shared library, except you use the `cpplib` wrapper.

```
mcc -W cpplib:libmatrix -T link:lib addmatrix.m multiplymatrix.m
    eigmatrix.m -v
```

The `-W cpplib:<libname>` option tells the MATLAB Compiler to generate a function wrapper for a shared library and call it `<libname>`. The `-T link:lib` option specifies the target output as a shared library. Note the directory where the Compiler puts the shared library because you will need it later on.

### Writing the Driver Application

---

**Note** Due to name mangling in C++, you must compile your driver application with the same version of your third-party compiler that you use to compile your C++ shared library.

---

This example uses a C++ version of the `matrixdriver` application, `matrixdriver.cpp`.

```
/*=====
 *
 * MATRIXDRIVER.CPP
 * Sample driver code that calls a C++ shared library created using
 * the MATLAB Compiler. Refer to the MATLAB Compiler documentation
 * for more information on this
 *
 * This is the wrapper CPP code to call a shared library created
 * using the MATLAB Compiler.
 *
 * Copyright 1984-2005 The MathWorks, Inc.
 *
 *=====*/

// Include the library specific header file as generated by the
// MATLAB Compiler
#include "libmatrix.h"

int main(){

    // Call application and library initialization. Perform this
    // initialization before calling any API functions or
    // Compiler-generated libraries.
    if (!mclInitializeApplication(NULL,0) ||
        !libmatrixInitialize())
    {
        std::cerr << "could not initialize the library properly"
                   << std::endl;
        return -1;
    }

    try
    {
        // Create input data
        double data[] = {1,2,3,4,5,6,7,8,9};
        mxArray in1(3, 3, mxDOUBLE_CLASS, mxREAL);
        mxArray in2(3, 3, mxDOUBLE_CLASS, mxREAL);
        in1.SetData(data, 9);
        in2.SetData(data, 9);
    }
}
```

```
        // Create output array
        mxArray out;

        // Call the library function
        addmatrix(1, out, in1, in2);

        // Display the return value of the library function
        std::cout << "The value of added matrix is:" << std::endl;
        std::cout << out << std::endl;

        multiplymatrix(1, out, in1, in2);
        std::cout << "The value of the multiplied matrix is:"
            << std::endl;
        std::cout << out << std::endl;

        eigmatrix(1, out, in1);
        std::cout << "The eigenvalues of the first matrix are:"
            << std::endl;
        std::cout << out << std::endl;
    }
    catch (const mxArrayException& e)
    {
        std::cerr << e.what() << std::endl;
        return -1;
    }
    catch (...)
    {
        std::cerr << "Unexpected error thrown" << std::endl;
        return -1;
    }

    // Call the application and library termination routine
    libmatrixTerminate();
    mclTerminateApplication();

    return 0;
}
```

## Compiling the Driver Application

To compile the `matrixdriver.cpp` driver code, you use your C++ compiler. By executing the following `mbuild` command that corresponds to your development platform, you will use your C++ compiler to compile the code.

```
mbuild matrixdriver.cpp libmatrix.lib           (Windows)
mbuild matrixdriver.cpp -L. -lmatrix -I.       (UNIX)
```

---

**Note** This command assumes that the shared library and the corresponding header file are in the current working directory.

On UNIX, if this is not the case, replace the “.” (dot) following the `-L` and `-I` options with the name of the directory that contains these files, respectively.

On Windows, if this is not the case, specify the full path to `libmatrix.lib`, and use a `-I` option to specify the directory containing the header file.

---

## Incorporating a C++ Shared Library Into an Application

To incorporate a C++ shared library into your application, you will, in general, follow the steps listed in “Steps to Use a Shared Library” on page 7-11. There are two main differences to note when using a C++ shared library.

- Interface functions use the `mwArray` type to pass arguments, rather than the `mxArray` type used with C shared libraries.
- C++ exceptions are used to report errors to the caller. Therefore, all calls must be wrapped in a try-catch block.

## Exported Function Signature

The C++ shared library target generates two sets of interfaces for each M-function. The first set of exported interfaces is identical to the `mx` signatures that are generated in C shared libraries. The second set of interfaces is the C++ function interfaces. The generic signature of the exported C++ functions is

**M-functions with no return values.**

```
void <function-name>(<list_of_input_variables>);
```

**M-functions with at least one return value.**

```
void <function-name>(int number_of_return_values,  
    <list_of_return_variables>, <list_of_input_variables>);
```

In this case, <list\_of\_input\_variables> represents a comma-separated list of type `const mxArray&` and <list\_of\_return\_variables> represents a comma-separated list of type `mxArray&`. For example, in the `libmatrix` library, the C++ interfaces to the `addmatrix` M-function is generated as

```
void addmatrix(int nargout, mxArray& a , const mxArray& a1,  
    const mxArray& a2);
```

**Error Handling**

C++ interface functions handle errors during execution by throwing a C++ exception. Use the `mwException` class for this purpose. Your application can catch `mwExceptions` and query the `what()` method to get the error message. To correctly handle errors when calling the C++ interface functions, wrap each call inside a try-catch block.

```
    try  
    {  
        .  
        (call function)  
        .  
    }  
    catch (const mwException& e)  
    {  
        .  
        (handle error)  
        .  
    }
```

The `matrixdriver.cpp` application illustrates the typical way to handle errors when calling the C++ interface functions.



## MATLAB Compiler-Generated Interface Functions

A shared library generated by the MATLAB Compiler contains at least seven functions. There are three generated functions to manage library initialization and termination, one each for printed output and error messages, and two generated functions for each M-file compiled into the library.

To generate the functions described in this section, first copy `sierpinski.m` and `triangle.c` from `<matlabroot>/extern/examples/compiler` into your directory, and then execute the appropriate Compiler command.

### For a C application

#### On Windows.

```
mcc -W lib:libtriangle -T link:lib sierpinski.m  
mbuild triangle.c libtriangle.lib
```

#### On UNIX.

```
mcc -W lib:libtriangle -T link:lib sierpinski.m  
mbuild triangle.c -L. -ltriangle -I.
```

### For a C++ application

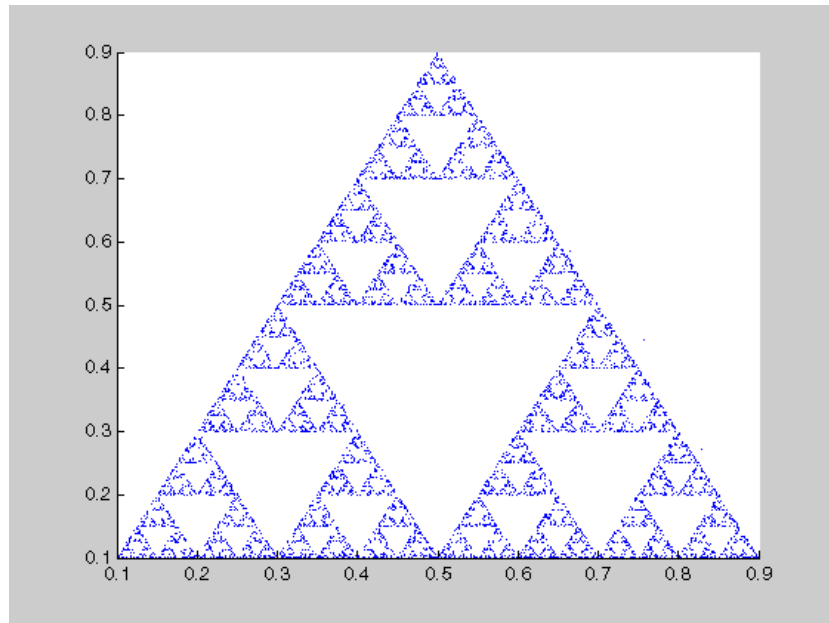
#### On Windows.

```
mcc -W cpplib:libtriangle -T link:lib sierpinski.m  
mbuild triangle.cpp libtriangle.lib
```

#### On UNIX.

```
mcc -W cpplib:libtriangle -T link:lib sierpinski.m  
mbuild triangle.cpp -L. -ltriangle -I.
```

These commands create a main program named `triangle`, and a shared library named `libtriangle`. The library exports a single function that uses a simple iterative algorithm (contained in `sierpinski.m`) to generate the fractal known as Sierpinski's Triangle. The main program in `triangle.c` or `triangle.cpp` can optionally take a single numeric argument, which, if present, specifies the number of points used to generate the fractal. For example, `triangle 8000` generates a diagram with 8,000 points.



In this example the MATLAB Compiler places all of the generated functions discussed below into the generated file `libtriangle.c` or `libtriangle.cpp`.

## Structure of Programs That Call Shared Libraries

All programs that call MATLAB Compiler-generated shared libraries have roughly the same structure:

- 1** Declare variables and process/validate input arguments.
- 2** Call `mclInitializeApplication`, and test for success. This function sets up the global MCR state and enables the construction of MCR instances.
- 3** Call, once for each library, `<libraryname>Initialize`, to create the MCR instance required by the library.
- 4** Invoke functions in the library, and process the results. (This is the main body of the program.)

- 5 Call, once for each library, `<libraryname>Terminate`, to destroy the associated MCR.
- 6 Call `mclTerminateApplication` to free resources associated with the global MCR state.
- 7 Clean up variables, close files, etc., and exit.

To see these steps in an actual example, review the main program in this example, `triangle.c`.

## Library Initialization and Termination Functions

The library initialization and termination functions create and destroy, respectively, the MCR instance required by the shared library. You must call the initialization function before you invoke any of the other functions in the shared library, and you should call the termination function after you are finished making calls into the shared library (or you risk leaking memory).

There are two forms of the initialization function and one type of termination function. The simpler of the two initialization functions takes no arguments; most likely this is the version your application will call. In this example, this form of the initialization function is called `libtriangleInitialize`.

```
bool libtriangleInitialize(void)
```

This function creates an MCR instance using the default print and error handlers, and other information generated during the compilation process.

However, if you want more control over how printed output and error messages are handled, you may call the second form of the function, which takes two arguments.

```
bool libtriangleInitializeWithHandlers(  
    mclOutputHandlerFcn error_handler,  
    mclOutputHandlerFcn print_handler  
)
```

By calling this function, you can provide your own versions of the print and error handling routines called by the MCR. Each of these routines has the same signature (for complete details, see “Print and Error Handling Functions” on page 7-22). By overriding the defaults, you can control how output is displayed and, for example, whether or not it goes into a log file.

---

**Note** Before calling either form of the library initialization routine, you must first call `mclInitializeApplication` to set up the global MCR state. See “Calling a Shared Library” on page 7-9 for more information.

---

On Microsoft Windows platforms, the Compiler generates an additional initialization function, the standard Microsoft DLL initialization function `DllMain`.

```
BOOL WINAPI DllMain(HINSTANCE hInstance, DWORD dwReason,  
void *pv)
```

The generated `DllMain` performs a very important service; it locates the directory in which the shared library is stored on disk. This information is used to find the CTF archive, without which the application will not run. If you modify the generated `DllMain` (which we do not recommend you do), make sure you preserve this part of its functionality.

Library termination is simple.

```
void libtriangleTerminate(void)
```

Call this function (once for each library) before calling `mclTerminateApplication`.

## Print and Error Handling Functions

By default, MATLAB Compiler-generated applications and shared libraries send printed output to standard output and error messages to standard error. The Compiler generates a default print handler and a default error handler that implement this policy. If you'd like to change this behavior, you must write your own error and print handlers and pass them in to the appropriate generated initialization function.

You may replace either, both, or neither of these two functions. Note that the MCR sends all regular output through the print handler and all error output through the error handler. Therefore, if you redefine either of these functions, the MCR will use your version of the function for all the output that falls into class for which it invokes that handler.

The default print handler takes the following form.

```
static int mclDefaultPrintHandler(const char *s)
```

The implementation is straightforward; it takes a string, prints it on standard output, and returns the number of characters printed. If you override or replace this function, your version must also take a string and return the number of characters “handled.” The MCR calls the print handler when an executing M-file makes a request for printed output, e.g., via the MATLAB function `disp`. The print handler does not terminate the output with a carriage return or line feed.

The default error handler has the same form as the print handler.

```
static int mclDefaultErrorHandler(const char *s)
```

However, the default implementation of the print handler is slightly different. It sends the output to the standard error output stream, but if the string does not end with carriage return, the error handler adds one. If you replace the default error handler with one of your own, you should perform this check as well, or some of the error messages printed by the MCR will not be properly formatted.

---

**Note** The error handler, despite its name, does not handle the actual errors, but rather the message produced after the errors have been caught and handled inside the MCR. You cannot use this function to modify the error handling behavior of the MCR — use the `try` and `catch` statements in your M-files if you want to control how a MATLAB Compiler-generated application responds to an error condition.

---

## Functions Generated from M-Files

For each M-file specified on the MATLAB Compiler command line, the Compiler generates two functions, the `m1x` function and the `m1f` function. Each of these generated functions performs the same action (calls your M-file function). The two functions have different names and present different interfaces. The name of each function is based on the name of the first function in the M-file (`sierpinski`, in this example); each function begins with a different three-letter prefix.

### **mlx Interface Function**

The function that begins with the prefix `mlx` takes the same type and number of arguments as a MATLAB MEX-function. (See the External Interfaces documentation for more details on MEX-functions). The first argument, `nlhs`, is the number of output arguments, and the second argument, `plhs`, is a pointer to an array that the function will fill with the requested number of return values. (The “lhs” in these argument names is short for “left-hand side” — the output variables in a MATLAB expression are those on the left-hand side of the assignment operator.) The third and fourth parameters are the number of inputs and an array containing the input variables.

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

### **mlf Interface Function**

The second of the generated functions begins with the prefix `mlf`. This function expects its input and output arguments to be passed in as individual variables rather than packed into arrays. If the function is capable of producing one or more outputs, the first argument is the number of outputs requested by the caller.

```
void mlfSierpinski(int nargout, mxArray** x, mxArray** y,
                  mxArray* iterations, mxArray* draw)
```

Note that in both cases, the generated functions allocate memory for their return values. If you do not delete this memory (via `mxDestroyArray`) when you are done with the output variables, your program will leak memory.

Your program may call whichever of these functions is more convenient, as they both invoke your M-file function in an identical fashion. Most programs will likely call the `mlf` form of the function to avoid managing the extra arrays required by the `mlx` form. The example program in `triangle.c` calls `mlfSierpinski`.

```
mlfSierpinski(2, &x, &y, iterations, draw);
```

In this call, the caller requests two output arguments, `x` and `y`, and provides two inputs, `iterations` and `draw`.

If the output variables you pass in to an `mlf` function are nonNULL, the `mlf` function will attempt to free them using `mxDestroyArray`. This means that you can reuse output variables in consecutive calls to `mlf` functions without

worrying about memory leaks. It also implies that you must pass either `NULL` or a valid MATLAB array for all output variables or your program will fail because the memory manager cannot distinguish between a noninitialized (invalid) array pointer and a valid array. It will try to free a pointer that is not `NULL` — freeing an invalid pointer usually causes a segmentation fault or similar fatal error).

### Using `varargin` and `varargout` in an M-Function Interface

If your M-function interface uses `varargin` or `varargout`, you must pass them as cell arrays. For example, if you have `N` `varargin`s, you need to create one cell array of size 1-by-`N`. Similarly, `varargout`s are returned back as one cell array. The length of the `varargout` is equal to the number of return values specified function call minus the number of actual variables passed. As in MATLAB, the cell array representing `varargout` has to be the last return variable (the variable preceding the first input variable) and the cell array representing `varargin`s has to be the last formal parameter to the function call.

For information on creating cell arrays, refer to the C MX-function interface in the External Interfaces documentation.

For example, consider this M-file interface.

```
[a,b,varargout] = myfun(x,y,z,varargin)
```

The corresponding C interface for this is

```
void mlfMyfun(int numOfRetVars, mxArray **a, mxArray **b,  
             mxArray **varargout, mxArray *x, mxArray *y,  
             mxArray *z, mxArray *varargin)
```

In this example, the number of elements in `varargout` is  $(\text{numOfRetVars} - 2)$ , where 2 represents the two actual variables, `a` and `b`, being returned. Both `varargin` and `varargout` are single row, multiple column cell arrays.





# Reference

---

Functions — Categorical List (p. 8-2)    Tables of functions grouped by category

## Functions – Categorical List

### Pragmas

<code>%#external</code>	Pragma to call arbitrary C/C++ functions from your M-code
<code>%#function</code>	<code>feval</code> pragma

### Command Line Tools

<code>buildmcr</code>	Generate MCRInstaller archive
<code>isdeployed</code>	Determine if code is running in deployed mode or MATLAB mode
<code>mbuild</code>	Compile and link source files into stand-alone executable or shared library
<code>mcc</code>	Invoke MATLAB Compiler

<b>Purpose</b>	Pragma to call arbitrary C/C++ functions from your M-code
<b>Syntax</b>	##external
<b>Description</b>	<p>The ##external pragma informs the MATLAB Compiler that the implementation version of the function (<i>M1xf</i>) 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).</p> <p>When using this pragma, the Compiler will generate an additional header file called <code>fcn_external.h</code>, where <code>fcn</code> is the name of the initial M-function containing the ##external pragma. This header file will contain the <code>extern</code> 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” on page 5-12.</p>

# **%#function**

---

**Purpose** Pragma to help Compiler locate functions that are called through `feval`, `eval`, or Handle Graphics callback.

**Syntax** `%#function <function_name-list>`

**Description** The `%#function` pragma informs the MATLAB Compiler that the specified function(s) will be called through an `feval`, `eval`, or Handle Graphics callback.

Use the `%#function` pragma in stand-alone C and C++ applications to inform the MATLAB Compiler that the specified function(s) should be included in the compilation, whether or not the Compiler's dependency analysis detects the function(s). Without this pragma, the Compiler's dependency analysis will not be able to locate and compile all M-files used in your application.

<b>Purpose</b>	Generate MCRInstaller archive
<b>Syntax</b>	<pre>buildmcr; filename = buildmcr; filename = buildmcr(dirname); filename = buildmcr(dirname,filename);</pre>
<b>Description</b>	The <code>buildmcr</code> function builds the MCRInstaller archive, <code>MCRInstaller.zip</code> , in the default directory. The archive is a ZIP file of the files required for the MCR. Directories are created as needed.
<b>Examples</b>	<p><b>Example 1</b></p> <pre>buildmcr;</pre> <p>This example builds <code>MCRInstaller.zip</code> in the default directory. It returns nothing (unless it encounters an error or it is not the first time).</p> <p><b>Example 2</b></p> <pre>mcr_zipfile = buildmcr;</pre> <p>This example builds <code>MCRInstaller.zip</code> in the default directory and returns the path of the generated ZIP file in <code>mcr_zipfile</code> as</p> <pre>mcr_zipfile = ...     fullfile(matlabroot,'toolbox','compiler',             'deploy',ARCH,'MCRInstaller.zip');</pre> <p><b>Example 3</b></p> <pre>mcr_zipfile = buildmcr(mcr_zipfile_dirname);</pre> <p>This example returns the ZIP file in</p> <pre>&lt;mcr_zipfile_dirname&gt;/MCRInstaller.zip</pre> <p><b>Example 4</b></p> <pre>mcr_zipfile =     buildmcr(mcr_zipfile_dirname,mcr_zipfile_filename);</pre> <p>returns the ZIP file in</p> <pre>&lt;mcr_zipfile_dirname&gt;/&lt;mcr_zipfile_filename&gt;</pre>

## Example 5

```
mcr_zipfile = buildmcr('.');
```

This example builds MCRInstaller.zip in the current directory and returns

```
mcr_zipfile = fullfile(pwd, 'MCRInstaller.zip')
```

## Example 6

```
mcr_zipfile = buildmcr('.', 'my.zip');
```

This example builds my.zip in the current directory and returns

```
mcr_zipfile = fullfile(pwd, 'my.zip')
```

## Example 7

```
[mcr_zipfile, mcrlist] = buildmcr(...)
```

This example returns the list of the files in the ZIP file in `mcrlist`. It is a cell array of paths each relative to the MATLAB root directory. If the ZIP file already exists, nothing is done and a warning is produced. The required list is constructed from the installer files and pruned appropriately.

**Purpose** Test if code is running in deployed mode or MATLAB mode

**Syntax** `x = isdeployed`

**Description** `x = isdeployed` returns true (1) when the function is running in deployed mode and false (0) if it is running in a MATLAB session.

If you include this function in an application and compile the application with the MATLAB Compiler, the function will return true when the application is run in deployed mode. If you run the application containing this function in a MATLAB session, the function will return false.

# mbuild

## Purpose

Compile and link source files into stand-alone executable or shared library

## Syntax

```
mbuild [option1 ... optionN] sourcefile1 [... sourcefileN]
      [objectfile1 ... objectfileN] [libraryfile1 ... libraryfileN]
      [exportfile1 ... exportfileN]
```

---

**Note** Supported types of source files are: .c, .cpp, .idl, .rc. To specify IDL source files to be compiled with the Microsoft Interface Definition Language (MIDL) Compiler, add <filename>.idl to the mbuild command line. To specify a DEF file, add <filename>.def to the command line. To specify an RC file, add <filename>.rc to the command line. Source files that are not one of the supported types are passed to the linker.

---

## Description

mbuild is a script that supports various options that allow you to customize the building and linking of your code. Table 8-1, mbuild Options, lists the set of mbuild options. If no platform is listed, the option is available on both UNIX and Windows.

**Table 8-1: mbuild Options**

Option	Description
-<arch>	(UNIX) Assume local host has architecture <arch>. Possible values for <arch> include sol2, hpux, glnx86, and glnxa64.
@<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.



**Table 8-1: mbuild Options (Continued)**

Option	Description
-D<name>#<value>	Define a symbol name and value to the C/C++ preprocessor. Equivalent to a <code>#define &lt;name&gt; &lt;value&gt;</code> directive in the source.
-D<name>=<value>	(UNIX) Define a symbol name and value to the C preprocessor. Equivalent to a <code>#define &lt;name&gt; &lt;value&gt;</code> directive in the source.
-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 <code>DEBUGFLAGS</code> 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 <code>#include</code> files.
-inline	Inline matrix accessor functions (mx*).
-l<name>	(UNIX) Link with object library <code>lib&lt;name&gt;</code> .
-L<directory>	(UNIX) Add <directory> to the list of directories containing object-library routines.

**Table 8-1: mbuild Options (Continued)**

<b>Option</b>	<b>Description</b>
-D<name>#<value>	Define a symbol name and value to the C/C++ preprocessor. Equivalent to a <code>#define &lt;name&gt; &lt;value&gt;</code> directive in the source.
-D<name>=<value>	(UNIX) Define a symbol name and value to the C preprocessor. Equivalent to a <code>#define &lt;name&gt; &lt;value&gt;</code> directive in the source.
-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 <code>DEBUGFLAGS</code> 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 <code>#include</code> files.
-inline	Inline matrix accessor functions (mx*).
-l<name>	(UNIX) Link with object library <code>lib&lt;name&gt;</code> .
-L<directory>	(UNIX) Add <directory> to the list of directories containing object-library routines.

**Table 8-1: mbuild Options (Continued)**

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.
-regsvr	(Windows) Use the regsvr32 program to register the resulting shared library at the end of compilation. The Compiler uses this option whenever it produces a COM wrapper file.

**Table 8-1: mbuild Options (Continued)**

<b>Option</b>	<b>Description</b>
-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\<rel_version> (Windows) or \$HOME/.matlab/<rel_version> (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'.
<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.

---

# mcc

---

**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).

Prepares M-file(s) for deployment outside of the MATLAB environment. Generates wrapper files in C or C++, and optionally builds stand-alone binary files. Writes any resulting files into the current directory, by default.

If more than one M-file is specified on the command line, the Compiler generates a C or C++ function for each M-file. If C or object files are specified, they are passed to `mbuild` along with any generated C files.

## Options

**-a Add to Archive.** Add a file to the CTF archive. Use

`-a filename`

to specify a file to be directly added to the CTF archive. Multiple `-a` options are permitted. The Compiler looks for these files on the MATLAB path, so specifying the full pathname is optional. These files are not passed to `mbuild`, so you can include files such as data files.

**-b Generate Excel-Compatible Formula Function.** Generate a Visual Basic file (.bas) containing the Microsoft Excel Formula Function interface to the Compiler-generated COM object. When imported into the workbook Visual Basic code, this code allows the MATLAB function to be seen as a cell formula function. Requires MATLAB Builder for Excel.

**-B Specify bundle File.** Replace the file on the `mcc` command line with the contents of the specified file. Use

`-B filename[:<a1>,<a2>,...,<an>]`

The bundle file `filename` should contain only `mcc` command line options and corresponding arguments and/or other filenames. The file may contain other `-B` options. A bundle file can include replacement parameters for Compiler options

that accept names and version numbers. See “Using Bundle Files” on page 5-7 for a list of the bundle files included with the Compiler.

**-c Generate C Code Only.** When used with a macro option, generate C code but do not invoke `mbuild`, i.e., do not produce a stand-alone application. This option is equivalent to `-T codegen` placed at the end of the `mcc` command line.

**-d Specified Directory for Output.** Place output in a specified directory. Use

`-d directory`

to direct the output files from the compilation to the directory specified by the `-d` option.

**-f Specified Options File.** Override the default options file with the specified options file. Use

`-f filename`

to specify `filename` as the options file when calling `mbuild`. This option allows you to use different ANSI compilers for different invocations of the MATLAB Compiler. This option is a direct pass-through to the `mbuild` script.

---

**Note** It is recommended that you use `mbuild -setup`.

---

**-g Generate Debugging Information.** Include debugging symbol information for the C/C++ code generated by the MATLAB Compiler. It also causes `mbuild` to pass appropriate debugging flags to the system C/C++ compiler. The debug option enables you to backtrace up to the point where you can identify if the failure occurred in the initialization of MCR, the function call, or the termination routine. This option does not allow you to debug your M-files with a C/C++ debugger.

**-G Debug Only.** Same as `-g`.

**-I Add Directory to 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.

**-l Generate a Function Library.** Macro to create a function library. This option generates a library wrapper function for each M-file on the command line and calls your C compiler to build a shared library, which exports these functions. The library name is the component name, which is derived from the name of the first M-file on the command line. This macro is equivalent to

```
-W lib -T link:lib
```

**-m Generate a Stand-Alone Application.** Macro to produce a stand-alone application. This macro is equivalent to

```
-W main -T link:exe
```

**-M Direct Pass Through.** Define compile-time options. Use

```
-M string
```

to pass `string` directly to the `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 rightmost `-M` option is used.

---

**-N Clear Path.** Passing `-N` effectively clears the path of all directories except the following core directories (this list is subject to change over time):

- `<matlabroot>/toolbox/matlab`
- `<matlabroot>/toolbox/local`
- `<matlabroot>/toolbox/compiler`

It also retains all subdirectories of the above list that appear on the MATLAB path at compile time. Including `-N` on the command line also allows you to replace directories from the original path, while retaining the relative ordering



of the included directories. All subdirectories of the included directories that appear on the original path are also included.

**-o Specify Executable.** Specify the name of the final executable (stand-alone applications only). Use

`-o outputfile`

to name the final executable output of the Compiler. A suitable, possibly platform-dependent, extension is added to the specified name (e.g., `.exe` for Windows stand-alone applications).

**-p Add Directory to Path.** Add a directory to the compilation path in an order-sensitive context, i.e., the same order in which they are found on your MATLAB path.

`-p directory`

where `directory` is the directory to be included. If `directory` is not an absolute path, it is assumed to be under the current working directory. The rules for how these directories are included are

- If a directory is included with `-p` that is on the original MATLAB path, the directory and all its subdirectories that appear on the original path are added to the compilation path in an order-sensitive context.
- If a directory is included with `-p` that is not on the original MATLAB path, that directory is not included in the compilation. (You can use `-I` to add it.)

If a path is added with the `-I` option while this feature is active (`-N` has been passed) and it is already on the MATLAB path, it is added in the order-sensitive context as if it were included with `-p`. Otherwise, the directory is added to the head of the path, as it normally would be with `-I`.

---

**Note** Requires `-N` option.

---

**-R Run-Time.** Provide MCR run-time options. Use the syntax

`-R option`

to provide any of these run-time options.

Option	Description
-nojvm	Do not use the Java Virtual Machine (JVM).
-nojit	Do not use the MATLAB JIT (binary code generation used to accelerate M-file execution).

---

**Note** The -R option is only available for stand-alone applications. To override MCR options in the other MATLAB Compiler targets, use the `mclInitializeApplication` and `mclTerminateApplication` functions. For more information on these functions, see “Calling a Shared Library” on page 7-9.

---

**-S Create Singleton MCR.** Create a singleton MCR when compiling a COM object. Each instance of the component uses the same MCR. Requires MATLAB Builder for COM.

**-T Specify Target Stage.** Specify the output target phase and type. Use the syntax

-T *target*

to define the output type. Valid *target* values are as follows:

**Table 8-2: Output Stage Options**

Target	Description
codegen	Generates a C/C++ wrapper file. The default is codegen.
compile:exe	Same as codegen plus compiles C/C++ files to object form suitable for linking into a stand-alone executable.

**Table 8-2: Output Stage Options (Continued)**

Target	Description
<code>compile:lib</code>	Same as <code>codegen</code> plus compiles C/C++ files to object form suitable for linking into a shared library/DLL.
<code>link:exe</code>	Same as <code>compile:exe</code> plus links object files into a stand-alone executable.
<code>link:lib</code>	Same as <code>compile:lib</code> plus links object files into a shared library/DLL.
Notes: <code>exe</code> uses the <code>mbuild</code> script to build an executable; <code>lib</code> uses <code>mbuild</code> to build a shared library.	

**-v Verbose.** Display the compilation steps, 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 `mbuild`

The `-v` option passes the `-v` option to `mbuild` and displays information about `mbuild`.

**-w Warning Messages.** Displays warning messages. Use the syntax

```
-w option[:<msg>]
```

to control the display of warnings. This table lists the valid syntaxes.

**Table 8-3: Warning Option**

Syntax	Description
-w list	Generates a table that maps <string> to warning message for use with enable, disable, and error. Appendix B, “Error and Warning Messages” lists the same information.
-w enable	Enables complete warnings.
-w disable[:<string>]	Disables specific warning associated with <string>. Appendix B, “Error and Warning Messages” 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>. Appendix B, “Error and Warning Messages” 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.

**-W Wrapper Function.** Controls the generation of function wrappers. Use the syntax

```
-W type
```

to 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 options.

**Table 8-4: Function Wrapper Types**

Type	Description
main	Produces a POSIX shell <code>main()</code> function.
lib:<string>	Creates a C interface and 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 <code>.exports</code> file that contains all nonstatic function names.
cpplib:<string>	Creates a C++ interface and 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 <code>.exports</code> file that contains all nonstatic function names.
com:<component_name>,<class_name>,<version>	Produces a COM object from MATLAB M-files.
none	Does not produce a wrapper file. The default is none.

**-Y License File.** Use

```
-Y license.dat_file
```

to override default `license.dat` file with specified argument.

**-z Specify Path.** Specify path for library and include files. Use

```
-z path
```

to specify path to use for the compiler libraries and include files instead of the path returned by `matlabroot`.

**-? Help Message.** Display MATLAB Compiler help at the command prompt.

## Examples

Make a stand-alone executable for `myfun.m`.

```
mcc -m myfun
```

Make a stand-alone executable for `myfun.m`, but 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 the stand-alone executable `myfun1` from `myfun1.m` and `myfun2.m` (using one `mcc` call).

```
mcc -m myfun1 myfun2
```

Make a shared/dynamically linked library called `liba` from `a0.m` and `a1.m`.

```
mcc -W lib:liba -T link:lib a0 a1
```

# MATLAB Compiler Quick Reference

---

This appendix summarizes the MATLAB Compiler options and provides brief descriptions of how to perform common tasks.

Common Uses of the Compiler (p. A-2)    Brief summary of how to use the Compiler

mcc (p. A-4)    Quick reference table of Compiler options

## Common Uses of the Compiler

This section summarizes how to use the MATLAB Compiler to generate some of its more standard results.

### Create a Stand-Alone Application

#### Example 1

To create a stand-alone executable from `mymfile.m`, use

```
mcc -m mymfile
```

#### Example 2

To create a stand-alone application from `mymfile.m`, look for `mymfile.m` in the directory `/files/source`, and put the resulting C files and executable in `/files/target`, use

```
mcc -m -I /files/source -d /files/target mymfile
```

#### Example 3

To create a stand-alone application `mymfile1` from `mymfile1.m` and `mymfile2.m` using a single `mcc` call, use

```
mcc -m mymfile1 mymfile2
```

### Create a Library

#### Example 1

To create a C shared library from `foo.m`, use

```
mcc -l foo.m
```

#### Example 2

To create a C shared library called `library_one` from `foo1.m` and `foo2.m`, use

```
mcc -W lib:library_one -T link:lib foo1 foo2
```



---

**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.

**Table A-1: mcc Quick Reference**

<b>Option</b>	<b>Description</b>	<b>Comment/Options</b>
-a filename	Add filename to the CTF archive	None
-b	Generate Excel-compatible formula function	Requires MATLAB Builder for Excel
-B filename[:arg[,arg]]	Replace -B filename on the mcc command line with the contents of filename	The file should contain only mcc command line options. These are MathWorks included options files: -B csharedlib:foo C shared library -B cpplib:foo C++ library
-c	Generate C wrapper code	Equivalent to -T codegen
-d directory	Place output in specified directory	None
-f filename	Use the specified options file, filename, when calling mbuild	mbuild -setup is recommended.
-g	Generate debugging information	None
-G	Same as -g	None
-I directory	Add directory to search path for M-files	MATLAB path is automatically included when running from MATLAB, but not when running from DOS/UNIX shell.

**Table A-1: mcc Quick Reference (Continued)**

<b>Option</b>	<b>Description</b>	<b>Comment/Options</b>
-l	Macro to create a function library	Equivalent to -W lib -T link:lib
-m	Macro to generate a C stand-alone application	Equivalent to -W main -T link:exe
-M string	Pass string to mbuild	Use to define compile-time options.
-N	Clear the path of all but a minimal, required set of directories	None
-o outputfile	Specify name of final executable	Adds appropriate extension
-P directory	Add directory to compilation path in an order-sensitive context	Requires -N option
-R <i>option</i>	Specify run-time options for MCR	<i>option</i> = -nojvm -nojit
-S	Create Singleton MCR	Requires MATLAB Builder for COM
-T <i>target</i>	Specify output stage	<i>target</i> = <b>codegen</b> compile: <i>bin</i> link: <i>bin</i> where <i>bin</i> = exe lib
-v	Verbose; Display compilation steps	None

**Table A-1: mcc Quick Reference (Continued)**

<b>Option</b>	<b>Description</b>	<b>Comment/Options</b>
<code>-w option</code>	Display warning messages	<code>option = list</code> <code>level</code> <code>level:string</code> where <code>level = disable</code> <code>enable</code> <code>error</code>
<code>-W type</code>	Control the generation of function wrappers	<code>type = main</code> <code>cpplib:&lt;string&gt;</code> <code>lib:&lt;string&gt;</code> <code>none</code> <code>com:compname,cname,version</code>
<code>-Y licensefile</code>	Use licensefile when checking out a Compiler license	None
<code>-z path</code>	Specify path for library and include files	None
<code>-?</code>	Display help message	None

# 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.

Use this reference to

- Confirm that an error has been reported
- Determine possible causes for an error
- Determine possible ways to correct an error

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](mailto:support@mathworks.com).

Compile-Time Errors (p. B-2)

Error messages generated at compile time

Warning Messages (p. B-5)

User-controlled warnings generated by the Compiler

Depfun Errors (p. B-7)

Errors generated by Depfun

## 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 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 `<matlabroot>\bin`.

**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 and 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" on page 5-16.

**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: 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('-m', '-v', 'hello') % Correct
mcc('-m -v', 'hello') % 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 Chapter 8, “Reference” or type `mcc -?` at the command prompt.

**Error: *libraryname* library not found.** MATLAB has been installed incorrectly.

**Error: No source files were specified (-? for help).** You must provide the Compiler with the name of the source file(s) to compile.

**Error: "*optionname*" is not a valid *-option* option argument.** You must use an argument that corresponds to the option. For example:

```
mcc -W main % Correct
mcc -W mex  % 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 Chapter 8, “Reference” 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 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 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 *-optionname* option requires an argument (e.g. "*proper\_example\_usage*").** You have incorrectly used a Compiler option. For more information about Compiler options, see Chapter 8, “Reference” or type `mcc -?` at the command prompt.

**Error: *-x* is no longer supported.** The MATLAB Compiler no longer generates MEX-files because there is no longer any performance advantage to doing so. The MATLAB JIT Accelerator makes compilation for speed obsolete.

**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: 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-5.

**Error: Unrecognized option: *-option*.** The option is not one of the valid options for this version of the Compiler. See Chapter 8, “Reference” for a complete list of valid options for MATLAB Compiler 3.0 or type `mcc -?` at the command prompt.



## Warning Messages

This section lists the warning messages that the MATLAB Compiler 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 produce an error message if you are using a demo MATLAB Compiler license to create your stand-alone application, you can use

```
mcc -w error:demo_license -mvg hello
```

To enable all warnings except those generated by the `save` command, use

```
mcc -w enable -w disable:demo_license
```

To display a list of all the warning message identifier strings, use

```
mcc -w list -m mfilename
```

For additional information about the `-w` option, see Chapter 8, “Reference.”

**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 will automatically compile the selected functions.

**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 -m -I /dir1 /dir2/afile.m
```

**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 -m 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: All warnings are disabled.** (*all\_warnings*) This warning displays all warnings generated by the MATLAB Compiler. This warning is disabled.

**Warning: A line has *num1* characters, violating the maximum page width (*num2*).** (*max\_page\_width\_violation*) This warning is generated if there are lines that exceed the maximum page width, *num2*. This warning is disabled.

**Warning: The option *-optionname* is ignored in *modename* mode (specify *-?* for help).** (*switch\_ignored*) This warning is generated if an option is specified on the `mcc` command line that is not meaningful in the specified mode. This warning is enabled.

**Warning: Unrecognized Compiler pragma "*pragmaname*".** (*unrecognized\_pragma*) This warning is generated if you use an unrecognized pragma. This warning is enabled.

**Warning: "*functionname1*" is a MEX- or P-file being referenced from "*functionname2*".** (*mex\_or\_p\_file*) This warning is generated if *functionname2* calls *functionname1*, which is a MEX- or P-file. This warning is enabled.

---

**Note** A link error is produced if a call to this function is made from stand-alone code.

---

**DEMO Compiler license. The generated application will expire 30 days from today, on *date*.** (*demo\_license*) This warning displays the date that the deployed application will expire. This warning is enabled.

## Depfun Errors

The MATLAB Compiler uses a dependency analysis (depfun) to determine the list of necessary files to include in the CTF package. If this analysis encounters a problem, Depfun displays an error.

These error messages take the form

```
Depfun Error: <message>
```

There are three causes of these messages:

- MCR/Dispatcher errors
- XML parser errors
- Depfun-produced errors

### MCR/Dispatcher Errors

These errors originate directly from the MCR/dispatcher. If one of these error occurs, report it to Technical Support at The MathWorks at [support@mathworks.com](mailto:support@mathworks.com).

### XML Parser Errors

These errors appear as

```
Depfun Error: XML error: <message>
```

Where <message> is a message returned by the XML parser. If this error occurs, report it to Technical Support at The MathWorks at [support@mathworks.com](mailto:support@mathworks.com).

### Depfun-Produced Errors

These errors originate directly from depfun.

**Depfun Error: Internal error.** This error occurs if an internal error is encountered that is unexpected, for example, a memory allocation error or a system error of some kind. This error is never user generated. If this error occurs, report it to Technical Support at The MathWorks at [support@mathworks.com](mailto:support@mathworks.com).

**Depfun Error: Unexpected error thrown.** This error is similar to the previous one. If this error occurs, report it to Technical Support at The MathWorks at [support@mathworks.com](mailto:support@mathworks.com).

**Depfun Error: Invalid file name: <filename>.** An invalid filename was passed to depfun.

**Depfun Error: Invalid directory: <dirname>.** An invalid directory was passed to depfun.

# Troubleshooting

---

This appendix identifies some of the more common problems that may occur when using the MATLAB Compiler.

`mbuild` (p. C-2)

Issues involving the `mbuild` utility and creating stand-alone applications

MATLAB Compiler (p. C-4)

Issues involving the MATLAB Compiler

## 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.

**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.** 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 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. For MS Visual Studio, for example, make sure to run `vcvars32.bat` (MSVC 6.x and earlier) or `vsvars32.bat` (MSVC 7.x).

**mbuild Not a Recognized Command.** If `mbuild` is not recognized, verify that `<matlabroot>\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

```
gcc -m hello
```

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 (Windows).** 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 5.3
- `MSVCDIR` for Microsoft Visual C/C++, Version 6.0, 7.0, or 7.1

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

**Internal Error When Using `mbuild -setup` (Windows).** 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 reenable 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](mailto:support@mathworks.com).

## MATLAB 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. A good source for additional troubleshooting information for the MATLAB Compiler is the MATLAB Compiler Product Support page at the MathWorks Web site.

**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.

**Missing Functions In Callbacks.** If your application includes a call to a function in a callback string or in a string passed as an argument to the `feval` function or an ODE solver, and this is the only place in your M-file this function is called, the Compiler will not compile the function. The Compiler does not look in these text strings for the names of functions to compile. See “Fixing Callback Problems: Missing Functions” on page 1-17 for more information.

**Borland Compiler Does Not Work with the Builder Products.** The only compiler that supports the building of COM objects is Microsoft Visual C/C++ (versions 6.0, 7.0, and 7.1).

**“MCRInstance not available” Message Displays.** If you receive the message `MCRInstance not available` when you try to run a stand-alone application that was generated with the MATLAB Compiler, it could be that the MCR is not located properly on your path or the CTF file is not in the proper directory.

To verify that the MCR is properly located on your path, from a development Windows machine, confirm that `<matlabroot>\bin\win32`, where `<matlabroot>` is your root MATLAB directory, appears on your system path ahead of any other MATLAB installations. From a Windows target machine, verify that `<mcr_root>\<ver>\runtime\win32`, where `<mcr_root>` is your root MCR directory, appears on your system path.



To verify that the CTF file that the MATLAB Compiler generated in the build process resides in the same directory as your program's executable file, look at the directory containing the program's executable file and make sure the corresponding .ctf file is also there.

The UNIX verification process is the same, except you use the appropriate UNIX path information.

**“MATLAB file may be corrupt” Message Displays.** If you receive the message

```
This MATLAB file does not have proper version information and may
be corrupt. Please delete the extraction directory and rerun the
application.
```

when you run your stand-alone executable that was generated by the MATLAB Compiler, you should check the following.

- Do you have a startup.m file that calls addpath? If so, this will cause run-time errors. As a workaround, use isdeployed to have the addpath command execute only from MATLAB. For example, use a construct such as:

```
if ~isdeployed
    addpath(path);
end
```
- Verify that the .ctf archive file self extracted and that you have write permission to the directory.
- Verify that none of the files in the <application name>\_mcr directory have been modified or removed. Modifying this directory is not supported, and if you have modified it, you should delete it and redeploy or restart the application.
- If none of the above possible causes apply, then the error is likely caused by a corruption. Delete the <application name>\_mcr directory and run the application.

**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.



# C++ Utility Library Reference

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This appendix describes the C++ utility library provided with the MATLAB Compiler.

Primitive Types (p. D-2)

Primitive types that can be stored in a MATLAB array

Utility Classes (p. D-3)

Utility classes used by the `mwArray`

`mwString` Class (p. D-4)

String class used by the API to pass string data as output

`mwException` Class (p. D-19)

Exception type used by the `mwArray` API and the C++ interface functions

`mwArray` Class (p. D-27)

Used to pass input/output arguments to MATLAB Compiler-generated C++ interface functions

## Primitive Types

The `mwArray` API supports all primitive types that can be stored in a MATLAB array. This table lists all the types.

Type	Description	mxClassID
<code>mxChar</code>	Character type	<code>mxCHAR_CLASS</code>
<code>mxLogical</code>	Logical or Boolean type	<code>mxLOGICAL_CLASS</code>
<code>mxDouble</code>	Double-precision floating-point type	<code>mxDOUBLE_CLASS</code>
<code>mxSingle</code>	Single-precision floating-point type	<code>mxSINGLE_CLASS</code>
<code>mxInt8</code>	1-byte signed integer	<code>mxINT8_CLASS</code>
<code>mxUInt8</code>	1-byte unsigned integer	<code>mxUINT8_CLASS</code>
<code>mxInt16</code>	2-byte signed integer	<code>mxUINT16_CLASS</code>
<code>mxUInt16</code>	2-byte unsigned integer	<code>mxUINT16_CLASS</code>
<code>mxInt32</code>	4-byte signed integer	<code>mxINT32_CLASS</code>
<code>mxUInt32</code>	4-byte unsigned integer	<code>mxUINT32_CLASS</code>
<code>mxInt64</code>	8-byte signed integer	<code>mxINT64_CLASS</code>
<code>mxUInt64</code>	8-byte unsigned integer	<code>mxUINT64_CLASS</code>

## Utility Classes

- “mwString Class” on page D-4
- “mwException Class” on page D-19
- “mwArray Class” on page D-27

## mwString Class

The `mwString` class is a simple string class used by the `mwArray` API to pass string data as output from some certain methods.

### Constructors

- “`mwString()`” on page D-5
- “`mwString(const char* str)`” on page D-6
- “`mwString(const mwString& str)`” on page D-7

### Methods

- “`int Length() const`” on page D-8

### Operators

- “`operator const char* () const`” on page D-9
- “`mwString& operator=(const mwString& str)`” on page D-10
- “`mwString& operator=(const char* str)`” on page D-11
- “`bool operator==(const mwString& str) const`” on page D-12
- “`bool operator!=(const mwString& str) const`” on page D-13
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- “`bool operator<=(const mwString& str) const`” on page D-15
- “`bool operator>(const mwString& str) const`” on page D-16
- “`bool operator>=(const mwString& str) const`” on page D-17
- “`friend std::ostream& operator<<(std::ostream& os, const mwString& str)`” on page D-18

## **mwString()**

Construct empty string.

### **C++ syntax**

```
#include "mclcppclass.h"
mwString str;
```

### **Arguments**

None

### **Return value**

None

### **Description**

Use this constructor to create an empty string.

## **mwString(const char\* str)**

Construct new string and initialize strings data with supplied char buffer.

### **C++ syntax**

```
#include "mclcppclass.h"  
mwString str("This is a string");
```

### **Arguments**

**str.** NULL-terminated char buffer to initialize the string.

### **Return value**

None

### **Description**

Use this constructor to create a string from a NULL-terminated char buffer.



## **mwString(const mwString& str)**

Copy constructor for `mwString`. Constructs a new string and initializes its data with the supplied `mwString`.

### **C++ syntax**

```
#include "mclcppclass.h"
mwString str("This is a string");
mwString new_str(str);    // new_str contains a copy of the
                          // characters in str.
```

### **Arguments**

**str.** `mwString` to be copied

### **Return value**

None

### **Description**

Use this constructor to create an `mwString` that is a copy of an existing one.

## **int Length() const**

Return number of characters in string.

### **C++ syntax**

```
#include "mclcppclass.h"
mwString str("This is a string");
int len = str.Length();    // len should be 16.
```

### **Arguments**

None

### **Return value**

The number of characters in the string.

### **Description**

Use this method to get the length of an `mwString`. The value returned does not include the terminating `NULL` character.

## operator const char\* () const

Return pointer to internal buffer of string.

### C++ syntax

```
#include "mclcppclass.h"
mwString str("This is a string");
const char* pstr = (const char*)str;
```

### Arguments

None

### Return value

A pointer to the internal buffer of the string.

### Description

Use this operator to get direct read-only access to the string's data buffer.

## **mwString& operator=(const mwString& str)**

mwString assignment operator.

### **C++ syntax**

```
#include "mclcppclass.h"
mwString str("This is a string");
mwString new_str = str;    // new_str contains a copy of the data
                          // in str.
```

### **Arguments**

**str.** String to make a copy of.

### **Return value**

A reference to the invoking mwString object.

### **Description**

Use this operator to copy the contents of one string into another.

## **mwString& operator=(const char\* str)**

mwString assignment operator.

### **C++ syntax**

```
#include "mclcppclass.h"
const char* pstr = "This is a string";
mwString str = pstr;    // str contains a copy of the data in pstr.
```

### **Arguments**

**str.** char buffer to make copy of.

### **Return value**

A reference to the invoking mwString object.

### **Description**

Use this operator to copy the contents of a NULL-terminated buffer into an mwString.

## **bool operator==(const mwString& str) const**

Test two mwStrings for equality.

### **C++ syntax**

```
#include "mclcppclass.h"
mwString str("This is a string");
mwString str2("This is another string");
bool ret = (str == str2); // ret should have a value of false.
```

### **Arguments**

**str.** String to compare.

### **Return value**

The result of the comparison.

### **Description**

Use this operator to test two strings for equality.

## bool operator!=(const mwString& str) const

Test two mwStrings for inequality.

### C++ syntax

```
#include "mclcppclass.h"
mwString str("This is a string");
mwString str2("This is another string");
bool ret = (str != str2);    // ret should have a value of
                             // true.
```

### Arguments

**str.** String to compare.

### Return value

The result of the comparison.

### Description

Use this operator to test two strings for inequality.

## **bool operator<(const mwString& str) const**

Compare input string with this string and return true if this string is lexicographically less than input string.

### **C++ syntax**

```
#include "mclcppclass.h"
mwString str("This is a string");
mwString str2("This is another string");
bool ret = (str < str2);           // ret should have a value of
                                   // true.
```

### **Arguments**

**str.** String to compare.

### **Return value**

The result of the comparison.

### **Description**

Use this operator to test two strings for order.



## bool operator<=(const mwString& str) const

Compare input string with this string and return true if this string is lexicographically less than or equal to input string.

### C++ syntax

```
#include "mclcppclass.h"
mwString str("This is a string");
mwString str2("This is another string");
bool ret = (str <= str2);    // ret should have a value of
                             // true.
```

### Arguments

**str.** String to compare.

### Return value

The result of the comparison.

### Description

Use this operator to test two strings for order.

## **bool operator>(const mwString& str) const**

Compare input string with this string and return true if this string is lexicographically greater than input string.

### **C++ syntax**

```
#include "mclcppclass.h"
mwString str("This is a string");
mwString str2("This is another string");
bool ret = (str > str2);           // ret should have a value of
                                   // false.
```

### **Arguments**

**str.** String to compare.

### **Return value**

The result of the comparison.

### **Description**

Use this operator to test two strings for order.

## bool operator>=(const mwString& str) const

Compare input string with this string and return true if this string is lexicographically greater than or equal to input string.

### C++ syntax

```
#include "mclcppclass.h"
mwString str("This is a string");
mwString str2("This is another string");
bool ret = (str >= str2); // ret should have a value of false.
```

### Arguments

**str.** String to compare.

### Return value

The result of the comparison.

### Description

Use this operator to test two strings for order.

## **friend std::ostream& operator<<(std::ostream& os, const mwString& str)**

Copy contents of input string to specified ostream.

### **C++ syntax**

```
#include "mclcppclass.h"
#include <ostream>
mwString str("This is a string");
std::cout << str << std::endl;    // should print "This is a
                                   // string" to standard out.
```

### **Arguments**

**os.** ostream to copy string to.

**str.** String to copy.

### **Return value**

The input ostream.

### **Description**

Use this operator to print the contents of an mwString to an ostream.

## mwException Class

The `mwException` class is the basic exception type used by the `mwArray` API and the C++ interface functions. All errors created during calls to the `mwArray` API and to MATLAB Compiler-generated C++ interface functions are thrown as `mwExceptions`.

### Constructors

- “`mwException()`” on page D-20
- “`mwException(const char* msg)`” on page D-21
- “`mwException(const mwException& e)`” on page D-22
- “`mwException(const std::exception& e)`” on page D-23

### Methods

- “`const char *what() const throw()`” on page D-24

### Operators

- “`mwException& operator=(const mwException& e)`” on page D-25
- “`mwException& operator=(const std::exception& e)`” on page D-26

## **mwException()**

Construct new `mwException` with default error message.

### **C++ syntax**

```
#include "mclcppclass.h"  
throw mwException();
```

### **Arguments**

None

### **Return value**

None

### **Description**

Use this constructor to create an `mwException` without specifying an error message.

## mwException(const char\* msg)

Construct new mwException with specified error message.

### C++ syntax

```
#include "mclcppclass.h"
try
{
    throw mwException("This is an error");
}
catch (const mwException& e)
{
    std::cout << e.what() << std::endl; // Displays "This is
                                        // an error" to
                                        // standard out.
}
}
```

### Arguments

**msg.** Error message.

### Return value

None

### Description

Use this constructor to create an mwException with a specified error message.

## **mwException(const mwException& e)**

Copy constructor for `mwException` class.

### **C++ syntax**

```
#include "mclcppclass.h"
try
{
    throw mwException("This is an error");
}
catch (const mwException& e)
{
    throw mwException(e);           // Rethrows same error.
}
```

### **Arguments**

**e.** `mwException` to create copy of.

### **Return value**

None

### **Description**

Use this constructor to create a copy of an `mwException`. The copy will have the same error message as the original.



## mwException(const std::exception& e)

Create new mwException from existing std::exception.

### C++ syntax

```
#include "mclcppclass.h"
try
{
    .
}
catch (const std::exception& e)
{
    throw mwException(e); // Rethrows same error.
}
```

### Arguments

e. std::exception to create copy of.

### Return value

None

### Description

Use this constructor to create a new mwException and initialize the error message with the error message from the given std::exception.

## **const char \*what() const throw()**

Return error message contained in this exception.

### **C++ syntax**

```
#include "mclcppclass.h"
try
{
    .
}
catch (const std::exception& e)
{
    std::cout << e.what() << std::endl; // Displays the error
                                        // message to
                                        // standard out.
}
```

### **Arguments**

None

### **Return value**

A pointer to a NULL-terminated character buffer containing the error message.

### **Description**

Use this method to retrieve the error message from an `mwException`.

## **mwException& operator=(const mwException& e)**

Assignment operator for mwException class.

### **C++ syntax**

```
#include "mclcppclass.h"
try
{

}
catch (const mwException& e)
{
    mwException e2 = e;
    throw e2;
}
```

### **Arguments**

e. mwException to create copy of.

### **Return value**

A reference to the invoking mwException.

### **Description**

Use this operator to create a copy of an mwException. The copy will have the same error message as the original.

## **mwException& operator=(const std::exception& e)**

Assignment operator for `mwException` class.

### **C++ syntax**

```
#include "mclcppclass.h"
try
{

}
catch (const std::exception& e)
{
    mwException e2 = e;
    throw e2;
}
```

### **Arguments**

**e.** `std::exception` to initialize copy with.

### **Return value**

A reference to the invoking `mwException`.

### **Description**

Use this operator to create a copy of an `std::exception`. The copy will have the same error message as the original.

## mwArray Class

Use the `mwArray` class to pass input/output arguments to MATLAB Compiler-generated C++ interface functions. This class consists of a thin wrapper around a MATLAB array. The `mwArray` class provides the necessary constructors, methods, and operators for array creation and initialization, as well as simple indexing.

### Constructors

- “`mwArray()`” on page D-30
- “`mwArray(mxClassID mxID)`” on page D-31
- “`mwArray(int num_rows, int num_cols, mxClassID mxID, mxComplexity cmplx = mxREAL)`” on page D-32
- “`mwArray(int num_dims, const int* dims, mxClassID mxID, mxComplexity cmplx = mxREAL)`” on page D-33
- “`mwArray(const char* str)`” on page D-34
- “`mwArray(int num_strings, const char** str)`” on page D-35
- “`mwArray(int num_rows, int num_cols, int num_fields, const char** fieldnames)`” on page D-36
- “`mwArray(int num_dims, const int* dims, int num_fields, const char** fieldnames)`” on page D-37
- “`mwArray(const mwArray& arr)`” on page D-38
- “`mwArray(<type> re)`” on page D-39
- “`mwArray(<type> re, <type> im)`” on page D-40

### Methods

- “`mwArray Clone() const`” on page D-41
- “`mwArray SharedCopy() const`” on page D-42
- “`mwArray Serialize() const`” on page D-43
- “`mxClassID ClassID() const`” on page D-44
- “`int ElementSize() const`” on page D-45
- “`int NumberOfElements() const`” on page D-46

- “int NumberOfNonZeros() const” on page D-47
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- “int NumberOfDimensions() const” on page D-49
- “int NumberOfFields() const” on page D-50
- “mwString GetFieldName(int index)” on page D-51
- “mwArray GetDimensions() const” on page D-52
- “bool IsEmpty() const” on page D-53
- “bool IsSparse() const” on page D-54
- “bool IsNumeric() const” on page D-55
- “bool IsComplex() const” on page D-56
- “bool Equals(const mwArray& arr) const” on page D-57
- “int CompareTo(const mwArray& arr) const” on page D-58
- “int GetHashCode() const” on page D-59
- “mwString ToString() const” on page D-60
- “mwArray RowIndex() const” on page D-61
- “mwArray ColumnIndex() const” on page D-62
- “void MakeComplex()” on page D-63
- “mwArray Get(int num\_indices, ...)” on page D-64
- “mwArray Get(const char\* name, int num\_indices, ...)” on page D-65
- “mwArray GetA(int num\_indices, const int\* index)” on page D-67
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- “mwArray Real()” on page D-70
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- “void Set(const mwArray& arr)” on page D-72
- “void GetData(<numeric-type>\* buffer, int len) const” on page D-73
- “void GetLogicalData(mxLogical\* buffer, int len) const” on page D-74
- “void GetCharData(mxChar\* buffer, int len) const” on page D-75
- “void SetData(<numeric-type>\* buffer, int len)” on page D-76
- “void SetLogicalData(mxLogical\* buffer, int len)” on page D-77
- “void SetCharData(mxChar\* buffer, int len)” on page D-78

## Operators

- “mwArray operator()(int i1, int i2, int i3, ..., )” on page D-79
- “mwArray operator()(const char\* name, int i1, int i2, int i3, ..., )” on page D-80
- “mwArray& operator=(const <type>& x)” on page D-82
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## Static Methods

- “static mwArray Deserialize(const mwArray& arr)” on page D-84
- “static double GetNaN()” on page D-85
- “static double GetEps()” on page D-86
- “static double GetInf()” on page D-87
- “static bool IsFinite(double x)” on page D-88
- “static bool IsInf(double x)” on page D-89
- “static bool IsNaN(double x)” on page D-90

## **mwArray()**

Construct empty array of type `mUNKNOWN_CLASS`.

### **C++ syntax**

```
#include "mclcppclass.h"  
mwArray a;
```

### **Return value**

None

### **Description**

Use this constructor to create an empty array of unknown type.



## **mwArray(mxClassID mxID)**

Construct empty array of specified type.

### **C++ syntax**

```
#include "mclcppclass.h"  
mwArray a(mxDOUBLE_CLASS);
```

### **Return value**

None

### **Description**

Use this constructor to create an empty array of the specified type. Any valid mxClassID can be used. See the External Interfaces documentation for more information on mxClassID.

## **mwArray(int num\_rows, int num\_cols, mxClassID mxID, mxComplexity cmplx = mxREAL)**

Construct 2D matrix of specified type and dimensions. For numeric types, the matrix can be either real or complex.

### **C++ syntax**

```
#include "mclcppclass.h"
mwArray a(2, 2, mxDOUBLE_CLASS);
mwArray b(3, 3, mxSINGLE_CLASS, mxCOMPLEX);
mwArray c(2, 3, mxCELL_CLASS);
```

### **Arguments**

**num\_rows.** The number of rows

**num\_cols.** The number of columns

**mxID.** The datatype type of the matrix

**cmplx.** The complexity of the matrix (numeric types only)

### **Return value**

None

### **Description**

Use this constructor to create a matrix of the specified type and complexity. You can use any valid `mxClassID`. Consult the External Interfaces documentation for more information on `mxClassID`. For numeric types, pass `mxCOMPLEX` for the last argument to create a complex matrix. All elements are initialized to zero. For cell matrices, all elements are initialized to empty cells.

## **mwArray(int num\_dims, const int\* dims, mxClassID mxID, mxComplexity cmplx = mxREAL)**

Construct n-dimensional array of specified type and dimensions. For numeric types, the array can be either real or complex.

### **C++ syntax**

```
#include "mclcppclass.h"
int dims[3] = {2,3,4};
mwArray a(3, dims, mxDOUBLE_CLASS);
mwArray b(3, dims, mxSINGLE_CLASS, mxCOMPLEX);
mwArray c(3, dims, mxCELL_CLASS);
```

### **Arguments**

**num\_dims.** Size of the `dims` array

**dims.** Dimensions of the array

**mxID.** The datatype type of the matrix.

**cmplx.** The complexity of the matrix (numeric types only)

### **Return value**

None

### **Description**

Use this constructor to create an n-dimensional array of the specified type and complexity. You can use any valid `mxClassID`. Consult the External Interfaces documentation for more information on `mxClassID`. For numeric types, pass `mxCOMPLEX` for the last argument to create a complex matrix. All elements are initialized to zero. For cell arrays, all elements are initialized to empty cells.

## **mwArray(const char\* str)**

Construct character array from supplied string.

### **C++ syntax**

```
#include "mclcppclass.h"  
mwArray a("This is a string");
```

### **Arguments**

**str.** NULL-terminated string

### **Return value**

None

### **Description**

Use this constructor to create a 1-by-n array of type `mxCHAR_CLASS`, with `n = strlen(str)`, and initialize the array's data with the characters in the supplied string.

## **mwArray(int num\_strings, const char\*\* str)**

Construct character matrix from list of strings.

### **C++ syntax**

```
#include "mclcppclass.h"
const char* str[] = {"String1", "String2", "String3"};
mwArray a(3, str);
```

### **Arguments**

**num\_strings.** Number of strings in the input array

**str.** Array of NULL-terminated strings

### **Return value**

None

### **Description**

Use this constructor to create a matrix of type `mxCHAR_CLASS`, and initialize the array's data with the characters in the supplied strings. The created array has dimensions `m-by-max`, where `max` is the length of the longest string in `str`.

## **mwArray(int num\_rows, int num\_cols, int num\_fields, const char\*\* fieldnames)**

Construct 2D MATLAB structure matrix of specified dimensions and fieldnames.

### **C++ syntax**

```
#include "mclcppclass.h"
const char* fields[] = {"a", "b", "c"};
mwArray a(2, 2, 3, fields);
```

### **Arguments**

**num\_rows.** Number of rows in the struct matrix

**num\_cols.** Number of columns in the struct matrix

**num\_fields.** Number of fields in the struct matrix

**fieldnames.** Array of NULL-terminated strings representing the fieldnames.

### **Return value**

None

### **Description**

Use this constructor to create a matrix of type `mxSTRUCT_CLASS`, with the specified fieldnames. All elements are initialized with empty cells.

## **mwArray(int num\_dims, const int\* dims, int num\_fields, const char\*\* fieldnames)**

Construct n-dimensional MATLAB structure array of specified dimensions and fieldnames.

### **C++ syntax**

```
#include "mclcppclass.h"
const char* fields[] = {"a", "b", "c"};
int dims[3] = {2, 3, 4}
mwArray a(3, dims, 3, fields);
```

### **Arguments**

**num\_dims.** Size of the dims array

**dims.** Dimensions of the struct array

**num\_fields.** Number of fields in the struct array

**fieldnames.** Array of NULL-terminated strings representing the fieldnames

### **Return value**

None

### **Description**

Use this constructor to create an n-dimensional array of type `mxSTRUCT_CLASS`, with the specified fieldnames. All elements are initialized with empty cells.

## **mwArray(const mwArray& arr)**

mwArray copy constructor. Constructs a new array from an existing one.

### **C++ syntax**

```
#include "mclcppclass.h"
mwArray a(2, 2, mxDOUBLE_CLASS);
mwArray b(a);
```

### **Arguments**

**arr.** mwArray to copy

### **Return value**

None

### **Description**

Use this constructor to create a copy of an existing array. The new array contains a deep copy of the input array.



## **mwArray(<type> re)**

Construct real scalar array of type of the input argument and initialize data with input argument's value.

### **C++ syntax**

```
#include "mclcppclass.h"
double x = 5.0;
mwArray a(x);          // Creates a 1X1 double array with value 5.0
```

### **Arguments**

**re.** Scalar value to initialize array with

### **Return value**

None

### **Description**

Use this constructor to create a real scalar array. <type> can be any of the following: `mxDouble`, `mxSingle`, `mxInt8`, `mxUInt8`, `mxInt16`, `mxUInt16`, `mxInt32`, `mxUInt32`, `mxInt64`, `mxUInt64`, or `mxLogical`. The scalar array is created with the type of the input argument.

## **mwArray(<type> re, <type> im)**

Construct complex scalar array of type of the input arguments and initialize real and imaginary parts of data with the input argument's values.

### **C++ syntax**

```
#include "mclcppclass.h"
double re = 5.0;
double im = 10.0;
mwArray a(re, im); // Creates a 1X1 complex array with value 5+10i
```

### **Arguments**

- re.** Scalar value to initialize real part with
- im.** Scalar value to initialize imaginary part with

### **Return value**

None

### **Description**

Use this constructor to create a complex scalar array. The first input argument initializes the real part and the second argument initializes the imaginary part. <type> can be any of the following: `mxDouble`, `mxFSingle`, `mxInt8`, `mxUInt8`, `mxInt16`, `mxUInt16`, `mxInt32`, `mxUInt32`, `mxInt64`, or `mxUInt64`. The scalar array is created with the type of the input arguments.

## **mwArray Clone() const**

Return new array representing deep copy of this array.

### **C++ syntax**

```
#include "mclcppclass.h"
mwArray a(2, 2, mxDOUBLE_CLASS);
mwArray b = a.Clone();
```

### **Arguments**

None

### **Return value**

New mwArray representing a deep copy of the original.

### **Description**

Use this method to create a copy of an existing array. The new array contains a deep copy of the input array.

## **mwArray SharedCopy() const**

Return new array representing shared copy of this array.

### **C++ syntax**

```
#include "mclcppclass.h"
mwArray a(2, 2, mxDOUBLE_CLASS);
mwArray b = a.SharedCopy();
```

### **Arguments**

None

### **Return value**

New `mwArray` representing a reference counted version of the original.

### **Description**

Use this method to create a shared copy of an existing array. The new array and the original array both point to the same data.

## **mwArray Serialize() const**

Serialize underlying array into byte array, and return this data in new array of type `mxUINT8_CLASS`.

### **C++ syntax**

```
#include "mclcppclass.h"
mwArray a(2, 2, mxDOUBLE_CLASS);
mwArray s = a.Serialize();
```

### **Arguments**

None

### **Return value**

New `mwArray` of type `mxUINT8_CLASS` containing the serialized data.

### **Description**

Use this method to serialize an array into bytes. A 1-by-n numeric matrix of type `mxUINT8_CLASS` is returned containing the serialized data. The data can be deserialized back into the original representation by calling `maArray::Deserialize()`.

## **mxClassID ClassID() const**

Return type of this array.

### **C++ syntax**

```
#include "mclcppclass.h"
mwArray a(2, 2, mxDOUBLE_CLASS);
mxClassID id = a.ClassID();// Should return mxDOUBLE_CLASS
```

### **Arguments**

None

### **Return value**

The mxClassID of the array.

### **Description**

Use this method to determine the type of the array. Consult the [External Interfaces](#) documentation for more information on mxClassID.

## int ElementSize() const

Return size in bytes of an element of this array.

### C++ syntax

```
#include "mclcppclass.h"
mwArray a(2, 2, mxDOUBLE_CLASS);
int size = a.ElementSize(); // Should return sizeof(double)
```

### Arguments

None

### Return value

The size in bytes of an element of this type of array.

### Description

Use this method to determine the size in bytes of an element of this array type.

## **int NumberOfElements() const**

Return number of elements in this array.

### **C++ syntax**

```
#include "mclcppclass.h"  
mwArray a(2, 2, mxDOUBLE_CLASS);  
int n = a.NumberOfElements();// Should return 4
```

### **Arguments**

None

### **Return value**

Number of elements in this array.

### **Description**

Use this method to determine the total size of the array.



---

## int NumberOfNonZeros() const

Return number of nonzero elements for sparse array.

### C++ syntax

```
#include "mclcppclass.h"
mwArray a(2, 2, mxDOUBLE_CLASS);
int n = a.NumberOfNonZeros(); // Should return 4
```

### Arguments

None

### Return value

Actual number of nonzero elements in this array.

### Description

Use this method to determine the size of the of the array's data. If the underlying array is not sparse, this returns the same value as `NumberOfElements()`.

---

**Note** This method does not analyze the actual values of the array elements. Instead, it returns the number of elements that could potentially be nonzero. This is exactly the number of elements for which the sparse matrix has allocated storage.

---

## **int MaximumNonZeros() const**

Return maximum number of nonzero elements for sparse array. If the underlying array is not sparse, returns the same value as `NumberOfElements()`.

### **C++ syntax**

```
#include "mclcppclass.h"
mwArray a(2, 2, mxDOUBLE_CLASS);
int n = a.MaximumNonZeros();// Should return 4
```

### **Arguments**

None

### **Return value**

Number of allocated nonzero elements in this array.

### **Description**

Use this method to determine the allocated size of the of the array's data. If the underlying array is not sparse, this returns the same value as `NumberOfElements()`.

---

**Note** This method does not analyze the actual values of the array elements.

---

## int NumberOfDimensions() const

Return number of dimensions in this array.

### C++ syntax

```
#include "mclcppclass.h"
mwArray a(2, 2, mxDOUBLE_CLASS);
int n = a.NumberOfDimensions();// Should return 4
```

### Arguments

None

### Return value

Number of dimensions in this array.

### Description

Use this method to determine the dimensionality of the array.

## **int NumberOfFields() const**

Return number of fields in struct array.

### **C++ syntax**

```
#include "mclcppclass.h"
const char* fields[] = {"a", "b", "c"};
mwArray a(2, 2, 3, fields);
int n = a.NumberOfFields(); // Should return 3
```

### **Arguments**

None

### **Return value**

Number of fields in the array.

### **Description**

Use this method to determine the number of fields in a struct array. If the underlying array is not of type struct, zero is returned.

## **mwString GetFieldName(int index)**

Return string representing name of the (zero-based) *ith* field in struct array.

### **C++ syntax**

```
#include "mclcppclass.h"
const char* fields[] = {"a", "b", "c"};
mwArray a(2, 2, 3, fields);
const char* name = (const char*)a.GetFieldName(1); // Should
                                                    // return "b"
```

### **Arguments**

**Index.** zero-based field number.

### **Return value**

mwString containing the fieldname.

### **Description**

Use this method to determine the name of a given field in a struct array. If the underlying array is not of type struct, an exception is thrown.

## **mwArray GetDimensions() const**

Return array of type `mxINT32_CLASS` representing dimensions of this array.

### **C++ syntax**

```
#include "mclcppclass.h"
mwArray a(2, 2, mxDOUBLE_CLASS);
mwArray dims = a.GetDimensions();
```

### **Arguments**

None

### **Return value**

`mwArray` type `mxINT32_CLASS` containing the dimensions of the array.

### **Description**

Use this method to determine the size of each dimension in the array. The size of the returned array is 1-by-NumberOfDimensions().

## bool isEmpty() const

Return true if underlying array is empty.

### C++ syntax

```
#include "mclcppclass.h"
mwArray a;
bool b = a.IsEmpty(); // Should return true
```

### Arguments

None

### Return value

Boolean indicating if the array is empty.

### Description

Use this method to determine if an array is empty.

## **bool IsSparse() const**

Return true if underlying array is sparse.

### **C++ syntax**

```
#include "mclcppclass.h"  
mwArray a(2, 2, mxDOUBLE_CLASS);  
bool b = a.IsSparse(); // Should return false
```

### **Arguments**

None

### **Return value**

Boolean indicating if the array is sparse.

### **Description**

Use this method to determine if an array is sparse.



## bool IsNumeric() const

Return true if underlying array is numeric.

### C++ syntax

```
#include "mclcppclass.h"
mwArray a(2, 2, mxDOUBLE_CLASS);
bool b = a.IsNumeric(); // Should return true.
```

### Arguments

None

### Return value

Boolean indicating if the array is numeric.

### Description

Use this method to determine if an array is numeric.

## **bool IsComplex() const**

Return true if underlying array is complex.

### **C++ syntax**

```
#include "mclcppclass.h"  
mwArray a(2, 2, mxDOUBLE_CLASS, mxCOMPLEX);  
bool b = a.IsComplex(); // Should return true.
```

### **Arguments**

None

### **Return value**

Boolean indicating if the array is complex.

### **Description**

Use this method to determine if an array is complex.

## bool Equals(const mxArray& arr) const

Test two arrays for equality.

### C++ syntax

```
#include "mclcppclass.h"
mxArray a(1, 1, mxDOUBLE_CLASS);
mxArray b(1, 1, mxDOUBLE_CLASS);
a = 1.0;
b = 1.0;
bool b = a.Equals(b); // Should return true.
```

### Arguments

**arr.** Array to compare to this array.

### Return value

Boolean value indicating the equality of the two arrays.

### Description

Returns true if the input array is byte-wise equal to this array. This method makes a byte-wise comparison of the underlying arrays. Therefore, arrays of the same type should be compared. Arrays of different types will not in general be equal, even if they are initialized with the same data.

## **int CompareTo(const mwArray& arr) const**

Compare two arrays for order.

### **C++ syntax**

```
#include "mclcppclass.h"
mwArray a(1, 1, mxDOUBLE_CLASS);
mwArray b(1, 1, mxDOUBLE_CLASS);
a = 1.0;
b = 1.0;
int n = a.CompareTo(b); // Should return 0
```

### **Arguments**

**arr.** Array to compare to this array.

### **Return value**

Returns a negative integer, zero, or a positive integer if this array is less than, equal to, or greater than the specified array.

### **Description**

Compares this array with the specified array for order. This method makes a byte-wise comparison of the underlying arrays. Therefore, arrays of the same type should be compared. Arrays of different types will, in general, not be ordered equivalently, even if they are initialized with the same data.

## int GetHashCode() const

Return hash code for this array.

### C++ syntax

```
#include "mclcppclass.h"
mwArray a(1, 1, mxDOUBLE_CLASS);
int n = a.GetHashCode();
```

### Arguments

None

### Return value

An integer value representing a unique hash code for the array.

### Description

This method constructs a unique hash value from the underlying bytes in the array. Therefore, arrays of different types will have different hash codes, even if they are initialized with the same data.

## **mwString ToString() const**

Return string representation of underlying array.

### **C++ syntax**

```
#include <stdio.h>
#include "mclcppclass.h"
mwArray a(1, 1, mxDOUBLE_CLASS, mxCOMPLEX);
a.Real() = 1.0;
a.Imag() = 2.0;
printf("%s\n", (const char*)(a.ToString())); // Should print
// "1 + 2i" on the
// screen.
```

### **Arguments**

None

### **Return value**

An `mwString` containing the string representation of the array.

### **Description**

This method returns a string representation of the underlying array. The string returned is the same string that is returned by typing a variable's name at the MATLAB command prompt.

## **mwArray RowIndex() const**

Return array containing row indices of each element in this array.

### **C++ syntax**

```
#include <stdio.h>
#include "mclcppclass.h"
mwArray a(1, 1, mxDOUBLE_CLASS);
mwArray rows = a.RowIndex();
```

### **Arguments**

None

### **Return value**

An mwArray containing the row indices.

### **Description**

Returns an array of type mxINT32\_CLASS representing the row indices (first dimension) of this array. For sparse arrays, the indices are returned for just the non-zero elements and the size of the array returned is 1-by-NumberOfNonZeros(). For nonsparse arrays, the size of the array returned is 1-by-NumberOfElements(), and the row indices of all of the elements are returned.

## **mwArray ColumnIndex() const**

Return array containing column indices of each element in this array.

### **C++ syntax**

```
#include "mclcppclass.h"
mwArray a(1, 1, mxDOUBLE_CLASS);
mwArray rows = a.ColumnIndex();
```

### **Arguments**

None

### **Return value**

An `mwArray` containing the column indices.

### **Description**

Returns an array of type `mxINT32_CLASS` representing the column indices (second dimension) of this array. For sparse arrays, the indices are returned for just the non-zero elements and the size of the array returned is `1-by-NumberOfNonZeros()`. For nonsparse arrays, the size of the array returned is `1-by-NumberOfElements()`, and the column indices of all of the elements are returned.



## void MakeComplex()

Convert real numeric array to complex.

### C++ syntax

```
#include "mclcppclass.h"
double rdata[4] = {1.0, 2.0, 3.0, 4.0};
double idata[4] = {10.0, 20.0, 30.0, 40.0};
mwArray a(2, 2, mxDOUBLE_CLASS);
a.SetData(rdata, 4);
a.MakeComplex();
a.Imag().SetData(idata, 4);
```

### Arguments

None

### Return value

None

### Description

Use this method to convert a numeric array that has been previously allocated as real to complex. If the underlying array is of a nonnumeric type, an `mwException` is thrown.

## **mwArray Get(int num\_indices, ...)**

Return single element at the specified 1-based index. The index is passed by first passing the number of indices followed by a comma separated list of 1-based indices.

### **C++ syntax**

```
#include "mclcppclass.h"
double data[4] = {1.0, 2.0, 3.0, 4.0};
double x;
mwArray a(2, 2, mxDOUBLE_CLASS);
a.SetData(data, 4);
x = a.Get(1,1);           // x = 1.0
x = a.Get(2, 1, 2);      // x = 3.0
x = a.Get(2, 2, 2);      // x = 4.0
```

### **Arguments**

**num\_indices.** Number of indices passed in.

**...** Comma-separated list of input indices. Number of items must equal num\_indices.

### **Return value**

An mwArray containing the value at the specified index.

### **Description**

Use this method to fetch a single element at a specified index. The index is passed by first passing the number of indices followed by a comma-separated list of 1-based indices. The valid number of indices that can be passed in is either 1 (single subscript indexing), in which case the element at the specified 1-based offset is returned, accessing data in column-wise order, or NumberOfDimensions() (multiple subscript indexing), in which case, the index list is used to access the specified element. The valid range for indices is  $1 \leq \text{index} \leq \text{NumberOfElements}()$ , for single subscript indexing. For multiple subscript indexing, the *i*th index has the valid range:  $1 \leq \text{index}[i] \leq \text{GetDimensions}().\text{Get}(1, i)$ . An mwException is thrown if an invalid number of indices is passed in or if any index is out of bounds.

## mwArray Get(const char\* name, int num\_indices, ...)

Return single element at the specified field name and 1-based index in struct array. The index is passed by first passing the number of indices followed by a comma-separated list of 1-based indices.

### C++ syntax

```
#include "mclcppclass.h"
const char* fields[] = {"a", "b", "c"};

mwArray a(1, 1, 3, fields);
mwArray b = a.Get("a", 1, 1);           // b=a.a(1)
mwArray b = a.Get("b", 2, 1, 1);       // b=a.b(1,1)
```

### Arguments

**name.** NULL-terminated string containing the field name to get.

**num\_indices.** Number of indices passed in.

**...** Comma-separated list of input indices. Number of items must equal num\_indices.

### Return value

An mwArray containing the value at the specified field name and index.

### Description

Use this method to fetch a single element at a specified field name and index. This method may only be called on an array that is of type mxSTRUCT\_CLASS. An mwException is thrown if the underlying array is not a struct array. The field name passed must be a valid field name in the struct array. The index is passed by first passing the number of indices followed by a comma-separated list of 1-based indices. The valid number of indices that can be passed in is either 1 (single subscript indexing), in which case the element at the specified 1-based offset is returned, accessing data in column-wise order, or NumberOfDimensions() (multiple subscript indexing), in which case, the index list is used to access the specified element. The valid range for indices is  $1 \leq \text{index} \leq \text{NumberOfElements}()$ , for single subscript indexing. For multiple subscript indexing, the *i*th index has the valid range:

`1 <= index[i] <= GetDimensions().Get(1, i)`. An `mwException` is thrown if an invalid number of indices is passed in or if any index is out of bounds.

## **mwArray GetA(int num\_indices, const int\* index)**

Return single element at the specified 1-based index. The index is passed as an array of 1-based indices.

### **C++ syntax**

```
#include "mclcppclass.h"
double data[4] = {1.0, 2.0, 3.0, 4.0};
int index[2] = {1, 1};
double x;
mwArray a(2, 2, mxDOUBLE_CLASS);
a.SetData(data, 4);
x = a.GetA(1, index);      // x = 1.0
x = a.GetA(2, index);      // x = 1.0
index[0] = 2;
index[1] = 2;
x = a.Get(2, index);      // x = 4.0
```

### **Arguments**

**num\_indices.** Size of index array.

**index.** Array of at least size num\_indices containing the indices.

### **Return value**

An mwArray containing the value at the specified index.

### **Description**

Use this method to fetch a single element at a specified index. The index is passed by first passing the number of indices, followed by an array of 1-based indices. The valid number of indices that can be passed in is either 1 (single subscript indexing), in which case the element at the specified 1-based offset is returned, accessing data in column-wise order, or NumberOfDimensions() (multiple sub-script indexing), in which case, the index list is used to access the specified element. The valid range for indices is

$1 \leq \text{index} \leq \text{NumberOfElements}()$ , for single subscript indexing. For multiple subscript indexing, the *i*th index has the valid range:

$1 \leq \text{index}[i] \leq \text{GetDimensions}().\text{Get}(1, i)$ . An mwException is thrown if an invalid number of indices is passed in or if any index is out of bounds.

## **mwArray GetA(const char\* name, int num\_indices, const int\* index)**

Return single element at the specified field name and 1-based index in struct array. The index is passed as an array of 1-based indices.

### **C++ syntax**

```
#include "mclcppclass.h"
const char* fields[] = {"a", "b", "c"};
int index[2] = {1, 1};
mwArray a(1, 1, 3, fields);
mwArray b = a.Get("a", 1, index);      // b=a.a(1)
mwArray b = a.Get("b", 2, index);      // b=a.b(1,1)
```

### **Arguments**

**name.** NULL-terminated string containing the field name to get.

**num\_indices.** Number of indices passed in.

**index.** Array of at least size num\_indices containing the indices.

### **Return value**

An mwArray containing the value at the specified field name and index.

### **Description**

Use this method to fetch a single element at a specified field name and index. This method may only be called on an array that is of type mxSTRUCT\_CLASS. An mwException is thrown if the underlying array is not a struct array. The field name passed must be a valid field name in the struct array. The index is passed by first passing the number of indices followed by an array of 1-based indices. The valid number of indices that can be passed in is either 1 (single subscript indexing), in which case the element at the specified 1-based offset is returned, accessing data in column-wise order, or NumberOfDimensions() (multiple subscript indexing), in which case, the index list is used to access the specified element. The valid range for indices is  $1 \leq \text{index} \leq \text{NumberOfElements}()$ , for single subscript indexing. For multiple subscript indexing, the *i*th index has the valid range:

`1 <= index[i] <= GetDimensions().Get(1, i)`. An `mwException` is thrown if an invalid number of indices is passed in or if any index is out of bounds.

## **mwArray Real()**

Return `mwArray` that references real part of complex array.

### **C++ syntax**

```
#include "mclcppclass.h"
double rdata[4] = {1.0, 2.0, 3.0, 4.0};
double idata[4] = {10.0, 20.0, 30.0, 40.0};
mwArray a(2, 2, mxDOUBLE_CLASS, mxCOMPLEX);
a.Real().SetData(rdata, 4);
a.Imag().SetData(idata, 4);
```

### **Arguments**

None

### **Return value**

An `mwArray` referencing the real part of the array.

### **Description**

Use this method to access the real part of a complex array. The returned `mwArray` is considered real and has the same dimensionality and type as the original.



## mwArray Imag()

Return `mwArray` that references imaginary part of complex array.

### C++ syntax

```
#include "mclcppclass.h"
double rdata[4] = {1.0, 2.0, 3.0, 4.0};
double idata[4] = {10.0, 20.0, 30.0, 40.0};
mwArray a(2, 2, mxDOUBLE_CLASS, mxCOMPLEX);
a.Real().SetData(rdata, 4);
a.Imag().SetData(idata, 4);
```

### Arguments

None

### Return value

An `mwArray` referencing the imaginary part of the array.

### Description

Use this method to access the imaginary part of a complex array. The returned `mwArray` is considered real and has the same dimensionality and type as the original.

## **void Set(const mxArray& arr)**

Assign shared copy of input array to currently referenced cell for arrays of type `mxCELL_CLASS` and `mxSTRUCT_CLASS`.

### **C++ syntax**

```
#include "mclcppclass.h"
mxArray a(2, 2, mxDOUBLE_CLASS);
mxArray b(2, 2, mxINT16_CLASS);
mxArray c(1, 2, mxCELL_CLASS);
c.Get(1,1).Set(a);      // Sets c(1) = a
a.Get(1,2).Set(b);     // Sets c(2) = b
```

### **Arguments**

**arr.** mxArray to assign to currently referenced cell.

### **Return value**

None

### **Description**

Use this method to construct cell and struct arrays.

## void GetData(<numeric-type>\* buffer, int len) const

Copy array's data into supplied numeric buffer.

### C++ syntax

```
#include "mclcppclass.h"
double rdata[4] = {1.0, 2.0, 3.0, 4.0};
double data_copy[4] ;
mwArray a(2, 2, mxDOUBLE_CLASS);
a.SetData(rdata, 4);
a.GetData(data_copy, 4);
```

### Arguments

**buffer.** Buffer to receive copy.

**len.** Maximum length of buffer. A maximum of len elements will be copied.

### Return value

None

### Description

Valid types for <numeric-type> are mxDOUBLE\_CLASS, mxSINGLE\_CLASS, mxINT8\_CLASS, mxUINT8\_CLASS, mxINT16\_CLASS, mxUINT16\_CLASS, mxINT32\_CLASS, mxUINT32\_CLASS, mxINT64\_CLASS, and mxUINT64\_CLASS. The data is copied in column-major order. If the underlying array is not of the same type as the input buffer, the data is converted to this type as it is copied. If a conversion cannot be made, an mwException is thrown.

## **void GetLogicalData(mxLogical\* buffer, int len) const**

Copy array's data into supplied mxLogical buffer.

### **C++ syntax**

```
#include "mclcppclass.h"
mxLogical data[4] = {true, false, true, false};
mxLogical data_copy[4] ;
mwArray a(2, 2, mxLOGICAL_CLASS);
a.SetData(data, 4);
a.GetData(data_copy, 4);
```

### **Arguments**

**buffer.** Buffer to receive copy.

**len.** Maximum length of buffer. A maximum of len elements will be copied.

### **Return value**

None

### **Description**

The data is copied in column-major order. If the underlying array is not of type mxLOGICAL\_CLASS, the data is converted to this type as it is copied. If a conversion cannot be made, an mwException is thrown.

## void GetCharData(mxChar\* buffer, int len) const

Copy array's data into supplied mxChar buffer.

### C++ syntax

```
#include "mclcppclass.h"
mxChar data[6] = {'H', 'e', 'l', 'l', 'o', '\0'};
mxChar data_copy[6] ;
mwArray a(1, 6, mxCHAR_CLASS);
a.SetData(data, 6);
a.GetData(data_copy, 6);
```

### Arguments

**buffer.** Buffer to receive copy.

**len.** Maximum length of buffer. A maximum of len elements will be copied.

### Return value

None

### Description

The data is copied in column-major order. If the underlying array is not of type mxCHAR\_CLASS, the data is converted to this type as it is copied. If a conversion cannot be made, an mwException is thrown.

## **void SetData(<numeric-type> \* buffer, int len)**

Copy data from supplied numeric buffer into array.

### **C++ syntax**

```
#include "mclcppclass.h"
double rdata[4] = {1.0, 2.0, 3.0, 4.0};
double data_copy[4] ;
mwArray a(2, 2, mxDOUBLE_CLASS);
a.SetData(rdata, 4);
a.GetData(data_copy, 4);
```

### **Arguments**

**buffer.** Buffer containing data to copy.

**len.** Maximum length of buffer. A maximum of len elements will be copied.

### **Return value**

None

### **Description**

Valid types for <numeric-type> are mxDOUBLE\_CLASS, mxSINGLE\_CLASS, mxINT8\_CLASS, mxUINT8\_CLASS, mxINT16\_CLASS, mxUINT16\_CLASS, mxINT32\_CLASS, mxUINT32\_CLASS, mxINT64\_CLASS, and mxUINT64\_CLASS. The data is copied in column-major order. If the underlying array is not of the same type as the input buffer, the data is converted to this type as it is copied. If a conversion cannot be made, an mwException is thrown.

## void SetLogicalData(mxLogical\* buffer, int len)

Copy data from supplied mxLogical buffer into array.

### C++ syntax

```
#include "mclcppclass.h"
mxLogical data[4] = {true, false, true, false};
mxLogical data_copy[4] ;
mwArray a(2, 2, mxLOGICAL_CLASS);
a.SetData(data, 4);
a.GetData(data_copy, 4);
```

### Arguments

**buffer.** Buffer containing data to copy.

**len.**

Maximum length of buffer. A maximum of len elements will be copied.

### Return value

None

### Description

The data is copied in column-major order. If the underlying array is not of type mxLOGICAL\_CLASS, the data is converted to this type as it is copied. If a conversion cannot be made, an mxArrayException is thrown.

## **void SetCharData(mxChar\* buffer, int len)**

Copy data from supplied mxChar buffer into array.

### **C++ syntax**

```
#include "mclcppclass.h"
mxChar data[6] = {'H', 'e', 'l', 'l', 'o', '\0'};
mxChar data_copy[6] ;
mwArray a(1, 6, mxCHAR_CLASS);
a.SetData(data, 6);
a.GetData(data_copy, 6);
```

### **Arguments**

**buffer.** Buffer containing data to copy.

**len.**

Maximum length of buffer. A maximum of len elements will be copied.

### **Return value**

None

### **Description**

The data is copied in column-major order. If the underlying array is not of type mxCHAR\_CLASS, the data is converted to this type as it is copied. If a conversion cannot be made, an mwException is thrown.



## **mwArray operator()(int i1, int i2, int i3, ..., )**

Return single element at the specified 1-based index. The index is passed as a comma-separated list of 1-based indices. This operator is overloaded to support 1 through 32 indices.

### **C++ syntax**

```
#include "mclcppclass.h"
double data[4] = {1.0, 2.0, 3.0, 4.0};
double x;
mwArray a(2, 2, mxDOUBLE_CLASS);
a.SetData(data, 4);
x = a(1,1);    // x = 1.0
x = a(1,2);    // x = 3.0
x = a(2,2);    // x = 4.0
```

### **Arguments**

**i1, i2, i3, ...,** Comma-separated list of input indices.

### **Return value**

An `mwArray` containing the value at the specified index.

### **Description**

Use this operator to fetch a single element at a specified index. The index is passed as a comma-separated list of 1-based indices. The valid number of indices that can be passed in is either 1 (single subscript indexing), in which case the element at the specified 1-based offset is returned, accessing data in column-wise order, or `NumberOfDimensions()` (multiple subscript indexing), in which case, the index list is used to access the specified element. The valid range for indices is  $1 \leq \text{index} \leq \text{NumberOfElements}()$ , for single subscript indexing. For multiple subscript indexing, the *i*th index has the valid range:  $1 \leq \text{index}[i] \leq \text{GetDimensions}().\text{Get}(1, i)$ . An `mwException` is thrown if an invalid number of indices is passed in or if any index is out of bounds.

## **mwArray operator()(const char\* name, int i1, int i2, int i3, ..., )**

Return single element at the specified field name and 1-based index in struct array. The index is passed as a comma-separated list of 1-based indices. This operator is overloaded to support 1 through 32 indices.

### **C++ syntax**

```
#include "mclcppclass.h"
const char* fields[] = {"a", "b", "c"};
int index[2] = {1, 1};
mwArray a(1, 1, 3, fields);
mwArray b = a("a", 1, 1);      // b=a.a(1,1)
mwArray b = a("b", 1, 1);      // b=a.b(1,1)
```

### **Arguments**

**name.** NULL-terminated string containing the field name to get.

**i1, i2, i3, ...,** Comma-separated list of input indices.

### **Return value**

An `mwArray` containing the value at the specified field name and index.

### **Description**

Use this method to fetch a single element at a specified field name and index. This method may only be called on an array that is of type `mxSTRUCT_CLASS`. An `mwException` is thrown if the underlying array is not a struct array. The field name passed must be a valid field name in the struct array. The index is passed by first passing the number of indices, followed by an array of 1-based indices. The valid number of indices that can be passed in is either 1 (single subscript indexing), in which case the element at the specified 1-based offset is returned, accessing data in column-wise order, or `NumberOfDimensions()` (multiple subscript indexing), in which case, the index list is used to access the specified element. The valid range for indices is  $1 \leq \text{index} \leq \text{NumberOfElements}()$ , for single subscript indexing. For multiple subscript indexing, the *i*th index has the valid range:

`1 <= index[i] <= GetDimensions().Get(1, i)`. An `mwException` is thrown if an invalid number of indices is passed in or if any index is out of bounds.

## **mwArray& operator=(const <type>& x)**

Assign single scalar value to array. This operator is overloaded for all numeric and logical types.

### **C++ syntax**

```
#include "mclcppclass.h"
mwArray a(2, 2, mxDOUBLE_CLASS);
a(1,1) = 1.0;      // assigns 1.0 to element (1,1)
a(1,2) = 2.0;      // assigns 2.0 to element (1,2)
a(2,1) = 3.0;      // assigns 3.0 to element (2,1)
a(2,2) = 4.0;      // assigns 4.0 to element (2,2)
```

### **Arguments**

**x.** Value to assign.

### **Return value**

A reference to the invoking mwArray.

### **Description**

Use this operator to set a single scalar value.

## operator <type>() const

Fetch single scalar value from array. This operator is overloaded for all numeric and logical types.

### C++ syntax

```
#include "mclcppclass.h"
double data[4] = {1.0, 2.0, 3.0, 4.0};
double x;
mwArray a(2, 2, mxDOUBLE_CLASS);
a.SetData(data, 4);
x = (double)a(1,1);    // x = 1.0
x = (double)a(1,2);    // x = 3.0
x = (double)a(2,1);    // x = 2.0
x = (double)a(2,2);    // x = 4.0
```

### Arguments

None

### Return value

A single scalar value from the array.

### Description

Use this operator to fetch a single scalar value.

## **static mwArray Deserialize(const mwArray& arr)**

Deserialize array that has been serialized with `mwArray::Serialize`.

### **C++ syntax**

```
#include "mclcppclass.h"
double rdata[4] = {1.0, 2.0, 3.0, 4.0};
mwArray a;
a.SetData(rdata, 4);
mwArray b = a.Serialize();
a = mwArray::Deserialize(b);    // a should contain same data as
                                // original
```

### **Arguments**

**arr.** `mwArray` that has been obtained by calling `mwArray::Serialize`

### **Return value**

A new `mwArray` containing the deserialized array.

### **Description**

Use this method to deserialize an array that has been serialized with `mwArray::Serialize()`. The input array must be of type `mxCUINT8_CLASS` and contain the data from a serialized array. If the input data does not represent a serialized `mwArray`, the behavior of this method is undefined.

## static double GetNaN()

Get value of NaN (Not-a-Number).

### C++ syntax

```
#include "mclcppclass.h"  
double x = mwArray::GetNaN();
```

### Arguments

None

### Return value

The value of NaN (Not-a-Number) on your system.

### Description

Call `mwArray::GetNaN` to return the value of NaN for your system. NaN is the IEEE arithmetic representation for Not-a-Number. Certain mathematical operations return NaN as a result, for example,

- $0.0/0.0$
- $\text{Inf} - \text{Inf}$

The value of NaN is built in to the system; you cannot modify it.

## **static double GetEps()**

Get value of eps.

### **C++ syntax**

```
#include "mclcppclass.h"  
double x = mwArray::GetEps();
```

### **Arguments**

None

### **Return value**

The value of the MATLAB eps variable.

### **Description**

Call `mwArray::GetEps` to return the value of the MATLAB eps variable. This variable is the distance from 1.0 to the next largest floating-point number. Consequently, it is a measure of floating-point accuracy. The MATLAB `pinv` and `rank` functions use `eps` as a default tolerance.



## static double GetInf()

Get value of Inf (infinity).

### C++ syntax

```
#include "mclcppclass.h"  
double x = mxArray::GetInf();
```

### Arguments

None

### Return value

The value of Inf (infinity) on your system.

### Description

Call `mxArray::GetInf` to return the value of the MATLAB internal Inf variable. Inf is a permanent variable representing IEEE arithmetic positive infinity. The value of Inf is built into the system; you cannot modify it.

Operations that return Inf include:

- Division by 0. For example, `5/0` returns Inf.
- Operations resulting in overflow. For example, `exp(10000)` returns Inf because the result is too large to be represented on your machine.

## **static bool IsFinite(double x)**

Test if value is finite and returns true if value is finite.

### **C++ syntax**

```
#include "mclcppclass.h"  
bool x = mwArray::IsFinite(1.0);    // Returns true
```

### **Arguments**

Value to test for finiteness

### **Return value**

Result of test.

### **Description**

Call `mwArray::IsFinite` to determine whether or not a value is finite. A number is finite if it is greater than `-Inf` and less than `Inf`.

## static bool IsInf(double x)

Test if value is infinite and returns true if value is infinite.

### C++ syntax

```
#include "mclcppclass.h"
bool x = mxArray::IsInf(1.0);           // Returns false
```

### Arguments

Value to test for infinity

### Return value

Result of test.

### Description

Call `mxArray::IsInf` to determine whether or not a value is equal to infinity or minus infinity. MATLAB stores the value of infinity in a permanent variable named `Inf`, which represents IEEE arithmetic positive infinity. The value of the variable, `Inf`, is built into the system; you cannot modify it.

Operations that return infinity include:

- Division by 0. For example, `5/0` returns infinity.
- Operations resulting in overflow. For example, `exp(10000)` returns infinity because the result is too large to be represented on your machine. If the value equals NaN (Not-a-Number), then `mxIsInf` returns false. In other words, NaN is not equal to infinity.

## **static bool isNaN(double x)**

Test if value is NaN (Not-a-Number) and returns true if value is NaN.

### **C++ syntax**

```
#include "mclcppclass.h"
bool x = mxArray::isNaN(1.0); // Returns false
```

### **Arguments**

Value to test for NaN

### **Return value**

Result of test.

### **Description**

Call `mxArray::isNaN` to determine whether or not the value is NaN. NaN is the IEEE arithmetic representation for Not-a-Number. NaN is obtained as a result of mathematically undefined operations such as

- `0.0/0.0`
- `Inf-Inf`

The system understands a family of bit patterns as representing NaN. In other words, NaN is not a single value, rather it is a family of numbers that MATLAB (and other IEEE-compliant applications) use to represent an error condition or missing data.

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