ANALOG DEVICES

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ADuC8xx Evaluation Kit Getting Started User Guide

INTRODUCTION

This user guide functions as a tutorial to introduce the various tools that are part of the MicroConverter® QuickStart™ development system. Because these tools are ADuC8xx generic, this user guide applies to all ADuC8xx parts.

The ADuC8xx parts and the evaluation boards referenced in this tutorial guide are shown in Table 1. The tools described in this user guide are listed in Table 2.

Table 1. ADuCxx Parts and Evaluation Boards

Part	Evaluation Board
ADuC812	MicroConverter SAR Evaluation Board, Rev. A3
ADuC814	EVAL-ADuC814QS SAR Evaluation Board, Rev. B1
ADuC831	MicroConverter SAR Evaluation Board, Rev. A3
ADuC832	MicroConverter SAR Evaluation Board, Rev. A3
ADuC841	MicroConverter SAR Evaluation Board, Rev. A3
ADuC842/ ADuC843	MicroConverter SAR Evaluation Board, Rev. A3
ADuC816	MicroConverter Σ-Δ Evaluation Board, Rev. B
ADuC824	MicroConverter Σ-Δ Evaluation Board, Rev. B
ADuC834	MicroConverter Σ-Δ Evaluation Board, Rev. B
ADuC836	MicroConverter Σ-Δ Evaluation Board, Rev. B
ADuC845	MicroConverter Σ-Δ Evaluation Board, Rev. 0
ADuC847	MicroConverter Σ-Δ Evaluation Board, Rev. 0

Table 2. Software Tools

Tool	Executable	Function
Metalink 8051 Cross Assembler	Asm51.exe	This assembler takes an assembly language source file created with a text editor and saved with a .asm extension, and translates it into two files: a listing file output (.lst) and a machine language object file in standard Intel HEX format (.hex).
Windows Serial Downloader (WSD)	WSD.exe	The WDS is a Windows® software program developed by Analog Devices, Inc., that allows one to serially download standard Intel HEX files created by the ASM51 assembler to the MicroConverter while in circuit.
Integrated Development Environment (IDE) Assembly Source	Available online	Keil and IAR provide a complete IDE integrating all tools necessary to edit, assemble, simulate, and debug assembly source code via the serial port. Download the latest 8051 tools from the official Keil-An ARM Company or IAR Systems Software, Inc. company website(s).
Windows Analog Software Program (WASP)	WASP.exe	WASP is an analysis tool allowing easy measurement of the analog noise performance of the MicroConverter.
USB-EA Emulation	None	This emulation is used for nonintrusive debugging using Keil or IAR development tools. It is also used for serial downloading via the EA pin and the WSD software.

Figure 1. The ADuC8xx QuickStart Development System

08412-001

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REVISION HISTORY

10/09—Rev. 0 to Rev. A

8/09—Revision 0: Initial Version

INSTALLATION

INSTALLING FROM THE CD

1. Insert the MicroConverter QuickStart Development System CD-ROM into your CD ROM drive, select the CD-ROM drive, and double-click on the **setup.exe file**.
2. Follow the screen instructions to install the software on your PC.

Note the following regarding installation:

- Although you can install the software onto any hard drive and into any directory, the remainder of this user guide assumes that you have installed the software at the default location of **C:\ADuC**.
- If you already have a previous ADuC8xx QuickStart Development System tool suite installed on your machine, this version may also be installed by default at **C:\ADuC**. The ADuC8xx software tools installation automatically updates any previous ADuC8xx tools in this directory.

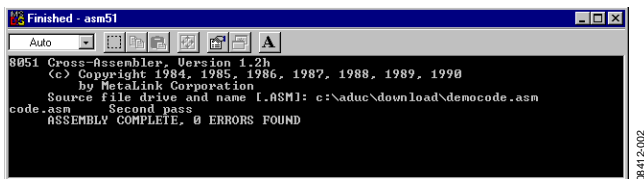# THE METALINK 8051 CROSS ASSEMBLER

The Metalink 8051 Cross Assembler takes an assembly language source file created with a text editor and saved with a .asm extension, and creates two files: an output list file (.lst) and a machine language object file in standard Intel HEX format (.hex).

The list file output (.lst) displays the results of the assembler operation, including any syntax or other errors present in the original source code.

The Intel HEX file (.hex) is used to program the part using the Windows serial downloader (WSD).

USING THE METALINK ASSEMBLER

1. In the C:\ADuC\ASM51 directory, double-click on the **ASM51.exe** executable.
2. In the DOS window, enter the path of the assembly file you want to assemble. For example, to assemble the example file C:\ADuC\Download\DemoCode.asm, enter **C:\ADuC\ Download\DemoCode.asm**.

Figure 2. DOS Window

The assembler displays **ASSEMBLY COMPLETE, 0 ERRORS FOUND** indicating assembly of the file and creation of the hex and list files (that is, DemoCode.hex and DemoCode.lst) with the assembly input file (that is, DemoCode.asm). If the assembler indicates assembly errors, view the list file (DemoCode.lst) to examine the errors. To view the list file, open it with Microsoft® Notepad or any standard text editor.

If the assembler returns an error message indicating a failure to read the A drive or a fatal error opening a file on the A drive, then it is most likely failing to find the MOD52 or MOD8xx file referenced by the assembly file. Make sure all MOD files (plus any other "include" files referenced in your assembly code) are located in the C:\ADuC\ASM51 directory.

The ASM51.exe program can be copied/moved to another directory to prevent typing in the long path name repeatedly. Make sure that the relevant MOD files are also moved with the ASM51.exe program.

For additional details on the use of the Metalink ASM51 assembler, refer to the ASM51 user manual at **C:\ADuC\ASM51\ASM51.pdf**. This manual was provided on the evaluation kit CD.

THE ADuC WINDOWS SERIAL DOWNLOADER

The Windows serial downloader (WSD) is a Windows software program that allows a user to serially download standard Intel HEX files created by the ASM51 assembler to the Micro-Converter via the serial port. The standard Intel HEX file is downloaded into the on-chip Flash/EE program memory via a selected PC serial port (COM1 to COM32). The WSD also incorporates the protocols for downloading to Flash/EE data memory, and setting security bits and various run options.

OPENING THE WINDOWS SERIAL DOWNLOADER

1. Power up the evaluation board using the 9 V power supply. Connect the evaluation board header, J4, to your PC COM1 serial port using the RS-232 dongle cable provided. The PC serial COM port may be changed from COM1 via the WSD configuration option.
2. Place the MicroConverter into serial download mode.
    *   To enter serial download mode on the ADuC814: Connect S3 into the DLOAD/DEBUG position and press **Reset**.
    *   To enter serial download mode on any of the other ADuC8xx products:
        Hold down the **Serial Download** button, and press and release the **Reset** button.
3. From the **Start** menu, choose **Programs→ADuC→WSD**. This launches the Windows serial downloader application. The WSD executable, provided on the CD, is located at C:\ADuC\Download\WSD.exe.

The WSD automatically sends the reset command to the MicroConverter. If the MicroConverter is in serial download mode and the communications between the PC and the evaluation board are setup correctly, then the WSD should display **ADuC8xx version 2.Y** above the top right corner of the status box.
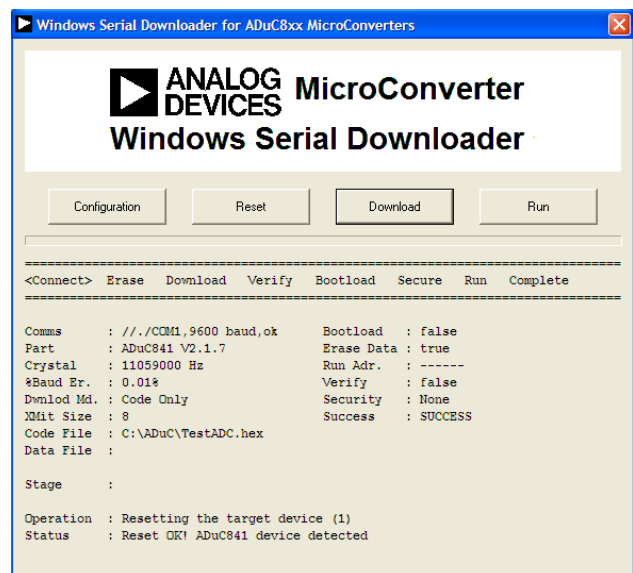

Figure 3. Windows Serial Downloader Window

DOWNLOADING USING THE WSD

From the Windows serial download window

1. Click **Download**.
2. Select the file at **C:\ADuC\Download\DemoCode.hex**.
3. Double-click on the selected file or click **Open** to download the file.
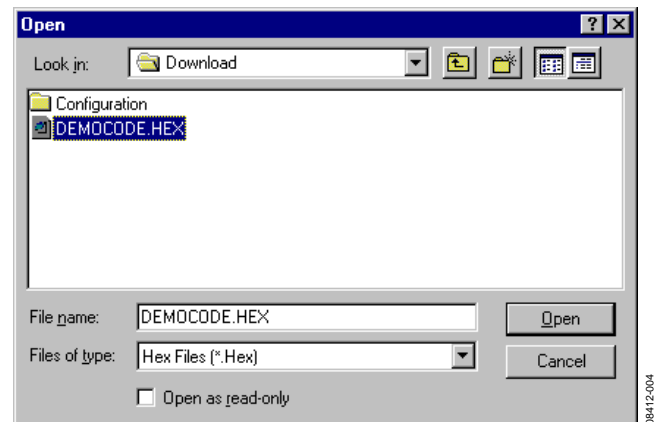

Figure 4. Open Window

While the file is downloading, a progress bar appears indicating how much of the file has been downloaded.

Once the file has been successfully downloaded, the progress bar disappears and the status box is updated with the message

```
DOWNLOADING CODE
[C:\ADuC\Download\DEMOCODE.HEX]:..
OK
```

RUNNING THE DOWNLOADED FILE

Running Using the WSD

From the Windows serial download window, click **Run**. The status box is updated with the message

```
Run OK!
```

The program starts running from Address 0000h; this is indicated by a flashing LED on the evaluation board.

To perform additional downloads, repeat Step 2 in the Opening the Windows Serial Downloader section and click **Reset** on the WSD.

Manual Run Option

Click **Reset** on the evaluation board with the **Serial Download** switch released (for the ADuC814, switch S3 to the **Normal** position). The program starts running automatically after reset and the LED flashes.

Note that DemoCode.hex causes an LED to blink on the eval board. The rate of blinking is reduced each time the **Int0** button is pressed.

Additional Download/Run Options

The MicroConverter incorporates a serial download protocol that also allows various download/run options (see uC004 at C:\ADuC\Documentation\TechNotes provided on the CD).

These options, as well as other options including **Erase**, can be selected via the Configuration window as shown in Figure 5. Remember, this window appears after clicking the **Configuration** button found on the front panel of the WSD shown in Figure 3. Certain options may be grayed out depending on the MicroConverter used.
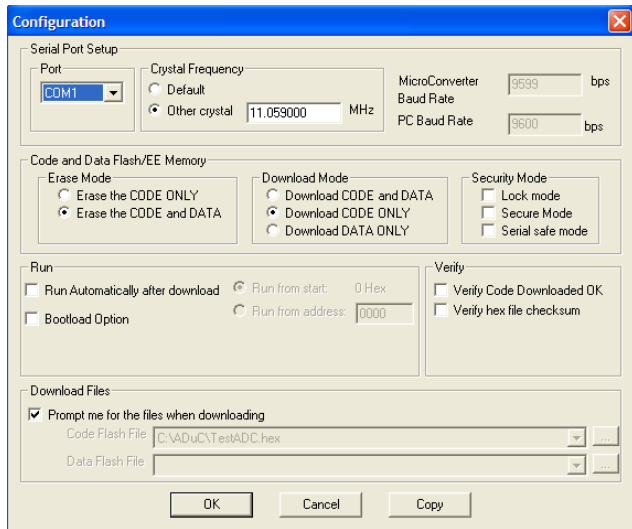

Figure 5. Configuration Window

On the Configuraton window

1. Check **Run Automatically after Download** and click **OK**.
2. Enter serial download mode as described in Step 2 in the Opening the Windows Serial Downloader section.
3. Download as described in the Downloading Using the WSD section.

The program starts running automatically after download; this is indicated by the flashing LED.

USING THE PC COM PORT

Only one application at a time may use the PC serial port.

The WSD only uses the PC COM serial port when

- Resetting the device
- Downloading to the device
- Sending the run command to the device

Therefore, the WSD does not have to be closed before launching the debugger/WASP/hyperterminal or any other application that uses the PC COM serial port.

However, if another application that uses the PC serial port is open, then the WSD is not able to communicate with the MicroConverter until the PC serial port is released by disconnecting/closing the other application.

DOWNLOADING VIA THE USB-EA EMULATOR

The USB-EA Emulator Debugging section discusses using the USB-EA emulator for debug purposes. However, it is also possible to use the USB-EA emulator to serially program the ADuC8xx parts via the EA pin. This does not require a connection to the UART pins.

After installing the USB-EA emulator, your PC assigns the emulator a COM port.

When using the USB-EA emulator to download to the ADuC8xx, select this COM port in the WSD application and follow the instructions provided in the USB_EA Emulator Debugging section.

USB-EA EMULATOR FOR DEBUGGING

The USB-EA emulator allows nonintrusive debugging of the ADuC8xx series of devices. The USB-EA pod is either shipped as part of the Quick Start Plus kits or purchased separately.

The following parts are supported by the USB-EA emulator:

- ADuC831
- ADuC832
- ADuC841
- ADuC842/ADuC843
- ADuC834
- ADuC836
- ADuC845
- ADuC847
- ADuC848

Note that the ADuC812/ADuC814/ADuC816/ADuC824 are not supported by the USB-EA emulator.

The debugger interfaces to the ADuC8xx via a single pin—the EA pin of the ADuC8xx part. To enter debug mode, first place the part into download mode by toggling the RESET pin while holding the serial download pin low. When using the evaluation boards, this involves keeping the Serial Download button pressed while toggling the Reset button.

CONNECTING THE USB-EA EMULATOR TO THE TARGET BOARD

The pod connects to a PC via a standard mini-USB cable. It connects to a target board via a 2-pin header.
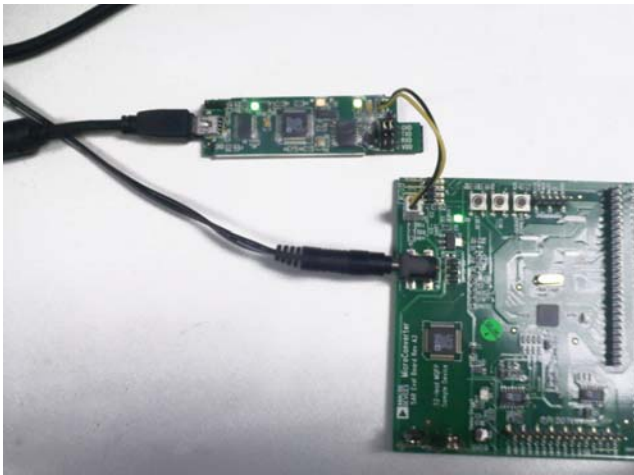

Figure 6. Target Board Connected to the USB EA Emulator

DRIVERS FOR THE USB-EA EMULATOR

If the USB drivers for the USB-EA dongle do not install automatically on your PC, then download drivers for the FT245R part for your operating system from the official website for the Future Technology Devices International Ltd.

When the drivers are installed and the USB-EA dongle is connected to the PC, it appears as an extra COM port under the Device Manager window as shown in Figure 7.
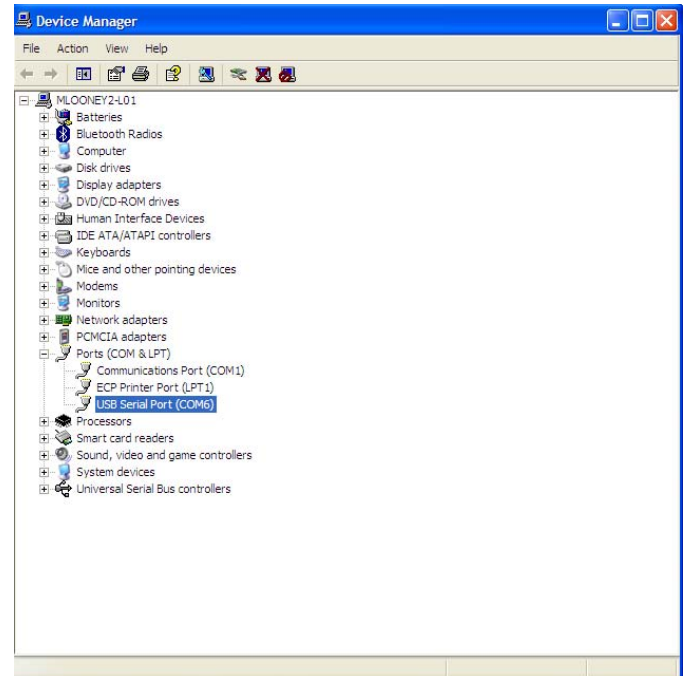

Figure 7. Device Manager Window

The older versions of the Keil tools only work with COM ports numbered COM8 or lower. If your PC allocates a COM port number of COM9 or higher, change the COM port number to a lower number by completing the following steps:

1. Right-click your mouse on the **USB Serial Port** entry in the Device Manager window and then select **Properties**.
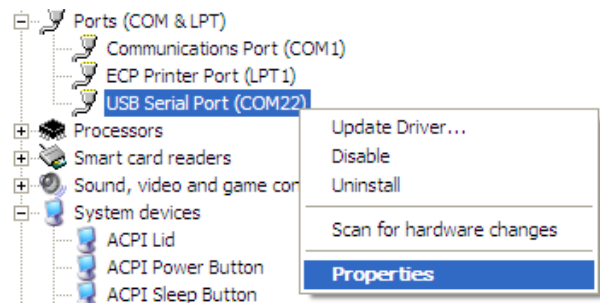

Figure 8. Choosing the USB Entry in the Device Manger Window

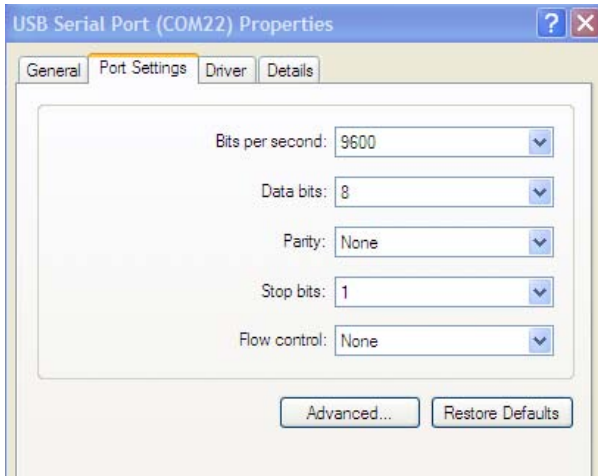2. Next, select the **Port Settings** tab and click **Advanced**.

Figure 9. USB Serial Port Properties Window

3. In the **Advanced Settings** window, change the **COM Port Number** to a port lower than COM 9 by making an appropriate selection.
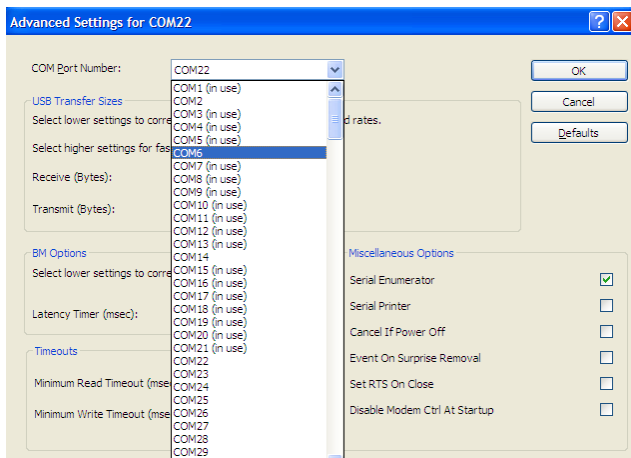

Figure 10. Advanced Settings Window

4. Click **OK** and return to the main Device Manager window.
5. To update the newly selected COM port, unplug and replug the USB cable to the USB-EA dongle and the newly selected COM port should appear in the Device Manager window.
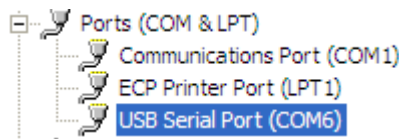

Figure 11. COM Port Selection in Device Manager Window

CONFIGURING KEIL TOOLS FOR THE USB-EA EMULATOR

1. Open your project using a recent version of Keil PK51 development software.
2. From the Keil uVision menu, select **Flash→Configure Flash Tools→Debug**.
3. Make the selections as shown on the right side of Figure 12, making sure to select the ADI Monitor Driver.
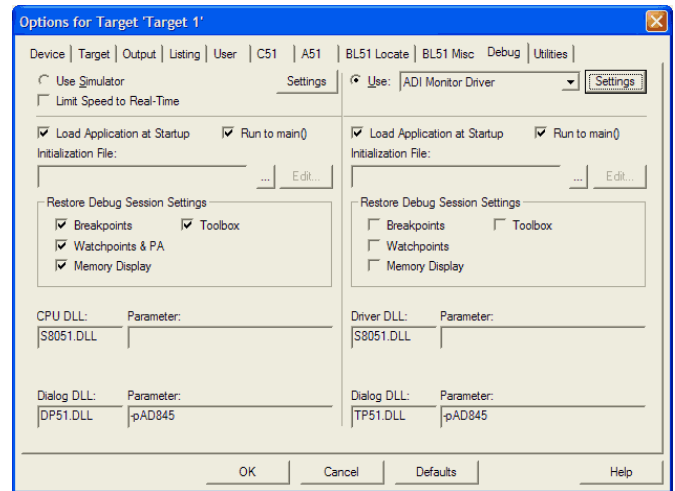

Figure 12. Options for Target WIndow

4. Click **Settings** at the top right (see Figure 12) and then select **1-Pin Pod** and the COM port assigned to the emulator as shown in Figure 13. Use the Device Manager to identify the appropriate COM port.
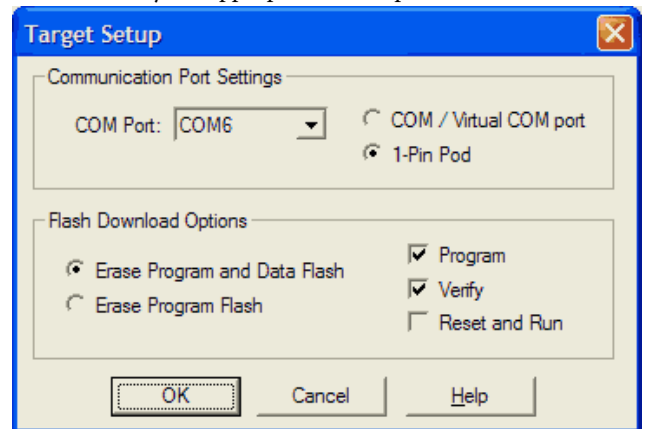

Figure 13. Target Setup Window

The latest 8051 tools are available for download from the Keil website.

CONFIGURING IAR TOOLS FOR THE USB-EA EMULATOR

1. Open your project using a recent version of IAR EW51 development software.
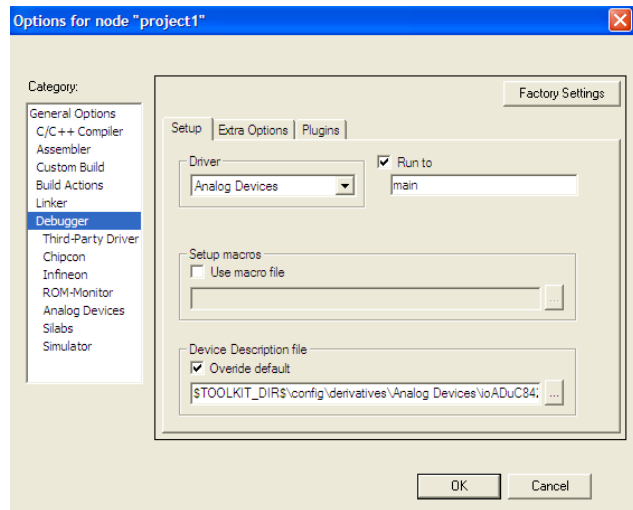2. In the Options window, go to the **Debugger** section and select the **Analog Devices** driver.

Figure 14. Options Window

3. Select **Analog Devices** and then, on the **Download** tab, select **UART debug mode**.
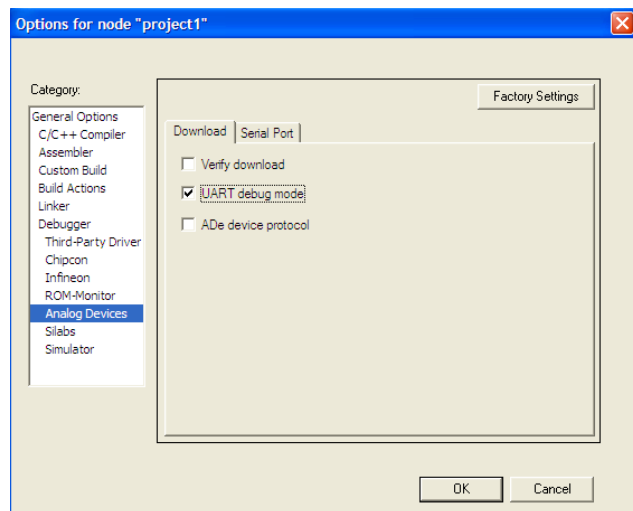

Figure 15. Download Tab

4. On the **Serial Port** tab, ensure that the correct COM port is selected. Use Device Manager to identify the correct COM port.
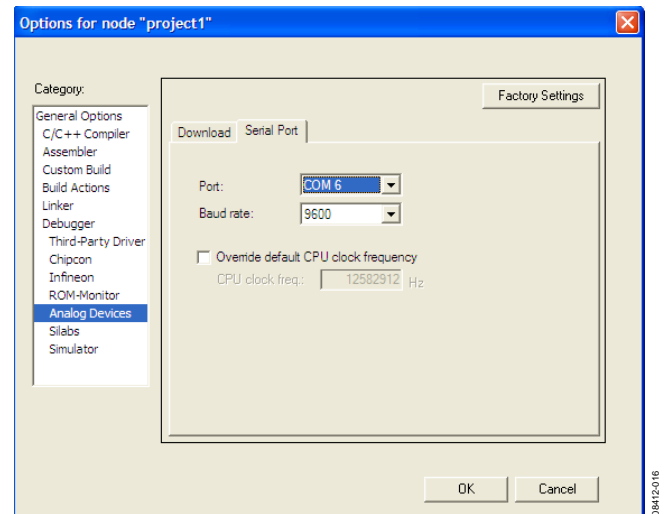

Figure 16.

Note that the latest 8051 tools are available for download on the IAR company website.

KEIL/IAR LIMITATIONS WHEN USING THE USB-EA EMULATOR

Note the following limitations:

- The Halt feature does not work with older versions of the Keil or IAR tools. See the IAR and Keil websites for further details and updated feature lists.
- To stop the program, breakpoints should be inserted.

TIMING CONSIDERATIONS WHEN DEBUGGING

As with other 8052-based parts, the watchdog on ADuC8xx parts is not stopped during debugging. This leads to unpredictable results when the watchdog timer times out. During initial development, it is recommended that the watchdog timer be left disabled. For final software, Analog Devices suggests you place code similar to the code shown below in your code.

When debugging, place a breakpoint at the second line shown, and when this breakpoint is reached manually, using the debugger, change the value in cWdcon to 0x00, so that the watchdog does not start. This scheme ensures that the program is debugged as it will be placed in the field. The watchdog itself cannot be debugged by the debugger.

Other timing considerations to keep in mind are as follows:
- As with other 8052 debuggers, the user should not halt the ADuC8xx if the part is either in idle or power-down mode. When a break from either power saving mode occurs, the debugger will not be able to regain control of the part and the debug interface will crash.
- The timers on the ADuC8xx are not stopped on a break from emulation. They will continue to run if left enabled when breaking from emulation.

```
…
cWdcon = 0xe2 ;         //Place parameters for watchdog in variable cWdcon.
WdWr(cWdcon);           //Call assembly function to start watchdog.
…


cWdcon:                 //Assume interrupts not enabled.
setb    WDWR
mov     WDCON,r7        //Parameter cWdcon passed in r7.
ret
```

THE ADuC WASP

The Windows Analog software program (WASP) is a general application for all MicroConverter products that allows analysis of the analog performance of these parts. The WASP recognizes which MicroConverter the PC is communicating with, before automatically downloading the appropriate code.

This section serves as a tutorial to introduce both the SAR WASP (for SAR ADC parts ADuC812, ADuC814, ADuC831, ADuC832, ADuC841, ADuC842, and ADuC843) and the Σ-Δ WASP (for Σ-Δ ADC parts ADuC816, ADuC824, ADuC834, ADuC836, ADuC845, ADuC847, and ADuC848). The terms SAR WASP and Σ-Δ WASP relate to the same WASP software. The software differentiates between the different products.

After downloading the appropriate code, the WASP launches the Acquisition window. This allows the user to configure, control, and analyze the ADC noise performance with the various analog and digital peripherals enabled/disabled.

1. Power up the evaluation board using the 9 V power supply. Connect the evaluation board to your PC's COM1 serial port using the RS-232 dongle cable connected to the 4-way header, J4.
2. Place the MicroConverter into serial download mode as described in the Opening the Windows Serial Downloader section.
3. From the **Start** menu, choose **Programs → ADuC → WASP**. This launches the WASP application. The WASP executable file, WASP.exe, is located at C:\ADuC\WASP\WASP.exe.
4. Click **Download**. **ADuC8xx** appears and the code starts to download. A task bar indicates the download progression. A message appears when the file is downloaded. The program automatically runs when the download is complete.
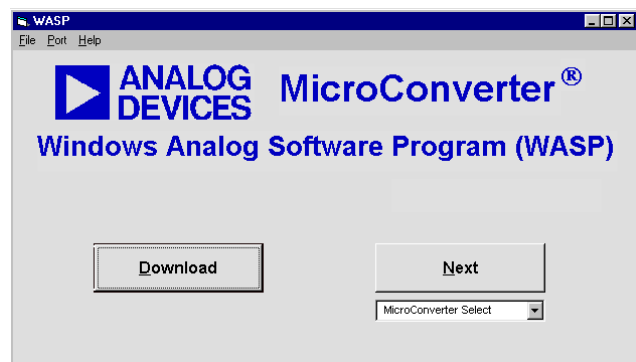

Figure 17. WASP Window

The **Next** button bypasses the download sequence and can be used if the WASP code is already downloaded and running on the MicroConverter. To identify the MicroConverter for the WASP software, select the appropriate MicroConverter from the **MicroConverter Select** option box and click **Next**.

SAR WASP

The SAR Acquisition window (see Figure 18) opens for any of the SAR ADC MicroConverter products (ADuC812, ADuC814, ADuC831, ADuC832, ADuC841, ADuC842 or the ADuC843).

From the Acquisition window you can
- Select the channel for converting
- Set up the ADC conversion time and sampling parameters
- Select the number of samples to acquire
- Set up voltages on the DAC channels
- Select the use of the internal reference or an external reference device.
- Enable/disable various analog/digital peripherals

Figure 18 shows an example for converting on the temperature sensor using the internal reference as displayed. Using the example parameters shown, press **Run**. The acquired ADC samples appear on the chart as shown on the bottom portion of the screen for the ADuC812.
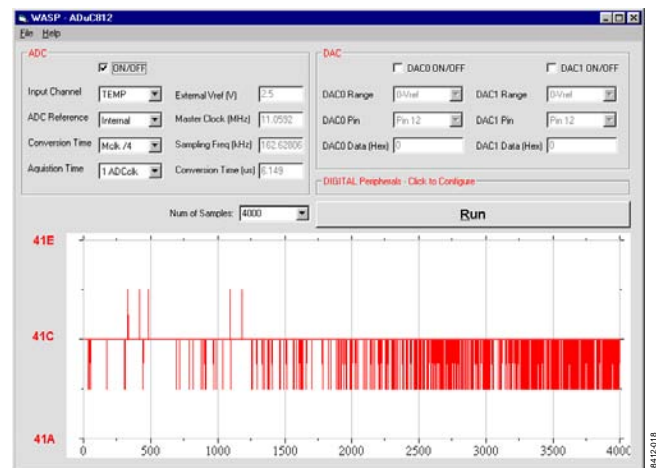

Figure 18. SAR Acquisition Menu

When all the samples are collected, the WASP immediately launches the Analysis window. The histogram plot and the ADC data analysis fields within the analysis window gives a measure of the code distribution for the ADC input.
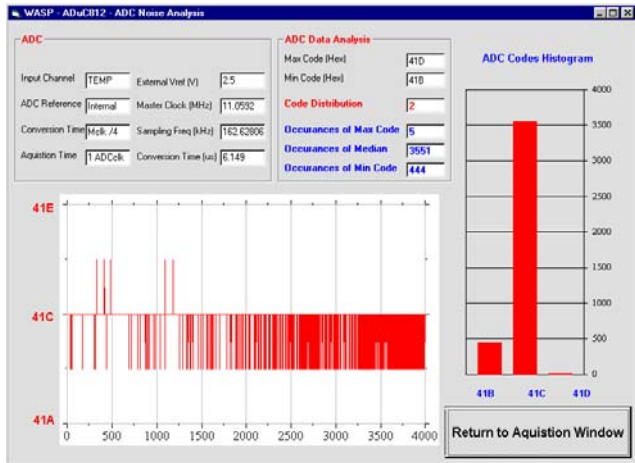
Figure 19. ADC Noise Analysis Window

Click on **Return to Acquisition Window** in the ADC Noise Analysis window (see Figure 19) to return to the acquisition panel.

The functionality of the DAC(s) and general digital peripherals can also be exercised via the options available from the WASP front panel.

Σ-Δ WASP

The Sigma-Delta Acquisition window opens for any of the Σ-Δ ADC MicroConverter products (ADuC816, ADuC824, ADuC834, ADuC836, ADuC845, ADuC847, and ADuC848)

From the Acquisition window you can

- Select the channel on which you want to convert
- Set up the ADC update rate
- Select the number of samples that you want to acquire
- Set up voltages on the DAC channels
- Select the use of the internal reference or an external reference device
- Enable/disable various analog/digital peripherals

Switch Configuration

Make sure that the external reference (2.5 V REF+) is connected (S1.6 ON) for the ADuC845/ADuC847 (S4.5 ON), and that AIN2 is biased to 2.5 V (S1.7 ON). For the ADuC845/ADuC847, read AINCOM for Ain2 and ensure AINCOM is biased to 2.5 V (S4.7 ON). In addition, ensure that REF− is grounded (S1.5 ON) for the ADuC845/ADuC847 (S4.4 ON). All other connections should be off.

By default, the WASP enables the primary ADC configured as shown in Figure 20. In this example, the primary ADC is converting in bipolar mode using an external reference on the 2.56 V range with internally shorted inputs AIN2 → AIN2 (ADuC845/ADuC847 AINCOM → AINCOM. The auxiliary ADC, DAC, and Current sources are all disabled). Note that Aux ADC and DAC are not available on the ADuC847.

Click **Run** to send this default configuration to the MicroConverter device and begin the conversions. The screen changes to configure for a single primary ADC acquisition sequence. The results of conversion are displayed in real time. Because the channel is configured for an internal short, ADC conversions close to 80000h can be expected. The WASP performs 500 ADC conversions by default and displays the conversion results.
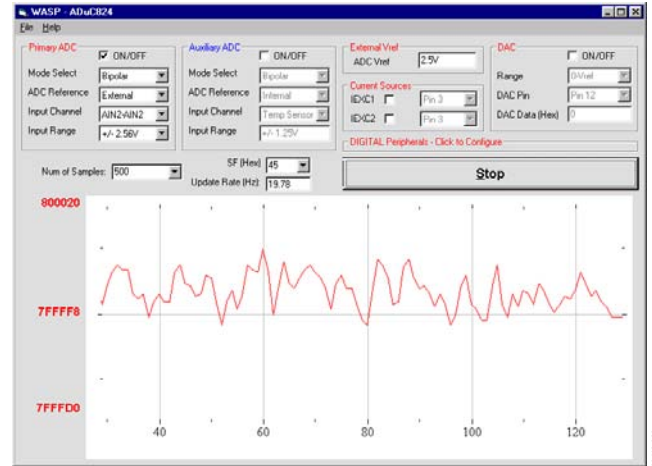

Figure 20. Primary ADC

When all the samples are collected, the WASP immediately launches the Analysis window. This window displays some mathematical analysis on the ADC conversions, including rms noise (in μV and bits) and peak-to-peak Noise (code distribution, μV and bits). The most important performance figures are highlighted in red in Figure 21.
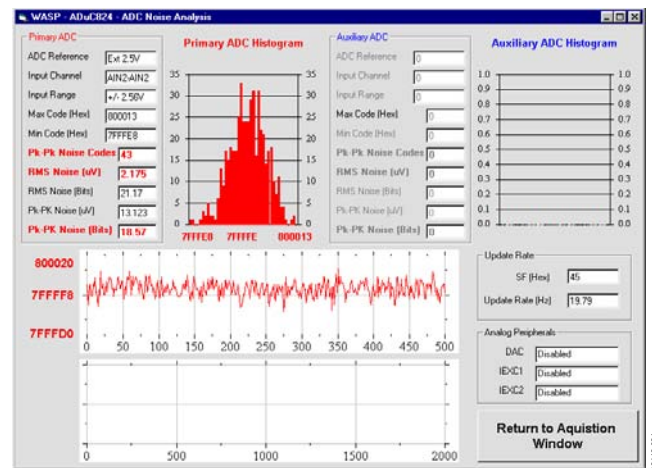

Figure 21. ADC Noise Analysis Window with Performance Highlights

Click **Return to Acquisition Window** in the Noise Analysis window to return to the acquisition panel.

The functionality of the DAC(s) and general digital peripherals can also be exercised via the options available from the WASP front panel.

INSTALLED DOCUMENTATION AND CODE DIRECTORY

Installing the MicroConverter QuickStart Development System CD installs documentation for all the MicroConverter products at C:\ADuC\Documentation. Review this documentation prior to starting the QuickStart Development System.

Directories for each product exist in the Documentation folder, as well as QuickStartTools and TechNotes directories. Each of the product directories follows a similar folder structure as shown below. All Technical Notes for any of the MicroConverter products appear in the \TechNotes directory. Check the Analog Devices website for the latest tech notes (www.analog.com/microconverter).

```
C:\ADuC\Documentation\ADuC8XX\
    DataSheets\
        ADuC8XX_Y.pdf          ADuC8XX DataSheet version Y
        Errata8XX_Y.pdf        ADuC8XX Errata Sheet version Y
        8XXqrefY.pdf           ADuC8XX Quick Reference Guide version Y
    EvalDocs\
        8XXEvalGuide_Y.pdf  ADuC8XX Eval Board Reference Guide version Y
        8XXPCB_Y.pdf           ADuC8XX Eval Board Schematic version Y
        8XXgbrs\8XXgbrs_Y.zip    ADuC8XX Eval Board Gerber files version Y.
    Other\
        8XXFAQs_Y.pdf          ADuC8XX Frequently Asked Questions version Y
        8XXgetstartedY.pdf   Get Started Guide version Y
        USERGuideDRAFTY.pdf  Draft User guide version Y
```

INSTALLED CODE LOCATIONS

Installing the MicroConverter QuickStart Development System CD installs an Assembly code directory for each MicroConverter product at C:\ADuC\Code. Product directories (such as for the ADuC832) for each MicroConverter exist with Assembly code examples.

```
C:\ADuC\Code\832\
        ADC –              - code examples for the ADC
        DAC                - code examples for the DAC
        DualDPTR           - code example for using the Dual Data Pointer
        FlashEE            - code example for using the Flash/EE Data Memory
        I2C                - code examples for I2C master and slave operation
        Misc               - Miscellaneous MicroConverter code example
        PDown              - code example demonstrating powerdown mode
        PSMon              - code example for the power supply monitor
        SP                 - code example for the extended stack pointer
        SPI                - code examples for SPI master and slave operation
        TIC                - code example for the Time Interval counter
        Uart               - code examples for configuring the UART
        WDTimer            - code example for watchdog timer
```

C example code is available in the C-Code directory. C-Code for the ADuC832 is in the \832 folder.

```
C:\ADuC\C-Code\832\
        ADC              - code examples for the ADC
        DAC              - code example for the DAC
        MISC             - Miscellaneous MicroConverter code example
        PDOWN            - code example demonstrating powerdown mode
        PLL              - code example for changing the core execution speed
        TIC              - code example for the Time Interval counter
```

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