Getting Started with MASM and Visual Studio 2015

Updated 1/19/2017

This tutorial assumes that you are using the Seventh Edition of *Assembly Language for x86 Processors*. We show you how to set up Visual Studio 2015.

Here's how to get started:
Right-click here to download the code examples and required libraries for the book. Unzip the downloaded file into a directory named Irvine on Drive C. Next, Right-click here to download a zip file containing a 32-bit Visual Studio 2015 project. You can extract this file into any folder on your computer. Finally, Right-click here to download a zip file containing a 64-bit Visual Studio 2015 project. You can extract this file into any folder on your computer. Now you are ready to begin the tutorials listed below.

Topics:

The book's example programs in Chapters 1-13 have been successfully tested in both 32/64-bit Windows 7,8, and 10. On the other hand, many programs in Chapters 14-17 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 the author. Except where noted, all instructions in this document apply equally to *Visual Studio* and *Visual Studio Community Edition*.

Required Setup for 32-bit Applications

When installing Visual Studio, be sure to select Visual C++ under the *Programming Languages* category. (If you forget to do this, you can always rerun the install file and modify the existing installation.) Visual Studio includes Microsoft Assembler (MASM) version 14. Look for the file named **ml.exe** in the \vc\bin folder of your Visual Studio installation directory, such as c:\Program Files (x86)\Microsoft Visual Studio 14.0\vc\bin.

The Book's Example Programs

At the top of this document, we explained how to download the file named Irvine.zip and extract it into the C:\Irvine folder. Unless you have some objection to using that location, do not alter the path. (Note to lab administrators: you can designate c:\Irvine directory as read-only.) If you plan to change the installation location, read our instructions relating to Creating a Project from Scratch.

The folllowing files should appear in the c:\Irvine directory:

Filename	**Description**
b16.asm, b32.asm	Blank templates for 16-bit and 32-bit assembly language source files
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)
Irvine32.lib	Irvine's 32-bit link library
Kernel32.lib	32-bit link library for Windows API
Link16.exe	16-bit Microsoft linker

Macros.inc	Irvine's macro include file (see Chapter 10)
make16_vs2012.bat	Visual Studio 2012 batch file for building 16-bit applications
make16_vs2013.bat	Visual Studio 2013 batch file for building 16-bit applications
SmallWin.inc	Small-sized include file containing MS-Windows definitions, used by Irvine32.inc
User32.lib	MS-Windows basic I/O link library
VirtualKeys.inc	Keyboard code definitions file, used by Irvine32.inc

A subdirectory named **Examples** will contain all the example programs shown in the book, source code for the book's 16-, 32-, and 64-bit libraries, and two sample projects for earlier versions of Visual Studio.

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.

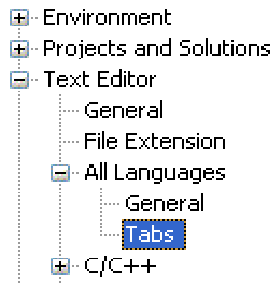
Select the C++ Configuration

Visual Studio supports multiple programming languages and application types. The C++ programming language configuration most closely matches that of assembly language programming, so we suggest the following steps:

1. Select Tools | Import and Export Settings from the menu
2. Select the "Import selected environment settings" radio button
3. Select the "No, just import..." radio button
4. Select "Visual C++" from the Default Settings List and click the Next button
5. Click the Finish button, then click the Close button
6. Notice the tabs on the left and right sides of the Visual Studio workspace. Close the Server Explorer, Toolbox, and Properties tabs. Use the mouse to drag the Solution Explorer tool window to the right side of the workspace. You can also select other tabs at the bottom of this window, such as "Class View", "Property Manager", and "Team Explorer", and close them. They will not be used in the future. If you need to bring back the Solution Explorer window at any time in the future, select View from the menu, and locate Solution Explorer in the list of views.

Set the Tab Size to 5

(This is an optional step.) Start Visual Studio, and select **Options** from the **Tools** menu. Select **Text Editor**, Select **All Languages**, and select **Tabs**. Optionally, you may want to select the **Insert spaces** radio button:



Set the Tab Size and Indent Size to 5.

Tutorial: Building a 32-Bit Assembly Language Program

Now you're ready to open and build your first 32-bit project.

Opening a Project

Visual Studio requires 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.

If you have not already done so,Right-click here to download a zip file containing an up-to-date Visual Studio 2015 project that has been configured for assembly language. After downloading this file, un-zip it into your working directory. It contains a sample asm test file named AddTwo.asm.

Do the following steps, in order:

1. Start Visual Studio.
2. To begin, open our sample Visual Studio project file by selecting **File/Open/Project** from the Visual Studio menu.
3. Navigate to your working folder where you unzipped our project file, and select the file named **Project.sln**.
4. Once the project has been opened, you will see the project name in the Solution Explorer window. You should also see an assembly language source file in the project named AddTwo.asm. Double-click the file name to open it in the editor.

You should see the following program in the editor window:

```
; AddTwo.asm - adds two 32-bit integers.
; Chapter 3 example

.386
.model flat,stdcall
.stack 4096
ExitProcess proto,dwExitCode:dword

.code
main proc
        mov     eax,5
        add     eax,6

        invoke ExitProcess,0
main endp
end main
```

In the future, you can use this file as a starting point to create new programs by copying it and renaming the copy in the Solution Explorer window.

Adding a File to a Project: If you ever need to add an .asm file to an open project, do the following: (1) Right-click the project name in the Visual Studio window, select Add, select Existing Item. (2) In the *Add Existing Item* dialog window, browse to the location of the file you want to add, select the filename, and click the Add button to close the dialog window.

Build the Program

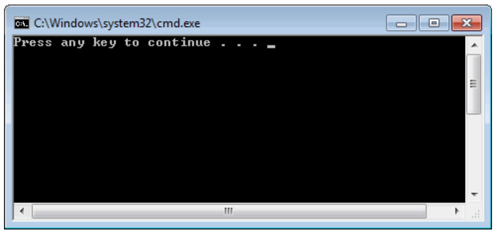
Now you will build (assemble and link) the sample program. Select **Build Project** from the Build menu. In the Output window for Visual Studio at the bottom of the screen, you should see messages similar to the following, indicating the build progress:

```
1>------ Build started: Project: Project, Configuration: Debug Win32 ------
1>  Assembling ..\Project32_VS2015\AddTwo.asm...
1>  Project.vcxproj -> ...\Project32_VS2015\Debug\Project.exe
========== Rebuild All: 1 succeeded, 0 failed, 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:



```
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.

Running a program from the Command Prompt: When you assembled and linked the project, a file named Project32_VS2015.exe was created inside the project's \Debug folder. This file executes when you run the project. You can execute any EXE by double-clicking its name inside Windows Explorer, but it will often just flash on the screen and disappear. That is because Windows Explorer does not pause the display before closing the command window. On the other hand, you can open a Command prompt window, move to the Debug directory, and run Project32_VS2015.exe by typing "Project32_VS2015" (without the quotes). You will need to do some reading on Windows shell commands if you plan to use the command line.

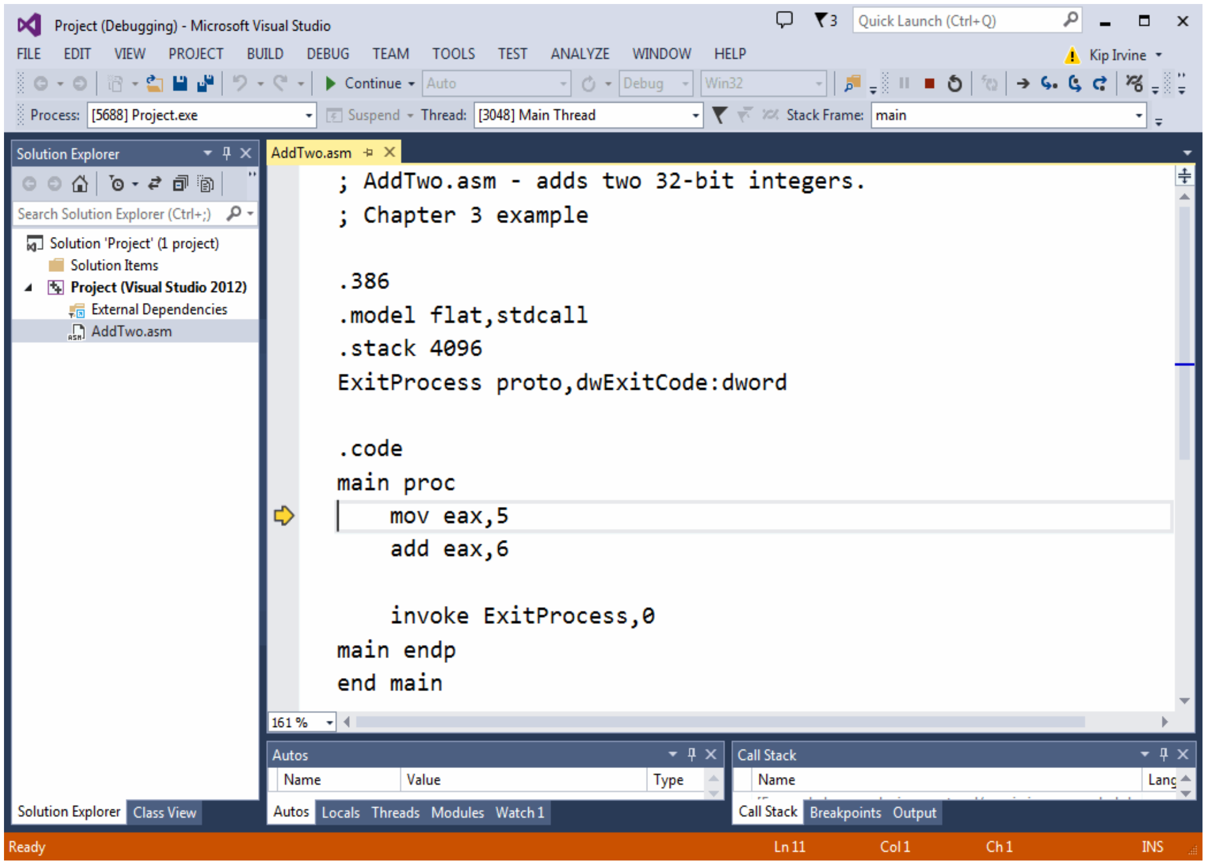
Any time you want to remove a source file from the Visual Studio window, right-click its filename and select **Remove**. The file will not be deleted from the file system. On the other hand, if you want to delete the file, select it and press the Del key.

Step 5: Running the Sample Program in Debug Mode

In this step, you set a breakpoint inside the sample program. Then you use the Visual Studio 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 should appear next to the first program statement.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 **invoke** 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. The window should be blank because this program does not display any output.
6. Press F10 one more time to end the program.


Project (Debugging) - Microsoft Visual Studio
FILE EDIT VIEW PROJECT BUILD DEBUG TEAM TOOLS TEST ANALYZE WINDOW HELP
Continue
Process: [5688] Project.exe
Thread: [3048] Main Thread
Stack Frame: main
Solution Explorer
Solution 'Project' (1 project)
Solution Items
Project (Visual Studio 2012)
External Dependencies
AddTwo.asm
Autos
Call Stack
Ready
Ln 11
Col 1
Ch 1
INS

```
; AddTwo.asm - adds two 32-bit integers.
; Chapter 3 example

.386
.model flat,stdcall
.stack 4096
ExitProcess proto,dwExitCode:dword

.code
main proc
    mov eax,5
    add eax,6

    invoke ExitProcess,0
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 Registers window may appear at the bottom of the workspace, as a tab highlighted in yellow. Use the mouse to drag the window to the right side of the work area. Right click inside the Registers window and check the item *Flags* to enable the display of CPU status 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 maroon-colored square button on the toolbar. To remove a breakpoint from the program, click on its red dot to make it disappear.

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. In our sample program, click the mouse along the border to the left of the **mov eax,5** 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 remove the existing assembly language file from the Solution Explorer window and insert a new .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 **Remove**. 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.

Adding a File to a Project

An easy 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. The physical file will not be copied--the project only holds a reference to the file's location. Try this now:

1. Remove the AddTwo.asm file from your project.
2. Add a reference to the file Examples\ch03\AddTwoSum.asm to the project.
3. Build and run the project.

Copying a Source File

One way to make a copy of an existing source code file is to 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.

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Tutorial: Building and Running a 64-Bit Program

In this tutorial, we will show you how to assemble, link, and run a sample 64-bit program. We assume you have already completed our tutorial entitled *Building a 32-Bit Assembly Language Program*.

Do the following steps, in order:

1. Right-click here to download the Project64_VS2015.zip file and unzip it into your working directory.
2. In Visual Studio 2015, select Open Project from the File menu, navigate to the Project64_VS2015 folder, and select the file named **Project.sln**.
3. You are about to add an existing source code file to the project. To do that, right-click on **Project** in the Solution Explorer window, select **Add**, select **Existing Item**, navigate to the book's Examples\ch03\64 bit" folder, select **AddTwoSum_64.asm**, and click the **Add** button to close the dialog window.
4. Open the AddTwoSum_64.asm file for editing by double-clicking its filename in the Solution Explorer window.

You should see the following program in the editor window:

```
; AddTwoSum_64.asm - Chapter 3 example.

ExitProcess proto
.data
sum qword 0
.code
main proc
   mov  rax,5
   add  rax,6
   mov  sum,rax

   mov  ecx,0
   call ExitProcess
main endp
end
```

(Notice that the program's entry point is the main procedure. If you wish to use a different name for your startup procedure in your own programs, you can modify this option by selecting Properties from the Project menu, and then selecting Linker / Advanced / Entry Point.)

Build the Program

Select **Build Project** from the Build menu. You should see text written to Visual Studio's output window like the following:

```
1>------ Build started: Project: Project, Configuration: Debug x64 ------
1>  Assembling ..\examples\ch03\64 bit\AddTwoSum_64.asm...
1>  Project64_VS2015.vcxproj -> D:\Asmbook 7\Project64_VS2015\x64\Debug\Project.exe
1>  Project64_VS2015.vcxproj -> D:\Asmbook 7\Project64_VS2015\x64\Debug\Project.pdb (Full PDB)
========== 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.

You use the same Visual Studio commands to run and debug 64-bit programs as you would for 32-bit programs.

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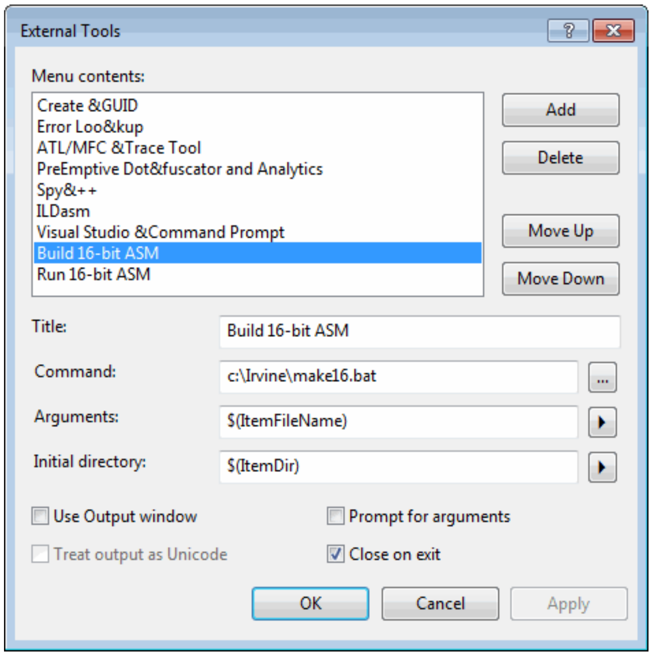
Building 16-bit Applications (Chapters 14-17)

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 Visual Studio Tools menu. 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. The filename in the sample image (make16.bat) has been replaced by two files:

- make16_vs2012.bat for Visual Studio 2012)
- make16_vs2013.bat for Visual Studio 2013)



Title: Build 16-bit ASM

Command: c:\Irvine\make16.bat

Arguments: $(ItemFileName)

Initial directory: $(ItemDir)

Use Output window: unchecked

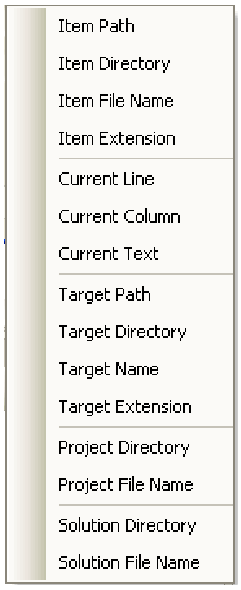
Prompt for arguments: unchecked

Treat output as Unicode: unchecked

Close on exit: ✓

Step 1: Create the Build 16-bit ASM Command

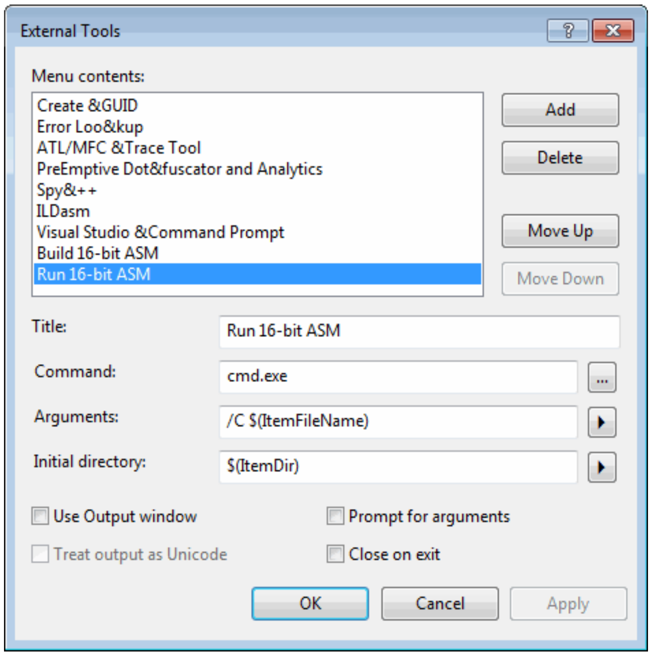
Click the **Add** button and fill in the Title, Command, Arguments, and Initial directory fields as shown in the screen snapshot. If you click the buttons with arrows on the right side of the Arguments and Initial directory fields, a convenient list appears. You can select an item without having to worry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

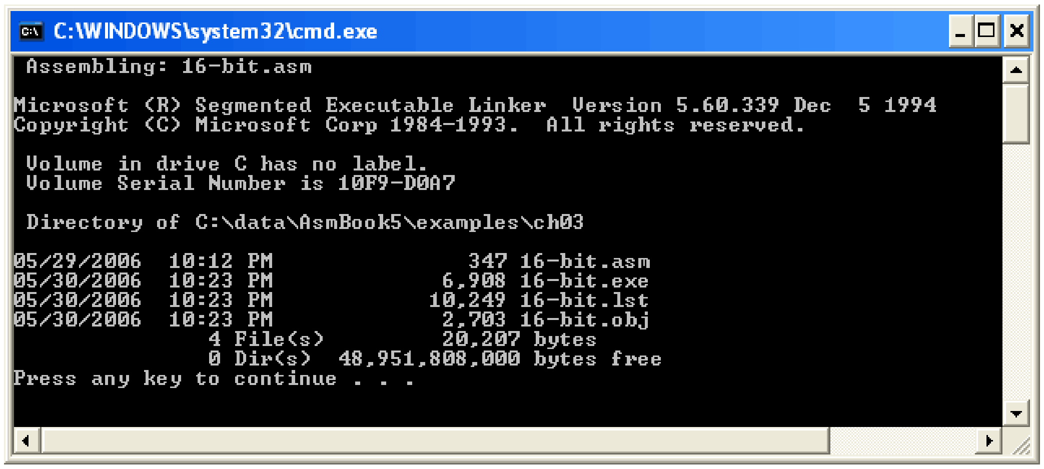


Title: Run 16-bit ASM
Command: cmd.exe
Arguments: /C $(ItemFileName)
Initial directory: $(ItemDir)
Use Output window
Prompt for arguments
Treat output as Unicode
Close on exit

Uncheck the "Close on exit" option and click the OK button to save the command and close the External Tools dialog.

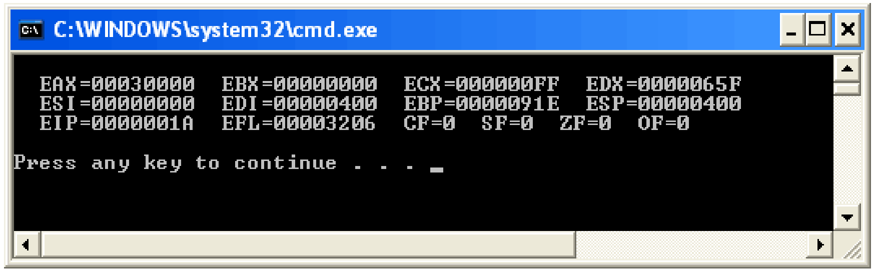
Testing Your new 16-Bit Commands

To test your new 16-bit commands, close any Visual Studio project that happens to be open. Then, select File | Open | File from the menu and choose 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:



```
C:\WINDOWS\system32\cmd.exe
 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:



```
C:\WINDOWS\system32\cmd.exe

  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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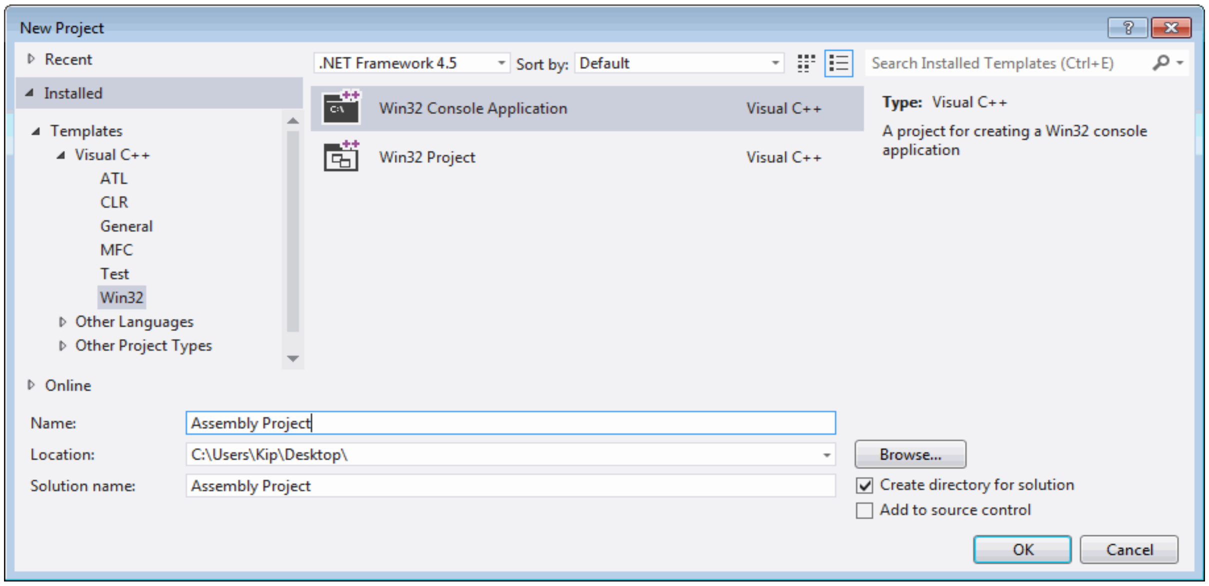
Creating a 32-Bit Project From Scratch

Visual Studio makes it possible (in 14 steps!) to create an Assembly Language project from scratch. You must create a Win32 Console application designed for C++ and modify various settings.

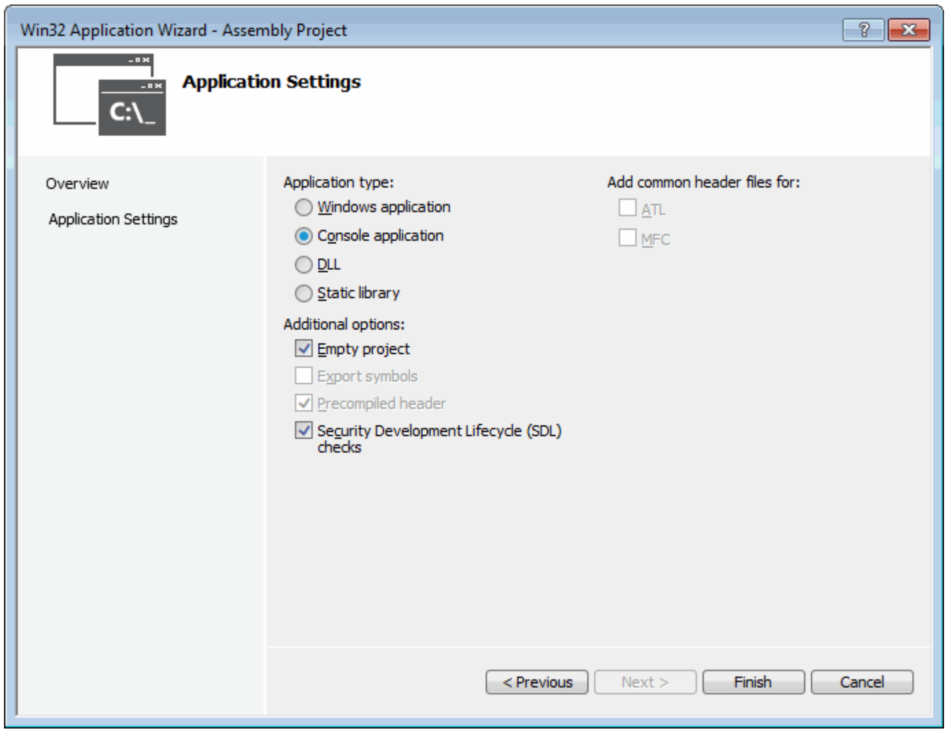
Step 1: Select New from the File menu, then select Project. In the New Project window, select **Win32** under Visual C++ in the left panel, and select **Win32 Console Application** in the middle panel. Give your project a suitable name (near the bottom of the window):



Name: Assembly Project
Location: C:\Users\Kip\Desktop\
Solution name: Assembly Project
☑ Create directory for solution
☐ Add to source control

(Depending on your Visual Studio configuration, you might have to find Visual C++ under the "Other Languages" category in the left panel.)

Step 2: Click the **OK** button to continue. The Win32 Application Wizard window will appear. Select **Application Settings**, and then select the **Empty project** check box.



Application type:
○ Windows application
● Console application
○ DLL
○ Static library

Additional options:
☑ Empty project
☐ Export symbols
☑ Precompiled header
☑ Security Development Lifecycle (SDL) checks

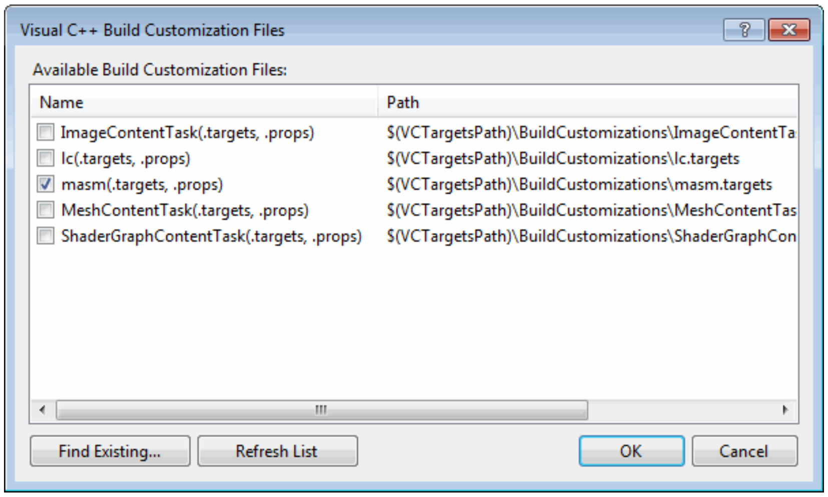
Add common header files for:
☐ ATL
☐ MFC

Step 3: Click the **Finish** button to save the new project.

Step 4: Open the Solution Explorer window and add an assembly language source file to your project. Here's how: Right-click the project name in the Visual Studio window, select Add, select Existing Item. In the *Add Existing Item* dialog window, browse to the location of the file you want to add, select the filename, and click the Add button to close the dialog window.

Note: You may delete the Header Files, Resource Files, and Source Files folders if you wish. They are not necessary.

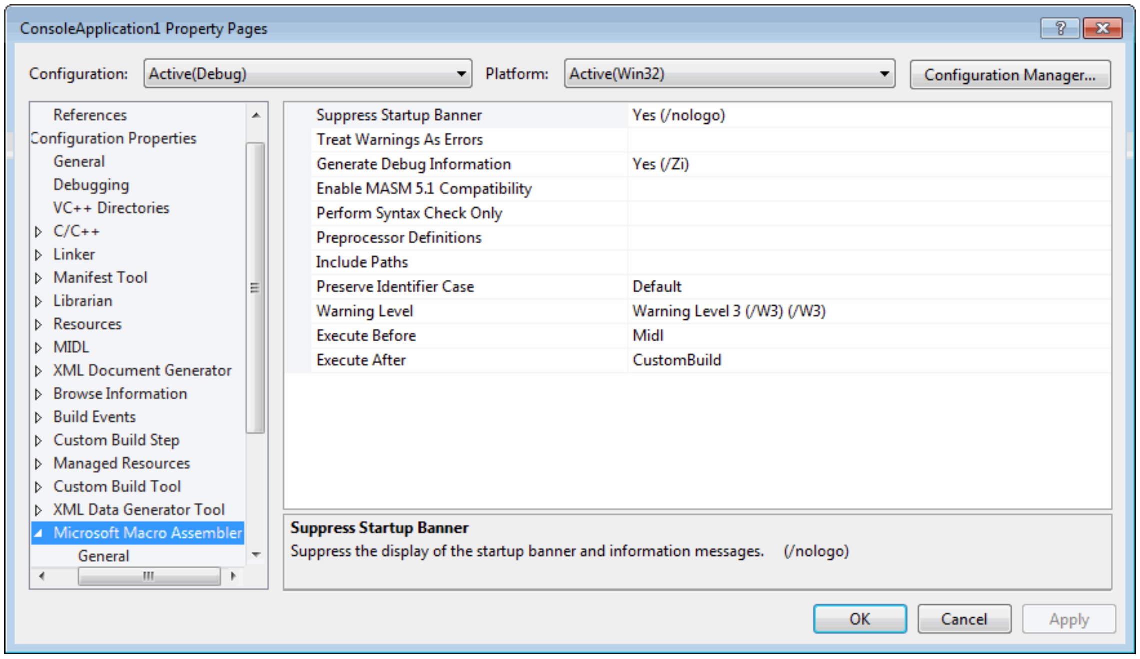
Step 5: Next, right click your project name, select **Build Dependencies**, then select **Build Customizations** from the popup menu. When you see this window, select the check box next to **masm** and click the OK button to close the dialog.


Visual C++ Build Customization Files
Available Build Customization Files:
Find Existing...
Refresh List
OK
Cancel

	Name	Path
☐	ImageContentTask(.targets, .props)	$(VCTargetsPath)\BuildCustomizations\ImageContentTa
☐	lc(.targets, .props)	$(VCTargetsPath)\BuildCustomizations\lc.targets
✓	masm(.targets, .props)	$(VCTargetsPath)\BuildCustomizations\masm.targets
☐	MeshContentTask(.targets, .props)	$(VCTargetsPath)\BuildCustomizations\MeshContentTas
☐	ShaderGraphContentTask(.targets, .props)	$(VCTargetsPath)\BuildCustomizations\ShaderGraphCon

Step 6: You're almost ready to set the assembler properties. But first, you must help Visual Studio associate source code files having the .asm extension with the Microsoft Macro Assembler. To do this, right-click the .asm file in the Solution Explorer window, select Properties from the popup window, click on *Item Type* in the right-hand pane, scroll down the list, and select *Microsoft Macro Assembler*. Click OK to close the dialog window.

Step 7: Right-click the project name in the Solution Explorer window and select Properties from the popup menu. Expand the entry under **Configuration Properties**. Then expand the entry named **Microsoft Macro Assembler**. This is what you should see:

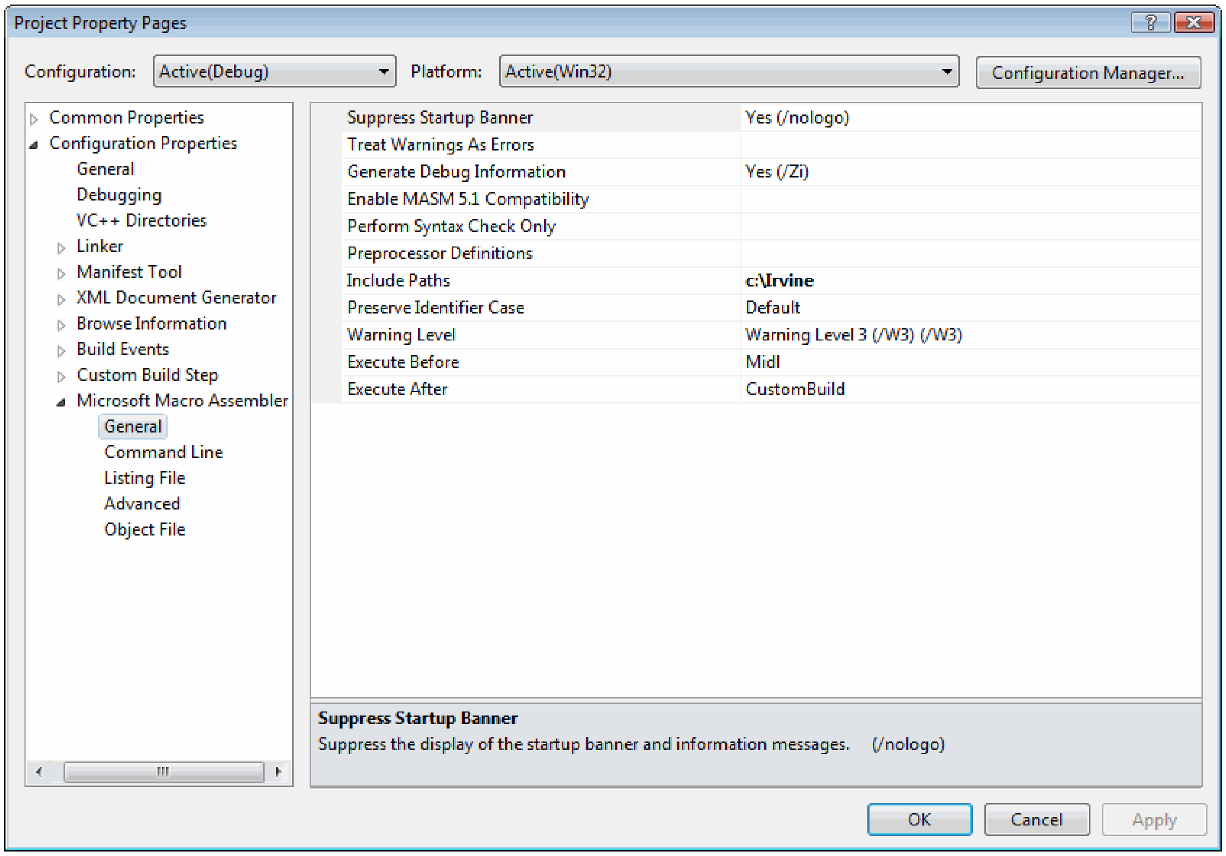


Configuration: Active(Debug) Platform: Active(Win32)

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	
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)

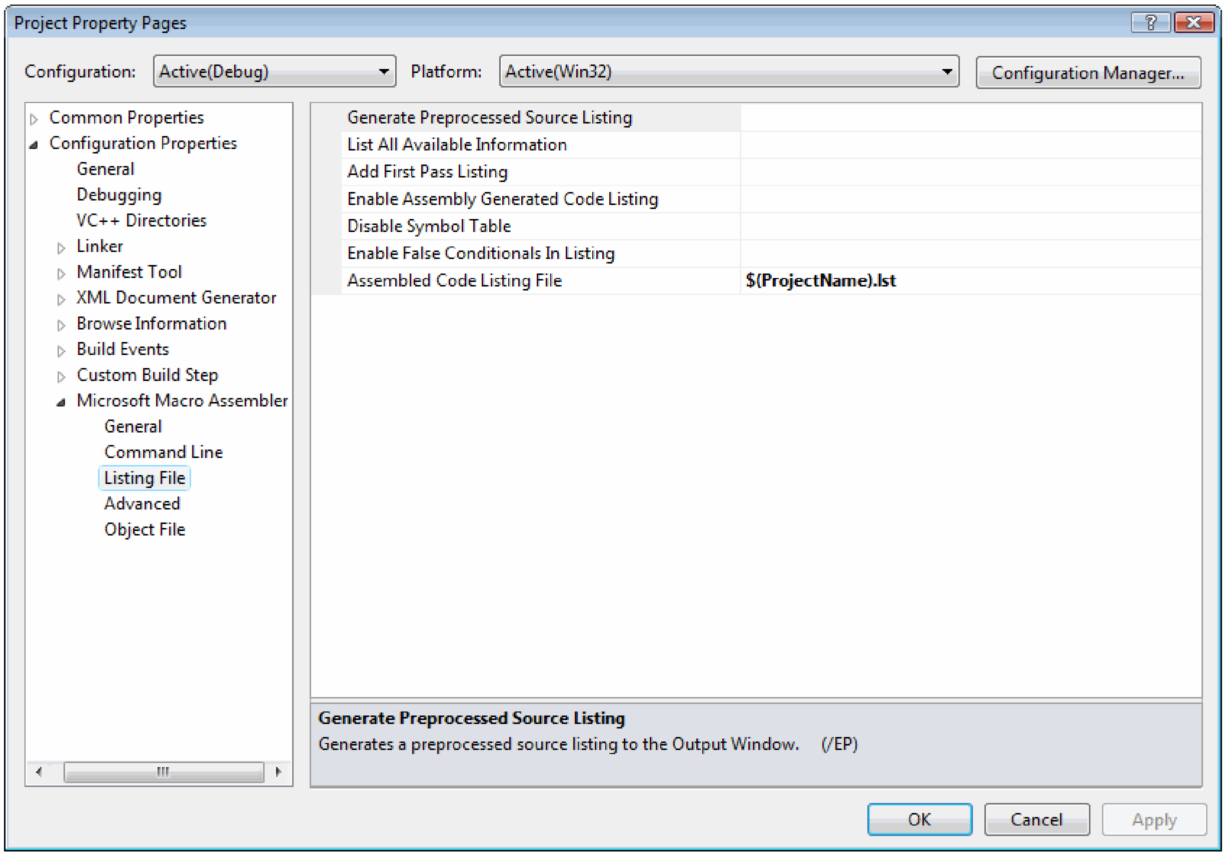
Step 8: Modify the **Include Paths** option so it equals "C:\Irvine". This tells the assembler where to find files having a filename extension of ".inc". Here is a sample:



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)

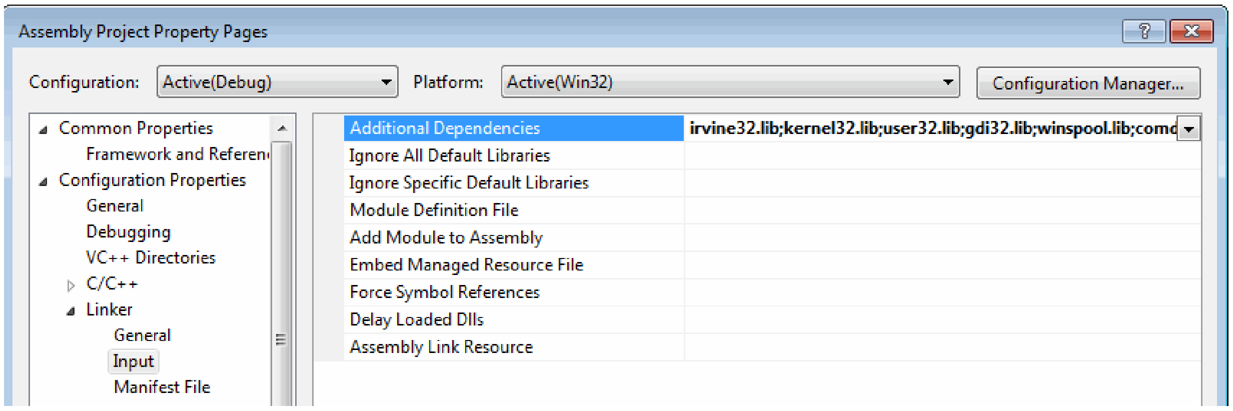
Step 9: Next, select the **Listing File** entry, also in the Microsoft Macro Assembler group. Modify the Assembled Code Listing File entry (shown below) so it contains **$(ProjectName).lst.** This uses a built-in variable to identify the name of the source input file, with a file extension of .lst. So, if your project were named MyProject, the listing file would be named MyProject.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

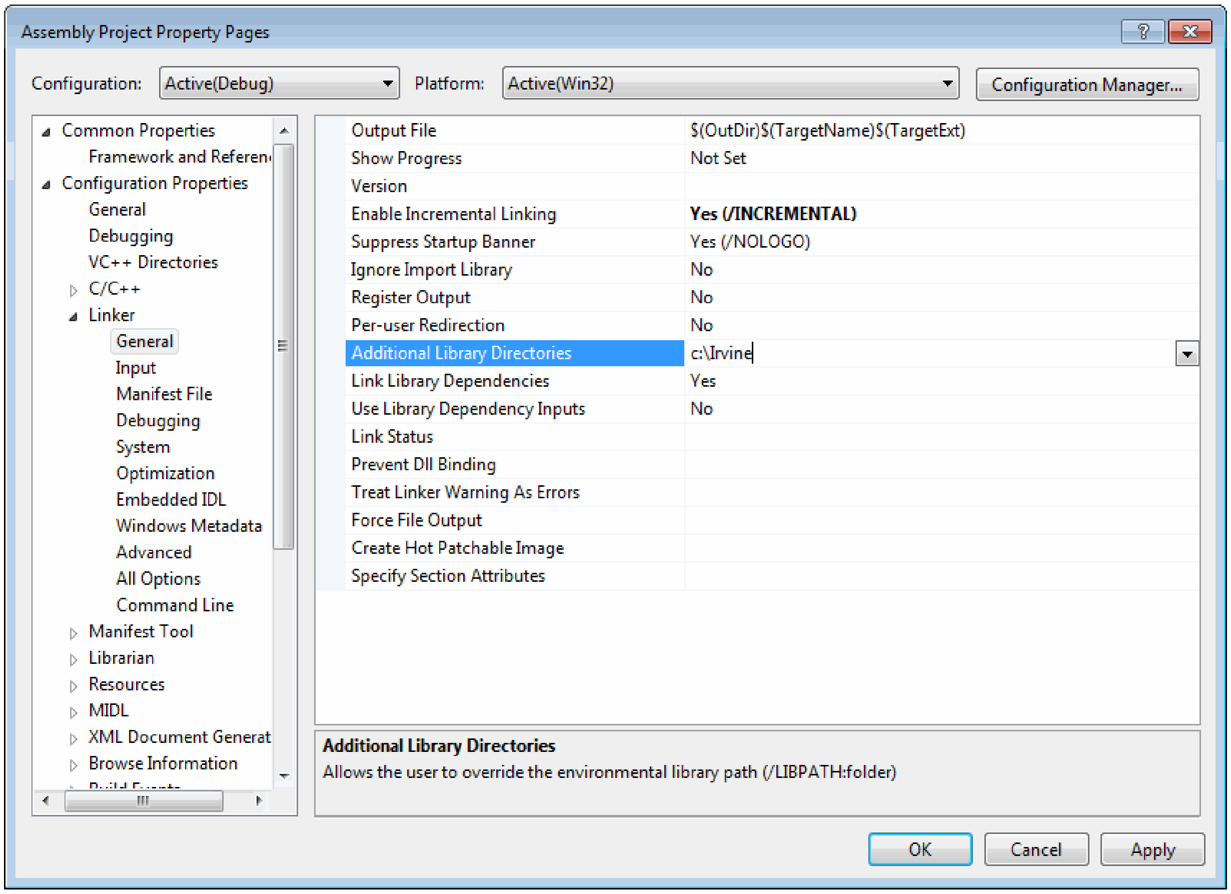
Generate Preprocessed Source Listing
Generates a preprocessed source listing to the Output Window. (/EP)

Step 10: Find the Linker entry under **Configuration Properties**. Select the **Input** entry in the left panel and insert **irvine32.lib;** at the beginning of the **Additional Dependencies** entry. The **irvine32.lib** file is the link library file supplied with this book. The filenames must be separated by semicolons.



Additional Dependencies	irvine32.lib;kernel32.lib;user32.lib;gdi32.lib;winspool.lib;comd
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	

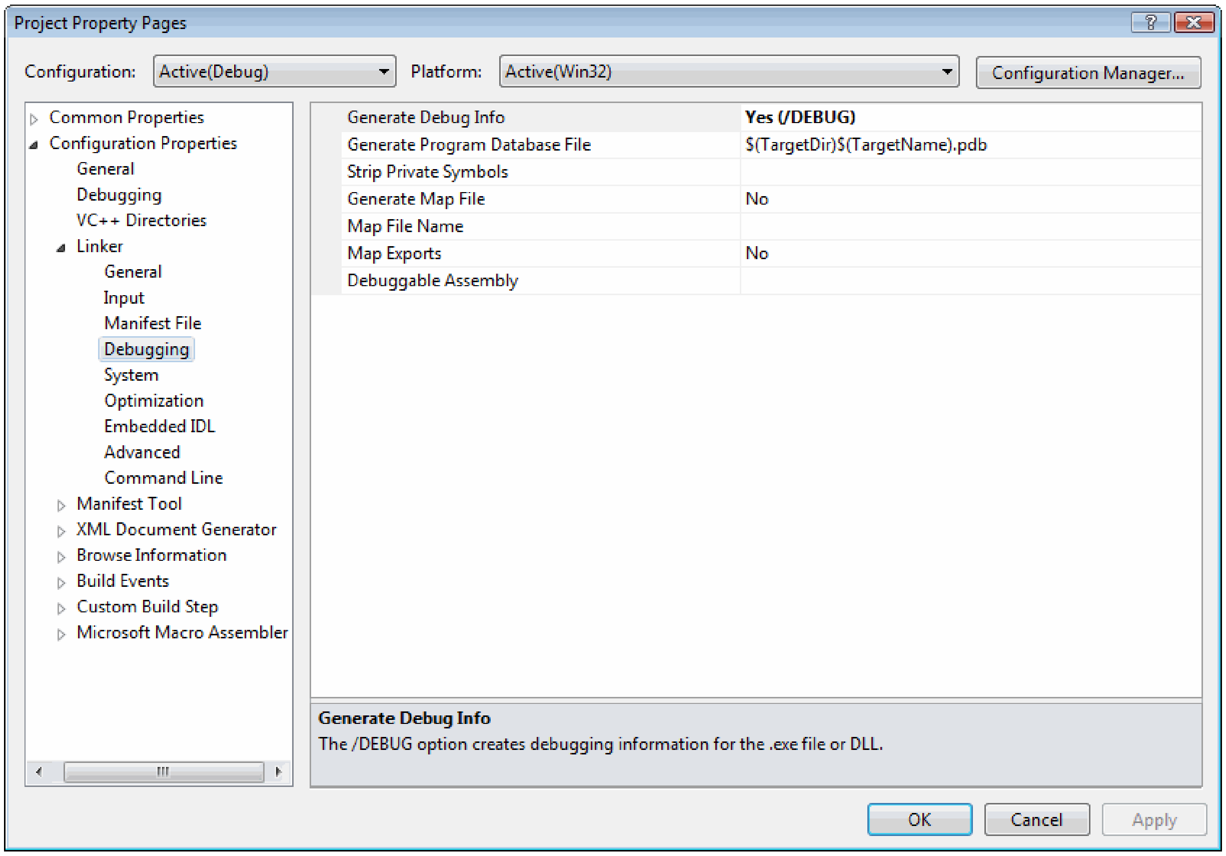
Step 11: Select **Linker** under Configuration Properties, and then select **General**. The **Additional Library Directories** entry must contain **c:\Irvine** so the linker can find the Irvine32.lib library file:



Output File	$(OutDir)$(TargetName)$(TargetExt)
Show Progress	Not Set
Version	
Enable Incremental Linking	**Yes (/INCREMENTAL)**
Suppress Startup Banner	Yes (/NOLOGO)
Ignore Import Library	No
Register Output	No
Per-user Redirection	No
Additional Library Directories	c:\Irvine
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	
Specify Section Attributes	

Additional Library Directories
Allows the user to override the environmental library path (/LIBPATH:folder)

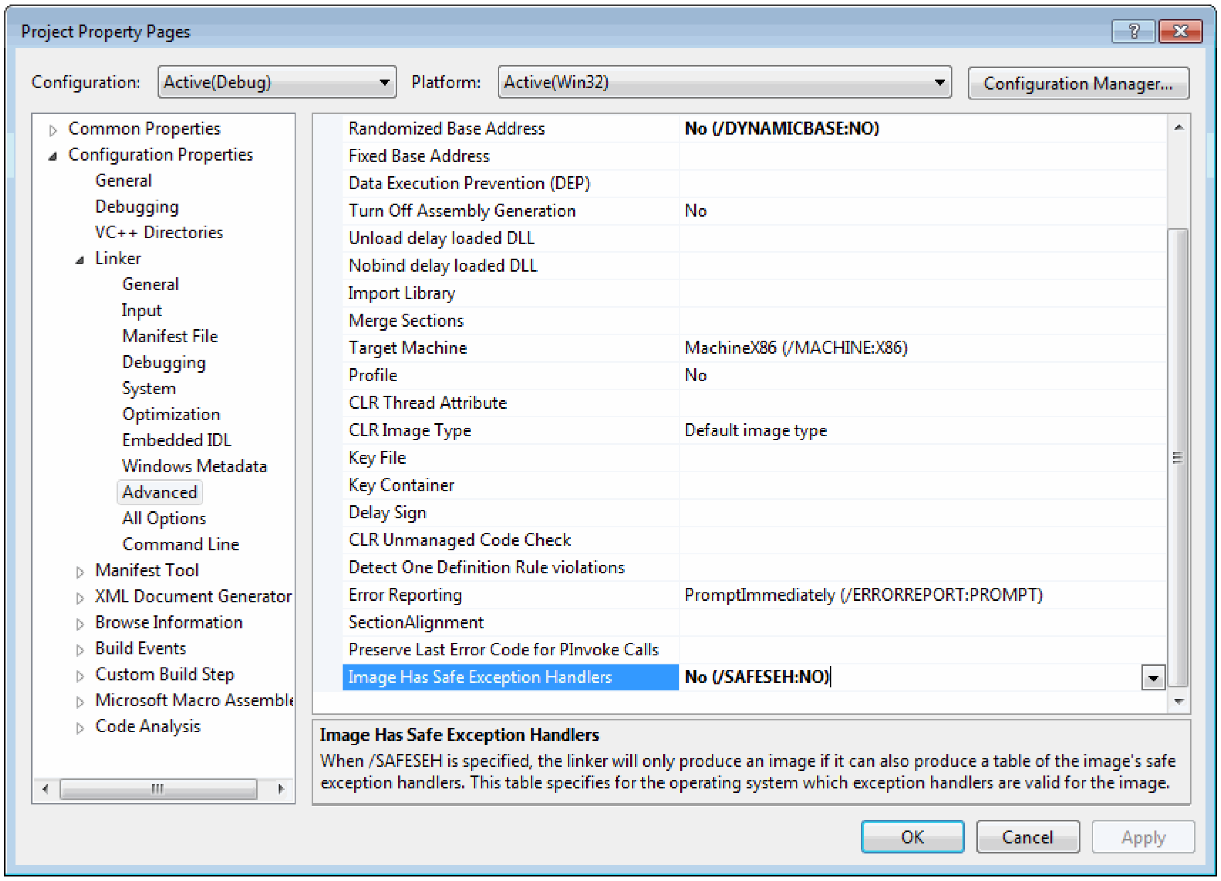
Step 12: Select **Linker** under the **Configuration Properties** and select **Debugging**. Verify that the **Generate Debug Info** option is equal to **Yes(/DEBUG)**



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.

Step 13: Select **Advanced** under the **Linker** entry. Set the *Image Has Safe Exception Handlers* option to **No**.



Randomized Base Address	No (/DYNAMICBASE:NO)
Fixed Base Address	
Data Execution Prevention (DEP)	
Turn Off Assembly Generation	No
Unload delay loaded DLL	
Nobind delay loaded DLL	
Import Library	
Merge Sections	
Target Machine	MachineX86 (/MACHINE:X86)
Profile	No
CLR Thread Attribute	
CLR Image Type	Default image type
Key File	
Key Container	
Delay Sign	
CLR Unmanaged Code Check	
Detect One Definition Rule violations	
Error Reporting	PromptImmediately (/ERRORREPORT:PROMPT)
SectionAlignment	
Preserve Last Error Code for PInvoke Calls	
Image Has Safe Exception Handlers	No (/SAFESEH:NO)

Image Has Safe Exception Handlers
When /SAFESEH is specified, the linker will only produce an image if it can also produce a table of the image's safe exception handlers. This table specifies for the operating system which exception handlers are valid for the image.

Step 14: Click the OK button to close the Property Pages window. Verify that your project has been created correctly by building and debugging the program as you did in an earlier tutorial.

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Generating a Source Listing File

Open the project. From the menu, select **Project**, select **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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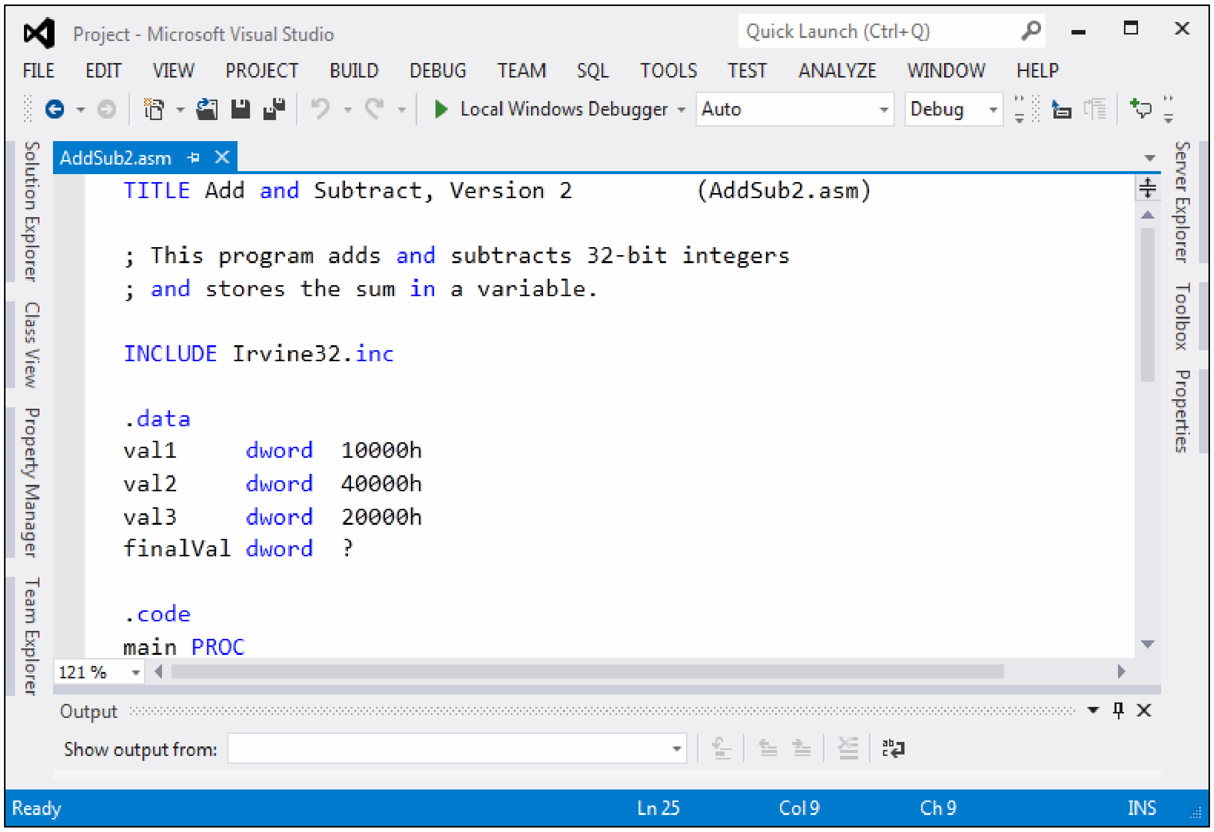
MASM syntax highlighting

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



```
TITLE Add and Subtract, Version 2         (AddSub2.asm)

; This program adds and subtracts 32-bit integers
; and stores the sum in a variable.

INCLUDE Irvine32.inc

.data
val1     dword  10000h
val2     dword  40000h
val3     dword  20000h
finalVal dword  ?

.code
main PROC
```

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

There is an interesting third party Visual Studio 2015 extension named Asm-Dude, featuring a rich set of syntax highlighting and code completion features. You can download it from GitHub.

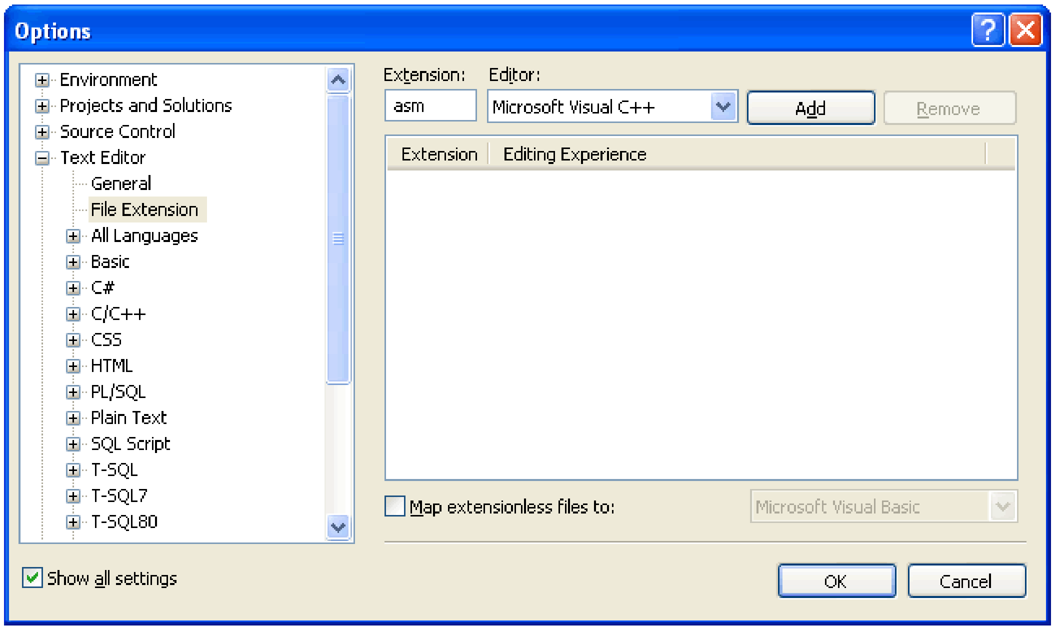
If you decide to use Visual Studio's built-in MASM syntax highlighter, here are the required steps to set it up:

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 7, 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 12.x\Common7\IDE folder. *In 64-bit windows, Program Files will be named Program Files(x86).*

Windows will display a verification dialog before copying the file.

3) Open Visual Studio, 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.



Close Visual Studio and restart it. Open your project and display an ASM file. You should see syntax highlighting in the editor. There is a glitch in the highlighting--assembly language comment line starts start with a semicolon, which C++ doesn't recognize. But this is a simple workaround: add an extra // right after the semicolon, like this, which will cause the comments to appear in their usual green color:

```
;// AddTwo.asm - adds two 32-bit integers.
;// Chapter 3 example
```

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Was your program's EXE file blocked by an Antivirus scanner?

Antivirus scanner software has improved greatly in recent years, and so have the number of viruses (one website reports 50,000 at present). Because of this, your computer's antivirus scanner may report a false positive when you build your program, and refuse to let you run it. There are a couple of workarounds: (1) You can add your project's bin/debug folder into an exclusion list in your antivirus configuration. (2) You can suspend your realtime antivirus scanner software, but this will leave you open to malware for a short time. If you choose this option, be sure to disconnect from the Internet at the same time. (3) You can send a copy of your program's EXE file to the antivirus software vendor, labeling it as a false positive. The virus scanner I use automatically uploads any questionable EXE file to their website and either quarantines or releases the file within about 30 minutes.

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