Getting Started with MASM and Visual Studio 2010

Updated 8/15/2011

This tutorial shows you how to set up Visual Studio 2010 (including the Express version) to work with Microsoft MASM. If you are using Visual Studio 2008 or Visual C++ 2008 Express, Click here.

If you're in a hurry to get started, you only need to read Item 1 below:

1. Project properties settings
2. Generating a source listing file
3. Using the Visual Studio debugger
4. MASM syntax highlighting
5. Assembling, linking, and debugging with a batch file
6. Custom Build Rules

The book's example programs in Chapters 1-14 have been successfully tested in Windows XP, 32-bit Vista and the 32-bit version of Windows 7. On the other hand, many programs in Chapters 15-17 will not run in any Microsoft OS later than Windows 98, because they rely on direct access to hardware and system memory. You cannot directly run 16-bit applications in any 64-bit version of Windows.

Found an error in this document? Please email me immediately. Except where noted, all instructions in this document apply equally to Visual Studio 2010 and Visual C++ Express 2010.

Required Setup for 32-bit Applications

First, you must install Visual Studio 2010 and select the C++ language option. VS 2010 and Visual C++ 2010 Express both include the current version of the Microsoft Assembler. You can verify that the Microsoft Assembler is installed by looking for the file **ml.exe** in the \vc\bin folder of your Visual Studio installation directory, such as c:\Program Files\Microsoft Visual Studio 10.x\vc\bin.

Using Visual Studio Express? You must do the following in order to see the same menu options as the users of Visual Studio professional: from the *Tools* menu, select *Settings*, and select *Expert Settings*.

Next: Install the Book's Example Programs

Click this link to get the latest copy of the book's link libraries and example programs. The examples are stored in a self-extracting archive file that automatically extracts to the **c:\Irvine** folder. Unless you have some objection to using that location, do not alter the path. (Lab managers: you can designate c:\Irvine directory as read-only.) If you plan to change the installation location, read our instructions relating to changing project properties.

The folllowing files will be copied into the c:\Irvine directory:

Filename	**Description**
cmd.exe	Shortcut to the Windows command-line interpreter (named cmd.exe)
GraphWin.inc	Include file for writing Windows applications
Irvine16.inc	Include file used with the Irvine16 link library (16-bit applications)
Irvine16.lib	16-bit link function library used with this book
Irvine32.inc	Include file used with the Irvine32 link library (32-bit applications)
Link16.exe	16-bit linker
Irvine32.lib	32-bit link function library used with this book
User32.lib	Basic I/O link library
Macros.inc	Include file containing macros (explained in Chapter 10)
SmallWin.inc	Small-sized include file, used by Irvine32.inc
make16.bat	Batch file for building 16-bit applications
VirtualKeys.inc	Keyboard code definitions file, used by Irvine32.inc

A subdirectory named **Examples** will contain all the example programs shown in the book, as well as all the source code for the book's 16- and 32-bit link libraries.

Setting up Visual Studio

You will only have to do these steps the first time you use Visual Studio.

Add the *Start Without Debugging* command to the Debug menu

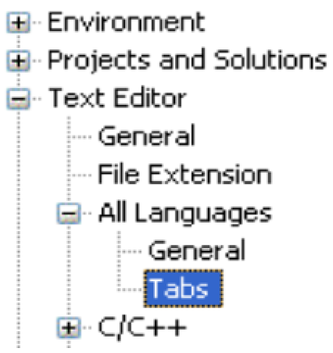
It's very useful to run programs without having to debug them. To do that, you will want to add a new command to the Debug menu: Start Without Debugging. Here's how to do it:

1. From the Tools, menu, select *Customize*.
2. Select the *Commands* tab.
3. Select Menu bar (radio button).
4. Click the *Add Command* button.
5. Select *Debug* from the Categories list.
6. Select *Start Without Debugging* in the right-hand list box.
7. Click the OK button.
8. Click the Close button.

In fact, you can use the same sequence to customize any of the menus and toolbars in Visual Studio.

Set the Tab Size to 5

Start Visual Studio, and select **Options** from the **Tools** menu. Select **Text Editor**, Select **All Languages**, and select **Tabs**:



Set the Tab Size and Indent Size to 5.

Building a Sample Assembly Language Program

Now you're ready to open and build your first project.

Opening a Project

Visual Studio and Visual Studio Express require assembly language source files to belong to a *project*, which is a kind of container. A project holds configuration information such as the locations of the assembler, linker, and required libraries. A project has its own folder, and it holds the names and locations of all files belonging to it. We have created a sample project folder in the *c:\Irvine\cxamples\ch03* directory, and its name is *Project*.

Do the following steps, in order:

1. Start Visual Studio.
2. First you will open an existing Visual Studio project file. If you're using Visual Studio, select **Open Project** from the File menu. Or, if you're using Visual Studio Express, select **Open**, and select **Project/Solution.**
3. Navigate to the **c:\Irvine\Examples\ch03** folder and open the file named **Project.sln**.
4. In the *Solution Explorer* window, you will see the word Project. This is the name of a Visual Studio project.
5. Next, you need to add a source code file named *main.asm* to the project. To do that, right-click on **Project**, select **Add**, select **Existing Item**, select **main.asm**, and click the **Add** button to close the dialog window. (You can use this sequence of commands in the future to add any asm file into a project.)
6. Next, you will open the main.asm file for editing. Double-click the file named **main.asm** to open it in the editing window. (Visual Studio users may see a popup dialog asking for the encoding method used in the asm file. just click the OK button to continue.)

Tip: If the *Solution Explorer* window is not visible, select *Solution Explorer* from the *View* menu. Also, if you do not see *main.asm* in the Solution Explorer window, it might be hidden behind another window. To bring it to the front, click the *Solution Explorer* tab from the tabs shown along the bottom of the window.

You should see the following program in the editor window:

```
TITLE MASM Template                          (main.asm)

; Description:
;
; Revision date:

INCLUDE Irvine32.inc

.data
myMessage BYTE "MASM program example",0dh,0ah,0

.code
main PROC
    call Clrscr

    mov  edx,OFFSET myMessage
    call WriteString

    exit
main ENDP

END main
```

Later, we'll show you how to copy this program and use it as a starting point to write your own programs.

Build the Program

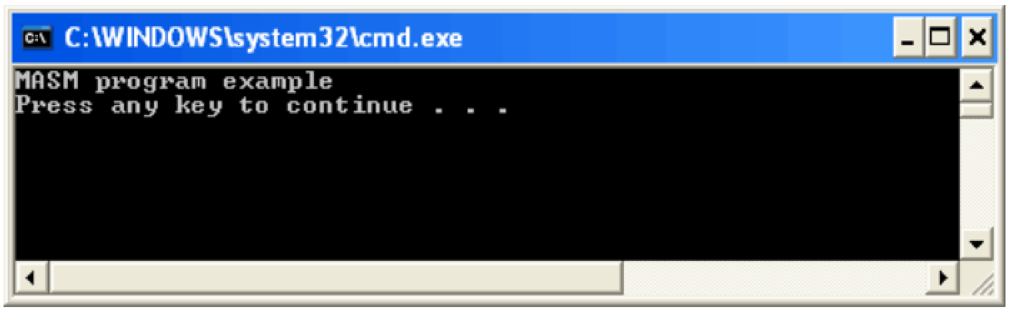
Next, you will build (assemble and link) the sample program. Select **Build Project** from the Build menu. In the Output window for Visual Studio at the bottom of the screen, you should see messages similar to the following, indicating the build progress:

```
1>------ Build started: Project: Project, Configuration: Debug Win32 ------
1>Assembling...
1>Assembling: .\main.asm
1>Linking...
1>Embedding manifest...
1>Build log was saved at "file://g:\masm\Project_sample\Debug\BuildLog.htm"
1>Project - 0 error(s), 0 warning(s)
========== Build: 1 succeeded, 0 failed, 0 up-to-date, 0 skipped ==========
```

If you do not see these messages, the project has probably not been modified since it was last built. No problem--just select **Rebuild Project** from the Build menu.

Run the Program

Select **Start without Debugging** from the Debug menu. The following console window should appear, although your window will be larger than the one shown here:



```
MASM program example
Press any key to continue . . .
```

The "Press any key to continue..." message is automatically generated by Visual Studio.

Congratulations, you have just run your first Assembly Language program.

Press any key to close the Console window.

When you assembled and linked the project, a file named **Project.exe** was created inside the project's \Debug folder. This is the file that executes when you run the project. You can execute Project.exe by double-clicking its name inside Windows Explorer, but it will just flash on the screen and disappear. That is because Windows Explorer does not pause the display before closing the command window.

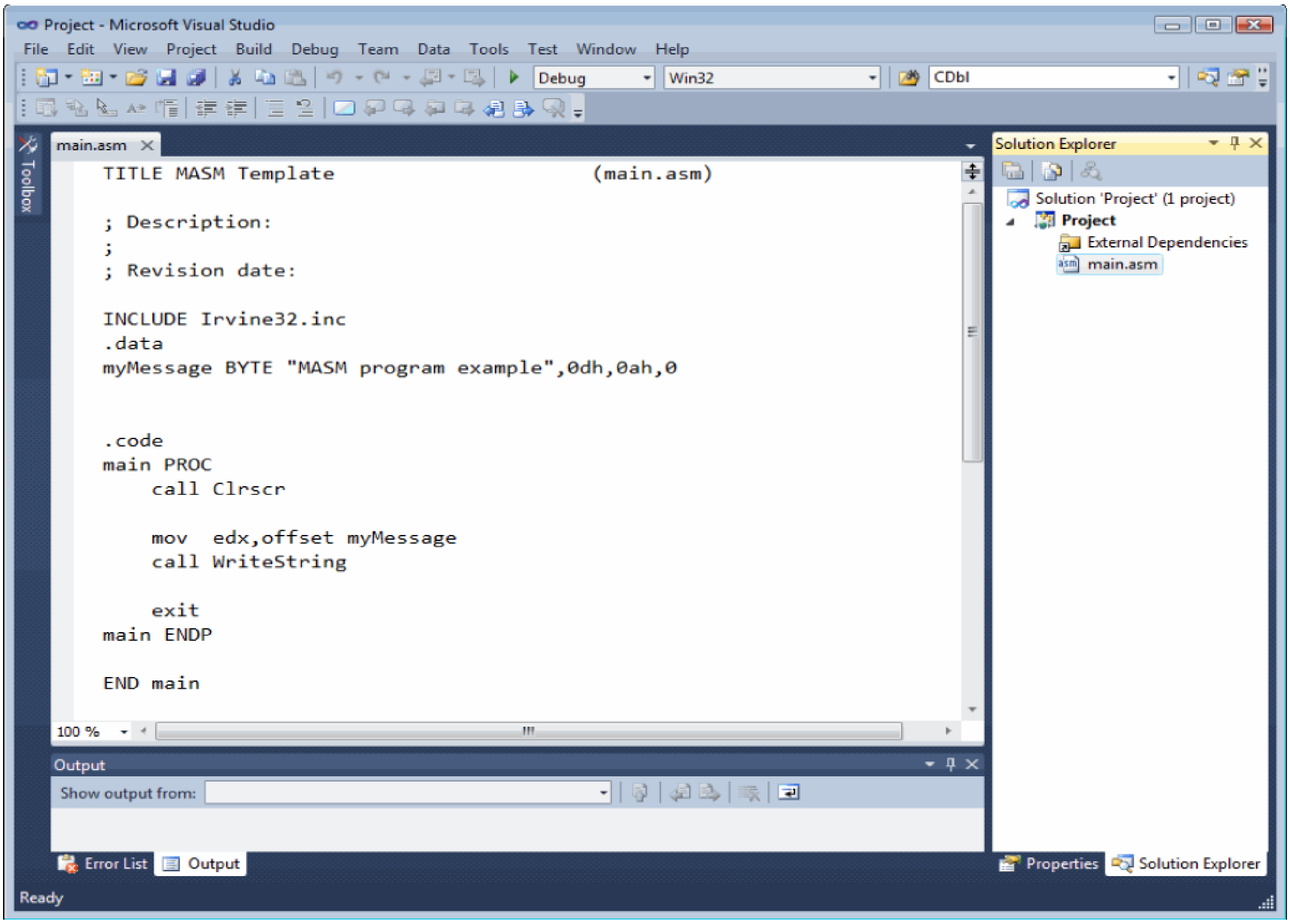
Creating New Projects of Your Own

Before long, you will want to create your own projects. The easiest way to do this is to copy the entire **c:\Irvine\Examples\Project_Sample** folder to a new location. Copy it to a folder in which you have read/write permissions. (If you're working in a college computer lab, a useful location is a portable USB drive. Then you can modify the program, build, and run it again.

Step 5: Running the Sample Program in Debug Mode

In this step, you will set a breakpoint inside the sample program. Then you will use the Visual C++ debugger to step through the program's execution one statement at a time.

1. Make sure the ASM source code file is open in the editor window.
2. To begin stepping through your program in Debug mode, press the F10 key.
3. A yellow arrow will appear next to the first program statement (*call Clrscr*).The arrow indicates that the statement is next to be executed.
4. Press the F10 key (called *Step Over*) to execute the current statement. Continue pressing F10 until the program is about to execute the **exit** statement.
5. A small black window icon should appear on your Windows status bar. Open it and look at the contents of the Command window. You should see the words "MASM program example" in the window.
6. Press F10 one more time to end the program.



```
TITLE MASM Template                    (main.asm)

; Description:
;
; Revision date:

INCLUDE Irvine32.inc
.data
myMessage BYTE "MASM program example",0dh,0ah,0


.code
main PROC
    call Clrscr

    mov  edx,offset myMessage
    call WriteString

    exit
main ENDP

END main
```

Registers

If you want to display the CPU registers, do the following: Start debugging the program, then select *Windows* from the *Debug* menu. Select *Registers* from the drop-down list. The bottom window will display the register contents. Right click this window and check the item *Flags* to enable the display of conditional flags.

You can interrupt a debugging session at any time by selecting *Stop Debugging* from the Debug menu. You can do the same by clicking the blue square button on the toolbar. To remove a breakpoint from the program, click on the red dot so that it disappears.

Setting a BreakPoint

If you set a breakpoint in a program, you can use the debugger to execute the program a full speed (more or less) until it reaches the breakpoint. At that point, the debugger drops into single-step mode.

1. Click the mouse along the border to the left of the call WriteString statement. A large red dot should appear in the margin.
2. Select Start Debugging from the Debug menu. The program should run, and pause on the line with the breakpoint, showing the same Yellow arrow as before.
3. Press F10 until the program finishes.

You can remove a breakpoint by clicking its red dot with the mouse. Take a few minutes to experiment with the Debug menu commands. Set more breakpoints and run the program again. For the time being, you can use the F11 key to step through the program in the same way the F10 key did.

Building and Running Other Programs

Suppose you want to run another example program, or possibly create your own program. You can either edit and modify main.asm, or you can remove main.asm from the project and insert some other .asm file into the project.

- To remove a program from a project without deleting the file, right-click its name in the *Solution Explorer window*. In the context menu, select **Exclude from Project**. If you change your mind and decide to add it back to the project, right-click in the same window, select **Add**, select **Existing item,** and select the file you want to add.
- To remove a program from a project and delete the source code file, select the file with the mouse and press the **Del** key. Or, you can right-click the file name and select **Remove.**

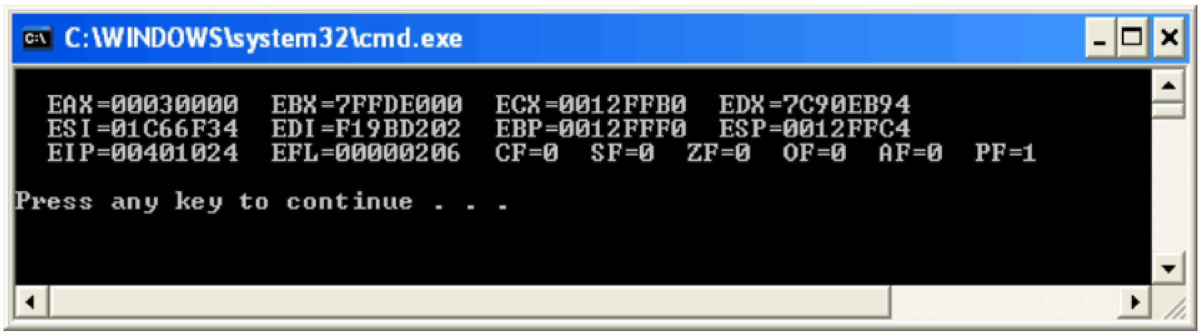
Adding a File to a Project

The easiest way to add an assembly language source file to an open project is to drag its filename with the mouse from a Windows Explorer window onto the name of your project in the Solution Explorer window. A reference to the file (not a copy) will be inserted in your project's directory. Try this now:

1. Remove the main.asm file from your project.

2. Add a reference to the file c:\Irvine\Examples\ch03\AddSub.asm to the project.
3. Build and run the project.

Here is what you should see in the Console window, except that only your EAX register will have the same value as ours:



```
  EAX=00030000  EBX=7FFDE000  ECX=0012FFB0  EDX=7C90EB94
  ESI=01C66F34  EDI=F19BD202  EBP=0012FFF0  ESP=0012FFC4
  EIP=00401024  EFL=00000206  CF=0  SF=0  ZF=0  OF=0  AF=0  PF=1

Press any key to continue . . .
```

When you press a key, the console window will close.

Copying a source file

If you want to make a copy of an existing file, use Windows Explorer to copy the file into your project directory.

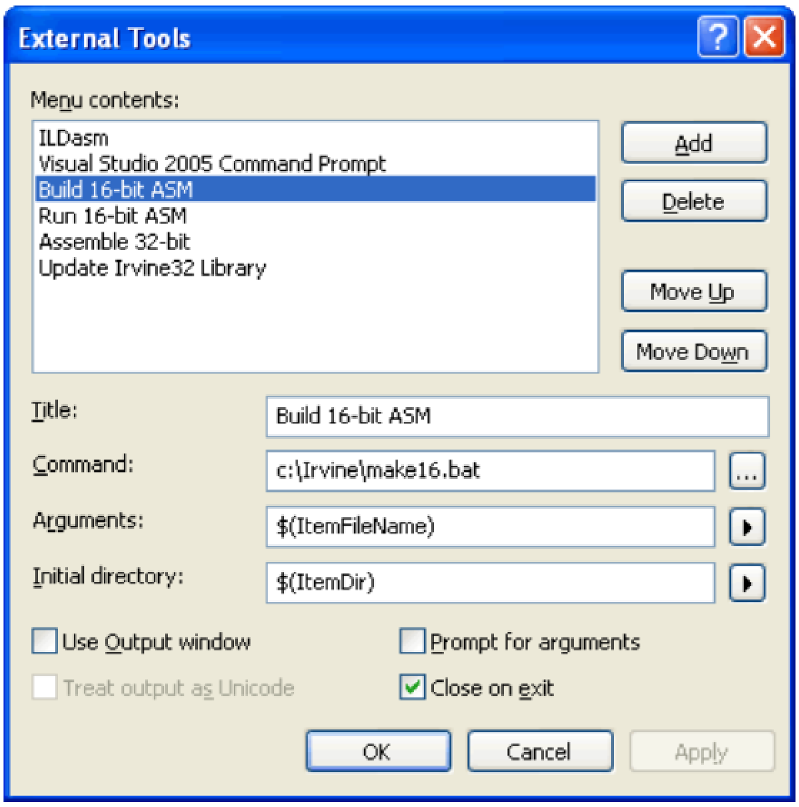
Then, right-click the project name in Solution Explorer, select Add, select Existing Item, and select the filename.

Return to top or read about Project Properties settings.

Building 16-bit Applications (Chapters 14-17)

Only Chapters 14 through 17 require you to build 16-bit applications. Except for a few exceptions, which are noted in the book, your 16-bit applications will run under the 32-bit versions of Windows (XP, Vista, 7). But 16-bit applications will not run directly in any 64-bit version of Windows.

If you plan to build 16-bit applications, you need to add two new commands to the Tools menu in Visual C++ Express (or Visual Studio). To add a command, select **External Tools** from the Tools menu. The following dialog will appear, although many of the items in your list on the left side will be missing:


External Tools

Menu contents:

- ILDasm
- Visual Studio 2005 Command Prompt
- Build 16-bit ASM
- Run 16-bit ASM
- Assemble 32-bit
- Update Irvine32 Library

Title: Build 16-bit ASM

Command: c:\Irvine\make16.bat

Arguments: $(ItemFileName)

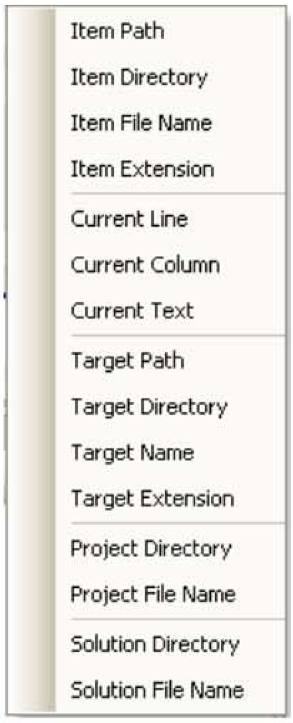
Initial directory: $(ItemDir)

☐ Use Output window ☐ Prompt for arguments

☐ Treat output as Unicode ✓ Close on exit

Step 1: Create the Build 16-bit ASM Command

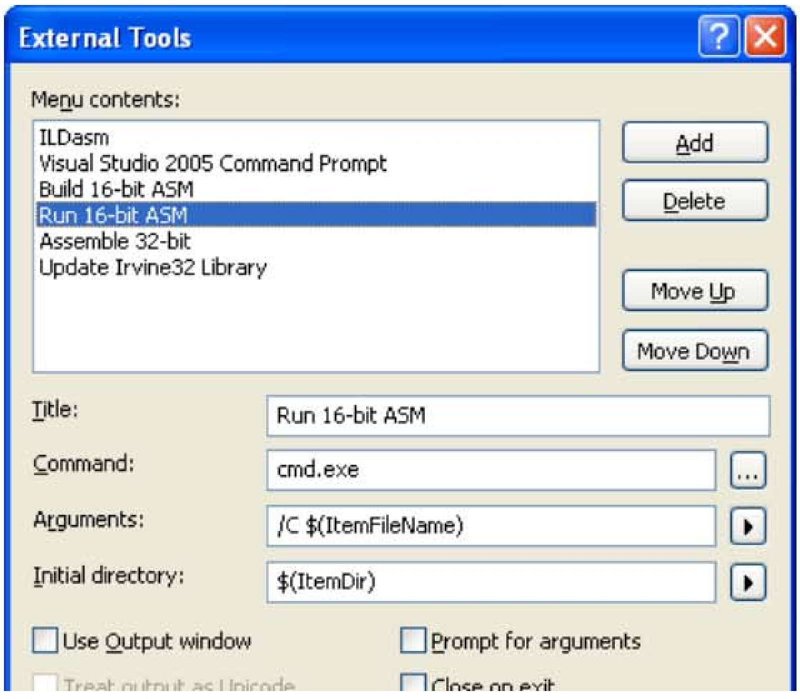
Click the **Add** button and fill in the Title, Command, Arguments, and Initial directory fields as shown in the screen snapshot. If you click the buttons with arrows on the right side of the Arguments and Initial directory fields, a convenient list appears. You can select an item without having to worry about spelling:



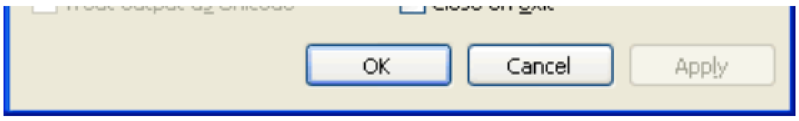
Click the **Apply** button to save the command.

Step 2: Create the Run 16-bit ASM Command

Click the Add button again, and create a new command named **Run 16-bit ASM**:



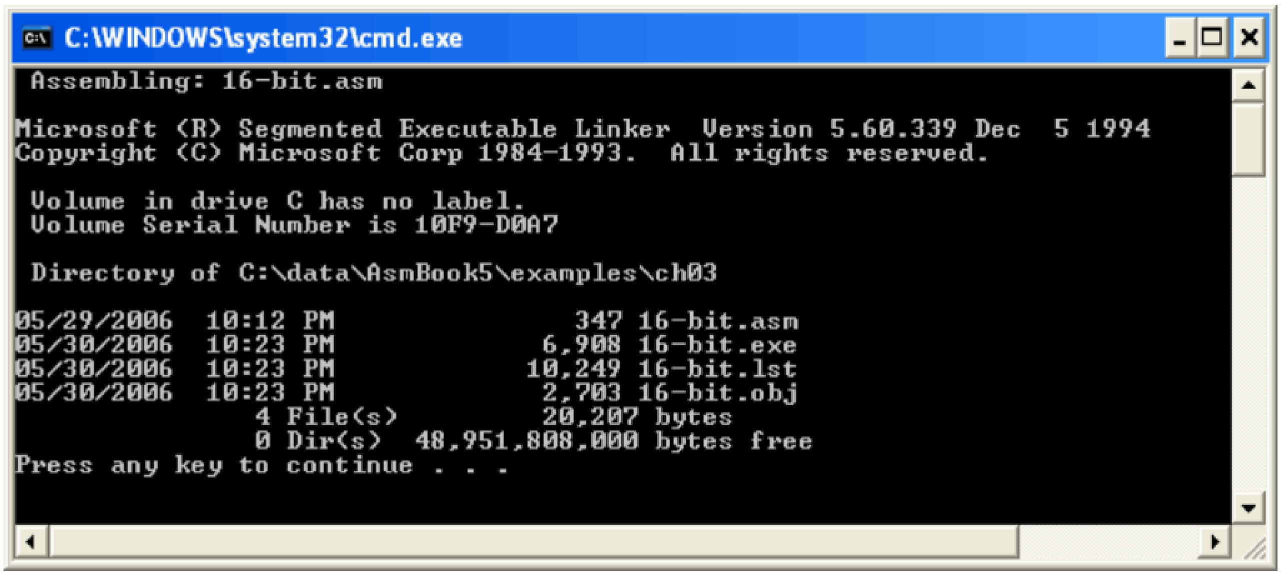
Title: Run 16-bit ASM
Command: cmd.exe
Arguments: /C $(ItemFileName)
Initial directory: $(ItemDir)
☐ Use Output window
☐ Prompt for arguments
☐ Treat output as Unicode
☐ Close on exit



Click the OK button to save the command and close the External Tools dialog.

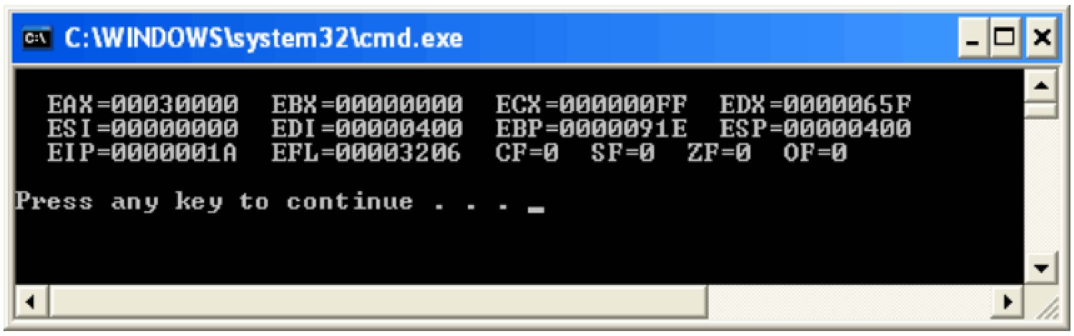
Testing Your new 16-Bit Commands

To test your new 16-bit commands, open the file named **16-bit.asm** from the ch03 folder in the book's example programs. Select **Build 16-bit ASM** from the Tools menu. The following command window should appear, showing the successful execution of the assembler and linker, followed by a listing of all files related to this program:



```
 Assembling: 16-bit.asm

Microsoft (R) Segmented Executable Linker  Version 5.60.339 Dec  5 1994
Copyright (C) Microsoft Corp 1984-1993.  All rights reserved.

 Volume in drive C has no label.
 Volume Serial Number is 10F9-D0A7

 Directory of C:\data\AsmBook5\examples\ch03

05/29/2006  10:12 PM                347 16-bit.asm
05/30/2006  10:23 PM              6,908 16-bit.exe
05/30/2006  10:23 PM             10,249 16-bit.lst
05/30/2006  10:23 PM              2,703 16-bit.obj
               4 File(s)         20,207 bytes
               0 Dir(s)  48,951,808,000 bytes free
Press any key to continue . . .
```

Press a key to close the window. Next, you will run the program. Select **Run 16-bit ASM** from the Tools menu. The following window will appear, although the contents of all registers except EAX will be different:



```
  EAX=00030000  EBX=00000000  ECX=000000FF  EDX=0000065F
  ESI=00000000  EDI=00000400  EBP=0000091E  ESP=00000400
  EIP=0000001A  EFL=00003206  CF=0  SF=0  ZF=0  OF=0

Press any key to continue . . . _
```

Press a key to close the window.

You have completed the setup for building and running 16-bit assembly language programs.

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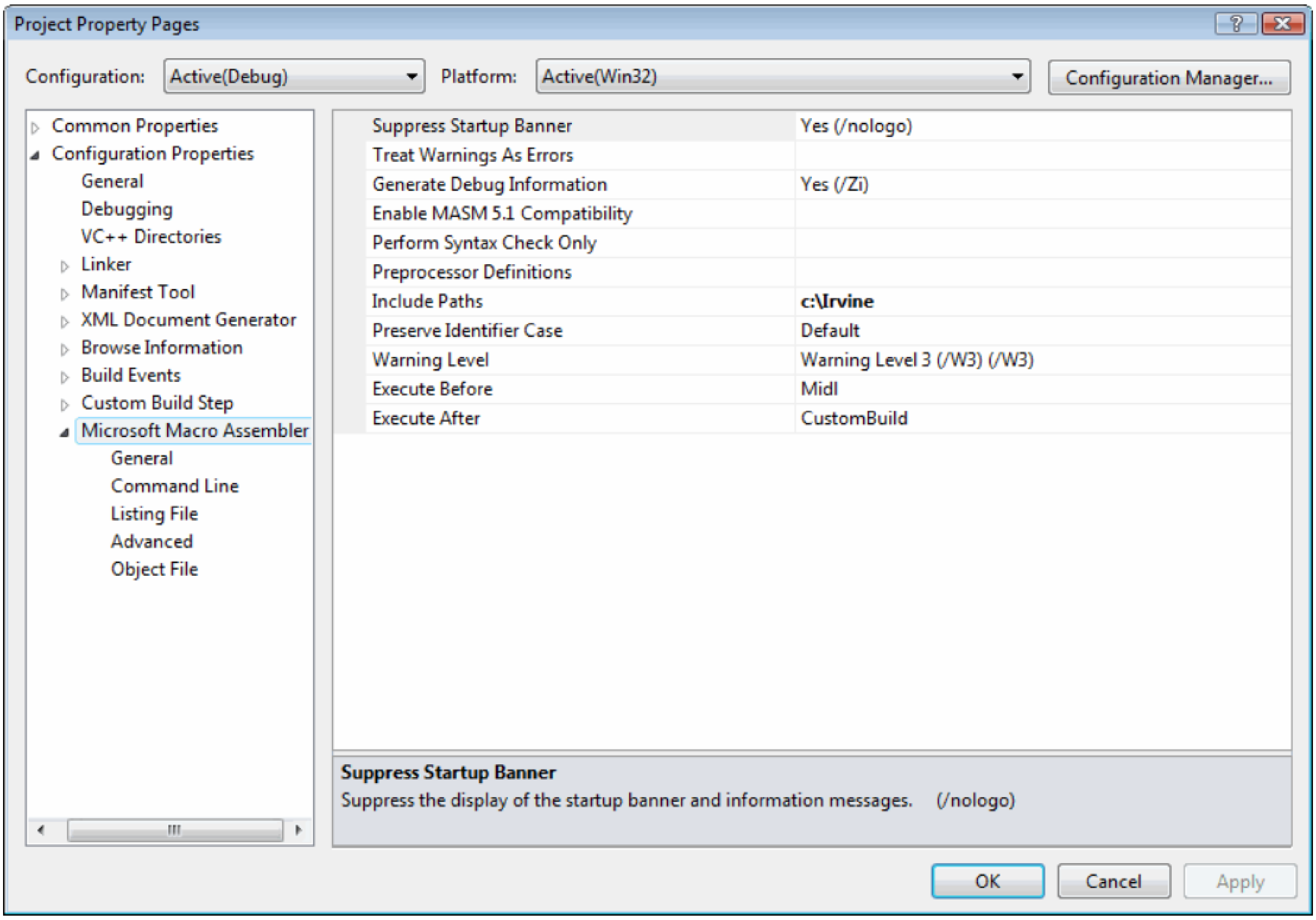
Project Properties Settings

You might be interested to know more about how Visual C++ projects are set up for assembly language programs.

Assuming that our sample project is still open, select **Project Properties** from the Project menu. Expand the entry under **Configuration Properties**. Then expand the entry named **Microsoft Macro Assembler**. This is what you should see:



Project Property Pages

Configuration: Active(Debug)   Platform: Active(Win32)   Configuration Manager...

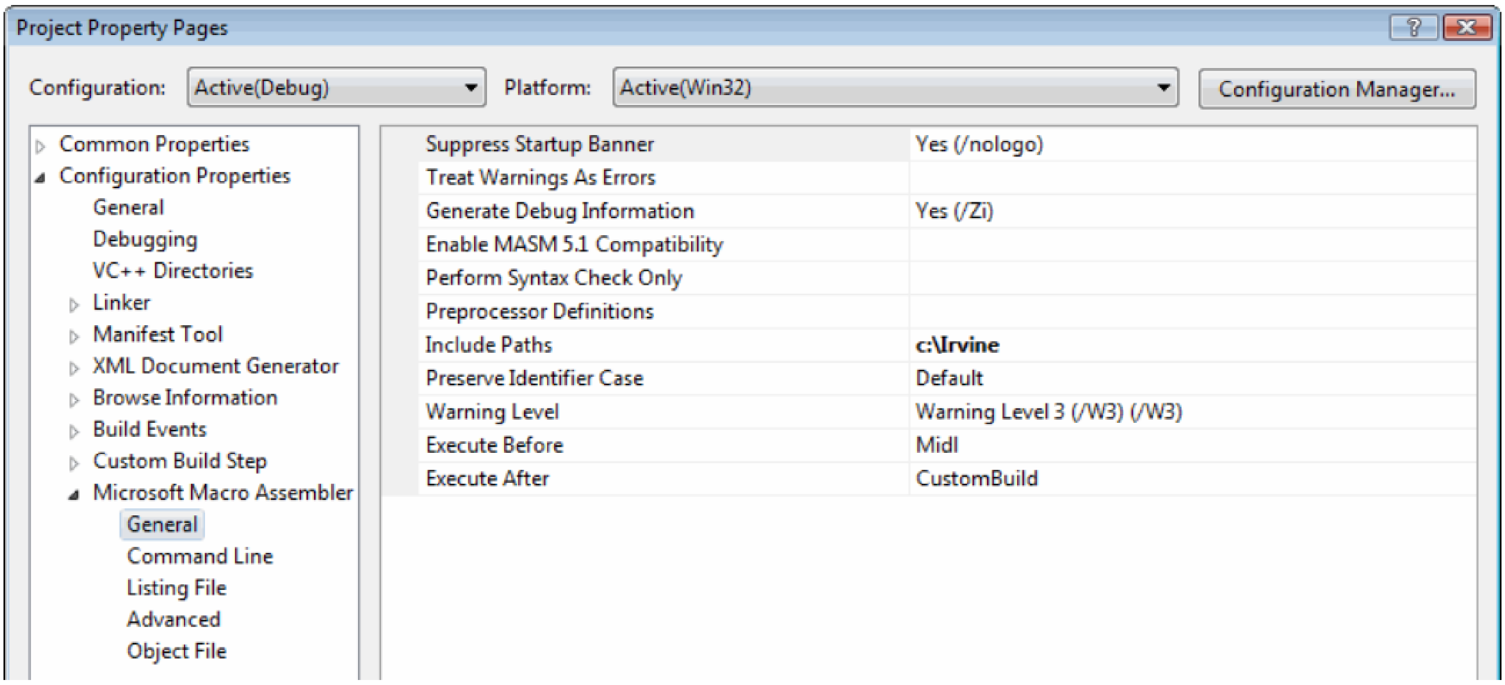
- Common Properties
- Configuration Properties
  - General
  - Debugging
  - VC++ Directories
  - Linker
  - Manifest Tool
  - XML Document Generator
  - Browse Information
  - Build Events
  - Custom Build Step
  - Microsoft Macro Assembler
    - General
    - Command Line
    - Listing File
    - Advanced
    - Object File

Suppress Startup Banner	Yes (/nologo)
Treat Warnings As Errors	
Generate Debug Information	Yes (/Zi)
Enable MASM 5.1 Compatibility	
Perform Syntax Check Only	
Preprocessor Definitions	
Include Paths	**c:\Irvine**
Preserve Identifier Case	Default
Warning Level	Warning Level 3 (/W3) (/W3)
Execute Before	Midl
Execute After	CustomBuild

Suppress Startup Banner
Suppress the display of the startup banner and information messages. (/nologo)

OK   Cancel   Apply

Click the entry named **General** under **Microsoft Macro Assembler** . Notice that the **Include Paths** option has been set to the c:\Irvine directory. This tells the assembler where to find files having a filename extension of ".inc". Here is a sample:

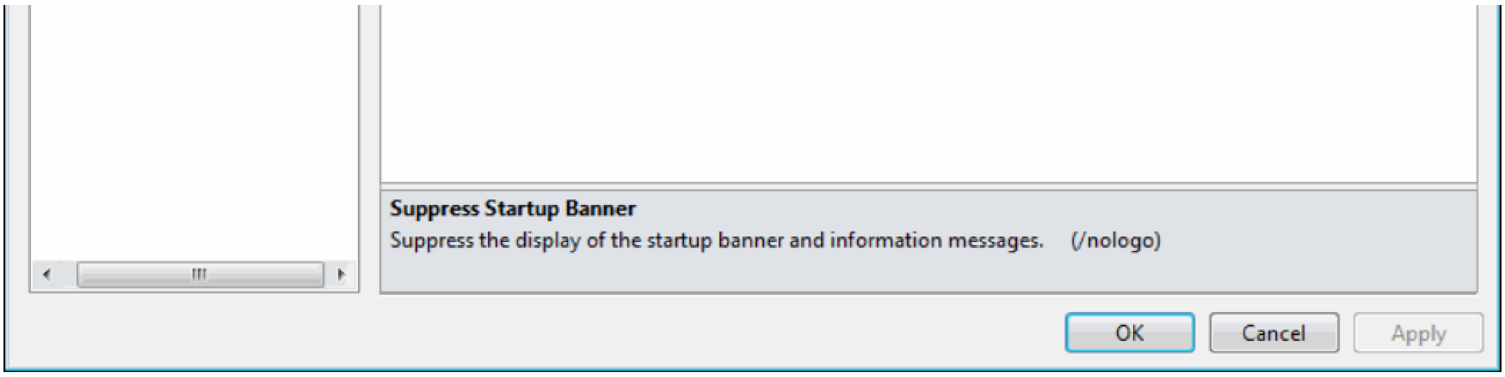


Project Property Pages

Configuration: Active(Debug)   Platform: Active(Win32)   Configuration Manager...

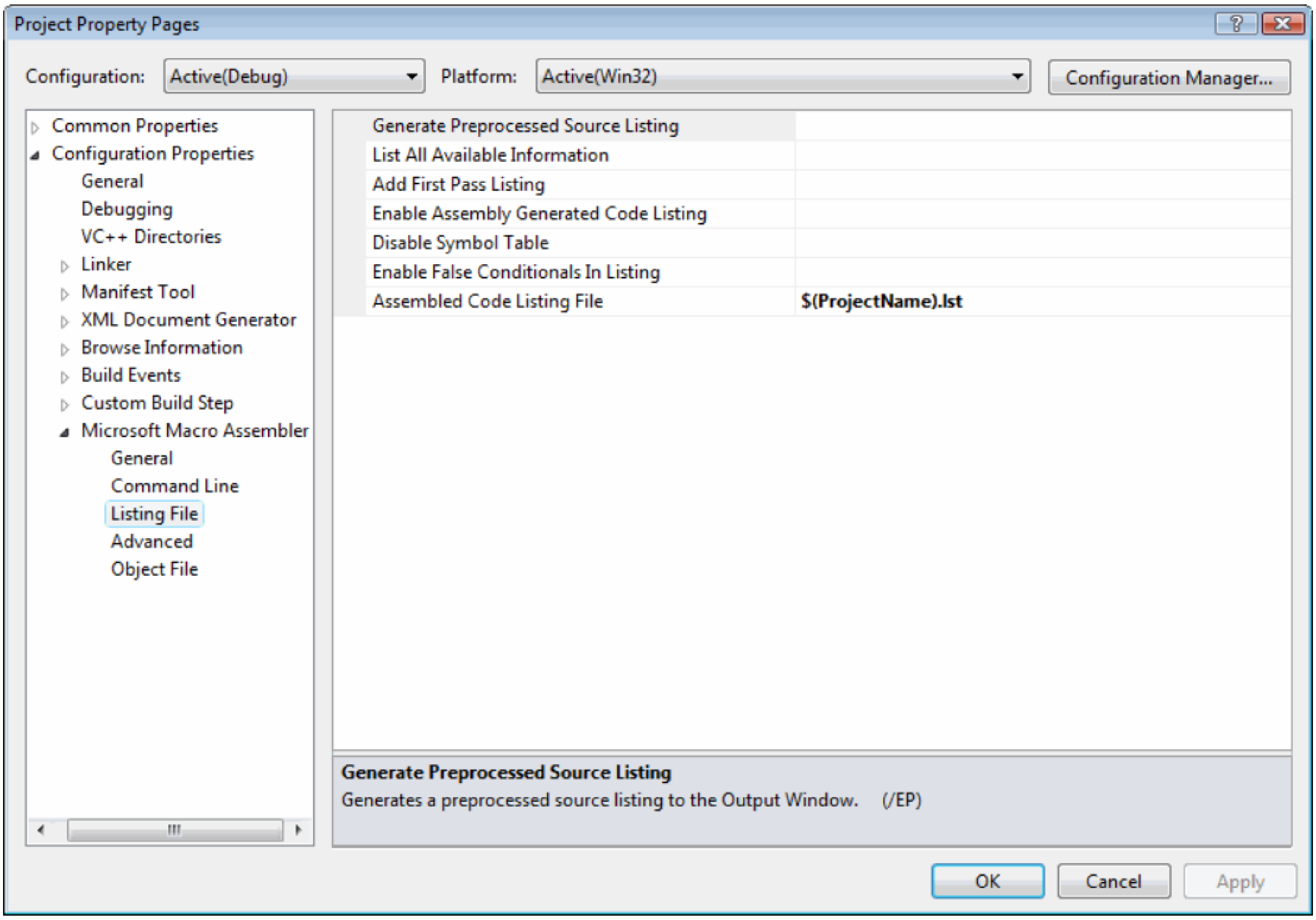
- Common Properties
- Configuration Properties
  - General
  - Debugging
  - VC++ Directories
  - Linker
  - Manifest Tool
  - XML Document Generator
  - Browse Information
  - Build Events
  - Custom Build Step
  - Microsoft Macro Assembler
    - General
    - Command Line
    - Listing File
    - Advanced
    - Object File

Suppress Startup Banner	Yes (/nologo)
Treat Warnings As Errors	
Generate Debug Information	Yes (/Zi)
Enable MASM 5.1 Compatibility	
Perform Syntax Check Only	
Preprocessor Definitions	
Include Paths	**c:\Irvine**
Preserve Identifier Case	Default
Warning Level	Warning Level 3 (/W3) (/W3)
Execute Before	Midl
Execute After	CustomBuild



Suppress Startup Banner
Suppress the display of the startup banner and information messages. (/nologo)

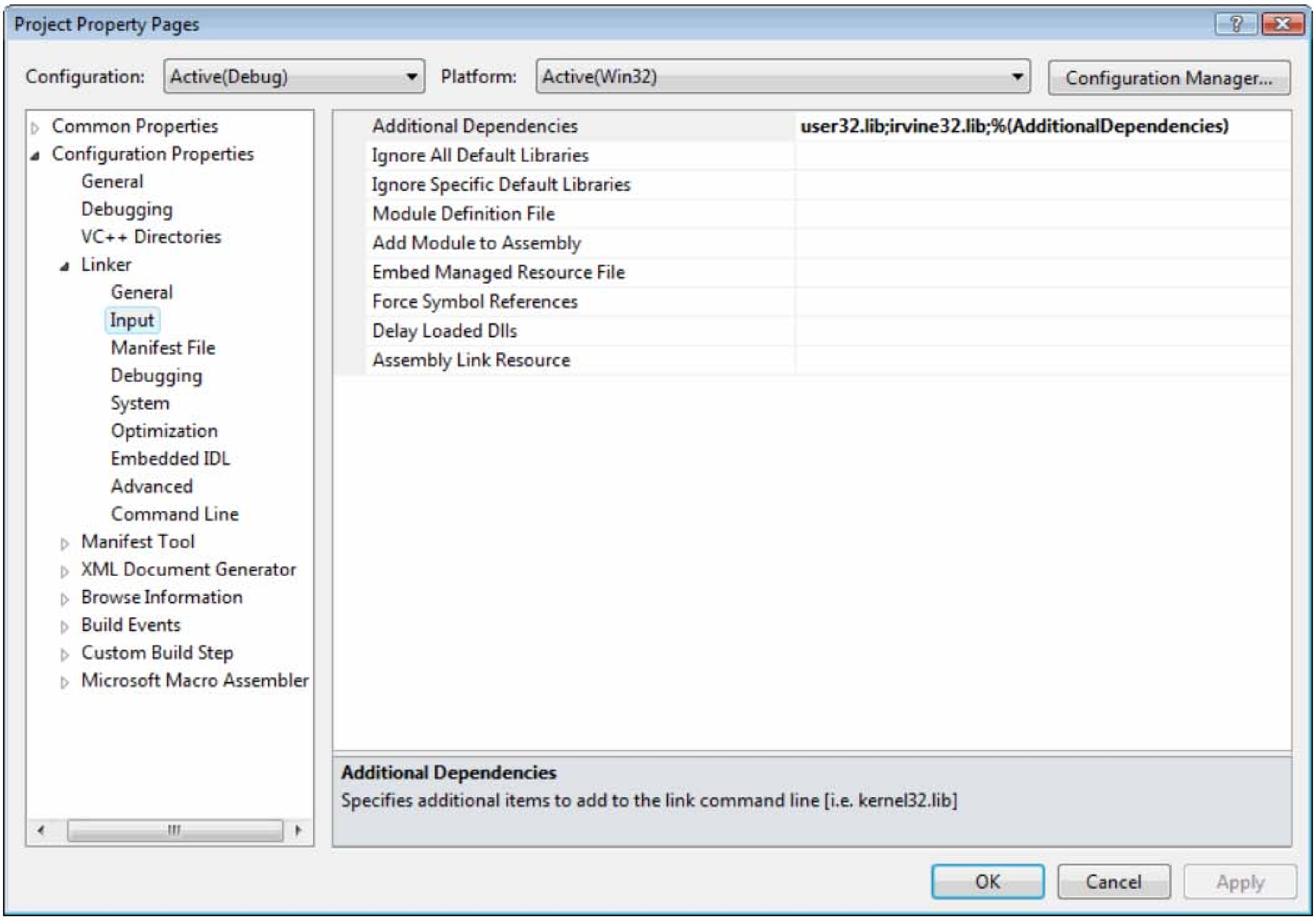
Next, select the **Listing File** entry, also in the Microsoft Macro Assembler group. Notice that the Assembled Code Listing File entry (shown below) has been assigned a macro name (starting with $) that identifies the name of the source input file, with a file extension of .lst. So, if your program were named main.asm, the listing file would be named main.lst:



Generate Preprocessed Source Listing	
List All Available Information	
Add First Pass Listing	
Enable Assembly Generated Code Listing	
Disable Symbol Table	
Enable False Conditionals In Listing	
Assembled Code Listing File	**$(ProjectName).lst**

Generate Preprocessed Source Listing
Generates a preprocessed source listing to the Output Window. (/EP)

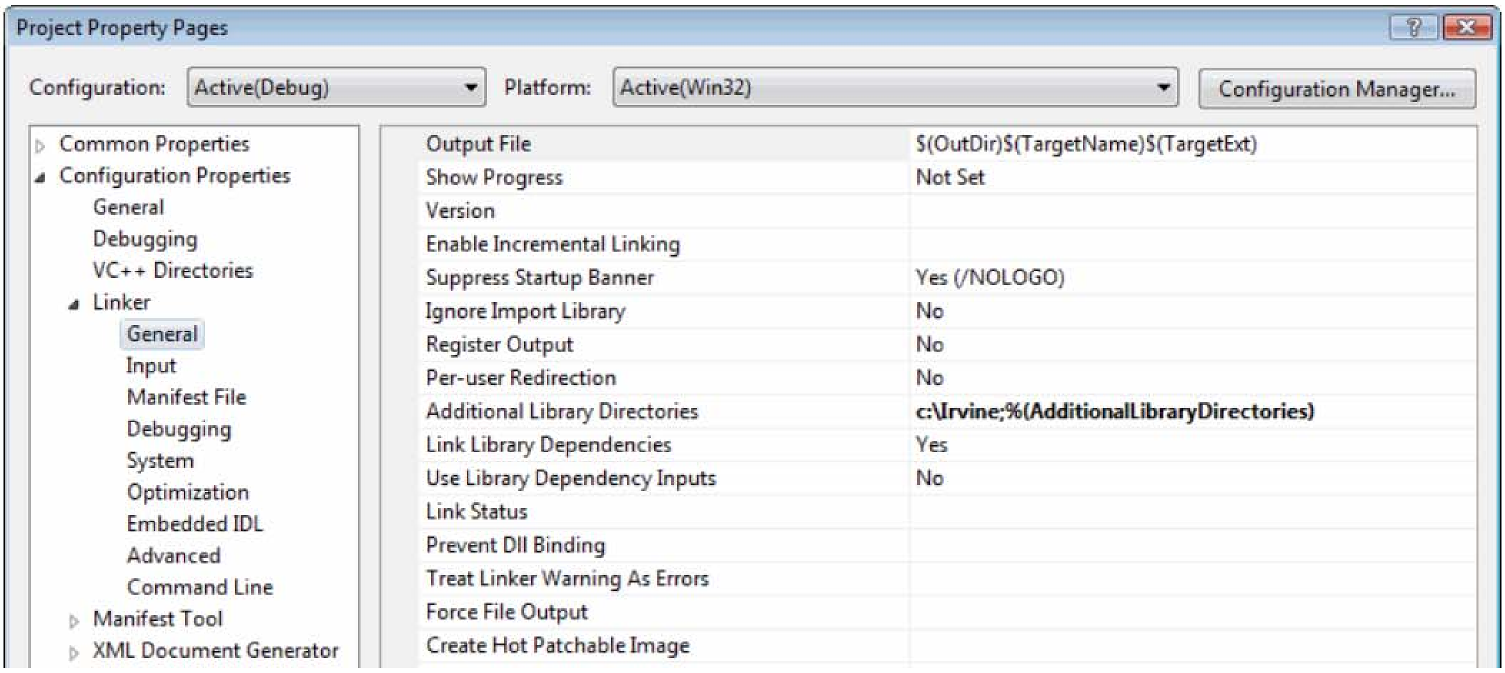
Find the Linker entry under **Configuration Properties**. Select the **Input** entry, and notice that two filenames have been added to the **Additional Dependencies** entry. The **user32.lib** file is a standard MS-Windows file. The **irvine32.lib** file is the link library file supplied with this book. There must be at least one space separating the file names:



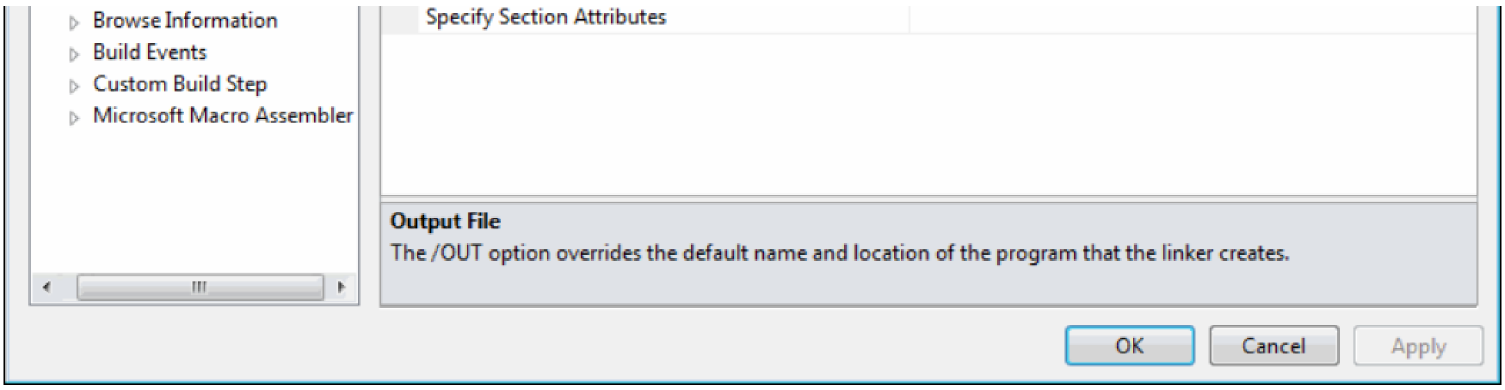
Additional Dependencies	user32.lib;irvine32.lib;%(AdditionalDependencies)
Ignore All Default Libraries	
Ignore Specific Default Libraries	
Module Definition File	
Add Module to Assembly	
Embed Managed Resource File	
Force Symbol References	
Delay Loaded Dlls	
Assembly Link Resource	

Additional Dependencies
Specifies additional items to add to the link command line [i.e. kernel32.lib]

Next, select **Linker** under Configuration Properties, and then select **General**. The **Additional Library Directories** option equals **c:\Irvine**, so the linker can find the Irvine32.lib library file:



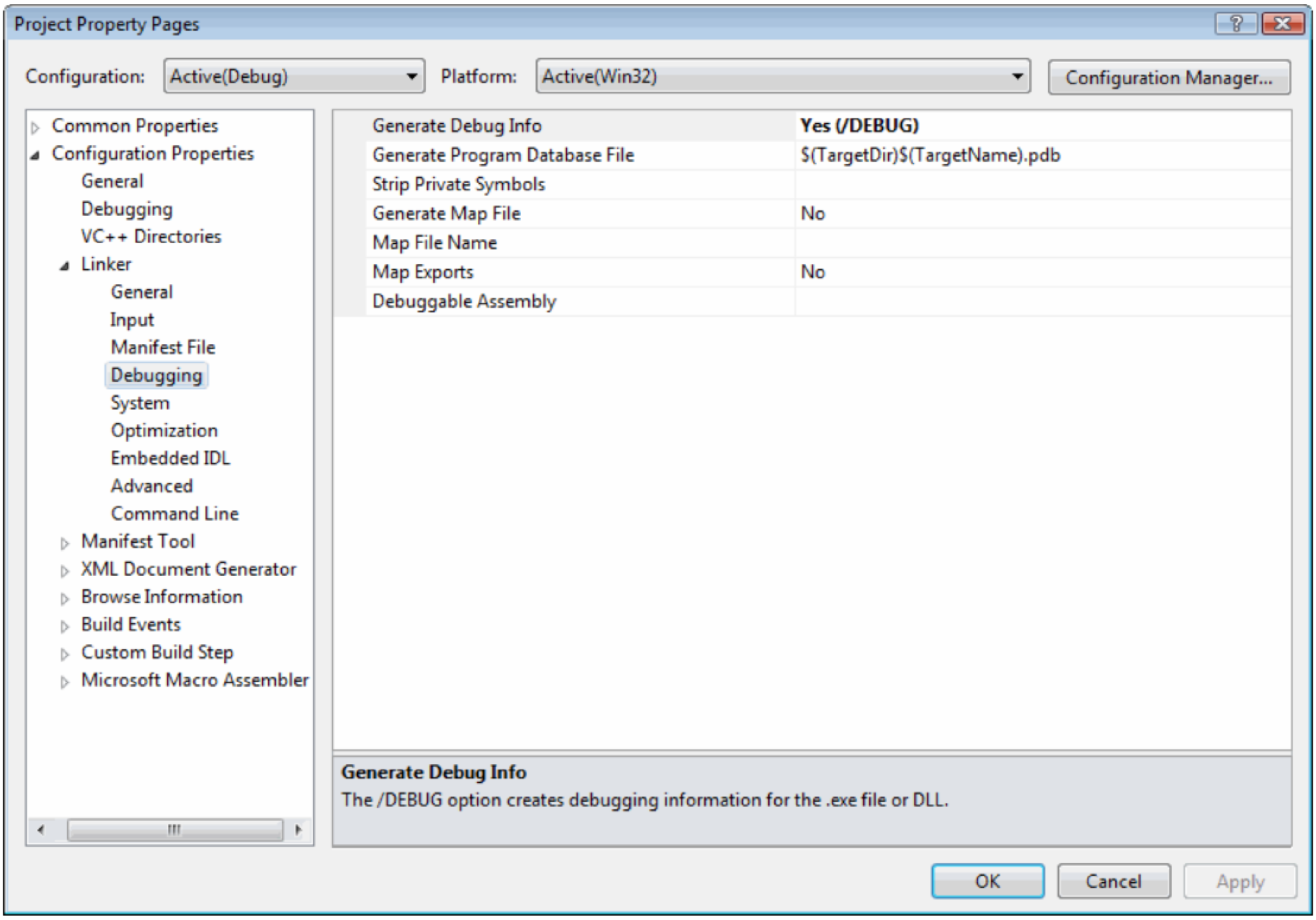
Output File	$(OutDir)$(TargetName)$(TargetExt)
Show Progress	Not Set
Version	
Enable Incremental Linking	
Suppress Startup Banner	Yes (/NOLOGO)
Ignore Import Library	No
Register Output	No
Per-user Redirection	No
Additional Library Directories	c:\Irvine;%(AdditionalLibraryDirectories)
Link Library Dependencies	Yes
Use Library Dependency Inputs	No
Link Status	
Prevent Dll Binding	
Treat Linker Warning As Errors	
Force File Output	
Create Hot Patchable Image	



Output File

The /OUT option overrides the default name and location of the program that the linker creates.

Select **Linker** under the **Configuration Properties** and select **Debugging**. Notice that the **Generate Debug Info** option is set to **Yes**:



Configuration: Active(Debug)

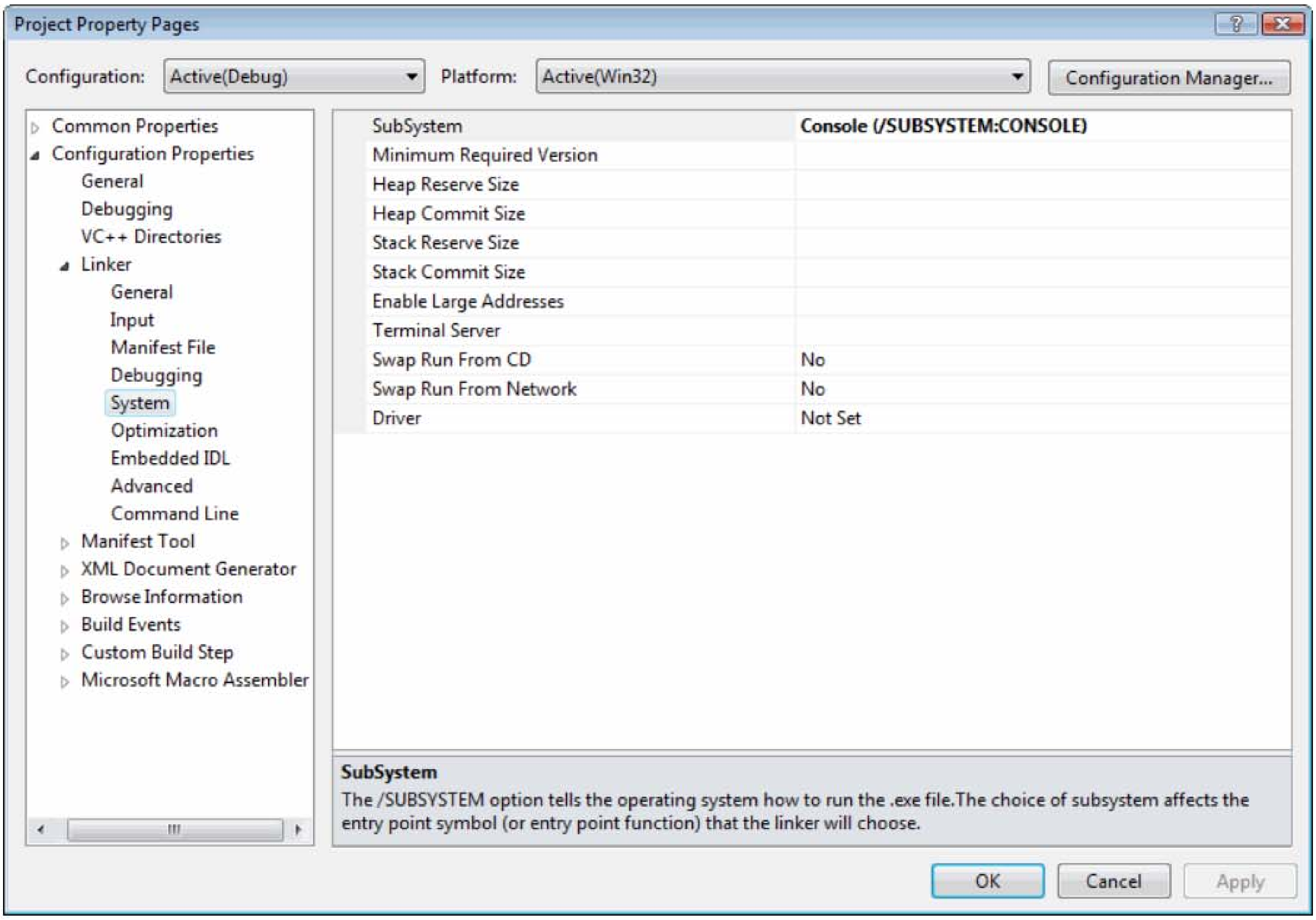
Platform: Active(Win32)

Generate Debug Info	**Yes (/DEBUG)**
Generate Program Database File	$(TargetDir)$(TargetName).pdb
Strip Private Symbols	
Generate Map File	No
Map File Name	
Map Exports	No
Debuggable Assembly	

Generate Debug Info

The /DEBUG option creates debugging information for the .exe file or DLL.

Select **System** under the **Linker** entry. Notice that the SubSystem option has been set to **Console**:



SubSystem	**Console (/SUBSYSTEM:CONSOLE)**
Minimum Required Version	
Heap Reserve Size	
Heap Commit Size	
Stack Reserve Size	
Stack Commit Size	
Enable Large Addresses	
Terminal Server	
Swap Run From CD	No
Swap Run From Network	No
Driver	Not Set

SubSystem
The /SUBSYSTEM option tells the operating system how to run the .exe file.The choice of subsystem affects the entry point symbol (or entry point function) that the linker will choose.

We use the Console setting because it is easy for assembly language programs to write output to a text console (Command) window. This is the window you see when running cmd.exe from the Start > Run menu in Windows.

Click the OK button to close the Project Property Pages window.

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Generating a Source Listing File

Open the project. From the menu, select **Project**, select **Project Properties**. In the list box, select **Microsoft Macro Assembler**, then select **Listing File**. Set the **Assembled Code Listing file** option to **$(InputName).lst**.

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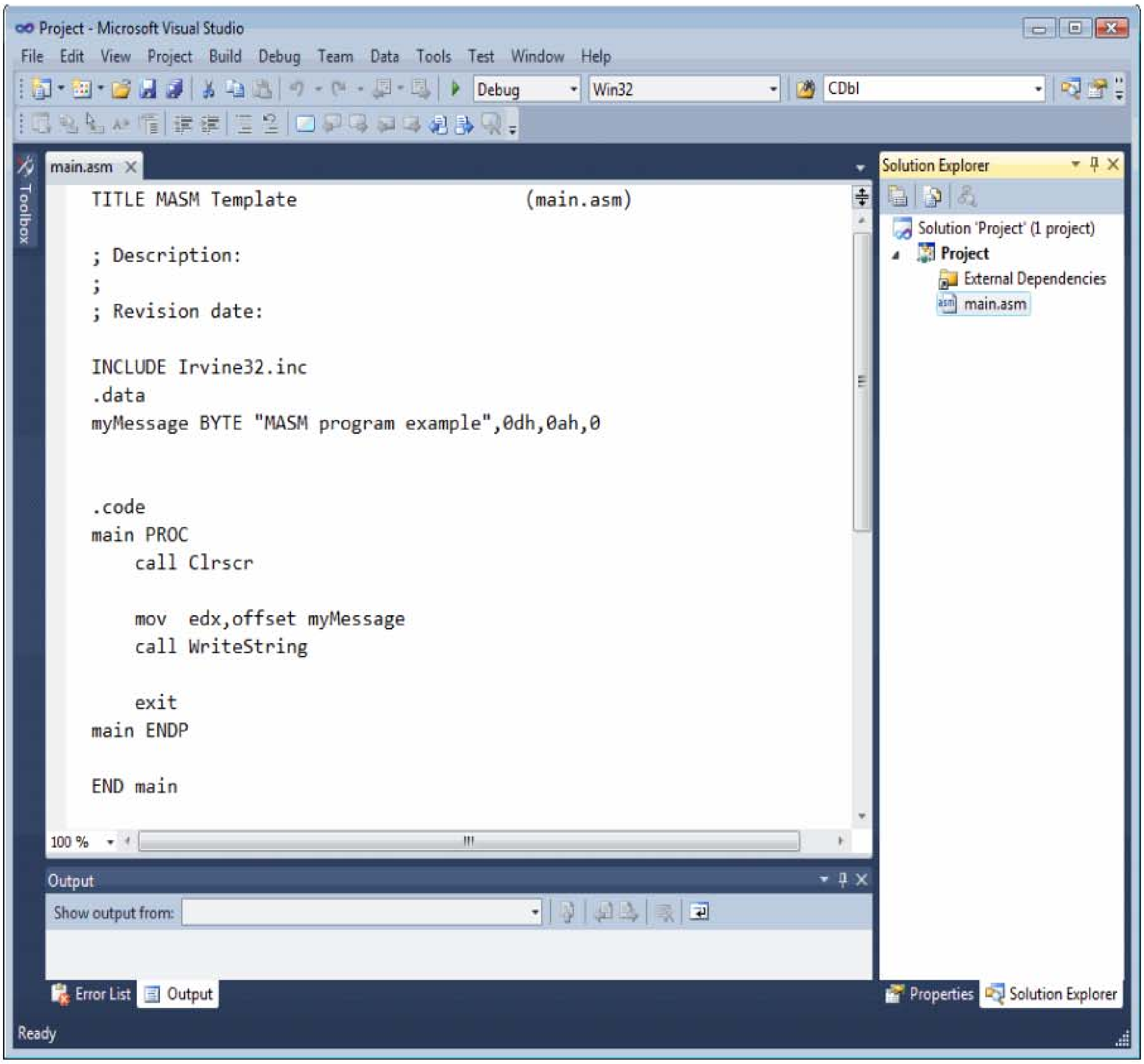
MASM syntax highlighting

When a text editor uses syntax highlighting, language keywords, strings, and other elements appear in different colors. Visual Studio and Visual C++ Express can highlight MASM reserved words and strings, as shown in the following example:



```
TITLE MASM Template                    (main.asm)

; Description:
;
; Revision date:

INCLUDE Irvine32.inc
.data
myMessage BYTE "MASM program example",0dh,0ah,0


.code
main PROC
    call Clrscr

    mov  edx,offset myMessage
    call WriteString

    exit
main ENDP

END main
```

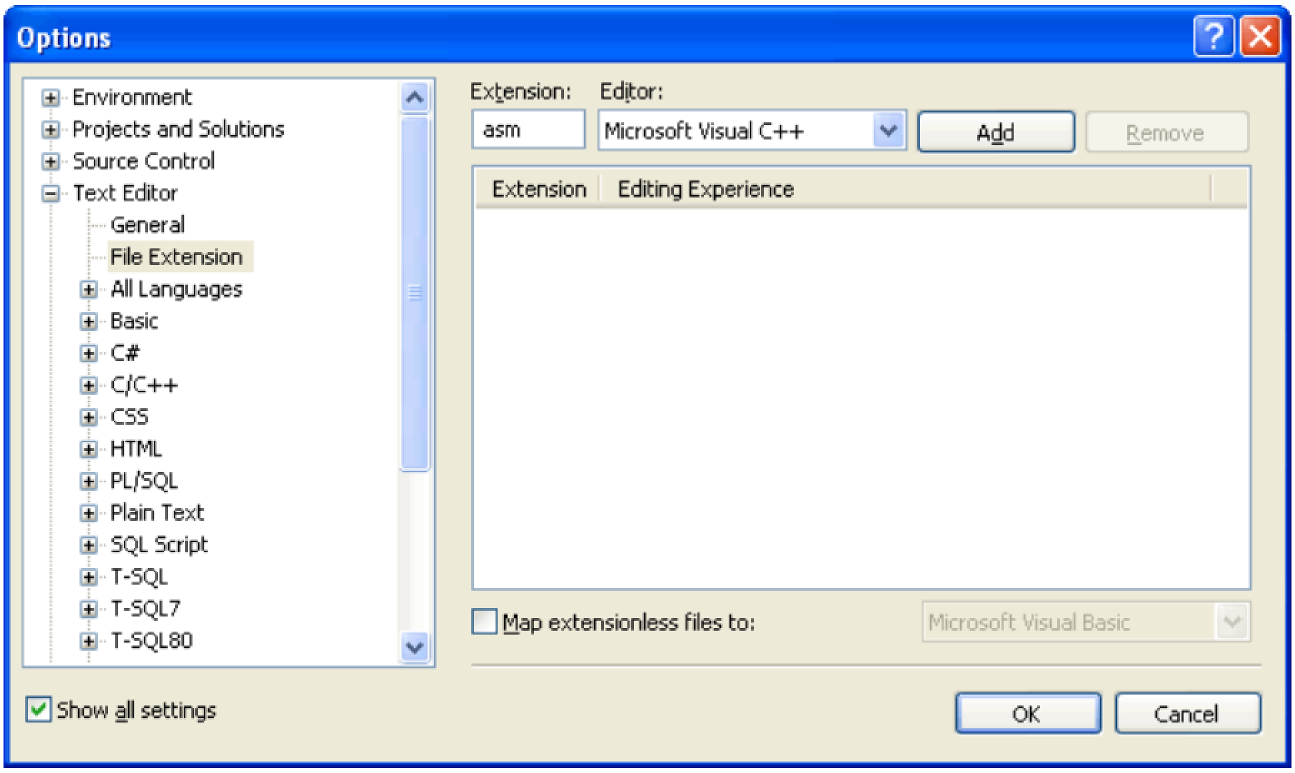
This won't happen automatically, but you can create a syntax definition file named Usertype.dat that contains MASM keywords. Then when Visual Studio (or Visual C++ Express) starts, it reads the syntax file and highlights MASM keywords.

Here are the required steps to set up MASM syntax highlighting in Visual Studio or Visual C++ Express:

1) Download the Usertype.dat file (enclosed in a ZIP file) given here to a folder in which you have read/write permissions. If you are using Windows Vista, download to My Documents, or C:\temp, or any folder that doesn't have security restrictions.

2) Copy Usertype.dat to the C:\Program Files\Microsoft Visual Studio xx.x\Common7\IDE folder. If you are using Windows Vista, it will display a verification window before copying the file. ("xx" may be 9.x or 10.x)

3) Open Visual Studio or Visual C++ Express, select **Options** from the Tools menu, select **Text Editor**, and select **File Extension**. On the right side of the dialog (shown below), enter **asm** as the extension, select **Microsoft Visual C++** from the Editor list, and click the **Add** button. Click the **OK** button to save your changes.



Extension: asm
Editor: Microsoft Visual C++

Close Visual Studio and restart it. Open your project and display an ASM file. You should see syntax highlighting in the editor.

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Assembling, Linking, and Debugging with a Batch File

Many people like to use a *Windows batch file* to assemble and link programs. A batch file is a text file containing a sequence of commands that execute as if they had been typed at the command prompt. In fact, they are powerful enough to contain variables, loops, IF statements, and so on.

The easiest way to run a batch file is to first open a Command window and then type the name of the batch file (along with arguments) at the command prompt. To open a Command window, you must execute a program named **cmd.exe**. We will make that easy for you.

Step 1: Download a ZIP file containing the following items:

- **A shortcut to cmd.exe**, which opens a Command window in the current directory
- **asm32.bat**, a batch file for assembling and linking programs
- **main.asm**, a sample assembly language program

Step 2: Extract the ZIP file into the c:\Irvine\Examples directory on your computer.

Step 3: Do the following:

- Copy asm32.bat to any directory on your system path. By doing this, you make it possible for MS-Windows to recognize **asm32** as a valid command when typed at the MS-Windows command prompt.(If you want to find out which directories are on the current system path, type **path** and press Enter at the system command prompt.)
- Double-click the shortcut to **cmd.exe**. A Command window should appear.
- At the command prompt in this window, type **asm32** and press Enter. This will execute the asm32 batch file

and display help information.

```
This file assembles, links, and debugs a single assembly language
source file. Before using it, install Visual Studio 2010 in the following
directory:

    C:\Program Files\Microsoft Visual Studio 10.0


Next, install the Irvine 6th edition link libraires and include
files in the following directory: C:\Irvine


Finally, copy this batch file to a location on your system path.
We recommend the following directory:


C:\Program Files\Microsoft Visual Studio 10.0\VC\bin


Command-line syntax:

  asm32 [/H | /h | -H | -h] -- display this help information


  asm32 filelist -- assemble and link all files
  asm32 /D filelist -- assemble, link, and debug
  asm32 /C filelist -- assemble only

<filelist> is a list of up to 5 filenames (without extensions),
separated by spaces. The filenames are assumed to refer to files
having .asm extensions. Command-line switches are case-sensitive.
```

Type the following command to assemble and link a source file named **main.asm**:

```
    asm32 main
```

You should see the following messages:

```
  Assembling: main.asm

 The file main.obj was produced.
 ..................................

 Linking main.obj to the Irvine32, Kernel32, and User32 libraries.

 The file main.exe was produced.
 ..................................
```

In fact, several files were produced.

- main.obj - the object file
- main.ilk - incremental link status file
- main.pdb - debug symbol file

You might get a linker error saying that it cannot find Kernel32.lib. This file is normally installed as part of the Windows SDK, but you can get a copy here. Copy this file into your c:\Irvine folder.

If there were syntax errors in your program, you would see error messages generated by the assembler. Here is an example:

```
 Assembling: main.asm
main.asm(9) : error A2008: syntax error : myMessage
main.asm(15) : error A2006: undefined symbol : myMessage
```

You would then open the main.asm file with a text editor (such as Notepad), fix the errors, and run the asm32 batch file again.

Although we used a file named main.asm in this example, the asm32.bat batch file will work for any assembly language file, regardless of the name. The only requirement is that your assembly language source file have a **.asm** filename extension.

Assembling Programs in Other Directories

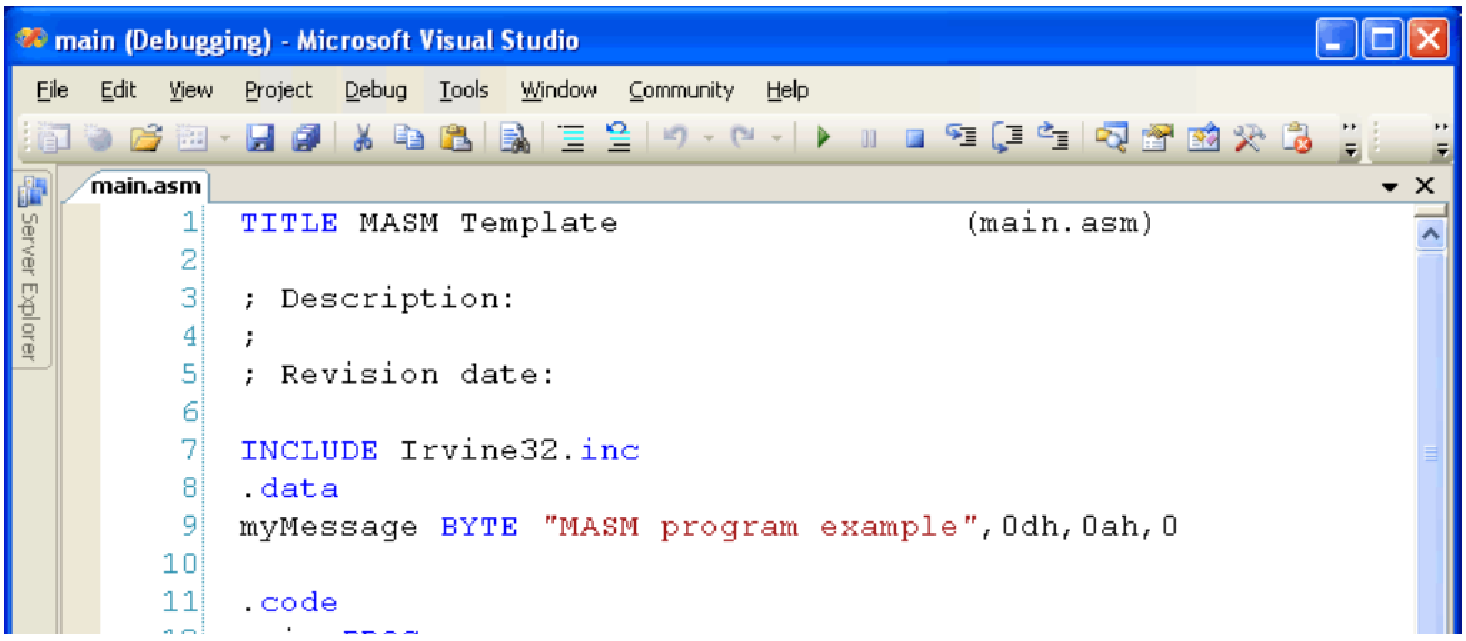
No doubt, you will want to assemble programs in various different disk folders, not just the batch_sample folder used in the foregoing example. All you need to do is copy the **cmd.exe** shortcut we gave you to your working directory, where your assembly language source files are located. When you double-click to run the shortcut, it will open a Command window in the current folder.

Assembling, Linking, and Debugging

In addition to assembling and linking, you can use the asm32.bat file to launch your program in the Visual Studio debugger. Try the following command:

```
asm32 /D main
```

If the program assembles and links with no errors, your program should load in Visual Studio. The first time you do this with a new program, the source code will not appear. All you have to do is press the **F10 key** to begin debugging, and your program should appear with a yellow band across the first executable line:

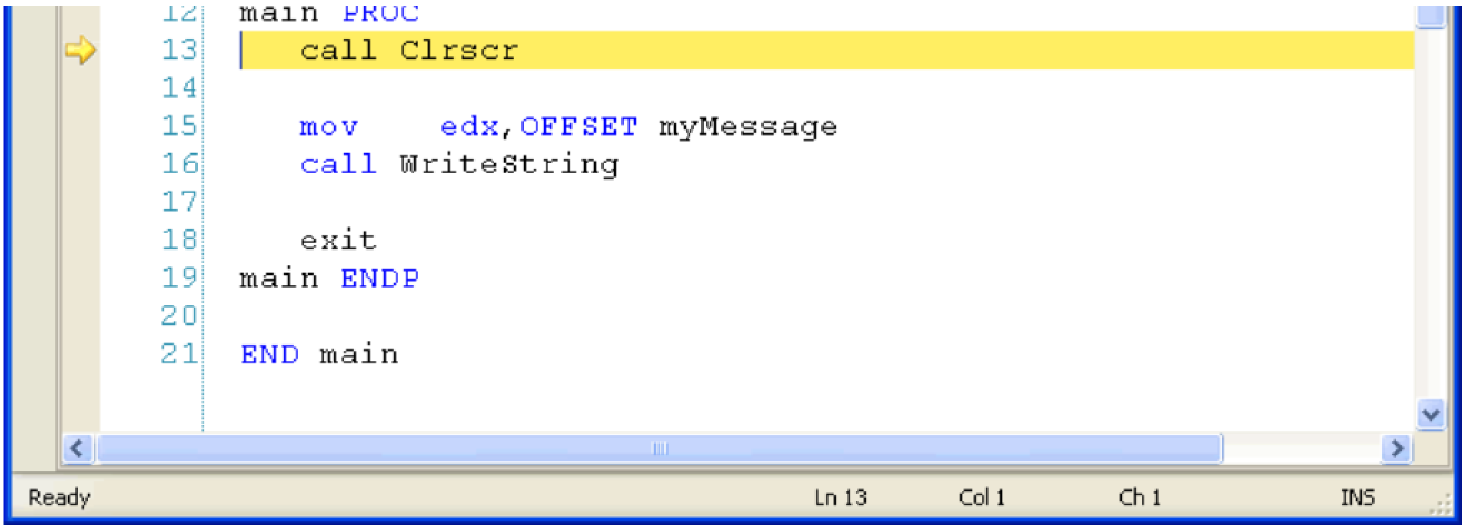


```
TITLE MASM Template                         (main.asm)

; Description:
;
; Revision date:

INCLUDE Irvine32.inc
.data
myMessage BYTE "MASM program example",0dh,0ah,0

.code
```



```
main PROC
    call Clrscr

    mov    edx,OFFSET myMessage
    call WriteString

    exit
main ENDP

END main
```

(Depending on how Visual Studio is configured, you might have to press F8 to do the same thing.)

From here, you can step through the program. When you get to the call to WriteString, you can even trace into its code by pressing the F11 key (trace to). When you finish, close Visual Studio.

From this time on, when you load the same program in the Visual Studio debugger, your source code will appear right away.

Assembling without Linking

Occasionally, you may want to assemble programs but not link them. This happens, for example, when you are creating a multimodule project and you want to assemble each asm file into an obj file separately before linking them into the final exe program. Or, you might be assembling a module to be inserted into a link library (like Irvine32.lib).

To assemble a source file only, inser the /C option before the name of the file being assembled:

```
    asm32 /C main
```

You should see the following output:

```
 Assembling: main.asm

The file main.obj was produced.
..................................
```

If you are interested in learning more about how batch file commands work, here are some reference links we found:

- Allenware.com: Batch file tutorial
- Microsoft TechNet article: Creating Truly Powerful Batch Files, by Brien Posey
- Microsoft TechNet article: Using Batch Files in Windows NT, by Troy Thompson

Links go out of date quickly, but you can google for *Windows batch files* and get plenty of hits.

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