

MATLAB[®] COM Builder

The Language of Technical Computing

Computation

Visualization

Programming

User's Guide

Version 1



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MATLAB COM Builder User's Guide

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Preface

“What Is MATLAB COM Builder?” on page viii	Briefly describes the purpose of MATLAB COM Builder.
“Required Background” on page ix	Describes other products you need to have familiarity with for COM Builder use.
“Requirements for MATLAB COM Builder” on page x	Describes system and application requirements for COM Builder use.
“Related Products” on page xi	Describes products relevant to the tasks you can perform with MATLAB COM Builder.
“Typographical Conventions” on page xii	Describes the typographical conventions used throughout this document.

What Is MATLAB COM Builder?

The MATLAB COM Builder is an extension to the MATLAB Compiler that enables customers to automatically convert MATLAB applications to Component Object Model (COM) objects. Developers can do modeling and analysis in MATLAB and convert the models to ready-to-use COM objects. These objects can be immediately integrated with any COM-based application..

Required Background

Users of this product need to be familiar with

- MATLAB and the MATLAB Compiler
- Visual Basic

It is helpful to have some background in Component Object Model (COM) objects (DLLs).

See the documentation provided by the vendors for detailed information.

Requirements for MATLAB COM Builder

System Requirements

System requirements and restrictions on use for COM Builder are almost identical to those listed in the *MATLAB Compiler User's Guide*. For specific information see the “System Requirements” section under “Microsoft Windows on PCs” in your Compiler document.

Compiler Requirements

Because not all compilers are capable of producing Microsoft-compatible COM objects, COM Builder supports only these compiler choices:

- Borland C++ Builder 4
- Borland C++ Builder 5
- Borland C++ Builder 6
- Microsoft Visual Studio 5.0
- Microsoft Visual Studio 6.0
- Microsoft Visual Studio .NET

After installing COM Builder, you must run the MATLAB Compiler `mbuild` tool with the `-setup` argument. You can find information about `mbuild` in the *MATLAB Compiler User's Guide* in the section “Building Stand-Alone Applications on PCs.” You also need to run the MATLAB command `mccsavepath` one time to set up the MATLAB Compiler search path. Type `help mccsavepath` at the MATLAB command line for a description of this command.

Limitations and Restrictions

In general, limitations and restrictions on the use of MATLAB COM Builder are the same as those for the MATLAB Compiler. See the “Limitations and Restrictions” section of the *MATLAB Compiler User's Guide* for details. Note that although the Compiler supports some usage of the MATLAB `input` command, MATLAB COM Builder does not support this command at all.

Related Products

The MathWorks provides several products relevant to the tasks you can perform with MATLAB COM Builder.

For more information about any of these products, see either

- The online documentation for that product if it is installed or if you are reading the documentation from the CD
- The MathWorks Web site, at <http://www.mathworks.com>; see the “products” section

Note The toolboxes listed below all include functions that extend the capabilities of MATLAB.

Product	Description
MATLAB Compiler	Convert MATLAB M-files to C and C++ code
MATLAB Runtime Server	Deploy runtime versions of MATLAB applications
MATLAB Web Server	Use MATLAB with HTML Web applications

Typographical Conventions

This manual uses some or all of these conventions.

Item	Convention	Example
Example code	Monospace font	To assign the value 5 to A, enter <code>A = 5</code>
Function names, syntax, filenames, directory/folder names, and user input	Monospace font	The <code>cos</code> function finds the cosine of each array element. Syntax line example is <code>MLGetVar ML_var_name</code>
Buttons and keys	Boldface with book title caps	Press the Enter key.
Literal strings (in syntax descriptions in reference chapters)	Monospace bold for literals	<code>f = freqspace(n, 'whole')</code>
Mathematical expressions	<i>Italics</i> for variables Standard text font for functions, operators, and constants	This vector represents the polynomial $p = x^2 + 2x + 3$.
MATLAB output	Monospace font	MATLAB responds with <code>A =</code> <code>5</code>
Menu and dialog box titles	Boldface with book title caps	Choose the File Options menu.
New terms and for emphasis	<i>Italics</i>	An <i>array</i> is an ordered collection of information.
Omitted input arguments	(...) ellipsis denotes all of the input/output arguments from preceding syntaxes.	<code>[c,ia,ib] = union(...)</code>
String variables (from a finite list)	<i>Monospace italics</i>	<code>sysc = d2c(sysd, 'method')</code>

Overview

“Building a Deployable Application” on page 1-2 Provides a brief overview of how you use MATLAB COM Builder to create and deploy an application.

Building a Deployable Application

Using MATLAB COM Builder to create a COM component is a simple process requiring a sequence of four steps. For details see

- “Creating a Project” on page 1-3
- “Managing M-Files and MEX-Files” on page 1-5
- “Building a Project” on page 1-7
- “Packaging and Distributing the Component” on page 1-7

This section references various menus provided by the COM Builder graphical user interface (GUI). For a full discussion of these menus, see Chapter 2, “Graphical User Interface.”

Elements of a COM Builder Project

A project consists of all the elements necessary to build a deployable application using the MATLAB COM Builder. COM Builder *components* are COM objects accessible through Visual Basic, C++, or any other language that supports COM. COM is an acronym for Component Object Model, which is Microsoft’s binary standard for object interoperability. Each COM object exposes one or more classes to the Visual Basic programming environment. Each class contains a set of functions called methods, corresponding to the original MATLAB functions included in the component’s project.

Classes

When creating a component, you must additionally provide one or more class names. The component name represents the name of the DLL file to be created. A class name denotes the name of the class that performs a call on a specific method at run-time. The relationship between component name and class name, and which methods (MATLAB functions) go into a particular class, are purely organizational. As a general rule, when compiling many MATLAB functions, it helps to determine a scheme of function categories and to create a separate class for each category. The name of each class should be descriptive of what the class does.

Versions

MATLAB COM Builder components also support a simple versioning mechanism. A version number is attached to a given component. This number

gets automatically built into the DLL file name and the system registry information. As a general rule, the first version of a component is 1.0 (the default value if none is chosen). Changes made to the component before deployment keep the same version number. After deployment, change the version number for all subsequent changes, so that you can easily manage the new and old versions. The system sees classes in different versions of the same component as distinct, even if they have the same name.

Creating a Project

To begin project creation, enter the MATLAB command `comtool` at the command line. The **MATLAB COM Builder** main window appears.

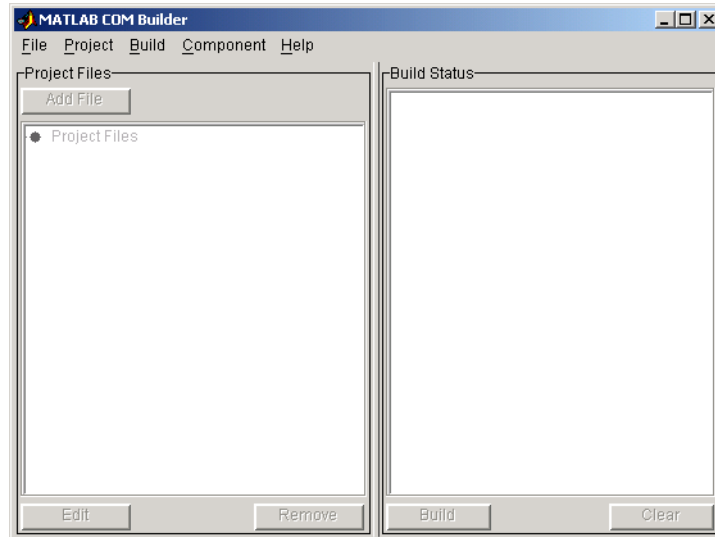


Figure 1-1: MATLAB COM Builder Main Window

For a complete description of the features available from this window, see “Graphical User Interface Menus” on page 2-2.

Select **File -> New Project** on this window to view the **New Project Settings** dialog box.

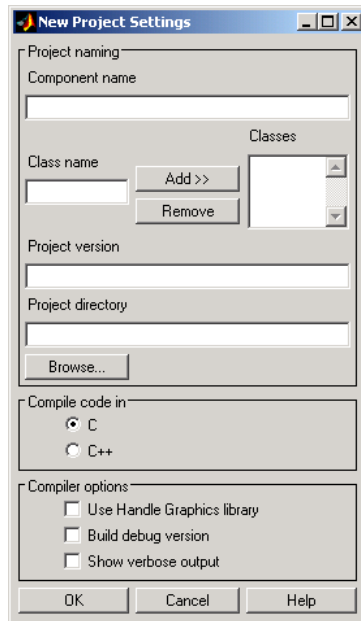


Figure 1-2: New Project Settings Dialog Box

Component name denotes the name of the DLL created later in the build process. After you enter the component name, the GUI automatically enters a **Class name** identical to the component name. You can change the class name to something more descriptive. Although the component name and class name can be the same, the component name cannot match the name of any M- or MEX-files added to the project later.

To add a class to your component, enter the class name in the **Class name** field and click **Add >>**. The added class now appears in the **Classes** list. .

The **Project version** default value is 1.0. See “Versions” on page 1-2 for additional information about **Project version**.

Project directory specifies where any project and build files are written when compiling and packaging your models. The project directory is automatically generated from the name of your current directory and the component name.

Note You can accept the automatically generated project directory path or choose another of your liking. Once you click **OK** on this menu, this path is saved. If you later decide to move the project or change anything on its path, you need to redo the entire project specification process, including adding files to the project (see “Project Settings” on page 2-5) and respecifying the project directory path.

You can choose to generate C or C++ code. Components written in C give better performance, while C++ components are more readable, allowing easier modification of the generated code if needed. The files generated pertaining to the COM interface are always C++ files regardless of which option you choose.

If your models contain MATLAB Handle Graphics® calls, include the MATLAB C/C++ Graphics library in your project by selecting **Use Handle Graphics library**.

You can also create a debug version of your compiled models and can specify verbose output when you invoke the MATLAB Compiler. A debug version of your component:

- Enables backtraces so that any reported error shows the M-file and line where the error occurred. The full backtrace is reported. Without debugging, you get the error without any indication of its location in your MATLAB code.
- Allows full debugging using the Visual Studio debugger.

Once you accept these settings on the **New Project Settings** dialog box by clicking **OK**, they become part of your project workspace and are saved to the project file along with the names of any M- or MEX- files you subsequently add to the project. A project file of the name <component_name>.cb1 is automatically saved to the project directory.

Managing M-Files and MEX-Files

After you create a project, you enable the **Project, Build and Component** menu options on the MATLAB COM Builder main window.

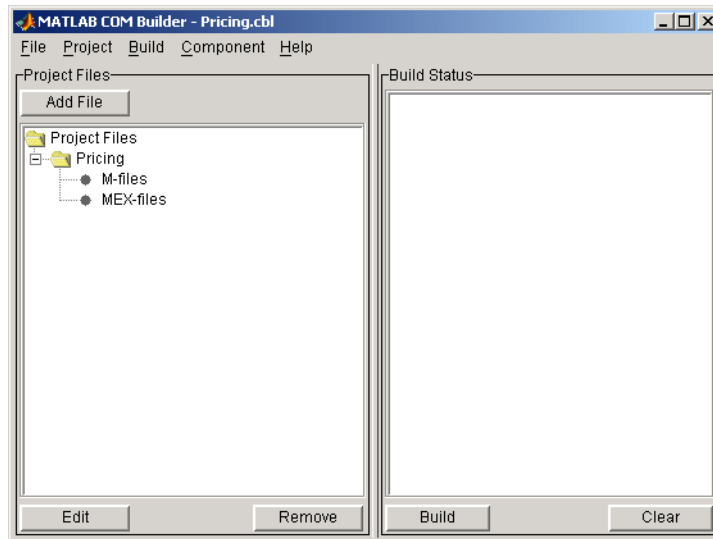


Figure 1-3: Main Window with Options Activated

Add M- and/or MEX-files to the project by clicking the **Add File** button or selecting the **Project -> Add File...** menu choice. You can add only a single file at a time to the project.

Note The name of any file added to the project cannot duplicate the name of any function existing in the library of precompiled functions.

The **Remove** button or **Project -> Remove File** menu choice removes any selected M- or MEX-files. You can highlight multiple files for removal at one time.

The **Edit** button, the **Project -> Edit File...** or double-clicking an M-file name opens the selected M-file(s) in the MATLAB editor for modification or debugging. You cannot edit MEX files.

Building a Project

After you define your project settings and add the desired M- and MEX-functions, you can build a deployable DLL. Choosing **Build -> COM Object** or clicking the **Build** button invokes the MATLAB Compiler, writing the intermediate source files to `<project_dir>\src` and the output files necessary for deployment to `<project_dir>\distrib`.

Build Status

The **Build Status** panel shows the output of the build process and informs you of any problems encountered. The files appearing in the `<project_dir>\distrib` directory will be a DLL. The resulting DLL is automatically registered on your system.

To clear the **Build Status** panel, select **Build -> Clear Status**. The output of the build process is saved in the file `<project_dir>\build.log`. To open the Build Log, choose **Build -> Open Build Log**. The Build Log provides a record of the build process that you can refer to after you have cleared the **Build Status** panel. If you ever contact MathWorks Technical Support with a question about the build process, you will be asked to provide a copy of this log.

Packaging and Distributing the Component

Once you have successfully compiled your models and tested the COM object, you are ready to package the component for distribution to your end users.

Choose **Component -> Package Component** to create a self-extracting executable containing these files.

File	Purpose
<code>_install.bat</code>	Script run by the self-extracting executable
<code><componentname_projectversion>.dll</code>	Compiled component
<code>mglinstaller.exe</code>	MATLAB math and graphics installer

File	Purpose
<code>mwcomutil.dll</code>	COM Builder utility library
<code>mwregsvr.exe</code>	Executable that registers DLLs on target machines

The self-extracting executable is named `<componentname>.exe`.

Running the installer on a target machine performs these steps:

- `mginstaller` installs the MATLAB C/C++ Math and Graphics libraries.
Action: Add the `<application>\bin\win32` directory that `mginstaller` creates to your path. (`<application>` represents the deployed application's root directory, the directory where the deployed application resides on your system.)
- `mwregsvr` registers `mwcomutil.dll` and `<componentname>_<projectversion>.dll`.

You must repeat this distribution process on each target machine.

Graphical User Interface

“Graphical User Interface Menus” on page 2-2

Describes the complete set of graphical user interface menus that can be generated with the `comtool` function.

“Project Settings” on page 2-5

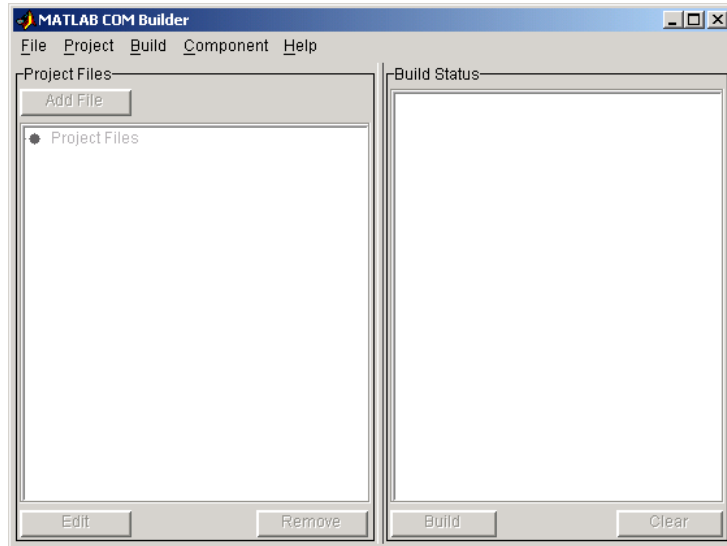
Describes how to create project settings for a new project or edit the settings for an existing project.

“Component Information” on page 2-7

Discusses the dialog box that presents the component information stored in the registry.

Graphical User Interface Menus

The MATLAB function `comtool` displays the MATLAB COM Builder graphical user interface (GUI) main window.



The information below describes the use of the various menus that the main window provides. These menus are

- “File Menu” on page 2-2
- “Project Menu” on page 2-3
- “Build Menu” on page 2-4
- “Component Menu” on page 2-4
- “Help Menu” on page 2-4

File Menu

The **File** menu creates and manages MATLAB COM Builder projects.



- **New Project** opens the project settings dialog box. This menu item creates a project workspace where you can add M- and MEX-files to the project and store project settings.
- **Open Project** allows you to load a previously saved project.
- **Save Project** saves the current project. If you have not yet saved the current project, you are prompted for a filename.
- **Save As Project** saves the current project after prompting for a filename.
- **Close Project** closes the current project.
- **Close COMTOOL** closes the COM Builder interface.

Project Menu

The **Project** menu controls the management of the current project's files.

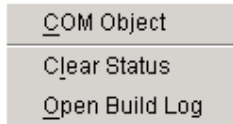


- **Add File** adds an M-file or MEX-file to the current project. (The **Add File** button in the **Project files** frame of the main window performs the same task).
- **Edit File** allows you to edit the selected M-file. (The **Edit** button in the **Project files** frame of the main window performs the same task.)
- **Remove File** removes the currently selected files from the project. (The **Remove** button in the **Project files** frame of the main window performs the same task.)

- **Settings** opens the project settings dialog box showing the current project's information. See "Project Settings" on page 2-5 for details.

Build Menu

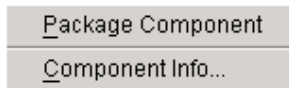
The **Build** menu controls the building of the project's files into a COM object.



- **COM Object** builds project files into a COM object.
- **Clear Status** clears the **Build status** window.
- **Open Build Log** displays project status that has been saved in this log file.

Component Menu

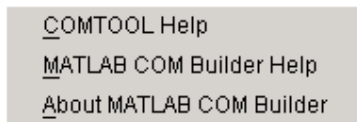
The **Component** menu complete the process of building a deployable application.



- **Package Component** readies files for deployment. The deployable files are packaged in a self-extracting executable.
- **Component Info** displays a dialog box with information about the current project's component and component versions. See "Component Information" on page 2-7 for details.

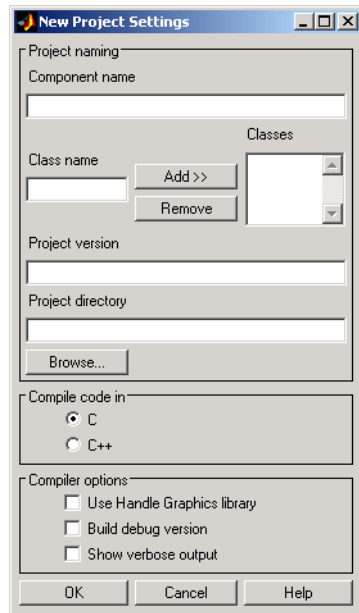
Help Menu

The **Help** menu provides access to the context-sensitive help for the MATLAB COM Builder graphical user interface.

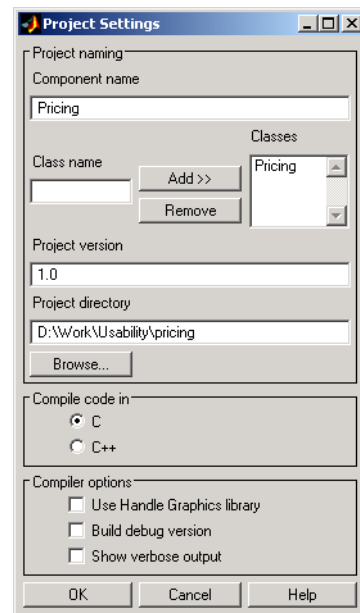


Project Settings

Choosing **New Project** or **Open Project** from the **File** menu or **Settings** from the **Project** menu opens the appropriate **Project Settings** dialog box.



New Project Settings



Existing Project Settings

See “Versioning” on page C-5 for a description of **Component name**, **Class name** and **Project version**. **Project directory** is the location of any project output files.

You can choose to generate C or C++ code. Components written in C give better performance, while C++ components are more readable, making it easier for you to modify the generated code if needed.

If your models contain MATLAB Handle Graphics calls, select **Use Handle Graphics library**.

You can create a debug version of your compiled models and can specify verbose output when you invoke the MATLAB Compiler.

Adding or Removing Classes

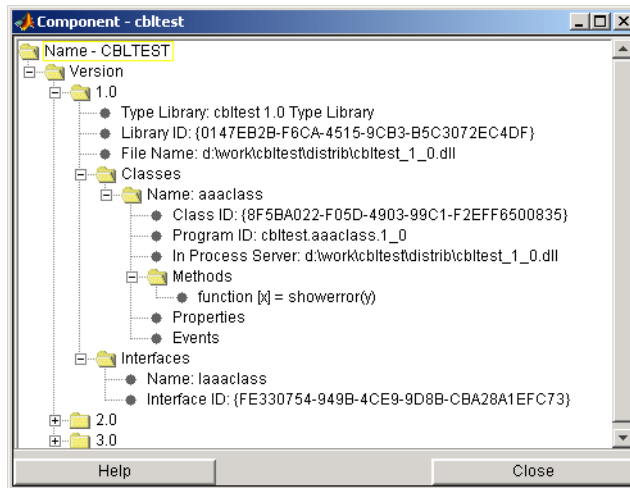
MATLAB COM Builder allows you to have multiple classes per component. To add a new class to your component, enter the class name in the **Class name** field and click **Add>>**. The added class now appears in the **Classes** list.

To remove a class or classes from the component, select the class(es) from the **Classes** list and click **Remove**.

Note that any new classes become part of the newly built component. Removed classes are removed from the component on the subsequent build.

Component Information

The **Component Info** choice under the **Component** menu displays the **Component** dialog box.



This dialog presents the component information that is stored in the registry.

See Table C-2, Registry Information Returned by componentinfo, on page C-8, for an explanation of these fields.

Programming with COM Builder Components

“Overview” on page 3-2	Describes the integration of MATLAB COM Builder components into Visual Basic.
“Adding Class Properties to COM Builder Objects” on page 3-3	Describes class properties, which allow an object to retain an internal state between method calls.
“Adding Events to COM Builder Objects” on page 3-6	Describes how you can turn a MATLAB function into an event function.
“Creating an Instance of a Class” on page 3-10	Describes two techniques for calling a class method (compiled MATLAB function).
“Calling the Methods of a Class Instance” on page 3-13	Describes how you call the class methods to access the compiled MATLAB functions.
“Processing varargin and varargout Arguments” on page 3-15	Describes how 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.
“Handling Errors During a Method Call” on page 3-17	Describes the Visual Basic exception handling capability.
“Modifying Flags” on page 3-18	Describes array formatting and data conversion flags.

Overview

Each MATLAB COM Builder component is built as a stand-alone COM object. You access a component through Visual Basic, C++, or any other language that supports COM. This section provides general information on how to integrate MATLAB COM Builder components into Visual Basic. It assumes that you have a working knowledge of VB and is not intended to be a discussion on how to program in Visual Basic. Refer to the VB documentation for general programming information.

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

- “Adding Class Properties to COM Builder Objects” on page 3-3
- “Adding Events to COM Builder Objects” on page 3-6
- “Creating an Instance of a Class” on page 3-10
- “Calling the Methods of a Class Instance” on page 3-13
- “Processing varargin and varargout Arguments” on page 3-15
- “Handling Errors During a Method Call” on page 3-17
- “Modifying Flags” on page 3-18

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

Adding Class Properties to COM Builder Objects

Class properties allow an object to retain an internal state between method calls. MATLAB COM Builder automatically converts all global variables shared by the M-files that make up a class to properties on that class. Global variables are variables that are declared with the `global` keyword. Properties are particularly useful when you have a large array that doesn't change often, but you need to operate on it frequently. In this case, the array can be set once as a class property and operated on repeatedly without incurring the overhead of passing (and converting) the data into each method every time it is called.

The next example illustrates using a class property in a matrix factorization class. The example develops a class that performs Cholesky, LU, and QR factorizations on the same matrix. It stores the input matrix as a class property so that it won't need to be passed to our factorization routines.

Consider these three M-files:

Cholesky.m

```
function [L] = Cholesky()
    global A;
    if (isempty(A))
        L = [];
        return;
    end
    L = chol(A);
```

LUDecomp.m

```
function [L,U] = LUDecomp()
    global A;
    if (isempty(A))
        L = [];
        U = [];
        return;
    end
    [L,U] = lu(A);
```

QRDecomp.m

```
function [Q,R] = QRDecomp()
    global A;
    if (isempty(A))
        Q = [];
        R = [];
        return;
    end
    [Q,R] = qr(A);
```

These three files share a common global variable A. Each function performs a matrix factorization on A and returns the results.

To build the class, create a new COM Builder project named `mymatrix` with a version of 1.0 and add a single class called `myfactor` to the component. Add the above three M-files to the class and build.

Use the following Visual Basic subroutine to test the `myfactor` class. First set a project reference to **mymatrix 1.0 Type Library** under **Project->References** in the Visual Basic main menu. Then run this subroutine, which creates an instance of the `myfactor` class and assigns a double matrix to the property A. Finally, it calls the three factorization methods.

```
Sub TestFactor()
    Dim x(1 To 2, 1 To 2) As Double
    Dim C As Variant, L As Variant, U As Variant, _
    Q As Variant, R As Variant
    Dim factor As myfactor

    On Error GoTo Handle_Error
    Set factor = New myfactor
    x(1, 1) = 2#
    x(1, 2) = -1#
    x(2, 1) = -1#
    x(2, 2) = 2#
    factor.A = x
    Call factor.cholesky(1, C)
    Call factor.ludecomp(2, L, U)
    Call factor.qrdecomp(2, Q, R)
Exit Sub
```

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

Adding Events to COM Builder Objects

MATLAB COM Builder supports events, or callbacks, through a simple MATLAB language pragma. You simply provide a MATLAB function stub that serves as the prototype for the event, and then provide an implementation of the function in your client code (Visual Basic, C++, etc.). The net effect is that when any other MATLAB function calls the event function, the call is dispatched to the “event handler” in the client code.

You can turn a MATLAB function into an event function by placing a `%#event` pragma into the code. MATLAB interprets this statement as a comment. When you include the same function as a method on a COM Builder object, the compiler generates an “outgoing interface” for the method, which identifies the method as an event. This outgoing interface is then implemented by the client code. Some examples of how you might use callbacks in your code are

- To give a client application periodic feedback during a long-running calculation. For example, if you have a task that requires n iterations, you might signal an event to increment a progress bar in the user interface on each iteration.
- To signal a warning during a calculation but continue execution of the task.
- To return intermediate results of a calculation to the user and continue execution of the task.

The next example illustrates using a callback in conjunction with a Visual Basic `ProgressBar` control. The MATLAB function `iterate` runs through n iterations and fires an event every `inc` iterations. When the function ends, it returns a single output. To simulate actually doing something, place a `pause` statement in the main loop so that the function waits for 1 second in each iteration.

Consider the MATLAB functions `iterate.m` and `progress.m`.

iterate.m

```
function [x] = iterate(n,inc)
    %initialize x
    x = 0;
    % Run n iterations, callback every inc time
    k = 0;
    for i=1:n
```

```

k = k + 1;
if k == inc
    progress(i);
    k = 0;
end;
% Do some work on x...
x = x + 1;
% We will just pause for 1 second to simulate doing
% something
pause(1);
end;

```

progress.m

```

function progress(i)
    %#event
    i

```

The `iterate` function runs through `n` iterations and calls the `progress` function every `inc` iterations, passing the current iteration number as an argument. When this function is executed in MATLAB, the value of `i` is displayed each time the `progress` function gets called. Suppose you create a COM Builder component that has these two functions included as class methods. This example assumes a component with a single class named `myclass`. The resulting COM class has a method `iterate` and an event `progress`. To receive the event calls implement a “listener” in your Visual Basic code. The VB syntax for the event handler needed for this example is

```

Sub aClass_progress(ByVal i As Variant)

```

where `aClass` is the variable name used for your class instance. The `ByVal` qualifier is used on all input parameters of an event function. To enable the listening process, dimension the `aClass` variable with the `WithEvents` keyword. Refer to the Visual Basic documentation for a complete discussion of VB event processing.

This example is based on a simple VB form with three `TextBox` controls, one `CommandButton` control, and one `ProgressBar` control. The first text box, `Text1`, inputs the number of iterations, stored in the form variable `N`. The second text box, `Text2`, inputs the callback increment, stored in the variable `Inc`. The third text box, `Text3`, displays the output of the function when it finishes executing. The command button, `Command1`, executes the `iterate` method on your class

when pressed. The progress bar control, ProgressBar1, updates itself in response to the progress event.

```
'Form Variables
Private WithEvents aClass As myclass      'Class instance
Private N As Long                        'Number of iterations
Private Inc As Long                      'Callback increment
Private Sub Form_Load()
'When form is loaded, create new myclass instance
    Set aClass = New myclass
    'Initialize variables
    N = 2
    Inc = 1
End Sub
Private Sub Text1_Change()
'Update value of N from Text1 text whenever it changes
    On Error Resume Next
    N = CLng(Text1.Text)
    If Err <> 0 Then N = 2
    If N < 2 Then N = 2
End Sub
Private Sub Text2_Change()
'Update value of Inc from Text2 text whenever it changes
    On Error Resume Next
    Inc = CLng(Text2.Text)
    If Err <> 0 Then Inc = 1
    If Inc <= 0 Then Inc = 1
End Sub
Private Sub Command1_Click()
'Execute function whenever Execute button is clicked
    Dim x As Variant
    On Error GoTo Handle_Error
    'Initialize ProgressBar
    ProgressBar1.Min = 1
    ProgressBar1.Max = N
    Text3.Text = ""
    'Iterate N times and call back at Inc intervals
    Call aClass.iterate(1, x, CDb1(N), CDb1(Inc))
    Text3.Text = Format(x)
Exit Sub
Handle_Error:
```

```
Handle_Error:
    MsgBox (Err.Description)
End Sub
Private Sub aClass_progress(ByVal i As Variant)
'Event handler. Called each time the iterate function
'calls the progress function. Progress bar is updated
'with the value passed in, causing the control to advance.
    ProgressBar1.Value = i
End Sub
```

Creating an Instance of a Class

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

- CreateObject function
- Visual Basic New operator

CreateObject Function

This method uses the Visual Basic application program interface (API) CreateObject function to create an instance of the class. To use this method, dimension a variable of type Object to hold a reference to the class instance and call CreateObject with 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
    aClass = CreateObject("mycomponent.myclass.1_0")
    ' (call some methods on aClass)
    Exit Function
Handle_Error:
    foo = Err.Description
End Function
```

Visual Basic 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 VB project. Do this by selecting the **Project** 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 could be dimensioned as simply `myclass`. The full declaration in the form `<component-name>.<class-name>` guards against name collisions that could occur if other libraries in the current project contain types named `myclass`.

Both methods are equivalent in functionality. The first method does not require a reference to the type library in the VB project, while the second results in faster code execution. The second method has the added advantage of enabling the **Auto-List-Members** and **Auto-Quick-Info** capabilities of the VB editor to work with your classes.

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 next 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
```

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 COM Builder applies a standard mapping from the original MATLAB function syntax to the method's argument list. See section "Calling Conventions" on page A-7 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 VB types, arrays of any type, and object references. Appendix B, "Data Conversion" describes in detail the conversion of `Variant`s 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. 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 VB to MATLAB COM Builder component class methods.

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

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

    On Error Goto Handle_Error
    aClass = CreateObject("mycomponent.myclass.1_0")
```

```
    Call aClass.foo(1,y,x1,x2)
    foo = y
    Exit Function
Handle_Error:
    foo = Err.Description
End Function
```

The second example rewrites the same function as a subroutine:

```
Sub foo(Xout As Variant, X1 As Variant, X2 As Variant)
    Dim aClass As Object

    On Error Goto Handle_Error
    aClass = CreateObject("mycomponent.myclass.1_0")
    Call aClass.foo(1,Xout,X1,X2)
    Exit Sub
Handle_Error:
    MsgBox(Err.Description)
End Sub
```

Processing varargin and varargout Arguments

When varargin and/or varargout are present in the original MATLAB function, these parameters are added to the argument list of the class method as the last input/output parameters. 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 Appendix D, “Utility Library” for more details.

The next example processes a varargout parameter into three separate arguments. This function makes use of the `MWUnpack` function in the utility library. The MATLAB function used is `varargout = foo(x1,x2)`.

```
Sub foo(Xout1 As Variant, Xout2 As Variant, Xout3 As Variant, _
        Xin1 As Variant, Xin2 As Variant)
    Dim aClass As Object
```

```
Dim aUtil As Object
Dim v As Variant

On Error Goto Handle_Error
aUtil = CreateObject("MComUtil.MWUtil")
aClass = CreateObject("mycomponent.myclass.1_0")
Call aClass.foo(3,v,Xin1,Xin2)
Call aUtil.MWUnpack(v,0,True,Xout1,Xout2,Xout3)
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 call create an exception in the current procedure. 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 documentation for a detailed discussion on VB error handling.)

Modifying Flags

Each MATLAB COM Builder 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*. The data conversion flags change selected behaviors of the data conversion process from Variants to MATLAB types and vice versa. By default, MATLAB COM Builder 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 COM Builder `MWStruct`, `MWField`, `MWComplex`, `MWSparse`, and `MWArg` types. Each of these types exposes its own `MWFlags` property and ignores the properties of the class whose method is being called. The `MWArg` class is supplied specifically for the case when a particular argument needs different settings from the default class properties.

This section provides a general discussion of how to set these flags and what they do. See “Class `MWFlags`” on page D-8 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 1.0 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

```

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. According to the default data conversion rules listed in Table B-3, COM VARIANT to MATLAB Conversion Rules, on page B-10, 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 InputArrayFormat flag controls how arrays of these two types are handled. As it turns out, the two arrays in the previous example both convert to double matrices because the default value for the InputArrayFormat flag is mwArrayFormatMatrix. This default is used because, as it turns out, 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 really 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), and you may prefer column output.

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 VB to MATLAB. Consider this 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 VB `Date` type is converted. This example sends the current date and time as an input argument and converts it to a string.

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

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

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

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

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


Usage Examples

- | | |
|--|--|
| “Magic Square Example” on page 4-2 | Demonstrates the creation of a COM component from a simple MATLAB M-file |
| “Spectral Analysis Example” on page 4-11 | Shows the creation of a comprehensive Excel add-in. |

Magic Square Example

This example uses a simple M-file that takes a single input and creates a magic square of that size. It then builds a COM Builder component using this M-file as a class method. Finally, the example shows the integration of this component into a stand-alone Visual Basic application. The application accepts the magic square size as input and displays the resultant matrix in a List View control box.

Creating the M-file

To get started, create the M-file `mymagic.m` containing the following code:

```
function y = mymagic(x)
y = magic(x);
```

Creating the Project

Enter the command `comtool` to start the MATLAB COM Builder graphical user interface. From the **File** menu select **New Project**. This opens the **New Project Settings** dialog.

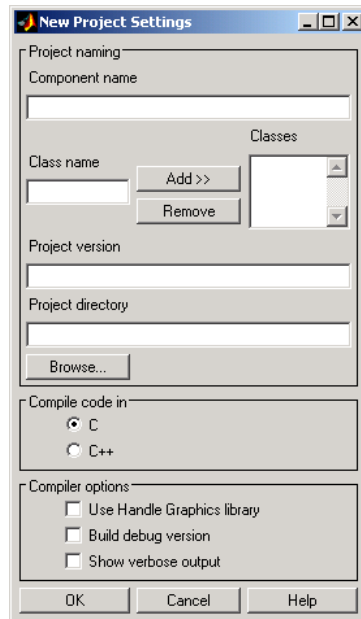
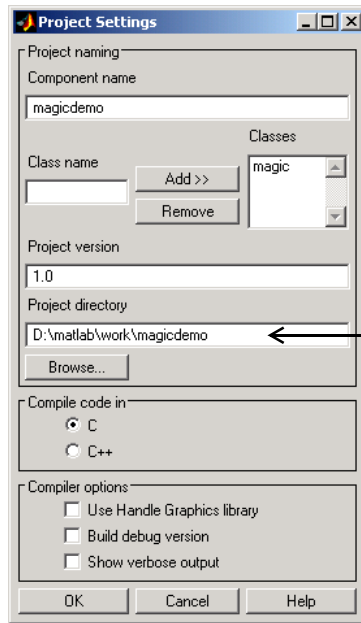


Figure 4-1: Empty New Project Settings Dialog Box

On the **New Project Settings** dialog, enter the settings as listed below:

- In the **Component name** text block enter the component name `magicdemo`. Press the **Tab** key to move to the **Class name** text block.
- Enter `magic` for the class name.
- The version has a default of 1.0. Leave this number unchanged.
- The **Project directory** field contains a default of a combination of the directory where COM Builder was started and the **Component name**, `magicdemo`. You can change this to any directory that you choose. If the directory you choose does not exist, you will be asked to create it.
- Select **C** as the code to compile in.
- Leave all **Compiler options** unselected.

The **New Project Settings** dialog now looks like Figure 4-2.



Default directory name depends upon the location of MATLAB on your machine. You can choose an alternative directory if you do not want to accept the default.

Figure 4-2: New Project Settings with Entries

- Click **OK** to create the magicdemo project.

Summary of Project Settings

Component name: magicdemo

Class name: magic

Project version: 1.0

Project directory: *(accept default or choose another directory)*

Compile code in: C

Compiler options: *(leave unselected)*

Use Handle Graphics library = No

Build debug version = No

Show verbose output = No

Building the Project

- From the COM Builder graphical user interface click **Add File**.
- Select the file `mymagic.m` from the directory where you saved it and click **Open**.
- Click **Build** or select **COM Object** from the **Build** menu.

Creating the Visual Basic Project

Note This procedure assumes that you are using Visual Basic 6.0.

- 1 Start Visual Basic.
- 2 In the **New Project** dialog box, select **Standard EXE** as the project type and click **Open**. This creates a new Visual Basic project with a blank form.
- 3 From the main menu, select **Project->References** to display the **Project References** dialog box.
- 4 Select **magicedemo 1.0 Type Library** from the list of available components, and click **OK**.
- 5 Returning to the Visual Basic main menu, select **Project->Components** to display the **Components** dialog box.
- 6 Select **Microsoft Common Controls 6.0** from the list, click **Apply**, then click **Close**.

Creating the User Interface

Now add a series of controls to the blank form to complete the dialog, as summarized in the next table.

Control Type	Control Name	Properties	Purpose
Frame	Frame1	Caption = Magic Squares Demo	Groups controls
Label	Label1	Caption = Magic Square Size	Labels the magic square edit box.
TextBox	edtSize		Accepts input of magic square size.
CommandButton	btnCreate	Caption = Create	When pressed, creates a new magic square with current size.
ListView	lstMagic	GridLines = True LabelEdit = lvwManual View = lvwReport	Displays the magic square.

Figure 4-3, Controls Layout on the Form, on page 4-7 shows the shows the controls layout on the form.

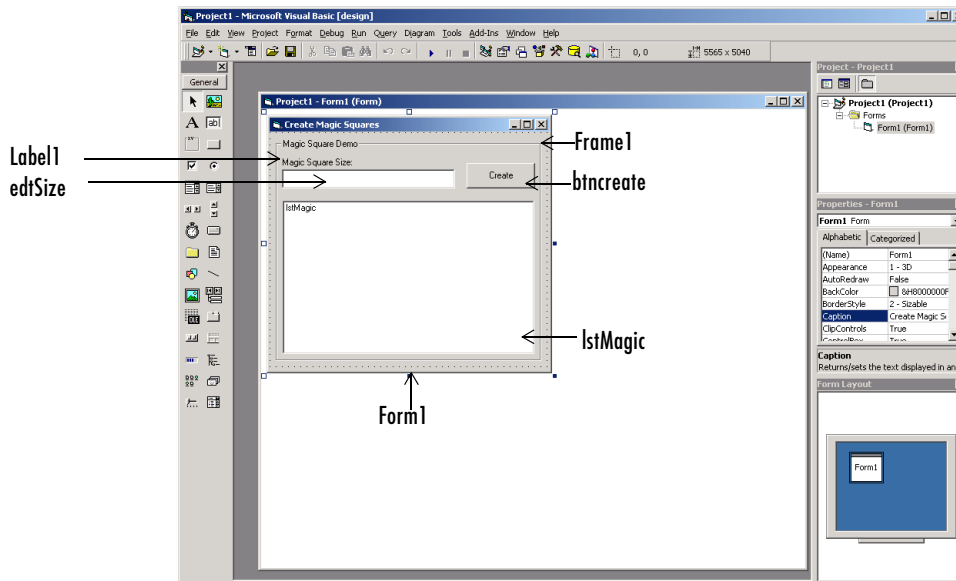


Figure 4-3: Controls Layout on the Form

When the form and controls are complete, add the code below to the form. This code references the control and variable names listed above. If you have given different names for any of the controls or any variable, change this code to reflect those differences.

```
Private Size As Double 'Holds current matrix size
Private theMagic As magicdemo.magic 'magic object instance

Private Sub Form_Load()
'This function is called when the form is loaded.
'Creates a new magic class instance.
    On Error GoTo Handle_Error
    Set theMagic = New magicdemo.magic
    Size = 0
Exit Sub
Handle_Error:
    MsgBox (Err.Description)
End Sub
```

```
Private Sub btnCreate_Click()
    'This function is called when the Create button is pressed.
    'Calls the mymagic method, and displays the magic square.
    Dim y As Variant
    If Size <= 0 Or theMagic Is Nothing Then Exit Sub
    On Error GoTo Handle_Error
    Call theMagic.mymagic(1, y, Size)
    Call ShowMatrix(y)
    Exit Sub
Handle_Error:
    MsgBox (Err.Description)
End Sub

Private Sub edtSize_Change()
    'This function is called when ever the contents of the
    'Text box change. Sets the current value of Size.
    On Error Resume Next
    Size = CDb1(edtSize.Text)
    If Err <> 0 Then
        Size = 0
    End If
End Sub

Private Sub ShowMatrix(y As Variant)
    'This function populates the ListView with the contents of
    'y. y is assumed to contain a 2D array.
    Dim n As Long
    Dim i As Long
    Dim j As Long
    Dim nLen As Long
    Dim Item As ListItem

    On Error GoTo Handle_Error
    'Get array size
    If IsArray(y) Then
        n = UBound(y, 1)
    Else
        n = 1
    End If
```

```

'Set up Column headers
nLen = lstMagic.Width / 5
Call lstMagic.ListItems.Clear
Call lstMagic.ColumnHeaders.Clear
Call lstMagic.ColumnHeaders.Add(, , "", nLen, lvwColumnLeft)
For i = 1 To n
    Call lstMagic.ColumnHeaders.Add(, , _
        "Column " & Format(i), nLen, lvwColumnLeft)
Next
'Add array contents
If IsArray(y) Then
    For i = 1 To n
        Set Item = lstMagic.ListItems.Add(, , "Row " & Format(i))
        For j = 1 To n
            Call Item.ListSubItems.Add(, , Format(y(i, j)))
        Next
    Next
Else
    Set Item = lstMagic.ListItems.Add(, , "Row 1")
    Call Item.ListSubItems.Add(, , Format(y))
End If
Exit Sub
Handle_Error:
    MsgBox (Err.Description)
End Sub

```

Creating the Executable

Now that the code is complete, you can create the standalone executable `magic.exe`:

- 1 Save the project by selecting **File->Save Project** from the main menu. Accept the default name for the main form and enter `magic.vbp` for the project name.
- 2 Return to the **File** menu. Select **File->Make magic.exe** to create the finished product.

Testing the Application

You can run the `magic.exe` executable as you would any other program. When the main dialog starts, enter a positive number in the input box and click the **Create** button. A magic square of the input size appears as shown here. The `ListView` control automatically implements scrolling if the magic square is larger than 4-by-4.

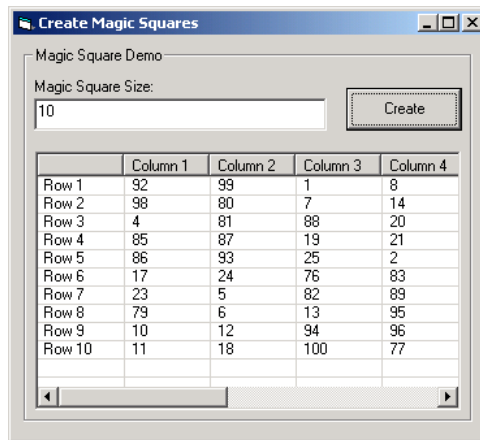


Figure 4-4: Running `magic.exe`

Packaging the Component

As a final step, package the `magicdemo` component and all supporting libraries into a self-extracting executable. You can now install this package, along with the `magic.exe` application, onto other computers. To package the component, follow these steps:

- 1 Return to `comtool`. If `comtool` has been dismissed, start it again and reload the `magicdemo` project.
- 2 Select **Component->Package Component**. This command creates the `magicdemo.exe` self-extracting executable.

To install this component onto another computer, copy the `magicdemo.exe` package and the `magic.exe` application to that machine, run `magicdemo.exe` from a command prompt, and follow the instructions.

Spectral Analysis Example

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 an 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.

To create this add-in requires four basic steps:

- 1 Build a stand-alone COM component from 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 M-files, `computefft.m` and `plotfft.m`.

```
computefft.m:  
function [fftdata, freq, powerspect] = computefft(data, interval)  
    if (isempty(data))  
        fftdata = [];  
        freq = [];
```

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

To proceed with the actual building of the component, follow these steps:

- 1 Start comtool. See “Graphical User Interface Menus” on page 2-2 for a discussion of using comtool to build a COM component from a collection of MATLAB M-files.
- 2 Create a new project with these settings:
 - **Component name:** Fourier
 - **Class name:** Fourier
 - **Project version:** 1.0

Check **Use Handle Graphics library**.

See “Project Settings” on page 2-5 for a description of new project settings.

- 3 Add the `computefft.m` and `plotfft.m` M-files to the project.
- 4 Save the project.
- 5 Click **Build** to create the component.

Integrating the Component with Visual Basic for Applications

Having built your component, you can implement the necessary VBA code to integrate it into Excel. Follow these steps to open Excel and select the libraries you need to develop the add-in:

- 1 Start Excel.
- 2 From the Excel main menu, select **Tools->Macro->Visual Basic Editor**.
- 3 When the Visual Basic Editor starts, select **Tools->References** to display the **Project References Dialog**. Check **Fourier 1.0 Type Library** and **MWComUtil 1.0 Type Library** on 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, as follows:

- 1 Right-click on the **VBAProject** item in the project window and select **Insert->Module** from the pop-up menu.
- 2 A new module appears under **Modules** in the **VBA Project**. In the module’s property page, set the Name property to `FourierMain`. See the next figure.

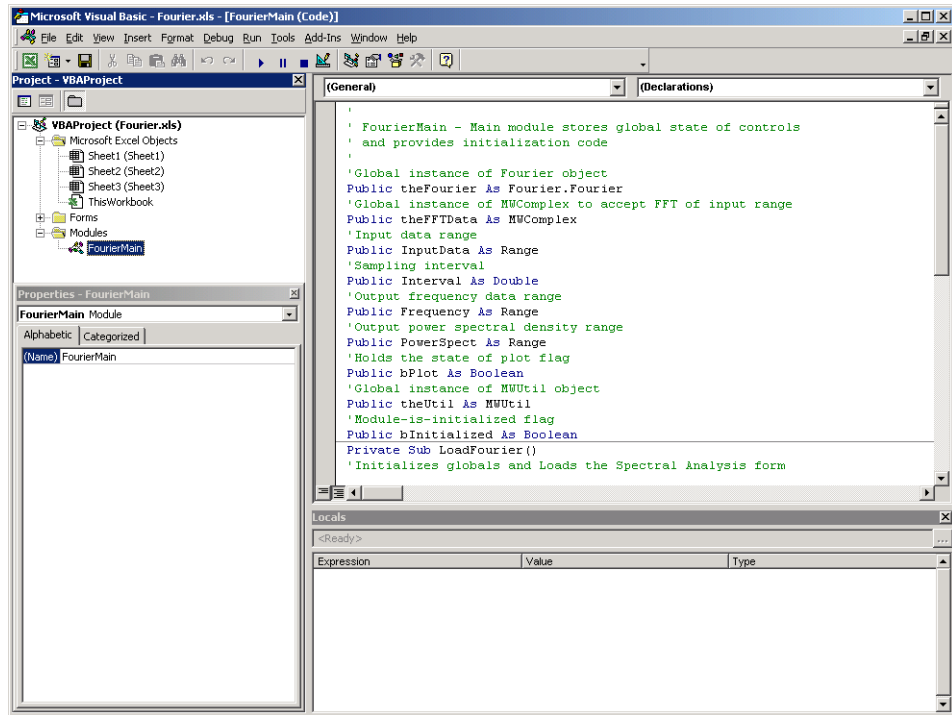


Figure 4-5: VBA Project: Insert->Module

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 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 theFourier Is Nothing Then
        Set theFourier = New Fourier.Fourier
    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. Follow the steps outlined here to create a new user form and populate it with the necessary controls:

- 1** Right-click on the **VBAProject** item in the project window and select **Insert->UserForm** from the pop-up menu.
- 2** A new form appears under Forms in the VBA Project. In the form's property page, set the name property to frmFourier and the Caption property to Spectral Analysis.

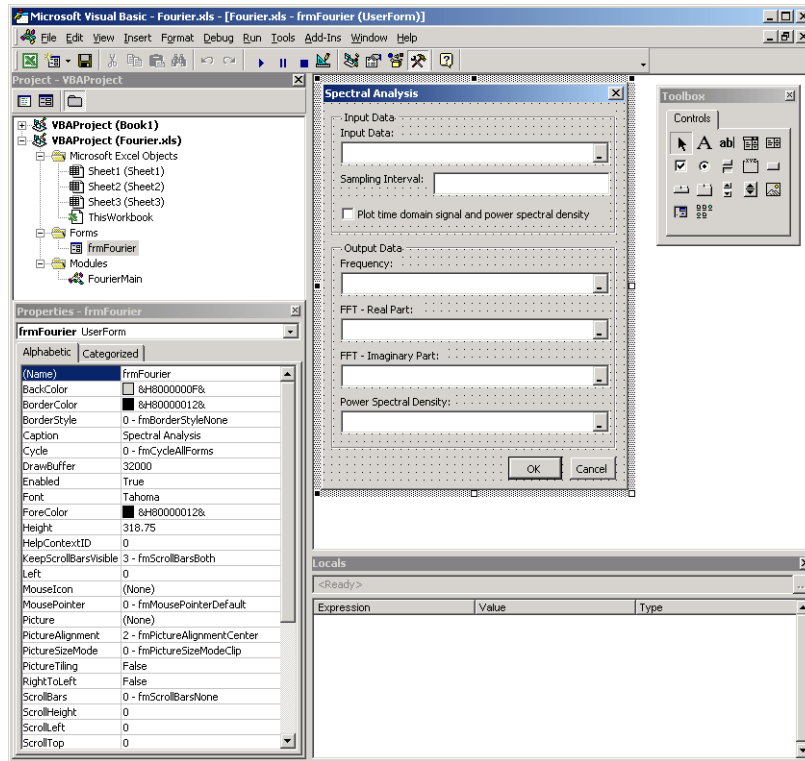


Figure 4-6: Creating the Visual Basic Form

3 Now add a series of controls to the blank form to complete the dialog, as summarized in the following table.

Control Type	Control Name	Properties	Purpose
Frame	Frame1	Caption = Input Data	Groups all input controls.
Label	Label1	Caption = Input Data:	Labels the RefEdit for input data.
RefEdit	refedtInput		Selects range for input data.

Control Type	Control Name	Properties	Purpose
Label	Label2	Caption = Sampling Interval	Labels the TextBox for sampling interval.
CheckBox	chkPlot	Caption = Plot time domain Signal and Power Spectral Density	Plots input data and power spectral density.
Frame	Frame2	Caption = Output Data	Groups all output controls.
Label	Label3	Caption = Frequency:	Labels the RefEdit for frequency output.
RefEdit	refedtFreq		Selects output range for frequency points.
Label	Label4	Caption = FFT - Real Part:	Labels the RefEdit for real part of FFT.
RefEdit	refedtReal		Selects output range for real part of FFT of input data.
Label	Label5	Caption = FFT - Imaginary Part:	Labels the RefEdit for imaginary part of FFT.
RefEdit	refedtImag		Selects output range for imaginary part of FFT of input data.
Label	Label6	Caption = Power Spectral Density	Labels the RefEdit for power spectral density.
RefEdit	refedtPowSpect		Selects output range for power spectral density of input data.

Control Type	Control Name	Properties	Purpose
CommandButton	btnOK	Caption = OK Default = True	Executes the function and dismisses the dialog
CommandButton	btnCancel	Caption = Cancel Cancel = True	Dismisses the dialog without executing the function.

Figure 4-7, Layout of Controls on Main Form, on page 4-19 shows the controls layout on the form.

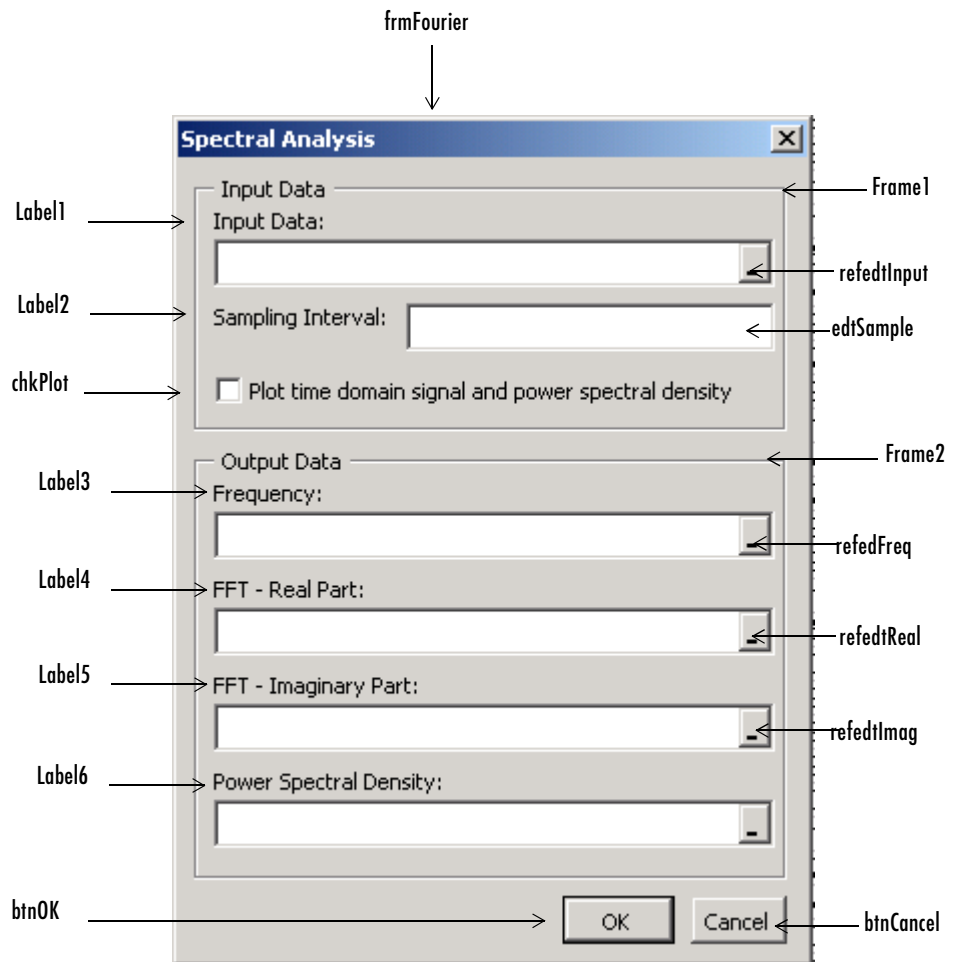


Figure 4-7: Layout of Controls on Main Form

When the form and controls are complete, right-click on the form and select **View Code** from the pop-up menu. The following code listing shows the code to implement. Note that this code references the control and variable names listed above. If you have given 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 = CDb1(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 invoke the tool from Excel's **Tools** menu. To do this you 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. Follow these steps to implement the menu item:

- 1 Right-click on the **ThisWorkbook** item in the Visual Basic project window and select **View Code** from the pop-up menu. See the next figure.

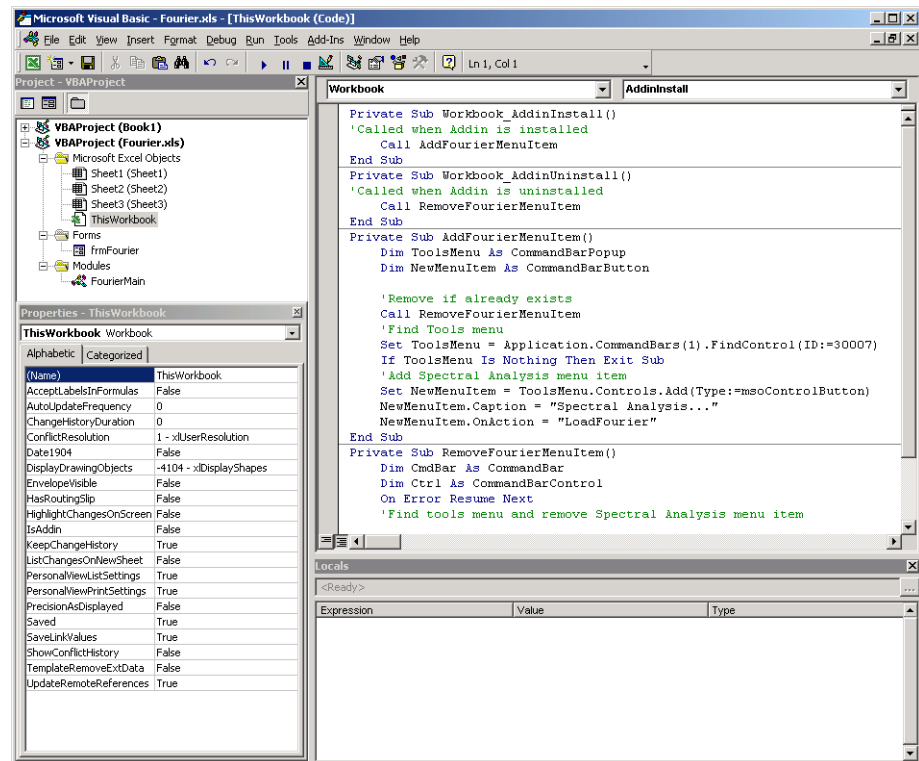


Figure 4-8: Adding a Menu Item to Excel

- 2 Place the code below into the **ThisWorkbook** object.

```

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

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

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

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

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

```

Saving the Add-in

Name the add-in Spectral Analysis and follow these steps to save it:

- 1 From the main menu in Excel, select **File->Properties**.
- 2 When the **Workbook Properties** dialog appears, select the **Summary** tab and enter Spectral Analysis as the workbook title.
- 3 Click **OK** to save the edits.

- 4 Select **File->Save As** from the Excel main menu.
- 5 When the **Save As** dialog appears, select **Microsoft Excel Add-In (*.xla)** as the file type.
- 6 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.

Follow the steps outlined below to create the test problem:

- 1 Start a new session of Excel with a blank workbook.
- 2 Select **Tools->Add-Ins** from the main menu.
- 3 When the **Add-Ins** dialog comes up, click **Browse**.
- 4 Browse to the `Fourier.xla` file click **OK**.
- 5 The **Spectral Analysis** add-in appears in the available **Add-Ins** list and is checked.
- 6 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 sec. Put the time points into column A and the signal points into column B.

Creating the Data

Follow these steps to create the data.

- 1 Enter 0 for cell A1 in the current worksheet.
- 2 Click on cell A2 and type the formula " $= A1 + 0.01$ ".
- 3 Click and hold on the lower right hand 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 on cell B1 and type the 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 on the **Input Data** box.
- 3 Select the B1:B1001 range from the worksheet or type this address into **Input Data**.
- 4 Click on the **Sampling Interval** box and type 0.01.
- 5 Check **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.

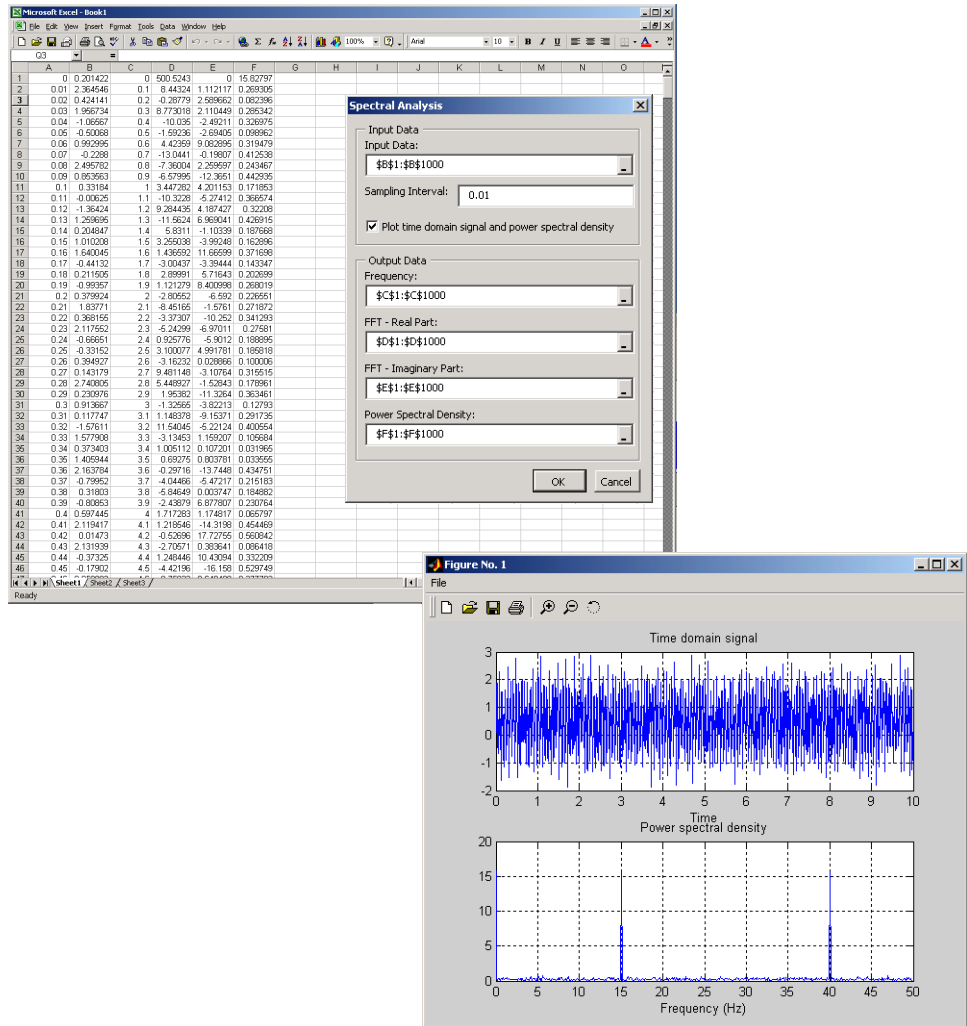


Figure 4-9: Worksheet with Inputs and Outputs for Test Problem

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

Package the Component

As a final step, package the COM component and all supporting libraries into a self-extracting executable. This package can now be installed onto other computers that need to use the Spectral Analysis component. You will also need to copy the `Fourier.xla` file to any machine that will use this component from inside Excel:

To package the component, follow these steps.

- 1** Return to `comtool`. If `comtool` has been dismissed, start it again and reload the `Fourier` project.
- 2** Select **Component->Package Component**.

This command creates the `Fourier.exe` self-extracting executable. To install this component onto another computer, copy the `Fourier.exe` package to that machine, run it from a command prompt, and follow the instructions.

Function Reference

componentinfo

Purpose Query system registry

Syntax Info = componentinfo(ComponentName, MajorRevision, MinorRevision)

Arguments

ComponentName	(Optional) A MATLAB string providing the name of a MATLAB COM Builder component. Names are case sensitive. If this argument is not supplied, the function returns information on all installed components.
MajorRevision	(Optional) Component major revision number. If this argument is not supplied, the function returns information on all major revisions.
MinorRevision	(Optional) Component minor revision number. Default = 0.

Description Info = componentinfo(ComponentName, MajorRevision, MinorRevision) returns registry and type information for a MATLAB COM Builder component. componentinfo takes between zero and three inputs and returns an array of structures representing all the registry and type information needed to load and use the component.

When you supply a component name, MajorRevision and MinorRevision are interpreted as shown below.

Value of MajorRevision	Information Returned
>0	Information on a specific major and minor revision
0	Information on the most recent revision
<0	Information on all versions

If you do not supply a component name, the function returns information for all components installed on the system.

Examples

Example 1.

```
Info = componentinfo('mycomponent',1,0)
```

With a component name and major revision supplied, the function returns information for revision 1.0 of mycomponent.

Example 2.

```
Info = componentinfo('mycomponent')
```

With a component name but no major revision supplied, the function returns information for all revisions of mycomponent.

Example 3.

```
Info = componentinfo
```

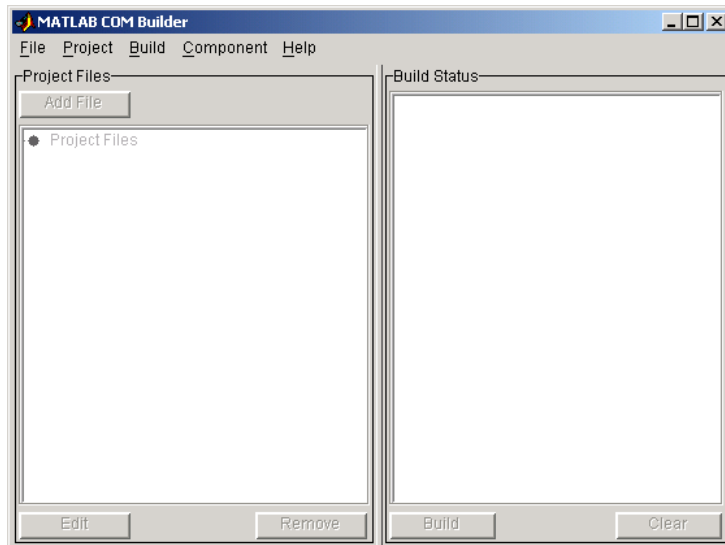
Without any arguments supplied, the function returns information for all installed components.

comtool

Purpose Graphical user interface to MATLAB COM Builder

Syntax comtool

Description comtool displays the graphical user interface (GUI) for MATLAB COM Builder.



Producing a COM Object from MATLAB

“Capabilities” on page A-2

Describes the process of creating a COM object from MATLAB input.

“Calling Conventions” on page A-7

Describes the calling conventions for MATLAB COM Builder components.

Capabilities

MATLAB COM Builder enables you to integrate compiled MATLAB models into Visual Basic, C++, or any other language that supports COM. Each MATLAB COM Builder component is built as a stand-alone COM object. (COM is an acronym for Component Object Model, Microsoft's binary standard for object interoperability. COM is the widely accepted standard for integration of external functionality into Microsoft Office applications, such as Excel.) Each MATLAB function included in a given component appears as a method of the created COM class. The resulting call syntax from Visual Basic is systematically mapped to the syntax of the original MATLAB function. This mapping provides an intuitive bridge from MATLAB, where the functions are created, to Visual Basic, where the functions are ultimately called.

MATLAB COM Builder provides robust data conversion and array formatting to preserve the flexibility of MATLAB when calling from Visual Basic. Also provided is custom error processing so that errors originating from MATLAB functions are automatically manifested as Visual Basic exceptions. The information returned with the error always references the original MATLAB code, making debugging easy.

A simple versioning mechanism is also built into each component to help manage deployment of multiple versions of the same component. Figure A-1 provides an overview of the process of creating a stand-alone COM object from compiled MATLAB M-files.

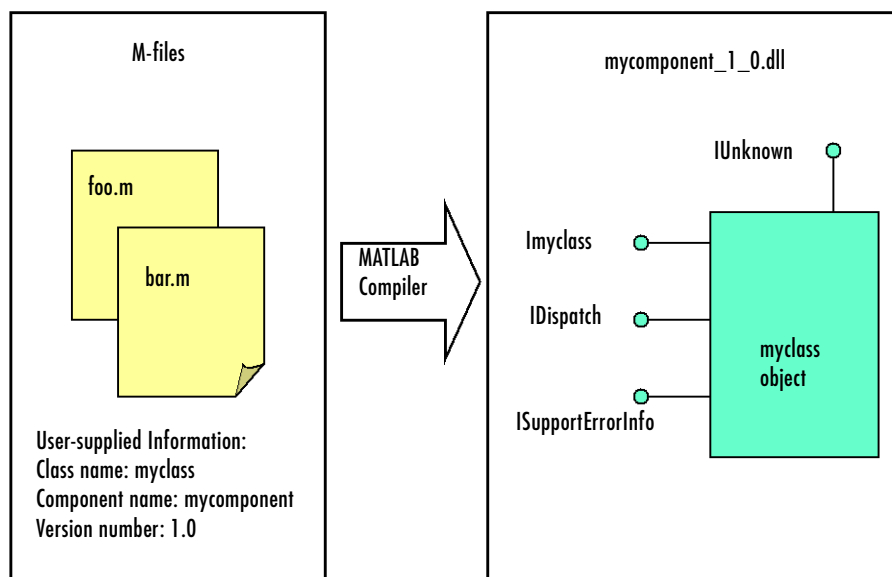


Figure A-1: Creating a Stand-Alone COM Object with the MATLAB Compiler

The process of creating a MATLAB COM Builder component is completely automatic. The user supplies a list of M-files to process and a few additional pieces of information, i.e., the component name, the class names, and the version number. The build process that follows involves code generation, compiling, linking, and registration of the finished component.

Figure A-2 shows the files created at each step in the entire process, from compilation to registration of the final DLL.

Note If you are reading this document online, click on Steps 1 - 5 in the figure for an explanation of what takes place at each specific point in the process.

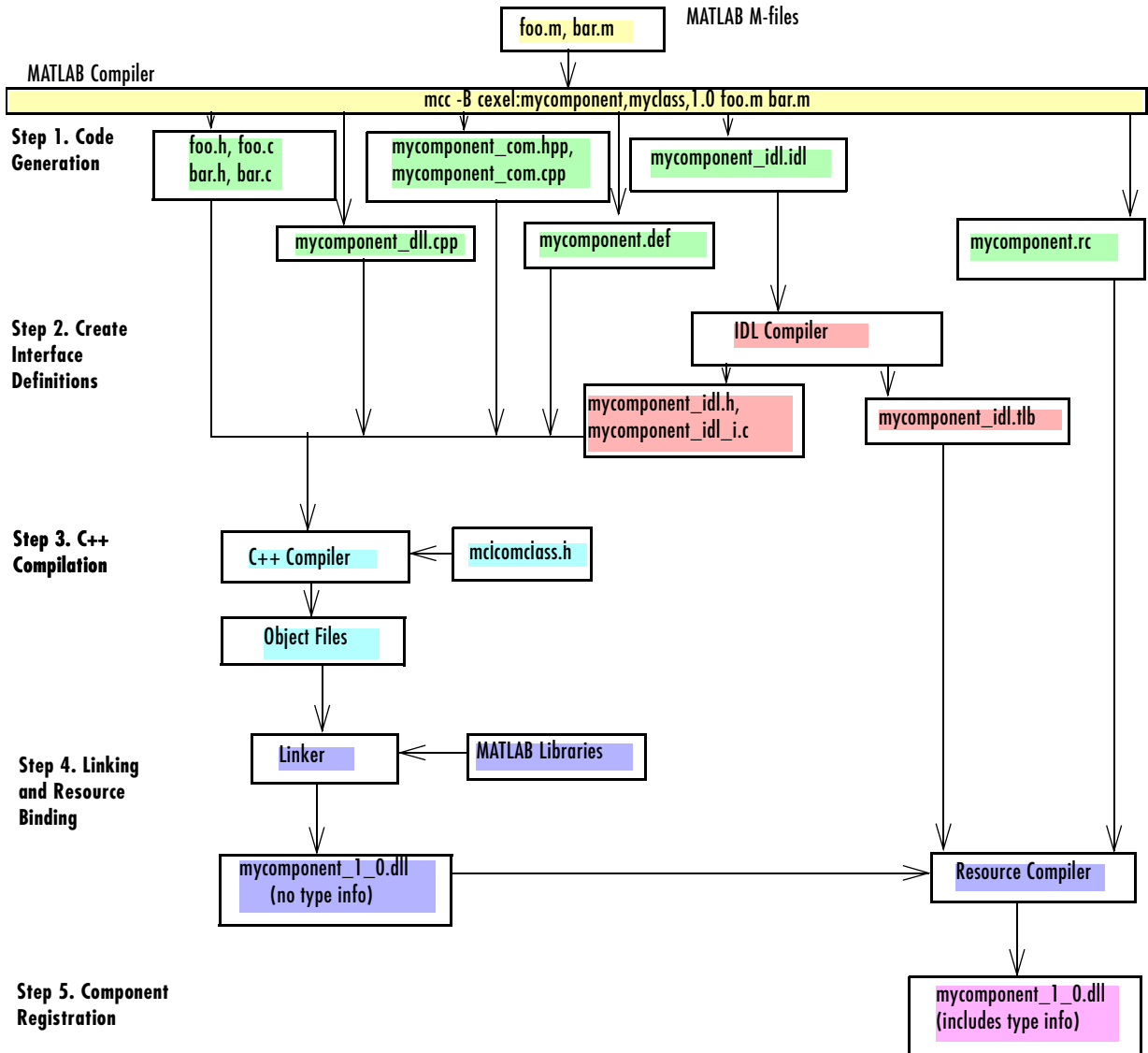


Figure A-2: M-Build Steps and Intermediate Files Created

Step 1. Code Generation

The first step in the build process generates all source code and other supporting files needed to create the component.

The compiler first produces `.c` and `.h` files (`foo.h`, `foo.c`, `bar.h`, and `bar.c`), representing the C-language translation of the M-code in the original M-files (`foo.m` and `bar.m`). It also creates the main source file (`mycomponent_dll.cpp`) containing the implementation of each exported function of the DLL. The compiler additionally produces an Interface Description Language (IDL) file (`mycomponent_idl.idl`), containing the specifications for the component's type library, interface, and class, with associated GUIDs. (GUID is an acronym for *Globally Unique Identifier*, a 128-bit integer guaranteed always to be unique.)

Created next are the C++ class definition and implementation files (`mycomponent_com.hpp` and `mycomponent_com.cpp`). In addition to these source files, the compiler generates a DLL exports file (`mycomponent.def`), and a resource script (`mycomponent.rc`).

Step 2. Create Interface Definitions

The second step of the build process invokes the IDL compiler on the IDL file generated in step 1 (`mycomponent_idl.idl`), creating the interface header file (`mycomponent_idl.h`), the interface GUID file (`mycomponent_idl_i.c`), and the component type library file (`mycomponent_idl.tlb`). The interface header file contains type definitions and function declarations based on the interface definition in the IDL file. The interface GUID file contains the definitions of the GUIDs from all interfaces in the IDL file. The component type library file contains a binary representation of all types and objects exposed by the component.

Step 3. C++ Compilation

The third step compiles all C/C++ source files generated in steps 1 and 2 into object code. One additional file containing a set of C++ template classes (`mc1comclass.h`) is included at this point. This file contains template implementations of all necessary COM base classes, as well as error handling and registration code. See "Compiler Requirements" for a list of supported C++ compilers.

Step 4. Linking and Resource Binding

The fourth step produces the finished DLL for the component. This step invokes the linker on the object files generated in step 3 and the necessary MATLAB libraries to produce a DLL component (`mycomponent_1_0.dll`). The resource compiler is then invoked on the DLL, along with the resource script generated in step 1, to bind the type library file generated in step 2 into the completed DLL.

Step 5. Component Registration

The final build step registers the DLL on the system. See “Component Registration” on page C-3 for information about this process.

Calling Conventions

This section describes the calling conventions for MATLAB COM Builder components, including mappings from the original M-functions to Visual Basic. A function call originating from a Visual Basic function into a compiled M-function, as shown in Figure A-3.

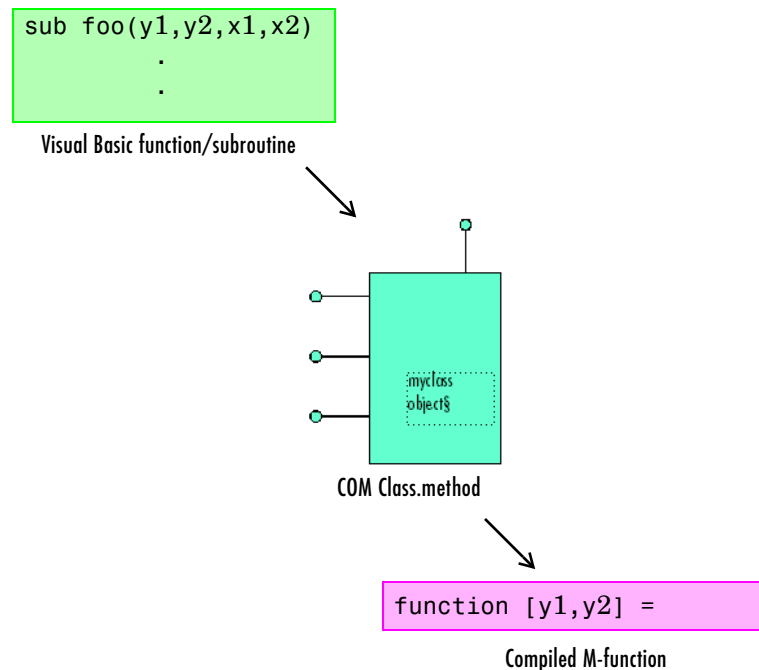


Figure A-3: Function Call Routing

Producing a COM Class

Producing a COM class requires the generation of a class definition file in Interface Description Language (IDL) as well as the associated C++ class definition/implementation files. (See the Microsoft COM documentation for a complete discussion of IDL and C++ coding rules for building COM objects.) The builder automatically produces the necessary IDL and C/C++ code to build

each COM class in the component. This process is generally transparent to the user.

IDL Mapping

The most generic MATLAB M-function is

```
function [Y1, Y2, , varargout] = foo(X1, X2, , varargin)
```

This function maps directly to the following IDL signature.

```
HRESULT foo([in] long nargout,  
            [in,out] VARIANT* Y1,  
            [in,out] VARIANT* Y2,  
            .  
            .  
            [in,out] VARIANT* varargout,  
            [in] VARIANT X1,  
            [in] VARIANT X2,  
            .  
            .  
            [in] VARIANT varargin);
```

This IDL function definition is generated by producing a function with the same name as the original M-function and an argument list containing all inputs and outputs of the original plus one additional parameter, `nargout`. (`nargout` is not produced if you compile an M-function containing no outputs.) When present, the `nargout` parameter is an `[in]` parameter of type `long`. It is always the first argument in the list. This parameter allows correct passage of the MATLAB `nargout` parameter to the compiled M-code. Following the `nargout` parameter, the outputs are listed in the order they appear on the left side of the MATLAB function, and are tagged as `[in,out]`, meaning that they are passed in both directions. The function inputs are listed next, appearing in the same order as they do on the right side of the original function. All inputs are tagged as `[in]` parameters. When present, the optional `varargin/varargout` parameters are always listed as the last input parameters and the last output parameters. All parameters other than `nargout` are passed as COM `VARIANT` types. “Data Conversion Rules” on page B-2 lists the rules for conversion between MATLAB arrays and COM `VARIANT`s.

Visual Basic Mapping

The Visual Basic mapping to the IDL signature shown above is

```
Sub foo(nargout As Long, _  
        Y1 As Variant, _  
        Y2 As Variant, _  
        .  
        .  
        varargout As Variant, _  
        X1 As Variant, _  
        X2 As Variant, _  
        .  
        .  
        varargin As Variant)
```

(See the COM documentation for mappings to other languages.) Visual Basic provides native support for COM `VARIANT`s with the `Variant` type, as well as implicit conversions for all Visual Basic basic types to and from `Variants`. In general, arrays/scalars of any Visual Basic basic type, as well as arrays/scalars of `Variant` types, can be passed as arguments. `MATLAB COM Builder` components also provide direct support for the `Excel Range` object, used by `Visual Basic for Applications` to represent a range of cells in an `Excel` worksheet. See the `Visual Basic for Applications` documentation included with `Microsoft Excel` for more information on `Visual Basic` data types and `Excel Range` manipulation.

Data Conversion

“Data Conversion Rules” on page B-2 Describes data conversion rules for MATLAB COM Builder components

Data Conversion Rules

This section describes the data conversion rules for MATLAB COM Builder components. COM Builder components are dual interface COM objects that support COM Automation compatible data types. When a method is invoked on a COM Builder component, the input parameters are converted to MATLAB internal array format and passed to the compiled MATLAB function. When the function exits, the output parameters are converted from 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. 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.

Table B-1 lists the VARIANT type codes supported by COM Builder components. Table B-2 and Table B-3 list the data conversion rules between COM VARIANTS and MATLAB arrays.

Table B-1: VARIANT Type Codes Supported

VARIANT Type Code (C/C++)	C/C++ Type	VARIANT Type Code (Visual Basic)	Visual Basic Type	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

Table B-1: VARIANT Type Codes Supported (Continued)

VARIANT Type Code (C/C++)	C/C++ Type	Variant Type Code (Visual Basic)	Visual Basic Type	Definition
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	-	A HRESULT (Signed four-byte integer representing a COM error code)
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

Table B-1: VARIANT Type Codes Supported (Continued)

VARIANT Type Code (C/C++)	C/C++ Type	Variant Type Code (Visual Basic)	Visual Basic Type	Definition
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
<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++.

Table B-2: MATLAB to COM VARIANT Conversion Rules

MATLAB Data Type	VARIANT type for Scalar Data	VARIANT type for Array Data	Comments
cell	A 1-by-1 cell array converts to a single VARIANT with a type conforming to the conversion rule for the MATLAB data type of the cell contents.	A multidimensional cell array converts to a VARIANT of type VT_VARIANT VT_ARRAY with the type of each array member conforming to the conversion rule for the MATLAB data type of the corresponding cell.	
structure	VT_DISPATCH	VT_DISPATCH	A MATLAB struct array is converted to an MWStruct object. (See “Class MWStruct” on page D-14.) This object is passed as a VT_DISPATCH type.

Table B-2: 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_DISPAATCH	VT_DISPATCH	A MATLAB sparse array is converted to an MWSparse object. (See “Class MWSparse” on page D-23.) This object is passed as a VT_DISPATCH type.

Table B-2: MATLAB to COM VARIANT Conversion Rules (Continued)

MATLAB Data Type	VARIANT type for Scalar Data	VARIANT type for Array Data	Comments
double	A real 1-by-1 double matrix converts to a VARIANT of type VT_R8. A complex 1-by-1 double matrix converts to a VARIANT of type VT_DISPATCH.	A real multidimensional double matrix converts to a VARIANT of type VT_R8 VT_ARRAY. A complex multidimensional double matrix converts to a VARIANT of type VT_DISPATCH.	Complex arrays are passed to and from compiled M-functions using the MWComplex class. See “Class MWComplex” on page D-21.)
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 M-functions using the MWComplex class. See “Class MWComplex” on page D-21.)
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 M-functions using the MWComplex class. See “Class MWComplex” on page D-21.)

Table B-2: MATLAB to COM VARIANT Conversion Rules (Continued)

MATLAB Data Type	VARIANT type for Scalar Data	VARIANT type for Array Data	Comments
uint8	A real 1-by-1 uint8 matrix converts to a VARIANT of type VT_UI1. A complex 1-by-1 uint8 matrix converts to a VARIANT of type VT_DISPATCH.	A real multidimensional uint8 matrix converts to a VARIANT of type VT_UI1 VT_ARRAY. A complex multidimensional uint8 matrix converts to a VARIANT of type VT_DISPATCH.	Complex arrays are passed to and from compiled M-functions using the MWComplex class. See “Class MWComplex” on page D-21.)
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 M-functions using the MWComplex class. See “Class MWComplex” on page D-21.)
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 M-functions using the MWComplex class. See “Class MWComplex” on page D-21.)

Table B-2: MATLAB to COM VARIANT Conversion Rules (Continued)

MATLAB Data Type	VARIANT type for Scalar Data	VARIANT type for Array Data	Comments
int32	A 1-by-1 int32 matrix converts to a VARIANT of type VT_I4. A complex 1-by-1 int32 matrix converts to a VARIANT of type VT_DISPATCH.	A multidimensional int32 matrix converts to a VARIANT of type VT_I4 VT_ARRAY. A complex multidimensional int32 matrix converts to a VARIANT of type VT_DISPATCH.	Complex arrays are passed to and from compiled M-functions using the MWComplex class. See “Class MWComplex” on page D-21.)
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 M-functions using the MWComplex class. See “Class MWComplex” on page D-21.)
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	

Table B-3: COM VARIANT to MATLAB Conversion Rules

VARIANT Type	MATLAB Data Type (scalar or array data)	Comments
VT_EMPTY	N/A	Empty array created.
VT_I1	int8	
VT_UI1	uint8	
VT_I2	int16	
VT_UI2	uint16	
VT_I4	int32	
VT_UI4	uint32	
VT_R4	single	
VT_R8	double	
VT_CY	double	
VT_BSTR	char	A VARIANT of type VT_BSTR converts to a 1-by-L MATLAB char array, where L = the length of the string to be converted. A VARIANT of type VT_BSTR VT_ARRAY converts to a MATLAB cell array of 1-by-L char arrays.
VT_ERROR	int32	

Table B-3: COM VARIANT to MATLAB Conversion Rules (Continued)

VARIANT Type	MATLAB Data Type (scalar or array data)	Comments
VT_DATE	double	<p>1. VARIANT dates are stored as doubles starting at midnight Dec. 31, 1899. 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 B-14 for more information on type coercion.</p>
VT_INT	int32	
VT_UINT	uint32	
VT_DECIMAL	double	
VT_BOOL	logical	
VT_DISPATCH	(varies)	<p>IDispatch* pointers are treated within the context of what they point to. Objects must be supported types with known data extraction and conversion rules or expose a generic “Value” property that points to a single VARIANT type. Data extracted from an object is converted based upon the rules for the particular VARIANT obtained. Currently, support exists for Excel Range objects as well as COM Builder types MWStruct, MWComplex, MWSparse, and MWArg. See “Utility Library Classes” on page D-3 for information on COM Builder types.</p>

Table B-3: COM VARIANT to MATLAB Conversion Rules (Continued)

VARIANT Type	MATLAB Data Type (scalar or array data)	Comments
<i><anything></i> 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.
<i><anything></i> 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

MATLAB COM Builder 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 Table B-2 and Table B-3. In some cases this is not possible, e.g., when existing MATLAB code is used in conjunction with a third party product like Excel.

Table B-4 shows the array formatting flags.

Table B-4: 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. Valid values for this flag are <code>mwArrayFormatAsIs</code>, <code>mwArrayFormatMatrix</code>, and <code>mwArrayFormatCell</code>.</p> <p><code>mwArrayFormatAsIs</code> passes the array unchanged.</p> <p><code>mwArrayFormatMatrix</code> (default) formats all arrays as matrices. When the input VARIANT is of type <code>VT_ARRAY <type></code>, where <code><type></code> is any numeric type, this flag has no effect. When the input VARIANT is of type <code>VT_VARIANT VT_ARRAY</code>, VARIANTS in the array are examined. If they are single-valued and homogeneous in type, a MATLAB matrix of the appropriate type is produced instead of a cell array.</p> <p><code>mwArrayFormatCell</code> interprets all arrays as MATLAB cell arrays.</p>
InputArrayIndFlag	<p>Sets the input array indirection level used with the <code>InputArrayFormat</code> flag (applicable only to nested arrays, i.e., VARIANT arrays of VARIANTS, which themselves are arrays). The default value for this flag is zero, which applies the <code>InputArrayFormat</code> flag to the outermost array. When this flag is greater than zero, e.g., equal to N, the formatting rule attempts to apply itself to the Nth level of nesting.</p>
OutputArrayFormat	<p>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.</p>
OutputArrayIndFlag	<p>(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>.</p>

Table B-4: Array Formatting Flags (Continued)

Flag	Description
AutoSizeOutput	(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 True to resize each Excel range to fit the output array.
TransposeOutput	Set this flag to True to transpose the output arguments. Useful when calling an COM Builder component from Excel where the MATLAB function returns outputs as row vectors, and you want the data in columns.

Data Conversion Flags

MATLAB COM Builder components contain flags to control the conversion of certain VARIANT types to MATLAB types.

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, and VT_DATE. Valid values for this flag are `mwTypeDefault`, `mwTypeChar`, `mwTypeDouble`, `mwTypeSingle`, `mwTypeLogical1`, `mwTypeInt8`, `mwTypeUInt8`, `mwTypeInt16`, `mwTypeUInt16`, `mwTypeInt32`, and `mwTypeUInt32`. The default for this flag, `mwTypeDefault`, converts numeric data according to the rules listed in Table B-3.

InputDateFormat

This flag tells the data converter how to convert VARIANT dates to MATLAB dates. Valid values for this flag are `mwDateFormatNumeric` (default) and `mwDateFormatString`. The default converts VARIANT dates according to the rule listed in Table B-3. `mwDateFormatString` 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 MATLAB numeric date conversions. The default value of this property is 693960, which represents 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 Builder components. To process dates with such code, set this property to 0.

Registration and Versioning

“Overview” on page C-2	Describes the contents of this section.
“Component Registration” on page C-3	Describes the registration process for MATLAB COM Builder components.
“Versioning” on page C-5	Describes the versioning mechanism that makes building and deploying multiple versions of the same component easy to implement.
“Obtaining Registry Information” on page C-6	Describes the use of the MATLAB function <code>componentinfo</code> to query the system registry for any installed COM Builder components.

Overview

This section describes the registration and versioning of MATLAB COM Builder components and how to retrieve information about any installed component from the system registry.

Component Registration

When the MATLAB COM Builder creates a component, it automatically generates a binary file called a *type library*. As a final step of the build, this file is bound with the resulting DLL as a resource.

Self-Registering Components

MATLAB COM Builder components are all *self-registering*. A self-registering component contains all the necessary code to add or remove a full description of itself to or from the system registry. The `mwregsvr` utility registers self-registering DLLs. For example, to register a component called `mycomponent_1_0.dll`, issue this command at the DOS command prompt.

```
mwregsvr mycomponent_1_0.dll
```

When `mwregsvr` completes the registration process, it displays a message indicating success or failure. Similarly, the command

```
mwregsvr /u mycomponent_1_0.dll
```

unregisters the component.

An COM Builder component installed onto a particular machine must be registered with `mwregsvr`. If you move a component into a different directory on the same machine, you must repeat the registration process. When deleting a component from a specific machine, first unregister it to ensure that the registry does not retain erroneous information.

Globally Unique Identifiers

Information is stored in the registry as keys with one or more associated named values. The keys themselves have values of primarily two types: readable strings and GUIDs. GUID is an acronym for *Globally Unique Identifier*, a 128-bit integer guaranteed always to be unique. The MATLAB Compiler automatically generates GUIDs for COM classes, interfaces, and type libraries that are defined within a component at build time, and codes these keys into the component's self-registration code. The interface to the system registry is directory based, and COM-related information is stored under a top-level key called `HKEY_CLASSES_ROOT`. Under `HKEY_CLASSES_ROOT` are several other keys under which the component writes its information. These keys are defined in Table C-1.

Table C-1: Keys

Key	Definition
HKEY_CLASSES_ROOT\CLSID	Information about COM classes on the system. Each component creates a new key under HKEY_CLASSES_ROOT\CLSID for each of its COM classes. The key created has a value of the GUID that has been assigned the class and contains several subkeys with information about the class.
HKEY_CLASSES_ROOT\Interface	Information about COM interfaces on the system. Each component creates a new key under HKEY_CLASSES_ROOT\Interface for each interface it defines. This key has the value of the GUID assigned to the interface and contains subkeys with information about the interface.
HKEY_CLASSES_ROOT\TypeLib	Information about type libraries on the system. Each component creates a key for its type library with the value of the GUID assigned to it. Under this key a new key is created for each version of the type library. Therefore, new versions of type libraries with the same name reuse the original GUID but create a new subkey for the new version.
HKEY_CLASSES_ROOT\<>ProgID>, HKEY_CLASSES_ROOT\<>VerIndProgID>	These two keys are created for the component's Program ID and Version Independent Program ID. These keys are constructed from strings of the form <component-name>.<class-name> and <component-name>.<class-name><version-number>. These keys are useful for creating a class instance from the component and class names instead of the GUIDs.

Versioning

MATLAB COM Builder components support a simple versioning mechanism designed to make building and deploying multiple versions of the same component easy to implement. The version number of a component appears as part of the DLL name, as well as part of the version-dependent ID in the system registry.

When a component is created, you can specify a version number (default = 1.0). During the development of a specific version of a component, the version number should be kept constant. When this is done, the MATLAB Compiler, in certain cases, reuses type library, class, and interface GUIDs for each subsequent build of the component. This avoids the creation of an excessive number of registry keys for the same component during multiple builds, as occurs if new GUIDs are generated for each build.

When a new version number is introduced, the MATLAB Compiler generates new class and interface GUIDs so that the system recognizes them as distinct from previous versions, even if the class name is the same. Therefore, once you deploy a built component, use a new version number for any changes made to the component. This ensures that after you deploy the new component, it is easy to manage the two versions.

The MATLAB Compiler implements the versioning rules for a specific component name, class name, and version number by querying the system registry for an existing component with the same name.

- If an existing component has the same version, it uses the GUID of the existing component's type library. If the name of the new class matches the previous version, it reuses the class and interface GUIDs. If the class names do not match, it generates new GUIDs for the new class and interface.
- If it finds an existing component with a different version, it uses the existing type library GUID and creates a new subkey for the new version number. It generates new GUIDs for the new class and interface.
- If it does not find an existing component of the specified name, it generates new GUIDs for the component's type library, class, and interface.

Obtaining Registry Information

MATLAB COM Builder includes the MATLAB function `componentinfo` to query the system registry for any installed COM Builder components. The function can be executed inside MATLAB with the component name, major version number, and minor version number as arguments. It returns an array of structures with the requested information. Calling `componentinfo` with no arguments returns all COM Builder components installed on the machine.

The next example queries the registry for a component named `mycomponent` and a version of 1.0. This component has four methods: `mysum`, `randvectors`, `getdates`, and `myprimes`, two properties: `m` and `n`, and one event: `myevent`.

```
Info = componentinfo('mycomponent', 1, 0)

Info =

    Name: 'mycomponent'
  TypeLib: 'mycomponent 1.0 Type Library'
   LIBID: '{3A14AB34-44BE-11D5-B155-00D0B7BA7544}'
 MajorRev: 1
 MinorRev: 0
 FileName: 'D:\Work\ mycomponent\distrib\mycomponent_1_0.dll'
 Interfaces: [1x1 struct]
 CoClasses: [1x1 struct]

Info.Interfaces

ans =

    Name: 'Imyclass'
   IID: '{3A14AB36-44BE-11D5-B155-00D0B7BA7544}'

Info.CoClasses

ans =

    Name: 'myclass'
  CLSID: '{3A14AB35-44BE-11D5-B155-00D0B7BA7544}'
 ProgID: 'mycomponent.myclass.1_0'
VerIndProgID: 'mycomponent.myclass'
```

```
InprocServer32: 'D:\Work\mycomponent\distrib\mycomponent_1_0.dll'  
    Methods: [1x4 struct]  
    Properties: {'m', 'n'}  
    Events: [1x1 struct]
```

```
Info.CoClasses.Events.M
```

```
ans =
```

```
function myevent(x, y)
```

```
Info.CoClasses.Methods
```

```
ans =
```

```
1x4 struct array with fields:
```

```
    IDL
```

```
    M
```

```
    C
```

```
    VB
```

```
Info.CoClasses.Methods.M
```

```
ans =
```

```
function [y] = mysum(varargin)
```

```
ans =
```

```
function [varargout] = randvectors()
```

```
ans =
```

```
function [x] = getdates(n, inc)
```

```
ans =
```

```
function [p] = myprimes(n)
```

The returned structure contains fields corresponding to the most important information from the registry and type library for the component. These fields are defined in Table C-2.

Table C-2: 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
FileName	Type library filename and path. Since all MATLAB COM Builder components have the type library bound into the DLL, this file name is the same as the DLL name and path.

Table C-2: Registry Information Returned by componentinfo (Continued)

Field	Description
Interfaces	<p data-bbox="649 343 1329 406">An array of structures defining all interface definitions in the type library. Each structure contains two fields:</p> <ul data-bbox="658 430 961 510" style="list-style-type: none"><li data-bbox="658 430 961 458">• Name - Interface name<li data-bbox="658 482 961 510">• IID - Interface GUID

Table C-2: Registry Information Returned by componentinfo (Continued)

Field	Description
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 Visual Basic 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: <ul style="list-style-type: none"> ▪ IDL - An array of IDL (Interface Description Language) function prototypes. ▪ M - An array of MATLAB function prototypes. ▪ C - An array of C-Language function prototypes. ▪ VB - An array of Visual Basic function prototypes

Utility Library

“Introduction” on page D-2

Overview of the `MWComUtil` utility library

“Utility Library Classes” on page D-3

Discusses the classes within the `MWComUtil` utility library

“Enumerations” on page D-28

Describes the enumerations (sets of constants)

Introduction

This section describes the `MWComUtil` library provided with the MATLAB COM Builder. 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 COM Builder components.

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 D-3) and three enumerated types (see “Enumerations” on page D-28). Before using these types, you must make explicit references to the `MWComUtil` type libraries in the 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.

Utility Library Classes

The COM Builder Utility Library provides several classes:

- “Class MWUtil” on page D-3
- “Class MWFlags” on page D-8
- “Class MWStruct” on page D-14
- “Class MWField” on page D-20
- “Class MWComplex” on page D-21
- “Class MWSparse” on page D-23
- “Class MWArg” on page D-26

Class MWUtil

The `MWUtil` class contains a set of static utility methods used in array processing. This class is implemented internally as a singleton. 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 D-3
- “Sub MWPack(pVarArg, [Var0], [Var1], ... ,[Var31])” on page D-4
- “Sub MWUnpack(VarArg, [nStartAt As Long], [bAutoResize As Boolean = False], [pVar0], [pVar1], ..., [pVar31])” on page D-5
- “Sub MWDate2VariantDate(pVar)” on page D-7

The function prototypes use Visual Basic syntax.

Sub MWInitApplication(pApp As Object)

Used with MATLAB Excel Builder only.

Parameters.

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

Return Value. None.

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

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

Parameters.

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

Return Value. None.

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

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

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

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

```
Function mysum(Optional V0 As Variant, _
               Optional V1 As Variant, _
               Optional V2 As Variant, _
               Optional V3 As Variant, _
               Optional V4 As Variant, _
               Optional V5 As Variant, _
```

```

        Optional V6 As Variant, _
        Optional V7 As Variant, _
        Optional V8 As Variant, _
        Optional V9 As Variant) As Variant
Dim y As Variant
Dim varargin As Variant
Dim aClass As Object
Dim aUtil As Object

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

```

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

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

Parameters.

Argument	Type	Description
VarArg	Variant	Input array of Variants to be processed
nStartAt	Long	Optional starting index (zero-based) in the array to begin processing. Default = 0.

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

Return Value. None.

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

Example. This example uses MWUnpack to process a varargout cell into four output arguments. The varargout parameter is supplied from a method that has been compiled from the MATLAB function.

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

This function produces a sequence of nargout random column vectors, with the length of the ith vector equal to i. Assume that this function is included in a class named myclass that is included in a component named mycomponent with a version of 1.0. If an error occurs, a message box displays the error text.

```
Sub GenVectors(v1 As Variant, v2 As Variant, _
              v3 As Variant, v4 As Variant)

    Dim aClass As Object
    Dim aUtil As Object
```

```

Dim v As Variant

On Error GoTo Handle_Error
Set aClass = CreateObject("mycomponent.myclass.1_0")
Set aUtil = CreateObject("MWComUtil.MWUtil")
Call aClass.randvectors(4, v)
Call aUtil.MWUnpack(v,0, ,v1 ,v2 ,v3 ,v4)
Exit Sub
Handle_Error:
MsgBox (Err.Description)
End Sub

```

Sub MWDate2VariantDate(pVar)

Converts output dates from MATLAB to Variant dates.

Parameters.

Argument	Type	Description
pVar	Variant	Variant to be converted.

Return Value. None.

Remarks. MATLAB handles dates as double precision floating point numbers with 0.0 representing 0/0/00 00:00:00 (See “Data Conversion Rules” on page B-2 for more information on conversion between MATLAB and COM date values). By default, numeric dates that are output parameters from compiled MATLAB functions are passed as Doubles that need to be decremented by the COM date bias as well as coerced to COM dates. The MWDate2VariantDate method performs this transformation and additionally converts dates in string form to COM date types.

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

```

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

```

This function produces an n-length column vector of numeric values representing dates starting from the current date and time with each element incremented by `inc` days. Assume that this function is included in a class named `myclass` that is included in a component named `mycomponent` with a version of 1.0. If an error occurs, a message box displays the error text.

```
Sub GenDates(Dates As Variant, num As Long, inc As Long)
    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, Dates, Cdbl(num), Cdbl(inc))
    Call aUtil.MWDate2VariantDate(Dates)
    Exit Sub
Handle_Error:
    MsgBox (Err.Description)
End Sub
```

Class MWFlags

The `MWFlags` class contains a set of array formatting and data conversion flags (See “Data Conversion Rules” on page B-2 for more information on conversion between MATLAB and COM Automation types). All MATLAB COM Builder components contain a reference to an `MWFlags` object that can modify data conversion rules at the object level. This class contains these properties:

- “Property `ArrayFormatFlags` As `MWArrayFormatFlags`” on page D-8
- “Property `DataConversionFlags` As `MWDataConversionFlags`” on page D-11
- “Sub `Clone(ppFlags As MWFlags)`” on page D-13

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 D-9
- “Property `InputArrayIndFlag` As Long” on page D-9

- “Property OutputArrayFormat As mwArrayFormat” on page D-10
- “Property OutputArrayIndFlag As Long” on page D-10
- “Property AutoResizeOutput As Boolean” on page D-10
- “Property TransposeOutput As Boolean” on page D-11

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

Table D-1: Array Formatting Rules for Input Arrays

Value	Behavior
<code>mwArrayFormatAsIs</code>	Converts arrays according to the default conversion rules listed in Table B-3, COM VARIANT to MATLAB Conversion Rules, on page B-10.
<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.
<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.

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 COM Builder class methods. The default value is mxArrayFormatAsIs. The behaviors indicated by this flag are listed in the next table.

Table D-2: Array Formatting Rules for Output Arrays

Value	Behavior
mxArrayFormatAsIs	Converts arrays according to the default conversion rules listed in Table B-2, MATLAB to COM VARIANT Conversion Rules, on page B-5.
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 an COM Builder component, where the MATLAB function returns outputs as row vectors, and you desire to place the data into columns. The default value for this flag is `False`.

Property `DataConversionFlags As MWDataConversionFlags`

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

- “Property `CoerceNumericToType As mwDataType`” on page D-11
- “Property `InputDateFormat As mwDateFormat`” on page D-11
- “Property `OutputAsDate As Boolean`” on page D-13
- “Property `DateBias As Long`” on page D-13

Property `CoerceNumericToType As mwDataType`. This property converts all numeric input arguments to one specific MATLAB type. This flag is useful is when variables maintained within the Visual Basic code are different types, e.g., `Long`, `Integer`, etc., and all variables passed to the compiled MATLAB code must be doubles. The default value for this property is `mwTypeDefault`, which uses the default rules in “COM VARIANT to MATLAB Conversion Rules” on page B-10.

Property `InputDateFormat As mwDateFormat`. This property converts dates passed as input parameters to method calls on COM Builder classes. The default value is `mwDateFormatNumeric`. The behaviors indicated by this flag are shown in Table D-3, Conversion Rules for Input Dates.

Table D-3: Conversion Rules for Input Dates

Value	Behavior
mwDateFormatNumeric	Convert dates to numeric values as indicated by the rule listed in Table B-3, COM VARIANT to MATLAB Conversion Rules, on page B-10.
mwDateFormatString	Convert input dates to strings.

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

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

```

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

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

```

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

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

Sub Clone(ppFlags As MWFlags)

Creates a copy of an MWFlags object.

Parameters.

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

Return Value. None

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

Class MWStruct

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

- “Sub Initialize([varDims], [varFieldNames])” on page D-14
- “Property Item([i0], [i1], ..., [i31]) As MWField” on page D-15
- “Property NumberOfFields As Long” on page D-18
- “Property NumberOfDims As Long” on page D-18
- “Property Dims As Variant” on page D-18
- “Property FieldNames As Variant” on page D-18
- “Sub Clone(ppStruct As MWStruct)” on page D-19

Sub Initialize([varDims], [varFieldNames])

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

Parameters.

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

Return Value. None.

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

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

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

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

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

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

    '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
<code>i0,i1, ..., i31</code>	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
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 D-20
- “Property Value As Variant” on page D-21
- “Property MWFlags As MWFlags” on page D-21
- “Sub Clone(ppField As MWField)” on page D-21

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 method's are called.

Sub Clone(ppField As MWField)

Creates a copy of an MWField object.

Parameters.

Argument	Type	Description
ppField	MWField	Reference to an uninitialized MWField object to receive the copy.

Return Value. None.

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

Class MWComplex

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

- “Property Real As Variant” on page D-22
- “Property Imag As Variant” on page D-22
- “Property MWFlags As MWFlags” on page D-23
- “Sub Clone(ppComplex As MWComplex)” on page D-23

Property Real As Variant

Stores the real part of a complex array (read/write). The `Real` property is the default property of the `MWComplex` class. The value of this property can be any type coercible to a `Variant`, as well as object types, with the restriction that the underlying array must resolve to a numeric matrix (no cell data allowed). Valid Visual Basic numeric types for complex arrays include `Byte`, `Integer`, `Long`, `Single`, `Double`, `Currency`, and `Variant/vbDecimal`.

Property Imag As Variant

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

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

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

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

```

    MsgBox(Err.Description)
End Sub

```

Property MWFlags As MWFlags

Stores a reference to an MWFlags object. This property sets or gets the array formatting and data conversion flags for a particular complex array. Each MWComplex object has its own MWFlags property. This property overrides the value of any flags set on the object whose method's 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 D-24
- “Property NumColumns As Long” on page D-24
- “PropertyRowIndex As Variant” on page D-24
- “Property ColumnIndex As Variant” on page D-24
- “Property Array As Variant” on page D-24
- “Property MWFlags As MWFlags” on page D-24
- “Sub Clone(ppSpase As MWSpase)” on page D-25

Property NumRows As Long

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

Property NumColumns As Long

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

Property RowIndex As Variant

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

Property ColumnIndex As Variant

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

Property Array As Variant

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

Property MWFlags As MWFlags

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

MWSparse object has its own MWFlags property. This property overrides the value of the any flags set on the object whose method's 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 D-27
- “Property MWFlags As MWFlags” on page D-27
- “Sub Clone(ppArg As MWArg)” on page D-27

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 the any flags set on the object whose method's 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

The MATLAB COM Builder Utility Library provides three enumerations (sets of constants):

- “Enum mwArrayFormat” on page D-28
- “Enum mwDataType” on page D-28
- “Enum mwDateFormat” on page D-29

Enum mwArrayFormat

The mwArrayFormat enumeration is a set of constants that denote an array formatting rule for data conversion. Table D-4 lists the members of this enumeration.

Table D-4: mwArrayFormat Values

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

Enum mwDataType

The mwDataType enumeration is a set of constants that denote a MATLAB numeric type. Table D-5 lists the members of this enumeration.

Table D-5: mwDataType Values

Constant	Numeric Value	MATLAB Type
mwTypeDefault	0	N/A
mwTypeLogical	3	logical

Table D-5: mwDataType Values (Continued)

Constant	Numeric Value	MATLAB Type
mwTypeChar	4	char
mwTypeDouble	6	double
mwTypeSingle	7	single
mwTypeInt8	8	int8
mwTypeUInt8	9	uint8
mwTypeInt16	10	int16
mwTypeUInt16	11	uint16
mwTypeInt32	12	int32
mwTypeUInt32	13	uint32

Enum mwDateFormat

The `mwDateFormat` enumeration is a set of constants that denote a formatting rule for dates. Table D-6 lists the members of this enumeration.

Table D-6: mwDateFormat Values

Constant	Numeric Value	Description
<code>mwDateFormatNumeric</code>	0	Format dates as numeric values.
<code>mwDateFormatString</code>	1	Format dates as strings.

Troubleshooting

This section provides a table showing errors you may encounter using MATLAB COM Builder, probable causes for these errors, and suggested solutions.

Table E-1: MATLAB COM Builder 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 mbuild -setup and choose a supported compiler.
Error in <i>component_name.class_name.1_0</i> : Error getting data conversion flags.	Usually caused by mwcomutil.dll not being registered.	Open a DOS window, change directories to <matlab>\bin\win32 (<matlab> represents the location of MATLAB on your system), and run the command mwregsvr mwcomutil.dll.
Error in VBAProject: ActiveX component can't create object.	<ol style="list-style-type: none"> 1. Project DLL is not registered. 2. An incompatible MATLAB DLL exists somewhere on the system path. 	If the DLL is not registered, open a DOS window, change directories to <projectdir>\distrib (<projectdir> represents the location of your project files), and run the command: mwregsvr <projectdll>.dll.
Error in VBAProject: Automation error The specified module could not be found.	This usually occurs if MATLAB is not on the system path.	Place <matlab>\bin\win32 on your path.

Table E-1: MATLAB COM Builder Errors and Suggested Solutions (Continued)

Message	Probable Cause	Suggested Solution
LoadLibrary("component_name_1_0.dll") failed - The specified module could not be found.	You may get this error message while registering the project DLL from the DOS prompt. This usually occurs if MATLAB is not on the system path.	Place <matlab>\bin\win32 on your path.
Cannot recompile the M file xxxx because it is already in the library libmmfile.mlib.	The name you have chosen for your M-file duplicates the name of an M-file already in the library of precompiled M-files.	Rename the M-file, choosing a name that does not duplicate the name of an M-file already in the library of precompiled M-files.

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