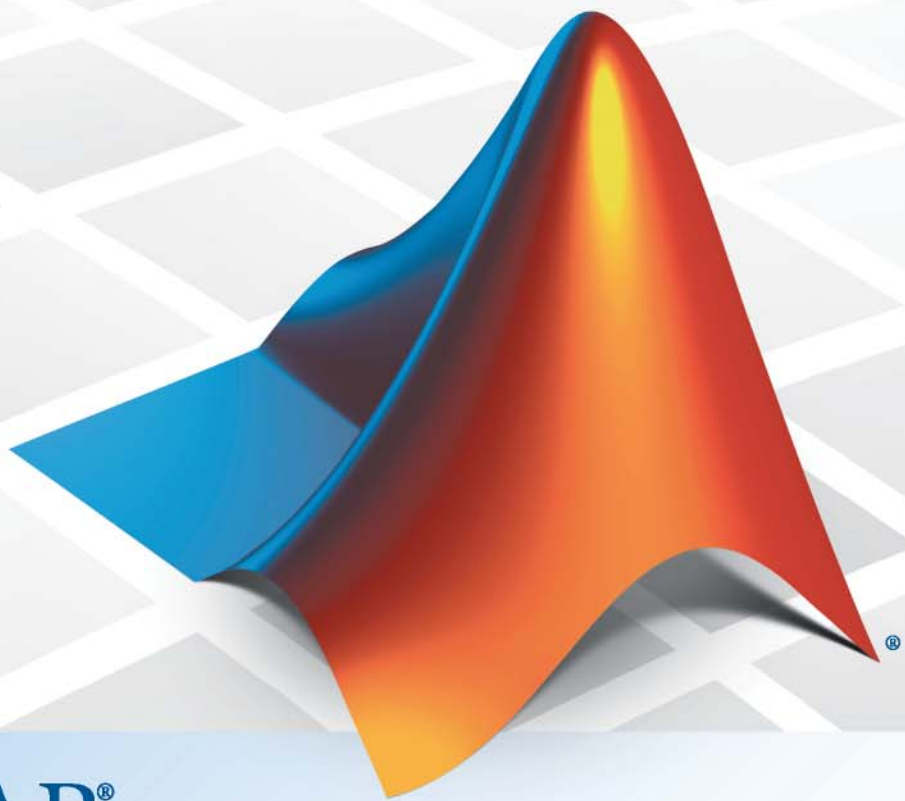


MATLAB® Builder™ EX 1

User's Guide



MATLAB®

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MATLAB® Builder™ EX User's Guide

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Product Overview

In this section...
“MATLAB® Compiler Extension” on page 1-2
“About Component Object Model (COM)” on page 1-2
“Limitations of Support” on page 1-3

MATLAB Compiler Extension

MATLAB® Builder™ EX is an extension to MATLAB® Compiler™. You use the builder to package MATLAB® functions so that Microsoft® Excel® consumers can access them from Excel®. The builder converts MATLAB functions to methods of a class that you define. From this class, the builder creates *components*.

MATLAB Builder EX components are Microsoft® COM objects that are accessible from Microsoft Excel through Visual Basic® for Applications (VBA). MATLAB Builder EX integrates the COM wrapper with the MATLAB Compiler-generated VBA code, saving you considerable development resources and time.

When you package and distribute an application that uses your component, include supporting files generated by MATLAB Builder EX. Include the MATLAB Compiler Runtime (MCR), which gives you access to an entire library of MATLAB functions within one file.

For information about how MATLAB® Compiler works, see “The MATLAB® Compiler Build Process” on page 1-13.

About Component Object Model (COM)

COM is an acronym for Component Object Model, which is a Microsoft® binary standard for object interoperability. COM components use a common integration architecture that provides a consistent model across multiple applications. All Microsoft Office applications support COM add-ins.

Each COM object exposes a *class* to the Visual Basic® programming environment. The class contains a set of functions called *methods*. These

methods correspond to the original MATLAB functions included in the project. The COM components created by MATLAB Builder EX contain a single class. This class provides the interface to the MATLAB functions that you add to the class at build time. The COM component provides a set of methods that wrap the MATLAB code and a DLL file.

Limitations of Support

MATLAB (MCOS) objects are not supported as inputs or outputs for compiled or deployed functions with MATLAB Builder EX.

Before You Use MATLAB Builder EX

In this section...
“Your Role in the Deployment Process” on page 1-4
“What You Need to Know” on page 1-6
“Install Required Products” on page 1-7
“Starting the Deployment Tool” on page 1-7
“Select Your C or C++ Compiler with mbuild -setup” on page 1-7

Your Role in the Deployment Process

The table Application Deployment Roles, Goals, and Tasks on page 1-5 describes the different roles, or jobs, that MATLAB Builder EX users typically perform. It also describes tasks they would most likely perform when running the examples in this documentation.

Application Deployment Roles, Goals, and Tasks

Role	Goals	Task To Achieve Goal
MATLAB programmer	<ul style="list-style-type: none"> • Understand the end-user business requirements and the mathematical models that support them. • Build an Microsoft Excel add-in with MATLAB tools (usually with support from a Microsoft® Visual Basic® programmer). • Package the component for distribution to customers. • Pass the packaged component to the Microsoft Visual Basic programmer for rollout and further integration into the end-user environment. 	See “Magic Square Example: MATLAB Programmer Tasks” on page 1-9.
Microsoft Excel developer	<ul style="list-style-type: none"> • Write VB/VBA code to complement or augment the Excel Add-in built by the MATLAB programmer. • Roll out the packaged component and integrate it into 	See “Magic Square Example: Microsoft® Excel Developer Tasks” on page 1-18.

Application Deployment Roles, Goals, and Tasks (Continued)

Role	Goals	Task To Achieve Goal
	<p>the end-user environment.</p> <ul style="list-style-type: none"> • Use the component in enterprise applications. Add and modify code as needed. • Verify that the final application executes reliably in the end-user environment. 	
End user	Execute the solution created by MATLAB and Microsoft Visual Basic programmers.	Execute the Microsoft Excel add-in or use the add-in as part of a larger-scale deployed application (outside the scope of this document).

What You Need to Know

To use the MATLAB Builder EX product, specific requirements exist for each user role.

Role	Requirements
MATLAB programmer	<ul style="list-style-type: none"> • A basic knowledge of MATLAB, and how to work with: <ul style="list-style-type: none"> ▪ MATLAB data types ▪ MATLAB structures
Microsoft Excel developer	Expert at building Microsoft Excel add-ins and spreadsheet solutions

Install Required Products

Install the following products to run the example described in this chapter:

- MATLAB
- MATLAB Compiler
- MATLAB Builder EX
- A supported C or C++ compiler

For more information about product installation and requirements, see MATLAB Compiler “Installation and Configuration”.

Starting the Deployment Tool

- 1 Start MATLAB.
- 2 Type `deploytool` at the MATLAB command prompt and press Enter. The `deploytool` GUI opens.

Select Your C or C++ Compiler with `mbuild -setup`

The first time you use MATLAB Compiler, after starting MATLAB, run the following command:

```
mbuild -setup
```

For more information about `mbuild -setup`, see “Installation and Configuration”.

If you need information about writing MATLAB files, see MATLAB Programming, which is part of MATLAB documentation.

The Magic Square Example

About This Example

This example shows you how to transform a MATLAB function into a deployable MATLAB Builder EX add-in component.

The `mymagic` function wraps a MATLAB function, `magic`, which computes a magic square.

Using MATLAB Builder EX, you deploy the `mymagic` function as a component by adding it to the `xlmagicclass` class, along with other files you need to deploy your application.

This example uses the `deploytool` GUI. If you want to use `mcc`, see the `mcc` reference page for complete reference information.

What Is a Magic Square?

A *magic square* is simply a square array of integers arranged so that their sum is the same when added vertically, horizontally, or diagonally.


How Do I Access the Examples?

See “Copying the Example Files” on page 1-10 for information about accessing the example code from within the product.

Magic Square Example: MATLAB Programmer Tasks

In this section...
“Copying the Example Files” on page 1-10
“Testing the MATLAB File You Want to Deploy” on page 1-10
“Building Your Component” on page 1-11
“Packaging Your Component (Optional)” on page 1-15
“Copying the Package You Created” on page 1-17

MATLAB Programmer

Role	Knowledge Base	Responsibilities
 <p>MATLAB programmer</p>	<ul style="list-style-type: none"> • MATLAB expert • No IT experience • No access to IT systems 	<ul style="list-style-type: none"> • Develops models; implements in MATLAB • Uses tools to create a component that is used by the COM developer

The MATLAB programmer usually performs the following tasks.

Key Tasks for the MATLAB Programmer

Task	Reference
1. Prepare to run the example by copying the MATLAB example files into a work folder.	“Copying the Example Files” on page 1-10
2. Verify that the MATLAB code is suitable for deployment.	“Testing the MATLAB File You Want to Deploy” on page 1-10
3. Create a Microsoft Excel add-in component (encapsulating your MATLAB code in a COM wrapper) by running the Build function in <code>deploytool</code> .	“Building Your Component” on page 1-11

Key Tasks for the MATLAB Programmer (Continued)

Task	Reference
4. Prepare to run the Packaging Tool by determining what additional files to include with the deployed component.	“Packaging Your Component (Optional)” on page 1-15
5. Copy the output from the Packaging Tool (the <code>distrib</code> folder).	“Copying the Package You Created” on page 1-17

Copying the Example Files

Prepare to run the example by copying needed files into your work area as follows:

- 1 Navigate to `matlabroot\toolbox\matlabx1\examples\xlmagic`.

Tip `matlabroot` is the MATLAB root folder (installation location of MATLAB). To find the value of this variable on your system, type `matlabroot` at a MATLAB command prompt.

- 2 Copy the `xlmagic` folder to a work area, for example, `D:\matlabx1_examples`. Avoid using spaces in your folder names. The example files now reside in `D:\matlabx1_examples\xlmagic`.

Testing the MATLAB File You Want to Deploy

In this example, you test a MATLAB file (`mymagic.m`) containing the predefined MATLAB function `magic`. You test to have a baseline to compare to the results of the function when it is ready to deploy.

- 1 Using MATLAB, locate the `mymagic.m` file at `D:\matlabx1_examples\xlmagic`. The contents of the file are as follows:

```
function y = mymagic(x)
%MYMAGIC Magic square of size x.
% Y = MYMAGIC(X) returns a magic square of size x.
```

```
% This file is used as an example for the MATLAB
% Builder EX product.

% Copyright 2001-2010 The MathWorks, Inc.
% $Revision: 1.1.4.6 $      $Date: 2010/06/26 05:11:14 $

y = magic(x)
```

2 At the MATLAB command prompt, enter `magic(5)`. View the resulting output, which appears as follows:

```
17 24  1  8 15
23  5  7 14 16
 4  6 13 20 22
10 12 19 21  3
11 18 25  2  9
```

Building Your Component

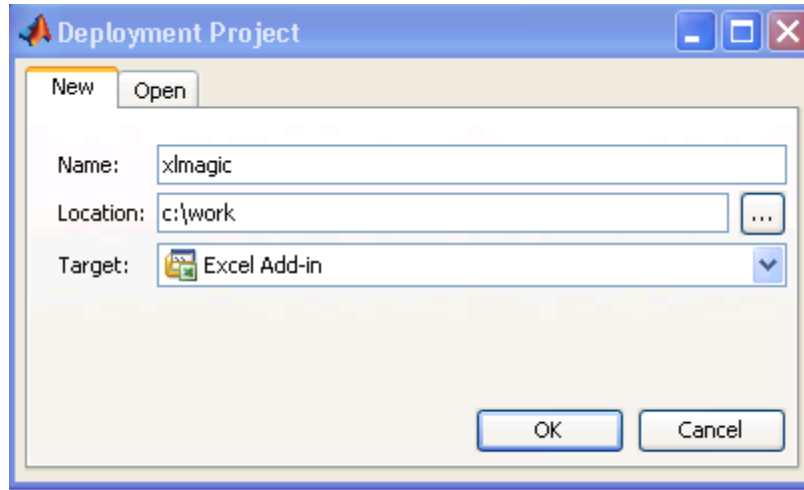
You create an Excel Add-in component by using the Deployment Tool GUI to build a COM wrapper and VB class. This wrapper and class wrap around the sample MATLAB code discussed in “Testing the MATLAB File You Want to Deploy” on page 1-10.

Use the following information when creating your component as you work through this example:

Project Name	xlmagic
File to compile	mymagic.m
Class Name	xlmagicclass

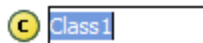
- 1** Start MATLAB if you have not done so already.
- 2** Type `deploytool` at the command prompt, and press **Enter**. The `deploytool` GUI opens.
- 3** Create a deployment project using the Deployment Project dialog box:
 - ▀ Type the name of your project in the **Name** field.

- b** Enter the location of the project in the **Location** field. Alternately, navigate to the location.
- c** Select the target for the deployment project from the **Target** drop-down menu.
- d** Click **OK**.



Creating an Excel Add-In Project

- 4** On the **Build** tab:
 - If you are building an Excel Add-In, rename the default class, **Class1**. Right-click and select **Rename Class**. Type the name of the class in the Class Name field, designated by the letter “c”:



For this class, add MATLAB files you want to compile by clicking **Add files**. To add another class, click **Add class**.

- You may optionally add supporting files. For examples of these files, see the `deploytool` Help. To add these files, in the Shared Resources and Helper Files area:
 - e** Click **Add files/directories**
 - f** Click **Open** to select the file or files.

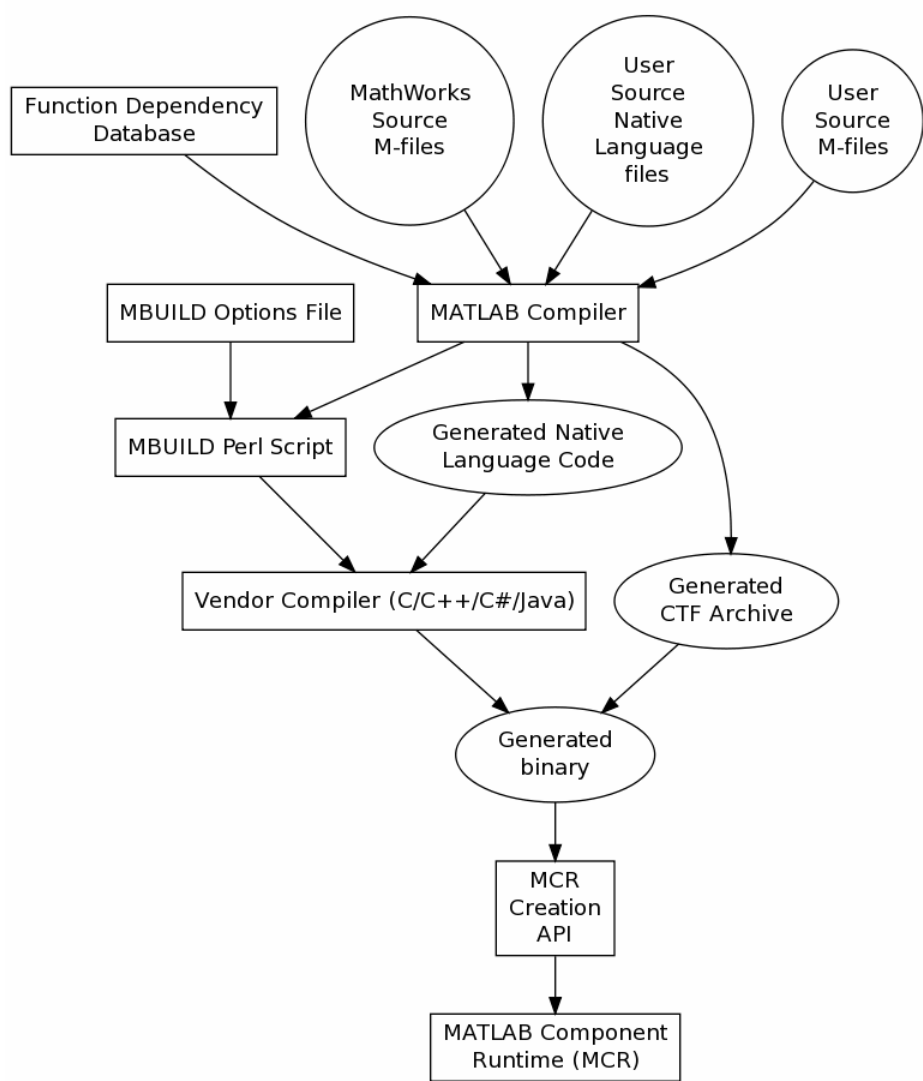
5 When you complete your changes, click the Build button ()

The MATLAB Compiler Build Process

To generate and package an application, the user:

- 1 Writes an application or component in MATLAB
- 2 Invokes the MATLAB Compiler, which:
 - a Examines the input MATLAB files and the external dependency database to determine the complete list of all functions used by the application or component. As part of this process, MATLAB Compiler determines which files are not able to be compiled and automatically excludes them.
 - b Determines which functions are to be made publicly visible (for example, those that can be called from another product or environment).
 - c Generates the appropriate interface code files based on the public function list and the complete function list from the preceding steps. The interface code generated is also dependent on what target the user wants to create (for example, a Java™ component, a standalone executable, or a Microsoft Excel add-in).
 - d Packages compilable functions into a CTF archive, creating a file on the user's disk. This archive is embedded by default in the binary executable.
 - e Optionally, invokes target specific compiler to generate a binary application or component from the files in C and the interface code libraries provided by MathWorks.
- 3 Locates the install package for the MATLAB Compiler Runtime (MCR).
- 4 Collects together the binary, the CTF archive, and the MCR installer (along with other optional, user-specified files) for the user.

The deployment GUI (`deploytool`) automates many of the steps in the process for user convenience.



- Circles: Input Files
- Boxes: MathWorks-supplied components
- Ellipses: Output Files

Packaging Your Component (Optional)


Bundling the Excel add-in component with additional files you distribute to consumers is referred to as *packaging*. You perform this step using the packaging function of `deploytool`. To create a shared component and want to include additional code with the component, perform this task. Alternately, copy the contents of the `distrib` folder and the MCR Installer to a local folder of your choice.

- 1 On the **Package** tab, add the MATLAB Compiler Runtime (MCR). To do so, click **Add MCR**, and choose one of the two options described in the following table.

Option	What Does This Option Do?	When Should I Use This Option?
<p>Embed the MCR in the package</p>	<p>This option physically copies the MCR Installer file into the package you create.</p>	<ul style="list-style-type: none"> • You have a limited number of end users who deploy a small number of applications at sporadic intervals • Your users have no intranet/network access • Resources such as disk space, performance, and processing time are not significant concerns <hr/> <p>Note Distributing the MCR Installer with each application requires more resources.</p> <hr/>
<p>Invoke the MCR from a network location</p>	<p>This option lets you add a link to an MCR Installer residing on a local area network, allowing you to invoke the installer over the network, as opposed to copying the</p>	<ul style="list-style-type: none"> • You have a large number of end users who deploy applications frequently • Your users have intranet/network access

Option	What Does This Option Do?	When Should I Use This Option?
	<p>installer physically into the deployable package. This option sets up a script to install the MCR from a specified network location, saving time and resources when deploying applications.</p>	<ul style="list-style-type: none"> Resources such as disk space, performance, and processing time are significant concerns for your organization <p>If you choose this option, modify the location of the MCR Installer, if needed. To do so, select the Preferences link in this dialog box, or change the Compiler option in your MATLAB Preferences.</p> <hr/> <p>Caution Before selecting this option, consult with your network or systems administrator. Your administrator may already have selected a network location from which to run the MCR Installer.</p> <hr/>

For more information about the role the MCR plays in the deployment process, see “Install Your Application on Target Computers Without MATLAB Using the MATLAB Compiler Runtime (MCR)” on page 1-21.

- 2 Next, add others files you feel may be useful to end users. To package additional files or folders, click **Add file/directories**, select the file or folder you want to package, and click **Open**.
- 3 In the Deployment Tool, click the Packaging button ()

- 4** For Windows®, the package is a self-extracting executable. On platforms other than Windows, the package is delivered as a .zip file. Verify that the contents of the `distrib` folder contains the files you specified.

Note When the self-extracting executable is uncompressed on a system, `VCREDSIT_X86` is installed. `VCREDSIT_X86` installs run-time components of Microsoft Visual C++ libraries necessary for running Visual C++ applications.


Copying the Package You Created

Copy the package you created from the `distrib` folder to the local folder of your choice or send them directly to the Microsoft Visual Basic programmer.

Magic Square Example: Microsoft Excel Developer Tasks

In this section...
“Gathering Files Necessary for Deployment” on page 1-19
“Testing the Component” on page 1-19
“Install Your Application on Target Computers Without MATLAB Using the MATLAB Compiler Runtime (MCR)” on page 1-21
“Deploying the Microsoft® Excel Add-In” on page 1-23
“Distributing the Component to End Users” on page 1-25
“Using the Excel Add-In” on page 1-25

Microsoft Excel Developer

Role	Knowledge Base	Responsibilities
 <p>Microsoft Excel developer</p>	<ul style="list-style-type: none"> • Little to no MATLAB experience • Moderate to little IT experience • Expert at building Microsoft Excel add-ins and spreadsheet solutions • Minimal access to IT systems • Varying knowledge of VBA or COM 	<ul style="list-style-type: none"> • Creates Microsoft Excel add-ins or spreadsheet solution from deployed MATLAB code • Integrates deployed MATLAB Figures with Microsoft Excel add-ins or spreadsheet solutions

The Microsoft Visual Basic programmer performs these tasks.

Key Tasks for the Microsoft Excel Developer

Task	Reference
1. Ensure that you have the needed files from the MATLAB programmer before proceeding.	“Gathering Files Necessary for Deployment” on page 1-19
2. Test the newly created Microsoft Visual Basic code to ensure that it produces the same results as your MATLAB code.	“Testing the Component” on page 1-19
3. Install the MATLAB Component Runtime on target systems and update system paths.	“Install Your Application on Target Computers Without MATLAB Using the MATLAB Compiler Runtime (MCR)” on page 1-21
4. Create the Microsoft Excel add-in and prepare it for deployment to your end users.	“Deploying the Microsoft® Excel Add-In” on page 1-23
5. Distribute the add-in to your end users.	“Distributing the Component to End Users” on page 1-25
6. Use the Excel Add-In	“Using the Excel Add-In” on page 1-25

Gathering Files Necessary for Deployment

Before beginning, verify that you have access to the following files, created by the MATLAB programmer in “Copying the Package You Created” on page 1-17. Customers who do not have a copy of MATLAB installed need these files:

- MCR Installer. For locations of all MCR Installers, run the `mcrinstaller` command.
- `readme.txt`

Testing the Component

After you build a component, test your software by importing the VBA file (VBA files have `.bas` extensions) into the Microsoft Excel Visual Basic Editor.

Invoke one of the functions from the Excel worksheet. To import the VBA code into the Excel Visual Basic Editor:

1 Open Excel

2 Do one of the following:

- If you use Microsoft Office 2007, click **Developer > Macros**.
- If you do not use Microsoft Office 2007, click **Tools > Macros > Macro**.

Tip You may need to enable the **Developer** menu item before performing this step. To do this:

- a** Click the Microsoft Office Excel 2007 button.
 - b** Click **Excel Options**.
 - c** In the **Top Options for Working With Excel** area, select **Show Developer tab in the Ribbon**.
-

3 From the Visual Basic Editor, select **File > Import** and select the created VBA file from the <project_dir>\distrib folder.

The Visual Basic module created contains the necessary initialization code and a VBA formula function for each MATLAB function processed. Each supplied formula function wraps a call to the respective compiled function in a format accessed from a cell in an Excel worksheet. The function takes a list of inputs corresponding to the inputs of the original MATLAB function and returns a single output. This output corresponds to the first output argument.

You can use formula functions of this type to access a function of one or more inputs that returns a single scalar value. When you require multiple outputs or outputs representing ranges of data, you need a more general Visual Basic subroutine. For details about integrating MATLAB Builder EX components into Microsoft Excel via Visual Basic for Applications, see Chapter 3, “Programming with MATLAB® Builder EX”.

Install Your Application on Target Computers Without MATLAB Using the MATLAB Compiler Runtime (MCR)

On target computers without MATLAB, install the MCR, if it is not already present on the development machine.

About the MCR and the MCR Installer

The *MATLAB Compiler Runtime (MCR)* is an execution engine made up of the same shared libraries MATLAB uses to enable the execution of MATLAB files on systems without an installed version of MATLAB. In order to deploy a component, you *package* the MCR along with it. Before you utilize the MCR on a system without MATLAB, run the *MCR installer*.

The installer does the following:

- 1 Installs the MCR (if not already installed on the target machine)
- 2 Installs the component assembly in the folder from which the installer is run
- 3 Copies the MWArray assembly to the Global Assembly Cache (GAC), as part of installing the MCR

Before You Install the MCR

- 1 Since installing the MCR requires write access to the system registry, ensure you have administrator privileges to run the MCR Installer.
- 2 The version of the MCR that runs your application on the target computer must be compatible with the version of MATLAB Compiler that built the component.

Caution If an MCR does not match the version of the instance of MATLAB that built the component, an inoperable application and unpredictable results can result.

Including the MCR installer With Your Deployment Package

Include the MCR in your deployment by using the Deployment Tool.

On the **Package** tab of the `deploytool` interface, click **Add MCR**.

Note For more information about additional options for including the MCR Installer (embedding it in your package or locating the installer on a network share), see “Packaging Your Deployment Application (Optional)” in the *MATLAB Compiler User’s Guide* or in your respective Builder User’s Guide.

Installing the MCR and Setting System Paths

To install the MCR, perform the following tasks on the target machines:

- 1 If you added the MCR during packaging, open the package to locate the installer (`MCRInstaller.exe`). Otherwise, run the command `mcrinstaller` to display the locations where you can download the installer.
- 2 If you are running on a platform other than Windows, set the system paths on the target machine. Setting the paths enables your application to find the MCR.

Windows paths are set automatically. On Linux and Mac, you can use the run script to set paths. See “Using Run Script to Set MCR Paths” in the appendix “Using MATLAB Compiler on UNIX®” in the *MATLAB Compiler User’s Guide* for more information.

For More Information

If you want to...	See...
Find more information about the MATLAB Compiler C++ API	“C++ Utility Library Reference” in this User’s Guide

If you want to...	See...
Find more information about the MWArray class library (the .NET API)	MATLAB Builder NE “Documentation Set” at the MathWorks Web site
Find more information about the MWArray class library (the Java API)	MATLAB Builder JA “Documentation Set” at the MathWorks Web site
<ul style="list-style-type: none"> • Perform basic MATLAB Programmer tasks • Understand how the deployment products process your MATLAB functions • Understand how the deployment products work together • Explore guidelines about writing deployable MATLAB code 	“Writing Deployable MATLAB Code”
Learn more about the MATLAB Compiler Runtime (MCR)	“Working with the MCR” in the <i>MATLAB Compiler User’s Guide</i>

Deploying the Microsoft Excel Add-In

After you create and test your component, create an Excel add-in (.xla) from the VBA code generated by MATLAB Builder EX. Save the worksheet file as an .xla file to the <project_dir>\distrib folder.

Note You must have administrator privileges to build and deploy Excel Add-ins.

For more information about creating an Excel Add-in, refer to the Excel documentation on creating a .xla file.

- 1 Start Excel.
- 2 Do one of the following:
 - If you use Microsoft Office 2007, click **Developer > Visual Basic**.
 - If you do not use Microsoft Office 2007, click **Tools > Macro > Visual Basic Editor**.

Tip You may need to enable the **Developer** menu item before performing this step. To do this:

- a Click the Microsoft Office Excel 2007 button.
 - b Click **Excel Options**.
 - c In the **Top Options for Working With Excel** area, select **Show Developer tab in the Ribbon**.
-

Select **Tools > Macros > Visual Basic Editor**.

- 3 In the Microsoft Visual Basic window, select **File > Import**.
- 4 Select VBA file (.bas) from the <projectdir>distrib folder.
- 5 Close the Visual Basic Editor.
- 6 From the Excel worksheet window, select **File > Save As**.
- 7 Set **Save as** to Microsoft Excel add-in (*.xla).
- 8 Save the .xla file to <projectdir>\distrib.

You can also deploy files in default Excel file format and *.bas formats. To deploy in default Excel file format, follow the previous steps but change the **Save as** type in step 7 to the default Excel file format. To deploy as VBA code, follow steps 1–4 only.

Distributing the Component to End Users

If you bundled the component as a self-extracting executable, paste it in a folder on the development machine, and run it. If you are using a .zip file bundled with WinZip, unzip it, and extract the contents to the development machine.

Using the Excel Add-In

To use the Excel add-ins, perform the steps in the following table.

Using Excel Add-Ins with Microsoft Excel before Office 2007	Using Excel Add-Ins with Microsoft Excel Office 2007
1. Start Excel.	1. Open the Microsoft Office Excel 2007 ribbon, and click Excel Options .
2. Select Tools > Add-Ins .	2. In the left pane of the Excel Options dialog box, click Add-Ins .
3. Select the desired .xla file.	3. Next to the Excel Add-ins drop-down box, click Go .
	4. Select the Add-ins you want to enable, and click OK .

Using the `mcc` Command Line Interface

You can use the command line to build components using the `mcc` command. You can also start the Deployment Tool GUI from the command line. See the `mcc` and `deploytool` reference pages for more details.

Next Steps

After you create and distribute the initial add-in, continue to enhance it. The following topics detail some of the more common tasks you perform as you develop your application.


To:	See...
Write Microsoft Visual Basic applications that can scale your MATLAB code applications in enterprise computing environments	Chapter 3, “Programming with MATLAB® Builder EX ”
Learn about sample applications that access methods developed in MATLAB	Chapter 4, “Usage Examples”
Learn about and Install the Function Wizard interface	Chapter 5, “Function Wizard”
Program with utility classes created expressly for Microsoft COM components	Chapter 7, “Utility Library for Microsoft COM Components”

Writing Deployable MATLAB Code

- “The MATLAB Application Deployment Products” on page 2-2
- “How the Deployment Products Process MATLAB Function Signatures” on page 2-4
- “The Application Deployment Products and the Deployment Tool” on page 2-8
- “Guidelines for Writing Deployable MATLAB Code” on page 2-15
- “Working with MATLAB Data Files Using Load and Save” on page 2-19

The MATLAB Application Deployment Products

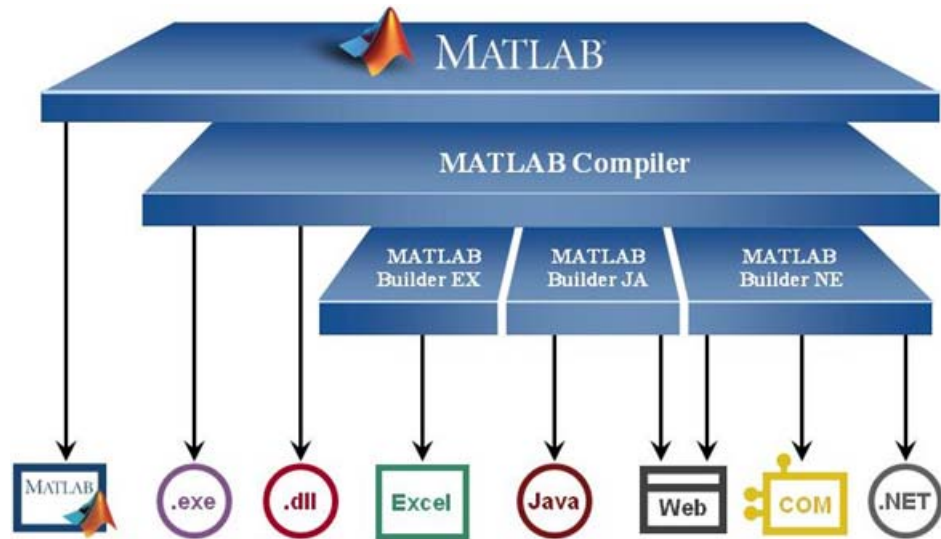
MATLAB Programmer

Role	Knowledge Base	Responsibilities
 <p>MATLAB programmer</p>	<ul style="list-style-type: none"> • MATLAB expert • No IT experience • No access to IT systems 	<ul style="list-style-type: none"> • Develops models; implements in MATLAB • Uses tools to create a component that is used by the COM developer

The following table and figure summarizes the target applications supported by each product.

The MATLAB Suite of Application Deployment Products

Product	Target	Stand-alones?	Function Libraries?	Graphical Apps?	Web Apps?	WebFigures?
MATLAB Compiler	C and C++ standalones	Yes	Yes	Yes	No	No
MATLAB Builder NE	C# .NET components Visual Basic COM components	No	Yes	Yes	Yes	Yes
MATLAB Builder JA	Java components	No	Yes	Yes	Yes	Yes
MATLAB Builder EX	Microsoft Excel add-ins	No	Yes	Yes	No	No



The MATLAB® Application Deployment Products

As this figure illustrates, each of the builder products uses the MATLAB Compiler core code to create deployable components.

How the Deployment Products Process MATLAB Function Signatures

In this section...
“The MATLAB Function Signature” on page 2-4
“MATLAB Programming Basics” on page 2-5
“Returning MATLAB Data Types” on page 2-5

The MATLAB Function Signature

MATLAB supports multiple signatures for function calls.

The generic MATLAB function has the following structure:

```
function [Out1,Out2,...,varargout]=foo(In1,In2,...,varargin)
```

To the *left* of the equal sign, the function specifies a set of explicit and optional return arguments.

To the *right* of the equal sign, the function lists explicit *input* arguments followed by one or more optional arguments.

All arguments represent a specific MATLAB type.

When the compiler or builder product processes your MATLAB code, it creates several overloaded methods that implement the MATLAB functions. Each of these overloaded methods corresponds to a call to the generic MATLAB function with a specific number of input arguments.

In addition to these methods, builder creates another method that defines the return values of the MATLAB function as an input argument. This method simulates the `feval` external API interface in MATLAB.

MATLAB Programming Basics

Creating a Deployable MATLAB Function

Virtually any calculation that you can create in MATLAB can be deployed, if it resides in a function. For example:

```
>> 1 + 1
```

cannot be deployed.

However, the following calculation:

```
function result = addSomeNumbers()  
    result = 1+1;  
end
```

can be deployed because the calculation now resides in a function.

Taking Inputs into a Function

You typically pass inputs to a function. You can use primitive data type as an input into a function.

To pass inputs, put them in parentheses. For example:

```
function result = addSomeNumbers(number1, number2)  
    result = number1 + number2;  
end
```

Returning MATLAB Data Types

MATLAB allows many different deployable data types. This section contains examples of how to work with figures. For an in-depth explanation of how to work with MATLAB primitive data types, see the *MATLAB External Interfaces* documentation.

MATLAB Figures

Often, you are dealing with images displayed in a figure window, and not just string and numerical data. Deployed Web applications can support figure window data in a number of ways. By using the WebFigures infrastructure (see “Deploying a Java Component Over the Web” in the MATLAB Builder JA User’s Guide or “Deploying a MATLAB Figure Over the Web Using WebFigures” in the MATLAB Builder NE User’s Guide), the respective builder marshalls the data for you.

Alternatively, you can take a snapshot of what is in the figure window at a given point and convert that data into the raw image data for a specific image type. This is particularly useful for streaming the images across the web.

Returning Data from a WebFigure Window

WebFigures is a feature that enables you to embed dynamic MATLAB figures onto a Web page through a Builder JA or Builder NE component. This concept can be used with any data in a figure window.

As in the following example, you close the figure before the code is exited so that the figure does not “pop up,” or appear later, in the deployed application. You do not need to specify any reorientation data when using WebFigures. If the figure is attached to the rest of the infrastructure, it will automatically pass, resize, and reorient accordingly.

```
%returns a WebFigure reference containing the
%data from the figure window
function resultWebFigure = getWebFigure
    f = figure;
    set(f, 'Color', [.8, .9, 1]);
    f = figure('Visible', 'off');
    surf(peaks);
    resultWebFigure = webfigure(f);
    close(f);
end
```

Returning a Figure as Data

This approach is typically used for instances where WebFigures can’t be used, or in a stateless application.

```

%We set the figure not to be visible since we are
%streaming the data out
%Notice how you can specify the format of the bytes,
% .net uses unsigned bytes (uint8)
% java uses signed bytes (int 8)
%This function allows you to specify the image format
%such as png, or jpg
function imageByteData = getSurfPeaksImageData(imageFormat)
    f = figure;
    surf(peaks);
    set(f, 'Visible', 'off');
    imageByteData = figToImStream(f, imageFormat, 'uint8');
    close(f);
end

```

Reorienting a Figure and Returning It as Data

Sometimes you want the function to change the perspective on an image before returning it. This can be accomplished like this:

```

%We set the figure not to be visible since we are
%streaming the data out
%Notice how you can specify the format of the bytes,
% .net uses unsigned bytes (uint8)
% java uses signed bytes (int 8)
%This function allows you to specify the image format
%such as png, or jpg
function imageData =
    getImageDataOrientation(width, height, rotation,
                            elevation, imageFormat)
    f = figure('Position', [0, 0, width, height]);
    surf(peaks);
    view([rotation, elevation]);
    set(f, 'Visible', 'off');
    imageData = figToImStream(f, imageFormat, 'uint8');
    close(f);
end

```

The Application Deployment Products and the Deployment Tool

In this section...

“What Is the Difference Between the Deployment Tool and the `mcc` Command Line?” on page 2-8

“How Does MATLAB® Compiler Software Build My Application?” on page 2-9

“What You Should Know About the Dependency Analysis Function (`depfun`)” on page 2-10

“Compiling MEX-Files, DLLs, or Shared Libraries” on page 2-10

“The Role of the Component Technology File (CTF Archive)” on page 2-11

What Is the Difference Between the Deployment Tool and the `mcc` Command Line?

When you use the Deployment Tool (`deploytool`) GUI, you perform any function you would invoke using the MATLAB Compiler `mcc` command-line interface. The Deployment Tool interactive menus and dialogs build `mcc` commands that are customized to your specification. As such, your MATLAB code is processed the same way as if you were compiling it using `mcc`.

Deployment Tool advantages include:

- You perform related deployment tasks with a single intuitive GUI.
- You maintain related information in a convenient project file.
- Your project state persists between sessions.
- Your previous project loads automatically when the Deployment Tool starts.
- You load previously stored compiler projects from a prepopulated menu.
- Package applications for distribution.

How Does MATLAB Compiler Software Build My Application?

To build an application, MATLAB Compiler software performs these tasks:

- 1** Parses command-line arguments and classifies by type the files you provide.
- 2** Analyzes files for dependencies using the Dependency Analysis Function (`depfun`). Dependencies affect deployability and originate from functions called by the file. Deployability is affected by:
 - File type — MATLAB, Java, MEX, and so on.
 - File location — MATLAB, MATLAB toolbox, user code, and so on.
 - File deployability — Whether the file is deployable outside of MATLAB

For more information about `depfun`, see “What You Should Know About the Dependency Analysis Function (`depfun`)” on page 2-10.

- 3** Validates MEX-files. In particular, `mexFunction` entry points are verified. For more details about MEX-file processing, see “Compiling MEX-Files, DLLs, or Shared Libraries” on page 2-10.
- 4** Creates a CTF archive from the input files and their dependencies. For more details about CTF archives see “The Role of the Component Technology File (CTF Archive)” on page 2-11.
- 5** Generates target-specific wrapper code. For example, a C main function requires a very different wrapper than the wrapper for a Java interface class.
- 6** Invokes a third-party target-specific compiler to create the appropriate binary software component (a standalone executable, a Java JAR file, and so on).

For details about how MATLAB Compiler software builds your deployable component, see “How Does MATLAB® Compiler Software Build My Application?” on page 2-9.

What You Should Know About the Dependency Analysis Function (depfun)

MATLAB Compiler uses a dependency analysis function (`depfun`) to determine the list of necessary files to include in the CTF package. Sometimes, this process generates a large list of files, particularly when MATLAB object classes exist in the compilation and `depfun` cannot resolve overloaded methods at compile time. Dependency analysis also processes `include/exclude` files on each pass (see the `mcc` flag “-a Add to Archive”).

Tip To improve compile time performance and lessen application size, prune the path with “-N Clear Path”, “-p Add Directory to Path”. You can also specify **Toolboxes on Path** in the `deploytool` **Settings**

For more information about `depfun` and `addpath` and `rmpath`, see “Dependency Analysis Function (`depfun`) and User Interaction with the Compilation Path”.

`depfun` searches for executable content such as:

- MATLAB files
- P-files
- Java classes and `.jar` files
- `.fig` files
- MEX-files

`depfun` does not search for data files of any kind (except MAT files). You must manually include data files in the search

Compiling MEX-Files, DLLs, or Shared Libraries

When you compile MATLAB functions containing MEX-files, ensure that `depfun` can find them. Doing so allows you to avoid many common compilation problems. In particular, note that:

- Because `depfun` cannot examine MEX-files, DLLs, or shared libraries to determine their dependencies, explicitly include all executable files these

files require. To do so, use either the `mcc -a` option or the options on the **Advanced** tab in the Deployment Tool under **Settings**.

- If you have any doubts that `depfun` can find a MATLAB function called by a MEX-file, DLL, or shared library, then manually include that function. To do so, use either the `mcc -a` option or by using the options on the **Advanced** tab in the Deployment Tool under **Settings**.
- Not all functions are compatible with MATLAB Compiler. Check the file `mccExcludedFiles.log` after your build completes. This file lists all functions called from your application that you cannot deploy.

The Role of the Component Technology File (CTF Archive)

Each application or shared library you produce using MATLAB Compiler has an associated Component Technology File (CTF) archive. The archive contains all the MATLAB based content (MATLAB files, MEX-files, and so on) associated with the component.

MATLAB Compiler also embeds a CTF archive in each generated binary. The CTF houses all deployable files. All MATLAB files encrypt in the CTF archive using the Advanced Encryption Standard (AES) cryptosystem.

If you choose to extract the CTF archive as a separate file the files remain encrypted. For more information on how to extract the CTF archive refer to the references in the following table.

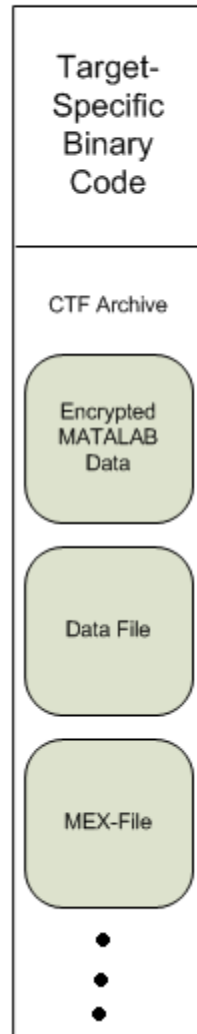
Information on CTF Archive Embedding/Extraction and Component Cache

Product	Refer to
MATLAB Compiler	“Overriding Default CTF Archive Embedding Using the MCR Component Cache”
MATLAB Builder NE	“Extracting the CTF Archive Manually Using the MCR Component Cache”

Information on CTF Archive Embedding/Extraction and Component Cache (Continued)

Product	Refer to
MATLAB Builder JA	“Using MCR Component Cache and MWComponentOptions”
MATLAB Builder EX	“Overriding Default CTF Archive Embedding for Components Using the MCR Component Cache” on page 3-30

Generated Component (EXE, DLL, SO, etc)



Additional Details

Multiple CTF archives, such as those generated with COM, .NET, or Excel components, can coexist in the same user application. You cannot, however, mix and match the MATLAB files they contain. You cannot combine encrypted and compressed MATLAB files from multiple CTF archives into another CTF archive and distribute them.

All the MATLAB files from a given CTF archive associate with a unique cryptographic key. MATLAB files with different keys, placed in the same CTF archive, do not execute. If you want to generate another application with a different mix of MATLAB files, recompile these MATLAB files into a new CTF archive.

MATLAB Compiler deleted the CTF archive and generated binary following a failed compilation, but only if these files did not exist before compilation initiates. Run `help mcc -K` for more information.

Caution Release Engineers and Software Configuration Managers:

Do not use build procedures or processes that strip shared libraries on CTF archives. If you do, you can possibly strip the CTF archive from the binary, resulting in run-time errors for the driver application.

Guidelines for Writing Deployable MATLAB Code

In this section...

“Compiled Applications Do Not Process MATLAB Files at Runtime” on page 2-15

“Do Not Rely on Changing Directory or Path to Control the Execution of MATLAB Files” on page 2-16

“Use ismcc and isdeployed Functions To Execute Deployment-Specific Code Paths” on page 2-16

“Gradually Refactor Applications That Depend on Noncompilable Functions” on page 2-17

“Do Not Create or Use Nonconstant Static State Variables” on page 2-17

Compiled Applications Do Not Process MATLAB Files at Runtime

The MATLAB Compiler was designed so that you can deploy locked down functionality. Deployable MATLAB files are suspended or frozen at the time MATLAB Compiler encrypts them—they do not change from that point onward. This does not mean that you cannot deploy a flexible application—it means that *you must design your application with flexibility in mind*. If you want the end user to be able to choose between two different methods, for example, they both must be compiled in.

The MCR only works on MATLAB code that was encrypted when the component was built. Any function or process that dynamically generates new MATLAB code will not work against the MCR.

Some MATLAB toolboxes, such as the Neural Network Toolbox™ product, generate MATLAB code dynamically. Because the MCR only executes encrypted MATLAB files, and the Neural Network Toolbox generates unencrypted MATLAB files, some functions in the Neural Network Toolbox cannot be deployed.

Similarly, functions that need to examine the contents of a MATLAB function file cannot be deployed. HELP, for example, is dynamic and not available in

deployed mode. You can use `LOADLIBRARY` in deployed mode if you provide it with a MATLAB function prototype.

Instead of compiling the function that generates the MATLAB code and attempting to deploy it, perform the following tasks:

- 1 Run the code once in MATLAB to obtain your generated function.
- 2 Compile the MATLAB code with MATLAB Compiler, including the generated function.

Tip Another alternative to using `EVAL` or `FEVAL` is using anonymous function handles.

If you require the ability to create MATLAB code for dynamic runtime processing, your end-users must have an installed copy of MATLAB.

Do Not Rely on Changing Directory or Path to Control the Execution of MATLAB Files

In general, good programming practices advise against redirecting a program search path dynamically within the code. Many developers are prone to this behavior since it mimics the actions they usually perform on the command line. However, this can lead to problems when deploying code.

For example, in a deployed application, the MATLAB and Java paths are fixed and cannot change. Therefore, any attempts to change these paths (using the `cd` command or the `addpath` command) fails

If you find you cannot avoid placing `addpath` calls in your MATLAB code, use `ismcc` and `isdeployed`. See the next section for details.

Use `ismcc` and `isdeployed` Functions To Execute Deployment-Specific Code Paths

The `isdeployed` function allows you to specify which portion of your MATLAB code is deployable, and which is not. Such specification minimizes your compilation errors and helps create more efficient, maintainable code.

For example, you find it unavoidable to use `addpath` when writing your `startup.m`. Using `ismcc` and `isdeployed`, you specify when and what is compiled and executed.

For an example of using `isdeployed`, see “Passing Arguments to and from a Standalone Application”.

Gradually Refactor Applications That Depend on Noncompilable Functions

Over time, refactor, streamline, and modularize MATLAB code containing non-compilable or non-deployable functions that use `ismcc` and `isdeployed`. Your eventual goal is “graceful degradation” of non-deployable code. In other words, the code must present the end user with as few obstacles to deployment as possible until it is practically eliminated.

Partition your code into design-time and run-time code sections:

- *Design-time code* is code that is currently evolving. Almost all code goes through a phase of perpetual rewriting, debugging, and optimization. In some toolboxes, such as the Neural Network Toolbox product, the code goes through a period of self-training as it reacts to various data permutations and patterns. Such code is almost never designed to be deployed.
- *Run-time code*, on the other hand, has solidified or become stable—it is in a finished state and is ready to be deployed by the end user.

Consider creating a separate directory for code that is not meant to be deployed or for code that calls undeployable code.

Do Not Create or Use Nonconstant Static State Variables

Avoid using the following:

- Global variables in MATLAB code
- Static variables in MEX-files
- Static variables in Java code

The state of these variables is persistent and shared with everything in the process.

When deploying applications, using persistent variables can cause problems because the MCR process runs in a single thread. You cannot load more than one of these non-constant, static variables into the same process. In addition, these static variables do not work well in multithreaded applications.

When programming with builder components, you should be aware that an instance of the MCR is created for each instance of a new class. If the same class is instantiated again using a different variable name, it is attached to the MCR created by the previous instance of the same class. In short, if an assembly contains n unique classes, there will be maximum of n instances of MCRs created, each corresponding to one or more instances of one of the classes.

If you must use static variables, bind them to instances. For example, defining instance variables in a Java class is preferable to defining the variable as `static`.

Note This guideline does not apply to MATLAB Builder EX. When programming with Microsoft Excel, you can assign global variables to large matrices that persist between calls.

Working with MATLAB Data Files Using Load and Save

If your deployed application uses MATLAB data files (MAT-files), it is helpful to code `LOAD` and `SAVE` functions to manipulate the data and store it for later processing.

- Use `isdeployed` to determine if your code is running in or out of the MATLAB workspace.
- Specify the data file by either using `WHICH` (to locate its full path name) define it relative to the location of `ctfroot`.
- All MAT-files are unchanged after `mcc` runs. These files are not encrypted when written to the CTF archive.

For more information about CTF archives, see “The Role of the Component Technology File (CTF Archive)” on page 2-11.

See the `ctfroot` reference page for more information about `ctfroot`.

Use the following example as a template for manipulating your MATLAB data inside, and outside, of MATLAB.

Using Load/Save Functions to Process MATLAB Data for Deployed Applications

The following example specifies three MATLAB data files:

- `user_data.mat`
- `userdata/extra_data.mat`
- `../externdata/extern_data.mat`

1 Navigate to `install_root\extern\examples\Data_Handling`.

2 Compile `ex_loadsave.m` with the following `mcc` command:

```
mcc -mv ex_loadsave.m -a 'user_data.mat' -a
    './userdata/extra_data.mat' -a
    '../externdata/extern_data.mat'
```

ex_loadsave.m

```
function ex_loadsave
% This example shows how to work with the
% "load/save" functions on data files in
% deployed mode. There are three source data files
% in this example.
%   user_data.mat
%   userdata/extra_data.mat
%   ../externdata/extern_data.mat
%
% Compile this example with the mcc command:
%   mcc -mC ex_loadsave.m -a 'user_data.mat' -a
%     './userdata/extra_data.mat'
%     -a '../externdata/extern_data.mat'
% All the folders under the current main MATLAB file directory will
% be included as
% relative path to ctffoot; All other folders will have the
% folder
% structure included in the ctf archive file from root of the
% disk drive.
%
% If a data file is outside of the main MATLAB file path,
% the absolute path will be
% included in ctf and extracted under ctffoot. For example:
% Data file
%   "c:\$matlabroot\examples\externdata\extern_data.mat"
% will be added into ctf and extracted to
% "$ctffoot\$matlabroot\examples\externdata\extern_data.mat".
%
% All mat/data files are unchanged after mcc runs. There is
% no encryption on these user included data files. They are
% included in the ctf archive.
%
% The target data file is:
%   ./output/saved_data.mat
% When writing the file to local disk, do not save any files
% under ctffoot since it may be refreshed and deleted
% when the application isnext started.
```

```

%==== load data file =====
if isdeployed
    % In deployed mode, all file under CTFroot in the path are loaded
    % by full path name or relative to $ctfroot.
    % LOADFILENAME1=which(fullfile(ctfroot,mfilename,'user_data.mat'));
    % LOADFILENAME2=which(fullfile(ctfroot,'userdata','extra_data.mat'));
    LOADFILENAME1=which(fullfile('user_data.mat'));
    LOADFILENAME2=which(fullfile('extra_data.mat'));
    % For external data file, full path will be added into ctf;
    % you don't need specify the full path to find the file.
    LOADFILENAME3=which(fullfile('extern_data.mat'));
else
    %running the code in MATLAB
    LOADFILENAME1=fullfile(matlabroot,'extern','examples','compiler',
        'Data_Handling','user_data.mat');
    LOADFILENAME2=fullfile(matlabroot,'extern','examples','compiler',
        'Data_Handling','userdata','extra_data.mat');
    LOADFILENAME3=fullfile(matlabroot,'extern','examples','compiler',
        'externdata','extern_data.mat');
end

% Load the data file from current working directory
disp(['Load A from : ',LOADFILENAME1]);
load(LOADFILENAME1,'data1');
disp('A= ');
disp(data1);

% Load the data file from sub directory
disp(['Load B from : ',LOADFILENAME2]);
load(LOADFILENAME2,'data2');
disp('B= ');
disp(data2);

% Load extern data outside of current working directory
disp(['Load extern data from : ',LOADFILENAME3]);
load(LOADFILENAME3);
disp('ext_data= ');
disp(ext_data);

%==== multiple the data matrix by 2 =====

```

```
result = data1*data2;
disp('A * B = ');
disp(result);

%==== save the new data to a new file =====
SAVEPATH=strcat(pwd,filesep,'output');
if ( ~isdir(SAVEPATH))
    mkdir(SAVEPATH);
end
SAVEFILENAME=strcat(SAVEPATH,filesep,'saved_data.mat');
disp(['Save the A * B result to : ',SAVEFILENAME]);
save(SAVEFILENAME, 'result');
```

Programming with MATLAB Builder EX

- “Overview of the Integration Process ” on page 3-2
- “When to Use a Formula Function or a Subroutine” on page 3-3
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Overview of the Integration Process

Each MATLAB Builder EX component is built as a COM object that you can access from Microsoft Excel through Microsoft Visual Basic for Applications (VBA). This topic provides general information on how to integrate the MATLAB Builder EX components into Excel using the VBA programming environment. It assumes that you have a working knowledge of VBA and is not intended to discuss how to program in Visual Basic. Refer to the VBA documentation provided with Excel for general programming information.

You can integrate the MATLAB Builder EX components into a VBA project by creating a simple code module with functions and/or subroutines that load the necessary components, call methods as needed, and process any errors. In general, you need to address the following items in any code written to use the MATLAB Builder EX components:

- “When to Use a Formula Function or a Subroutine” on page 3-3
- “Initializing MATLAB® Builder EX Libraries with Microsoft® Excel” on page 3-4
- “Creating an Instance of a Class” on page 3-6
- “Calling the Methods of a Class Instance” on page 3-9
- “Processing varargin and varargout Arguments” on page 3-11
- “Handling Errors During a Method Call” on page 3-17
- “Modifying Flags” on page 3-18

Note All code samples in these topics are for illustration purposes and reference a hypothetical class named `myclass` contained in a component named `mycomponent` with a version number of 1.0.

When to Use a Formula Function or a Subroutine

VBA provides two basic procedure types: functions and subroutines.

You access a VBA function directly from a cell in a worksheet as a formula function. Use function procedures when the original MATLAB function takes one or more inputs and returns one scalar output.

You access a subroutine as a general macro. Use a subroutine procedure when the original MATLAB function returns an array of values or multiple outputs because you need to map these outputs into multiple cells/ranges in the worksheet.

When you create a component, MATLAB Builder EX produces a VBA module (.bas file). This file contains simple call wrappers, each implemented as a function procedure for each method of the class.

Initializing MATLAB Builder EX Libraries with Microsoft Excel

Before you use any MATLAB Builder EX component, initialize the supporting libraries with the current instance of Microsoft Excel. Do this once for an Excel session that uses the MATLAB Builder EX components.

To do this initialization, call the utility library function `MWInitApplication`, which is a member of the `MWUtil` class. This class is part of the `MWComUtil` library. See “Utility Library Classes” on page B-3 for a detailed discussion of the functionality provided with this library.

One way to add this initialization code into a VBA module is to provide a subroutine that does the initialization once, and simply exits for all subsequent calls. The following Microsoft Visual Basic code sample initializes the libraries with the current instance of Excel. A global variable of type `Object` named `MCLUtil` holds an instance of the `MWUtil` class, and another global variable of type `Boolean` named `bModuleInitialized` stores the status of the initialization process. The private subroutine `InitModule()` creates an instance of the `MWComUtil` class and calls the `MWInitApplication` method with an argument of `Application`. Once this function succeeds, all subsequent calls exit without reinitializing.

```
Dim MCLUtil As Object
Dim bModuleInitialized As Boolean

Private Sub InitModule()
    If Not bModuleInitialized Then
        On Error GoTo Handle_Error
        If MCLUtil Is Nothing Then
            Set MCLUtil = CreateObject("MWComUtil.MWUtil")
        End If
        Call MCLUtil.MWInitApplication(Application)
        bModuleInitialized = True
        Exit Sub
    Handle_Error:
        bModuleInitialized = False
    End If
End Sub
```

This code is similar to the default initialization code generated in the VBA module created when the component is built. Each function that uses MATLAB Builder EX components can include a call to `InitModule` at the beginning to ensure that the initialization always gets performed as needed.

Creating an Instance of a Class

In this section...

“Overview” on page 3-6

“CreateObject Function” on page 3-6

“New Operator” on page 3-7

“How the MCR Is Shared Among Classes” on page 3-8

Overview

Before calling a class method (compiled MATLAB function), you must create an instance of the class that contains the method. VBA provides two techniques for doing this:

- CreateObject function
- New operator

CreateObject Function

This method uses the Microsoft Visual Basic application programming interface (API) CreateObject function to create an instance of the class. To use this method, Dim a variable of type Object to hold a reference to the class instance and call CreateObject using the class programmatic identifier (ProgID) as an argument, as shown in the next example:

```
Function foo(x1 As Variant, x2 As Variant) As Variant
    Dim aClass As Object

    On Error Goto Handle_Error
    Set aClass = CreateObject("mycomponent.myclass.1_0")
    ' (call some methods on aClass)
    Exit Function
Handle_Error:
    foo = Err.Description
End Function
```

New Operator

This method uses the Visual Basic `New` operator on a variable explicitly dimensioned as the class to be created. Before using this method, you must reference the type library containing the class in the current VBA project. Do this by selecting the **Tools** menu from the Visual Basic Editor, and then selecting **References** to display the **Available References** list. From this list, select the necessary type library.

The following example illustrates using the `New` operator to create a class instance. It assumes that you have selected **mycomponent 1.0 Type Library** from the **Available References** list before calling this function.

```
Function foo(x1 As Variant, x2 As Variant) As Variant
    Dim aClass As mycomponent.myclass

    On Error Goto Handle_Error
    Set aClass = New mycomponent.myclass
    ' (call some methods on aClass)
    Exit Function
Handle_Error:
    foo = Err.Description
End Function
```

In this example, the class instance can be dimensioned as simply `myclass`. The full declaration in the form `<component-name>.<class-name>` guards against name collisions that can occur if other libraries in the current project contain types named `myclass`.

Both methods are equivalent in functionality. The first method does not require a reference to the type library in the VBA project, while the second results in faster code execution. The second method has the added advantage of enabling the **Auto-List-Members** and **Auto-Quick-Info** capabilities of the Microsoft Visual Basic editor to work with your classes. The default function wrappers created with each built component all use the first method for object creation.

In the previous two examples, the class instance used to make the method call was a local variable of the procedure. This creates and destroys a new class instance for each call. An alternative approach is to declare one single

module-scoped class instance that is reused by all function calls, as in the initialization code of the previous example.

The following example illustrates this technique with the second method:

```
Dim aClass As mycomponent.myclass

Function foo(x1 As Variant, x2 As Variant) As Variant
    On Error Goto Handle_Error
    If aClass Is Nothing Then
        Set aClass = New mycomponent.myclass
    End If
    ' (call some methods on aClass)
    Exit Function
Handle_Error:
    foo = Err.Description
End Function
```

How the MCR Is Shared Among Classes

MATLAB Builder EX creates a single MATLAB Compiler Runtime (MCR) when the first Microsoft COM class is instantiated in an application. This MCR is reused and shared among all subsequent class instances within the component, resulting in more efficient memory usage and eliminating the MCR startup cost in each subsequent class instantiation.

All class instances share a single MATLAB workspace and share global variables in the MATLAB files used to build the component. This makes properties of a COM class behave as static properties instead of instance-wise properties.

Calling the Methods of a Class Instance

After you have created a class instance, you can call the class methods to access the compiled MATLAB functions. MATLAB Builder EX applies a standard mapping from the original MATLAB function syntax to the method's argument list. See Chapter 7, "Utility Library for Microsoft COM Components" for a detailed description of the mapping from MATLAB functions to COM class method calls.

When a method has output arguments, the first argument is always `nargout`, which is of type `Long`. This input parameter passes the normal MATLAB `nargout` parameter to the compiled function and specifies how many outputs are requested. Methods that do not have output arguments do not pass a `nargout` argument. Following `nargout` are the output parameters listed in the same order as they appear on the left side of the original MATLAB function. Next come the input parameters listed in the same order as they appear on the right side of the original MATLAB function. All input and output arguments are typed as `Variant`, the default Visual Basic data type.

The `Variant` type can hold any of the basic VBA types, arrays of any type, and object references. See "Data Conversion Rules" on page A-2 for a detailed description of how to convert `Variant` types of any basic type to and from MATLAB data types. In general, you can supply any Visual Basic type as an argument to a class method, with the exception of Visual Basic UDTs. You can also pass Microsoft Excel Range objects directly as input and output arguments.

When you pass a simple `Variant` type as an output parameter, the called method allocates the received data and frees the original contents of the `Variant`. In this case it is sufficient to dimension each output argument as a single `Variant`. When an object type (like an Excel Range) is passed as an output parameter, the object reference is passed in both directions, and the object's `Value` property receives the data.

The following examples illustrate the process of passing input and output parameters from VBA to the MATLAB Builder EX component class methods.

The first example is a formula function that takes two inputs and returns one output. This function dispatches the call to a class method that corresponds to a MATLAB function of the form `function y = foo(x1,x2)`.

```
Function foo(x1 As Variant, x2 As Variant) As Variant
    Dim aClass As Object
    Dim y As Variant

    On Error Goto Handle_Error
    aClass = CreateObject("mycomponent.myclass.1_0")
    Call aClass.foo(1,y,x1,x2)
    foo = y
    Exit Function
Handle_Error:
    foo = Err.Description
End Function
```

The second example rewrites the same function as a subroutine and uses Excel ranges for input and output.

```
Sub foo(Rout As Range, Rin1 As Range, Rin2 As Range)
    Dim aClass As Object

    On Error Goto Handle_Error
    aClass = CreateObject("mycomponent.myclass.1_0")
    Call aClass.foo(1,Rout,Rin1,Rin2)
    Exit Sub
Handle_Error:
    MsgBox(Err.Description)
End Sub
```


Processing varargin and varargout Arguments

In this section...

“Overview” on page 3-11

“Passing an Empty varargin from Microsoft® Visual Basic Code” on page 3-12

Overview

When `varargin` and/or `varargout` are present in the MATLAB function that you are using for the Excel component, these parameters are added to the argument list of the class method as the last input/output parameters in the list. You can pass multiple arguments as a `varargin` array by creating a `Variant` array, assigning each element of the array to the respective input argument.

The following example creates a `varargin` array to call a method resulting from a MATLAB function of the form `y = foo(varargin)`:

```
Function foo(x1 As Variant, x2 As Variant, x3 As Variant, _  
            x4 As Variant, x5 As Variant) As Variant  
    Dim aClass As Object  
    Dim v(1 To 5) As Variant  
    Dim y As Variant  
  
    On Error Goto Handle_Error  
    v(1) = x1  
    v(2) = x2  
    v(3) = x3  
    v(4) = x4  
    v(5) = x5  
    aClass = CreateObject("mycomponent.myclass.1_0")  
    Call aClass.foo(1,y,v)  
    foo = y  
    Exit Function  
Handle_Error:  
    foo = Err.Description  
End Function
```

The MWUtil class included in the MWComUtil utility library provides the MWPack helper function to create varargin parameters. See “Utility Library Classes” on page B-3 for more details.

The next example processes a vararginout parameter into three separate Excel Ranges. This function uses the MWUnpack function in the utility library. The MATLAB function used is vararginout = foo(x1,x2).

```
Sub foo(Rout1 As Range, Rout2 As Range, Rout3 As Range, _  
        Rin1 As Range, Rin2 As Range)  
    Dim aClass As Object  
    Dim aUtil As Object  
    Dim v As Variant  
  
    On Error Goto Handle_Error  
    aUtil = CreateObject("MWComUtil.MWUtil")  
    aClass = CreateObject("mycomponent.myclass.1_0")  
    Call aClass.foo(3,v,Rin1,Rin2)  
    Call aUtil.MWUnpack(v,0,True,Rout1,Rout2,Rout3)  
    Exit Sub  
Handle_Error:  
    MsgBox(Err.Description)  
End Sub
```

Passing an Empty varargin from Microsoft Visual Basic Code

In MATLAB, varargin inputs to functions are optional, and may be present or omitted from the function call. However, from Microsoft Visual Basic, function signatures are more strict—if varargin is present among the MATLAB function inputs, the VBA call must include varargin, even if you want it to be empty. To pass in an empty varargin, pass the Null variant, which is converted to an empty MATLAB cell array when passed.

Example: Passing an Empty varargin from VBA Code

The following example illustrates how to pass the null variant in order to pass an empty varargin:

```
Function foo(x1 As Variant, x2 As Variant, x3 As Variant, _
```

```
        x4 As Variant, x5 As Variant) As Variant
Dim aClass As Object
Dim v(1 To 5) As Variant
Dim y As Variant

On Error Goto Handle_Error
v(1) = x1
v(2) = x2
v(3) = x3
v(4) = x4
v(5) = x5
aClass = CreateObject("mycomponent.myclass.1_0")

'Call aClass.foo(1,y,v)
Call aClass.foo(1,y,Null)

foo = y
Exit Function
Handle_Error:
foo = Err.Description
End Function
```

Calling Compiled MATLAB Functions from Microsoft Excel

In order to call compiled MATLAB functions from within a Microsoft Excel spreadsheet, perform the following from the Development and Deployment machines, as specified.

Note in order for a function to be called using the Microsoft Excel function syntax (=myfunction(input)), the MATLAB function must return a single scalar output argument.

Perform the following steps on the Development machine:

- 1 Create the following MATLAB functions in three separate files named `doubleit.m`, `incrementit.m`, and `powerit.m`, respectively:

```
function output = doubleit(input)
    output = input * 2;
```

```
function output = incrementit(input1, input2)
    output = input1 + input2;
```

```
function output = powerit(input1, input2)
    output = power(input1, input2);
```

- 2 From the MATLAB Command Prompt, enter `mbuild -setup` and select a Visual C++® compiler.

Note This procedure was tested using Microsoft Visual C++ 8.0.

- 3 Start the Deployment Tool by entering `deploytool` at the MATLAB Command Prompt.
- 4 Use the following information as you work through this example using the instructions in “Building Your Component” on page 1-11:

Project Name	myexcelfunctions
Class Name	myexcelfunctionsclass
File to compile	doubleit.m incrementit.m powerit.m

- 5 Package your component by following the instructions in “Packaging Your Component (Optional)” on page 1-15.

Note You must have administrator privileges to build and deploy.

Perform the following steps on the Deployment machine:

- 1 Copy `myexcelfunctions_pkg.exe` to the deployment machine(s). Copy the file to a standard place for use with Microsoft Excel, such as *Office_Installation_folder*\Library\MATLAB where *Office_Installation_folder* is a folder such as C:\Program Files\Microsoft Office\OFFICE11.
- 2 Run `myexcelfunctions_pkg.exe` to extract the archive and register `myexcelfunctions_1_0.dll`. If you have also included `MCRInstaller.exe`, follow the prompts to install the MATLAB Compiler Runtime.
- 3 Start Microsoft Excel. The spreadsheet **Book1** should be open by default.
- 4 In Excel, select **Tools > Macro > Visual Basic Editor**. The Microsoft Visual Basic Editor starts.
- 5 In the Microsoft Visual Basic Editor, select **File > Import File**.
- 6 Browse to `myexcelfunctions.bas`, which was extracted from `myexcelfunctions_pkg.exe` and click **Open**. In the Project Explorer, **Module1** appears under the **Modules** node beneath **VBAProject (Book1)**.
- 7 In the Microsoft Visual Basic Editor, select **View > Microsoft Excel**. You can now use the `doubleit`, `incrementit`, and `powerit` functions in your **Book1** spreadsheet.

- 8** Test the functions, by doing the following:
 - a** Enter `=doubleit(2.5)` in cell A1.
 - b** Enter `=incrementit(11,17)` in cell A2.
 - c** Enter `=powerit(7,2)` in cell A3.
You should see values **5**, **28**, and **49** in cells **A1**, **A2**, and **A3** respectively.
- 9** To use the `doubleit`, `powerit`, and `incrementit` functions in all your new Microsoft Excel spreadsheets, do the following:
 - a** Select **File > Save As**.
 - b** Change the **Save as type** option to **.xlt (Template)**.
 - c** Browse to the *Office_Installation_folder*\XLSTART folder.
 - d** Save the file as *Office_Installation_folder*\XLSTART\Book.xlt.

Note Your Microsoft Excel Macro Security level must be set at **Medium** or **Low** to save this template.

Handling Errors During a Method Call

Errors that occur while creating a class instance or during a class method create an exception in the current procedure. Microsoft Visual Basic provides an exception handling capability through the `On Error Goto <label>` statement, in which the program execution jumps to `<label>` when an error occurs. (`<label>` must be located in the same procedure as the `On Error Goto` statement). All errors are handled this way, including errors within the original MATLAB code. An exception creates a Visual Basic `ErrObject` object in the current context in a variable called `Err`. (See the Visual Basic for Applications documentation for a detailed discussion on VBA error handling.) All of the examples in this section illustrate the typical error trapping logic used in function call wrappers for MATLAB Builder EX components.

Modifying Flags

In this section...

“Overview” on page 3-18

“Array Formatting Flags” on page 3-18

“Data Conversion Flags” on page 3-21

Overview

Each MATLAB Builder EX component exposes a single read/write property named `MWFlags` of type `MWFlags`. The `MWFlags` property consists of two sets of constants: array formatting flags and data conversion flags. *Array formatting flags* affect the transformation of arrays, whereas *data conversion flags* deal with type conversions of individual array elements.

The data conversion flags change selected behaviors of the data conversion process from `Variants` to MATLAB types and vice versa. By default, the MATLAB Builder EX components allow setting data conversion flags at the class level through the `MWFlags` class property. This holds true for all Visual Basic types, with the exception of the MATLAB Builder EX `MWStruct`, `MWField`, `MWComplex`, `MWSparse`, and `MWArg` types. Each of these types exposes its own `MWFlags` property and ignores the properties of the class whose method is being called. The `MWArg` class is supplied specifically for the case when a particular argument needs different settings from the default class properties.

This section provides a general discussion of how to set these flags and what they do. See “Class `MWFlags`” on page B-10 for a detailed discussion of the `MWFlags` type, as well as additional code samples.

Array Formatting Flags

Array formatting flags guide the data conversion to produce either a MATLAB cell array or matrix from general `Variant` data on input or to produce an array of `Variants` or a single `Variant` containing an array of a basic type on output.

The following examples assume that you have referenced the `MWComUtil` library in the current project by selecting **Tools > References** and selecting **MWComUtil 7.5 Type Library** from the list:


```
Sub foo( )
    Dim aClass As mycomponent.myclass
    Dim var1(1 To 2, 1 To 2), var2 As Variant
    Dim x(1 To 2, 1 To 2) As Double
    Dim y1,y2 As Variant

    On Error Goto Handle_Error
    var1(1,1) = 11#
    var1(1,2) = 12#
    var1(2,1) = 21#
    var1(2,2) = 22#
    x(1,1) = 11
    x(1,2) = 12
    x(2,1) = 21
    x(2,2) = 22
    var2 = x
    Set aClass = New mycomponent.myclass
    Call aClass.foo(1,y1,var1)
    Call aClass.foo(1,y2,var2)
    Exit Sub
Handle_Error:
    MsgBox(Err.Description)
End Sub
```

In addition, these examples assume you have referenced the COM object created with Builder EX (mycomponent) as mentioned in “New Operator” on page 3-7.

Here, two Variant variables, var1 and var2 are constructed with the same numerical data, but internally they are structured differently: var1 is a 2-by-2 array of Variants with each element containing a 1-by-1 Double, while var2 is a 1-by-1 Variant containing a 2-by-2 array of Doubles.

In MATLAB Builder EX , when using the default settings, both of these arrays will be converted to 2-by-2 arrays of doubles. This does not follow the general convention listed in COM VARIANT to the MATLAB Conversion Rules. According to these rules, var1 converts to a 2-by-2 cell array with each cell occupied by a 1-by-1 double, and var2 converts directly to a 2-by-2 double matrix.

The two arrays both convert to double matrices because the default value for the `InputArrayFormat` flag is `mwArrayFormatMatrix`. The `InputArrayFormat` flag controls how arrays of these two types are handled. This default is used because array data originating from Excel ranges is always in the form of an array of Variants (like `var1` of the previous example), and MATLAB functions most often deal with matrix arguments.

But what if you want a cell array? In this case, you set the `InputArrayFormat` flag to `mwArrayFormatCell`. Do this by adding the following line after creating the class and before the method call:

```
aClass.MWFlags.ArrayFormatFlags.InputArrayFormat =  
    mwArrayFormatCell
```

Setting this flag presents all array input to the compiled MATLAB function as cell arrays.

Similarly, you can manipulate the format of output arguments using the `OutputArrayFormat` flag. You can also modify array output with the `AutoResizeOutput` and `TransposeOutput` flags.

`AutoResizeOutput` is used for Excel Range objects passed directly as output parameters. When this flag is set, the target range automatically resizes to fit the resulting array. If this flag is not set, the target range must be at least as large as the output array or the data is truncated.

The `TransposeOutput` flag transposes all array output. This flag is useful when dealing with MATLAB functions that output one-dimensional arrays. By default, MATLAB realizes one-dimensional arrays as 1-by-n matrices (row vectors) that become rows in an Excel worksheet.

You may prefer worksheet columns from row vector output. This example auto-resizes and transposes an output range:

```
Sub foo(Rout As Range, Rin As Range )  
    Dim aClass As mycomponent.myclass  
  
    On Error Goto Handle_Error  
    Set aClass = New mycomponent.myclass  
    aClass.MWFlags.ArrayFormatFlags.AutoResizeOutput = True
```

```

        aClass.MWFlags.ArrayFormatFlags.TransposeOutput = True
        Call aClass.foo(1,Rout,Rin)
    Exit Sub
Handle_Error:
    MsgBox(Err.Description)
End Sub

```

Data Conversion Flags

Data conversion flags deal with type conversions of individual array elements. The two data conversion flags, `CoerceNumericToType` and `InputDateFormat`, govern how numeric and date types are converted from VBA to MATLAB. Consider the example:

```

Sub foo( )
    Dim aClass As mycomponent.myclass
    Dim var1, var2 As Variant
    Dim y As Variant

    On Error Goto Handle_Error
    var1 = 1
    var2 = 2#
    Set aClass = New mycomponent.myclass
    Call aClass.foo(1,y,var1,var2)
    Exit Sub
Handle_Error:
    MsgBox(Err.Description)
End Sub

```

This example converts `var1` of type `Variant/Integer` to an `int16` and `var2` of type `Variant/Double` to a `double`.

If the original MATLAB function expects `doubles` for both arguments, this code might cause an error. One solution is to assign a `double` to `var1`, but this may not be possible or desirable. In such a case set the `CoerceNumericToType` flag to `mwTypeDouble`, causing the data converter to convert all numeric input to `double`. In the previous example, place the following line after creating the class and before calling the methods:

```

aClass.MWFlags.DataConversionFlags.CoerceNumericToType =
mwTypeDouble

```

The `InputDateFormat` flag controls how the VBA `Date` type is converted. This example sends the current date and time as an input argument and converts it to a string:

```
Sub foo( )
    Dim aClass As mycomponent.myclass
    Dim today As Date
    Dim y As Variant

    On Error Goto Handle_Error
    today = Now
    Set aClass = New mycomponent.myclass
    aClass.MWFlags.DataConversionFlags.InputDateFormat =
mwDateFormatString
    Call aClass.foo(1,y,today)
    Exit Sub
Handle_Error:
    MsgBox(Err.Description)
End Sub
```

The next example uses an `MWArg` object to modify the conversion flags for one argument in a method call. In this case the first output argument (`y1`) is coerced to a `Date`, and the second output argument (`y2`) uses the current default conversion flags supplied by `aClass`.

```
Sub foo(y1 As Variant, y2 As Variant)
    Dim aClass As mycomponent.myclass
    Dim ytemp As MWArg
    Dim today As Date

    On Error Goto Handle_Error
    today = Now
    Set aClass = New mycomponent.myclass
    Set y1 = New MWArg
    y1.MWFlags.DataConversionFlags.OutputAsDate = True
    Call aClass.foo(2, ytemp, y2, today)
    y1 = ytemp.Value
    Exit Sub
Handle_Error:
```

```
    MsgBox(Err.Description)  
End Sub
```

Improving Data Access Using the MCR User Data Interface, COM Components, and MATLAB Builder EX

In this section...

“Overview” on page 3-24

“Example: Supplying Run-Time Configuration Information for Parallel Computing Toolbox Applications” on page 3-25

Overview

This feature provides a lightweight interface for easily accessing MCR data. It allows data to be shared between an MCR instance, the MATLAB code running on that MCR, and the wrapper code that created the MCR. Through calls to the MCR User Data interface API, you access MCR data by creating a per-MCR-instance associative array of `mxAArrays`, consisting of a mapping from string keys to `mxAArray` values. Reasons for doing this include, but are not limited to:

- You need to supply run-time configuration information to a client running an application created with the Parallel Computing Toolbox. Configuration information may be supplied (and change) on a per-execution basis. For example, two instances of the same application may run simultaneously with different configuration files.
- You want to initialize the MCR with constant values that can be accessed by all your MATLAB applications.
- You want to set up a global workspace — a global variable or variables that MATLAB and your client can access.
- You want to store the state of any variable or group of variables.

MATLAB Builder EX supports per-MCR instance state access through an object-oriented API. Unlike MATLAB Compiler, access to per-MCR instance state is optional, rather than on by default. You can access this state by adding `setmcruserdata.m` and `getmcruserdata.m` to your deployment project or by specifying them on the command line. Alternately, you use a helper function to call these methods, as shown in “Example: Supplying Run-Time

Configuration Information for Parallel Computing Toolbox Applications” on page 3-25.

For more information, see the MATLAB Compiler User’s Guide.

Example: Supplying Run-Time Configuration Information for Parallel Computing Toolbox Applications

Following is a complete example of how you can use the MCR User Data Interface as a mechanism to specify a configuration .mat file for Parallel Computing Toolbox applications.

Step 1: Write Your PCT Code

- 1 Compile `sample_pct.m` in MATLAB. By default, the code uses the local scheduler, starts the workers, and evaluates the result.

```
function speedup = sample_pct (n)
warning off all;
tic
if(ischar(n))
    n=str2double(n);
end
for ii = 1:n
    (cov(sin(magic(n)+rand(n,n))));
end
time1 =toc;
matlabpool('open',4);
tic
parfor ii = 1:n
    (cov(sin(magic(n)+rand(n,n))));
end
time2 =toc;
disp(['Normal loop times: ' num2str(time1) ...
    ',parallel loop time: ' num2str(time2) ]);
disp(['parallel speedup: ' num2str(1/(time2/time1)) ...
    ' times faster than normal']);
matlabpool('close','force');
```

```
disp('done');  
speedup = (time1/time2);
```

2 Run the code as follows:

```
a = sample_pct(200)
```

3 Verify that you get the following results;

```
Starting matlabpool using the 'local'  
configuration ... connected to 4 labs.  
Normal loop times: 1.4625, parallel loop time: 0.82891  
parallel speedup: 1.7643 times faster than normal  
Sending a stop signal to all the labs ... stopped.  
Did not find any pre-existing parallel jobs created  
by matlabpool.  
done  
a =  
    1.7643
```

Step 2: Set the Parallel Computing Toolbox Configuration

In order to compile MATLAB code to a COM component and utilize the Parallel Computing Toolbox, the `mcruserdata` must be set directly from MATLAB. There is no API available to access the `MCRUserdata` as there is for C and C++ applications built with MATLAB Compiler.

To set the `mcruserdata` from MATLAB, create an `init` function in your COM class. This is a separate MATLAB function that uses `setmcruserdata` to set the Parallel Computing Toolbox configuration once. You then call your other functions to utilize the Parallel Computing Toolbox functions.

Create the following `init` function:

```
function init_sample_pct  
% Set the Parallel Configuration file:  
if(isdeployed)  
    [matfile, matpath,c] = uigetfile('*.mat');  
    % let the USER select file  
    setmcruserdata('ParallelConfigurationFile',[matpath matfile]);
```


end

Step 3: Compile Your Function with the Deployment Tool or the Command Line

You can compile your function from the command line by entering the following:

```
 mcc -B 'cexcel:exPctComp,exPctClass,1.0' init_sample_pct.m sample_pct.m
```

Alternately, you can use the Deployment Tool as follows:

- 1 Follow the steps in “Building Your Component” on page 1-11 to compile your application. When the compilation finishes, a new folder (with the same name as the project) is created. This folder contains two subfolders: `distrib` and `src`.

Project Name	exPctComp
Class Name	exPctClass
File to compile	sample_pct.m and init_sample_pct.m

- 2 To deploy the compiled application, copy the `distrib` folder, which contains the following, to your end users. The packaging function of `deploytool` offers a convenient way to do this.
 - `exPctComp.dll`
 - VBA module (.bas file)
 - MCR installer
 - MAT file containing cluster configuration information

Note The end-user’s target machine must have access to the cluster.

Step 4: Modify the generated VBA Driver Application (the BAS File)

After registering the COM DLL on the deployment machine and importing the BAS file into Excel, modify the generated BAS file code as needed. See “Deploying the Microsoft® Excel Add-In” on page 1-23 for more information.

```
Dim MCLUtil As Object
Dim bModuleInitialized As Boolean
Dim exPctClass As Object

Private Sub InitModule()
    If Not bModuleInitialized Then
        On Error GoTo Handle_Error
        If MCLUtil Is Nothing Then
            Set MCLUtil = CreateObject("MWComUtil.MWUtil7.10")
        End If
        Call MCLUtil.MWInitApplication(Application)
        bModuleInitialized = True
        Exit Sub
    Handle_Error:
        bModuleInitialized = False
    End If
End Sub

Function init_sample_pct() As Variant

    On Error GoTo Handle_Error
    Call InitModule
    If exPctClass Is Nothing Then
        Set exPctClass = CreateObject("exPctComp.exPctClass.1_0")
    End If
    Call exPctClass.init_sample_pct
    init_sample_pct = Empty

    Exit Function
Handle_Error:
    init_sample_pct = "Error in " &
        Err.Source & ": " & Err.Description
End Function
```

```

Function sample_pct(Optional pelle As Variant) As Variant
    Dim speedup As Variant

    On Error GoTo Handle_Error
    Call InitModule
    If exPctClass Is Nothing Then
        Set exPctClass = CreateObject("exPctComp.exPctClass.1_0")
    End If
    Call exPctClass.sample_pct(1, speedup, pelle)
    sample_pct = speedup

    Exit Function
Handle_Error:
    sample_pct = "Error in " & Err.Source
        & ": " & Err.Description

End Function

```

The output is as follows:

	A	B	C	D	E	F
				0 <- init_sample_pct()		
			450			
	Speedup	2.013657	<-sample_pct(C3)			

Overriding Default CTF Archive Embedding for Components Using the MCR Component Cache

As of R2008b, CTF data is automatically embedded directly in MATLAB Builder EX components by default. In order to extract the CTF archive manually, you must build the component using the `mcc -C` option.

If you do not use the `mcc -C` option to specify that a separate CTF file is to be generated, you can add environment variables to specify various options, such as:

- Defining the location where you want the CTF archive to be extracted
- Adding diagnostic error printing options that can be utilized when extracting the CTF, for troubleshooting purposes
- Tuning the MCR component cache size for performance reasons.

Use the following environment variables to change these settings.

Environment Variable	Purpose	Notes
MCR_CACHE_ROOT	When set to the location of where you want the CTF archive to be extracted, this variable overrides the default per-user component cache location.	Does not apply
MCR_CACHE_VERBOSE	When set to any value, this variable prints logging details about the component cache for diagnostic reasons. This can be very helpful if problems are encountered during CTF archive extraction.	Logging details are turned off by default (for example, when this variable has no value).
MCR_CACHE_SIZE	When set, this variable overrides the default component cache size.	The initial limit for this variable is 32M (megabytes). This may, however, be changed after you have set the variable the first time. Edit the file

Environment Variable	Purpose	Notes
		.max_size, which resides in the file designated by running the mcrcachedir command, with the desired cache size limit.

Note If you run `mcc` specifying conflicting wrapper and target types, the CTF will not be embedded into the generated component. For example, if you run:

```
mcc -W lib:myLib -T link:exe test.m test.c
```

the generated `test.exe` will not have the CTF embedded in it, as if you had specified a `-C` option to the command line.

Caution Do not extract the files within the `.ctf` file and place them individually under version control. Since the `.ctf` file contains interdependent MATLAB functions and data, the files within it must be accessed only by accessing the `.ctf` file. For best results, place the entire `.ctf` file under version control.

Usage Examples

- “Magic Square Example ” on page 4-2
- “Multiple Files and Variable Arguments Example” on page 4-6
- “Spectral Analysis Example” on page 4-12

Note You can also find usage examples on MATLAB Central. Set the Search field to `File Exchange` and search for one or more of the following:

- `InterpExcelDemo`
 - `MatrixMathExcelDemo`
 - `ExcelCurveFit`
-

Note You must have administrator privileges to build and deploy Excel Add-ins.

Magic Square Example

In this section...

“Overview” on page 4-2

“Creating the Project” on page 4-3

“Adding the MATLAB® Builder EX COM Function to Microsoft® Excel” on page 4-3

“Output Magic Square Results to Microsoft® Excel” on page 4-3

“Transpose the Output” on page 4-4

“Resize the Output” on page 4-4

“Inspecting the Microsoft® Visual Basic Code” on page 4-5

Overview

The MATLAB file `mymagic` takes a single input, an integer, and creates a magic square of that size.

The Microsoft Excel file `mymagic.xls` uses this function in three different ways:

- “Output Magic Square Results to Microsoft® Excel” on page 4-3 calls the function `mymagic` with a value of 4. The function returns a magic square of size 4 and populates a range of Excel cells with that magic square.
- “Transpose the Output” on page 4-4 uses the transpose flag to transpose a magic square of size 4.
- “Resize the Output” on page 4-4 resizes the output to a higher value and moves its location within the Excel worksheet.

Note To get started, copy the distributed folder `xlmagic` from `matlabroot\toolbox\matlabxl\examples\xlmagic` to `myfiles\work`.

Creating the Project

- 1 From the MATLAB command prompt, change folders to `myfiles\work`.
- 2 If you have not already done so, execute the following command in the MATLAB prompt:

```
mbuild -setup
```

Be sure to choose a supported compiler. See Supported Compilers.

- 3 Enter the `deploytool` command to open the Deployment Tool.
- 4 Use the following information as you work through this example using the instructions in “Building Your Component” on page 1-11:

Project Name	<code>xlmagic</code>
Class Name	<code>xlmagicclass</code>
File to compile	<code>mymagic.m</code>

Adding the MATLAB Builder EX COM Function to Microsoft Excel

- 1 Start Microsoft Excel on your system.
- 2 Open the file `myfiles\work\xlmagic\mymagic.xls`.

Note If an Excel prompt says that this file contains macros, click **Enable Macros** to run this example. See the Appendix C, “Troubleshooting” appendix in this User’s Guide for details on enabling macros.

Output Magic Square Results to Microsoft Excel

From the Excel main window (not the Microsoft Visual Basic Editor), open the Macro dialog box by pressing the **Alt** and **F8** keys simultaneously, or by clicking **Tools > Macro > Macros**. If you are running Microsoft Office 2007 or Microsoft Office 2010, click **View > Macros > View Macros**.

Select `mymagic` from the list and click **Run**. This procedure returns a magic square of size 4 beginning in cell B2.

	A	B	C	D	E	F
1						
2		4	16	2	3	13
3			5	11	10	8
4			9	7	6	12
5			4	14	15	1
6						
7		The above example runs the macro "mymagic" which				
8		populates the cells B2 through E5 with a magic square of 4				
9		Select Tools->Macro-> Macros to run this example				

Transpose the Output

Reopen the Macro dialog box, select the `mymagic_transpose` macro and click **Run**. This procedure returns a magic square of size 4 transposed, beginning in cell B14.

13						
14		4	16	5	9	4
15			2	11	7	14
16			3	10	6	15
17			13	8	12	1
18						
19		The above example runs the macro "mymagic_transpose" which				
20		transposes the results of a magic square of 4 and populates the				
21		cells B14 through E17				
22		Select Tools->Macro-> Macros to run this example				

Resize the Output

Reopen the Macro dialog box, select the `mymagic_resize` macro, and click **Run**. This procedure returns a magic square of size 4 beginning in cell B32.

Change the value of 4 in cell A32 to a higher value and rerun this macro. A magic square of the size you specified in cell A32 is returned, beginning in cell B32.

27	The below example runs the macro "mymagic_resize" which									
28	has an initial range for a magic square of 4 but will resize if									
29	the output is larger. Gradually increase the number in cell A32 and rerun the macro.									
30	CAUTION: Resizing will over write any existing data in the target cells									
31										
32	8	64	2	3	61	60	6	7	57	
33		9	55	54	12	13	51	50	16	
34		17	47	46	20	21	43	42	24	
35		40	26	27	37	36	30	31	33	
36		32	34	35	29	28	38	39	25	
37		41	23	22	44	45	19	18	48	
38		49	15	14	52	53	11	10	56	
39		8	58	59	5	4	62	63	11	
40										

Inspecting the Microsoft Visual Basic Code

- 1 From the Excel main window, select **Tools > Macro > Visual Basic Editor**.
- 2 When the Visual Basic Editor opens, in the **Project - VBAProject** window, double-click to expand VBAProject (mymagic.xls).
- 3 Expand the **Modules** folder and double-click the **Module1** module.

This opens the VB Code window with the code for this project.

Multiple Files and Variable Arguments Example

In this section...
“Overview” on page 4-6
“Creating the Project” on page 4-6
“Adding the MATLAB® Builder EX COM Function to Microsoft® Excel” on page 4-7
“Calling myplot” on page 4-8
“Calling mysum Four Different Ways” on page 4-9
“myprimes Macro” on page 4-10
“Inspecting the Microsoft® Visual Basic Code” on page 4-11

Overview

The file, `myplot`, takes a single integer input and plots a line from 1 to that number.

The file, `mysum`, takes an input of `varargin` of type `integer`, adds all the numbers, and returns the result.

The file, `myprimes`, takes a single integer input `n` and returns all the prime numbers less than or equal to `n`.

The Microsoft Excel file, `xlmulti.xls`, demonstrates these functions in several ways.

Note To get started, copy the distributed folder `xlmulti` from `matlabroot\toolbox\matlabxl\examples\xlmulti` to `myfiles\work`.

Creating the Project

1 From the MATLAB command prompt, change folders to `myfiles\work`.

- 2 If you have not already done so, execute the following command at the MATLAB prompt:

```
mbuild -setup
```

Be sure to choose a supported compiler. See Supported Compilers.

- 3 While in MATLAB, issue the following command to open Deployment Tool:

```
deploytool
```

- 4 Use the following information as you work through this example using the instructions in “Building Your Component” on page 1-11:

Project Name	xlmulti
Class Name	xlmulticlass
File to compile (in the xlmulti folder of myfiles\work)	myplot.m myprimes.m mysum.m

Adding the MATLAB Builder EX COM Function to Microsoft Excel

- 1 Start Microsoft Excel on your system.
- 2 Open the file myfiles\work\xlmulti\xlmulti.xls.

Note If an Excel prompt says that this file contains macros, click **Enable Macros** to run this example. See the Appendix C, “Troubleshooting” appendix in this User’s Guide for details on enabling macros.

The example appears as shown:

	A	B	C	D	E	F	G	H	I	J	K
1											
2	Sample: myplot										
3											
4	In this simple example we are just plotting a line from 1 to whatever										
5	number is supplied as an argument to the function in cell A7.										
6											
7	0										
8											
9											
10	Sample: mysum										
11											
12	In the below example we are just adding up a series of numbers that										
13	are explicitly stated.										
14	55										
15											
16											
17	In the below example we are just adding up a series of numbers that										
18	are from a range of cells.										
19	55	1	2	3	4	5	6	7	8	9	10
20											
21											
22	In the below example, we are adding up 3 separate ranges of cells.										
23	The ranges do not need to be the same size nor do all the cells in the range need to have data in them.										
24	120	1	2	3	4	5	6	7	8	9	10
25		1	2	3	4	5	6		8	9	10
26		1	2	3							
27											
28											
29	In the below example, we are adding 10 to a range of cells.										
30	16	1	2	3							
31											
32											
33											
34	Sample: myprimes										
35											
36											
37	The below example runs the macro "myprimes" which										
38	has an initial range for 4 prime numbers but will resize if										
39	the output is larger. Gradually increase the number in cell A42 and rerun the macro.										
40	CAUTION: Resizing will over write any existing data in the target cells										
41											
42	10										

Calling myplot

This illustration calls the function `myplot` with a value of 4. To execute the function, make A7 (`=myplot(4)`) the active cell. Press **F2** and then **Enter**.

	A	B	C	D	E	F	G
1							
2	Sample: myplot						
3							
4	In this simple example we are just plotting a line from 1 to whatever						
5	number is supplied as an argument to the function in cell A7.						
6							
7	0						
8							

This procedure plots a line from 1 through 4 in a MATLAB Figure window. This graphic can be manipulated similarly to the way one would manipulate a figure in MATLAB. Some functionality, such as the ability to change line style or color, is not available.

The calling cell contains 0 because the function does not return a value.

Calling mysum Four Different Ways

This illustration calls the function mysum in four different ways:

- The first (cell A14) takes the values 1 through 10, adds them, and returns the result of 55 (=mysum(1,2,3,4,5,6,7,8,9,10)).
- The second (cell A19) takes a range object that is a range of cells with the values 1 through 10, adds them, and returns the result of 55 (=mysum(B19:K19)).
- The third (cell A24) takes several range objects, adds them, and returns the result of 120 (=mysum(B24:K24,B25:L25,B26:D26)). This illustration demonstrates that the ranges do not need to be the same size and that all the cells do not need a value.
- The fourth (cell A30) takes a combination of a range object and explicitly stated values, adds them, and returns the result of 16 (=mysum(10,B30:D30)).

10	Sample: mysum										
11											
12	In the below example we are just adding up a series of numbers that										
13	are explicitly stated.										
14	55										
15											
16											
17	In the below example we are just adding up a series of numbers that										
18	are from a range of cells.										
19	55	1	2	3	4	5	6	7	8	9	10
20											
21											
22	In the below example, we are adding up 3 separate ranges of cells.										
23	The ranges do not need to be the same size nor do all the cells in the range need to have data in them.										
24	120	1	2	3	4	5	6	7	8	9	10
25		1	2	3	4	5	6		8	9	10
26		1	2	3							
27											
28											
29	In the below example, we are adding 10 to a range of cells.										
30	16	1	2	3							
31											

This illustration runs when the Excel file is opened. To reactivate the illustration, activate the appropriate cell. Then press **F2** followed by **Enter**.

myprimes Macro

In this illustration, the macro myprimes calls the function myprimes.m with an initial value of 10 in cell A42. The function returns all the prime numbers less than 10 to cells B42 through E42.

34	Sample: myprimes			
35				
36				
37	The below example runs the macro "myprimes" which			
38	has an initial range for 4 prime numbers but will resize if			
39	the output is larger. Gradually increase the number in cell A42 and rerun the macro.			
40	CAUTION: Resizing will over write any existing data in the target cells			
41				
42	10			
43				

To execute the macro, from the main Excel window (not the Visual Basic Editor), open the Macro dialog box, by pressing the **Alt** and **F8** keys simultaneously, or by selecting **Tools > Macro > Macros**.

Select myprimes from the list and click **Run**.

34	Sample: myprimes							
35								
36								
37	The below example runs the macro "myprimes" which							
38	has an initial range for 4 prime numbers but will resize if							
39	the output is larger. Gradually increase the number in cell A42 and rerun the macro.							
40	CAUTION: Resizing will over write any existing data in the target cells							
41								
42	10	2	3	6	7			
43								

This function automatically resizes if the returned output is larger than the output range specified. Change the value in cell A42 to a number larger than 10. Then rerun the macro. The output returns all prime numbers less than the number you entered in cell A42.

34	Sample: myprimes								
35									
36									
37	The below example runs the macro "myprimes" which								
38	has an initial range for 4 prime numbers but will resize if								
39	the output is larger. Gradually increase the number in cell A42 and rerun the macro.								
40	CAUTION: Resizing will over write any existing data in the target cells								
41									
42	20	2	3	6	7	11	13	17	19

Inspecting the Microsoft Visual Basic Code

- 1 On the Microsoft Excel main window, select **Tools > Macro > Visual Basic Editor**.
- 2 On the Microsoft Visual Basic, in the Project - VBAProject window, double-click to expand VBAProject (xlmulti.xls)
- 3 Expand the Modules folder and double-click the Module1 module. This opens the VB Code window with the code for this project.

Spectral Analysis Example

In this section...
“Overview” on page 4-12
“Building the Component” on page 4-13
“Integrating the Component Using VBA” on page 4-14
“Testing the Add-In” on page 4-26
“Packaging and Distributing the Add-In” on page 4-28
“Installing the Add-In” on page 4-31

Overview

This example illustrates the creation of a comprehensive Excel add-in to perform spectral analysis. It requires knowledge of Visual Basic forms and controls, as well as Excel workbook events. See the VBA documentation for a complete discussion of these topics.

The example creates an Excel add-in that performs a fast Fourier transform (FFT) on an input data set located in a designated worksheet range. The function returns the FFT results, an array of frequency points, and the power spectral density of the input data. It places these results into ranges you indicate in the current worksheet. You can also optionally plot the power spectral density.

You develop the function so that you can invoke it from the Excel **Tools** menu and can select input and output ranges through a GUI.

Creating the add-in requires four basic steps:

- 1** Build a standalone COM component from the MATLAB code.
- 2** Implement the necessary VBA code to collect input and dispatch the calls to your component.
- 3** Create the GUI.

- 4 Create an Excel add-in and package all necessary components for application deployment.

Building the Component

Your component will have one class with two methods, `computefft` and `plotfft`. The `computefft` method computes the FFT and power spectral density of the input data and computes a vector of frequency points based on the length of the data entered and the sampling interval. The `plotfft` method performs the same operations as `computefft`, but also plots the input data and the power spectral density in a MATLAB Figure window. The MATLAB code for these two methods resides in two MATLAB files, `computefft.m` and `plotfft.m`.

```
computefft.m:
function [fftdata, freq, powerspect] =
    computefft(data, interval)
    if (isempty(data))
        fftdata = [];
        freq = [];
        powerspect = [];
        return;
    end
    if (interval <= 0)
        error('Sampling interval must be greater than zero');
        return;
    end
    fftdata = fft(data);
    freq = (0:length(fftdata)-1)/(length(fftdata)*interval);
    powerspect = abs(fftdata)/(sqrt(length(fftdata)));
plotfft.m:
function [fftdata, freq, powerspect] = plotfft(data, interval)
    [fftdata, freq, powerspect] = computefft(data, interval);
    len = length(fftdata);
    if (len <= 0)
        return;
    end
    t = 0:interval:(len-1)*interval;
    subplot(2,1,1), plot(t, data)
    xlabel('Time'), grid on
```

```
title('Time domain signal')
subplot(2,1,2), plot(freq(1:len/2), powerspect(1:len/2))
xlabel('Frequency (Hz)'), grid on
title('Power spectral density')
```

To proceed with the actual building of the component:

- 1 If you have not already done so, execute the following command in MATLAB:

```
mbuild -setup
```

Be sure to choose a supported compiler. See Supported Compilers.

- 2 Use the following information as you work through this example using the instructions in “Building Your Component” on page 1-11:

Setting	Value
Component name	Fourier
Class name	Fourier
Project folder	The name of your work folder followed by the component name
Show verbose output	Selected

Integrating the Component Using VBA

Having built your component, you can implement the necessary VBA code to integrate it into Excel.

Selecting the Libraries

To open Excel and select the libraries you need to develop the add-in:

- 1 Start Excel on your system.
- 2 From the Excel main menu, select **Tools > Macro > Visual Basic Editor**.

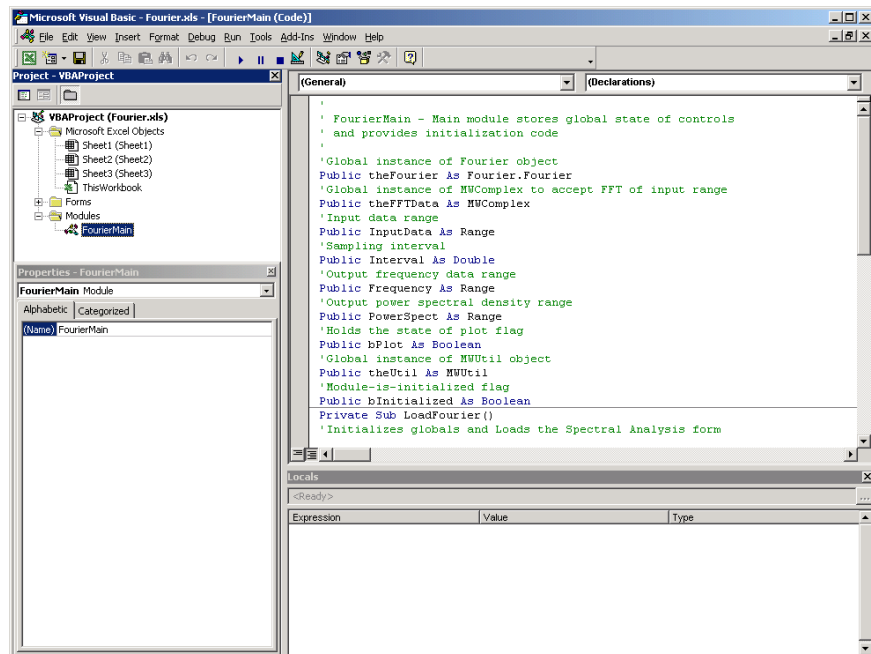
- 3 When the Visual Basic Editor starts, select **Tools > References** to open the Project References dialog box.
- 4 Select **Fourier 1.0 Type Library** and **MWComUtil 7.x Type Library** from the list.

Creating the Main VB Code Module for the Application. The add-in requires some initialization code and some global variables to hold the application's state between function invocations. To achieve this, implement a Visual Basic code module to manage these tasks:

- 1 Right-click the **VBAProject** item in the project window and select **Insert > Module**.

A new module appears under **Modules** in the **VBA Project**.

- 2 In the module's property page, set the Name property to **FourierMain**. See the next figure.



3 Enter the following code in the FourierMain module:

```
'
' FourierMain - Main module stores global state of controls
' and provides initialization code
'
Public theFourier As Fourier.Fourier 'Global instance of Fourier object
Public theFFTData As MWComplex      'Global instance of MWComplex to accept FFT
Public InputData As Range           'Input data range
Public Interval As Double           'Sampling interval
Public Frequency As Range           'Output frequency data range
Public PowerSpect As Range          'Output power spectral density range
Public bPlot As Boolean              'Holds the state of plot flag
Public theUtil As MWUtil             'Global instance of MWUtil object
Public bInitialized As Boolean       'Module-is-initialized flag

Private Sub LoadFourier()
'Initializes globals and Loads the Spectral Analysis form
    Dim MainForm As frmFourier
    On Error GoTo Handle_Error
    Call InitApp
    Set MainForm = New frmFourier
    Call MainForm.Show
    Exit Sub
Handle_Error:
    MsgBox (Err.Description)
End Sub

Private Sub InitApp()
'Initializes classes and libraries. Executes once
'for a given session of Excel
    If bInitialized Then Exit Sub
    On Error GoTo Handle_Error
    If theUtil Is Nothing Then
        Set theUtil = New MWUtil
        Call theUtil.MWInitApplication(Application)
    End If
    If theFourier Is Nothing Then
        Set theFourier = New Fourier.Fourierclass
    End If
End Sub
```

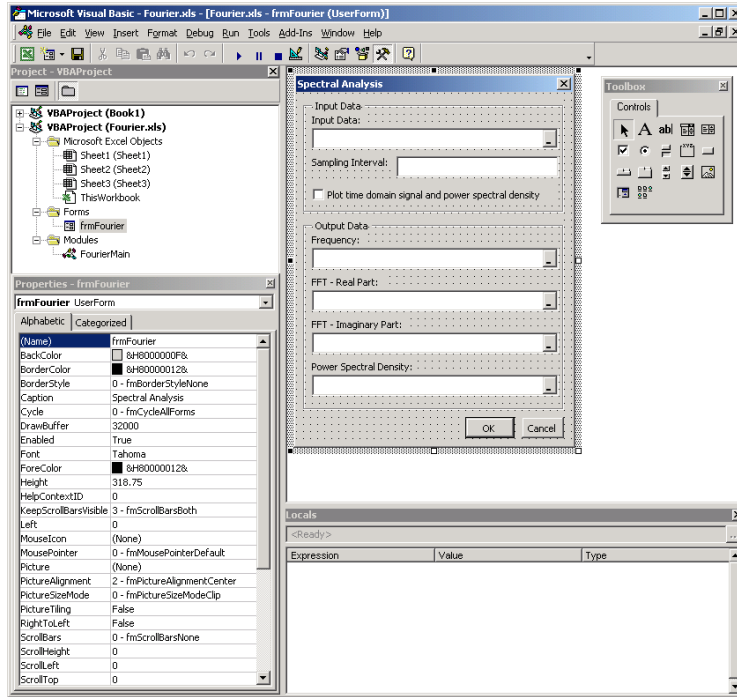
```
    If theFFTDData Is Nothing Then
        Set theFFTDData = New MWComplex
    End If
    bInitialized = True
    Exit Sub
Handle_Error:
    MsgBox (Err.Description)
End Sub
```

Creating the Visual Basic Form

The next step in the integration process develops a user interface for your add-in using the Visual Basic Editor. To create a new user form and populate it with the necessary controls:

- 1 Right-click **VBAProject** in the VBA project window and select **Insert > UserForm**.

A new form appears under **Forms** in the VBA project window.



- 2 In the form's property page, set the Name property to frmFourier and the Caption property to Spectral Analysis.
- 3 Add a series of controls to the blank form to complete the dialog box, as summarized in the following table:

Controls Needed for Spectral Analysis Example

Control Type	Control Name	Properties	Purpose
CheckBox	chkPlot	Caption = Plot time domain signal and power spectral density	Plots input data and power spectral density.

Controls Needed for Spectral Analysis Example (Continued)

Control Type	Control Name	Properties	Purpose
CommandButton	btnOK	Caption = OK Default = True	Executes the function and dismisses the dialog box.
CommandButton	btnCancel	Caption = Cancel Cancel = True	Dismisses the dialog box without executing the function.
Frame	Frame1	Caption = Input Data	Groups all input controls.
Frame	Frame2	Caption = Output Data	Groups all output controls.
Label	Label1	Caption = Input Data:	Labels the RefEdit for input data.
TextBox	edtSample	Not applicable	Not applicable
Label	Label2	Caption = Sampling Interval	Labels the TextBox for sampling interval.
Label	Label3	Caption = Frequency:	Labels the RefEdit for frequency output.
Label	Label4	Caption = FFT - Real Part:	Labels the RefEdit for real part of FFT.
Label	Label5	Caption = FFT - Imaginary Part:	Labels the RefEdit for imaginary part of FFT.

Controls Needed for Spectral Analysis Example (Continued)

Control Type	Control Name	Properties	Purpose
Label	Label6	Caption = Power Spectral Density	Labels the RefEdit for power spectral density.
RefEdit	refedtInput	Not applicable	Selects range for input data.
RefEdit	refedtFreq	Not applicable	Selects output range for frequency points.
RefEdit	refedtReal	Not applicable	Selects output range for real part of FFT of input data.
RefEdit	refedtImag	Not applicable	Selects output range for imaginary part of FFT of input data.
RefEdit	refedtPowSpect	Not applicable	Selects output range for power spectral density of input data.

The following figure shows the controls layout on the form:

- 4** When the form and controls are complete, right-click the form and select **View Code**.

The following code listing shows the code to implement. Notice that this code references the control and variable names listed in Controls Needed for Spectral Analysis Example on page 4-18. If you used different names for any of the controls or any global variable, change this code to reflect those differences.

```

'
'frmFourier Event handlers
'
Private Sub UserForm_Activate()
'UserForm Activate event handler. This function gets called before
'showing the form, and initializes all controls with values stored
'in global variables.
    On Error GoTo Handle_Error
    If theFourier Is Nothing Or theFFTData Is Nothing Then Exit Sub
    'Initialize controls with current state
    If Not InputData Is Nothing Then
        refedInput.Text = InputData.Address
    End If

```

```
    edtSample.Text = Format(Interval)
    If Not Frequency Is Nothing Then
        refedtFreq.Text = Frequency.Address
    End If
    If Not IsEmpty (theFFTDData.Real) Then
    If IsObject(theFFTDData.Real) And TypeOf theFFTDData.Real Is Range Then
        refedtReal.Text = theFFTDData.Real.Address
    End If
    End If
    If Not IsEmpty (theFFTDData.Imag) Then
    If IsObject(theFFTDData.Imag) And TypeOf theFFTDData.Imag Is Range Then
        refedtImag.Text = theFFTDData.Imag.Address
    End If
    End If
    If Not PowerSpect Is Nothing Then
        refedtPowSpect.Text = PowerSpect.Address
    End If
    chkPlot.Value = bPlot
    Exit Sub
Handle_Error:
    MsgBox (Err.Description)
End Sub

Private Sub btnCancel_Click()
'Cancel button click event handler. Exits form without computing fft
'or updating variables.
    Unload Me
End Sub
Private Sub btnOK_Click()
'OK button click event handler. Updates state of all variables from controls
'and executes the computefft or plotfft method.
    Dim R As Range

    If theFourier Is Nothing Or theFFTDData Is Nothing Then GoTo Exit_Form
    On Error Resume Next
    'Process inputs
    Set R = Range(refedtInput.Text)
    If Err <> 0 Then
        MsgBox ("Invalid range entered for Input Data")
    End If
    Exit Sub
```

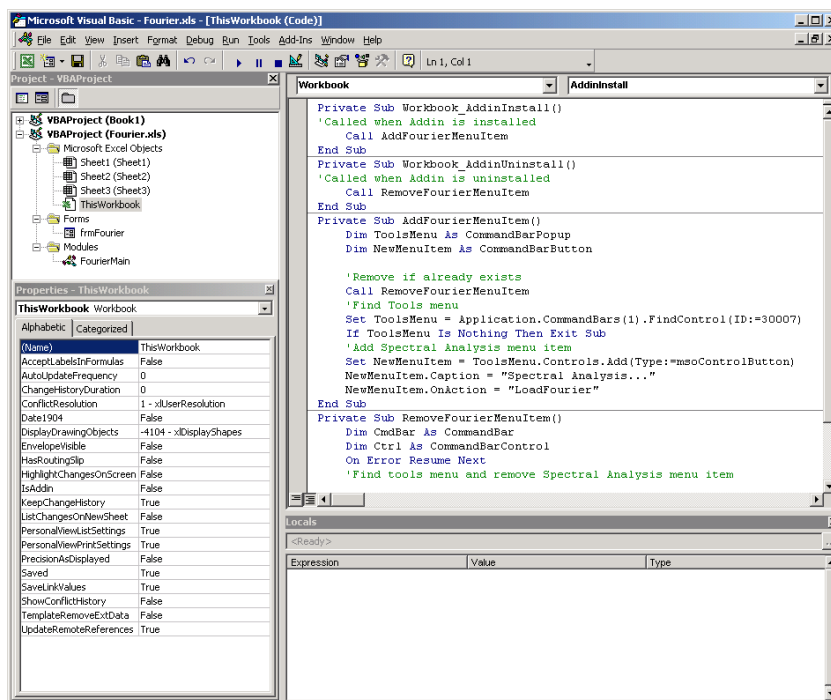
```
End If
Set InputData = R
Interval = CDBl(edtSample.Text)
If Err <> 0 Or Interval <= 0 Then
    MsgBox ("Sampling interval must be greater than zero")
    Exit Sub
End If
'Process Outputs
Set R = Range(refedtFreq.Text)
If Err = 0 Then
    Set Frequency = R
End If
Set R = Range(refedtReal.Text)
If Err = 0 Then
    theFFTData.Real = R
End If
Set R = Range(refedtImag.Text)
If Err = 0 Then
    theFFTData.Imag = R
End If
Set R = Range(refedtPowSpect.Text)
If Err = 0 Then
    Set PowerSpect = R
End If
bPlot = chkPlot.Value
'Compute the fft and optionally plot power spectral density
If bPlot Then
    Call theFourier.plotfft(3, theFFTData, Frequency, PowerSpect, _
        InputData, Interval)
Else
    Call theFourier.computefft(3, theFFTData, Frequency, PowerSpect, _
        InputData, Interval)
End If
GoTo Exit_Form
Handle_Error:
    MsgBox (Err.Description)
Exit_Form:
    Unload Me
End Sub
```

Adding the Spectral Analysis Menu Item to Excel

The last step in the integration process adds a menu item to Excel so that you can open the tool from the Excel **Tools** menu. To do this, add event handlers for the workbook's `AddinInstall` and `AddinUninstall` events that install and uninstall menu items. The menu item calls the `LoadFourier` function in the `FourierMain` module.

To implement the menu item:

- 1 Right-click the **ThisWorkbook** item in the VBA project window and select **View Code**.



- 2 Place the following code into `ThisWorkbook`.

```
Private Sub Workbook_AddinInstall()
    'Called when Addin is installed
    Call AddFourierMenuItem
```

```

End Sub

Private Sub Workbook_AddinUninstall()
'Called when Addin is uninstalled
    Call RemoveFourierMenuItem
End Sub

Private Sub AddFourierMenuItem()
    Dim ToolsMenu As CommandBarPopup
    Dim NewMenuItem As CommandBarButton

    'Remove if already exists
    Call RemoveFourierMenuItem
    'Find Tools menu
    Set ToolsMenu = Application.CommandBars(1).FindControl(ID:=30007)
    If ToolsMenu Is Nothing Then Exit Sub
    'Add Spectral Analysis menu item
    Set NewMenuItem = ToolsMenu.Controls.Add(Type:=msoControlButton)
    NewMenuItem.Caption = "Spectral Analysis..."
    NewMenuItem.OnAction = "LoadFourier"
End Sub

Private Sub RemoveFourierMenuItem()
    Dim CmdBar As CommandBar
    Dim Ctrl As CommandBarButton
    On Error Resume Next
    'Find tools menu and remove Spectral Analysis menu item
    Set CmdBar = Application.CommandBars(1)
    Set Ctrl = CmdBar.FindControl(ID:=30007)
    Call Ctrl.Controls("Spectral Analysis...").Delete
End Sub

```

3 Save the add-in.

Now that the VBA coding is complete, you can save the add-in. Save this file into the <project-folder>\distrib folder that Deployment Tool created when building the project. Here, <project-folder> refers to the project folder that Deployment Tool used to save the Fourier project. Name the add-in Spectral Analysis.

- From the Excel main menu, select **File > Properties**.

- b** When the Workbook Properties dialog box appears, click the **Summary** tab, and enter **Spectral Analysis** as the workbook title.
- c** Click **OK** to save the edits.
- d** From the Excel main menu, select **File > Save As**.
- e** When the Save As dialog box appears, select **Microsoft Excel Add-In (*.xla)** as the file type, and browse to `<project-folder>\distrib`.
- f** Enter `Fourier.xla` as the file name and click **Save** to save the add-in.

Testing the Add-In

Before distributing the add-in, test it with a sample problem.

Spectral analysis is commonly used to find the frequency components of a signal buried in a noisy time domain signal. In this example you will create a data representation of a signal containing two distinct components and add to it a random component. This data along with the output will be stored in columns of an Excel worksheet, and you will plot the time-domain signal along with the power spectral density.

Creating the Test Problem

Follow these steps to create the test problem:

- 1** Start a new session of Excel with a blank workbook.
- 2** From the main menu, select **Tools > Add-Ins**.
- 3** When the Add-Ins dialog box appears, click **Browse**.
- 4** Browse to the `<project-folder>\distrib` folder, select `Fourier.xla`, and click **OK**.

The **Spectral Analysis** add-in appears in the available **Add-Ins** list and is selected.

- 5** Click **OK** to load the add-in.

This add-in installs a menu item under the Excel **Tools** menu. You can display the Spectral Analysis GUI by selecting **Tools > Spectral Analysis**. Before

invoking the add-in, create some data, in this case a signal with components at 15 and 40 Hz. Sample the signal for 10 seconds at a sampling rate of 0.01 s. Put the time points into column A and the signal points into column B.

Creating the Data

To create the data:

- 1 Enter 0 for cell A1 in the current worksheet.
- 2 Click cell A2 and type the formula " $= A1 + 0.01$ ".
- 3 Click and hold the lower-right corner of cell A2 and drag the formula down the column to cell A1001. This procedure fills the range A1:A1001 with the interval 0 to 10 incremented by 0.01.
- 4 Click cell B1 and type the following formula

```
"= SIN(2*PI()*15*A1) + SIN(2*PI()*40*A1) + RAND()"
```

Repeat the drag procedure to copy this formula to all cells in the range B1:B1001.

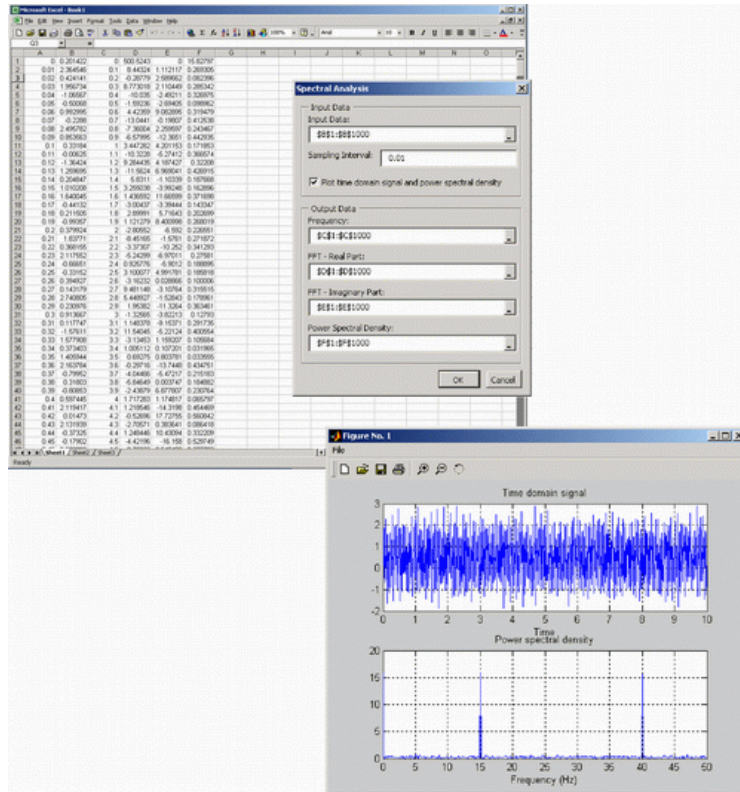
Running the Test

Using the column of data (column B), test the add-in as follows:

- 1 Select **Tools > Spectral Analysis** from the main menu.
- 2 Click the **Input Data** box.
- 3 Select the B1:B1001 range from the worksheet, or type this address into the **Input Data** field.
- 4 In the **Sampling Interval** field, type 0.01.
- 5 Select **Plot time domain signal and power spectral density**.
- 6 Enter C1:C1001 for frequency output, and likewise enter D1:D1001, E1:E1001, and F1:F1001 for the FFT real and imaginary parts, and spectral density.

7 Click **OK** to run the analysis.

The next figure shows the output.



The power spectral density reveals the two signals at 15 and 40 Hz.

Packaging and Distributing the Add-In


As a final step, package the add-in, the COM component, and all supporting libraries into a self-extracting executable. This package can be installed onto other computers that need to use the Spectral Analysis add-in.

- 1 On the **Package** tab, add the MATLAB Compiler Runtime (MCR). To do so, click **Add MCR**, and choose one of the two options described in the following table.

Option	What Does This Option Do?	When Should I Use This Option?
<p>Embed the MCR in the package</p>	<p>This option physically copies the MCR Installer file into the package you create.</p>	<ul style="list-style-type: none"> • You have a limited number of end users who deploy a small number of applications at sporadic intervals • Your users have no intranet/network access • Resources such as disk space, performance, and processing time are not significant concerns <hr/> <p>Note Distributing the MCR Installer with each application requires more resources.</p> <hr/>
<p>Invoke the MCR from a network location</p>	<p>This option lets you add a link to an MCR Installer residing on a local area network, allowing you to invoke the installer over the network, as opposed to copying the installer physically into the deployable package. This option sets up a script to install the MCR from a specified network location, saving time and resources when deploying applications.</p>	<ul style="list-style-type: none"> • You have a large number of end users who deploy applications frequently • Your users have intranet/network access • Resources such as disk space, performance, and processing time are significant concerns for your organization <p>If you choose this option, modify the location of the MCR</p>

Option	What Does This Option Do?	When Should I Use This Option?
		<p>Installer, if needed. To do so, select the Preferences link in this dialog box, or change the Compiler option in your MATLAB Preferences.</p> <hr/> <p>Caution Before selecting this option, consult with your network or systems administrator. Your administrator may already have selected a network location from which to run the MCR Installer.</p> <hr/>

For more information about the role the MCR plays in the deployment process, see “Install Your Application on Target Computers Without MATLAB Using the MATLAB Compiler Runtime (MCR)” on page 1-21.

- 2** Next, add others files you feel may be useful to end users. To package additional files or folders, click **Add file/directories**, select the file or folder you want to package, and click **Open**.
- 3** In the Deployment Tool, click the Packaging button (.
- 4** For Windows, the package is a self-extracting executable. On platforms other than Windows, the package is delivered as a .zip file. Verify that the contents of the `distrib` folder contains the files you specified.

Note When the self-extracting executable is uncompressed on a system, `VCREDSIT_X86` is installed. `VCREDSIT_X86` installs run-time components of Microsoft Visual C++ libraries necessary for running Visual C++ applications.

Installing the Add-In

To install this add-in onto another computer, copy the `Fourier_pkg.exe` package to that machine, run it from a command prompt, and follow the instructions in the `readme.txt` file that is automatically generated with your packaged output.

Function Wizard

- “Overview” on page 5-2
- “Installing a Microsoft® Excel Add-In” on page 5-3
- “Starting the Function Wizard” on page 5-5
- “Executing Functions” on page 5-6
- “Editing Argument Properties” on page 5-10
- “Using Function Utilities” on page 5-12

Overview

The Function Wizard enables you to pass Microsoft Excel (Excel 2000 or later) worksheet values to a compiled MATLAB model and then return model output to a cell or range of cells in the worksheet.

The Function Wizard provides an intuitive interface to Excel worksheets. You do not need previous knowledge of Microsoft Visual Basic for Applications (VBA) programming.

The Function Wizard reflects any changes that you make in the worksheets, such as range selections. You also use the Function Wizard to control the placement and output of data from MATLAB functions to the worksheets.

The Function Wizard does not currently support the MATLAB `struct`, `sparse`, and `complex` data types.

Installing a Microsoft Excel Add-In

In this section...

“Overview” on page 5-3

“Installing with Versions of Microsoft Office Prior to 2007” on page 5-3

“Installing with Microsoft Office 2007” on page 5-3

“Installing with Microsoft Office 2010” on page 5-4

Overview

The Function Wizard GUI resides in a Microsoft Excel add-in (`mfunction.xla`) located in the `matlabroot\toolbox\matlabxl\matlabxl` folder. You must install this add-in before using the Function Wizard.

To install the add-in:

The Function Wizard is not packaged by default with deployed components. To distribute the wizard, place `mfunction.xla` in the top-level folder of the installed component.

Installing with Versions of Microsoft Office Prior to 2007

- 1 Select **Tools > Add-Ins** from the Excel main menu.
- 2 If the Function Wizard was previously installed, **MATLAB Function Wizard** appears in the list. Select the item, and click **OK**.

If the Function Wizard was not previously installed, click **Browse** and proceed to the `matlabroot\toolbox\matlabxl\matlabxl` folder. Select `mfunction.xla`. Click **OK** to proceed.

Installing with Microsoft Office 2007

- 1 Click the Microsoft Office button  .

- 2 Select **Excel Options**.
- 3 Select **Add-ins**. Under **Manage**, select **Excel Add-ins**, and click **Go**.
- 4 Browse to `matlabroot/toolbox/matlabxl/matlabxl`, and select the **MATLAB Function Wizard**. To do so, choose `mlfunction.xla`.

Note The add-in may appear as **mlfunction** if it has previously been installed.

Installing with Microsoft Office 2010

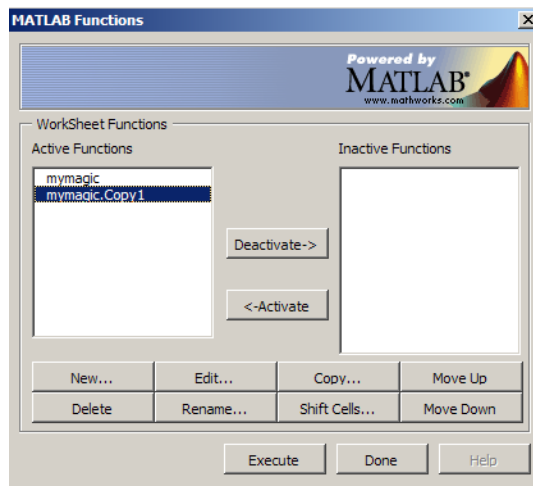
- 1 Click the **File** tab.
- 2 On the left navigation pane, select **Options**.
- 3 In the Excel Options dialog box, on the left navigation pane, select **Add-Ins**.
- 4 In the Manage drop-down, select **Excel Add-Ins**, and click **Go**.
- 5 In the Add-Ins dialog, click **Browse**.
- 6 Browse to `matlabroot/toolbox/matlabxl/matlabxl/arch`, and select the **MATLAB Function Wizard**. To do so, choose `mlfunction.xla` and click **OK**.

Note The add-in may appear as **mlfunction** if it has previously been installed.

- 7 In the Add-Ins dialog box, verify that the **MATLAB Function Wizard** is selected, and click **OK**.

Starting the Function Wizard

- 1 Start the Function Wizard in one of the following ways depending on what version of Microsoft Office® you have installed.
 - For versions of Microsoft Office prior to 2007, click **Tools > MATLAB Functions** from the Excel menu bar.
 - For versions of Microsoft Office 2007 or later, select **Add-Ins**, and then select **MATLAB Functions**.
- 2 On the toolbar, The starting point of the Function Wizard, called the Function Viewer, opens.



“Executing Functions” on page 5-6 explains more about the Function Viewer and how to use its features.

Executing Functions

In this section...
“Overview” on page 5-6
“Managing Functions with the Function Viewer” on page 5-6
“Executing Functions” on page 5-7

Overview

The Function Viewer controls the execution of worksheet functions. Use the Function Viewer to organize the list of all currently loaded MATLAB Builder EX functions.

Managing Functions with the Function Viewer

The Function Viewer displays the names of all loaded functions and provides a number of actions for managing them, represented by the buttons **New**, **Edit**, **Copy**, and so on. To invoke the selected action on a function, select the function name, and click the action you want to perform.

For more information about basic various function utilities such as **Rename**, **Move**, and **Copy**, see “Using Function Utilities” on page 5-12.

Adding a New Component

To add a new component to the list of loaded worksheet functions, click **New**.

Editing Function Properties

You can, for example specify that function arguments are either required or variable (varargin/varargout) arguments.

To edit properties of a function, click **Edit**. See “Executing Functions” on page 5-6 and “Editing Argument Properties” on page 5-10 for more information.

Activating and Deactivating Functions

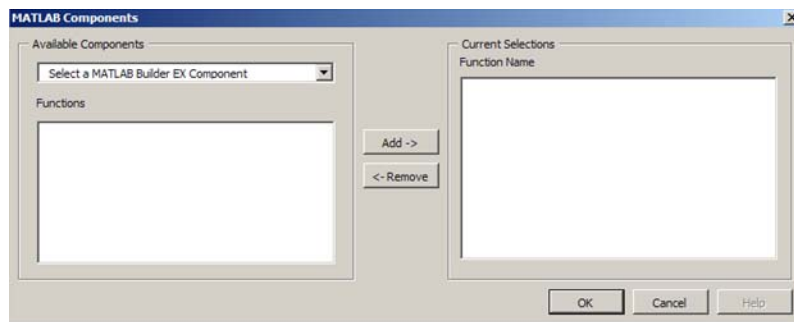
The function viewer interface includes panes for both **Active Function** and **Inactive Functions**. Change the status of a function to either Active or

Inactive by selecting the function name and moving it to the appropriate pane with the **Deactivate->** or **<-Activate** buttons. Changing the status of a function to inactive prevents a function from executing when you click **Execute**.

Executing Functions

To load and execute a MATLAB Builder EX function in your worksheet, perform these steps:

- 1 Load a MATLAB Builder EX component.



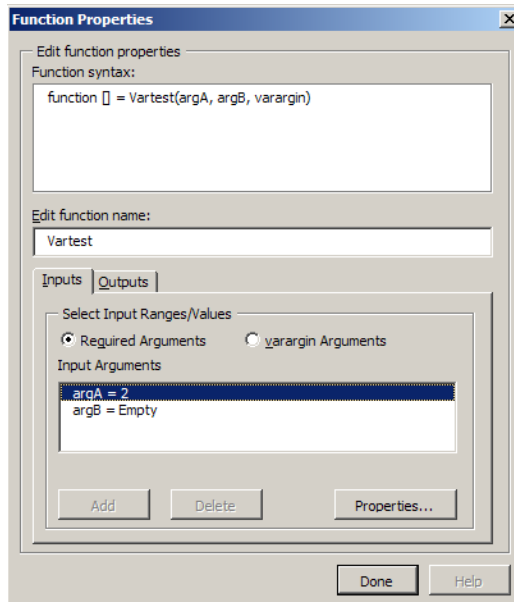
- a Click **New** on the Function Viewer to display the MATLAB Components Browser.
- b From the drop-down in the **Available Components** area, select the component you want to load from the list of all installed components. The browser displays a list of available functions registered to that component.
- c The MATLAB Component Browser lists each component by name and version. Expanding a component reveals the class name at the next level. You can also expand the class to reveal the MATLAB functions that make up the class methods.

Select the desired method, and click **Add** to add a function. To load all methods of a class, select the class name and click **Add**. Added functions appear in the **Current Selections** area on the right side of the browser.

To remove a function before returning to the Function Viewer, select that function under **Current Selections**, and click **Remove**.

- d** When you are finished, click **OK** to close the dialog box and return to the Function Viewer.
- 2** Set various properties of your function with the Function Properties dialog box.

Click **Edit** on the Function Viewer. The Function Properties dialog box appears, as shown.



Use this dialog box as follows:

- a** Click the appropriate tab to edit either **Inputs** or **Outputs**.
- b** Select arguments in the **Input Arguments** area. The **Add** and **Delete** buttons become active enabling you to add or delete arguments.
- c** To edit required arguments, select the argument from the list, and click **Properties**.

- Required arguments appear first on the left or right sides of a MATLAB function and are not named `varargin` or `varargout`.
- `varargin`/`varargout` arguments always appear as the last input or output. They let you specify a variable number of arguments.
- Before you can edit `varargin`/`varargout` arguments, you must first explicitly add them using **Add**.

Note If the MATLAB function does not have `varargin`/`varargout` arguments, the capability to add arguments to the list is disabled.

After you have added `varargin`/`varargout` arguments, you can edit them in the same way as required arguments.

- For more detailed about editing argument properties, see “Editing Argument Properties” on page 5-10
- d** When you are finished changing function properties, click **Done** to close the dialog box.
- 3** Click **Execute** on the Function Viewer. Functions execute in the order displayed in the list.

Editing Argument Properties

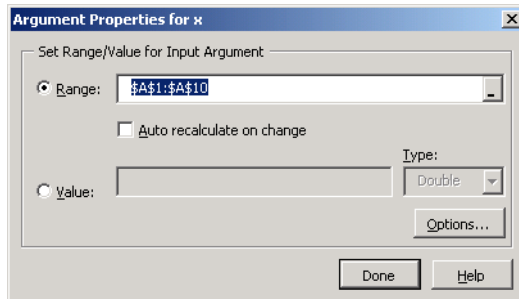
In this section...

“Input Argument Properties Dialog Box” on page 5-10

“Output Argument Properties Dialog Box” on page 5-11

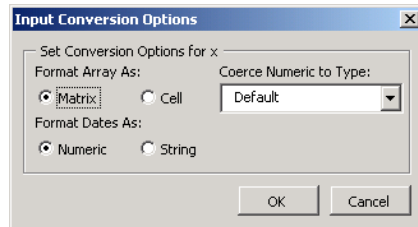
Input Argument Properties Dialog Box

This example shows the Argument Properties dialog box for input arguments. In this example, the input arguments have a range of A1 to A10.



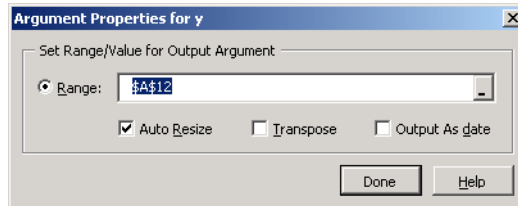
From this dialog box you can:

- Select the **Range** list to specify a range of current input arguments.
- Click **Auto recalculate on change** to tell MATLAB to recalculate the current function when any cell in the current argument changes.
- Select the **Value** list to set a single value for the current argument. Then, select the type from the **Type** list.
- Click **Options** to set the conversion options. Then, set the options in the Input Conversion Options dialog box as shown:



Output Argument Properties Dialog Box

This example shows the Argument Properties dialog box for output arguments. In this example, the output argument is A12.



From this dialog box you can:

- From the **Range** list, select the worksheet range to be used as the output argument.
- Select **Auto resize** to tell MATLAB to adjust the output range to fit the output array. You can use this setting when the target output from a method call is a range of cells in an Excel worksheet and the output array size and shape is not known at the time of the call.
- Select **Transpose output** to transpose the output arguments. You can use this setting when calling a component where the MATLAB function returns outputs as row vectors, and you want the data in columns.
- Select **Output as date** to force the output values to become Excel dates.

Using Function Utilities

In this section...

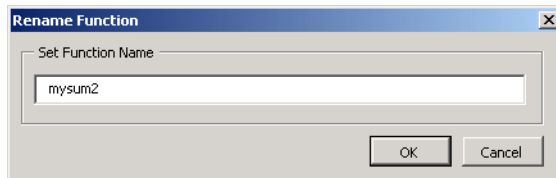
“Rename Function Dialog Box” on page 5-12

“Copy Function Dialog Box” on page 5-12

“Move Function Dialog Box” on page 5-13

Rename Function Dialog Box

Use the Rename Function dialog box to rename a function. To open this dialog box, click **Rename** on the Function Viewer. This example shows the dialog box, with `mysum2` as the new function name.



In this dialog box, you can:

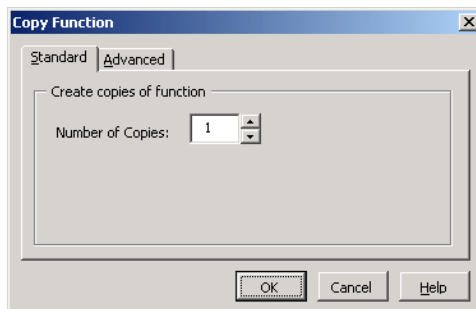
- Enter a new name for the selected function.
- Click **OK** to save the new name and return to the Function Viewer.
- Click **Cancel** to return to the Function Viewer without saving the new name.

Copy Function Dialog Box

Use the Copy Function dialog box to make copies of the current function. To open this dialog box, click **Copy** on the Function Viewer.

The Copy Function dialog box has two tabs:

- The **Standard** tab creates a specified number of copies of the function while copying any argument/range values you have set. This illustration shows the dialog box, with the number of copies, set to 1:

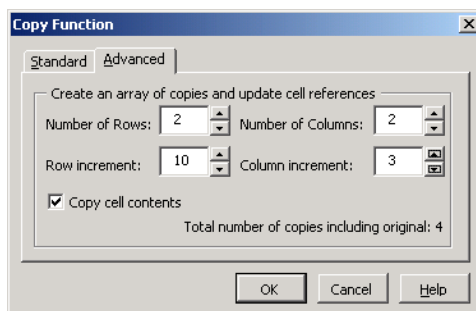


- The **Advanced** tab creates a rectangular array of copies of the current function in the current worksheet, and optionally copies the cell contents of ranges referenced by the function's arguments.

When you set the number of rows and columns and the row or column increments, the copy process automatically updates cell references by the specified increment amounts.

- Positive increments move rows down and columns to the right.
- Negative increments move rows up and columns to the left.

The following example shows the **Advanced** tab.



Move Function Dialog Box

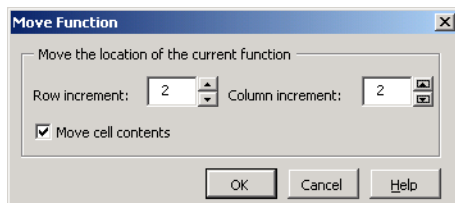
Use the Move Function dialog box to move the currently selected function to a new position in the current worksheet.

When you set the row and column increments, the move process automatically updates cell references by these values.

- Positive increments move rows down and columns to the right.
- Negative increments move rows up and columns to the left.

You can also optionally move the cell contents of any ranges referenced by the function.

This illustration shows the Move Function dialog box, set to move the location by two rows and two columns, and to move the cell contents.



Function Reference

componentinfo

Purpose Query system registry about component created with MATLAB Builder EX

Syntax

```
info = componentinfo
info = componentinfo(component_name)
info = componentinfo(component_name, major_revision_number)
info = componentinfo(component_name, major_revision_number,
    minor_revision_number)
```

Arguments	<i>component_name</i>	The MATLAB string providing the name of a MATLAB Builder EX component. Names are case sensitive. If this argument is not supplied, the function returns information on all installed components.
	<i>major_revision_number</i>	Component major revision number. If this argument is not supplied, the function returns information on all major revisions.
	<i>minor_revision_number</i>	Component minor revision number. Default value is 0.

Description

`info = componentinfo` returns information for all components installed on the system.

`info = componentinfo(component_name)` returns information for all revisions of *component_name*.

`info = componentinfo(component_name, major_revision_number)` returns information for the most recent minor revision corresponding to *major_revision_number* of *component_name*.

`info = componentinfo(component_name, major_revision_number, minor_revision_number)` returns information for the specific major and minor version of *component_name*.

The return value is an array of structures representing all the registry and type information needed to load and use the component.

When you supply a component name, *major_revision_number* and *minor_revision_number* are interpreted as shown below.

Value	Information Returned
> 0	Information on a specific major and minor revision
0	Information on the most recent revision. When omitted, <i>minor_revision_number</i> is assumed to be equal to 0.
< 0	Information on all versions

Note Although properties and events may appear in the output for `componentinfo`, they are not supported by builder components.

Registry Information

The information about a component has the fields shown in the following table.

Registry Information Returned by `componentinfo`

Field	Description
Name	Component name.
TypeLib	Component type library.
LIBID	Component type library GUID.
MajorRev	Major version number .
MinorRev	Minor version number.

componentinfo

Registry Information Returned by componentinfo (Continued)

Field	Description
FileName	Type library file name and path. Since all the MATLAB Builder EX components have the type library bound into the DLL, this file name is the same as the DLL name and path.
Interfaces	An array of structures defining all interface definitions in the type library. Each structure contains two fields: <ul style="list-style-type: none">• Name - Interface name.• IID - Interface GUID.

Registry Information Returned by componentinfo (Continued)

CoClasses	<p>An array of structures defining all COM classes in the component. Each structure contains these fields:</p> <ul style="list-style-type: none"> • Name - Class name. • CLSID - GUID of the class. • ProgID - Version-dependent program ID. • VerIndProgID - Version-independent program ID. • InprocServer32 - Full name and path to component DLL. • Methods - A structure containing function prototypes of all class methods defined for this interface. This structure contains four fields: <ul style="list-style-type: none"> ▪ IDL - An array of Interface Description Language function prototypes. ▪ M - An array of MATLAB function prototypes. ▪ C - An array of C-language function prototypes. ▪ VB - An array of VBA function prototypes. • Properties - A cell array containing the names of all class properties. • Events - A structure containing function prototypes of all events defined for this class. This structure contains four fields:
-----------	---

componentinfo

Registry Information Returned by componentinfo (Continued) (Continued)

	<ul style="list-style-type: none">▪ IDL - An array of Interface Description Language function prototypes.▪ M - An array of MATLAB function prototypes.▪ C - An array of C-language function prototypes.▪ VB - An array of VBA function prototypes.
--	---

Examples

Function Call	Returns
<code>Info = componentinfo</code>	Information for all installed components.
<code>Info = componentinfo('mycomponent')</code>	Information for all revisions of mycomponent.
<code>Info = componentinfo('mycomponent',1,0)</code>	Information for revision 1.0 of mycomponent.

Purpose Open GUI for MATLAB Builder EX and MATLAB Compiler

Syntax `deploytool`

Description The `deploytool` command displays the Deployment Tool dialog box, which is the graphical user interface (GUI) for MATLAB Builder EX and MATLAB Compiler.

See Chapter 1, “Getting Started” for more information about using the Deployment Tool to create COM components, and see “Getting Started” in the MATLAB Compiler documentation for information about using the Deployment Tool to create standalone applications and libraries.

Desired Results	Command
Start Deployment Tool GUI with the New/Open dialog box active	<code>deploytool</code> (default) or <code>deploytool -n</code>
Start Deployment Tool GUI and load <i>project_name</i>	<code>deploytool project_name.prj</code>
Start Deployment Tool command line interface and build <i>project_name</i> after initializing	<code>deploytool -win32 -build project_name.prj</code>
Start Deployment Tool command line interface and package <i>project_name</i> after initializing	<code>deploytool -package project_name.prj</code>
Display MATLAB Help for the <code>deploytool</code> command	<code>deploytool -?</code>

-win32 Run in 32-Bit Mode

Use this option to build a 32-bit application on a 64-bit system *only* when the following are both true:

- You use the same MATLAB installation root (*install_root*) for both 32-bit and 64-bit versions of MATLAB.

- You are running from a Windows command line (not a MATLAB command line).

See Also

“Product Overview” on page 1-2

Chapter 3, “Programming with MATLAB® Builder EX ”

Purpose Invoke MATLAB Compiler

Syntax

```
mcc -win32 -W 'excel:component_name,class_name,major.minor'
[-b] [-T link:lib file1..[filen]]
[-d output_dir_path]
```

```
mcc -B 'cexcel:component_name,class_name,major.minor'
[-d output_dir_path]
```

Description `mcc` is the MATLAB command that invokes MATLAB Compiler. You can issue the `mcc` command either from the MATLAB command prompt (MATLAB mode) or the DOS or UNIX command line (standalone mode).

Options The `-W` option is used when running `mcc` with the builder.

Note For a complete list of all `mcc` command options, see `mcc` in the MATLAB Compiler User's Guide documentation.

`-W`

Tells the compiler to create an Excel wrapper. This option takes a string argument that specifies the following characteristics of the component.

-W String Elements	Description
<code>excel:</code>	Keyword that tells the compiler the type of component to create, followed by a colon. Specify <code>excel</code> to create an Excel component.
<code>component_name</code>	Specifies the name of the component to be created.
<code>class_name</code>	Specifies the name of the class to be created. If you do not specify the class name, <code>mcc</code> uses the component name as the default.

-W String Elements	Description
<i>major</i>	Specifies the major version number (for example, 1 in 1.0). If you do not specify a version number, <code>mcc</code> uses the latest version built or 1.0, if there is no previous version.
<i>minor</i>	Specifies the minor version number (for example, 0 in 1.0). If you do not specify a version number, <code>mcc</code> uses the latest version built or 1.0, if there is no previous version.

`[-d output_dir_path]`

(Optional) Tells the builder to create a folder and copy the output files to it. If you use `mcc` instead of the Deployment Tool, the `project_folder\src` and `project_folder\distrib` folders are not automatically created.

`[-T link:lib file1..[filen]]`

(Optional) Tells the compiler to create a DLL. Specify the keyword `link:lib`, which links objects into a shared library (DLL).

`[-b]`

(Optional) Generates an Excel compatible formula function for each MATLAB file.

`-B`

Tells the compiler to use the `cexcel` bundle file option to simplify command line entry. By using this alternative to the `-W` option, the `-T` or the `-b` options do not need to be specified.

-B String Elements	Description
<code>cexcel:</code>	Keyword that tells the compiler to create an Excel component using the bundle file option.
<i>component_name</i>	Specifies the name of the component to be created.
<i>class_name</i>	Specifies the name of the class to be created. If you do not specify the class name, <code>mcc</code> uses the component name as the default.

-B String Elements	Description
<i>major</i>	Specifies the major version number (for example, 1 in 1.0). If you do not specify a version number, mcc uses the latest version built or 1.0, if there is no previous version.
<i>minor</i>	Specifies the minor version number (for example, 0 in 1.0). If you do not specify a version number, mcc uses the latest version built or 1.0, if there is no previous version.

`[-d output_dir_path]`
 (Optional) Tells the builder to create a folder and copy the output files to it. If you use `mcc` instead of the Deployment Tool, the `project_folder\src` and `project_folder\distrib` folders are not automatically created.

-win32 Run in 32-Bit Mode

Use this option to build a 32-bit application on a 64-bit system *only* when the following are both true:

- You use the same MATLAB installation root (*install_root*) for both 32-bit and 64-bit versions of MATLAB.
- You are running from a Windows command line (not a MATLAB command line).

Examples

Using -W to Create an Excel Component

```
mcc -W 'excel:mycomponent,myclass,1.0' -T link:lib
      foo.m bar.m
```

This example shows the `mcc` command used to create a COM component called `mycomponent` containing single COM class named `myclass` with methods `foo` and `bar`, and a version of 1.0 (note both major and minor versions are coded). The `-T` option tells `mcc` to create a DLL.

Using -b to Create a Function for Each MATLAB File

```
mcc -W 'excel:mycomponent,myclass,1.0' -b -T link:lib
```

```
foo.m bar.m
```

To generate an Excel compatible formula function for each MATLAB file, specify the `-b` option.

Using `-B` to Simplify Command Input

```
mcc -B 'cexcel:mycomponent,myclass,1.0' foo.m bar.m
```

As an alternative to using the `excel` keyword, use the `cexcel` bundle file option to simplify command line input. In the example, note how you do not need to specify the `-T` or the `-b` options when using `-B`.

Utility Library for Microsoft COM Components

- “Referencing Utility Classes” on page 7-2
- “Utility Library Classes” on page 7-3
- “Enumerations” on page 7-31

Referencing Utility Classes

This section describes the `MWComUtil` library. This library is freely distributable and includes several functions used in array processing, as well as type definitions used in data conversion. This library is contained in the file `mwcomutil.dll`. It must be registered once on each machine that uses Microsoft COM components created by MATLAB Builder EX.

Register the `MWComUtil` library at the DOS command prompt with the command:

```
mwregsvr mwcomutil.dll
```

The `MWComUtil` library includes seven classes (see “Utility Library Classes” on page 7-3) and three enumerated types (see “Enumerations” on page 7-31). Before using these types, you must make explicit references to the `MWComUtil` type libraries in the Microsoft Visual Basic IDE. To do this select **Tools > References** from the main menu of the Visual Basic Editor. The References dialog box appears with a scrollable list of available type libraries. From this list, select **MWComUtil 1.0 Type Library** and click **OK**.

Note You must specify the full path of the component when calling `mwregsvr`, or make the call from the folder in which the component resides.

Utility Library Classes

In this section...

“Class MWUtil” on page 7-3

“Class MWFlags” on page 7-10

“Class MWStruct” on page 7-16

“Class MWField” on page 7-23

“Class MWComplex” on page 7-24

“Class MWSparse” on page 7-26

“Class MWArg” on page 7-29

Class MWUtil

The MWUtil class contains a set of static utility methods used in array processing and application initialization. This class is implemented internally as a singleton (only one global instance of this class per instance of Microsoft Excel). It is most efficient to declare one variable of this type in global scope within each module that uses it. The methods of MWUtil are:

- “Sub MWInitApplication(pApp As Object)” on page 7-3
- “Sub MWPack(pVarArg, [Var0], [Var1], ... ,[Var31])” on page 7-5
- “Sub MWUnpack(VarArg, [nStartAt As Long], [bAutoSize As Boolean = False], [pVar0], [pVar1], ..., [pVar31])” on page 7-7
- “Sub MWDate2VariantDate(pVar)” on page 7-9

The function prototypes use Visual Basic syntax.

Sub MWInitApplication(pApp As Object)

Initializes the library with the current instance of Microsoft Excel.

Parameters.

Argument	Type	Description
pApp	Object	A valid reference to the current Excel application

Return Value. None.

Remarks. This function must be called once for each session of Excel that uses COM components created by MATLAB Builder for .NET. An error is generated if a method call is made to a member class of any MATLAB Builder for .NET COM component, and the library has not been initialized.

Example. This Visual Basic sample initializes the MWComUtil library with the current instance of Excel. A global variable of type Object named MCLUtil holds an instance of the MWUtil class, and another global variable of type Boolean named bModuleInitialized stores the status of the initialization process. The private subroutine InitModule() creates an instance of the MWComUtil class and calls the MWInitApplication method with an argument of Application. Once this function succeeds, all subsequent calls exit without recreating the object.

```

Dim MCLUtil As Object
Dim bModuleInitialized As Boolean

Private Sub InitModule()
    If Not bModuleInitialized Then
        On Error GoTo Handle_Error
        If MCLUtil Is Nothing Then
            Set MCLUtil = CreateObject("MWComUtil.MWUtil")
        End If
        Call MCLUtil.MWInitApplication(Application)
        bModuleInitialized = True
    Exit Sub
Handle_Error:
    bModuleInitialized = False
    End If
End Sub

```

Note If you are developing concurrently with multiple versions of MATLAB and MWComUtil.dll, for example, using this syntax:

```
Set MCLUtil = CreateObject("MWComUtil.MWUtil")
```

requires you to recompile your COM modules every time you upgrade. To avoid this, make your call to the MWUtil module version-specific, for example:

```
Set MCLUtil = CreateObject("MWComUtil.MWUtilx.x")
```

where *x.x* is the specific version number.

Sub MWPack(pVarArg, [Var0], [Var1], ... ,[Var31])

Packs a variable length list of Variant arguments into a single Variant array. This function is typically used for creating a varargin cell from a list of separate inputs. Each input in the list is added to the array only if it is nonempty and nonmissing. (In Visual Basic, a missing parameter is denoted by a Variant type of vbError with a value of &H80020004.)

Parameters.

Argument	Type	Description
pVarArg	Variant	Receives the resulting array
[Var0], [Var1], ...	Variant	Optional list of Variants to pack into the array. From 0 to 32 arguments can be passed.

Return Value. None.

Remarks. This function always frees the contents of pVarArg before processing the list.

Example. This example uses `MWPack` in a formula function to produce a `varargin` cell to pass as an input parameter to a method compiled from a MATLAB function with the signature

```
function y = mysum(varargin)
    y = sum([varargin{:}]);
```

The function returns the sum of the elements in `varargin`. Assume that this function is a method of a class named `myclass` that is included in a component named `mycomponent` with a version of 1.0. The Visual Basic function allows up to 10 inputs, and returns the result `y`. If an error occurs, the function returns the error string. This function assumes that `MWInitApplication` has been previously called.

```
Function mysum(Optional V0 As Variant, _
               Optional V1 As Variant, _
               Optional V2 As Variant, _
               Optional V3 As Variant, _
               Optional V4 As Variant, _
               Optional V5 As Variant, _
               Optional V6 As Variant, _
               Optional V7 As Variant, _
               Optional V8 As Variant, _
               Optional V9 As Variant) As Variant
    Dim y As Variant
    Dim varargin As Variant
    Dim aClass As Object
    Dim aUtil As Object

    On Error Goto Handle_Error
    Set aClass = CreateObject("mycomponent.myclass.1_0")
    Set aUtil = CreateObject("MWComUtil.MWUtil")
    Call aUtil.MWPack(varargin,V0,V1,V2,V3,V4,V5,V6,V7,V8,V9)
    Call aClass.mysum(1, y, varargin)
    mysum = y
    Exit Function
Handle_Error:
    mysum = Err.Description
End Function
```

Sub MWUnpack(VarArg, [nStartAt As Long], [bAutoSize As Boolean = False], [pVar0], [pVar1], ..., [pVar31])

Unpacks an array of Variants into individual Variant arguments. This function provides the reverse functionality of MWPack and is typically used to process a varargout cell into individual Variants.

Parameters.

Argument	Type	Description
VarArg	Variant	Input array of Variants to be processed
nStartAt	Long	Optional starting index (zero-based) in the array to begin processing. Default = 0.
bAutoSize	Boolean	Optional auto-resize flag. If this flag is True, any Excel range output arguments are resized to fit the dimensions of the Variant to be copied. The resizing process is applied relative to the upper left corner of the supplied range. Default = False.
[pVar0], [pVar1], ...	Variant	Optional list of Variants to receive the array items contained in VarArg. From 0 to 32 arguments can be passed.

Return Value. None.

Remarks. This function can process a Variant array in one single call or through multiple calls using the nStartAt parameter.

Example. This example uses MWUnpack to process a varargout cell into several Excel ranges, while auto-resizing each range. The varargout parameter is supplied from a method that has been compiled from the MATLAB function.

```
function varargout = randvectors
    for i=1:nargout
        varargout{i} = rand(i,1);
    end
```

This function produces a sequence of nargout random column vectors, with the length of the ith vector equal to i. Assume that this function is included in a class named myclass that is included in a component named mycomponent with a version of 1.0. The Visual Basic subroutine takes no arguments and places the results into Excel columns starting at A1, B1, C1, and D1. If an error occurs, a message box displays the error text. This function assumes that MWInitApplication has been previously called.

```
Sub GenVectors()
    Dim aClass As Object
    Dim aUtil As Object
    Dim v As Variant
    Dim R1 As Range
    Dim R2 As Range
    Dim R3 As Range
    Dim R4 As Range

    On Error GoTo Handle_Error
    Set aClass = CreateObject("mycomponent.myclass.1_0")
    Set aUtil = CreateObject("MWComUtil.MWUtil")
    Set R1 = Range("A1")
    Set R2 = Range("B1")
    Set R3 = Range("C1")
    Set R4 = Range("D1")
    Call aClass.randvectors(4, v)
    Call aUtil.MWUnpack(v,0,True,R1,R2,R3,R4)
    Exit Sub
```



```

Handle_Error:
    MsgBox (Err.Description)
End Sub

```

Sub MWDate2VariantDate(pVar)

Converts output dates from MATLAB to Variant dates.

Parameters.

Argument	Type	Description
pVar	Variant	Variant to be converted

Return Value. None.

Remarks. MATLAB handles dates as double-precision floating-point numbers with 0.0 representing 0/0/00 00:00:00. By default, numeric dates that are output parameters from compiled MATLAB functions are passed as Doubles that need to be decremented by the COM date bias as well as coerced to COM dates. The MWDate2VariantDate method performs this transformation and additionally converts dates in string form to COM date types.

Example. This example uses MWDate2VariantDate to process numeric dates returned from a method compiled from the following MATLAB function.

```

function x = getdates(n, inc)
    y = now;
    for i=1:n
        x(i,1) = y + (i-1)*inc;
    end

```

This function produces an n-length column vector of numeric values representing dates starting from the current date and time with each element incremented by inc days. Assume that this function is included in a class named myclass that is included in a component named mycomponent with a version of 1.0. The subroutine takes an Excel range and a Double as inputs and places the generated dates into the supplied range. If an error

occurs, a message box displays the error text. This function assumes that `MWInitApplication` has been previously called.

```
Sub GenDates(R As Range, inc As Double)
    Dim aClass As Object
    Dim aUtil As Object

    On Error GoTo Handle_Error
    Set aClass = CreateObject("mycomponent.myclass.1_0")
    Set aUtil = CreateObject("MWComUtil.MWUtil")
    Call aClass.getdates(1, R, R.Rows.Count, inc)
    Call aUtil.MWDate2VariantDate(R)
    Exit Sub
Handle_Error:
    MsgBox (Err.Description)
End Sub
```

Class MWFlags

The `MWFlags` class contains a set of array formatting and data conversion flags (See “Data Conversion Rules” for more information on conversion between MATLAB and COM Automation types.) All MATLAB Builder for .NET COM components contain a reference to an `MWFlags` object that can modify data conversion rules at the object level. This class contains these properties and method:

- “Property `ArrayFormatFlags As MWArrayFormatFlags`” on page 7-10
- “Property `DataConversionFlags As MWDataConversionFlags`” on page 7-13
- “Sub `Clone(ppFlags As MWFlags)`” on page 7-15

Property `ArrayFormatFlags As MWArrayFormatFlags`

The `ArrayFormatFlags` property controls array formatting (as a matrix or a cell array) and the application of these rules to nested arrays. The `MWArrayFormatFlags` class is a noncreatable class accessed through an `MWFlags` class instance. This class contains six properties:

- “Property `InputArrayFormat As mwArrayFormat`” on page 7-11
- “Property `InputArrayIndFlag As Long`” on page 7-12

- “Property OutputArrayFormat As mwArrayFormat” on page 7-12
- “Property OutputArrayIndFlag As Long” on page 7-13
- “Property AutoResizeOutput As Boolean” on page 7-13
- “Property TransposeOutput As Boolean” on page 7-13

Property InputArrayFormat As mwArrayFormat. This property of type `mwArrayFormat` controls the formatting of arrays passed as input parameters to .NET Builder class methods. The default value is `mwArrayFormatMatrix`. The behaviors indicated by this flag are listed in the next table.

Array Formatting Rules for Input Arrays

Value	Behavior
<code>mwArrayFormatAsIs</code>	Converts arrays according to the default conversion rules listed in “Data Conversion Rules”.
<code>mwArrayFormatCell</code>	Coerces all arrays into cell arrays. Input scalar or numeric array arguments are converted to cell arrays with each cell containing a scalar value for the respective index.
<code>mwArrayFormatMatrix</code>	Coerces all arrays into matrices. When an input argument is encountered that is an array of Variants (the default behavior is to convert it to a cell array), the data converter converts this array to a matrix if each Variant is single valued, and all elements are homogeneous and of a numeric type. If this conversion is not possible, creates a cell array.

Property InputArrayIndFlag As Long. This property governs the level at which to apply the rule set by the InputArrayFormat property for nested arrays (an array of Variants is passed and each element of the array is an array itself). It is not necessary to modify this flag for varargin parameters. The data conversion code automatically increments the value of this flag by 1 for varargin cells, thus applying the InputArrayFormat flag to each cell of a varargin parameter. The default value is 0.

Property OutputArrayFormat As mxArrayFormat. This property of type mxArrayFormat controls the formatting of arrays passed as output parameters to MATLAB Builder NE class methods. The default value is mxArrayFormatAsIs. The behaviors indicated by this flag are listed in the next table.

Array Formatting Rules for Output Arrays

Value	Behavior
mwArrayFormatAsIs	Converts arrays according to the default conversion rules listed in “Data Conversion Rules”.
mwArrayFormatMatrix	Coerces all arrays into matrices. When an output cell array argument is encountered (the default behavior converts it to an array of Variants), the data converter converts this array to a Variant that contains a simple numeric array if each cell is single valued, and all elements are homogeneous and of a numeric type. If this conversion is not possible, an array of Variants is created.
mwArrayFormatCell	Coerces all output arrays into arrays of Variants. Output scalar or numeric array arguments are converted to arrays of Variants, each Variant containing a scalar value for the respective index.

Property OutputArrayIndFlag As Long. This property is similar to the InputArrayIndFlag property, as it governs the level at which to apply the rule set by the OutputArrayFormat property for nested arrays. As with the input case, this flag is automatically incremented by 1 for a varargout parameter. The default value of this flag is 0.

Property AutoResizeOutput As Boolean. This flag applies to Excel ranges only. When the target output from a method call is a range of cells in an Excel worksheet, and the output array size and shape is not known at the time of the call, setting this flag to True instructs the data conversion code to resize each Excel range to fit the output array. Resizing is applied relative to the upper left corner of each supplied range. The default value for this flag is False.

Property TransposeOutput As Boolean. Setting this flag to True transposes the output arguments. This flag is useful when processing an output parameter from a method call on a COM component, where the MATLAB function returns outputs as row vectors, and you desire to place the data into columns. The default value for this flag is False.

Property DataConversionFlags As MWDataConversionFlags

The DataConversionFlags property controls how input variables are processed when type coercion is needed. The MWDataConversionFlags class is a noncreatable class accessed through an MWFlags class instance. This class contains these properties:

- “Property CoerceNumericToType As mwDataType” on page 7-13
- “Property InputDateFormat As mwDateFormat” on page 7-14
- “Property OutputAsDate As Boolean” on page 7-14
- “Property DateBias As Long” on page 7-14

Property CoerceNumericToType As mwDataType. This property converts all numeric input arguments to one specific MATLAB type. This flag is useful is when variables maintained within the Visual Basic code are different types, e.g., Long, Integer, etc., and all variables passed to the compiled MATLAB code must be doubles. The default value for this property is mwTypeDefault, which uses the default rules in “Data Conversion Rules”.

Property InputDateFormat As mwDateFormat. This property converts dates passed as input parameters to method calls on .NET Builder classes. The default value is `mwDateFormatNumeric`. The behaviors indicated by this flag are shown in the following table.

Conversion Rules for Input Dates

Value	Behavior
<code>mwDateFormatNumeric</code>	Convert dates to numeric values as indicated by the rule listed in “Data Conversion Rules”.
<code>mwDateFormatString</code>	Convert input dates to strings.

Property OutputAsDate As Boolean. This property processes an output argument as a date. By default, numeric dates that are output parameters from compiled MATLAB functions are passed as `Doubles` that need to be decremented by the COM date bias (693960) as well as coerced to COM dates. Set this flag to `True` to convert all output values of type `Double`.

Property DateBias As Long. This property sets the date bias for performing COM to MATLAB numeric date conversions. The default value of this property is 693960, representing the difference between the COM `Date` type and MATLAB numeric dates. This flag allows existing MATLAB code that already performs the increment of numeric dates by 693960 to be used unchanged with COM components created by MATLAB Builder NE. To process dates with such code, set this property to 0.

This example uses data conversion flags to reshape the output from a method compiled from a MATLAB function that produces an output vector of unknown length.

```
function p = myprimes(n)
if length(n)~=1, error('N must be a scalar'); end
if n < 2, p = zeros(1,0); return, end
p = 1:2:n;
q = length(p);
p(1) = 2;
for k = 3:2:sqrt(n)
    if p((k+1)/2)
```

```

        p(((k*k+1)/2):k:q) = 0;
    end
end
p = (p(p>0));

```

This function produces a row vector of all the prime numbers between 0 and n. Assume that this function is included in a class named `myclass` that is included in a component named `mycomponent` with a version of 1.0. The subroutine takes an Excel range and a Double as inputs, and places the generated prime numbers into the supplied range. The MATLAB function produces a row vector, although you want the output in column format. It also produces an unknown number of outputs, and you do not want to truncate any output. To handle these issues, set the `TransposeOutput` flag and the `AutoResizeOutput` flag to `True`. In previous examples, the Visual Basic `CreateObject` function creates the necessary classes. This example uses an explicit type declaration for the `aClass` variable. As with previous examples, this function assumes that `MWInitApplication` has been previously called.

```

Sub GenPrimes(R As Range, n As Double)
    Dim aClass As mycomponent.myclass

    On Error GoTo Handle_Error
    Set aClass = New mycomponent.myclass
    aClass.MWFlags.ArrayFormatFlags.AutoResizeOutput = True
    aClass.MWFlags.ArrayFormatFlags.TransposeOutput = True
    Call aClass.myprimes(1, R, n)
    Exit Sub
Handle_Error:
    MsgBox (Err.Description)
End Sub

```

Sub Clone(ppFlags As MWFlags)

Creates a copy of an `MWFlags` object.

Parameters.

Argument	Type	Description
ppFlags	MWFlags	Reference to an uninitialized MWFlags object that receives the copy

Return Value. None

Remarks. Clone allocates a new MWFlags object and creates a deep copy of the object's contents. Call this function when a separate object is required instead of a shared copy of an existing object reference.

Class MWStruct

The MWStruct class passes or receives a Struct type to or from a compiled class method. This class contains seven properties/methods:

- “Sub Initialize([varDims], [varFieldNames])” on page 7-16
- “Property Item([i0], [i1], ..., [i31]) As MWField” on page 7-18
- “Property NumberOfFields As Long” on page 7-21
- “Property NumberOfDims As Long” on page 7-21
- “Property Dims As Variant” on page 7-21
- “Property FieldNames As Variant” on page 7-21
- “Sub Clone(ppStruct As MWStruct)” on page 7-22

Sub Initialize([varDims], [varFieldNames])

This method allocates a structure array with a specified number and size of dimensions and a specified list of field names.

Parameters.

Argument	Type	Description
varDims	Variant	Optional array of dimensions
varFieldNames	Variant	Optional array of field names

Return Value. None.

Remarks. When created, an MWStruct object has a dimensionality of 1-by-1 and no fields. The Initialize method dimensions the array and adds a set of named fields to each element. Each time you call Initialize on the same object, it is redimensioned. If you do not supply the varDims argument, the existing number and size of the array's dimensions unchanged. If you do not supply the varFieldNames argument, the existing list of fields is not changed. Calling Initialize with no arguments leaves the array unchanged.

Example. The following Visual Basic code illustrates use of the Initialize method to dimension struct arrays.

```
Sub foo ()
    Dim x As MWStruct
    Dim y As MWStruct

    On Error Goto Handle_Error
    'Create 1X1 struct arrays with no fields for x, and y
    Set x = new MWStruct
    Set y = new MWStruct

    'Initialize x to be 2X2 with fields "red", "green",
    '                                     and "blue"
    Call x.Initialize(Array(2,2), Array("red", "green", "blue"))
    'Initialize y to be 1X5 with fields "name" and "age"
    Call y.Initialize(5, Array("name", "age"))

    'Re-dimension x to be 3X3 with the same field names
    Call x.Initialize(Array(3,3))
End Sub
```

```

        'Add a new field to y
        Call y.Initialize(, Array("name", "age", "salary"))

        Exit Sub
    Handle_Error:
        MsgBox(Err.Description)
    End Sub

```

Property Item([i0], [i1], ..., [i31]) As MWField

The Item property is the default property of the MWStruct class. This property is used to set/get the value of a field at a particular index in the structure array.

Parameters.

Argument	Type	Description
i0,i1, ..., i31	Variant	Optional index arguments. Between 0 and 32 index arguments can be entered. To reference an element of the array, specify all indexes as well as the field name.

Remarks. When accessing a named field through this property, you must supply all dimensions of the requested field as well as the field name. This property always returns a single field value, and generates a bad index error if you provide an invalid or incomplete index list. Index arguments have four basic formats:

- Field name only

This format may be used only in the case of a 1-by-1 structure array and returns the named field's value. For example:

```

x("red") = 0.2
x("green") = 0.4

```

```
x("blue") = 0.6
```

In this example, the name of the `Item` property was neglected. This is possible since the `Item` property is the default property of the `MWStruct` class. In this case the two statements are equivalent:

```
x.Item("red") = 0.2
x("red") = 0.2
```

- Single index and field name

This format accesses array elements through a single subscripting notation. A single numeric index `n` followed by the field name returns the named field on the `n`th array element, navigating the array linearly in column-major order. For example, consider a 2-by-2 array of structures with fields "red", "green", and "blue" stored in a variable `x`. These two statements are equivalent:

```
y = x(2, "red")
y = x(2, 1, "red")
```

- All indices and field name

This format accesses an array element of an multidimensional array by specifying `n` indices. These statements access all four of the elements of the array in the previous example:

```
For I From 1 To 2
  For J From 1 To 2
    r(I, J) = x(I, J, "red")
    g(I, J) = x(I, J, "green")
    b(I, J) = x(I, J, "blue")
  Next
Next
```

- Array of indices and field name

This format accesses an array element by passing an array of indices and a field name. The next example rewrites the previous example using an index array:

```
Dim Index(1 To 2) As Integer
```

```
For I From 1 To 2
    Index(1) = I
    For J From 1 To 2
        Index(2) = J
        r(I, J) = x(Index, "red")
        g(I, J) = x(Index, "green")
        b(I, J) = x(Index, "blue")
    Next
Next
```

With these four formats, the `Item` property provides a very flexible indexing mechanism for structure arrays. Also note:

- You can combine the last two indexing formats. Several index arguments supplied in either scalar or array format are concatenated to form one index set. The combining stops when the number of dimensions has been reached. For example:

```
Dim Index1(1 To 2) As Integer
Dim Index2(1 To 2) As Integer

Index1(1) = 1
Index1(2) = 1
Index2(1) = 3
Index2(2) = 2
x(Index1, Index2, 2, "red") = 0.5
```

The last statement resolves to

```
x(1, 1, 3, 2, 2, "red") = 0.5
```

- The field name must be the last index in the list. The following statement produces an error:

```
y = x("blue", 1, 2)
```

- Field names are case sensitive.

Property NumberOfFields As Long

The read-only `NumberOfFields` property returns the number of fields in the structure array.

Property NumberOfDims As Long

The read-only `NumberOfDims` property returns the number of dimensions in the struct array.

Property Dims As Variant

The read-only `Dims` property returns an array of length `NumberOfDims` that contains the size of each dimension of the struct array.

Property FieldNames As Variant

The read-only `FieldNames` property returns an array of length `NumberOfFields` that contains the field names of the elements of the structure array.

Example. The next Visual Basic code sample illustrates how to access a two-dimensional structure array's fields when the field names and dimension sizes are not known in advance.

```
Sub foo ()
    Dim x As MWStruct
    Dim Dims as Variant
    Dim FieldNames As Variant

    On Error Goto Handle_Error
    '
    '... Call a method that returns an MWStruct in x
    '

    Dims = x.Dims
    FieldNames = x.FieldNames
    For I From 1 To Dims(1)
        For J From 1 To Dims(2)
            For K From 1 To x.NumberOfFields
                y = x(I,J,FieldNames(K))
                ' ... Do something with y
            
```

```

                Next
            Next
        Next
    Exit Sub
Handle_Error:
    MsgBox(Err.Description)
End Sub

```

Sub Clone(ppStruct As MWStruct)

Creates a copy of an MWStruct object.

Parameters.

Argument	Type	Description
ppStruct	MWStruct	Reference to an uninitialized MWStruct object to receive the copy

Return Value. None

Remarks. Clone allocates a new MWStruct object and creates a deep copy of the object's contents. Call this function when a separate object is required instead of a shared copy of an existing object reference.

Example. The following Visual Basic example illustrates the difference between assignment and Clone for MWStruct objects.

```

Sub foo ()
    Dim x1 As MWStruct
    Dim x2 As MWStruct
    Dim x3 As MWStruct

    On Error Goto Handle_Error
    Set x1 = new MWStruct
    x1("name") = "John Smith"
    x1("age") = 35

```

```

'Set reference of x1 to x2
Set x2 = x1
'Create new object for x3 and copy contents of x1 into it
Call x1.Clone(x3)
'x2's "age" field is
'also modified 'x3's "age" field unchanged
x1("age") = 50
.
.
.
Exit Sub
Handle_Error:
MsgBox(Err.Description)
End Sub

```

Class MWField

The MWField class holds a single field reference in an MWStruct object. This class is noncreatable and contains four properties/methods:

- “Property Name As String” on page 7-23
- “Property Value As Variant” on page 7-23
- “Property MWFlags As MWFlags” on page 7-23
- “Sub Clone(ppField As MWField)” on page 7-24

Property Name As String

The name of the field (read only).

Property Value As Variant

Stores the field’s value (read/write). The Value property is the default property of the MWField class. The value of a field can be any type that is coercible to a Variant, as well as object types.

Property MWFlags As MWFlags

Stores a reference to an MWFlags object. This property sets or gets the array formatting and data conversion flags for a particular field. Each field in a

structure has its own `MWFlags` property. This property overrides the value of any flags set on the object whose methods are called.

Sub Clone(ppField As MWField)

Creates a copy of an `MWField` object.

Parameters.

Argument	Type	Description
<code>ppField</code>	<code>MWField</code>	Reference to an uninitialized <code>MWField</code> object to receive the copy

Return Value. None.

Remarks. `Clone` allocates a new `MWField` object and creates a deep copy of the object's contents. Call this function when a separate object is required instead of a shared copy of an existing object reference.

Class MWComplex

The `MWComplex` class passes or receives a complex numeric array into or from a compiled class method. This class contains four properties/methods:

- “Property `Real As Variant`” on page 7-24
- “Property `Imag As Variant`” on page 7-25
- “Property `MWFlags As MWFlags`” on page 7-26
- “Sub `Clone(ppComplex As MWComplex)`” on page 7-26

Property Real As Variant

Stores the real part of a complex array (read/write). The `Real` property is the default property of the `MWComplex` class. The value of this property can be any type coercible to a `Variant`, as well as object types, with the restriction that the underlying array must resolve to a numeric matrix (no cell data allowed).

Valid Visual Basic numeric types for complex arrays include Byte, Integer, Long, Single, Double, Currency, and Variant/vbDecimal.

Property Imag As Variant

Stores the imaginary part of a complex array (read/write). The Imag property is optional and can be Empty for a pure real array. If the Imag property is nonempty and the size and type of the underlying array do not match the size and type of the Real property's array, an error results when the object is used in a method call.

Example. The following Visual Basic code creates a complex array with the following entries:

```
x = [ 1+i 1+2i
      2+i 2+2i ]
Sub foo()
  Dim x As MWComplex
  Dim rval(1 To 2, 1 To 2) As Double
  Dim ival(1 To 2, 1 To 2) As Double

  On Error Goto Handle_Error
  For I = 1 To 2
    For J = 1 To 2
      rval(I,J) = I
      ival(I,J) = J
    Next
  Next
  Set x = new MWComplex
  x.Real = rval
  x.Imag = ival
  .
  .
  .
  Exit Sub
Handle_Error:
  MsgBox(Err.Description)
End Sub
```

Property **MWFlags As MWFlags**

Stores a reference to an MWFlags object. This property sets or gets the array formatting and data conversion flags for a particular complex array. Each MWComplex object has its own MWFlags property. This property overrides the value of any flags set on the object whose methods are called.

Sub **Clone(ppComplex As MWComplex)**

Creates a copy of an MWComplex object.

Parameters.

Argument	Type	Description
ppComplex	MWComplex	Reference to an uninitialized MWComplex object to receive the copy

Return Value. None

Remarks. Clone allocates a new MWComplex object and creates a deep copy of the object’s contents. Call this function when a separate object is required instead of a shared copy of an existing object reference.

Class **MWSparse**

The MWSparse class passes or receives a two-dimensional sparse numeric array into or from a compiled class method. This class has seven properties/methods:

- “Property NumRows As Long” on page 7-27
- “Property NumColumns As Long” on page 7-27
- “PropertyRowIndex As Variant” on page 7-27
- “Property ColumnIndex As Variant” on page 7-27
- “Property Array As Variant” on page 7-27
- “Property MWFlags As MWFlags” on page 7-28
- “Sub Clone(ppSparse As MWSparse)” on page 7-28

Property NumRows As Long

Stores the row dimension for the array. The value of NumRows must be nonnegative. If the value is zero, the row index is taken from the maximum of the values in the RowIndex array.

Property NumColumns As Long

Stores the column dimension for the array. The value of NumColumns must be nonnegative. If the value is zero, the row index is taken from the maximum of the values in the ColumnIndex array.

Property RowIndex As Variant

Stores the array of row indices of the nonzero elements of the array. The value of this property can be any type coercible to a Variant, as well as object types, with the restriction that the underlying array must resolve to or be coercible to a numeric matrix of type Long. If the value of NumRows is nonzero and any row index is greater than NumRows, a bad-index error occurs. An error also results if the number of elements in the RowIndex array does not match the number of elements in the Array property's underlying array.

Property ColumnIndex As Variant

Stores the array of column indices of the nonzero elements of the array. The value of this property can be any type coercible to a Variant, as well as object types, with the restriction that the underlying array must resolve to or be coercible to a numeric matrix of type Long. If the value of NumColumns is nonzero and any column index is greater than NumColumns, a bad-index error occurs. An error also results if the number of elements in the ColumnIndex array does not match the number of elements in the Array property's underlying array.

Property Array As Variant

Stores the nonzero array values of the sparse array. The value of this property can be any type coercible to a Variant, as well as object types, with the restriction that the underlying array must resolve to or be coercible to a numeric matrix of type Double or Boolean.

Property **MWFlags As MWFlags**

Stores a reference to an MWFlags object. This property sets or gets the array formatting and data conversion flags for a particular sparse array. Each MWSparse object has its own MWFlags property. This property overrides the value of any flags set on the object whose methods are called.

Sub **Clone(ppSparse As MWSparse)**

Creates a copy of an MWSparse object.

Parameters.

Argument	Type	Description
ppSparse	MWSparse	Reference to an uninitialized MWSparse object to receive the copy

Return Value. None.

Remarks. Clone allocates a new MWSparse object and creates a deep copy of the object's contents. Call this function when a separate object is required instead of a shared copy of an existing object reference.

Example. The following Visual Basic sample creates a 5-by-5 tridiagonal sparse array with the following entries:

```
X = [ 2 -1 0 0 0
      -1 2 -1 0 0
        0 -1 2 -1 0
        0 0 -1 2 -1
        0 0 0 -1 2 ]
```

```
Sub foo()
    Dim x As MWSparse
    Dim rows(1 To 13) As Long
    Dim cols(1 To 13) As Long
    Dim vals(1 To 13) As Double
```

```
Dim I As Long, K As Long

On Error GoTo Handle_Error
K = 1
For I = 1 To 4
    rows(K) = I
    cols(K) = I + 1
    vals(K) = -1
    K = K + 1
    rows(K) = I
    cols(K) = I
    vals(K) = 2
    K = K + 1
    rows(K) = I + 1
    cols(K) = I
    vals(K) = -1
    K = K + 1
Next
rows(K) = 5
cols(K) = 5
vals(K) = 2
Set x = New MWSparsed
x.NumRows = 5
x.NumColumns = 5
x.RowIndex = rows
x.ColumnIndex = cols
x.Array = vals
    .
    .
    .
Exit Sub
Handle_Error:
MsgBox (Err.Description)
End Sub
```

Class MWArg

The MWArg class passes a generic argument into a compiled class method. This class passes an argument for which the data conversion flags are changed for that one argument. This class has three properties/methods:

- “Property Value As Variant” on page 7-30
- “Property MWFlags As MWFlags” on page 7-30
- “Sub Clone(ppArg As MWArg)” on page 7-30

Property Value As Variant

The Value property stores the actual argument to pass. Any type that can be passed to a compiled method is valid for this property.

Property MWFlags As MWFlags

Stores a reference to an MWFlags object. This property sets or gets the array formatting and data conversion flags for a particular argument. Each MWArg object has its own MWFlags property. This property overrides the value of any flags set on the object whose methods are called.

Sub Clone(ppArg As MWArg)

Creates a copy of an MWArg object.

Parameters.

Argument	Type	Description
ppArg	MWArg	Reference to an uninitialized MWArg object to receive the copy

Return Value. None.

Remarks. Clone allocates a new MWArg object and creates a deep copy of the object’s contents. Call this function when a separate object is required instead of a shared copy of an existing object reference.

Enumerations

In this section...
“Enum mwArrayFormat” on page 7-31
“Enum mwDataType” on page 7-31
“Enum mwDateFormat” on page 7-32

Enum mwArrayFormat

The `mwArrayFormat` enumeration is a set of constants that denote an array formatting rule for data conversion.

mwArrayFormat Values

Constant	Numeric Value	Description
<code>mwArrayFormatAsIs</code>	0	Do not reformat the array.
<code>mwArrayFormatMatrix</code>	1	Format the array as a matrix.
<code>mwArrayFormatCell</code>	2	Format the array as a cell array.

Enum mwDataType

The `mwDataType` enumeration is a set of constants that denote a MATLAB numeric type.

mwDataType Values

Constant	Numeric Value	MATLAB Type
<code>mwTypeDefault</code>	0	Not applicable
<code>mwTypeLogical</code>	3	logical
<code>mwTypeChar</code>	4	char
<code>mwTypeDouble</code>	6	double

mwDataType Values (Continued)

Constant	Numeric Value	MATLAB Type
mwTypeSingle	7	single
mwTypeInt8	8	int8
mwTypeUInt8	9	uint8
mwTypeInt16	10	int16
mwTypeUInt16	11	uint16
mwTypeInt32	12	int32
mwTypeUInt32	13	uint32

Enum mwDateFormat

The `mwDateFormat` enumeration is a set of constants that denote a formatting rule for dates.

mwDateFormat Values

Constant	Numeric Value	Description
mwDateFormatNumeric	0	Format dates as numeric values
mwDateFormatString	1	Format dates as strings

Data Conversion

- “Data Conversion Rules ” on page A-2
- “Array Formatting Flags” on page A-12
- “Data Conversion Flags” on page A-14

Data Conversion Rules

This topic describes the data conversion rules for the MATLAB Builder EX components. These components are dual interface Microsoft COM objects that support data types compatible with Automation.

Note *Automation* (formerly called OLE Automation) is a technology that allows software packages to expose their unique features to scripting tools and other applications. Automation uses the Component Object Model (COM), but may be implemented independently from other OLE features, such as in-place activation.

When a method is invoked on a MATLAB Builder EX component, the input parameters are converted to the MATLAB internal array format and passed to the compiled MATLAB function. When the function exits, the output parameters are converted from the MATLAB internal array format to COM Automation types.

The COM client passes all input and output arguments in the compiled MATLAB functions as type `VARIANT`. The COM `VARIANT` type is a union of several simple data types. A type `VARIANT` variable can store a variable of any of the simple types, as well as arrays of any of these values.

The Win32 application program interface (API) provides many functions for creating and manipulating `VARIANT`s in C/C++, and Visual Basic provides native language support for this type.

Note This discussion of data refers to both `VARIANT` and `Variant` data types. `VARIANT` is the C++ name and `Variant` is the corresponding data type in Visual Basic.

See the Visual Studio® documentation for definitions and API support for COM `VARIANT`s. `VARIANT` variables are self describing and store their type code as an internal field of the structure.

The following table lists the VARIANT type codes supported by the MATLAB Builder EX components.

VARIANT Type Codes Supported

VARIANT Type Code (C/C++)	C/C++ Type	Variant Type Code (Visual Basic)	Visual BasicType	Definition
VT_EMPTY		vbEmpty		Uninitialized VARIANT
VT_I1	char			Signed one-byte character
VT_UI1	unsigned char	vbByte	Byte	Unsigned one-byte character
VT_I2	short	vbInteger	Integer	Signed two-byte integer
VT_UI2	unsigned short	—	—	Unsigned two-byte integer
VT_I4	long	vbLong	Long	Signed four-byte integer
VT_UI4	unsigned long	—	—	Unsigned four-byte integer
VT_R4	float	vbSingle	Single	IEEE® four-byte floating-point value
VT_R8	double	vbDouble	Double	IEEE eight-byte floating-point value
VT_CY	CY ⁺	vbCurrency	Currency	Currency value (64-bit integer, scaled by 10,000)
VT_BSTR	BSTR ⁺	vbString	String	String value
VT_ERROR	SCODE ⁺	vbError	—	An HRESULT (signed four-byte integer representing a COM error code)

VARIANT Type Codes Supported (Continued)

VARIANT Type Code (C/C++)	C/C++ Type	Variant Type Code (Visual Basic)	Visual BasicType	Definition
VT_DATE	DATE ⁺	vbDate	Date	Eight-byte floating point value representing date and time
VT_INT	int	—	—	Signed integer; equivalent to type int
VT_UINT	unsigned int	—	—	Unsigned integer; equivalent to type unsigned int
VT_DECIMAL	DECIMAL ⁺	vbDecimal	—	96-bit (12-byte) unsigned integer, scaled by a variable power of 10
VT_BOOL	VARIANT_BOOL ⁺	vbBoolean	Boolean	Two-byte Boolean value (0xFFFF = True; 0x0000 = False)
VT_DISPATCH	IDispatch*	vbObject	Object	IDispatch* pointer to an object
VT_VARIANT	VARIANT ⁺	vbVariant	Variant	VARIANT (can only be specified if combined with VT_BYREF or VT_ARRAY)
<anything> VT_ARRAY	—	—	—	Bitwise combine VT_ARRAY with any basic type to declare as an array

VARIANT Type Codes Supported (Continued)

VARIANT Type Code (C/C++)	C/C++ Type	Variant Type Code (Visual Basic)	Visual BasicType	Definition
<anything> VT_BYREF	—	—	—	Bitwise combine VT_BYREF with any basic type to declare as a reference to a value

+ Denotes Windows-specific type. Not part of standard C/C++.

The following table lists the rules for converting from MATLAB to COM.

MATLAB to COM VARIANT Conversion Rules

MATLAB Data Type	VARIANT Type for Scalar Data	VARIANT Type for Array Data	Comments
cell	A 1-by-1 cell array converts to a single VARIANT with a type conforming to the conversion rule for the MATLAB data type of the cell contents.	A multidimensional cell array converts to a VARIANT of type VT_VARIANT VT_ARRAY with the type of each array member conforming to the conversion rule for the MATLAB data type of the corresponding cell.	
structure	VT_DISPATCH	VT_DISPATCH	A MATLAB struct array is converted to an MWStruct object. (See “Class MWStruct” on page B-16.) This object is passed as a VT_DISPATCH type.

MATLAB to COM VARIANT Conversion Rules (Continued)

MATLAB Data Type	VARIANT Type for Scalar Data	VARIANT Type for Array Data	Comments
char	A 1-by-1 char matrix converts to a VARIANT of type VT_BSTR with string length = 1.	A 1-by-L char matrix is assumed to represent a string of length L in MATLAB. This case converts to a VARIANT of type VT_BSTR with a string length = L. char matrices of more than one row, or of a higher dimensionality convert to a VARIANT of type VT_BSTR VT_ARRAY. Each string in the converted array is of length 1 and corresponds to each character in the original matrix.	Arrays of strings are not supported as char matrices. To pass an array of strings, use a cell array of 1-by-L char matrices.
sparse	VT_DISPATCH	VT_DISPATCH	A MATLAB sparse array is converted to an MWSparse object. (See “Class MWSparse” on page B-27.) This object is passed as a VT_DISPATCH type.

MATLAB to COM VARIANT Conversion Rules (Continued)

MATLAB Data Type	VARIANT Type for Scalar Data	VARIANT Type for Array Data	Comments
double	A real 1-by-1 double matrix converts to a VARIANT of type VT_R8. A complex 1-by-1 double matrix converts to a VARIANT of type VT_DISPATCH.	A real multidimensional double matrix converts to a VARIANT of type VT_R8 VT_ARRAY. A complex multidimensional double matrix converts to a VARIANT of type VT_DISPATCH.	Complex arrays are passed to and from compiled MATLAB functions using the MWComplex class. (See “Class MWComplex” on page B-25.)
single	A real 1-by-1 single matrix converts to a VARIANT of type VT_R4. A complex 1-by-1 single matrix converts to a VARIANT of type VT_DISPATCH.	A real multidimensional single matrix converts to a VARIANT of type VT_R4 VT_ARRAY. A complex multidimensional single matrix converts to a VARIANT of type VT_DISPATCH.	Complex arrays are passed to and from compiled MATLAB functions using the MWComplex class. (See “Class MWComplex” on page B-25.)
int8	A real 1-by-1 int8 matrix converts to a VARIANT of type VT_I1. A complex 1-by-1 int8 matrix converts to a VARIANT of type VT_DISPATCH.	A real multidimensional int8 matrix converts to a VARIANT of type VT_I1 VT_ARRAY. A complex multidimensional int8 matrix converts to a VARIANT of type VT_DISPATCH.	Complex arrays are passed to and from compiled MATLAB functions using the MWComplex class. (See “Class MWComplex” on page B-25.)

MATLAB to COM VARIANT Conversion Rules (Continued)

MATLAB Data Type	VARIANT Type for Scalar Data	VARIANT Type for Array Data	Comments
uint8	A real 1-by-1 uint8 matrix converts to a VARIANT of type VT_UI1. A complex 1-by-1 uint8 matrix converts to a VARIANT of type VT_DISPATCH.	A real multidimensional uint8 matrix converts to a VARIANT of type VT_UI1 VT_ARRAY. A complex multidimensional uint8 matrix converts to a VARIANT of type VT_DISPATCH.	Complex arrays are passed to and from compiled MATLAB functions using the MWComplex class. (See “Class MWComplex” on page B-25.)
int16	A real 1-by-1 int16 matrix converts to a VARIANT of type VT_I2. A complex 1-by-1 int16 matrix converts to a VARIANT of type VT_DISPATCH.	A real multidimensional int16 matrix converts to a VARIANT of type VT_I2 VT_ARRAY. A complex multidimensional int16 matrix converts to a VARIANT of type VT_DISPATCH.	Complex arrays are passed to and from compiled MATLAB functions using the MWComplex class. (See “Class MWComplex” on page B-25.)
uint16	A real 1-by-1 uint16 matrix converts to a VARIANT of type VT_UI2. A complex 1-by-1 uint16 matrix converts to a VARIANT of type VT_DISPATCH.	A real multidimensional uint16 matrix converts to a VARIANT of type VT_UI2 VT_ARRAY. A complex multidimensional uint16 matrix converts to a VARIANT of type VT_DISPATCH.	Complex arrays are passed to and from compiled MATLAB functions using the MWComplex class. (See “Class MWComplex” on page B-25.)

MATLAB to COM VARIANT Conversion Rules (Continued)

MATLAB Data Type	VARIANT Type for Scalar Data	VARIANT Type for Array Data	Comments
int32	A 1-by-1 int32 matrix converts to a VARIANT of type VT_I4. A complex 1-by-1 int32 matrix converts to a VARIANT of type VT_DISPATCH.	A multidimensional int32 matrix converts to a VARIANT of type VT_I4 VT_ARRAY. A complex multidimensional int32 matrix converts to a VARIANT of type VT_DISPATCH.	Complex arrays are passed to and from compiled MATLAB functions using the MWComplex class. (See “Class MWComplex” on page B-25.)
uint32	A 1-by-1 uint32 matrix converts to a VARIANT of type VT_UI4. A complex 1-by-1 uint32 matrix converts to a VARIANT of type VT_DISPATCH.	A multidimensional uint32 matrix converts to a VARIANT of type VT_UI4 VT_ARRAY. A complex multidimensional uint32 matrix converts to a VARIANT of type VT_DISPATCH.	Complex arrays are passed to and from compiled MATLAB functions using the MWComplex class. (See “Class MWComplex” on page B-25.)
Function handle	VT_EMPTY	VT_EMPTY	Not supported
Java class	VT_EMPTY	VT_EMPTY	Not supported
User class	VT_EMPTY	VT_EMPTY	Not supported
logical	VT_Boolean	VT_Boolean VT_ARRAY	

The following table lists the rules for conversion from COM to MATLAB.

COM VARIANT to MATLAB Conversion Rules

VARIANT Type	MATLAB Data Type (scalar or array data)	Comments
VT_EMPTY	Not applicable	Empty array created.
VT_I1	int8	

COM VARIANT to MATLAB Conversion Rules (Continued)

VARIANT Type	MATLAB Data Type (scalar or array data)	Comments
VT_UI1	uint8	
VT_I2	int16	
VT_UI2	uint16	
VT_I4	int32	
VT_UI4	uint32	
VT_R4	single	
VT_R8	double	
VT_CY	double	
VT_BSTR	char	A VARIANT of type VT_BSTR converts to a 1-by-L MATLAB char array, where L = the length of the string to be converted. A VARIANT of type VT_BSTR VT_ARRAY converts to a MATLAB cell array of 1-by-L char arrays.
VT_ERROR	int32	
VT_DATE	double	<p>1. VARIANT dates are stored as doubles starting at midnight Dec. 31, 1899. The MATLAB dates are stored as doubles starting at 0/0/00 00:00:00. Therefore, a VARIANT date of 0.0 maps to a MATLAB numeric date of 693960.0. VARIANT dates are converted to MATLAB double types and incremented by 693960.0.</p> <p>2. VARIANT dates can be optionally converted to strings. See “Data Conversion Flags” on page A-14 for more information on type coercion.</p>
VT_INT	int32	
VT_UINT	uint32	

COM VARIANT to MATLAB Conversion Rules (Continued)

VARIANT Type	MATLAB Data Type (scalar or array data)	Comments
VT_DECIMAL	double	
VT_BOOL	logical	
VT_DISPATCH	(varies)	<p>IDispatch* pointers are treated within the context of what they point to. Objects must be supported types with known data extraction and conversion rules, or expose a generic Value property that points to a single VARIANT type. Data extracted from an object is converted based upon the rules for the particular VARIANT obtained.</p> <p>Currently, support exists for Excel Range objects as well as the MATLAB Builder EX types MWStruct, MWComplex, MWSparse, and MWArg. See “Utility Library Classes” on page B-3 for information on the MATLAB Builder EX types.</p>
<anything> VT_BYREF	(varies)	Pointers to any of the basic types are processed according to the rules for what they point to. The resulting MATLAB array contains a deep copy of the values.
<anything> VT_ARRAY	(varies)	Multidimensional VARIANT arrays convert to multidimensional MATLAB arrays, each element converted according to the rules for the basic types. Multidimensional VARIANT arrays of type VT_VARIANT VT_ARRAY convert to multidimensional cell arrays, each cell converted according to the rules for that specific type.

Array Formatting Flags

The MATLAB Builder EX components have flags that control how array data is formatted in both directions. Generally, you should develop client code that matches the intended inputs and outputs of the MATLAB functions with the corresponding methods on the compiled COM objects, in accordance with the rules listed in MATLAB® to COM VARIANT Conversion Rules on page A-5 and COM VARIANT to MATLAB® Conversion Rules on page A-9. In some cases this is not possible, for example, when existing MATLAB code is used in conjunction with a third-party product like Excel.

The following table shows the array formatting flags.

Array Formatting Flags

Flag	Description
InputArrayFormat	<p>Defines the array formatting rule used on input arrays. An input array is a VARIANT array, created by the client, sent as an input parameter to a method call on a compiled COM object.</p> <p>Valid values for this flag are <code>mwArrayFormatAsIs</code>, <code>mwArrayFormatMatrix</code>, and <code>mwArrayFormatCell</code>.</p> <p><code>mwArrayFormatAsIs</code> passes the array unchanged.</p> <p><code>mwArrayFormatMatrix</code> (default) formats all arrays as matrices. When the input VARIANT is of type <code>VT_ARRAY type</code>, where <code>type</code> is any numeric type, this flag has no effect. When the input VARIANT is of type <code>VT_VARIANT VT_ARRAY</code>, VARIANTS in the array are examined. If they are single-valued and homogeneous in type, a MATLAB matrix of the appropriate type is produced instead of a cell array.</p> <p><code>mwArrayFormatCell</code> interprets all arrays as MATLAB cell arrays.</p>
InputArrayIndFlag	<p>Sets the input array indirection level used with the <code>InputArrayFormat</code> flag (applicable only to nested arrays, i.e., VARIANT arrays of VARIANTS, which themselves are arrays). The default value for this flag is zero, which</p>

Array Formatting Flags (Continued)

Flag	Description
	applies the <code>InputArrayFormat</code> flag to the outermost array. When this flag is greater than zero, e.g., equal to <code>N</code> , the formatting rule attempts to apply itself to the <code>N</code> th level of nesting.
<code>OutputArrayFormat</code>	Defines the array formatting rule used on output arrays. An output array is a MATLAB array, created by the compiled COM object, sent as an output parameter from a method call to the client. The values for this flag, <code>mwArrayFormatAsIs</code> , <code>mwArrayFormatMatrix</code> , and <code>mwArrayFormatCell</code> , cause the same behavior as the corresponding <code>InputArrayFormat</code> flag values.
<code>OutputArrayIndFlag</code>	(Applies to nested cell arrays only.) Output array indirection level used with the <code>OutputArrayFormat</code> flag. This flag works exactly like <code>InputArrayIndFlag</code> .
<code>AutoResizeOutput</code>	(Applies to Excel ranges only.) When the target output from a method call is a range of cells in an Excel worksheet and the output array size and shape is not known at the time of the call, set this flag to <code>True</code> to resize each Excel range to fit the output array.
<code>TransposeOutput</code>	Set this flag to <code>True</code> to transpose the output arguments. Useful when calling a MATLAB Builder EX component from Excel where the MATLAB function returns outputs as row vectors, and you want the data in columns.

Data Conversion Flags

In this section...
“CoerceNumericToType” on page A-14
“InputDateFormat” on page A-15
“OutputAsDate As Boolean” on page A-16
“DateBias As Long” on page A-16

CoerceNumericToType

This flag tells the data converter to convert all numeric VARIANT data to one specific MATLAB type.

VARIANT type codes affected by this flag are

VT_I1

VT_UI1

VT_I2

VT_UI2

VT_I4

VT_UI4

VT_R4

VT_R8

VT_CY

VT_DECIMAL

VT_INT

VT_UINT

VT_ERROR

VT_BOOL

VT_DATE

Valid values for this flag are

mwTypeDefault

mwTypeChar

mwTypeDouble

mwTypeSingle

mwTypeLogical

mwTypeInt8

mwTypeUInt8

mwTypeInt16

mwTypeUInt16

mwTypeInt32

mwTypeUInt32

The default for this flag, `mwTypeDefault`, converts numeric data according to the rules listed in “Data Conversion Rules ” on page A-2.

InputDateFormat

This flag tells the data converter how to convert VARIANT dates to the MATLAB dates. Valid values for this flag are `mwDateFormatNumeric` (default) and `mwDateFormatString`. The default converts VARIANT dates

according to the rule listed in VARIANT Type Codes Supported on page A-3. The `mwDateFormatString` flag converts a VARIANT date to its string representation. This flag only affects VARIANT type code `VT_DATE`.

OutputAsDate As Boolean

This flag instructs the data converter to process an output argument as a date. By default, numeric dates that are output parameters from compiled MATLAB functions are passed as `Doubles` that need to be decremented by the COM date bias (693960) as well as coerced to COM dates. Set this flag to `True` to convert all output values of type `Double`.

DateBias As Long

This flag sets the date bias for performing COM to the MATLAB numeric date conversions. The default value of this property is 693960, which represents the difference between the COM Date type and the MATLAB numeric dates. This flag allows existing MATLAB code that already performs the increment of numeric dates by 693960 to be used unchanged with the MATLAB Builder EX components. To process dates with such code, set this property to 0.

Utility Library

- “Referencing Utility Classes ” on page B-2
- “Utility Library Classes” on page B-3
- “Enumerations” on page B-32

Referencing Utility Classes

This section describes the `MWComUtil` library provided with MATLAB Builder EX. This library is freely distributable and includes several functions used in array processing, as well as type definitions used in data conversion. This library is contained in the file `mwcomutil.dll`. It must be registered once on each machine that uses builder components.

Register the `MWComUtil` library at the DOS command prompt with the following command:

```
mwregsvr mwcomutil.dll
```

The `MWComUtil` library includes seven classes (see “Utility Library Classes” on page B-3) and three enumerated types (see “Enumerations” on page B-32). Before using these types, you must make explicit references to the `MWComUtil` type libraries in the Microsoft Visual Basic IDE. To do this, select **Tools > References** from the main menu of the Visual Basic editor. The References dialog box appears with a scrollable list of available type libraries. From this list, select **MWComUtil x.x Type Library** (where *x.x* is the version number of the MCR) and click **OK**.

Note To obtain the MCR version number, use the MATLAB function `mcrversion`.

Note You must specify the full path of the component when calling `mwregsvr`, or make the call from the folder in which the component resides.

Utility Library Classes

In this section...

“Class MWUtil” on page B-3
“Class MWFlags” on page B-10
“Class MWStruct” on page B-16
“Class MWField” on page B-24
“Class MWComplex” on page B-25
“Class MWSparse” on page B-27
“Class MWArg” on page B-30

Class MWUtil

The `MWUtil` class contains a set of static utility methods used in array processing and application initialization. This class is implemented internally as a singleton (only one global instance of this class per instance of Excel). It is most efficient to declare one variable of this type in global scope within each module that uses it. The methods of `MWUtil` are

- “Sub `MWInitApplication(pApp As Object)`” on page B-3
- “Sub `MWPack(pVarArg, [Var0], [Var1], ... , [Var31])`” on page B-5
- “Sub `MWUnpack(VarArg, [nStartAt As Long], [bAutoResize As Boolean = False], [pVar0], [pVar1], ..., [pVar31])`” on page B-6
- “Sub `MWDate2VariantDate(pVar)`” on page B-8

The function prototypes use Visual Basic syntax.

Sub `MWInitApplication(pApp As Object)`

Initializes the library with the current instance of Excel.

Parameters.

Argument	Type	Description
pApp	Object	A valid reference to the current Excel application

Return Value. None.

Remarks. This function must be called once for each session of Excel that uses builder components. An error is generated if a method call is made to a member class of any builder component, and the library has not been initialized.

Example. This Visual Basic sample initializes the MWComUtil library with the current instance of Excel. A global variable of type Object named MCLUtil holds an instance of the MWUtil class, and another global variable of type Boolean named bModuleInitialized stores the status of the initialization process. The private subroutine InitModule() creates an instance of the MWComUtil class and calls the MWInitApplication method with an argument of Application. Once this function succeeds, all subsequent calls exit without recreating the object.

```
Dim MCLUtil As Object
Dim bModuleInitialized As Boolean

Private Sub InitModule()
    If Not bModuleInitialized Then
        On Error GoTo Handle_Error
        If MCLUtil Is Nothing Then
            Set MCLUtil = CreateObject("MWComUtil.MWUtil")
        End If
        Call MCLUtil.MWInitApplication(Application)
        bModuleInitialized = True
    Exit Sub
Handle_Error:
    bModuleInitialized = False
End If
End Sub
```

Sub MWPack(pVarArg, [Var0], [Var1], ... ,[Var31])

Packs a variable length list of Variant arguments into a single Variant array. This function is typically used for creating a varargin cell from a list of separate inputs. Each input in the list is added to the array only if it is nonempty and nonmissing. (In Visual Basic, a missing parameter is denoted by a Variant type of vbError with a value of &H80020004.)

Parameters.

Argument	Type	Description
pVarArg	Variant	Receives the resulting array
[Var0], [Var1], ...	Variant	Optional list of Variants to pack into the array. 0 to 32 arguments can be passed.

Return Value. None.

Remarks. This function always frees the contents of pVarArg before processing the list.

Example. This example uses MWPack in a formula function to produce a varargin cell to pass as an input parameter to a method compiled from a MATLAB function with the signature:

```
function y = mysum(varargin)
    y = sum([varargin{:}]);
```

The function returns the sum of the elements in varargin. Assume that this function is a method of a class named myclass that is included in a component named mycomponent with a version of 1.0. The Visual Basic function allows up to 10 inputs, and returns the result y. If an error occurs, the function returns the error string. This function assumes that MWInitApplication has been previously called.

```
Function mysum(Optional V0 As Variant, _
               Optional V1 As Variant, _
```

```
        Optional V2 As Variant, _
        Optional V3 As Variant, _
        Optional V4 As Variant, _
        Optional V5 As Variant, _
        Optional V6 As Variant, _
        Optional V7 As Variant, _
        Optional V8 As Variant, _
        Optional V9 As Variant) As Variant
Dim y As Variant
Dim varargin As Variant
Dim aClass As Object
Dim aUtil As Object

    On Error Goto Handle_Error
    Set aClass = CreateObject("mycomponent.myclass.1_0")
    Set aUtil = CreateObject("MWComUtil.MWUtil")
    Call aUtil.MWPack(varargin,V0,V1,V2,V3,V4,V5,V6,V7,V8,V9)
    Call aClass.mysum(1, y, varargin)
    mysum = y
    Exit Function
Handle_Error:
    mysum = Err.Description
End Function
```

Sub MWUnpack(VarArg, [nStartAt As Long], [bAutoSize As Boolean = False], [pVar0], [pVar1], ..., [pVar31])

Unpacks an array of Variants into individual Variant arguments. This function provides the reverse functionality of MWPack and is typically used to process a varargout cell into individual Variants.

Parameters.

Argument	Type	Description
VarArg	Variant	Input array of Variants to be processed
nStartAt	Long	Optional starting index (zero-based) in the array to begin processing. Default = 0.
bAutoResize	Boolean	Optional auto-resize flag. If this flag is True, any Excel range output arguments are resized to fit the dimensions of the Variant to be copied. The resizing process is applied relative to the upper-left corner of the supplied range. Default = False.
[pVar0],[pVar1], ...	Variant	Optional list of Variants to receive the array items contained in VarArg. 0 to 32 arguments can be passed.

Return Value. None.

Remarks. This function can process a Variant array in a single call or through multiple calls using the nStartAt parameter.

Example. This example uses MWUnpack to process a varargout cell into several Excel ranges, while auto-resizing each range. The varargout parameter is supplied from a method that has been compiled from the MATLAB function.

```
function varargout = randvectors
    for i=1:nargout
        varargout{i} = rand(i,1);
    end
```

This function produces a sequence of `nargout` random column vectors, with the length of the i th vector equal to i . Assume that this function is included in a class named `myclass` that is included in a component named `mycomponent` with a version of 1.0. The Visual Basic subroutine takes no arguments and places the results into Excel columns starting at A1, B1, C1, and D1. If an error occurs, a message box displays the error text. This function assumes that `MWInitApplication` has been previously called.

```
Sub GenVectors()
    Dim aClass As Object
    Dim aUtil As Object
    Dim v As Variant
    Dim R1 As Range
    Dim R2 As Range
    Dim R3 As Range
    Dim R4 As Range
    .
    .
    .
    On Error GoTo Handle_Error
    Set aClass = CreateObject("mycomponent.myclass.1_0")
    Set aUtil = CreateObject("MWComUtil.MWUtil")
    Set R1 = Range("A1")
    Set R2 = Range("B1")
    Set R3 = Range("C1")
    Set R4 = Range("D1")
    Call aClass.randvectors(4, v)
    Call aUtil.MWUnpack(v,0,True,R1,R2,R3,R4)
    Exit Sub
Handle_Error:
    MsgBox (Err.Description)
End Sub
```

Sub MWDate2VariantDate(pVar)

Converts output dates from MATLAB to Variant dates.

Parameters.

Argument	Type	Description
pVar	Variant	Variant to be converted

Return Value. None.

Remarks. MATLAB handles dates as double-precision floating-point numbers with 0.0 representing 0/0/00 00:00:00 (see “Data Conversion Rules” on page A-2 for more information on conversion between MATLAB and COM date values). By default, numeric dates that are output parameters from compiled MATLAB functions are passed as **Doubles** that need to be decremented by the COM date bias as well as coerced to COM dates. The `MWDate2VariantDate` method performs this transformation and additionally converts dates in string form to COM date types.

Example. This example uses `MWDate2VariantDate` to process numeric dates returned from a method compiled from the following MATLAB function:

```
function x = getdates(n, inc)
    y = now;
    for i=1:n
        x(i,1) = y + (i-1)*inc;
    end
```

This function produces an n-length column vector of numeric values representing dates starting from the current date and time with each element incremented by `inc` days. Assume that this function is included in a class named `myclass` that is included in a component named `mycomponent` with a version of 1.0. The subroutine takes an Excel range and a **Double** as inputs and places the generated dates into the supplied range. If an error occurs, a message box displays the error text. This function assumes that `MWInitApplication` has been previously called.

```
Sub GenDates(R As Range, inc As Double)
    Dim aClass As Object
    Dim aUtil As Object

    On Error GoTo Handle_Error
    Set aClass = CreateObject("mycomponent.myclass.1_0")
```

```
        Set aUtil = CreateObject("MComUtil.MWUtil")
        Call aClass.getdates(1, R, R.Rows.Count, inc)
        Call aUtil.MWDate2VariantDate(R)
    Exit Sub
Handle_Error:
    MsgBox (Err.Description)
End Sub
```

Class MWFlags

The MWFlags class contains a set of array formatting and data conversion flags (see “Data Conversion Rules” on page A-2 for more information on conversion between MATLAB and COM Automation types). All builder components contain a reference to an MWFlags object that can modify data conversion rules at the object level. This class contains these properties:

- “Property ArrayFormatFlags As MWArrayFormatFlags” on page B-10
- “Property DataConversionFlags As MWDataConversionFlags” on page B-13
- “Sub Clone(ppFlags As MWFlags)” on page B-15

Property ArrayFormatFlags As MWArrayFormatFlags

The ArrayFormatFlags property controls array formatting (as a matrix or a cell array) and the application of these rules to nested arrays. The MWArrayFormatFlags class is a noncreatable class accessed through an MWFlags class instance. This class contains these properties:

- “Property InputArrayFormat As mwArrayFormat” on page B-11
- “Property InputArrayIndFlag As Long” on page B-11
- “Property OutputArrayFormat As mwArrayFormat” on page B-12
- “Property OutputArrayIndFlag As Long” on page B-12
- “Property AutoResizeOutput As Boolean” on page B-13
- “Property TransposeOutput As Boolean” on page B-13

Property InputArrayFormat As mwArrayFormat. This property of type `mwArrayFormat` controls the formatting of arrays passed as input parameters to builder class methods. The default value is `mwArrayFormatMatrix`. The behaviors indicated by this flag are listed in the following table.

Array Formatting Rules for Input Arrays

Value	Behavior
<code>mwArrayFormatAsIs</code>	Converts arrays according to the default conversion rules listed in “Data Conversion Rules ” on page A-2.
<code>mwArrayFormatCell</code>	Coerces all arrays into cell arrays. Input scalar or numeric array arguments are converted to cell arrays with each cell containing a scalar value for the respective index.
<code>mwArrayFormatMatrix</code>	Coerces all arrays into matrices. When an input argument is encountered that is an array of <code>Variants</code> (the default behavior is to convert it to a cell array), the data converter converts this array to a matrix if each <code>Variant</code> is single valued, and all elements are homogeneous and of a numeric type. If this conversion is not possible, creates a cell array.

Property InputArrayIndFlag As Long. This property governs the level at which to apply the rule set by the `InputArrayFormat` property for nested arrays (an array of `Variants` is passed and each element of the array is an array itself). It is not necessary to modify this flag for `varargin` parameters. The data conversion code automatically increments the value of this flag by 1 for `varargin` cells, thus applying the `InputArrayFormat` flag to each cell of a `varargin` parameter. The default value is 0.

Property `OutputArrayFormat` As `mwArrayFormat`. This property of type `mwArrayFormat` controls the formatting of arrays passed as output parameters to builder class methods. The default value is `mwArrayFormatAsIs`. The behaviors indicated by this flag are listed in the following table.

Array Formatting Rules for Output Arrays

Value	Behavior
<code>mwArrayFormatAsIs</code>	Converts arrays according to the default conversion rules listed in MATLAB® to COM VARIANT Conversion Rules on page A-5.
<code>mwArrayFormatMatrix</code>	Coerces all arrays into matrices. When an output cell array argument is encountered (the default behavior converts it to an array of Variants), the data converter converts this array to a Variant that contains a simple numeric array if each cell is single valued, and all elements are homogeneous and of a numeric type. If this conversion is not possible, an array of Variants is created.
<code>mwArrayFormatCell</code>	Coerces all output arrays into arrays of Variants. Output scalar or numeric array arguments are converted to arrays of Variants, each Variant containing a scalar value for the respective index.

Property `OutputArrayIndFlag` As `Long`. This property is similar to the `InputArrayIndFlag` property, as it governs the level at which to apply the rule set by the `OutputArrayFormat` property for nested arrays. As with the input case, this flag is automatically incremented by 1 for a `varargout` parameter. The default value of this flag is 0.

Property `AutoSizeOutput As Boolean`. This flag applies to Excel ranges only. When the target output from a method call is a range of cells in an Excel worksheet, and the output array size and shape is not known at the time of the call, setting this flag to `True` instructs the data conversion code to resize each Excel range to fit the output array. Resizing is applied relative to the upper-left corner of each supplied range. The default value for this flag is `False`.

Property `TransposeOutput As Boolean`. Setting this flag to `True` transposes the output arguments. This flag is useful when processing an output parameter from a method call on a builder component, where the MATLAB function returns outputs as row vectors, and you desire to place the data into columns. The default value for this flag is `False`.

Property `DataConversionFlags As MWDataConversionFlags`

The `DataConversionFlags` property controls how input variables are processed when type coercion is needed. The `MWDataConversionFlags` class is a noncreatable class accessed through an `MWFlags` class instance. This class contains these properties:

- “Property `CoerceNumericToType As mwDataType`” on page B-13
- “Property `InputDateFormat As mwDateFormat`” on page B-13
- “Property `OutputAsDate As Boolean`” on page B-15
- “Property `DateBias As Long`” on page B-15

Property `CoerceNumericToType As mwDataType`. This property converts all numeric input arguments to one specific MATLAB type. This flag is useful is when variables maintained within the Visual Basic code are different types, e.g., `Long`, `Integer`, etc., and all variables passed to the compiled MATLAB code must be doubles. The default value for this property is `mwTypeDefault`, which uses the default rules in COM VARIANT to MATLAB® Conversion Rules on page A-9.

Property `InputDateFormat As mwDateFormat`. This property converts dates passed as input parameters to method calls on builder classes. The default value is `mwDateFormatNumeric`. The behaviors indicated by this flag are shown in the following table.

Conversion Rules for Input Dates

Value	Behavior
mwDateFormatNumeric	Convert dates to numeric values as indicated by the rule listed in COM VARIANT to MATLAB® Conversion Rules on page A-9.
mwDateFormatString	Convert input dates to strings.

Example. This example uses data conversion flags to reshape the output from a method compiled from a MATLAB function that produces an output vector of unknown length:

```
function p = myprimes(n)
if length(n)~=1, error('N must be a scalar'); end
if n < 2, p = zeros(1,0); return, end
p = 1:2:n;
q = length(p);
p(1) = 2;
for k = 3:2:sqrt(n)
    if p((k+1)/2)
        p(((k*k+1)/2):k:q) = 0;
    end
end
p = (p>0);
```

This function produces a row vector of all the prime numbers from 0 to n.

Assume that this function is included in a class named `myclass` that is included in a component named `mycomponent` with a version of 1.0. The subroutine takes an Excel range and a `Double` as inputs, and places the generated prime numbers into the supplied range. The MATLAB function produces a row vector, although you want the output in column format. It also produces an unknown number of outputs, and you do not want to truncate any output.

To handle these issues, set the `TransposeOutput` flag and the `AutoSizeOutput` flag to `True`. In previous examples, the Visual Basic `CreateObject` function creates the necessary classes. This example uses an

explicit type declaration for the `aClass` variable. As with previous examples, this function assumes that `MWInitApplication` has been previously called.

```
Sub GenPrimes(R As Range, n As Double)
    Dim aClass As mycomponent.myclass

    On Error GoTo Handle_Error
    Set aClass = New mycomponent.myclass
    aClass.MWFlags.ArrayFormatFlags.AutoResizeOutput = True
    aClass.MWFlags.ArrayFormatFlags.TransposeOutput = True
    Call aClass.myprimes(1, R, n)
    Exit Sub
Handle_Error:
    MsgBox (Err.Description)
End Sub
```

PropertyOutputAsDate As Boolean. This property processes an output argument as a date. By default, numeric dates that are output parameters from compiled MATLAB functions are passed as `Doubles` that need to be decremented by the COM date bias (693960) as well as coerced to COM dates. Set this flag to `True` to convert all output values of type `Double`.

PropertyDateBias As Long. This property sets the date bias for performing COM to MATLAB numeric date conversions. The default value of this property is 693960, representing the difference between the COM `Date` type and MATLAB numeric dates. This flag allows existing MATLAB code that already performs the increment of numeric dates by 693960 to be used unchanged with builder components. To process dates with such code, set this property to 0.

Sub Clone(ppFlags As MWFlags)

Creates a copy of an `MWFlags` object.

Parameters.

Argument	Type	Description
ppFlags	MWFlags	Reference to an uninitialized MWFlags object that receives the copy

Return Value. None

Remarks. Clone allocates a new MWFlags object and creates a deep copy of the object's contents. Call this function when a separate object is required instead of a shared copy of an existing object reference.

Class MWStruct

The MWStruct class passes or receives a Struct type to or from a compiled class method. This class contains these properties/methods:

- “Sub Initialize([varDims], [varFieldNames])” on page B-16
- “Property Item([i0], [i1], ..., [i31]) As MWField” on page B-18
- “Property NumberOfFields As Long” on page B-21
- “Property NumberOfDims As Long” on page B-21
- “Property Dims As Variant” on page B-21
- “Property FieldNames As Variant” on page B-21
- “Sub Clone(ppStruct As MWStruct)” on page B-22

Sub Initialize([varDims], [varFieldNames])

Allocates a structure array with a specified number and size of dimensions and a specified list of field names.

Parameters.

Argument	Type	Description
varDims	Variant	Optional array of dimensions
varFieldNames	Variant	Optional array of field names

Return Value. None.

Remarks. When created, an MWStruct object has a dimensionality of 1-by-1 and no fields. The Initialize method dimensions the array and adds a set of named fields to each element. Each time you call Initialize on the same object, it is redimensioned. If you do not supply the varDims argument, the existing number and size of the array's dimensions unchanged. If you do not supply the varFieldNames argument, the existing list of fields is not changed. Calling Initialize with no arguments leaves the array unchanged.

Example. The following Visual Basic code illustrates use of the Initialize method to dimension struct arrays:

```
Sub foo ()
    Dim x As MWStruct
    Dim y As MWStruct

    On Error Goto Handle_Error
    'Create 1X1 struct arrays with no fields for x, and y
    Set x = new MWStruct
    Set y = new MWStruct

    'Initialize x to be 2X2 with fields "red", "green",
    '                                     and "blue"
    Call x.Initialize(Array(2,2), Array("red", "green", "blue"))
    'Initialize y to be 1X5 with fields "name" and "age"
    Call y.Initialize(5, Array("name", "age"))

    'Re-dimension x to be 3X3 with the same field names
    Call x.Initialize(Array(3,3))
End Sub
```

```
'Add a new field to y  
Call y.Initialize(, Array("name", "age", "salary"))  
  
Exit Sub  
Handle_Error:  
    MsgBox(Err.Description)  
End Sub
```

Property Item([i0], [i1], ..., [i31]) As MWField

The Item property is the default property of the MWStruct class. This property is used to set and get the value of a field at a particular index in the structure array.

Parameters.

Argument	Type	Description
i0,i1, ..., i31	Variant	Optional index arguments. 0 to 32 index arguments can be entered. To reference an element of the array, specify all indexes as well as the field name.

Remarks. When accessing a named field through this property, you must supply all dimensions of the requested field as well as the field name. This property always returns a single field value, and generates a bad index error if you provide an invalid or incomplete index list. Index arguments have four basic formats:

Field name only

This format may be used only in the case of a 1-by-1 structure array and returns the named field's value. For example:

```
x("red") = 0.2  
x("green") = 0.4  
x("blue") = 0.6
```

In this example, the name of the `Item` property was neglected. This is possible since the `Item` property is the default property of the `MWStruct` class. In this case the two statements are equivalent:

```
x.Item("red") = 0.2  
x("red") = 0.2
```

Single index and field name

This format accesses array elements through a single subscripting notation. A single numeric index `n` followed by the field name returns the named field on the `n`th array element, navigating the array linearly in column-major order.

For example, consider a 2-by-2 array of structures with fields "red", "green", and "blue" stored in a variable `x`. These two statements are equivalent:

```
y = x(2, "red")  
y = x(2, 1, "red")
```

All indices and field name

This format accesses an array element of a multidimensional array by specifying *n* indices. These statements access all four of the elements of the array in the previous example:

```
For I From 1 To 2
  For J From 1 To 2
    r(I, J) = x(I, J, "red")
    g(I, J) = x(I, J, "green")
    b(I, J) = x(I, J, "blue")
  Next
Next
```

Array of indices and field name

This format accesses an array element by passing an array of indices and a field name. The following example rewrites the previous example using an index array:

```
Dim Index(1 To 2) As Integer

For I From 1 To 2
  Index(1) = I
  For J From 1 To 2
    Index(2) = J
    r(I, J) = x(Index, "red")
    g(I, J) = x(Index, "green")
    b(I, J) = x(Index, "blue")
  Next
Next
```

With these four formats, the `Item` property provides a very flexible indexing mechanism for structure arrays. Also note:

- You can combine the last two indexing formats. Several index arguments supplied in either scalar or array format are concatenated to form one index set. The combining stops when the number of dimensions has been reached. For example:

```
Dim Index1(1 To 2) As Integer
Dim Index2(1 To 2) As Integer

Index1(1) = 1
Index1(2) = 1
Index2(1) = 3
Index2(2) = 2
x(Index1, Index2, 2, "red") = 0.5
```

The last statement resolves to

```
x(1, 1, 3, 2, 2, "red") = 0.5
```

- The field name must be the last index in the list. The following statement produces an error:

```
y = x("blue", 1, 2)
```

- Field names are case sensitive.

Property NumberOfFields As Long

The read-only `NumberOfFields` property returns the number of fields in the structure array.

Property NumberOfDims As Long

The read-only `NumberOfDims` property returns the number of dimensions in the structure array.

Property Dims As Variant

The read-only `Dims` property returns an array of length `NumberOfDims` that contains the size of each dimension of the structure array.

Property FieldNames As Variant

The read-only `FieldNames` property returns an array of length `NumberOfFields` that contains the field names of the elements of the structure array.

Example. The next Visual Basic code sample illustrates how to access a two-dimensional structure array's fields when the field names and dimension sizes are not known in advance:

```
Sub foo ()
    Dim x As MWStruct
    Dim Dims as Variant
    Dim FieldNames As Variant

    On Error Goto Handle_Error
    '
    '... Call a method that returns an MWStruct in x
    '
    Dims = x.Dims
    FieldNames = x.FieldNames
    For I From 1 To Dims(1)
        For J From 1 To Dims(2)
            For K From 1 To x.NumberOfFields
                y = x(I,J,FieldNames(K))
                ' ... Do something with y
            Next
        Next
    Next
Exit Sub
Handle_Error:
    MsgBox(Err.Description)
End Sub
```

Sub Clone(ppStruct As MWStruct)

Creates a copy of an MWStruct object.

Parameters.

Argument	Type	Description
ppStruct	MWStruct	Reference to an uninitialized MWStruct object to receive the copy

Return Value. None

Remarks. Clone allocates a new MWStruct object and creates a deep copy of the object's contents. Call this function when a separate object is required instead of a shared copy of an existing object reference.

Example. The following Visual Basic example illustrates the difference between assignment and Clone for MWStruct objects:

```

Sub foo ()
    Dim x1 As MWStruct
    Dim x2 As MWStruct
    Dim x3 As MWStruct

    On Error Goto Handle_Error
    Set x1 = new MWStruct
    x1("name") = "John Smith"
    x1("age") = 35

    'Set reference of x1 to x2
    Set x2 = x1
    'Create new object for x3 and copy contents of x1 into it
    Call x1.Clone(x3)
    'x2's "age" field is also modified 'x3's "age"
    '      field unchanged
    x1("age") = 50
    .
    .
    .
    Exit Sub
Handle_Error:

```

```
        MsgBox(Err.Description)
    End Sub
```

Class MWField

The `MWField` class holds a single field reference in an `MWStruct` object. This class is noncreatable and contains these properties/methods:

- “Property Name As String” on page B-24
- “Property Value As Variant” on page B-24
- “Property MWFlags As MWFlags” on page B-24
- “Sub Clone(ppField As MWField)” on page B-24

Property Name As String

The name of the field (read only).

Property Value As Variant

Stores the field’s value (read/write). The `Value` property is the default property of the `MWField` class. The value of a field can be any type that is coercible to a `Variant`, as well as object types.

Property MWFlags As MWFlags

Stores a reference to an `MWFlags` object. This property sets or gets the array formatting and data conversion flags for a particular field. Each field in a structure has its own `MWFlags` property. This property overrides the value of any flags set on the object whose methods are called.

Sub Clone(ppField As MWField)

Creates a copy of an `MWField` object.

Parameters.

Argument	Type	Description
ppField	MWField	Reference to an uninitialized MWField object to receive the copy

Return Value. None.

Remarks. Clone allocates a new MWField object and creates a deep copy of the object's contents. Call this function when a separate object is required instead of a shared copy of an existing object reference.

Class MWComplex

The MWComplex class passes or receives a complex numeric array into or from a compiled class method. This class contains these properties/methods:

- “Property Real As Variant” on page B-25
- “Property Imag As Variant” on page B-25
- “Property MWFlags As MWFlags” on page B-26
- “Sub Clone(ppComplex As MWComplex)” on page B-27

Property Real As Variant

Stores the real part of a complex array (read/write). The Real property is the default property of the MWComplex class. The value of this property can be any type coercible to a Variant, as well as object types, with the restriction that the underlying array must resolve to a numeric matrix (no cell data allowed). Valid Visual Basic numeric types for complex arrays include Byte, Integer, Long, Single, Double, Currency, and Variant/vbDecimal.

Property Imag As Variant

Stores the imaginary part of a complex array (read/write). The Imag property is optional and can be Empty for a pure real array. If the Imag property is nonempty and the size and type of the underlying array do not match the size

and type of the `Real` property's array, an error results when the object is used in a method call.

Example. The following Visual Basic code creates a complex array with the following entries:

```
x = [ 1+i 1+2i
      2+i 2+2i ]
Sub foo()
  Dim x As MWComplex
  Dim rval(1 To 2, 1 To 2) As Double
  Dim ival(1 To 2, 1 To 2) As Double

  On Error Goto Handle_Error
  For I = 1 To 2
    For J = 1 To 2
      rval(I,J) = I
      ival(I,J) = J
    Next
  Next
  Set x = new MWComplex
  x.Real = rval
  x.Imag = ival
  .
  .
  .
  Exit Sub
Handle_Error:
  MsgBox(Err.Description)
End Sub
```

Property MWFlags As MWFlags

Stores a reference to an `MWFlags` object. This property sets or gets the array formatting and data conversion flags for a particular complex array. Each `MWComplex` object has its own `MWFlags` property. This property overrides the value of any flags set on the object whose methods are called.

Sub Clone(ppComplex As MWComplex)

Creates a copy of an MWComplex object.

Parameters.

Argument	Type	Description
ppComplex	MWComplex	Reference to an uninitialized MWComplex object to receive the copy

Return Value. None

Remarks. Clone allocates a new MWComplex object and creates a deep copy of the object's contents. Call this function when a separate object is required instead of a shared copy of an existing object reference.

Class MWSparse

The MWSparse class passes or receives a two-dimensional sparse numeric array into or from a compiled class method. This class has these properties/methods:

- “Property NumRows As Long” on page B-27
- “Property NumColumns As Long” on page B-28
- “PropertyRowIndex As Variant” on page B-28
- “Property ColumnIndex As Variant” on page B-28
- “Property Array As Variant” on page B-28
- “Property MWFlags As MWFlags” on page B-28
- “Sub Clone(ppSparse As MWSparse)” on page B-29

Property NumRows As Long

Stores the row dimension for the array. The value of NumRows must be nonnegative. If the value is zero, the row index is taken from the maximum of the values in theRowIndex array.

Property NumColumns As Long

Stores the column dimension for the array. The value of NumColumns must be nonnegative. If the value is 0, the row index is taken from the maximum of the values in the ColumnIndex array.

Property RowIndex As Variant

Stores the array of row indices of the nonzero elements of the array. The value of this property can be any type coercible to a Variant, as well as object types, with the restriction that the underlying array must resolve to or be coercible to a numeric matrix of type Long. If the value of NumRows is nonzero and any row index is greater than NumRows, a bad-index error occurs. An error also results if the number of elements in the RowIndex array does not match the number of elements in the Array property's underlying array.

Property ColumnIndex As Variant

Stores the array of column indices of the nonzero elements of the array. The value of this property can be any type coercible to a Variant, as well as object types, with the restriction that the underlying array must resolve to or be coercible to a numeric matrix of type Long. If the value of NumColumns is nonzero and any column index is greater than NumColumns, a bad-index error occurs. An error also results if the number of elements in the ColumnIndex array does not match the number of elements in the Array property's underlying array.

Property Array As Variant

Stores the nonzero array values of the sparse array. The value of this property can be any type coercible to a Variant, as well as object types, with the restriction that the underlying array must resolve to or be coercible to a numeric matrix of type Double or Boolean.

Property MWFlags As MWFlags

Stores a reference to an MWFlags object. This property sets or gets the array formatting and data conversion flags for a particular sparse array. Each MWSparse object has its own MWFlags property. This property overrides the value of any flags set on the object whose methods are called.

Sub Clone(ppSparse As MWSparse)

Creates a copy of an MWSparse object.

Parameters.

Argument	Type	Description
ppSparse	MWSparse	Reference to an uninitialized MWSparse object to receive the copy

Return Value. None.

Remarks. Clone allocates a new MWSparse object and creates a deep copy of the object's contents. Call this function when a separate object is required instead of a shared copy of an existing object reference.

Example. The following Visual Basic sample creates a 5-by-5 tridiagonal sparse array with the following entries:

```
X = [ 2 -1 0 0 0
      -1 2 -1 0 0
        0 -1 2 -1 0
        0 0 -1 2 -1
        0 0 0 -1 2 ]
```

```
Sub foo()
    Dim x As MWSparse
    Dim rows(1 To 13) As Long
    Dim cols(1 To 13) As Long
    Dim vals(1 To 13) As Double
    Dim I As Long, K As Long

    On Error GoTo Handle_Error
    K = 1
    For I = 1 To 4
        rows(K) = I
        cols(K) = I + 1
```

```
        vals(K) = -1
        K = K + 1
        rows(K) = I
        cols(K) = I
        vals(K) = 2
        K = K + 1
        rows(K) = I + 1
        cols(K) = I
        vals(K) = -1
        K = K + 1
    Next
    rows(K) = 5
    cols(K) = 5
    vals(K) = 2
    Set x = New MWSparse
    x.NumRows = 5
    x.NumColumns = 5
    x.RowIndex = rows
    x.ColumnIndex = cols
    x.Array = vals
        :
        :
        :
    Exit Sub
Handle_Error:
    MsgBox (Err.Description)
End Sub
```

Class MWArg

The MWArg class passes a generic argument into a compiled class method. This class passes an argument for which the data conversion flags are changed for that one argument. This class has these properties/methods:

- “Property Value As Variant” on page B-31
- “Property MWFlags As MWFlags” on page B-31
- “Sub Clone(ppArg As MWArg)” on page B-31

Property Value As Variant

The Value property stores the actual argument to pass. Any type that can be passed to a compiled method is valid for this property.

Property MWFlags As MWFlags

Stores a reference to an MWFlags object. This property sets or gets the array formatting and data conversion flags for a particular argument. Each MWArg object has its own MWFlags property. This property overrides the value of any flags set on the object whose methods are called.

Sub Clone(ppArg As MWArg)

Creates a copy of an MWArg object.

Parameters.

Argument	Type	Description
ppArg	MWArg	Reference to an uninitialized MWArg object to receive the copy

Return Value. None.

Remarks. Clone allocates a new MWArg object and creates a deep copy of the object's contents. Call this function when a separate object is required instead of a shared copy of an existing object reference.

Enumerations

In this section...
“Enum mwArrayFormat” on page B-32
“Enum mwDataType” on page B-32
“Enum mwDateFormat” on page B-33

Enum mwArrayFormat

The `mwArrayFormat` enumeration is a set of constants that denote an array formatting rule for data conversion. The following table lists the members of this enumeration.

mwArrayFormat Values

Constant	Numeric Value	Description
<code>mwArrayFormatAsIs</code>	0	Do not reformat the array.
<code>mwArrayFormatMatrix</code>	1	Format the array as a matrix.
<code>mwArrayFormatCell</code>	2	Format the array as a cell array.

Enum mwDataType

The `mwDataType` enumeration is a set of constants that denote a MATLAB numeric type. The following table lists the members of this enumeration.

mwDataType Values

Constant	Numeric Value	MATLAB Type
<code>mwTypeDefault</code>	0	Not applicable
<code>mwTypeLogical</code>	3	logical
<code>mwTypeChar</code>	4	char

mwDataType Values (Continued)

Constant	Numeric Value	MATLAB Type
mwTypeDouble	6	double
mwTypeSingle	7	single
mwTypeInt8	8	int8
mwTypeUInt8	9	uint8
mwTypeInt16	10	int16
mwTypeUInt16	11	uint16
mwTypeInt32	12	int32
mwTypeUInt32	13	uint32

Enum mwDateFormat

The `mwDateFormat` enumeration is a set of constants that denote a formatting rule for dates. The following table lists the members of this enumeration.

mwDateFormat Values

Constant	Numeric Value	Description
mwDateFormatNumeric	0	Format dates as numeric values.
mwDateFormatString	1	Format dates as strings.

Troubleshooting

This appendix provides a table showing errors you may encounter using MATLAB Builder EX, probable causes for these errors, and suggested solutions.

Note MATLAB Builder EX uses MATLAB Compiler to generate components. This means that you might see diagnostic messages from MATLAB Compiler. See the MATLAB Compiler documentation for more information about those messages.

MATLAB Builder EX Errors and Suggested Solutions

Message	Probable Cause	Suggested Solution
MBUILD.BAT: Error: The chosen compiler does not support building COM objects.	The chosen compiler does not support building COM objects.	Rerun <code>mbuild -setup</code> and choose a supported compiler.
Error in <code>component_name.class_name</code> : Error getting data conversion flags.	Usually caused by <code>mwcomutil.dll</code> not being registered.	Open a DOS window, change folders to <code>matlabroot\runtime\win32</code> (<code>matlabroot</code> represents the location of MATLAB on your system), and run the command <code>mwregsvr mwcomutil.dll</code> .
Error in VBAPProject: ActiveX component can't create object.	<ul style="list-style-type: none"> • Project DLL is not registered. • An incompatible MATLAB DLL exists somewhere on the system path. 	If the DLL is not registered, open a DOS window, change folders to <code><projectdir>\distrib</code> (<code><projectdir></code> represents the location of your project files), and run the command: <code>mwregsvr <projectdll>.dll</code> .

MATLAB Builder EX Errors and Suggested Solutions (Continued)

Message	Probable Cause	Suggested Solution
Error in VBAProject: Automation error The specified module could not be found.	This usually occurs if MATLAB is not on the system path. This error message occurs if you have more than one version of MATLAB on your system path.	Anytime you have multiple versions of MATLAB, ensure that the newest version of MATLAB appears on your path first. You can verify that the newest version of MATLAB is on the path first by typing <code>path</code> at the DOS prompt. See the table Required Locations to Develop and Use Components on page C-5.
LoadLibrary ("component_name.dll") failed - The specified module could not be found.	You may get this error message while registering the project DLL from the DOS prompt. This usually occurs if MATLAB is not on the system path.	See the table Required Locations to Develop and Use Components on page C-5.
Cannot recompile the M file xxxx because it is already in the library libmmfile.mlib.	The name you have chosen for your MATLAB file duplicates the name of a MATLAB file already in the library of precompiled MATLAB files.	Rename the MATLAB file, choosing a name that does not duplicate the name of an MATLAB file already in the library of precompiled MATLAB files.
Arguments may only be defaulted at the end of an argument list.	You have modified the VB script generated for MATLAB Builder EX and have not provided one or more arguments used in the modified script.	Provide a value for any argument that requires an explicit value. Arguments that accept defaults appear at the end of the argument list.
Unable to use accessibility screen-readers or assistive technologies, such as JAWS®,	Required files JavaAccessBridge.dll and WindowsAccessBridge.dll	Add the following DLLs to your Windows path: JavaAccessBridge.dll

MATLAB Builder EX Errors and Suggested Solutions (Continued)

Message	Probable Cause	Suggested Solution
	no longer added automatically to your Windows path.	WindowsAccessBridge.dll

Required Locations to Develop and Use Components

Component	Development Machine	Target Machine
MCR	Make sure that <i>matlabroot</i> \runtime\win32 appears on your system path ahead of any other MATLAB installations. (<i>matlabroot</i> is your root MATLAB folder.)	Verify that <i>mcr_root</i> \ver\runtime\win32 appears on your system path. (<i>mcr_root</i> is your root MCR folder.)

Microsoft Excel Errors and Suggested Solutions

Message	Probable Cause	Suggested Solution
<p>The macros in this project are disabled. Please refer to the online help or documentation of the host application to determine how to enable macros.</p> <p>Note: Wording may vary depending upon the version of Excel you are running.</p>	<p>The macro security for Excel is set to High.</p>	<p>Set Excel macro security to Medium on the Security Level tab by doing the following:</p> <ul style="list-style-type: none"> • For Microsoft Office 2003: <ol style="list-style-type: none"> 1 Click Tools > Macro > Security. 2 For Security Level, select Medium. • For Microsoft Office 2007: <ol style="list-style-type: none"> 1 Click the 2007 Office ribbon. 2 Click Excel Options > Trust Center > Trust Center Settings > Macro Settings. 3 For Security Level, select Medium. • For Microsoft Office 2010: <ol style="list-style-type: none"> 1 Click File > Options > Trust Center > Trust Center Settings > Macro Settings. 2 For Security Level, select Medium.

Function Wizard Problems

Problem	Probable Cause	Suggested Solution
The Function Wizard Help does not appear.	The Function Wizard Help file (mfunction.chm) is not in the same folder as the Function Wizard add-in (mfunction.xla).	Copy the Help file (mfunction.chm) into the same folder as the add-in.

Examples

Use this list to find examples in the documentation.

Using Load and Save

“Using Load/Save Functions to Process MATLAB Data for Deployed Applications” on page 2-19

Programming

“Initializing MATLAB® Builder EX Libraries with Microsoft® Excel” on page 3-4

“Creating an Instance of a Class” on page 3-6

“Calling the Methods of a Class Instance” on page 3-9

“Processing varargin and varargout Arguments” on page 3-11

“Passing an Empty varargin from Microsoft® Visual Basic Code” on page 3-12

“Calling Compiled MATLAB Functions from Microsoft® Excel” on page 3-14

The MCR User Data Interface

“Improving Data Access Using the MCR User Data Interface, COM Components, and MATLAB® Builder EX” on page 3-24

Calling a MATLAB Function from Microsoft Excel

“Magic Square Example ” on page 4-2

Using Multiple Files and Variable Arguments

“Multiple Files and Variable Arguments Example” on page 4-6

Creating a Comprehensive Microsoft Excel Add-In: Spectral Analysis

“Spectral Analysis Example” on page 4-12

Utility Library Classes for COM Components

Chapter 7, “Utility Library for Microsoft COM Components”

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