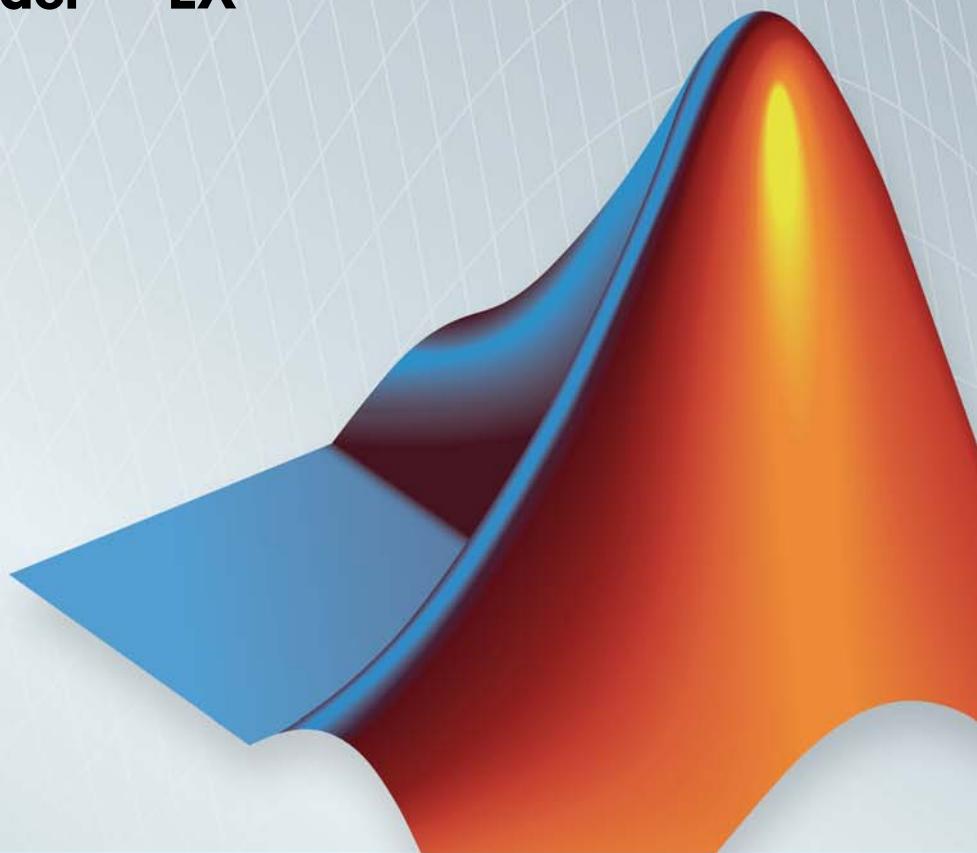


MATLAB® Builder™ EX

User's Guide

R2013a



MATLAB®



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MATLAB® Builder™ EX User's Guide

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Product Description

Deploy MATLAB® code as Microsoft® Excel® add-ins

MATLAB Builder™ EX lets you package MATLAB programs as Microsoft Excel add-ins and integrate them into Excel spreadsheets. These add-ins enable you to perform analyses and simulations within Excel that include MATLAB math, graphics, and GUIs developed in MATLAB. The add-ins can be distributed royalty-free to computers that do not have MATLAB installed using the MATLAB Compiler Runtime (MCR) that is provided with MATLAB Compiler™.

Using MATLAB Compiler, MATLAB Builder EX encrypts your MATLAB programs and then generates Microsoft Visual Basic® for Applications (VBA) wrappers around them so that they behave just like other Excel add-ins.

MATLAB Builder EX creates VBA macros that let you pass Excel worksheet values to a deployed MATLAB program without writing or editing VBA code. It lets you prototype in Excel, debug your MATLAB source code, build the add-in, and load and test it in the worksheet.

Key Features

- Royalty-free distribution of Excel add-ins to computers that do not have MATLAB installed
- Automatic conversion between Excel and MATLAB data types
- One-click VBA macro creation for interacting with a MATLAB application from within Excel
- Ability to prototype in Excel and debug source code in MATLAB

Product Overview

In this section...
“MATLAB® Compiler™ Extension” on page 1-3
“MATLAB® Builder™ EX and COM” on page 1-3

MATLAB Compiler Extension

MATLAB Builder EX lets you package MATLAB programs as Microsoft Excel add-ins and integrate them into Excel spreadsheets. These add-ins enable you to perform analyses and simulations within Excel that include MATLAB math, graphics, and GUIs developed in MATLAB. The add-ins can be distributed royalty-free to computers that do not have MATLAB installed.

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MATLAB Builder EX creates VBA macros that let you pass Excel worksheet values to a deployed MATLAB program without writing or editing VBA code. It lets you prototype in Excel, debug your MATLAB source code, build the add-in, and load and test it in the worksheet.

MATLAB Builder EX and COM

The builder converts MATLAB functions to methods of a class that you define. From this class, the builder creates Excel add-ins (an `.xla` file, in addition to a `.bas` file).

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.

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.

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 “How Does MATLAB® Compiler™ Software Build My Application?” on page 3-4.

MATLAB Builder EX Prerequisites


In this section...
“Your Role in the Deployment Process” on page 1-5
“What You Need to Know” on page 1-7
“Products, Compilers, and IDE Installation” on page 1-7
“Compiler Selection with mbuild -setup” on page 1-8
“Macro Execution Security Levels in Microsoft® Excel®” on page 1-8
“Deployment Target Architectures and Compatibility” on page 1-9
“Dependency and Non-Compilable Code Considerations” on page 1-9
“For More Information” on page 1-10

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.

You may occupy one or more of the following roles.

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 a Microsoft Excel add-in with MATLAB tools. 	See “Create a Microsoft® Excel® Add-In and COM Component” on page 1-15.

Application Deployment Roles, Goals, and Tasks (Continued)




	<ul style="list-style-type: none"> • Package the component for distribution to customers. • Pass the package to the Microsoft Excel developer for further integration into the end-user environment. 	
 End user	<ul style="list-style-type: none"> • Consumes add-in created by MATLAB Programmer. • Uses Function Wizard to customize the add-in and create executable macros. • May roll out the packaged component and integrate it into the end-user environment. 	See “Integrate a Add-In and COM Component with Microsoft® Excel®” on page 1-23
 Microsoft Excel developer	<ul style="list-style-type: none"> • Roll out the packaged component and integrate it into the end-user environment. • Write VB/VBA code to complement or augment the Excel Add-in built by the MATLAB programmer. Add 	See “Overview of the Integration Process ” on page 5-2 “Code Your Microsoft® Visual Basic® Application” on page 5-3

Application Deployment Roles, Goals, and Tasks (Continued)

	<p>and modify code as needed.</p> <ul style="list-style-type: none"> • Verify that the final application executes reliably in the end-user environment. 	
--	--	--

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
 End user	Moderate to expert user of Microsoft Excel
 Microsoft Excel developer	Expert at providing customized Microsoft Excel spreadsheet solutions

Products, Compilers, and IDE Installation

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 “Installing MATLAB Compiler”.

Compiler Selection 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 “Installing MATLAB Compiler”.

If you need information about writing MATLAB files, see the MATLAB documentation.

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

Macro Execution Security Levels in Microsoft Excel


If you will be creating macros and generating add-ins with MATLAB Builder EX, adjust the security settings accordingly in Microsoft Excel.

Failure to do so may result in add-ins not being generated or warning messages sent to MATLAB Compiler

Depending on what version of Microsoft Office you are using, do one of the following:

- For Microsoft Office 2003:
 - 1 Click **Tools > Macro > Security**.
 - 2 For **Security Level**, select **Medium**.
- For Microsoft Office 2007:



- 1** Click the 2007 Office ribbon button ().
 - 2** Click **Excel Options > Trust Center > Trust Center Settings > Macro Settings**.
 - 3** In **Developer Macro Settings**, select **Trust access to the VBA project object model**.
- For Microsoft Office 2010:
 - 1** Click **File > Options > Trust Center > Trust Center Settings > Macro Settings**.
 - 2** In **Developer Macro Settings**, select **Trust access to the VBA project object model**.

Deployment Target Architectures and Compatibility

Before you deploy a component with MATLAB Builder EX, consider if your target machines are 32-bit or 64-bit.

Applications developed on one architecture must be compatible with the architecture on the system where they are deployed.

For example, if you have a 64-bit system, you usually install a 64-bit version of MATLAB (and most other applications), by default. Running functions you have developed with a 64-bit version of MATLAB requires a Function Wizard installed with a 64-bit version of Microsoft Excel.

Migration Considerations for 32-bit and 64-bit Microsoft Excel

If you are migrating to the 64-bit version of Microsoft Excel, you *must* uninstall the 32-bit version of MATLAB Builder EX *before* installing the 64-bit version of Microsoft Excel.

Dependency and Non-Compilable Code Considerations

Before you deploy your code, examine the code for dependencies on functions that may not be compatible with MATLAB Compiler.

For more detailed information about dependency analysis (`depfun`) and how MATLAB Compiler evaluates MATLAB code prior to compilation, see “Write Deployable MATLAB Code” in the MATLAB Compiler documentation.

For More Information

If you...	See...
Want to verify your MATLAB code or function can be deployed successfully	“Write Deployable MATLAB Code”
Know your function is deployable and want to select a Getting Started workflow	“Choosing Function Deployment Workflow” on page 1-11

Choosing Function Deployment Workflow

In this section...
“Is Your Function Ready for Deployment?” on page 1-11
“Other Examples” on page 1-11

Is Your Function Ready for Deployment?

If These Statements are True...	See...
<ul style="list-style-type: none"> • I have a MATLAB function that conforms to guidelines in “Write Deployable MATLAB Code”. • I want to create a Microsoft Excel compatible add-in from my existing MATLAB function. • I have tested and debugged my MATLAB function with MATLAB. 	<p>“Create a Microsoft® Excel® Add-In and COM Component” on page 1-15 to build your add-in and</p> <p>“Integrate a Add-In and COM Component with Microsoft® Excel®” on page 1-23 to execute the newly built add-in and create macros and associated GUIs with the Function Wizard and Microsoft Excel.</p>
<ul style="list-style-type: none"> • I have not yet developed a MATLAB function for deployment as an add-in or I am in the process of developing it. • I have not tested my MATLAB function thoroughly with MATLAB. 	<p>“End-to-End Deployment of a MATLAB Function Using the Function Wizard” on page 2-22 for an end-to-end example of creating, debugging, building, and packaging MATLAB function from scratch using the Function Wizard.</p>

Other Examples

For other types of examples, see the following:

- “Execute a Graphical Function” on page 4-11
- “Create Dialog Box and Error Message Macros” on page 4-15

- “Work with Variable-Length Inputs and Outputs” on page 4-5
- MATLAB Central. Set the Search field to File Exchange and search for one or more of the following:
 - InterpExcelDemo
 - MatrixMathExcelDemo
 - ExcelCurveFit

The Magic Square Example

In this section...
“About the Magic Square Example” on page 1-13
“Example File Copying” on page 2-26

About the Magic Square Example

The `mymagic` function wraps a MATLAB function, `magic`, which computes a magic square, a function with multidimensional matrix output. You can use this example as a template for deploying functions with no output, scalar output, or multidimensional matrix output.

In the Magic Square example, the MATLAB programmer first deploys the `mymagic` function as a component by adding it to the `xlmagicclass` class, along with other files needed to deploy the application. The MATLAB programmer then builds a deployable add-in and associated COM component with MATLAB Builder EX.

After the add-in has been built, the end user accepts the newly-built add-in from the MATLAB programmer and uses the Function Wizard (which is included in the MATLAB Compiler Runtime) to incorporate the add-in to a Excel spreadsheet. The end user can also create a macro from this add-in, as well as a GUI button, to generate a Magic Square automatically.

This example uses the `deploytool` GUI. For examples using the `mcc` command, see the `mcc` reference page for complete reference information.

The MATLAB programmer usually performs the following tasks.

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.

Example File Copying

All MATLAB Builder EX examples reside in `matlabroot\toolbox\matlabx1\examples\`. The following table identifies examples by folder:


For Example Files Relating To...	Find Example Code in Folder...	For Example Documentation See...
Magic Square Example	xlmagic	“Create a Microsoft® Excel® Add-In and COM Component” on page 1-15 “Integrate a Add-In and COM Component with Microsoft® Excel®” on page 1-23
Variable-Length Argument Example	xlmulti	“Work with Variable-Length Inputs and Outputs” on page 4-5
Calling Compiled MATLAB Functions from Microsoft Excel	xlbasic	“Calling Compiled MATLAB Functions from Microsoft® Excel®” on page 6-5
Spectral Analysis Example	xlspectral	“Build and Integrate with Spectral Analysis” on page 5-18

Create a Microsoft Excel Add-In and COM Component

In this section...

- “mymagic Testing” on page 2-26
- “Deployable Component Creation” on page 1-16
- “Add-in Packaging (Recommended)” on page 1-19
- “Package Copying” on page 1-22

MATLAB Programmer

Role	Knowledge Base	Responsibilities
 MATLAB programmer	<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

Key Tasks for the MATLAB Programmer

Task	Reference
Verify that the MATLAB code is suitable for deployment.	“mymagic Testing” on page 2-26
Create a Microsoft Excel add-in component (encapsulating your MATLAB code in a COM wrapper) by running the Build function in <code>deploytool</code> .	“Deployable Component Creation” on page 1-16
Prepare to run the Packaging Tool by determining what additional files to include with the deployed component.	“Add-in Packaging (Recommended)” on page 1-19
Copy the output from the Packaging Tool (the <code>distrib</code> folder).	“Package Copying” on page 1-22

mymagic Testing

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** In MATLAB, locate `mymagic.m`. See “Example File Copying” on page 2-26 for locations of examples. 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 2001-2012 The MathWorks, Inc.
% $Revision: 1.1.8.3.6.1 $      $Date: 2012/12/15 20:00:38 $

y = magic(x)
```

- 2** At the MATLAB command prompt, enter `mymagic(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
```

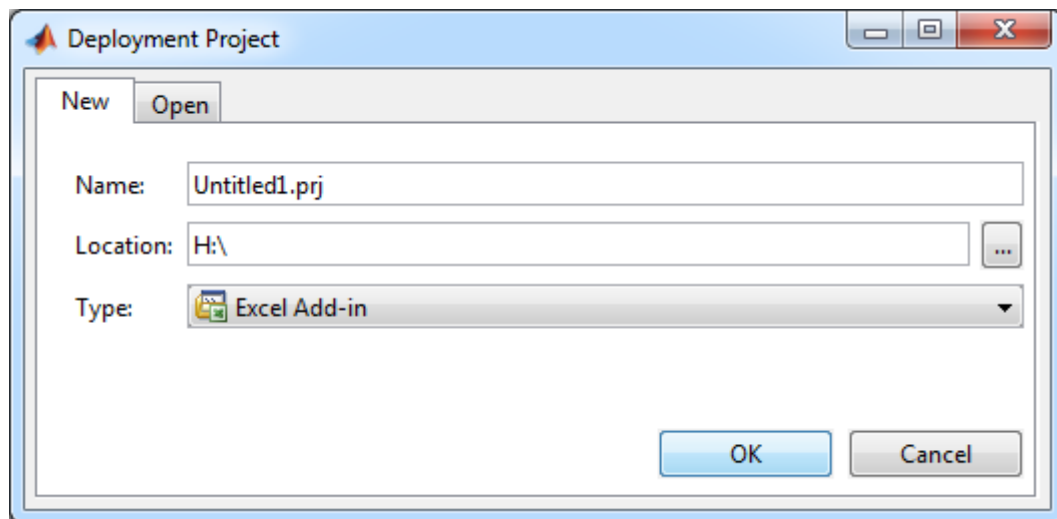
Deployable Component Creation

You create the COM component that runs your Excel add-in 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 “mymagic Testing” on page 2-26.

Use the following information when creating your add-in 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 Deployment Project dialog box opens.



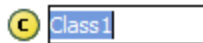
The Deployment Project Dialog Box

- 3 Create a deployment project using the Deployment Project dialog box:
 - a 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 **Type** drop-down menu.
 - d Click **OK**.

Tip You can inspect the values in the Settings dialog before building your project. To do so, click the Action icon () on the toolbar, and then click **Settings**. Verify where your `src` and `distrib` folders will be created because you will need to reference these folders later.

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** then click **Open** to select the file or 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.

Note If you are building a COM component or add-in and you don't have administrator privileges, you can select the **Register the resulting component for you only on the development machine** option in the **Settings** dialog of the Deployment Tool (in the **Advanced** tab) or use the `mcc -u` option.

- 5 When you complete your changes, click the Build button () . When the build finishes, click **Close** to dismiss the dialog box.

What Gets Built?

After you build your add-in with the Deployment Tool, you have the following in the `src` and `distrib` subdirectories of your project directory:

These Subdirectories of the Project Directory:	Contain these files:
src	<ul style="list-style-type: none"> • C and C++ COM component source files (intermediary files)
distrib	<ul style="list-style-type: none"> • .xla file (the add-in) • .bas file (the generated VBA code that can be customized by the Excel Developer) • .dll component (the code that runs the add-in) • readme.txt

Specifying MCR Options

To specify MCR run-time options, such as `-nojvm` and `-logfile`, see “MCR Run-Time Options” on page 6-16 for details.

Caution These options, while usually specified by the MATLAB programmer at build time, are advanced and should only be invoked on advice from the Excel developer or your system administrator.

Add-in Packaging (Recommended)

About Packaging for MATLAB Builder EX Components

Packaging is an optional step for many of the MATLAB Builder products. However, some MATLAB Builder EX customers find it helpful to run the packaging tool because that tool generates a self-extracting file that *automatically registers* the DLL and unpacks all deployable deliverables.

When you run the packaging tool, MATLAB Builder EX first attempts to register the component to all users on the machine. This generally requires administrator privileges, however. If it cannot do this, it defaults to attempting to register under the current user name. For additional

registration options, see “Add-in and COM Component Registration” on page 1-25.

If you run the packaging tool, there is no need to manually register your DLL component as explained in “Add-in and COM Component Registration” on page 1-25.

Packaging Wizard

On the **Package** tab, add the MATLAB Compiler Runtime (MCR). To do so, click **Add MCR**. There are two packaging options from which to choose: **Embed the MCR in the Package** or **Add a batch file to invoke the MCR over the network**.

Note As of R2012a, you can now download the MCR over the Web as opposed to packaging it. See the MATLAB Compiler product page for full details.

Embed the MCR in the Package. This option physically copies the MCR Installer file into the package you create. Use this option when:


- 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.

Note Distributing the MCR Installer with each application requires more resources.

Add a Batch File to Invoke the MCR Over the Network. This option lets you add a link to an MCR Installer residing on a local area network. Adding such a link allows you to invoke the installer over the network, as opposed to copying the installer physically into the deployable package. The builder sets up a script to install the MCR from a specified network location, saving time and resources. Use this option when:

- 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 when deploying applications. 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.

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.

- 1** Select either **Embed the MCR in the Package** or **Add a batch file to invoke the MCR over the network**.
- 2** Add to the package any other files or folders you feel may be useful to end users.
 - a** Click **Add file/directories**.
 - b** Select the file or folder you want to package.
 - c** Click **Open**.
- 3** In the Deployment Tool, click the Packaging icon ()
- 4** Choose to package your deployment as either a **Self-extracting executable** or as a **ZIP file** by selecting the appropriate option in the **Save as type** drop-down box.
- 5** Click **Save**.
- 6** Verify that the contents of the `distrib` folder contains the files you specified.

Package Copying

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

Integrate a Add-In and COM Component with Microsoft Excel

In this section...

“Files Necessary for Deployment” on page 1-24


“Add-in and COM Component Registration” on page 1-25

“COM Component Incorporation into Microsoft Excel using the Function Wizard” on page 1-26

“Distributing MATLAB Code Using the MATLAB Compiler Runtime (MCR)” on page 6-2

“Add-in Installation and Distribution” on page 1-29

End User

Role	Knowledge Base	Responsibilities
 End user	<ul style="list-style-type: none"> • No MATLAB experience • Some knowledge of the data that is being displayed, but not how it was created 	<ul style="list-style-type: none"> • In Web environments, consumes what the front-end developer creates • Integrates MATLAB code with other third-party applications, such as Excel

The end user performs these tasks. Print this documentation or send other customers a Web link to these instructions on the MathWorks® documentation site.

Key Tasks for the Microsoft Excel End User

Task	Reference
Verify that you have received all necessary files from the MATLAB programmer.	“Files Necessary for Deployment” on page 1-24
Verify registry permissions for the add-in file and associated component.	“Add-in and COM Component Registration” on page 1-25
Execute your generated functions and create macros.	“Executing Functions and Creating Macros Using the Function Wizard” on page 2-2
Install the MATLAB Compiler Runtime on target systems and update system paths.	“Distributing MATLAB Code Using the MATLAB Compiler Runtime (MCR)” on page 6-2
Use the Excel add-in.	“Add-in Installation and Distribution” on page 1-29

For general information about the Magic Square example and MATLAB programmer and end user’s associated tasks pertaining to the example, see “The Magic Square Example” on page 1-13.

Files Necessary for Deployment

Before beginning, verify that you have access to the following files, created by the MATLAB programmer in “Package Copying” on page 1-22. Customers who do not have a copy of MATLAB installed need these files:

- The MCR Installer. For locations of all MCR Installers, run the `mcrinstaller` command.
- `.xla` file (the add-in)
- `.bas` file (the generated VBA code)
- `.dll` file
- `readme.txt`

Add-in and COM Component Registration

Note If the MATLAB programmer ran the Packaging Tool in “Add-in Packaging (Recommended)” on page 1-19 you do *not* need to manually register your DLL using the instructions in this section.

When you create your COM component, it is registered in either HKEY_LOCAL_MACHINE or HKEY_CURRENT_USER, based on your log-in privileges.

If you find you need to change your run-time permissions due to security standards imposed by Microsoft or your installation, you can do one of the following before deploying your COM component or add-in:

- Log on as administrator before running your COM component or add-in
- Run the following `mwregsvr` command prior to running your COM component or add-in, as follows:

```
mwregsvr [/u] [/s] [/useronly] project_name.dll
```

where:

- `/u` allows any user to unregister a COM component or add-in for this server
- `/s` runs this command silently, generating no messages. This is helpful for use in silent installations.
- `/useronly` allows only the currently logged-in user to run the COM component or add-in on this server

Caution If your COM component is registered in the USER hive, it will not be visible to Windows Vista™ or Windows® 7 users running as administrator on systems with UAC (**User Access Control**) enabled.

If you register a component to the USER hive under Windows 7 or Windows Vista, your COM component may fail to load when running with elevated (administrator) privileges.

If this occurs, do the following to re-register the component to the LOCAL MACHINE hive:

- 1 Unregister the component with this command:

```
mwregsvr /u /useronly my_dll.dll
```

- 2 Reregister the component to the LOCAL MACHINE hive with this command:

```
mwregsvr my_dll.dll
```

COM Component Incorporation into Microsoft Excel using the Function Wizard

Now that your add-in and COM component have been created, use the Function Wizard to integrate the COM component into Microsoft Excel.

See “Executing Functions and Creating Macros Using the Function Wizard” on page 2-2 for a complete example of how to execute functions and create macros using the Magic Square example in this chapter.

Distributing MATLAB Code Using the MATLAB Compiler Runtime (MCR)

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

Install MATLAB Compiler Runtime (MCR)

The *MATLAB Compiler Runtime (MCR)* is an execution engine made up of the same shared libraries MATLAB uses to enable execution of MATLAB files on systems without an installed version of MATLAB.

The MATLAB Compiler Runtime (MCR) is now available for downloading from the Web to simplify the distribution of your applications or components created with the MATLAB Compiler. Download the MCR from the MATLAB Compiler product page.

The MCR 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

MCR Prerequisites

- 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.
- 3 Avoid installing the MCR in MATLAB installation directories.


Add the MCR Installer To Your Deployment Package (Optional)

The example shows how to optionally include the MCR in your deployment package, using the Deployment Tool. A *package* is a zipped (compressed) file containing all files needed to run the standalone application or shared library built with MATLAB Compiler.

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

Select one of the following options:

- **Embed the MCR in the package** — This option adds the MCR to the Deployment package, which contains all the files needed to run the standalone application or shared library built with MATLAB Compiler. Choosing this option adds `MCRInstaller.exe` to your package, which can increase the size of the package substantially.
- **Add a batch file to invoke the MCR over the network** — The option adds a batch file that, when executed, invokes the MCR from a single location on your network. You must customize this file to point to the location of the MCR on your network. Choosing this option adds `MCRInstaller.cmd` to your package.

Click the Package button ()

In the Package dialog box, navigate to the location where you want to save the package file. In the **File name** field, enter a name for the package file (for example, `libmatrixp.exe`).

Click **Save**. The Package dialog appears and your package is created in the location specified. When packaging is complete, click **Close** to dismiss the dialog box.

Distribute the package file as needed to additional end users.

Installing the MCR

This example shows how to install the MATLAB Compiler Runtime (MCR) on a system.

Locate the MCR Installer that was either packaged with the Deployment Tool or downloaded from the Web.

Run the installer as you would any other executable on your system, following the Wizard instructions.

Note 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 MATLAB Compiler on Mac or Linux®” for detailed information on performing all deployment tasks specifically with UNIX variants such as Linux and Mac.

Add-in Installation and Distribution

Since Microsoft Excel add-ins are written directly to the `distrib` folder by MATLAB Builder EX, you and your end users install them exactly as you installed the Function Wizard in “Installation of the Function Wizard” on page 2-27.

Calling Add-in Code from the Excel Spreadsheet

To run the executable code from a cell in the Excel spreadsheet, invoke the add-in name with a method call. For example, if you deployed a piece of MATLAB code called `mymagic.m`, or a figure called `mymagic.fig`, you invoke that code by entering the following in a cell in the spreadsheet:

```
=mymagic()
```

Tip If the method call does not evaluate immediately, press **Ctrl**, **Shift**, and **Enter** simultaneously.

Next Steps

The following topics detail some of the more common tasks you perform as you continue to develop your applications.

To:	See:
Try more examples using MATLAB Builder EX	MATLAB Central. Set the Search field to File Exchange and search for one or more of the following: <ul style="list-style-type: none"> • InterpExcelDemo • MatrixMathExcelDemo • ExcelCurveFit
Learn how to write MATLAB code that is optimized for deployability	“Write Deployable MATLAB Code”
Work with functions having graphical output	“Execute a Graphical Function” on page 4-11
Work with functions having variable inputs and output	“Work with Variable-Length Inputs and Outputs” on page 4-5
Create displayable dialog boxes and error messages	“Create Dialog Box and Error Message Macros” on page 4-15

To:	See:
Troubleshoot common error messages	Appendix B, “Troubleshooting”
Integrate your application into your enterprise environment by enhancing your application’s generated Visual Basic code	“Code Your Microsoft® Visual Basic® Application” on page 5-3


The Function Wizard

- “Executing Functions and Creating Macros Using the Function Wizard” on page 2-2
- “End-to-End Deployment of a MATLAB Function Using the Function Wizard” on page 2-22

Executing Functions and Creating Macros Using the Function Wizard

In this section...
“What Can the Function Wizard Do for Me?” on page 2-25
“Installation of the Function Wizard” on page 2-27
“Function Wizard Start-Up” on page 2-29
“Workflow Selection for MATLAB Functions Ready for Deployment” on page 2-7
“Defining Functions Ready to Execute” on page 2-8
“Function Execution” on page 2-17
“Macro Creation” on page 2-17
“Macro Execution” on page 2-47
“Microsoft® Visual Basic® Code Access (Optional Advanced Task)” on page 2-49
“For More Information” on page 2-21

End User

Role	Knowledge Base	Responsibilities
 End user	<ul style="list-style-type: none"> No MATLAB experience Some knowledge of the data that is being displayed, but not how it was created 	<ul style="list-style-type: none"> In Web environments, consumes what the front-end developer creates Integrates MATLAB code with other third-party applications, such as Excel

If your MATLAB function is ready to be deployed and you have already built your add-in and COM component with the Deployment Tool, follow this workflow to incorporate your built COM component into Microsoft Excel using the Function Wizard. To follow the workflow in this section effectively, you must already be running “The Magic Square Example” on page 1-13.

The Function Wizard also allows you to iteratively test, develop, and debug your MATLAB function. Using this end-to-end workflow assumes you are still be in the process of developing your MATLAB function for deployment. See “End-to-End Deployment of a MATLAB Function Using the Function Wizard” on page 2-22 for complete instructions for this workflow.

See “Choosing Function Deployment Workflow” on page 1-11 for further details.

Key Tasks for the End User

Task	Reference
1. Install the Function Wizard.	“Installation of the Function Wizard” on page 2-27
2. Start the Function Wizard.	“Function Wizard Start-Up” on page 2-29
3. Select the option to incorporate your built COM component into Microsoft Excel.	“Workflow Selection for MATLAB Functions Ready for Deployment” on page 2-7
4. Define the new MATLAB function you want to prototype by adding it to the Function Wizard and establishing input and output ranges.	“Defining Functions Ready to Execute” on page 2-8
5. Test your MATLAB function by executing it with the Function Wizard.	“Function Execution” on page 2-17
6. Create a macro.	“Macro Creation” on page 2-17
7. Execute the macro you created using the Function Wizard.	“Macro Execution” on page 2-47
8. Optionally inspect or modify the Microsoft Visual Basic code you generated with the COM component. Optionally, attach the macro you created to a GUI button.	“Microsoft® Visual Basic® Code Access (Optional Advanced Task)” on page 2-49

What Can the Function Wizard Do for Me?

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.

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

Installation of the Function Wizard


Before you can use the Function Wizard, you must first install it as an add-in that is accessible from Microsoft Excel.

After you install the Function Wizard, the entry **MATLAB Functions** appears as an available Microsoft Excel add-in button.

Using Office 2007

- 1 Start Microsoft Excel if it is not already running.



- 2 Click the Office Button () and select **Excel Options**.
- 3 In the left pane of the Excel Options dialog box, click **Add-Ins**.
- 4 In the right pane of the Excel Options dialog box, select **Excel Add-ins** from the **Manage** drop-down box.
- 5 Click **Go**.

- 6 Click **Browse**. Navigate to *matlabroot\toolbox\matlabxl\matlabxl\arch* and select *FunctionWizard2007.xlam*. Click **OK**.
- 7 In the Excel Add-Ins dialog box, verify that the entry **MATLAB Builder EX Function Wizard** is selected. Click **OK**.

Using 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 box, click **Browse**.
- 6 Browse to *matlabroot\toolbox\matlabxl\matlabxl\arch*, and select *FunctionWizard2007.xlam*. Click **OK**.
- 7 In the Excel Add-Ins dialog, verify that the entry **MATLAB Builder EX Function Wizard** is selected. Click **OK**.

The Home tab of the Microsoft Office Ribbon should now contain the Function Wizard tile. See The Home Tab of the Microsoft® Office Ribbon with Function Wizard Installed on page 2-29.

Using Office 2003

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

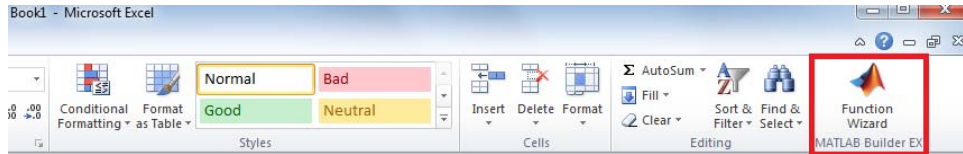
If the Function Wizard was not previously installed, click **Browse** and navigate to *matlabroot\toolbox\matlabxl\matlabxl* folder. Select *FunctionWizard.xla*. Click **OK** to proceed.

Function Wizard Start-Up

Start the Function Wizard in one of the following ways. When the wizard has initialized, the Function Wizard Start Page dialog box displays.

Using Office 2007 or Office 2010

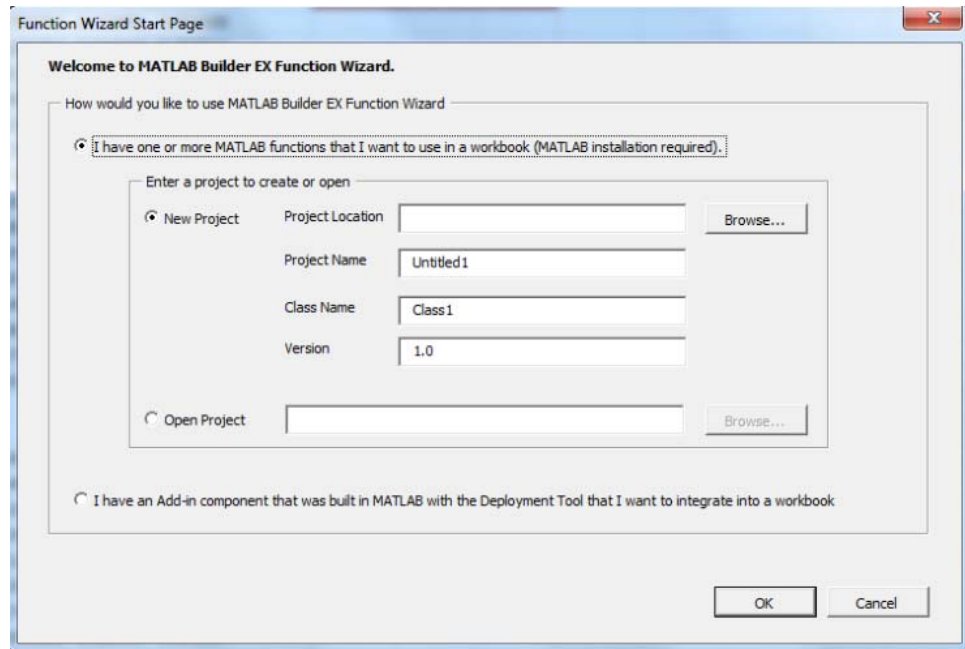
In Microsoft Excel, on the Microsoft Office ribbon, on the **Home** tab, select **MATLAB Functions**.



The Home Tab of the Microsoft® Office Ribbon with Function Wizard Installed

Using Office 2003

- 1 Select **Tools > Add-Ins** from the Excel main menu.
- 2 Select **Function Wizard**.

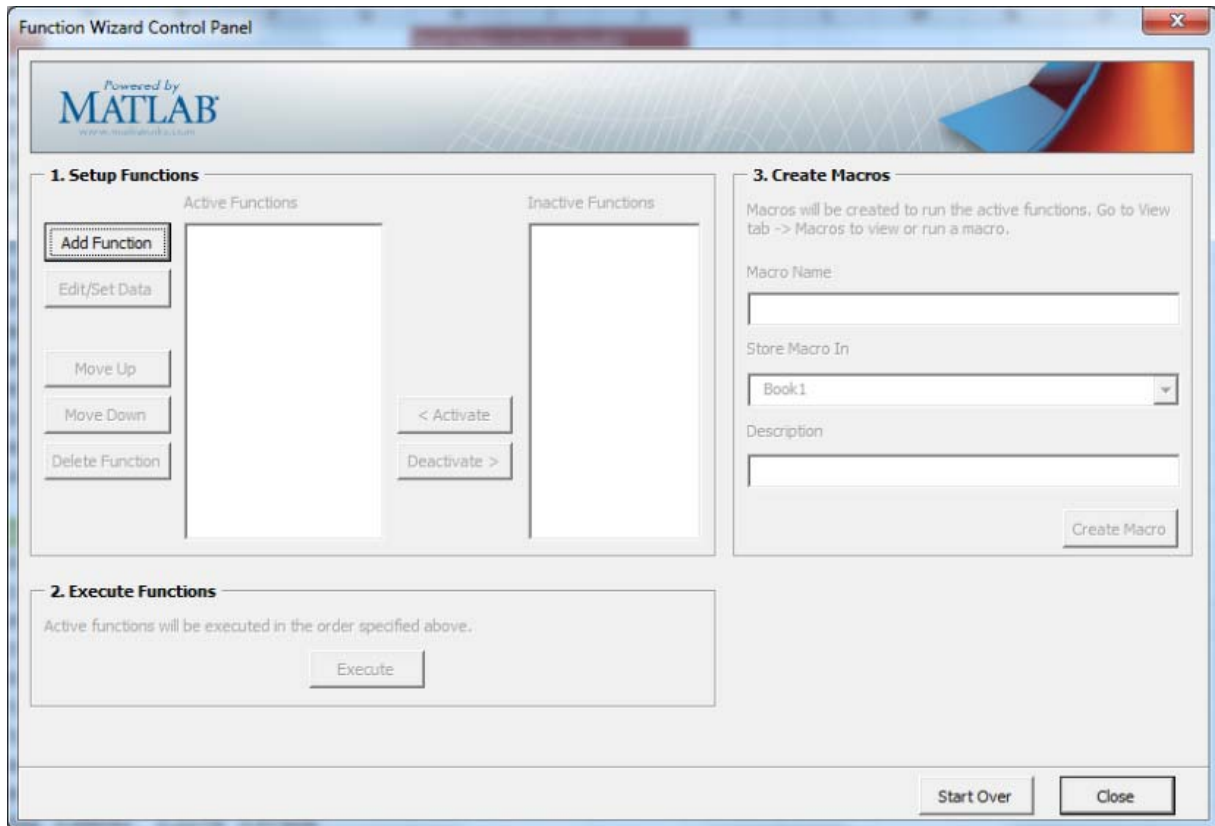


The Function Wizard Start Page Dialog Box

Workflow Selection for MATLAB Functions Ready for Deployment

After you have installed and started the Function Wizard, do the following:

- 1** From the Function Wizard Start Page, select the option **I have an Add-in component that was built in MATLAB with the Deployment Tool that I want to integrate into a workbook.**
- 2** Click **OK**. The Function Wizard Control Panel opens with the **Add Function** button enabled..



The Function Wizard Control Panel for Working with MATLAB Functions Ready for Deployment

Tip To return to the Function Wizard Start Page, click **Start Over**.

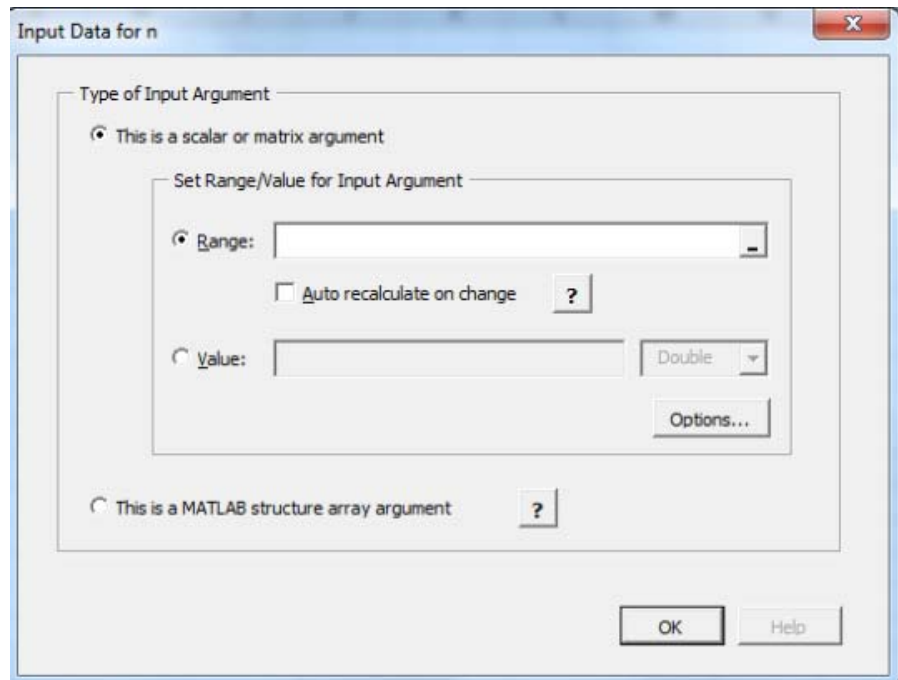
Defining Functions Ready to Execute

- 1 Define the function you want to execute to the Function Wizard. Click **Add Function** in the Set Up Functions area of the Function Wizard Control Panel. The MATLAB Components dialog box opens.
- 2 In the Available Components area of the MATLAB Components dialog box, select the name of your component (xlmagic) from the drop-down box.

- 3 Select the function you want to execute (mymagic) from the box labeled **Functions for Class xlmagic**.
- 4 Click **Add**. The Function Properties dialog box opens.

Tip The **Function Syntax and Help** area, in the Function Properties dialog box, displays the first help text line (sometimes called the *H1 line*) in a MATLAB function. Displaying these comments in the Function Properties dialog box can be helpful when deploying new or unfamiliar MATLAB functions to end-users.

- 5 Define input argument properties as follows.
 - a On the **Input** tab, click **Set Input Data**. The Input Data for *n* dialog box opens.



- b** Specify a **Range** or **Value** by selecting the appropriate option and entering the value. If the argument refers to a *structure array (struct)*, select the option **This is a MATLAB structure array argument**. See “Working with Struct Arrays” on page 2-38 for information on assigning ranges and values to fields in a struct array.

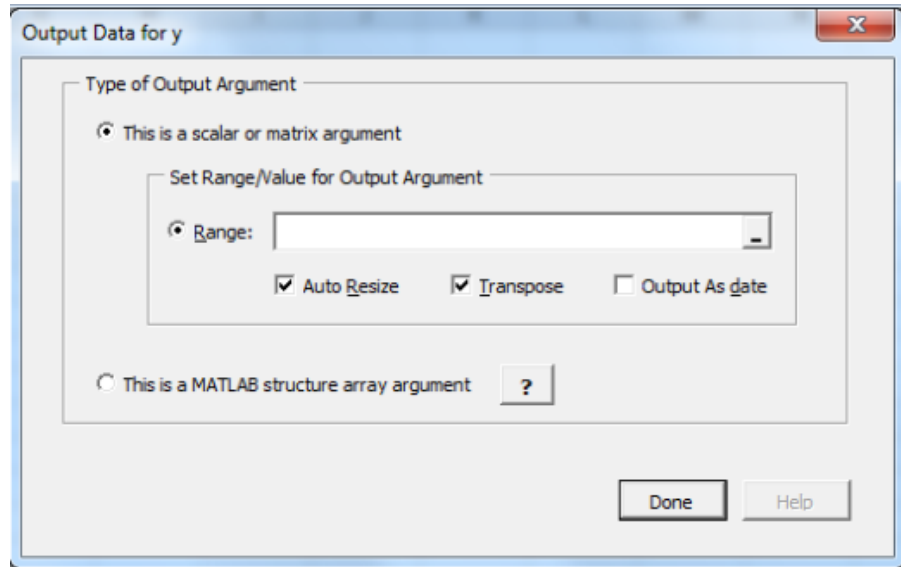
Caution Avoid selecting ranges using arrow keys. If you must use arrow keys to select ranges, apply the necessary fix from the Microsoft site: <http://support.microsoft.com/kb/291110>.

Note Select the **Auto Recalculate on Change** option to force Microsoft Excel to automatically recalculate the spreadsheet data each time it changes.

- c** Click **OK**.

Tip To specify how MATLAB Builder EX handles blank cells (or cells containing no data), see “Empty Cell Value Control” on page 2-37.

- 6** Define output argument properties as follows.
 - a** On the **Output** tab, click **Set Output Data**. The Output Data for y dialog box appears, where y is the name of the output variable you are defining properties of.

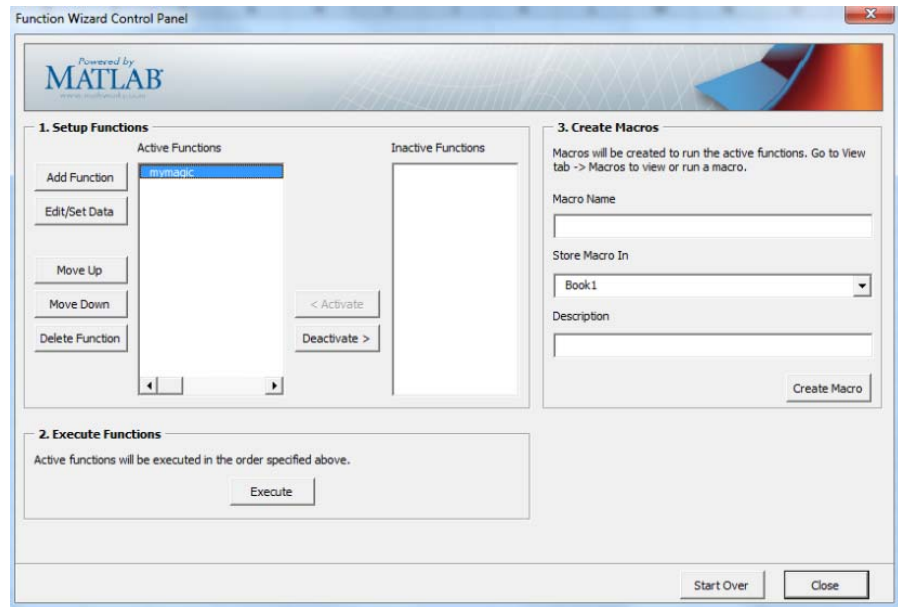


Tip You can also specify MATLAB Builder EX to **Auto Resize**, **Transpose** or output your data in date format (**Output as date**). To do so, select the appropriate option in the Argument Properties for *y* dialog box.

- b** Specify a **Range**. Alternately, select a range of cells on your Excel sheet; the range will be entered for you in the **Range** field.

Caution Avoid selecting ranges using arrow keys. If you must use arrow keys to select ranges, apply the necessary fix from the Microsoft site: <http://support.microsoft.com/kb/291110>.

- c** Select **Auto Resize** if it is not already selected.
- d** Click **Done** in the Output Data for *y* dialog box.
- e** Click **Done** in the Function Properties dialog box.



mymagic now appears in the **Active Functions** list of the Function Wizard Control Panel.

Empty Cell Value Control

You can specify how MATLAB Builder EX processes empty cells, allowing you to assign undefined or unrepresented (NaN, for example) data values to them.

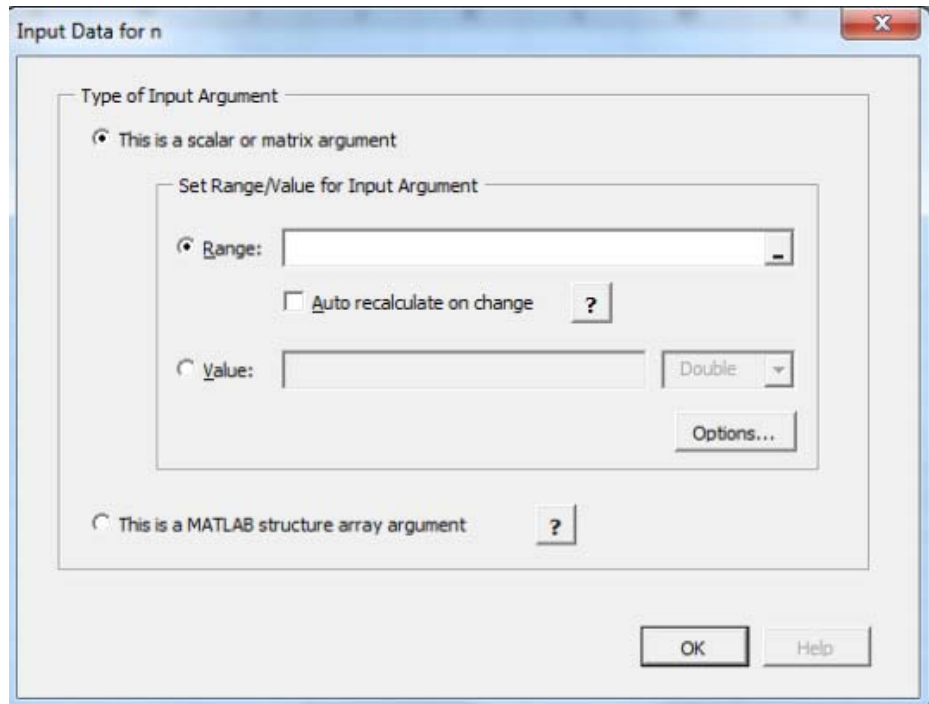
To specify how to handle empty cells, do the following.

- 1 Click **Options** in the Input Data for N dialog box.
- 2 Click the **Treat Missing Data As** drop-down box.
- 3 Specify either **Zero** or **NaN (Not a Number)**, depending on how you want to handle empty cells.

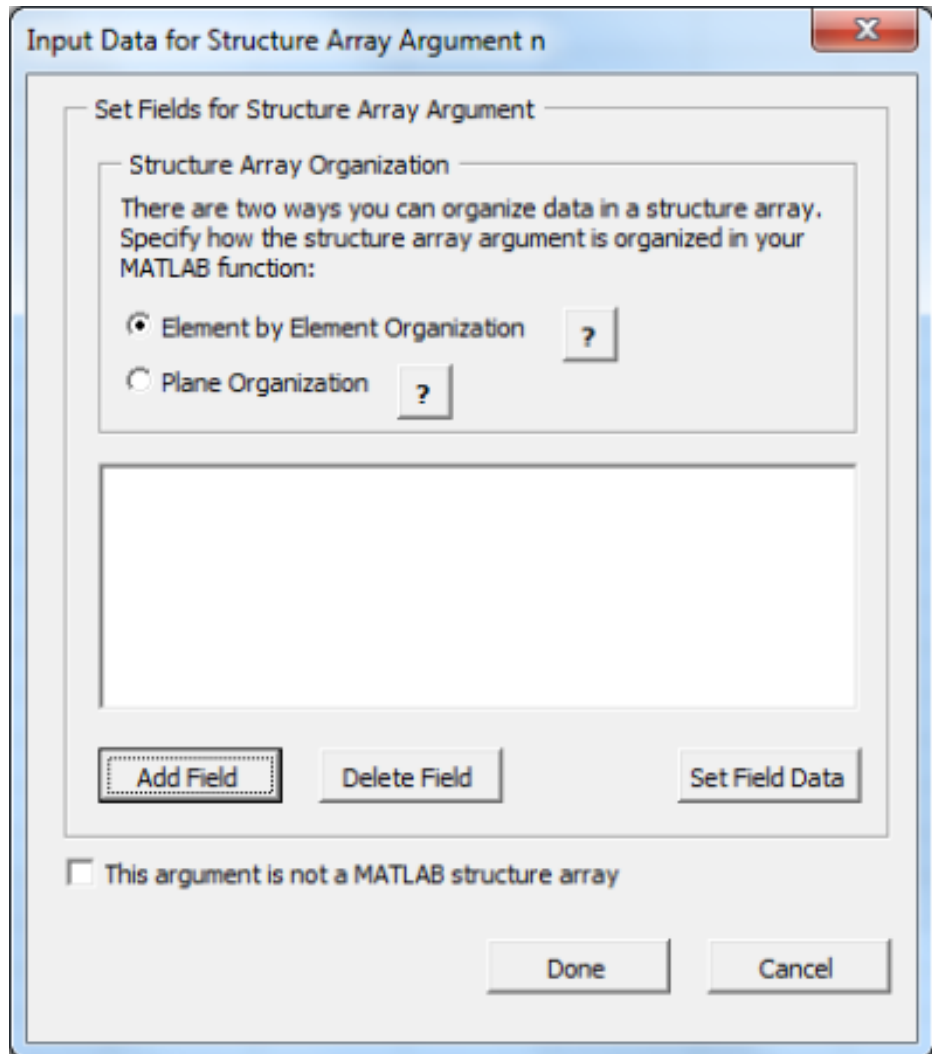
Working with Struct Arrays

To assign ranges to fields in a struct array, do the following:

- 1 If you have not already done so, select **This is a MATLAB structure array argument** in the Input Data for n dialog box and click **OK**.



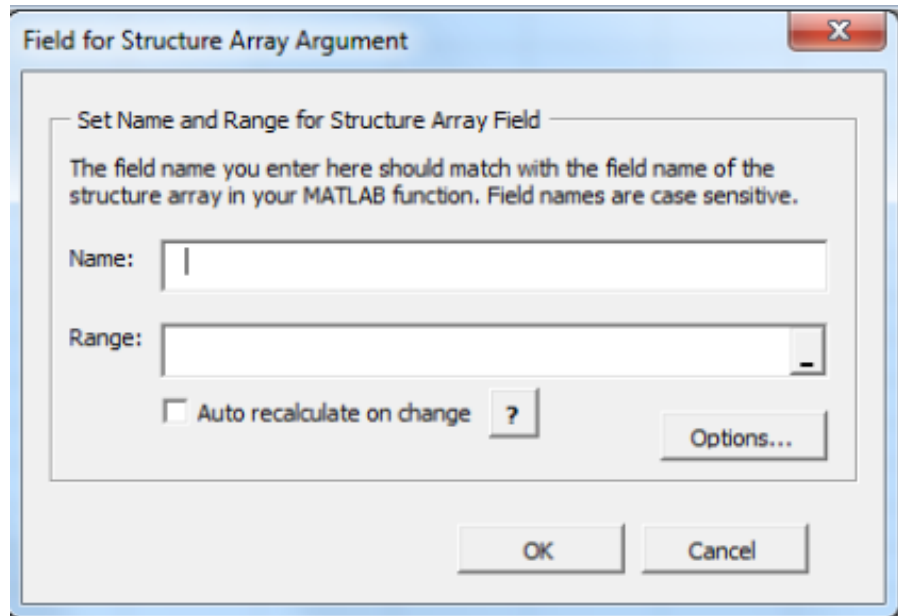
The Input Data for Structure Array Argument n dialog box opens.



- 2** The Function Wizard supports Vector and Two-dimensional struct arrays organized in either Element by Element or Plane organization, for both input and output.

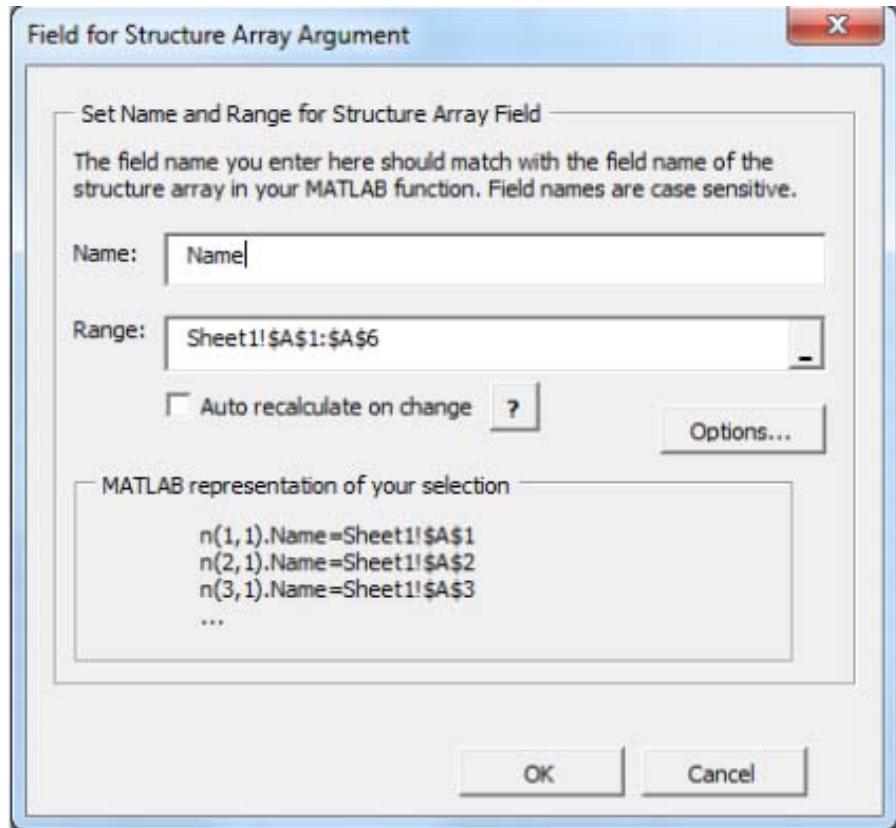
In the Input Data for Structure Array Argument *n* dialog box, do the following:

- a In the Structure Array Organization area, select either **Element by Element Organization** or **Plane Organization**.
- b Click **Add Field** to add fields for each of your struct array arguments. The Field for Structure Array Argument dialog box opens.



- 3 In the Field for Argument dialog box, do the following:
 - a In the **Name** field, define the field name. The **Name** you specify must match the field name of the structure array in your MATLAB function.
 - b Specify the **Range** for the field.

Caution Avoid selecting ranges using arrow keys. If you must use arrow keys to select ranges, apply the necessary fix from the Microsoft site: <http://support.microsoft.com/kb/291110>.



- c Click **Done**.

How Structure Arrays are Supported. MATLAB Builder EX supports one and two-dimensional MATLAB structure arrays.

The product converts data passed into structure arrays in *element-by-element organization* or *plane organization*. See *MATLAB Programming Fundamentals* for more information about all MATLAB data types, including structures.

Deploying Structure Arrays as Inputs and Outputs. If you are a MATLAB programmer and want to deploy a MATLAB function with structure arrays as input or output arguments, build Microsoft Excel macros using the Function Wizard and pass them (with the Excel Add-In and COM component) to the end users. If you can't do this, let your end users know:

- Which arguments are structure arrays
- Field names of the structure arrays

Using Macros with Struct Arrays. The macro generation feature of MATLAB Builder EX works with struct arrays as input or output arguments. See “Macro Creation” on page 2-17 if you have a MATLAB function you are ready to deploy. See “Microsoft® Excel® Add-in and Macro Creation Using the Function Wizard” on page 2-45 if you are using the Function Wizard to create your MATLAB function from scratch. See “Choosing Function Deployment Workflow” on page 1-11 for more information on both workflows.

Function Execution

In the Execute Functions area of the Function Wizard Control Panel, click **Execute** to run `mymagic`. Cells A1:E5 on the Excel sheet are automatically populated with the output of `mymagic` (a Magic Square of dimension 5).

A	B	C	D	E
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

Macro Creation

Continuing the example, create a Microsoft Excel macro using the Function Wizard Control Panel:

- 1 In the Create Macros area of the control panel, enter `mymagic` in the **Macro Name** field.

- 2 Select the location of where to store the macro in the **Store Macro** drop-down box.
- 3 Enter a brief description of the macro's functionality in the **Description** field.
- 4 Click **Create Macro**.

A macro is created in the current Excel workbook.

Macro Execution

Run the macro you created in “Macro Creation” on page 2-17 by doing one of the following, after first clearing cells A1:E5 (which contain the output of the Magic Square function you ran in “Function Execution” on page 2-17).

Tip You may need to enable the proper security settings before running macros in Microsoft Excel. For information about macro permissions and error messages occurring from executing macros, see the Appendix B, “Troubleshooting” appendix.

Using Office 2007 or Office 2010

- 1 In Microsoft Excel, click **View > Macros > View Macros**.
- 2 Select `mymagic` from the **Macro name** drop-down box.
- 3 Click **Run**. Cells A1:E5 on the Excel sheet are automatically populated with the output of `mymagic` (a Magic Square of dimension 5).

Using Office 2003

- 1 In Microsoft Excel, click **Tools > Macro > Macros**.
- 2 Select `mymagic` from the **Macro name** drop-down box.
- 3 Click **Run**. Cells A1:E5 on the Excel sheet are automatically populated with the output of `mymagic` (a Magic Square of dimension 5).

Watch a Video

Watch a video that demonstrates how to execute deployed functions with the Function Wizard and Microsoft Excel.

Microsoft Visual Basic Code Access (Optional Advanced Task)

Optionally, you may want to access the Visual Basic code or modify it, depending on your programming expertise or the availability of an Excel developer. If so, follow these steps.

From the Excel main window, open the Microsoft Visual Basic editor by doing one of the following. select **Tools > Macro > Visual Basic Editor**.

Using Office 2007 or Office 2010

- 1 Click **Developer > Visual Basic**.
- 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 **Matlab Macros** module.

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

Using Office 2003

- 1 Click **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 **Matlab Macros** module.

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

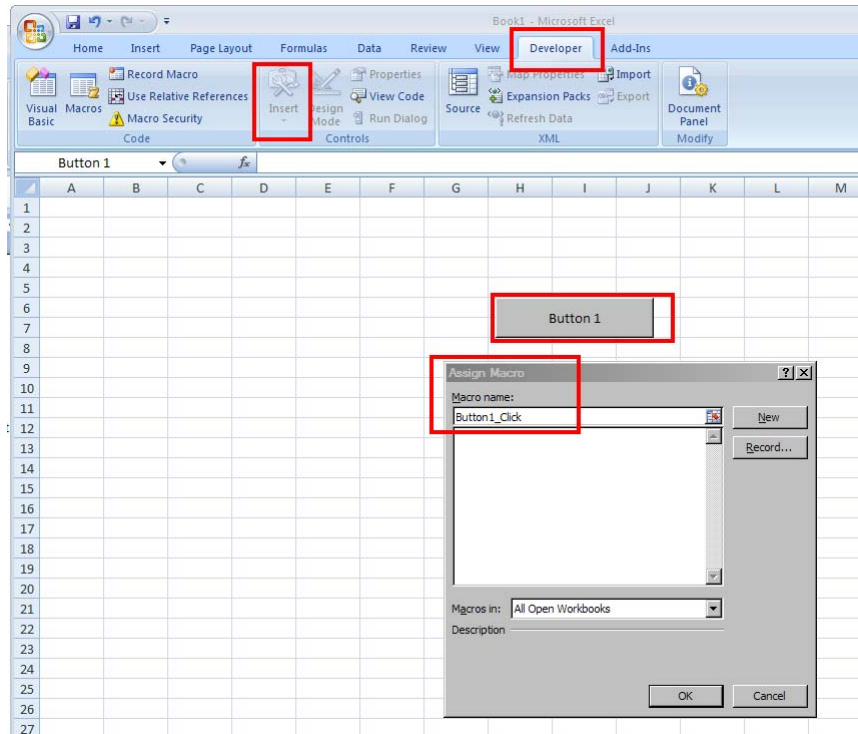
Mapping a Macro to a GUI Button or Control (Optional)

To attach the macro to a GUI button, do the following:

- 1 Click **Developer > Insert**.
- 2 From the **Form Controls** menu, select the **Button (Form Control)** icon.

Tip Hover your mouse over the Form Controls menu to see the various control labels.

- 3 In the Assign Macros dialog box, select the macro you want to assign the GUI button to, and click **OK**.



Attaching a Macro to a Button

For More Information

If you want to...	See...
<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	“Write Deployable MATLAB Code” on page 3-12
See more examples about building add-ins and COM components	“Add-in and Macro Creation from MATLAB Functions ” on page 4-5
Learn how to customize and integrate the COM component you built by modifying the Microsoft Visual Basic code	“Code Your Microsoft® Visual Basic® Application” on page 5-3

End-to-End Deployment of a MATLAB Function Using the Function Wizard

In this section...

“What Can the Function Wizard Do for Me?” on page 2-25

“Example File Copying” on page 2-26

“mymagic Testing” on page 2-26

“Installation of the Function Wizard” on page 2-27

“Function Wizard Start-Up” on page 2-29

“Workflow Selection for Prototyping and Debugging MATLAB Functions” on page 2-30

“New MATLAB Function Definition” on page 2-32

“MATLAB Function Prototyping and Debugging” on page 2-42

“Function Execution from MATLAB” on page 2-44

“Microsoft® Excel® Add-in and Macro Creation Using the Function Wizard” on page 2-45

“Function Execution from the Deployed Component” on page 2-47


“Macro Execution” on page 2-47

“Microsoft® Excel® Add-in and Macro Packaging using the Function Wizard” on page 2-48

“Microsoft® Visual Basic® Code Access (Optional Advanced Task)” on page 2-49

“For More Information” on page 2-51

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

If you are still in the process of developing a MATLAB function that is not yet ready to be deployed, you may find this example to be an appropriate introduction to using MATLAB Builder EX.

The Function Wizard allows you to iteratively test, develop, and debug your MATLAB function. It does this by invoking MATLAB from the Function Wizard Control Panel.

Developing your function in an interactive environment ensures that it works in an expected manner, prior to deployment to larger-scale applications. Usually, these applications are programmed by the Excel Developer using an enterprise language like Microsoft Visual Basic.

Similar to the Magic Square example, the Prototyping and Debugging example develops a function named `mymagic`, which wraps a MATLAB function, `magic`, which computes a magic square, a function with a single multidimensional matrix output.

If your MATLAB function is ready to be deployed and you have already built your add-in and COM component with the Deployment Tool, see “Executing Functions and Creating Macros Using the Function Wizard” on page 2-2.

Key Tasks for the MATLAB Programmer

Task	Reference
1. Review MATLAB Builder EX prerequisites, if you have not already done so.	“MATLAB® Builder™ EX Prerequisites” on page 1-5
2. Prepare to run the example by copying the example files.	“Example File Copying” on page 2-26
3. Test the MATLAB function you want to deploy as an add-in or COM component.	“mymagic Testing” on page 2-26
4. Install the Function Wizard.	“Installation of the Function Wizard” on page 2-27
5. Start the Function Wizard.	“Function Wizard Start-Up” on page 2-29
6. Select the prototyping and debugging workflow.	“Workflow Selection for Prototyping and Debugging MATLAB Functions” on page 2-30
7. Define the new MATLAB function you want to prototype by adding it to the Function Wizard and establishing input and output ranges.	“New MATLAB Function Definition” on page 2-32
8. Test your MATLAB function by executing it with the Function Wizard.	“Function Execution from MATLAB” on page 2-44
9. Prototype and Debug the MATLAB function if needed, using MATLAB and the Function Wizard.	“MATLAB Function Prototyping and Debugging” on page 2-42
10. Create the add-in and COM component, as well as the macro, using the Function Wizard to invoke MATLAB and the Deployment Tool.	“Microsoft® Excel® Add-in and Macro Creation Using the Function Wizard” on page 2-45

Key Tasks for the MATLAB Programmer (Continued)

Task	Reference
11. Execute the your function from the newly created component, to ensure the function's behavior is identical to when it was tested.	"Function Execution from the Deployed Component" on page 2-47
12. Execute the macro you created using the Function Wizard.	"Macro Execution" on page 2-47
13. Package your deployable add-in and macro using the Function Wizard to invoke MATLAB and the Deployment Tool.	"Microsoft® Excel® Add-in and Macro Packaging using the Function Wizard" on page 2-48
14. Optionally inspect or modify the Microsoft Visual Basic code you generated with the COM component. Optionally, attach the macro you created to a GUI button.	"Microsoft® Visual Basic® Code Access (Optional Advanced Task)" on page 2-49

What Can the Function Wizard Do for Me?

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.

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

Example File Copying

All MATLAB Builder EX examples reside in `matlabroot\toolbox\matlabx1\examples\`. The following table identifies examples by folder:

For Example Files Relating To...	Find Example Code in Folder...	For Example Documentation See...
Magic Square Example	<code>xlmagic</code>	“Create a Microsoft® Excel® Add-In and COM Component” on page 1-15 “Integrate a Add-In and COM Component with Microsoft® Excel®” on page 1-23
Variable-Length Argument Example	<code>xlmulti</code>	“Work with Variable-Length Inputs and Outputs” on page 4-5
Calling Compiled MATLAB Functions from Microsoft Excel	<code>xlbasic</code>	“Calling Compiled MATLAB Functions from Microsoft® Excel®” on page 6-5
Spectral Analysis Example	<code>xlspectral</code>	“Build and Integrate with Spectral Analysis” on page 5-18

mymagic Testing

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 In MATLAB, locate `mymagic.m`. See “Example File Copying” on page 2-26 for locations of examples. 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 2001-2012 The MathWorks, Inc.
% $Revision: 1.1.8.3.6.1 $      $Date: 2012/12/15 20:00:38 $

y = magic(x)

```

- 2 At the MATLAB command prompt, enter `mymagic(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

```

Installation of the Function Wizard


Before you can use the Function Wizard, you must first install it as an add-in that is accessible from Microsoft Excel.

After you install the Function Wizard, the entry **MATLAB Functions** appears as an available Microsoft Excel add-in button.

Using Office 2007

- 1 Start Microsoft Excel if it is not already running.



- 2 Click the Office Button () and select **Excel Options**.
- 3 In the left pane of the Excel Options dialog box, click **Add-Ins**.
- 4 In the right pane of the Excel Options dialog box, select **Excel Add-ins** from the **Manage** drop-down box.
- 5 Click **Go**.

- 6 Click **Browse**. Navigate to *matlabroot\toolbox\matlabxl\matlabxl\arch* and select *FunctionWizard2007.xlam*. Click **OK**.
- 7 In the Excel Add-Ins dialog box, verify that the entry **MATLAB Builder EX Function Wizard** is selected. Click **OK**.

Using 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 box, click **Browse**.
- 6 Browse to *matlabroot\toolbox\matlabxl\matlabxl\arch*, and select *FunctionWizard2007.xlam*. Click **OK**.
- 7 In the Excel Add-Ins dialog, verify that the entry **MATLAB Builder EX Function Wizard** is selected. Click **OK**.

The Home tab of the Microsoft Office Ribbon should now contain the Function Wizard tile. See The Home Tab of the Microsoft® Office Ribbon with Function Wizard Installed on page 2-29.

Using Office 2003

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

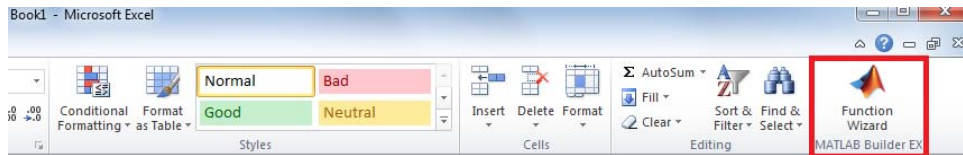
If the Function Wizard was not previously installed, click **Browse** and navigate to *matlabroot\toolbox\matlabxl\matlabxl* folder. Select *FunctionWizard.xla*. Click **OK** to proceed.

Function Wizard Start-Up

Start the Function Wizard in one of the following ways. When the wizard has initialized, the Function Wizard Start Page dialog box displays.

Using Office 2007 or Office 2010

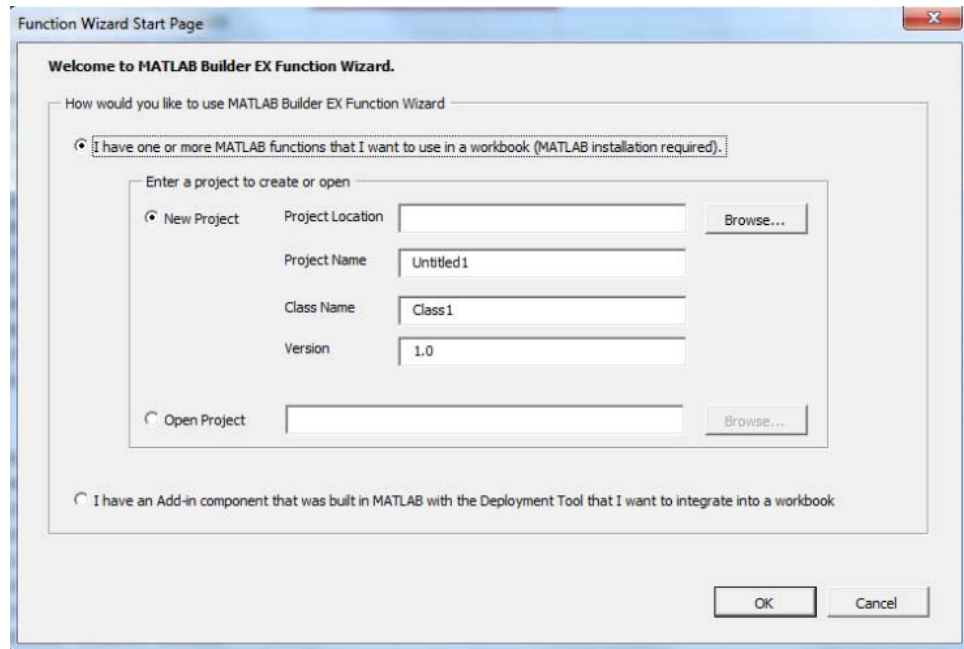
In Microsoft Excel, on the Microsoft Office ribbon, on the **Home** tab, select **MATLAB Functions**.



The Home Tab of the Microsoft® Office Ribbon with Function Wizard Installed

Using Office 2003

- 1 Select **Tools > Add-Ins** from the Excel main menu.
- 2 Select **Function Wizard**.



The Function Wizard Start Page Dialog Box

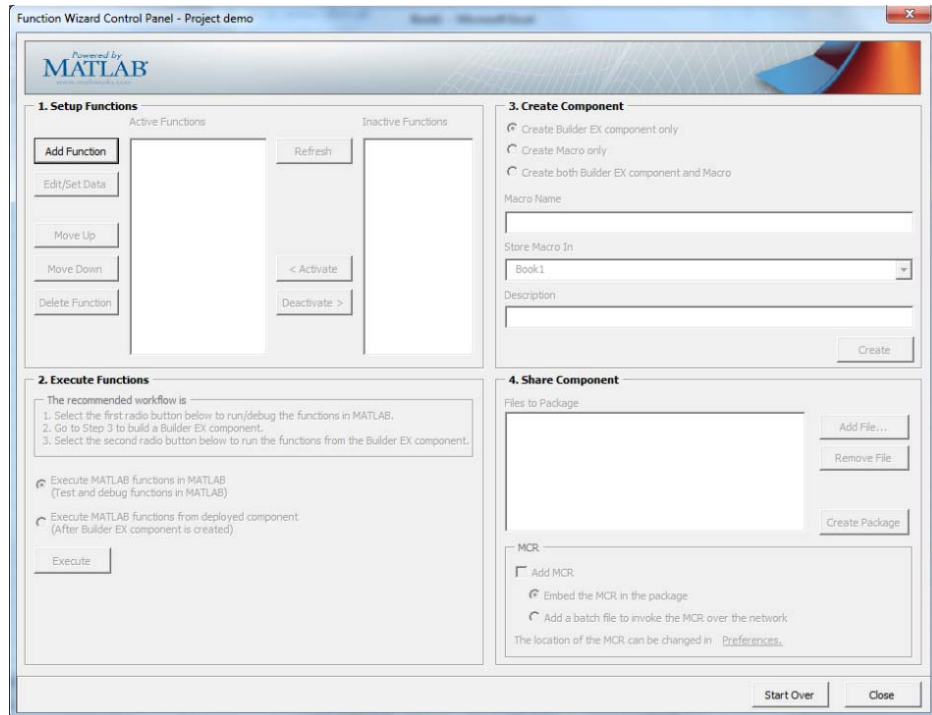
Workflow Selection for Prototyping and Debugging MATLAB Functions

After you have installed and started the Function Wizard, do the following.

- 1 From the Function Wizard Start Page dialog box, select **I have one or more MATLAB functions that I want to use in a workbook (MATLAB installation required)**. The **New Project** option is selected by default. Enter a meaningful project name in the **Project Name** field, like `testmagic`, for example.

Tip Some customers find it helpful to assign a unique name as the **Class Name** (default is `Class1`) and to assign a **Version** number for source control purposes.

- 2** Click **OK**. The Function Wizard Control Panel displays with the **Add Function** button enabled.



About Project Files

Keep in mind the following information about project files when working with the Function Wizard:

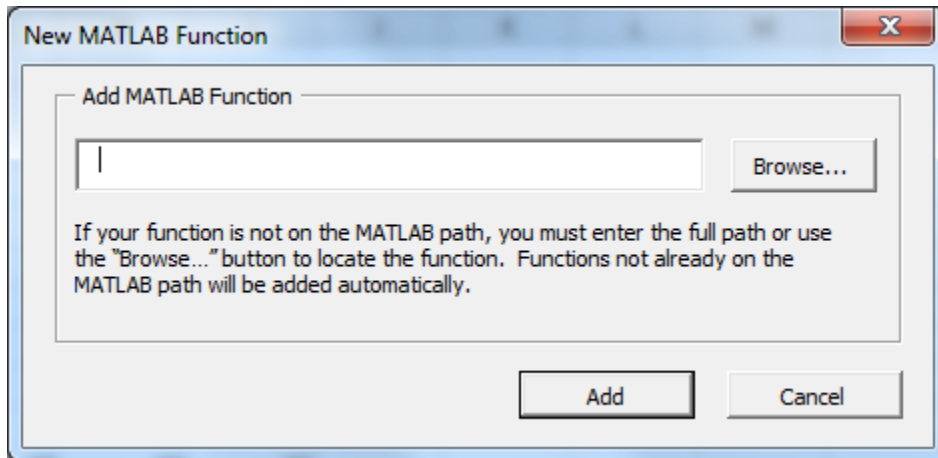
- The project files created by the Function Wizard are the same project files created and used by the Deployment Tool (deploytool).
- The Function Wizard prompts you to specify a location for your project files when you open your first new project. Project files are auto-saved to this location and may be opened in the future through either the Deployment Tool or the Function Wizard.
- If you previously built a component using the Function Wizard, the wizard will prompt you to load it.

Quitting the MATLAB Session Invoked by the Function Wizard

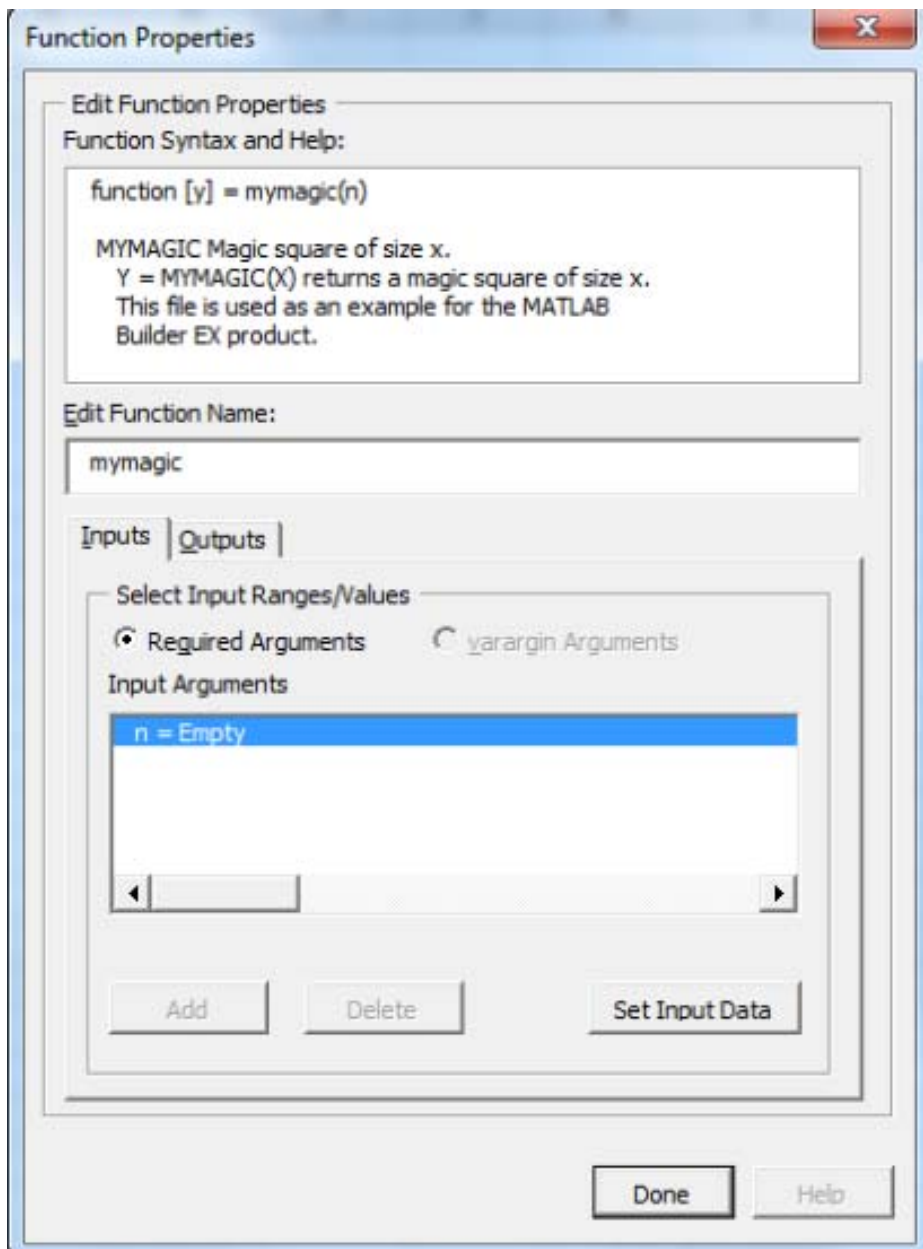
Avoid manually terminating the MATLAB session invoked by the Function Wizard. Doing so can prevent you from using the Wizard's MATLAB-related features from your Excel session. If you want to quit the remotely invoked MATLAB session, restart Excel.

New MATLAB Function Definition

- 1 Add the function you want to deploy to the Function Wizard. Click **Add** in the Set Up Functions area of the Function Wizard Control Panel. The New MATLAB Function dialog box appears.

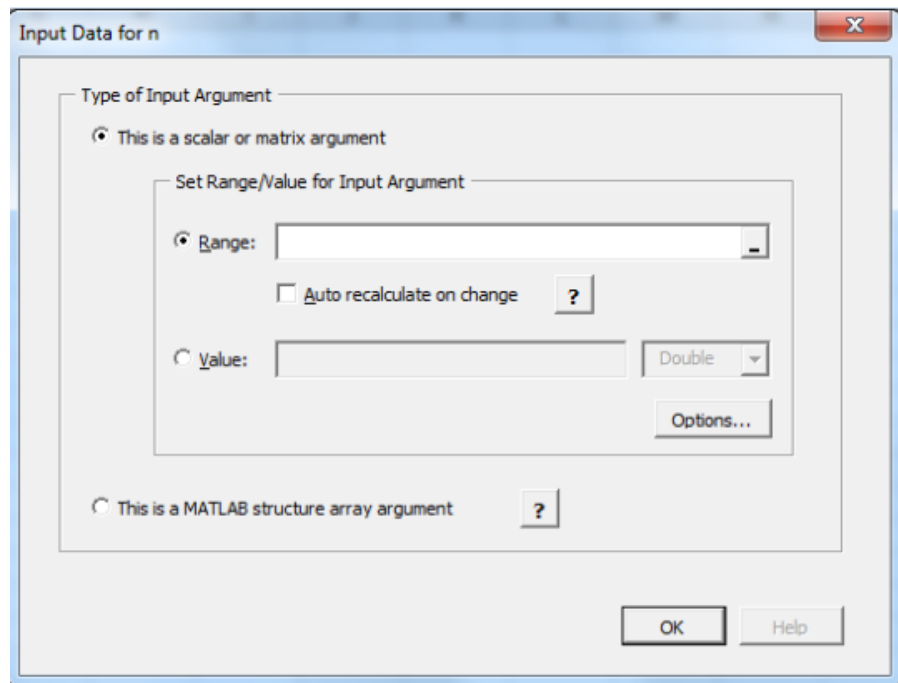


- 2 Browse to locate your MATLAB function. Select the function and click **Open**.
- 3 In the New MATLAB Function dialog box, click **Add**. The Function Properties dialog box appears.



Tip The **Function Syntax and Help** area, in the Function Properties dialog box, displays the first help text line (sometimes called the *H1 line*) in a MATLAB function. Displaying these comments in the Function Properties dialog box can be helpful when deploying new or unfamiliar MATLAB functions to end-users.

- 4 Define input argument properties as follows.
 - a On the **Input** tab, click **Set Input Data**. The Input Data for *n* dialog box appears.



- b Specify a **Range** or **Value** by selecting the appropriate option and entering the value.

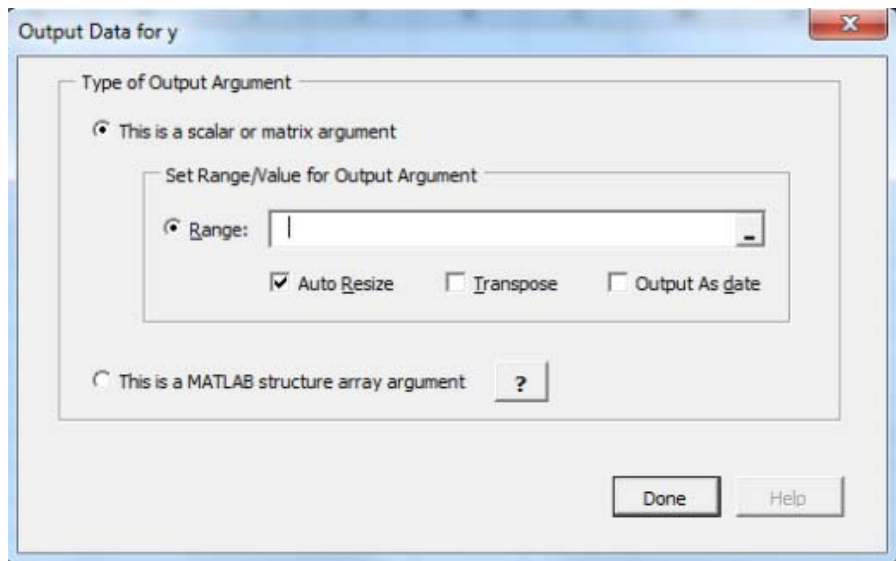
Caution Avoid selecting ranges using arrow keys. If you must use arrow keys to select ranges, apply the necessary fix from the Microsoft site: <http://support.microsoft.com/kb/291110>.

- c Click **Done**.

Tip To specify how MATLAB Builder EX handles blank cells (or cells containing no data), see “Empty Cell Value Control” on page 2-37.

- 5 Define output argument properties as follows.

- a On the **Output** tab, click **Set Output Data**. The Output Data for y dialog box appears, where x is the name of the output variable you are defining properties of.

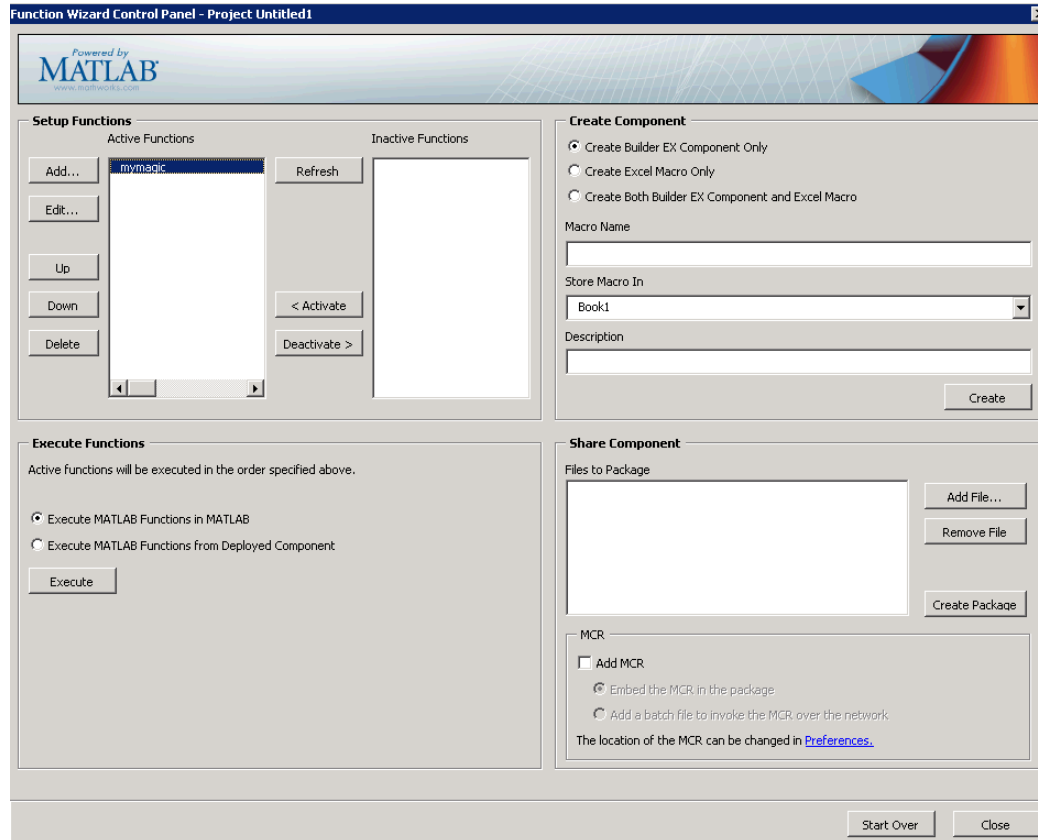


Tip You can also specify MATLAB Builder EX to **Auto Resize**, **Transpose** or output your data in date format (**Output as date**). To do so, select the appropriate option in the Argument Properties For *y* dialog box.

- b** Specify a **Range**. Alternately, select a range of cells on your Excel sheet; the range will be entered for you in the **Range** field.

Caution Avoid selecting ranges using arrow keys. If you must use arrow keys to select ranges, apply the necessary fix from the Microsoft site: <http://support.microsoft.com/kb/291110>.

- c** Select **Auto Resize** if it is not already selected.
- d** Click **Done** in the Argument Properties For *y* dialog box.
- e** Click **Done** in the Function Properties dialog box. `mymagic` now appears in the **Active Functions** list of the Function Wizard Control Panel.



Empty Cell Value Control

You can specify how MATLAB Builder EX processes empty cells, allowing you to assign undefined or unrepresented (NaN, for example) data values to them.

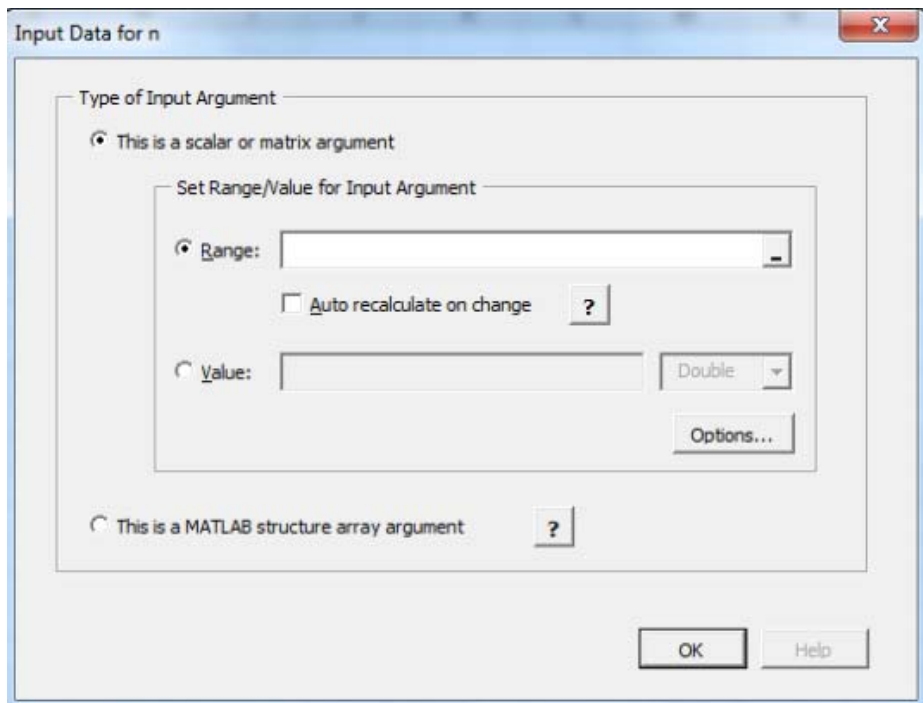
To specify how to handle empty cells, do the following.

- 1 Click **Options** in the Input Data for N dialog box.
- 2 Click the **Treat Missing Data As** drop-down box.
- 3 Specify either **Zero** or **NaN (Not a Number)**, depending on how you want to handle empty cells.

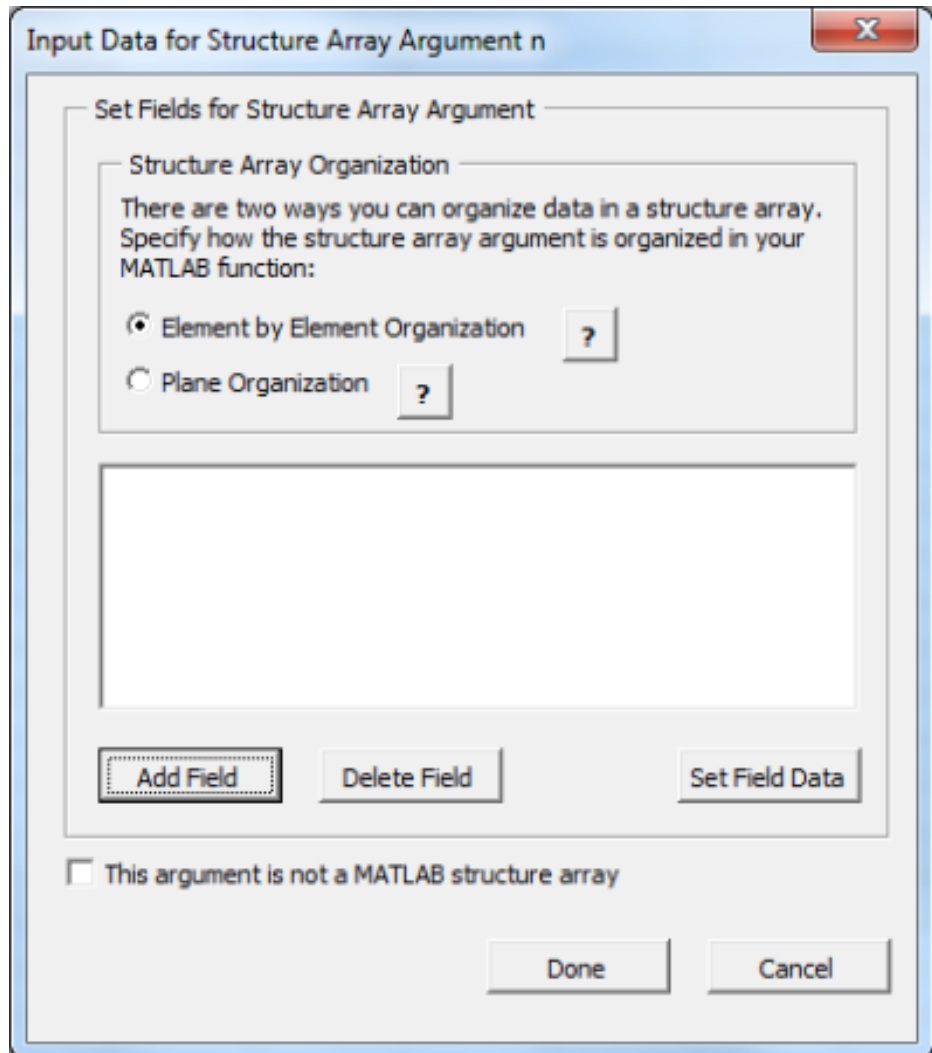
Working with Struct Arrays

To assign ranges to fields in a struct array, do the following:

- 1 If you have not already done so, select **This is a MATLAB structure array argument** in the Input Data for n dialog box and click **OK**.



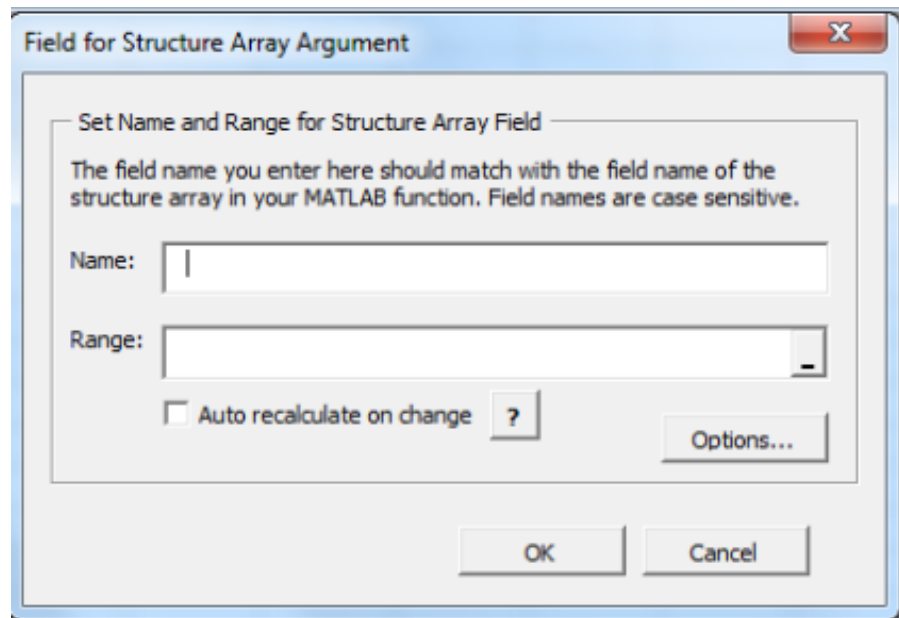
The Input Data for Structure Array Argument n dialog box opens.



- 2 The Function Wizard supports Vector and Two-dimensional struct arrays organized in either Element by Element or Plane organization, for both input and output.

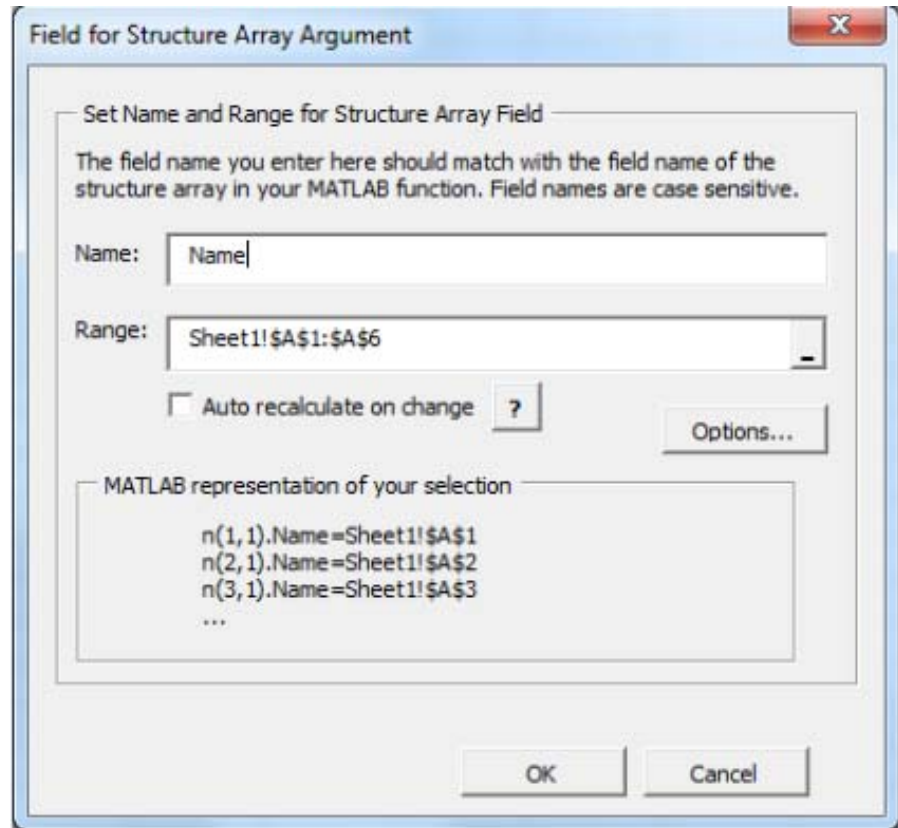
In the Input Data for Structure Array Argument n dialog box, do the following:

- a In the Structure Array Organization area, select either **Element by Element Organization** or **Plane Organization**.
- b Click **Add Field** to add fields for each of your struct array arguments. The Field for Structure Array Argument dialog box opens.



- 3 In the Field for Argument dialog box, do the following:
 - a In the **Name** field, define the field name. The **Name** you specify must match the field name of the structure array in your MATLAB function.
 - b Specify the **Range** for the field.

Caution Avoid selecting ranges using arrow keys. If you must use arrow keys to select ranges, apply the necessary fix from the Microsoft site: <http://support.microsoft.com/kb/291110>.



- c Click **Done**.

How Structure Arrays are Supported. MATLAB Builder EX supports one and two-dimensional MATLAB structure arrays.

The product converts data passed into structure arrays in *element-by-element organization* or *plane organization*. See *MATLAB Programming Fundamentals* for more information about all MATLAB data types, including structures.

Deploying Structure Arrays as Inputs and Outputs. If you are a MATLAB programmer and want to deploy a MATLAB function with structure arrays as input or output arguments, build Microsoft Excel macros using the Function Wizard and pass them (with the Excel Add-In and COM component) to the end users. If you can't do this, let your end users know:

- Which arguments are structure arrays
- Field names of the structure arrays

Using Macros with Struct Arrays. The macro generation feature of MATLAB Builder EX works with struct arrays as input or output arguments. See “Macro Creation” on page 2-17 if you have a MATLAB function you are ready to deploy. See “Microsoft® Excel® Add-in and Macro Creation Using the Function Wizard” on page 2-45 if you are using the Function Wizard to create your MATLAB function from scratch. See “Choosing Function Deployment Workflow” on page 1-11 for more information on both workflows.

MATLAB Function Prototyping and Debugging

Use the Function Wizard to interactively prototype and debug a MATLAB function.

Since `mymagic` calls the prewritten MATLAB magic function directly, it does not provide an illustrative example of how to use the prototyping and debugging feature of MATLAB Builder EX.

Following is an example of how you might use this feature with `myprimes`, a function containing multiple lines of code.

Prototyping and Debugging with `myprimes`

For example, say you are in the process of prototyping code that uses the equation `P = myprimes(n)`. This equation returns a row vector of prime numbers less than or equal to `n` (a prime number has no factors other than 1 and the number itself).

Your code uses `P = myprimes(n)` as follows:

```
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)

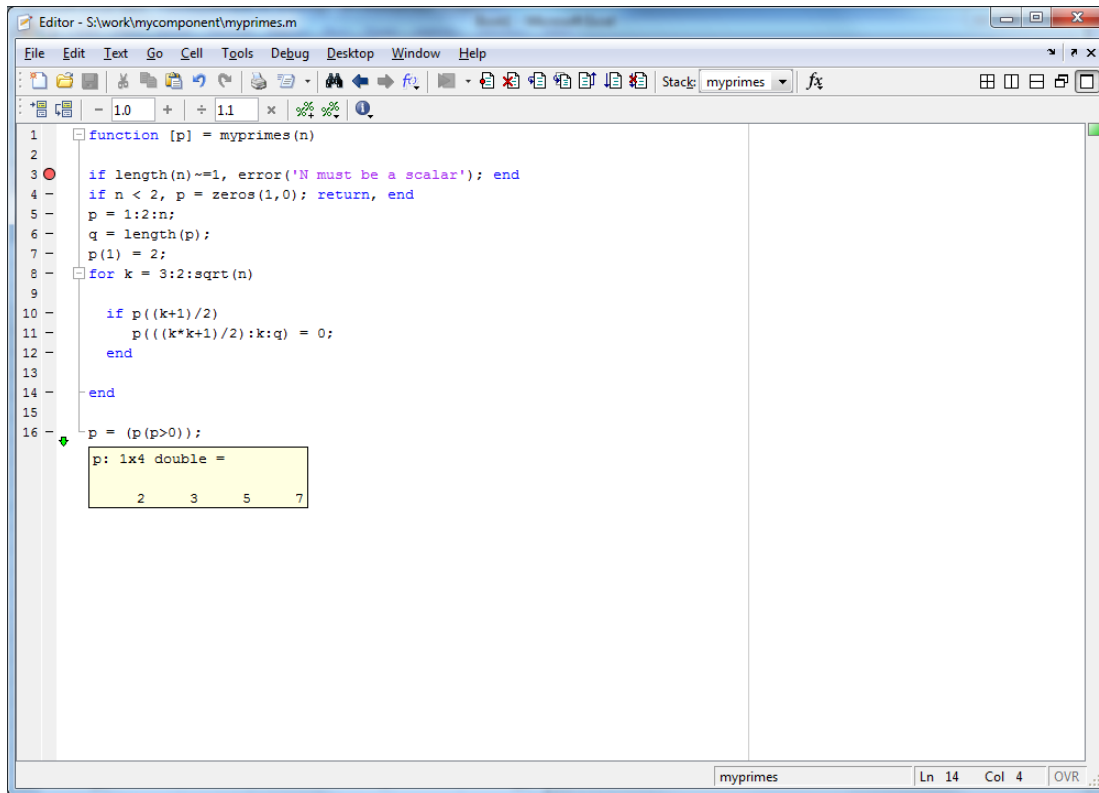
    if p((k+1)/2)
        p(((k*k+1)/2):k:q) = 0;
    end

end

p = (p(p>0));
```

In designing your code, you want to handle various use cases. For example, you want to experiment with scenarios that may assign a column vector value to the output variable `p` (`myprimes` only returns a row vector, as stated previously). You follow this general workflow:

- 1** Set a breakpoint in `myprimes` at the first `if` statement, using the GUI or `dbstop`, for instance.
- 2** On the Function Wizard Control Panel, in the Execute Functions area, click **Execute**. Execution will stop at the previously set breakpoint. Note the value of `p` in the yellow box in the following figure. Step-through and debug your code as you normally would using the MATLAB Editor.



Debugging myprimes Using the Function Wizard

For more information about debugging MATLAB code, see “Editing and Debugging MATLAB Code” in the *MATLAB Desktop Tools and Development Environment User’s Guide*.

Function Execution from MATLAB

Test your deployable MATLAB function by executing it in MATLAB:

- 1 From the Function Wizard Control Panel, in the Execute Functions area, select **Execute MATLAB Functions in MATLAB**.
- 2 Click **Execute**. In Excel, the Magic Square function executes, producing results similar to the following.

A	B	C	D	E
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

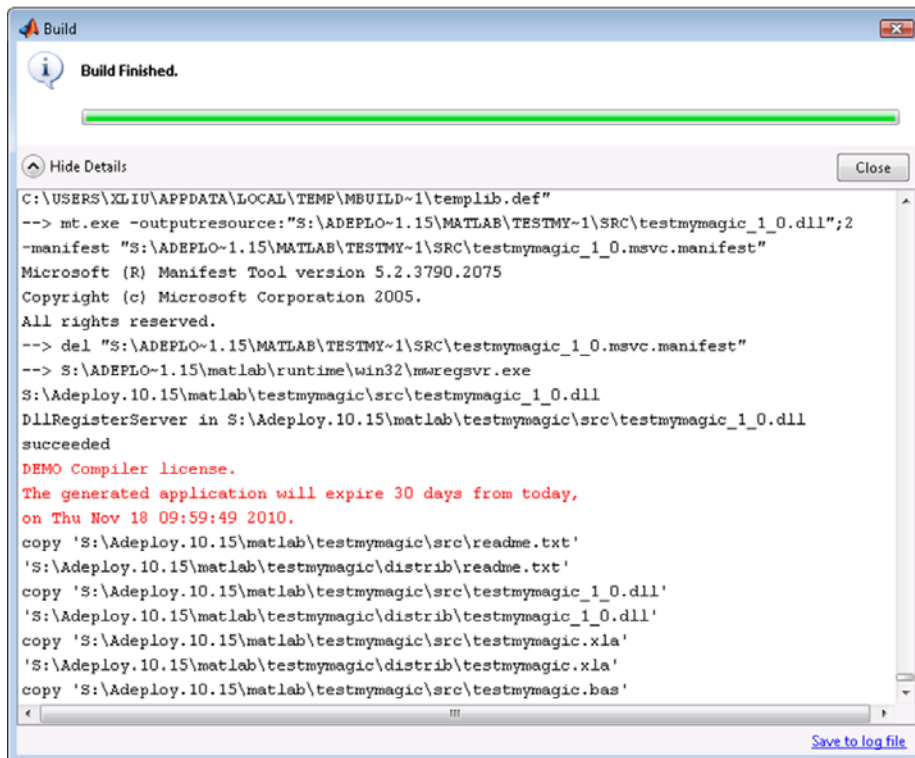
Microsoft Excel Add-in and Macro Creation Using the Function Wizard

The Function Wizard can automatically create a deployable Microsoft Excel add-in and macro. To create your add-in in this manner, use one of the following procedures.

Creating an Add-in and Associated Excel Macro

To create both a deployable add-in and an associated Excel macro:

- 1 In the Function Wizard Control Panel dialog box, in the Create Component area, select **Create Both Builder EX Component and Excel Macro**.
- 2 Enter `mymagic` in the **Macro Name** field.
- 3 Select the location of where to store the macro, using the **Store Macro In** drop-down box.
- 4 Enter a brief description of the macro's functionality in the **Description** field.
- 5 Click **Create** to build both the add-in (as well as the underlying COM component) and the associated macro. The Deployment Tool Build dialog box appears, indicating the status of the add-in and COM component compilation (build).



The Build Dialog

For More Information About:	See:
Troubleshooting compilation (build) problems	“Compile-Time Errors” in the <i>MATLAB Compiler User’s Guide</i>
The build process	“Deployable Component Creation” on page 1-16

Creating a COM Component or a Macro Only Without Creating an Add-in

To create either a COM component or a macro without also creating the Excel add-in, do the following

- 1 In the Function Wizard Control Panel dialog box, in the Create Component area, select either **MATLAB Builder EX Component Only** or **Create Excel Macro Only**.
- 2 Enter `mymagic` in the **Macro Name** field.
- 3 Select the location of where to store the macro, using the **Store Macro In** drop-down box.
- 4 Enter a brief description of the macro's functionality in the **Description** field.
- 5 Click **Create**.

Function Execution from the Deployed Component

Execute your function as you did similarly in “Function Execution from MATLAB” on page 2-44, but this time execute it from the deployed component to ensure it matches your previous output.

- 1 From the Function Wizard Control Panel, in the Execute Functions area, select **Execute MATLAB Functions from Deployed Component**.
- 2 Click **Execute**. In Excel, the Magic Square function executes, producing results similar to the following.

A	B	C	D	E
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

Macro Execution

Run the macro you created in “Macro Creation” on page 2-17 by doing one of the following, after first clearing cells A1:E5 (which contain the output of the Magic Square function you ran in “Function Execution” on page 2-17).

Tip You may need to enable the proper security settings before running macros in Microsoft Excel. For information about macro permissions and error messages occurring from executing macros, see the Appendix B, “Troubleshooting” appendix.

Using Office 2007 or Office 2010

- 1 In Microsoft Excel, click **View > Macros > View Macros**.
- 2 Select **mymagic** from the **Macro name** drop-down box.
- 3 Click **Run**. Cells A1:E5 on the Excel sheet are automatically populated with the output of **mymagic** (a Magic Square of dimension 5).

Using Office 2003

- 1 In Microsoft Excel, click **Tools > Macro > Macros**.
- 2 Select **mymagic** from the **Macro name** drop-down box.
- 3 Click **Run**. Cells A1:E5 on the Excel sheet are automatically populated with the output of **mymagic** (a Magic Square of dimension 5).

Watch a Video

Watch a video that demonstrates how to execute deployed functions with the Function Wizard and Microsoft Excel.

Microsoft Excel Add-in and Macro Packaging using the Function Wizard

The Function Wizard can automatically package a deployable Microsoft Excel add-in and macro for sharing. To package your add-in in this manner, use one of the following procedures.

- 1 After successfully building your component and add-in, in the Share Component area of the Function Wizard Control Panel dialog box, review

the files listed in the **Files to include in packaging** field. **Add Files** or **Remove Files** to and from the package by clicking the appropriate buttons.

- 2** To add access to the MCR Installer to your package, select one of the options in the MCR area. These options are described in “Packaging Wizard” on page 1-20. For information about the MCR and the MCR Installer, see “Install MATLAB Compiler Runtime (MCR)” on page 6-2.
- 3** When you are ready to create your package, click **Create Package**.

For More Information About:	See:
The packaging process	“Add-in Packaging (Recommended)” on page 1-19 and “Package Copying” on page 1-22

Microsoft Visual Basic Code Access (Optional Advanced Task)

Optionally, you may want to access the Visual Basic code or modify it, depending on your programming expertise or the availability of an Excel developer. If so, follow these steps.

From the Excel main window, open the Microsoft Visual Basic editor by doing one of the following. select **Tools > Macro > Visual Basic Editor**.

Using Office 2007 or Office 2010

- 1** Click **Developer > Visual Basic**.
- 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 **Matlab Macros** module.

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

Using Office 2003

- 1 Click **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 **Matlab Macros** module.
This opens the VB Code window with the code for this project.

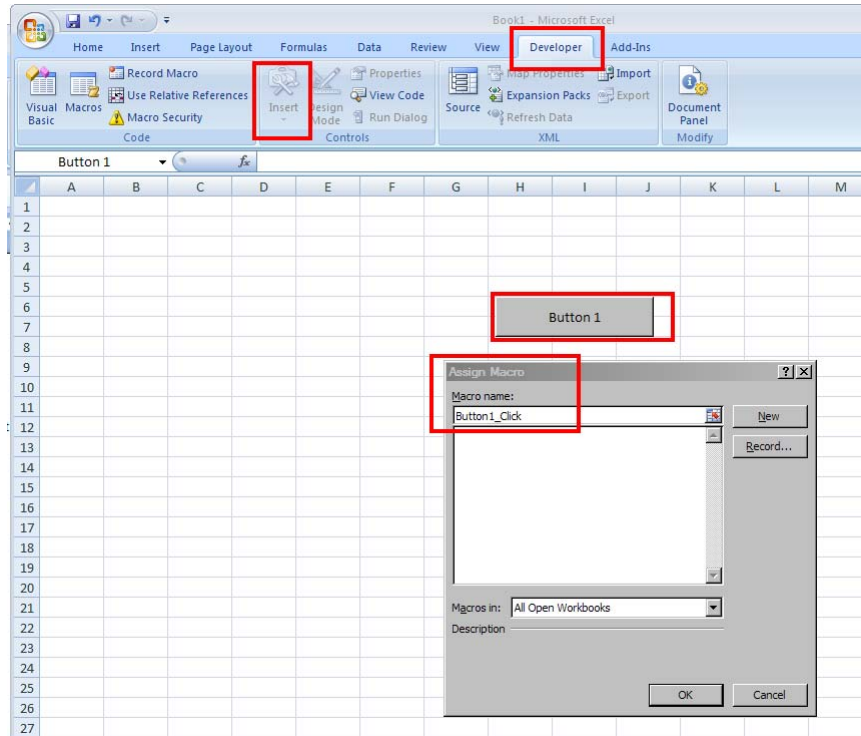
Mapping a Macro to a GUI Button or Control (Optional)

To attach the macro to a GUI button, do the following:

- 1 Click **Developer > Insert**.
- 2 From the **Form Controls** menu, select the **Button (Form Control)** icon.

Tip Hover your mouse over the **Form Controls** menu to see the various control labels.

- 3 In the **Assign Macros** dialog box, select the macro you want to assign the GUI button to, and click **OK**.



Attaching a Macro to a Button

For More Information

If you want to...	See...
<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 	<p>“Write Deployable MATLAB Code” on page 3-12</p>


If you want to...	See...
• Explore guidelines about writing deployable MATLAB code	
See more examples about building add-ins and COM components	“Add-in and Macro Creation from MATLAB Functions ” on page 4-5
Learn more about the MATLAB Compiler Runtime (MCR)	“Working with the MCR” in the <i>MATLAB Compiler User’s Guide</i>
Learn how to customize and integrate the COM component you built by modifying the Microsoft Visual Basic code	“Code Your Microsoft® Visual Basic® Application” on page 5-3 “Build and Integrate with Spectral Analysis” on page 5-18

MATLAB Code Deployment

- “MATLAB Application Deployment Products ” on page 3-2
- “Application Deployment Products and the Deployment Tool” on page 3-4
- “Write Deployable MATLAB Code” on page 3-12
- “How the Deployment Products Process MATLAB Function Signatures” on page 3-17
- “Load MATLAB Libraries using loadlibrary” on page 3-19
- “Use MATLAB Data Files (MAT Files) in Compiled Applications” on page 3-21

MATLAB Application Deployment Products

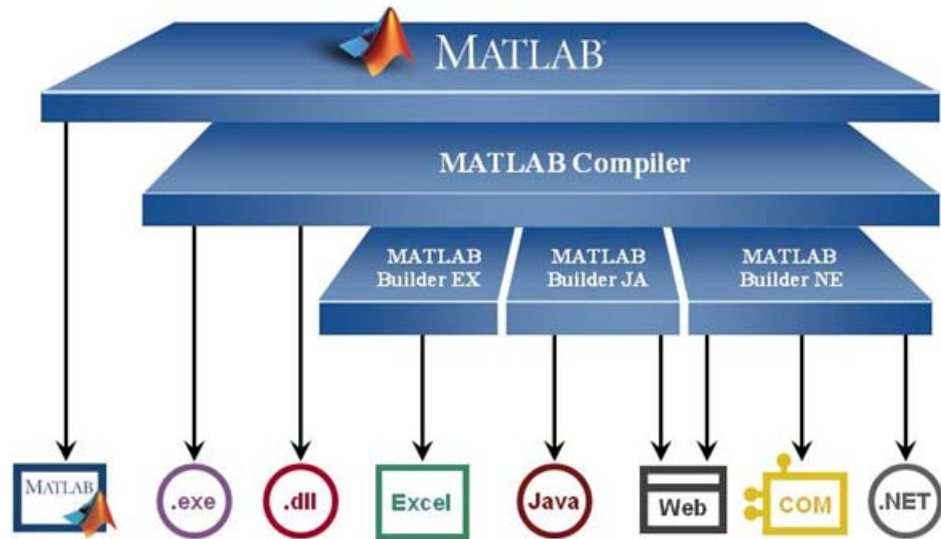
MATLAB Programmer

Role	Knowledge Base	Responsibilities
 MATLAB programmer	<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.

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



MATLAB® Application Deployment Products

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

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 3-4

“How Does MATLAB® Compiler™ Software Build My Application?” on page 3-4

“Dependency Analysis Function (depfun)” on page 3-7

“MEX-Files, DLLs, or Shared Libraries” on page 3-8

“Component Technology File (CTF Archive)” on page 3-8

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:

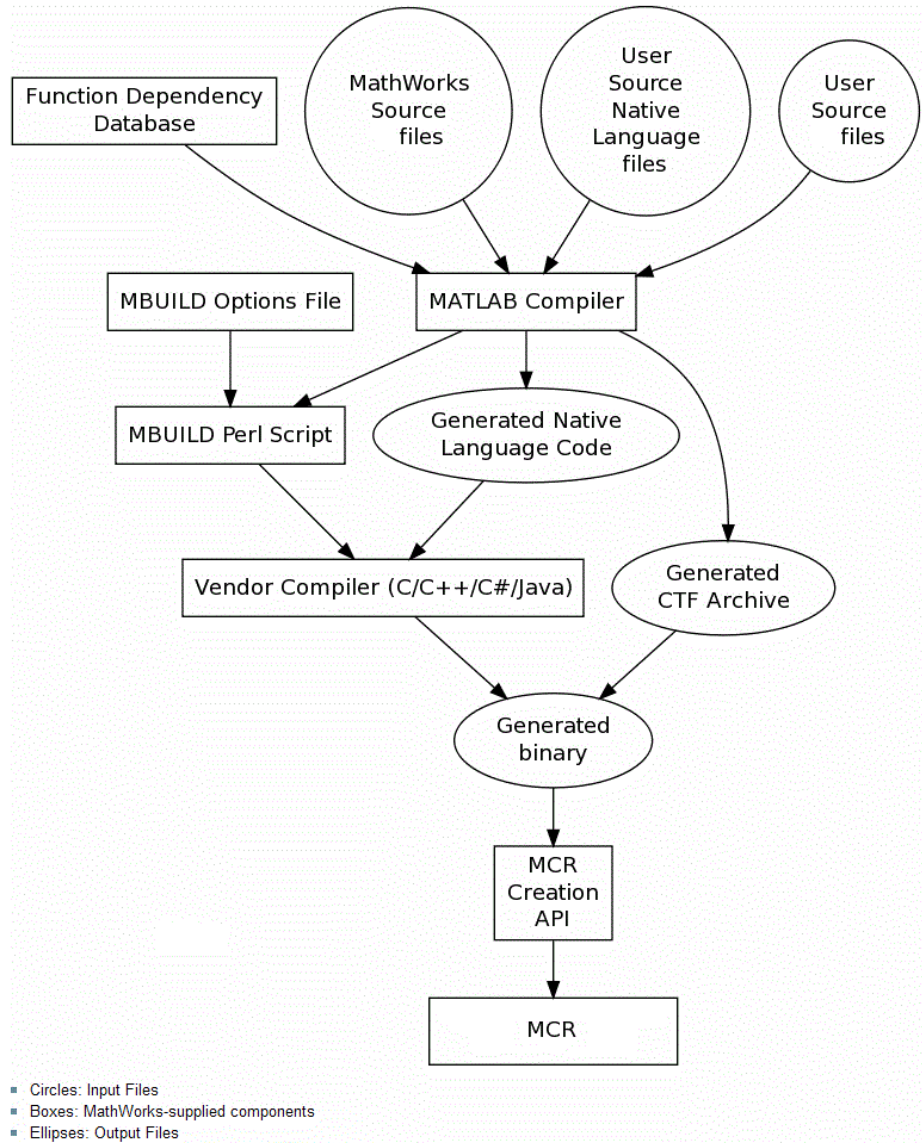
- You perform related deployment tasks with a single intuitive GUI.
- You maintain related information in a convenient project file.
- Your project state persists between sessions.
- Your previous project loads automatically when the Deployment Tool starts.
- You load previously stored compiler projects 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 “Dependency Analysis Function (`depfun`)” on page 3-7.



MATLAB® Compiler™ Build Process

- 3** Validates MEX-files. In particular, `mexFunction` entry points are verified. For more details about MEX-file processing, see “MEX-Files, DLLs, or Shared Libraries” on page 3-8.
- 4** Creates a CTF archive from the input files and their dependencies. For more details about CTF archives see “Component Technology File (CTF Archive)” on page 3-8.
- 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).

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`, `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. You must manually include data files in the search

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.

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.

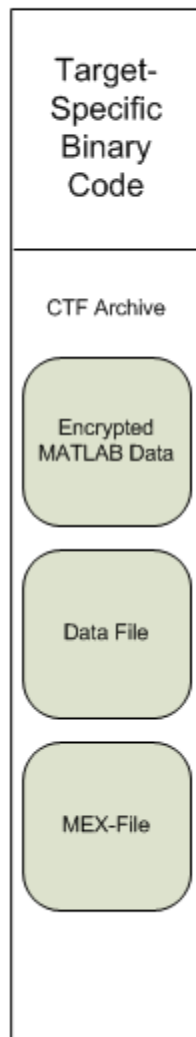
MATLAB Compiler also embeds a CTF archive in each generated binary. The CTF houses all deployable files. All MATLAB files encrypt in the CTF archive using the Advanced Encryption Standard (AES) cryptosystem.

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	“MCR Component Cache and CTF Archive Embedding”
MATLAB Builder NE	“MCR Component Cache and CTF Archive Embedding”
MATLAB Builder JA	“CTF Archive Embedding and Extraction”
MATLAB Builder EX	Using MCR Component Cache and CTF Archive Embedding

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 deletes 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.

Note CTF archives are extracted by default to `user_name\AppData\Local\Temp\userid\mcrCachen.nn`.

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.

Write Deployable MATLAB Code

In this section...

“Compiled Applications Do Not Process MATLAB Files at Runtime” on page 3-12

“Do Not Rely on Changing Directory or Path to Control the Execution of MATLAB Files” on page 3-13

“Use ismcc and isdeployed Functions To Execute Deployment-Specific Code Paths” on page 3-14

“Gradually Refactor Applications That Depend on Noncompilable Functions” on page 3-14

“Do Not Create or Use Nonconstant Static State Variables” on page 3-15

“Get Proper Licenses for Toolbox Functionality You Want to Deploy” on page 3-15

Compiled Applications Do Not Process MATLAB Files at Runtime

MATLAB Compiler secures your code against unauthorized changes. 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, both methods must be available in the built component.

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 run time 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.

Get Proper Licenses for Toolbox Functionality You Want to Deploy

You must have a valid MathWorks license for toolboxes you use to create deployable components.

If you do not have a valid license for your toolbox, you cannot create a deployable component with it.

How the Deployment Products Process MATLAB Function Signatures

In this section...

“MATLAB Function Signature” on page 3-17

“MATLAB Programming Basics” on page 3-17

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
```

Load MATLAB Libraries using loadlibrary

Note It is important to understand the difference between the following:

- MATLAB `loadlibrary` function — Loads shared library into MATLAB.
 - Operating system `loadlibrary` function — Loads specified Windows or UNIX operating system module into the address space of the calling process.
-

With MATLAB Compiler version 4.0 (R14) and later, you can use MATLAB file prototypes as described below to load your library in a compiled application. Loading libraries using H-file headers is not supported in compiled applications. This behavior occurs when `loadlibrary` is compiled with the header argument as in the statement:

```
loadlibrary(library, header)
```

In order to work around this issue, execute the following at the MATLAB command prompt:

```
loadlibrary(library, header, 'mfilename', 'mylibrarymfile');
```

where *mylibrarymfile* is the name of a MATLAB file you would like to use when loading this library. This step only needs to be performed once to generate a MATLAB file for the library.

In the code that is to be compiled, you can now call `loadlibrary` with the following syntax:

```
loadlibrary(library, @mylibrarymfile, 'alias', alias)
```

It is only required to add the prototype `.m` file and `.dll` file to the CTF archive of the deployed application. There is no need for `.h` files and C/C++ compilers to be installed on the deployment machine if the prototype file is used.

Once the prototype file is generated, add the file to the CTF archive of the application being compiled. You can do this with the `-a` option (if using the

`mcc` command) or by dragging it under **Other/Additional Files** (as a helper file) if using the Deployment Tool.

With MATLAB Compiler versions 4.0.1 (R14+) and later, generated MATLAB files will automatically be included in the CTF file as part of the compilation process. For MATLAB Compiler versions 4.0 (R14) and later, include your library MATLAB file in the compilation with the `-a` option with `mcc`.

Restrictions on Using MATLAB Function `loadlibrary` with MATLAB Compiler

Note the following limitations in regards to using `loadlibrary` with MATLAB Compiler. For complete documentation and up to date restrictions on `loadlibrary`, please reference the MATLAB documentation.

- You can not use `loadlibrary` inside of MATLAB to load a shared library built with MATLAB Compiler.
- With MATLAB Compiler Version 3.0 (R13SP1) and earlier, you cannot compile calls to `loadlibrary` because of general restrictions and limitations of the product.

Use MATLAB Data Files (MAT Files) in Compiled Applications

In this section...

“Explicitly Including MAT files Using the `%#function` Pragma” on page 3-21

“Load and Save Functions” on page 3-21

“MATLAB Objects” on page 3-24

Explicitly Including MAT files Using the `%#function` Pragma

MATLAB Compiler excludes MAT files from “Dependency Analysis Function (depfun)” on page 3-7 by default.

If you want MATLAB Compiler to explicitly inspect data within a MAT file, you need to specify the `%#function` pragma when writing your MATLAB code.

For example, if you are creating a solution with Neural Network Toolbox, you need to use the `%#function` pragma within your GUI code to include a dependency on the `gmdistribution` class, for instance.

Load and Save Functions

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 “Component Technology File (CTF Archive)” on page 3-8.

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 `matlab_root\extern\examples\compiler\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 -m 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 ctroot; 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 exryption 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 $ctffoot.
    % LOADFILENAME1=which(fullfile(ctffoot,mfilename,'user_data.mat'));
    % LOADFILENAME2=which(fullfile(ctffoot,'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');
```

MATLAB Objects

When working with MATLAB objects, remember to include the following statement in your MAT file:

```
%#function class_constructor
```


Using the `%#function` pragma in this manner forces `depfun` to load needed class definitions, enabling the MCR to successfully load the object.

Microsoft Excel Add-in Creation, Function Execution, and Deployment

- “Supported Compilation Targets” on page 4-2
- “The Deployment Tool and the Command Line Interface” on page 4-4
- “Add-in and Macro Creation from MATLAB Functions ” on page 4-5
- “Execute Add-in With the Function Wizard” on page 4-11

Supported Compilation Targets

In this section...
“Microsoft® Excel® Add-in” on page 4-2
“What Are MATLAB® Builder™ EX Components and When Should You Create Them?” on page 4-2
“MATLAB® Builder™ EX Limitations” on page 4-3

Microsoft Excel Add-in

Using MATLAB Builder EX and the Deployment Tool (`deploytool` or `mcc`), you create deployable add-ins and Excel functions from MATLAB code that runs in Microsoft Excel applications. The Deployment Tool and `mcc` support the following function outputs:

- No outputs
- Figure (graphical) output
- Scalar output

Using the MATLAB Builder EX Function Wizard, you create Excel macros that can be deployed as add-ins or workbooks.

MATLAB Builder EX supports multidimensional matrix output(s).

Migration Considerations for 32-bit and 64-bit Microsoft Excel

If you are migrating to the 64-bit version of Microsoft Excel, you *must* uninstall the 32-bit version of MATLAB Builder EX *before* installing the 64-bit version of Microsoft Excel.

What Are MATLAB Builder EX Components and When Should You Create Them?

MATLAB Builder EX generates two primary artifacts from your MATLAB code, using the Deployment Tool: a Microsoft Excel add-in and a COM component.

Existing MATLAB functions can be integrated into new or existing spreadsheet solutions, as add-ins, with the Function Wizard. You can also use the Function Wizard to create and test add-ins for new MATLAB functions.

COM components created with either the Deployment Tool or the Function Wizard (.bas files) can be integrated into existing Microsoft Visual Basic applications.

MATLAB Builder EX Components are ideal solutions for deploying MATLAB code to users of Microsoft Excel and large-scale enterprise financial applications written in Microsoft Visual Basic.

MATLAB Builder EX Limitations

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

The Deployment Tool and the Command Line Interface

In this section...
“Using the Deployment Tool” on page 4-4
“Using the mcc Command Line Interface” on page 4-4

Using the Deployment Tool

For a complete example of how to use the MATLAB Compiler Deployment Tool (`deploytool`) GUI, read “The Magic Square Example” on page 1-13 in the MATLAB Builder EX User’s Guide. For information about how the graphical interface differs from the command line interface, read “What Is the Difference Between the Deployment Tool and the mcc Command Line?” on page 3-4 in “Write Deployable MATLAB Code” on page 3-12 in this User’s Guide.

Using the mcc Command Line Interface


As an alternative to using the Deployment Tool, you can use the command line to create your deployable executable, 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.

Add-in and Macro Creation from MATLAB Functions

In this section...

“Create Add-ins and Macros with Single and Multiple Outputs” on page 4-5
 “Work with Variable-Length Inputs and Outputs” on page 4-5

MATLAB Programmer

Role	Knowledge Base	Responsibilities
 MATLAB programmer	<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

Create Add-ins and Macros with Single and Multiple Outputs

The basic workflow for Microsoft Excel add-in and macro creation can be found in “Create a Microsoft® Excel® Add-In and COM Component” on page 1-15 and “Integrate a Add-In and COM Component with Microsoft® Excel®” on page 1-23 in this user’s guide.

Work with Variable-Length Inputs and Outputs

This example shows you how to work with, and create macros from, functions having variable-length inputs and outputs

Overview

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

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

`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.

Where Is the Example Code?

See “Example File Copying” on page 2-26 for information about accessing the example code from within the product.

Creating the Project

Use the following information as you work through this example using the instructions in “Deployable Component Creation” on page 1-16:

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

Adding a MATLAB Builder EX COM Function to Microsoft Excel

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

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										

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

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**.

The screenshot shows an Excel spreadsheet with the following content:

	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	=myplot(4)						
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	11
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 (Optional)

- 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.

For More Information

For more information about working with variable-length arguments, see “Programming with Variable Arguments” on page 5-10.

Execute Add-in With the Function Wizard


In this section...

“Execute an Add-in to Validate Nongraphical Function Output” on page 4-11

“Execute a Graphical Function” on page 4-11

“Create Dialog Box and Error Message Macros” on page 4-15

End User

Role	Knowledge Base	Responsibilities
 End user	<ul style="list-style-type: none"> • No MATLAB experience • Some knowledge of the data that is being displayed, but not how it was created 	<ul style="list-style-type: none"> • In Web environments, consumes what the front-end developer creates • Integrates MATLAB code with other third-party applications, such as Excel

Execute an Add-in to Validate Nongraphical Function Output

If you have built your add-in and COM component using `deploytool` or `mcc` and are ready to begin validating your non-graphical function’s output, see “Executing Functions and Creating Macros Using the Function Wizard” on page 2-2.

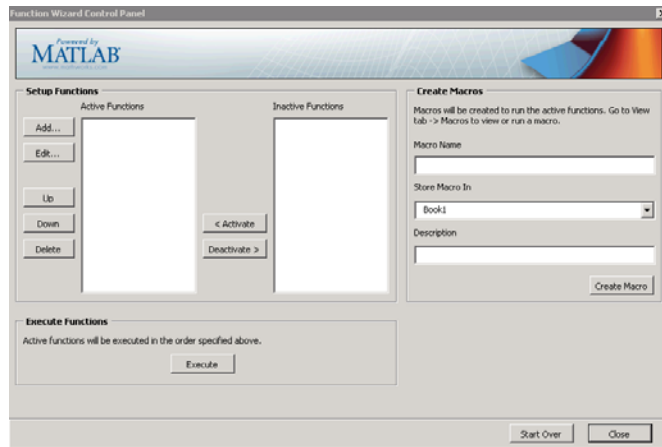
Functions Having Multiple Outputs

When working with functions having multiple outputs, simply define each specific output range with the Argument Properties For *y* dialog box. See the Argument Properties For *y* step in “Function Execution” on page 2-17 for details.

Execute a Graphical Function

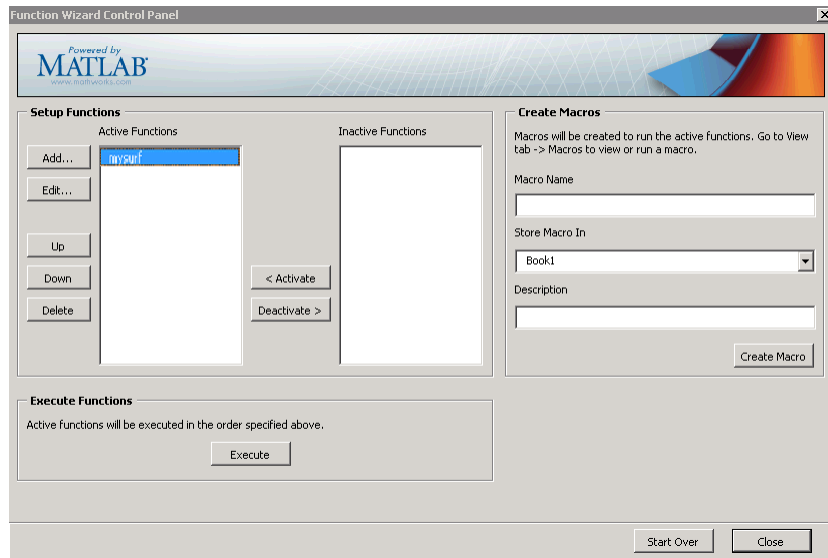
Execute a graphical function on a Microsoft Excel spreadsheet by doing the following.

- 1 Install and start the Function Wizard using the procedures detailed in “Installation of the Function Wizard” on page 2-27 and “Function Wizard Start-Up” on page 2-29. Successfully completing each of these procedures causes the Function Wizard Control Panel to display.

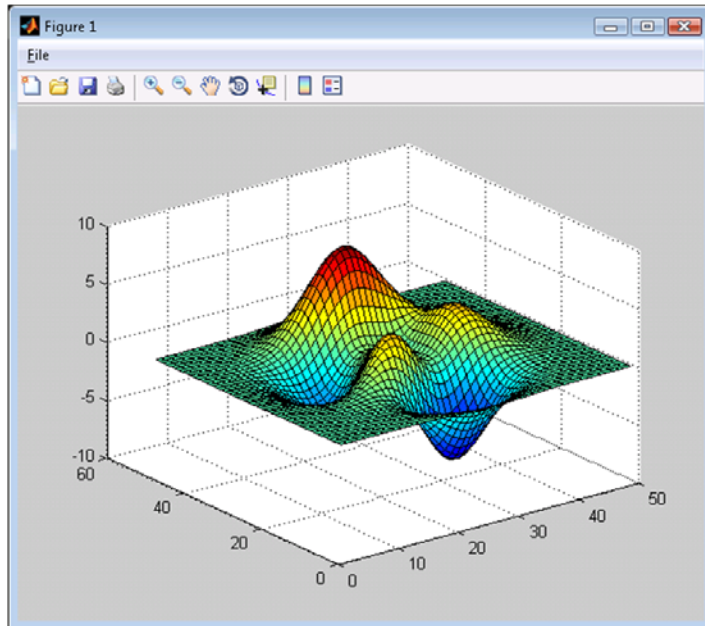


- 2 Click **Add**.
- 3 Select a function with a graphical output, such as **mysurf** for example, from the **Functions for Class *class_name*** box.
- 4 Click **Add**. The Function Properties dialog box appears.
- 5 Click **Done**. The Function Wizard Control Panel appears with **mysurf** selected in the list of **Active Functions**.

Note Since `mysurf.m` does not have any inputs or outputs, there is no need to specify **Properties**.



- 6 In the Execute Functions area of the Function Wizard Control Panel, click **Execute**. The graphical output for `mysurf` appears in a separate window.



7 Test to ensure you can interact with the figure and that it is usable.

For example, try dragging the figure window, inserting color bars and legends in the toolbar, and so on.

If you encounter problems working with the figure, consult the person who created it (usually the MATLAB Programmer on page 4-5).

Create a Macro Using a Graphical Function

Once you are satisfied your graphical figure is usable, do the following to create a macro to execute it at your convenience.

Caution To create a macro, you must have already built your COM component and add-in with MATLAB Builder EX.

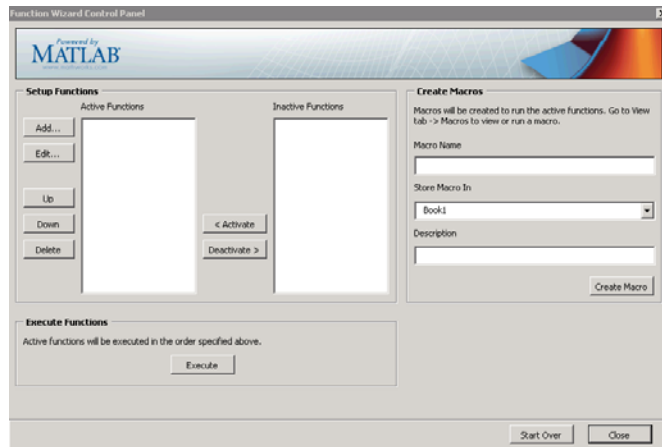
For complete Function Wizard workflows, see “Executing Functions and Creating Macros Using the Function Wizard” on page 2-2 and “End-to-End Deployment of a MATLAB Function Using the Function Wizard” on page 2-22.

- 1** In the Function Wizard Control Panel, label the macro by entering `mysurf` in the **Macro Name** field of the Create Macros area.
- 2** If desired, change the default value **Book1** (for the default Excel sheet name) in the **Store Macro In** field.
- 3** Click **Create Macro**.
- 4** See “Macro Execution” on page 2-47 for details on executing macros with different versions of Microsoft Office. When the macro is **Run**, you should see output similar to the Surf Peaks image in “Execute a Graphical Function” on page 4-11 in this chapter.

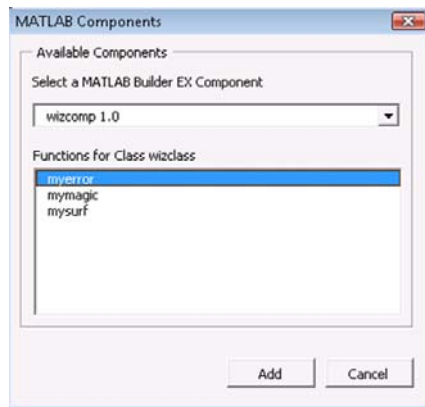
Create Dialog Box and Error Message Macros

Create a macro that displays a dialog box using this workflow, which is useful for error message presentation.

- 1** Install and start the Function Wizard using the procedures detailed in “Installation of the Function Wizard” on page 2-27 and “Function Wizard Start-Up” on page 2-29. Successfully completing each of these procedures causes the Function Wizard Control Panel to display.



2 Click **Add**. The MATLAB Components dialog box appears.



3 Select a function that displays a graphical error message, such as **myerror** for example, from the **Functions for Class *class_name*** box.

4 Click **Add**. The Function Properties dialog box appears.

5 Associate an input value of -1 with **myerror**.

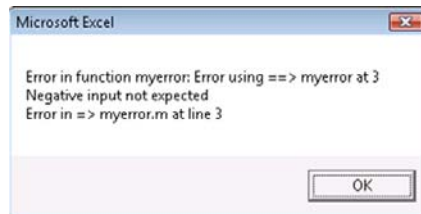
a On the **Inputs** tab, click **Properties**. The Argument Properties for in dialog box appears.

b Select **Value** and enter -1.

- c Click **Done**.
- 6** Define the output of `myerror`—any Excel spreadsheet cell, in this case.
- a On the **Outputs** tab, click **Properties**. The Argument Properties For `x` dialog box appears, where `x` is the name of the output variable you are defining properties of.
 - b Select **Range** and enter and spreadsheet cell value, `=C13`, for example.
 - c Click **Done**. The Function Wizard Control Panel appears with `myerror` selected in the list of **Active Functions**.

Tip If you have functions besides `myerror` listed in the **Active Functions** list that you don't want to execute when you test `myerror`, deactivate these functions by selecting them and clicking **Deactivate**.

- 7** Click **Execute**. The following will display.



Create a Macro That Displays an Error Message or Dialog Box

Create a macro to display your error message on demand.

- 1** In the Function Wizard Control Panel, label the macro by entering `myerror` in the **Macro Name** field of the Create Macros area.
- 2** If desired, change the default value **Book1** (for the default Excel sheet name) in the **Store Macro In** field.
- 3** Click **Create Macro**.
- 4** See “Macro Execution” on page 2-47 for details on executing macros with different versions of Microsoft Office.

Microsoft Excel Add-in Integration

- “Overview of the Integration Process ” on page 5-2
- “Code Your Microsoft® Visual Basic® Application” on page 5-3
- “Build and Integrate with Spectral Analysis” on page 5-18
- “For More Information” on page 5-37

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 you have the skill set of a Microsoft® Excel® Developer on page 5-3 and have a working knowledge of VBA.

This section is not intended to teach you to program in Visual Basic. Refer to the VBA documentation provided with Excel for general programming information.


For a comprehensive example of building and integrating a COM component using Visual Basic programming, see “Build and Integrate with Spectral Analysis” on page 5-18.

Code Your Microsoft Visual Basic Application

In this section...

- “When to Use a Formula Function or a Subroutine” on page 5-3
- “Initializing MATLAB® Builder™ EX Libraries with Microsoft® Excel®” on page 5-4
- “Creating an Instance of a Class” on page 5-5
- “Calling the Methods of a Class Instance” on page 5-8
- “Programming with Variable Arguments” on page 5-10
- “Modifying Flags” on page 5-12
- “Handling Errors During a Method Call” on page 5-17

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

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 zero outputs.

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” 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

- “Overview” on page 5-5
- “CreateObject Function” on page 5-5
- “New Operator” on page 5-6
- “How the MCR Is Shared Among Classes” on page 5-7

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. Microsoft refers to calling `CreateObject` as *late binding* and using `new` as *early binding*.

To use this method, declare a variable of type `Object` using `Dim` 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`.

Using both `CreateObject` and `New` produce a dimensioned class instance. The first method does not require a reference to the type library in the VBA project; 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 "Utility Library Classes" on page 8-3 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
    Set aClass = New mycomponent.myclass
    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
```

Programming with Variable Arguments

Processing varargin and varargout Arguments

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 for more details.

The next example processes a varargout parameter into three separate Excel Ranges. This function uses the MWUnpack function in the utility library. The MATLAB function used is `varargout = 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.

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
```

For More Information

For more information about working with variable-length arguments, see “Work with Variable-Length Inputs and Outputs” on page 4-5.

Modifying Flags

- “Overview” on page 5-12
- “Array Formatting Flags” on page 5-13
- “Data Conversion Flags” on page 5-15

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” 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 5-6.

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.

Tip If your MATLAB function is specifically returning a row vector, for example, ensure you assign a similar row vector of cells in Excel.

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
```

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.

Build and Integrate with Spectral Analysis

In this section...
“Overview” on page 5-18
“Building the Component” on page 5-19
“Integrating the Component Using VBA” on page 5-20
“Testing the Add-in” on page 5-32
“Packaging and Distributing the Add-in” on page 5-34
“Installing the Add-in” on page 5-36

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 then 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 “Deployable Component Creation” on page 1-16:

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

Where Is the Example Code?

See “Example File Copying” on page 2-26 for information about accessing the example code from within the product.

Integrating the Component Using VBA

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

Note To use `Fourier.xla` directly in the folder `xlspectral` (see “Example File Copying” on page 2-26), add references to **Fourier 1.0 Type Library** and **MWComUtil 7.x Type Library**.

Selecting the Libraries

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

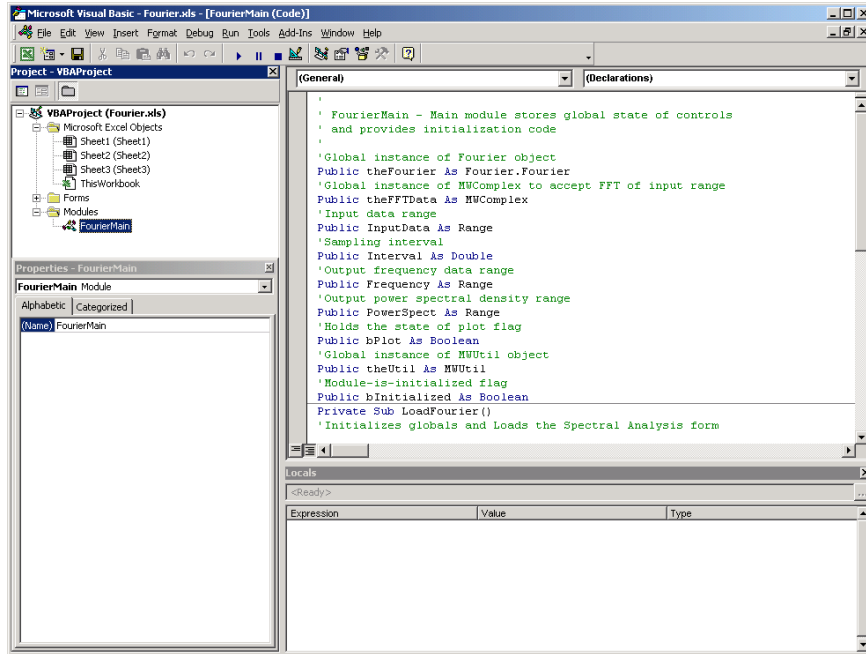
- 1 Start Excel on your system.
- 2 From the Excel main menu, select **Tools > Macro > Visual Basic Editor**.
- 3 When the Visual Basic Editor starts, select **Tools > References** to open the Project References dialog box.
- 4 Select **Fourier 1.0 Type Library** and **MWComUtil 7.x Type Library** from 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 theFFTDData 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 MMUtil             'Global instance of MMUtil 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
    If theFFTDData Is Nothing Then
        Set theFFTDData = New MWComplex
    End If
    bInitialized = True
    Exit Sub
Handle_Error:
        MsgBox (Err.Description)
End Sub

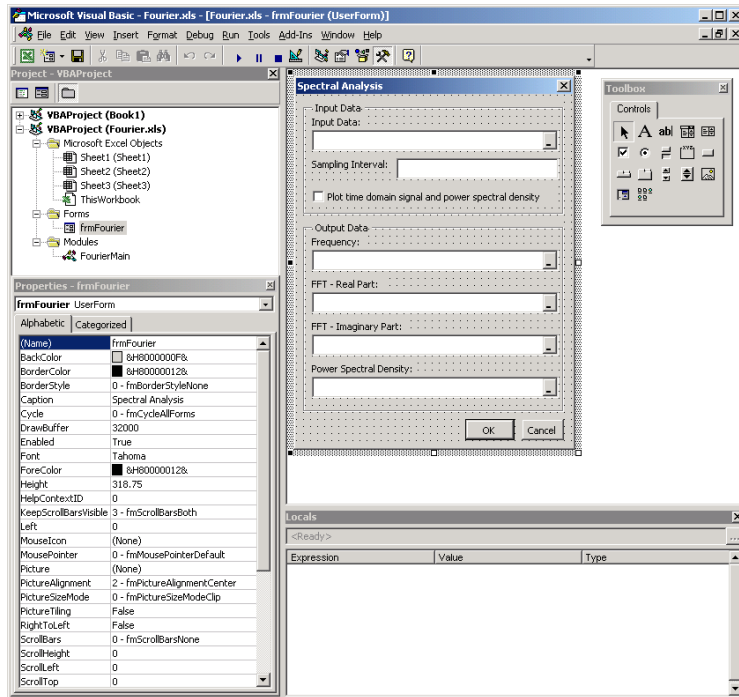
```

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.
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.

Controls Needed for Spectral Analysis Example (Continued)

Control Type	Control Name	Properties	Purpose
Label	Label14	Caption = FFT - Real Part:	Labels the RefEdit for real part of FFT.
Label	Label15	Caption = FFT - Imaginary Part:	Labels the RefEdit for imaginary part of FFT.
Label	Label16	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 5-25. 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 theFFTDData Is Nothing Then Exit Sub
    'Initialize controls with current state
    If Not InputData Is Nothing Then
        refedtInput.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")
    Exit Sub
```



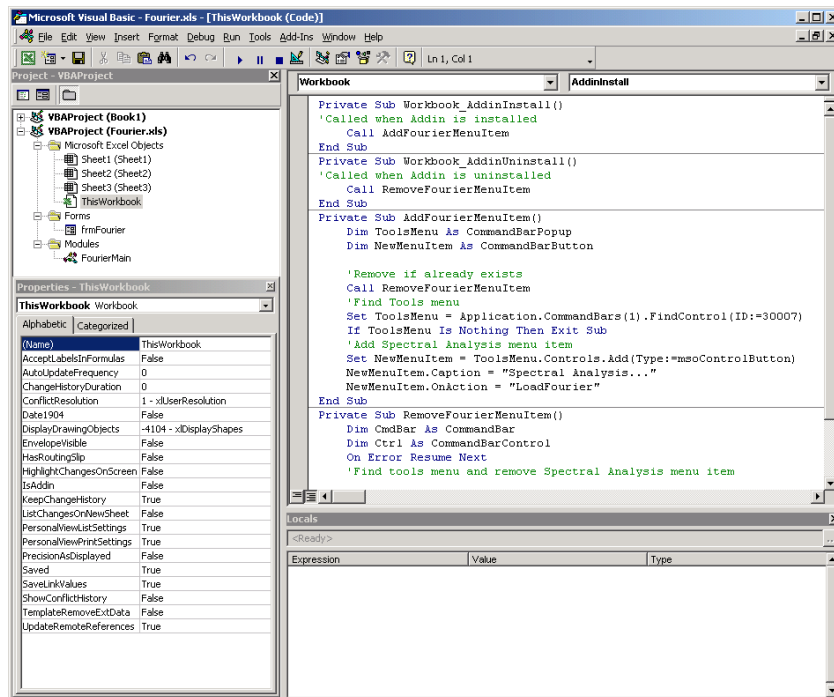
```
End If
Set InputData = R
Interval = CDBl(edtSample.Text)
If Err <> 0 Or Interval <= 0 Then
    MsgBox ("Sampling interval must be greater than zero")
    Exit Sub
End If
'Process Outputs
Set R = Range(refedtFreq.Text)
If Err = 0 Then
    Set Frequency = R
End If
Set R = Range(refedtReal.Text)
If 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 CommandBarControl
    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

$$= \text{SIN}(2*\text{PI}()*15*A1) + \text{SIN}(2*\text{PI}()*40*A1) + \text{RAND}()$$

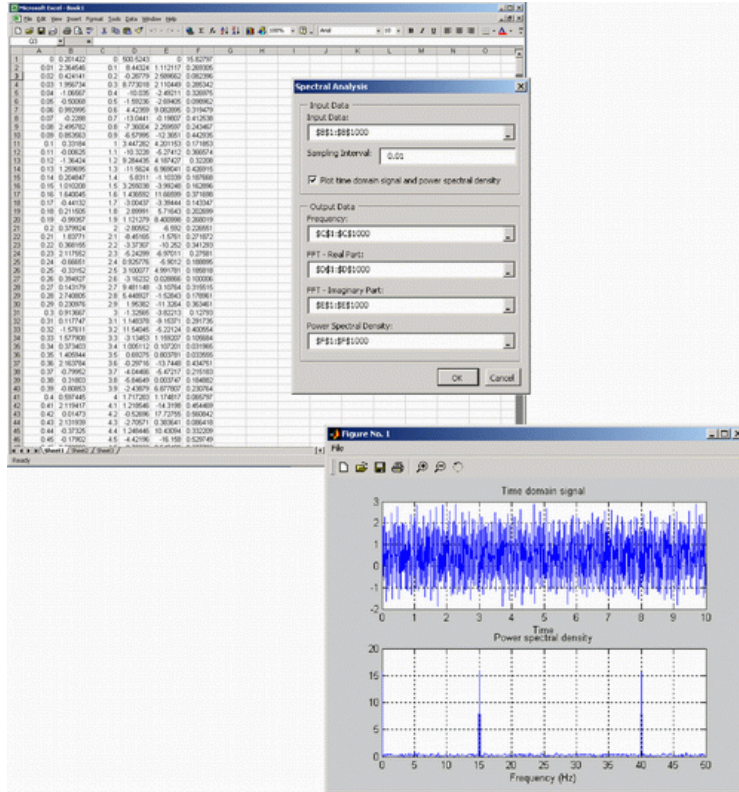
Repeat the drag procedure to copy this formula to all cells in the range B1:B1001.

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?
Embed the MCR in the package	This option physically copies the MCR Installer file into the package you create.	<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/>
Invoke the MCR from a network location	<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.</p> <p>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 Installer, if needed. To do so, select the Preferences link in this dialog box, or change</p>

Option	What Does This Option Do?	When Should I Use This Option?
		<p>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 “Distributing MATLAB Code Using the MATLAB Compiler Runtime (MCR)” on page 6-2.

- 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.

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.

For More Information

For more information about...	See...
Functions available through MATLAB Builder EX	Function reference in MATLAB Builder EX documentation
Utility functions you can use to customize COM components created with MATLAB Builder EX	"Utility Library Classes" on page 8-3

Distribution to End Users

- “Distribute Your Add-Ins and COM Components to End Users” on page 6-2
- “Deploying Your Microsoft® Visual Basic® Application” on page 6-5
- “For More Information” on page 6-18

Distribute Your Add-Ins and COM Components to End Users

Distributing MATLAB Code Using the MATLAB Compiler Runtime (MCR)

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

Install MATLAB Compiler Runtime (MCR)

The *MATLAB Compiler Runtime (MCR)* is an execution engine made up of the same shared libraries MATLAB uses to enable execution of MATLAB files on systems without an installed version of MATLAB.

The MATLAB Compiler Runtime (MCR) is now available for downloading from the Web to simplify the distribution of your applications or components created with the MATLAB Compiler. Download the MCR from the MATLAB Compiler product page.

The MCR 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

MCR Prerequisites

- 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.

3 Avoid installing the MCR in MATLAB installation directories.


Add the MCR Installer To Your Deployment Package (Optional)

The example shows how to optionally include the MCR in your deployment package, using the Deployment Tool. A *package* is a zipped (compressed) file containing all files needed to run the standalone application or shared library built with MATLAB Compiler.

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

Select one of the following options:

- **Embed the MCR in the package** — This option adds the MCR to the Deployment package, which contains all the files needed to run the standalone application or shared library built with MATLAB Compiler. Choosing this option adds `MCRInstaller.exe` to your package, which can increase the size of the package substantially.
- **Add a batch file to invoke the MCR over the network** — The option adds a batch file that, when executed, invokes the MCR from a single location on your network. You must customize this file to point to the location of the MCR on your network. Choosing this option adds `MCRInstaller.cmd` to your package.

Click the Package button ()

In the Package dialog box, navigate to the location where you want to save the package file. In the **File name** field, enter a name for the package file (for example, `libmatrixp.exe`).

Click **Save**. The Package dialog appears and your package is created in the location specified. When packaging is complete, click **Close** to dismiss the dialog box.

Distribute the package file as needed to additional end users.

Installing the MCR

This example shows how to install the MATLAB Compiler Runtime (MCR) on a system.

Locate the MCR Installer that was either packaged with the Deployment Tool or downloaded from the Web.

Run the installer as you would any other executable on your system, following the Wizard instructions.

Note 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 MATLAB Compiler on Mac or Linux” for detailed information on performing all deployment tasks specifically with UNIX variants such as Linux and Mac.

Deploying Your Microsoft Visual Basic Application

In this section...

“Calling Compiled MATLAB Functions from Microsoft® Excel®” on page 6-5

“Improving Data Access Using the MCR User Data Interface, COM Components, and MATLAB® Builder™ EX” on page 6-8

“MCR Component Cache and CTF Archive Embedding” on page 6-13

“MCR Run-Time Options” on page 6-16

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 “Deployable Component Creation” on page 1-16:

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

- 5 Package your component by following the instructions in “Add-in Packaging (Recommended)” on page 1-19.

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 the MCR Installer, follow the prompts to install the MATLAB Compiler Runtime.

Caution You need to re-register your DLL file if you move it following its creation. Unlike DLL files, Excel files can be moved anywhere at anytime.

- 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.

Where Is the Example Code?

See “Example File Copying” on page 2-26 for information about accessing the example code from within the product.

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

- “Overview” on page 6-8
- “Supplying Run-Time Profile Information for Parallel Computing Toolbox Applications” on page 6-9

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 `mxArrays`, consisting of a mapping from string keys to `mxArray` values. Reasons for doing this include, but are not limited to:

- You need to supply run-time profile information to a client running an application created with the Parallel Computing Toolbox. Profile information may be supplied (and change) on a per-execution basis. For example, two instances of the same application may run simultaneously with different profiles.
- 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 “Supplying Run-Time Profile Information for Parallel Computing Toolbox Applications” on page 6-9.

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

Supplying Run-Time Profile 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 profile for Parallel Computing Toolbox applications.

Note Standalone executables and shared libraries generated from MATLAB Compiler for parallel applications can now launch up to twelve local workers without MATLAB Distributed Computing Server™.

Step 1: Write Your Parallel Computing Toolbox™ Code.

1 Compile `sample_pct.m` in MATLAB.

This example code uses the cluster defined in the default profile.

The output assumes that the default profile is `local`.

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

- 2** Run the code as follows after changing the default profile to `local`, if needed.

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

- 3** Verify that you get the following results;

```
Starting matlabpool using the 'local'  
profile ... 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.  
done  
a =  
    1.7643
```

Step 2: Set the Parallel Computing Toolbox Profile. 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 profile 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 Profile:  
if(isdeployed)  
    [profile] = uigetfile('*.settings');  
    % let the USER select file  
    setmcruserdata('ParallelProfile',[profile]);  
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 “Deployable Component Creation” on page 1-16 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

Note If you are using the GPU feature of Parallel Computing Toolbox, you need to manually add the PTX and CU files.

If you are using a Deployment Tool project, click **Add files/directories** on the **Build** tab.

If you are using the `mcc` command, use the `-a` option.

- 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
 - Cluster profile

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.

```
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)			

MCR Component Cache and CTF Archive Embedding

- “Overriding Default Behavior” on page 6-15
- “For More Information” on page 6-16

CTF data is automatically embedded directly in MATLAB Builder EX components by default and extracted to a temporary folder.

Automatic embedding enables usage of MCR Component Cache features through environment variables.

These variables allow you to specify the following:

- Define the default location where you want the CTF archive to be automatically extracted
- Add diagnostic error printing options that can be used when automatically 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 <code>.max_size</code> , which resides in the file designated by running

Environment Variable	Purpose	Notes
		the <code>mcrcachedir</code> command, with the desired cache size limit.

You can override this automatic embedding and extraction behavior by compiling with the `-C` option. See “Overriding Default Behavior” on page 6-15 for details.

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.

Overriding Default Behavior

To extract the CTF archive in a manner prior to R2008b, alongside the compiled COM component, compile using the option “`-C Do Not Embed CTF Archive by Default`”.

You can also implement this override by checking the appropriate **Option** in the Deployment Tool.

You might want to use this option to troubleshoot problems with the CTF archive, for example, as the log and diagnostic messages are much more visible.

For More Information

For more information about the CTF archive, see “Component Technology File (CTF Archive)” on page 3-8.

MCR Run-Time Options

When you roll-out a component to end users, there are times when you need to specify MCR options to create a log file or improve performance.

Pass these options with either `mcc` or `deploytool`.

What MCR Options are Supported by MATLAB Builder EX?

- `-nojvm` — Launches the MCR without a Java Virtual Machine (JVM). This can improve performance of deployed applications, in some cases.
- `-logfile` — Allows you to specify a log file name.

How Do I Specify MCR Options?

If your add-in was ready to be immediately deployed after you wrote your MATLAB function, and you only used the Function Wizard to execute it (you didn't create a function from scratch with the wizard), simply specify the desired options (`-nojvm` and `-logfile`) with the `mcc -R` command or by checking the desired options on the **Advanced** tab of the Deployment Tool **Settings** panel. You can do this, because the code to invoke the MCR options is automatically generated when you don't build a function from scratch with the Function Wizard. Otherwise, see “If You Created a Function From Scratch Using the Function Wizard” on page 6-16.

For more information about Function Wizard workflows, see “Choosing Function Deployment Workflow” on page 1-11 in this User's Guide.

If You Created a Function From Scratch Using the Function Wizard.

If you created a function from scratch using the Function Wizard, and want to specify MCR options, you have to manually modify the `.bas` file code (the `.bas` file can be found in your `distrib` folder).

You do this by invoking the following `MWUtil` API calls, detailed with examples in “Utility Library Classes” on page 8-3:

- Sub MWInitApplicationWithMCROptions(pApp As Object, [mcrOptionList])
- Function IsMCRJVMEEnabled() As Boolean
- Function IsMCRInitialized() As Boolean

For More Information

For more information about...	See...
Functions available through MATLAB Builder EX	Function Reference pages in MATLAB Builder EX documentation
Utility functions you can use to customize COM components created with MATLAB Builder EX	"Utility Library Classes" on page 8-3

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 “The Magic Square Example” on page 1-13 in this User’s Guide for more information about using the Deployment Tool to create COM components, and see 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 -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>

deploytool

Desired Results	Command
Start Deployment Tool and package an existing project from the Command Line Interface. Specifying the <i>package_name</i> is optional. By default, a project is packaged into a .zip file. On Windows, if the <i>package_name</i> ends with .exe, the project is packaged into a self-extracting .exe.	<code>deploytool -package <i>project_name</i>.prj <i>package_name</i></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 (*matlabroot*) for both 32-bit and 64-bit versions of MATLAB.
- You are running from a Windows command line (not a MATLAB command line).

How To

- “Product Overview” on page 1-3
- “Code Your Microsoft® Visual Basic® Application” on page 5-3

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]
[-u ]

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

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.

-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.
<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.

-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.

[-b]

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

[-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.

[-S -W '*my_component,my_class*' *foo*..*bar*]

The example creates a component called `my_component` containing a single class named `my_class` with methods `foo` and `bar`.

If and when multiple instances of `my_class` are instantiated in an application, only one MCR is initialized, and it is shared by all instances of `my_class`.

[-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).

-u

Tells the compiler to not auto-register the COM component or Microsoft Excel add-in for the current user.

This can be helpful when a user wants to ensure the component is registered for specific privileges (such as administrator, for example).

See “Deployable Component Creation” on page 1-16 and “Add-in and COM Component Registration” on page 1-25 in this User’s Guide for more information.

-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.
<code>major</code>	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.
<code>minor</code>	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.

Using -S to Initialize a Single MCR

```
mcc -S -W 'java:mycomponent,myclass' foo.m bar.m
```

The example creates a Java component called `mycomponent` containing a single Java class named `myclass` with methods `foo` and `bar`. (See the first example in this table)

If and when multiple instances of `myclass` are instantiated in an application, only one MCR is initialized, and it is shared by all instances of `myclass`.

Note All of these command-line examples produce the `mycomponent.jar` file (component jar file).

Notice that the component name used to create these files is derived from the last item on the period-separated list that specifies the fully qualified name of the class.

-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 (*matlabroot*) 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 -u to Not Auto-Register an Add-in to administrator

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

In this example, the add-in generated by this build command will only be registered to the current user on the development machine. This behavior is contrary to the default behavior to auto-register the add-in or COM component to administrator.

See “Deployable Component Creation” on page 1-16 and “Add-in and COM Component Registration” on page 1-25 in this user’s guide for more information.

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 8-2
- “Utility Library Classes” on page 8-3
- “Enumerations” on page 8-33

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 8-3) and three enumerated types (see “Enumerations” on page 8-33). 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 8-3
“Class MWFlags” on page 8-12
“Class MWStruct” on page 8-18
“Class MWField” on page 8-25
“Class MWComplex” on page 8-26
“Class MWSparse” on page 8-28
“Class MWArg” on page 8-32

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 8-4
- “Sub `MWInitApplicationWithMCROptions(pApp As Object, [mcrOptionList])`” on page 8-5
- “Function `IsMCRJVMEEnabled() As Boolean`” on page 8-6
- “Function `IsMCRInitialized() As Boolean`” on page 8-7
- “Sub `MWPack(pVarArg, [Var0], [Var1], ... , [Var31])`” on page 8-7
- “Sub `MWUnpack(VarArg, [nStartAt As Long], [bAutoSize As Boolean = False], [pVar0], [pVar1], ..., [pVar31])`” on page 8-9
- “Sub `MWDate2VariantDate(pVar)`” on page 8-11

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 NE. An error is generated if a method call is made to a member class of any MATLAB Builder NE 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 MWInitApplicationWithMCROptions(pApp As Object, [mcrOptionList])

Start MCR with MCR options. Similar to mclInitializeApplication used in C/C++ shared libraries.

Parameters.

Argument	Type	Description
pApp	Object	A valid reference only when called from an Excel application Non Excel COM clients pass in Empty.

Return Value. None.

Remarks. Call this function to pass in MCR options (nojvm, logfile, etc.). Call this function once per process (since the MCR can only be initialized once).

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 MWInitApplicationWithMCROptions method with an argument of Application and a string array that contains the options. Once this function succeeds, all subsequent calls exit without recreating the object. When this function successfully executes, the MCR starts up with no JVM and a logfile named logfile.txt.

```
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
        Dim mcrOptions(1 To 3) as String
        mcrOptions(1) = "-nojvm"
        mcrOptions(2) = "-logfile"
        mcrOptions(3) = "logfile.txt"
        Call MCLUtil.MWInitApplicationWithMCROptions(Application, mcrOptions)
        bModuleInitialized = True
        Exit Sub
    Handle_Error:
        bModuleInitialized = False
    End If
End Sub
```

Note If you are not using Excel, pass in Empty instead of Application to MWInitApplicationWithMCROptions.

Function IsMCRJVMEabled() As Boolean

Returns true if MCR is launched with JVM; otherwise returns false.

Parameters. None.

Return Value. Boolean

Function IsMCRInitialized() As Boolean

Returns true if MCR is initialized; otherwise returns true

Parameters. None.

Return Value. Boolean

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 not empty or missing. (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], [bAutoResize 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. 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 *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. 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 NE 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 8-12
- “Property DataConversionFlags As MWDataConversionFlags” on page 8-15
- “Sub Clone(ppFlags As MWFlags)” on page 8-18

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 8-13
- “Property InputArrayIndFlag As Long” on page 8-14

- “Property OutputArrayFormat As mwArrayFormat” on page 8-14
- “Property OutputArrayIndFlag As Long” on page 8-15
- “Property AutoResizeOutput As Boolean” on page 8-15
- “Property TransposeOutput As Boolean” on page 8-15

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
mxArrayFormatAsIs	Converts arrays according to the default conversion rules listed in “Data Conversion Rules”.
mxArrayFormatMatrix	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.
mxArrayFormatCell	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 8-15
- “Property DateBias As Long” on page 8-16
- “Property InputDateFormat As mwDateFormat” on page 8-17
- “Property OutputAsDate As Boolean” on page 8-17
- “Property ReplaceMissing As mwReplaceMissingData” on page 8-17

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”.

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 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>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 `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

```

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 ReplaceMissing As mwReplaceMissingData. This property is an enumeration and can have two possible values: `mwReplaceNaN` and `mwReplaceZero`.

To treat empty cells referenced by input parameters as zeros, set the value to `mwReplaceZero`. To treat empty cells referenced by input parameters as NaNs (Not a Number), set the value to `mwReplaceNaN`.

By default, the value is `mwReplaceZero`.

Sub Clone(ppFlags As MWFlags)

Creates a copy of an `MWFlags` object.

Parameters.

Argument	Type	Description
<code>ppFlags</code>	<code>MWFlags</code>	Reference to an uninitialized <code>MWFlags</code> 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 8-19
- “Property Item([i0], [i1], ..., [i31]) As MWField” on page 8-20
- “Property NumberOfFields As Long” on page 8-23
- “Property NumberOfDims As Long” on page 8-23
- “Property Dims As Variant” on page 8-23
- “Property FieldNames As Variant” on page 8-23
- “Sub Clone(ppStruct As MWStruct)” on page 8-24

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"))
End Sub
```

```

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

'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 8-25
- “Property Value As Variant” on page 8-25
- “Property MWFlags As MWFlags” on page 8-26
- “Sub Clone(ppField As MWField)” on page 8-26

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 8-26
- “Property `Imag As Variant`” on page 8-27
- “Property `MWFlags As MWFlags`” on page 8-28
- “Sub `Clone(ppComplex As MWComplex)`” on page 8-28

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 not empty 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 MWSpase

The MWSpase 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 8-29
- “Property NumColumns As Long” on page 8-29
- “PropertyRowIndex As Variant” on page 8-29
- “Property ColumnIndex As Variant” on page 8-29
- “Property Array As Variant” on page 8-29

- “Property MWFlags As MWFlags” on page 8-30
- “Sub Clone(ppSparse As MWSparse)” on page 8-30

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 zero, the row index is taken from the maximum of the values in theColumnIndex 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 theRowIndex 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 theColumnIndex 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 three properties/methods:

- “Property Value As Variant” on page 8-32
- “Property MWFlags As MWFlags” on page 8-32
- “Sub Clone(ppArg As MWArg)” on page 8-32

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 8-33
“Enum mwDataType” on page 8-33
“Enum mwDateFormat” on page 8-34

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 `VARIANTs` 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 `VARIANTs`. `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”.) 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”.) This object is passed as a VT_DISPATCH type.
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 .)

MATLAB to COM VARIANT Conversion Rules (Continued)

MATLAB Data Type	VARIANT Type for Scalar Data	VARIANT Type for Array Data	Comments
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 .)
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 .)
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 .)

MATLAB to COM VARIANT Conversion Rules (Continued)

MATLAB Data Type	VARIANT Type for Scalar Data	VARIANT Type for Array Data	Comments
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 MWCComplex class. (See .)
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 MWCComplex class. (See .)
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 MWCComplex class. (See .)

MATLAB to COM VARIANT Conversion Rules (Continued)

MATLAB Data Type	VARIANT Type for Scalar Data	VARIANT Type for Array Data	Comments
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 MWCComplex class. (See .)
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	
VT_UI1	uint8	
VT_I2	int16	
VT_UI2	uint16	
VT_I4	int32	
VT_UI4	uint32	
VT_R4	single	

COM VARIANT to MATLAB Conversion Rules (Continued)

VARIANT Type	MATLAB Data Type (scalar or array data)	Comments
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	
VT_DECIMAL	double	
VT_BOOL	logical	

COM VARIANT to MATLAB Conversion Rules (Continued)

VARIANT Type	MATLAB Data Type (scalar or array data)	Comments
VT_DISPATCH	<i>(varies)</i>	<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 8-3 for information on the MATLAB Builder EX types.</p>
<anything> VT_BYREF	<i>(varies)</i>	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	<i>(varies)</i>	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 <i>type</i> 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.

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> . See “Add-in and COM Component Registration” on page 1-25 for full details.
Error in VBAProject: 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> . See “Add-in and COM Component Registration” on page 1-25 for full details.

MATLAB Builder EX Errors and Suggested Solutions (Continued)

Message	Probable Cause	Suggested Solution
<p>Error in VBAProject: Automation error The specified module could not be found.</p>	<p>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.</p>	<p>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 B-5.</p>
<p>LoadLibrary ("component_name.dll") failed - The specified module could not be found.</p>	<p>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.</p>	<p>See the table Required Locations to Develop and Use Components on page B-5.</p>
<p>Cannot recompile the M file xxxx because it is already in the library libmmfile.mlib.</p>	<p>The name you have chosen for your MATLAB file duplicates the name of a MATLAB file already in the library of precompiled MATLAB files.</p>	<p>Rename the MATLAB file, choosing a name that does not duplicate the name of a MATLAB file already in the library of precompiled MATLAB files.</p>
<p>Arguments may only be defaulted at the end of an argument list.</p>	<p>You have modified the VB script generated for MATLAB Builder EX and have not provided one or more arguments used in the modified script.</p>	<p>Provide a value for any argument that requires an explicit value. Arguments that accept defaults appear at the end of the argument list.</p>


MATLAB Builder EX Errors and Suggested Solutions (Continued)

Message	Probable Cause	Suggested Solution
Unable to use accessibility screen-readers or assistive technologies, such as JAWS®,	Required files JavaAccessBridge.dll and WindowsAccessBridge.dll no longer added automatically to your Windows path.	Add the following DLLs to your Windows path: JavaAccessBridge.dll WindowsAccessBridge.dll
Error in <i>class.method.version</i>	This is a generic message, but is sometimes seen when there are conflicts in architecture versions of MATLAB and Microsoft Excel.	See “Deployment Target Architectures and Compatibility” on page 1-9 for detailed information.

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 button on the Microsoft Office  ribbon (). 2 Click Excel Options > Trust Center > Trust Center Settings > Macro Settings. 3 In Developer Macro Settings, select Trust access to the VBA project object model. • For Microsoft Office 2010: <ol style="list-style-type: none"> 1 Click File > Options > Trust Center > Trust Center Settings > Macro Settings. 2 In Developer Macro Settings, select Trust access to the VBA project object model.

Function Wizard Problems

Problem	Probable Cause	Suggested Solution
The Function Wizard Help does not appear.	The Function Wizard Help file (mlfunction.chm) is not in the same folder as the Function Wizard add-in (mlfunction.xla).	Copy the Help file (mlfunction.chm) into the same folder as the add-in.
The Function Wizard did not automatically import your .bas file, and you have to create your macro manually	The Function Wizard has malfunctioned with an unspecified error	<ol style="list-style-type: none"> 1 Open Excel 2 Do one of the following: <ul style="list-style-type: none"> • If you use Microsoft Office 2007 or 2010, click Developer > Macros. • If you use Microsoft Office 2003, click Tools > Macros > Macro.
You get an error when trying to create a macro with the Function Wizard		

Function Wizard Problems (Continued)

Problem	Probable Cause	Suggested Solution
		<hr/> <p>Tip You may need to enable the Developer menu item before performing this step. To do this:</p> <ul style="list-style-type: none"> a Click the 2007 Office button on the Microsoft Office ribbon () or, in Office 2010, click File to display the Office Backstage View. b Click Excel Options. c In the Top Options for Working With Excel area, select Show Developer tab in the Ribbon. <hr/> <p>3 From the Visual Basic Editor, select File > Import and select the created VBA file from the <project_dir>\distrib folder.</p>

Function Wizard Problems (Continued)

Problem	Probable Cause	Suggested Solution
<p>The message Failed to start MATLAB appears instead of Starting MATLAB... when MATLAB is invoked by the Function Wizard.</p>	<p>This message may appear if you manually terminate the MATLAB session that is invoked from the Function Wizard. As a result, you can no longer use the wizard's MATLAB-related features in your current Excel session.</p>	<p>Save your work and restart Microsoft Excel.</p>
<p>When I use CTRL + arrow keys to select ranges with the Function Wizard, once I select a function and begin to select the function inputs, keyboard navigation no longer works in excel.</p>	<p>This behavior results from a bug in Microsoft Excel.</p>	<p>If you must use arrow keys to select ranges, apply the following fix from the Microsoft Web site: http://support.microsoft.com/kb/291110 .</p>

Application Deployment Terms

Glossary of Deployment Product Terms

A

Add-in — A Microsoft Excel add-in is an executable piece of code that can be actively integrated into a Microsoft Excel application. Add-ins are front-ends for COM components, usually written in some form of Microsoft Visual Basic.

API — Application program interface. An implementation of the proxy software design pattern. See *MWArray*.

Application — An end user-system into which a deployed functions or solution is ultimately integrated. Typically, the end goal for the Deployment customer is integration of a deployed MATLAB function into a larger enterprise environment application. The deployment products prepare the MATLAB function for integration by wrapping MATLAB code with enterprise-compatible source code, such as C, C++, C# (.NET), F#, and Java code.

Assembly — An executable bundle of code, especially in .NET. For example, after building a deployable .NET component with MATLAB Builder NE, the .NET developer integrates the resulting .NET assembly into a larger enterprise C# application. See *Executable*.

B

Binary — See *Executable*.

Boxed Types — Data types used to wrap opaque C structures.

Build — See *Compile*.

C

Class — A user-defined type used in C++, C#, and Java, among other object-oriented languages that is a prototype for an object in an object-oriented language. It is analogous to a derived type in a procedural language. A class is a set of objects which share a common structure and behavior. Classes

relate in a class hierarchy. One class is a specialization (a *subclass*) of another (one of its *superclasses*) or comprises other classes. Some classes use other classes in a client-server relationship. Abstract classes have no members, and concrete classes have one or more members. Differs from a *MATLAB class*

Compile — In MATLAB Compiler terminology, to compile a component involves generating a binary that wraps around MATLAB code, enabling it to execute in various computing environments. For example, when MATLAB code builds with MATLAB Builder JA, a Java wrapper provides Java code that enables the MATLAB code to execute in a Java environment.

COM component — In MATLAB Builder EX, the executable back-end code behind a Microsoft Excel add-in. In MATLAB Builder NE, an executable component, to be integrated with Microsoft COM applications.

Component — In MATLAB, a generic term used to describe the wrapped MATLAB code produced by MATLAB Compiler. You can plug these self-contained bundles of code you plug into various computing environments. The wrapper enables the compatibility between the computing environment and your code.

Console application — Any application that is executed from a system command prompt window. If you are using a non-Windows operating system, console applications are often referred to as standalone applications.

CTF archive (Component Technology File) — The Component Technology File (CTF) archive is embedded by default in each generated binary by MATLAB Compiler. It houses the deployable package. All MATLAB-based content in the CTF archive uses the Advanced Encryption Standard (AES) cryptosystem. See “Additional Details” in the MATLAB Compiler documentation.

D

Data Marshaling — Data conversion, usually from one type to another. Unless a MATLAB deployment customer is using type-safe interfaces, data marshaling—as from mathematical data types to MathWorks data types such as represented by the `MWArray` API—must be performed manually, often at great cost.

Deploy — The act of integrating a component into a larger-scale computing environment, usually to an enterprise application, and often to end users.

DLL — Dynamic link library. Microsoft's implementation of the shared library concept for Windows. Using DLLs is much preferred over the previous technology of static (or non-dynamic) libraries, which had to be manually linked and updated.

E

Empties — Arrays of zero (0) dimensions.

Executable — An executable bundle of code, made up of binary bits (zeros and ones) and sometimes called a *binary*.

F

Fields — For this definition in the context of MATLAB Data Structures, see *Structs*.

Fields and Properties — In the context of .NET, *Fields* are specialized classes used to hold data. *Properties* allow users to access class variables as if they were accessing member fields directly, while actually implementing that access through a class method.

H

Helper files — Files that support the main file or the file that calls all supporting functions. Add resources that depend upon the function that calls the supporting function to the **Shared Resources and Helper Files** section of the Deployment Tool GUI. Other examples of supporting files or resources include:

- Functions called using `eval` (or variants of `eval`)
- Functions not on the MATLAB path
- Code you want to remain private
- Code from other programs that you want to compile and link into the main file

I

Integration — Combining a deployed component’s functionality with functionality that currently exists in an enterprise application. For example, a customer creates a mathematical model to forecast trends in certain commodities markets. In order to use this model in a larger-scale financial application (one written with the Microsoft .NET Framework, for instance) the deployed financial model must be integrated with existing C# applications, run in the .NET enterprise environment. Integration is usually performed by an IT developer, rather than a MATLAB Programmer, in larger environments.

Instance — For the definition of this term in context of MATLAB Production Server™ software, see *MATLAB Production Server Server Instance*.

J

JAR — Java archive. In computing software, a JAR file (or Java ARchive) aggregates many files into one. Software developers generally use JARs to distribute Java applications or libraries, in the form of classes and associated metadata and resources (text, images, etc.). Computer users can create or extract JAR files using the `jar` command that comes with a Java Development Kit (JDK).

Java-MATLAB Interface — Known as the *JMI Interface*, this is the Java interface built into MATLAB software.

JDK — The *Java Development Kit* is a free Sun Microsystems product which provides the environment required for programming in Java. The JDK™ is available for various platforms, but most notably Sun™ Solaris™ and Microsoft Windows. To build components with MATLAB Builder JA, download the JDK that corresponds to the latest version of Java supported by MATLAB.

JMI Interface — see *Java-MATLAB Interface*.

JRE — *Java Run-Time Environment* is the part of the Java Development Kit (JDK) required to run Java programs. It comprises the Java Virtual Machine, the Java platform core classes, and supporting files. It does not include the compiler, debugger, or other tools present in the JDK. The JRE™

is the smallest set of executables and files that constitute the standard Java platform.

M

Magic Square — A square array of integers arranged so that their sum is the same when added vertically, horizontally, or diagonally.

MATLAB Production Server Client — In the MATLAB Production Server software, clients are applications written in a language supported by MATLAB Production Server that call deployed functions hosted on a server.

MATLAB Production Server Configuration — An instance of the MATLAB Production Server containing at least one server and one client. Each configuration of the software usually contains a unique set of values in the server configuration file, `main_config`.

MATLAB Production Server Server Instance — A logical server configuration created using the `mps -new` command in MATLAB Production Server software.

MATLAB Production Server Software — Product for server/client deployment of MATLAB programs within your production systems, enabling you to incorporate numerical analytics in enterprise applications. When you use this software, Web, database, and enterprise applications connect to MATLAB programs running on MATLAB Production Server via a lightweight client library, isolating the MATLAB programs from your production system. MATLAB Production Server software consists of one or more servers and clients.

Marshaling — See *Data Marshaling*.

mbuild — MATLAB Compiler command that invokes a script which compiles and links C and C++ source files into standalone applications or shared libraries. For more information, see the `mbuild` function reference page.

mcc — The MATLAB command that invokes MATLAB Compiler. It is the command-line equivalent of using the Deployment Tool GUI. See the `mcc` reference page for the complete list of options available. Each builder product has customized `mcc` options. See the respective builder documentation for details.

MCR — The *MATLAB Compiler Runtime* is an execution engine made up of the same shared libraries. MATLAB uses these libraries to enable the execution of MATLAB files on systems without an installed version of MATLAB. To deploy a component, you package the MCR along with it. Before you use the MCR on a system without MATLAB, run the *MCR Installer*.

MCR Installer — An installation program run to install the MATLAB Compiler Runtime on a development machine that does not have an installed version of MATLAB. Find out more about the MCR Installer by reading “Distributing MATLAB Code Using the MATLAB Compiler Runtime (MCR)”.

MCR Singleton — See *Shared MCR Instance*.

MCR Workers — A MATLAB Compiler Runtime session. Using MATLAB Production Server software, you have the option of specifying more than one MCR session, using the `--num-workers` options in the server configurations file, `main_config`.

Method Attribute — In the context of .NET, a mechanism used to specify declarative information to a .NET class. For example, in the context of client programming with MATLAB Production Server software, you specify method attributes to define MATLAB structures for input and output processing.

mxArray interface — The MATLAB data type containing all MATLAB representations of standard mathematical data types.

MWArray interface — A proxy to `mxArray`. An application program interface (API) for exchanging data between your application and MATLAB. Using `MWArray`, you marshal data from traditional mathematical types to a form that can be processed and understood by MATLAB data type `mxArray`. There are different implementations of the `MWArray` proxy for each application programming language.

P

Package — The act of bundling the deployed component, along with the MCR and other files, for rollout to users of the MATLAB deployment products. After running the packaging function of the Deployment Tool, the package file resides in the `distrib` subfolder. On Windows®, the package is a

self-extracting executable. On platforms other than Windows, it is a .zip file. Use of this term is unrelated to *Java Package*.

PID File — See *Process Identification File (PID File)*.

Pool — A pool of threads, in the context of server management using MATLAB Production Server software. Servers created with the software do not allocate a unique thread to each client connection. Rather, when data is available on a connection, the required processing is scheduled on a *pool*, or group, of available threads. The server configuration file option `--num-threads` sets the size of that pool (the number of available request-processing threads) in the master server process.

Process Identification File (PID File) — A file that documents informational and error messages relating to a running server instance of MATLAB Production Server software.

Program — A bundle of code that is executed to achieve a purpose. Programs usually are written to automate repetitive operations through computer processing. Enterprise system applications usually consist of hundreds or even thousands of smaller programs.

Properties — For this definition in the context of .NET, see *Fields and Properties*.

Proxy — A software design pattern typically using a class, which functions as an interface to something else. For example, `MWArray` is a proxy for programmers who need to access the underlying type `mxAarray`.

S

Server Instance — See MATLAB Production Server Server Instance.

Shared Library — Groups of files that reside in one space on disk or memory for fast loading into Windows applications. Dynamic-link libraries (DLLs) are Microsoft's implementation of the shared library concept in for Microsoft Windows.

Shared MCR Instance — When using MATLAB Builder NE or MATLAB Builder JA, you can create a shared MCR instance, also known as a *singleton*.

For builder NE, this only applies to COM components. When you invoke MATLAB Compiler with the `-S` option through the builders (using either `mcc` or the Deployment Tool), a single MCR instance is created for each COM or Java component in an application. You reuse this instance by sharing it among all subsequent class instances within the component. Such sharing results in more efficient memory usage and eliminates 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. MATLAB Builder NE and MATLAB Builder EX are designed to create singletons by default for .NET assemblies and COM components, respectively. For more information, see “Sharing an MCR Instance in COM or Java Applications”.

Standalone application — Programs that are not part of a bundle of linked libraries (as in shared libraries). Standalones are not dependent on operating system services and can be accessed outside of a shared network environment. Standalones are typically `.exes` (EXE files) in the Windows run-time environment.

State — A specific data value in a program or program variable. MATLAB functions often carry state, in the form of variable values or even the MATLAB Workspace itself. When deploying functions that carry state, you must often take additional steps to ensure state retention when deploying applications that use such functions. When running MATLAB Production Server software, there are additional considerations for preserving state. See “Write MATLAB Code for Deployment” in the *MATLAB Production Server User’s Guide* for additional information.

Structs — MATLAB Structures. Structs are MATLAB arrays with elements that you access using textual field designators. Fields are data containers that store data of a specific MATLAB type.

System Compiler — A key part of Interactive Development Environments (IDEs) such as Microsoft Visual Studio. Before using MATLAB Compiler, select a system compiler using the MATLAB command `mbuild -setup`.

T

Threads — In the context of MATLAB Production Server software, this term has essentially the same meaning as in any server/client software product.

See *pool* for additional information on managing the number of processing threads available to a server instance.

Type-safe interface — An API that minimizes explicit type conversions by hiding the `MWArray` type from the calling application. Using “Generate and Implement Type-Safe Interfaces”, for example, .NET Developers work directly with familiar native data types. You can avoid performing tedious `MWArray` data marshaling by using type-safe interfaces.

W

WAR — Web Application ARchive. In computing, a WAR file is a JAR file used to distribute a collection of `JavaServer` pages, servlets, Java classes, XML files, tag libraries, and static Web pages (HTML and related files) that together constitute a Web application.

WCF — Windows Communication Foundation. The Windows Communication Foundation™ (or WCF) is an application programming interface in the .NET Framework for building connected, service-oriented, Web-centric applications. WCF is designed in accordance with service oriented architecture principles to support distributed computing where services are consumed. Clients consume multiple services that can be consumed by multiple clients. Services are loosely coupled to each other.

Webfigure — A MathWorks representation of a MATLAB figure, rendered on the Web. Using the `WebFigures` feature, you display MATLAB figures on a Web site for graphical manipulation by end users. This enables them to use their graphical applications from anywhere on the Web, without the need to download MATLAB or other tools that can consume costly resources.

Windows standalone application — Windows standalones differ from regular standalones in that Windows standalones suppress their MS-DOS window output. The equivalent method to specify a Windows standalone target on the `mcc` command line is “-e Suppress MS-DOS Command Window” If you are using a non-Windows operating system, console applications are referred to as standalone applications.

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