

## 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. ADuC8xx Parts and Evaluation Boards**

Parts	Evaluation Boards <sup>1</sup>
SAR MicroConverters	
<a href="#">ADuC812</a>	EVAL-ADuC812QSZ, Rev. A3
<a href="#">ADuC814</a>	EVAL-ADuC814QSZ, Rev. B1
<a href="#">ADuC831</a>	EVAL-ADuC831QSZ, Rev. A3
<a href="#">ADuC832</a>	EVAL-ADuC832QSZ, Rev. A3
<a href="#">ADuC841</a>	EVAL-ADuC841QSZ, EVAL-ADuC841QSPZ, Rev. A3
<a href="#">ADuC842/ ADuC843</a>	EVAL-ADuC842QSZ, EVAL-ADuC842QSPZ, Rev. A3
Σ-Δ MicroConverters	
<a href="#">ADuC824, ADuC816</a>	EVAL-ADuC824QSZ, Rev. B
<a href="#">ADuC834, ADuC836</a>	EVAL-ADuC834QSZ, Rev. B
<a href="#">ADuC845</a>	EVAL-ADuC845QSZ, EVAL-ADuC845QSPZ, Rev. 0
<a href="#">ADuC847, ADuC848</a>	EVAL-ADuC847QSZ, Rev. 0

<sup>1</sup> Models ending in QSZ are QuickStart development systems; models ending in QSPZ are QuickStart plus development systems.

**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 an .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 WSD is a Windows® software program developed by Analog Devices, Inc., that allows you 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 website.
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

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## REVISION HISTORY

### 3/13—Rev. A to Rev. B

Deleted ADuC816 Evaluation Board and ADuC836 Evaluation Board .....	Universal
Changes to Table 1 and Table 2.....	1
Changes to Downloading Using the WSD Section and to Manual Run Option Section.....	5
Changes to USB-EA Emulator for Debugging Section and Replaced Figure 6 .....	7
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Added ESD Caution and Legal Terms and Conditions.....	16

### 10/09—Rev. 0 to Rev. A

Changes to Keil/IAR Limitations when Using the USB_EA Emulator Section .....	9
Added Timing Considerations when Debugging Section .....	10

### 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 the **setup.exe** file.
2. Follow the on-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 have also been 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 an .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 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.

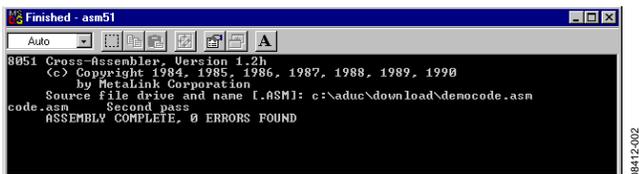


Figure 2. DOS Window

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 is 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 MicroConverter 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 for 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 can be changed from COM1 via the WSD configuration option.
2. Place the MicroConverter into serial download mode.
  - a. To enter serial download mode on the ADuC814, connect S3 into the DLOAD/DEBUG position and press the RESET switch.
  - b. To enter serial download mode on any of the other ADuC8xx products, hold down the SERIAL DOWNLOAD switch, and press and release the RESET switch.
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 set up correctly, the WSD should display **ADuC8xx version 2.Y** above the top right corner of the **Status** box.

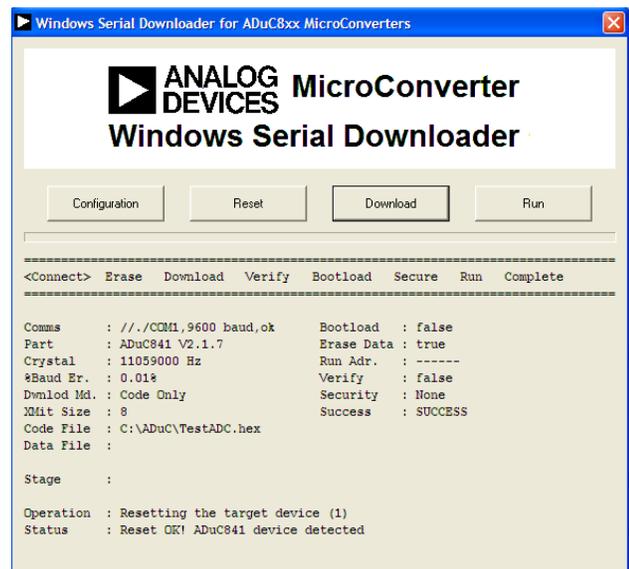


Figure 3. Windows Serial Downloader Window

### DOWNLOADING USING THE WSD

From the **Windows Serial Downloader** window

1. Click **Download**.
2. Open the file at **C:\ADuC\Download\DEMOCODE.HEX**.

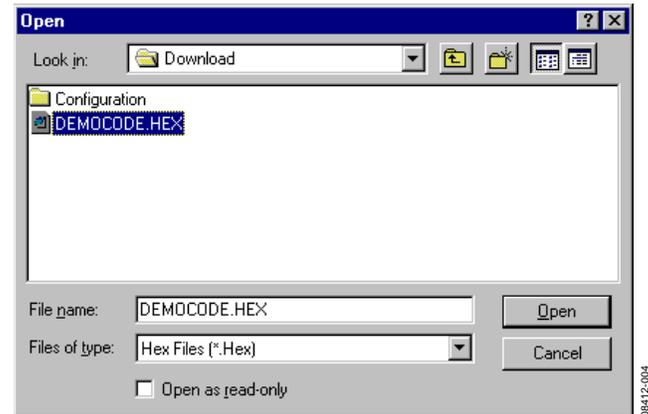


Figure 4. Open Window

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

After 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 Downloader** window, click **Run**. The **Status** box is updated with the message

```
Run OK!
```

The program starts running from Address 0x0000; 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 **Windows Serial Downloader** window.

#### Manual Run Option

Press the RESET switch 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 the reset is complete and the LED flashes.

Note that running DEMOCODE.HEX causes an LED to blink on the evaluation board. The rate of blinking is reduced each time the INT0 switch 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 erasing code or erasing code and data, can be selected via the **Configuration** window as shown in Figure 5. Remember, this window appears after clicking **Configuration** on the **Windows Serial Downloader** window (see Figure 3). Certain options may be unavailable, depending on the MicroConverter used.

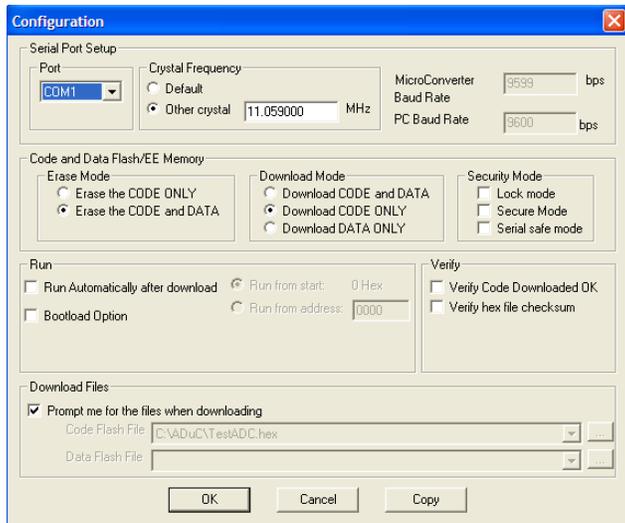


Figure 5. Configuration Window

On the **Configuration** window

1. Select **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 the required file as described in the Downloading Using the WSD section.

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

### USING THE PC COM PORT

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

The WSD uses the PC COM serial port only 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 for 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 for 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 QuickStart Plus kit 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/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 PSEN pin low. When using the evaluation boards, this involves keeping the SERIAL DOWNLOAD switch pressed while pressing and releasing the RESET switch.

### 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.

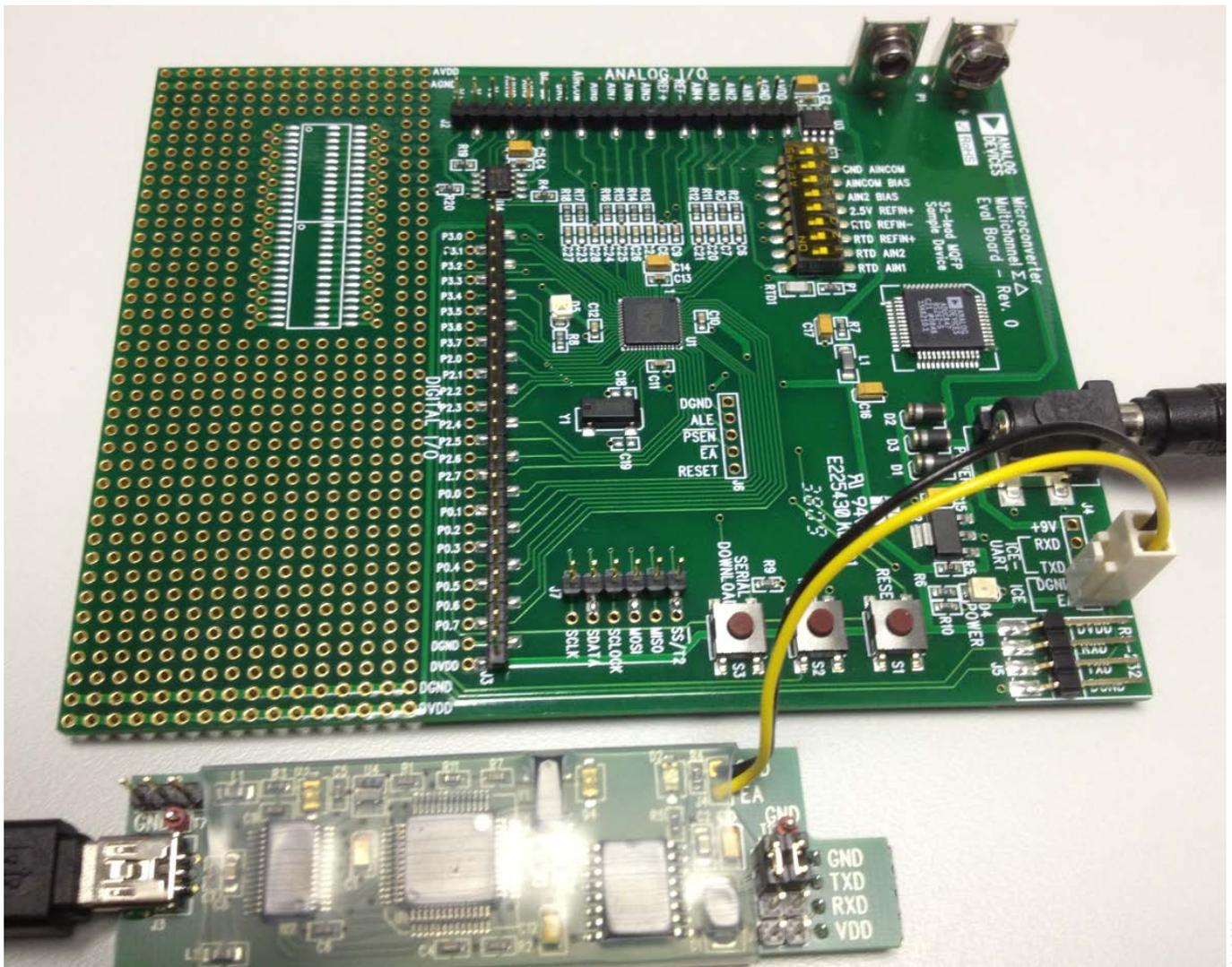


Figure 6. Target Board Connected to the USB-EA Emulator

**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 in the **Device Manager** window as shown in Figure 7.

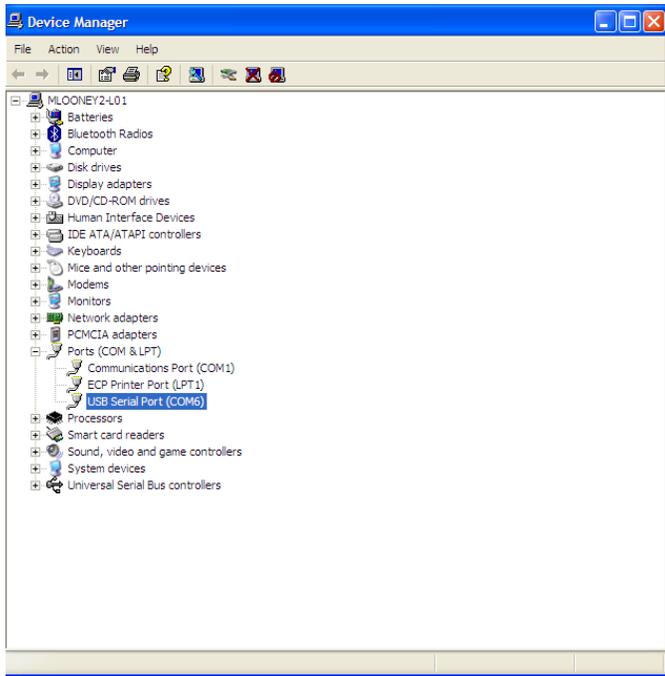


Figure 7. Device Manager Window

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 on **USB Serial Port** in the **Device Manager** window and then select **Properties**.

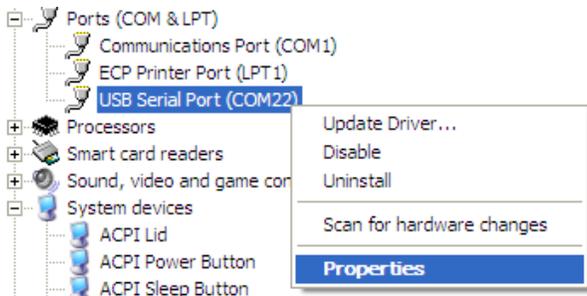


Figure 8. Choosing the USB Entry in the Device Manager Window

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

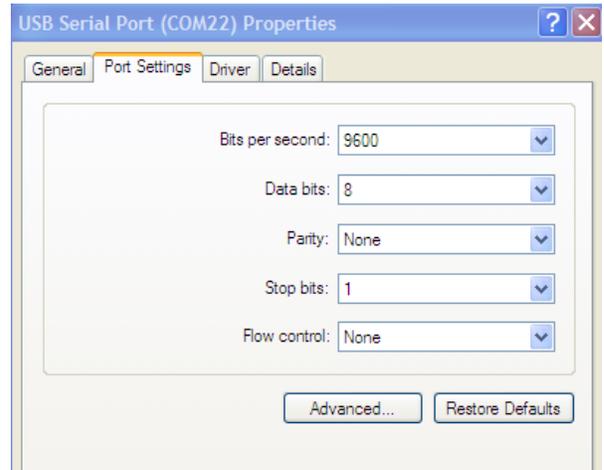


Figure 9. USB Serial Port Properties Window

3. In the **Advanced Settings** window, change the **COM Port Number** to a port lower than COM9 by making an appropriate selection.

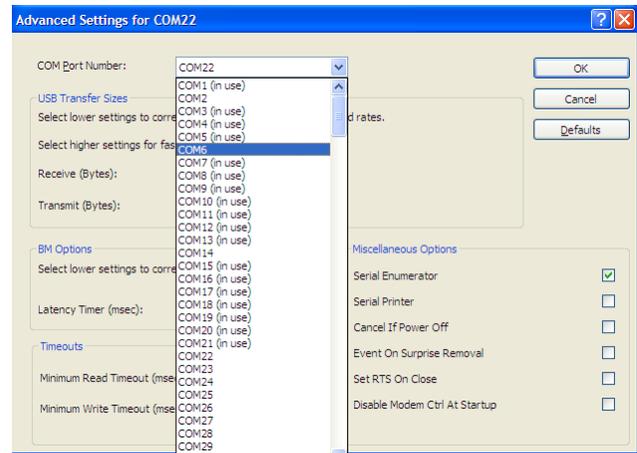


Figure 10. Advanced Settings Window

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. The newly selected COM port should appear in the **Device Manager** window.

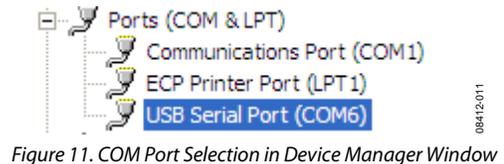


Figure 11. COM Port Selection in Device Manager Window

**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**.

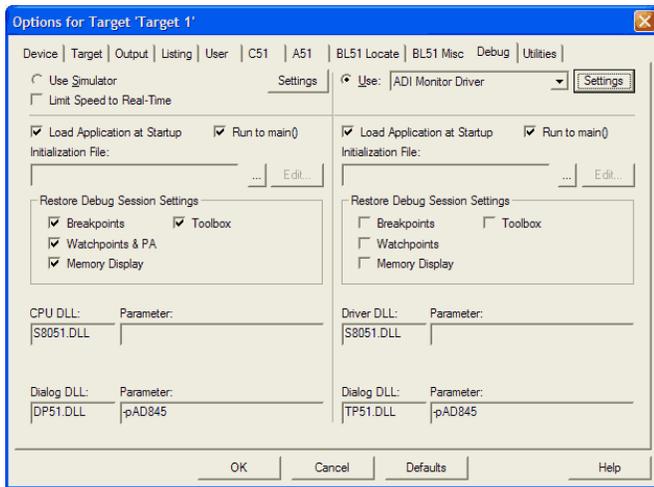


Figure 12. Options for Target Window

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.

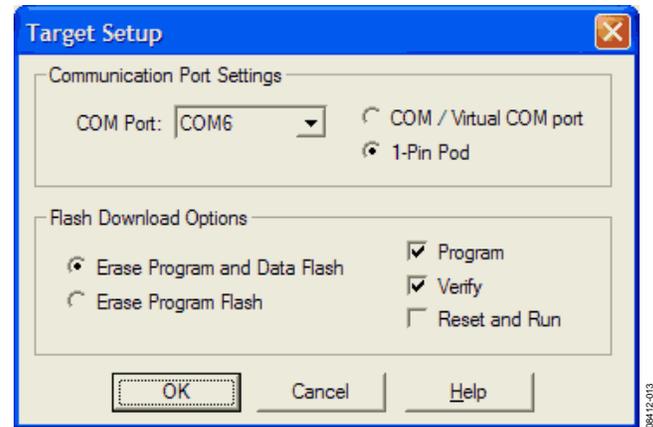


Figure 13. Target Setup Window

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, select **Debugger** in the **Category** box, and then select **Analog Devices** in the **Driver** box.

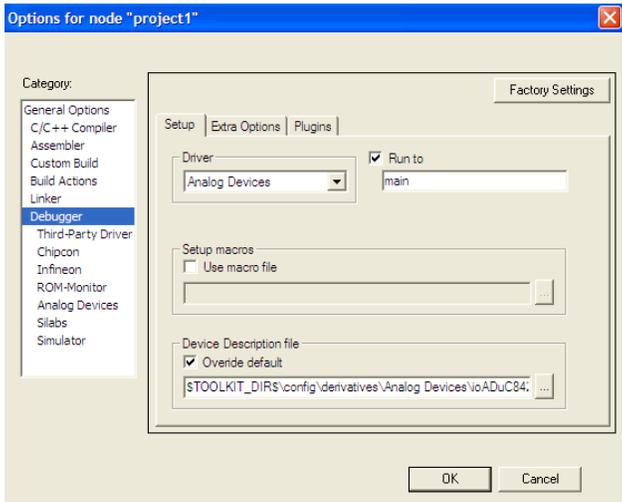


Figure 14. Options Window

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

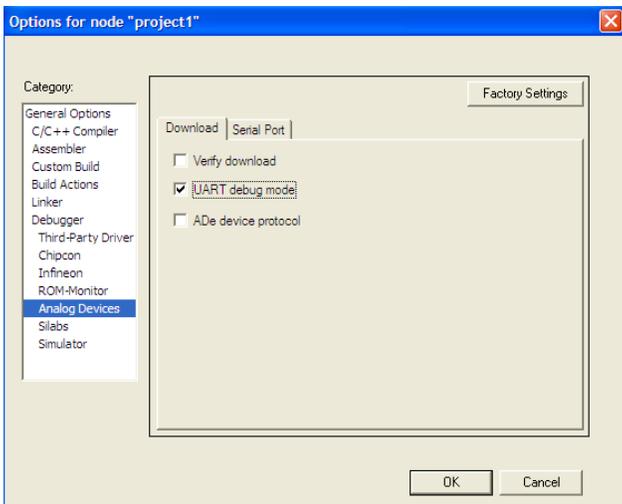


Figure 15. Download Tab

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

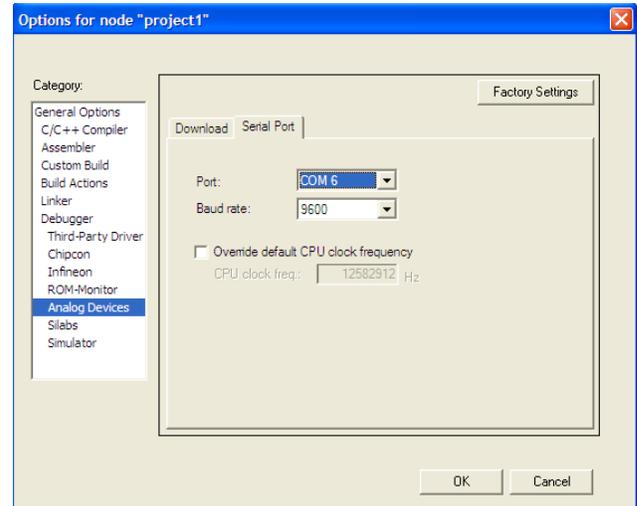


Figure 16. Serial Port Tab

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 that you include code similar to the code that follows.

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.

```
...
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
```

Other timing considerations to keep in mind are as follows:

- As with other 8052-based 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 continue to run if left enabled when breaking from emulation.

## 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  $\Sigma$ - $\Delta$  WASP (for  $\Sigma$ - $\Delta$  ADC parts [ADuC816](#), [ADuC824](#), [ADuC834](#), [ADuC836](#), [ADuC845](#), [ADuC847](#), and [ADuC848](#)). The terms SAR WASP and  $\Sigma$ - $\Delta$  WASP relate to the same WASP software. The software differentiates between the different products.

After downloading the appropriate code, the WASP launches an 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 the COM1 serial port of your PC 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**. The **ADuC8xx** window 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.

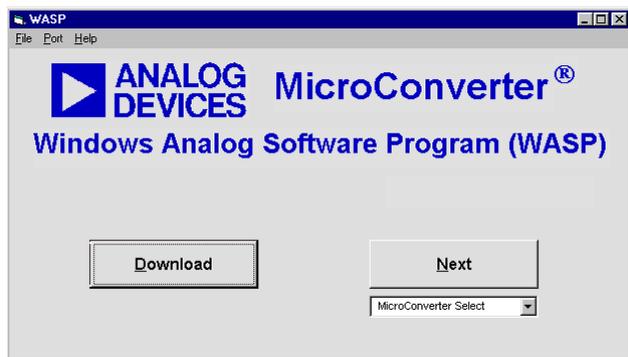


Figure 17. WASP Window

Clicking **Next** 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

An acquisition window (see Figure 18) opens for any of the SAR ADC MicroConverter products ([ADuC812](#), [ADuC814](#), [ADuC831](#), [ADuC832](#), [ADuC841](#), [ADuC842](#), and [ADuC843](#)).

From this 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, click **Run**. The acquired ADC samples appear on the chart as shown in the bottom portion of the window for the [ADuC812](#).

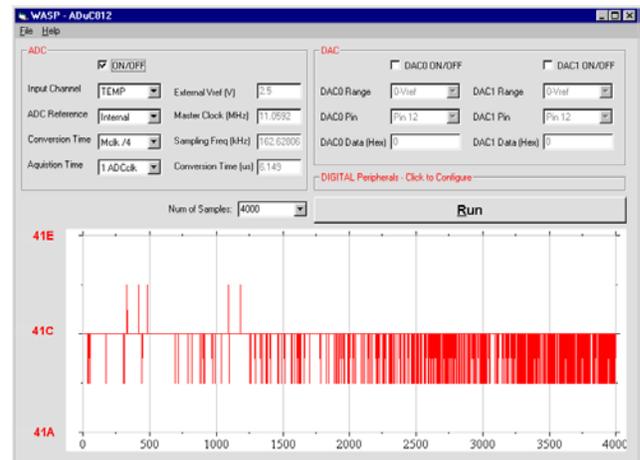


Figure 18. SAR Acquisition Window

When all the samples are collected, the WASP immediately opens the **ADC Noise Analysis** window. The **ADC Codes Histogram** and the **ADC Data Analysis** sections within this window provide a measure of the code distribution for the ADC input.

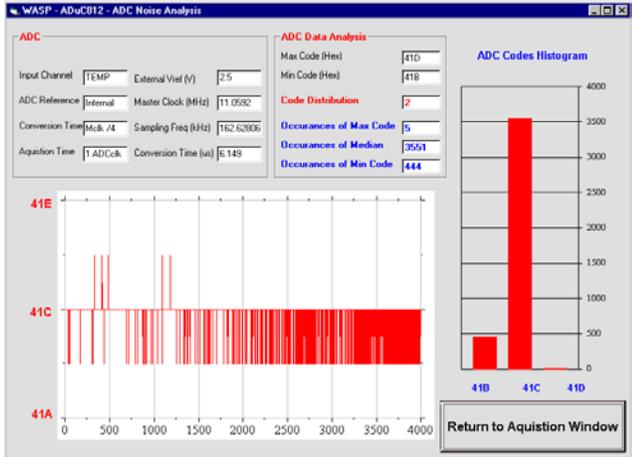


Figure 19. ADC Noise Analysis Window

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

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

### Σ-Δ WASP

An acquisition window (see Figure 20) opens for any of the Σ-Δ ADC MicroConverter products ([ADuC816](#), [ADuC824](#), [ADuC834](#), [ADuC836](#), [ADuC845](#), [ADuC847](#), and [ADuC848](#)).

From this acquisitions 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 that 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 to be 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 input AIN2 connected to AIN2 ([ADuC845/ADuC847](#) AINCOM connected to AINCOM). The auxiliary ADC, DAC, and current sources are all disabled. Note that auxiliary ADC and DAC are not available on the [ADuC847](#).

Click **Run** to send this default configuration to the MicroConverter device and to begin the conversions. The window changes to be configured 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 0x80000 can be expected. The WASP performs 500 ADC conversions by default and displays the conversion results.

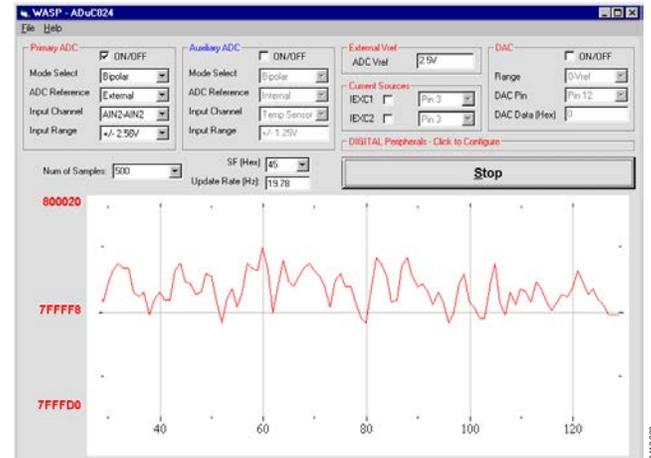


Figure 20. Σ-Δ Acquisitions Window, Primary ADC

When all the samples are collected, the WASP immediately opens the **ADC Noise Analysis** window. This window displays some mathematical analysis on the ADC conversions, including rms noise (in  $\mu\text{V}$  and bits) and peak-to-peak noise (in code distribution,  $\mu\text{V}$ , and bits). The most important performance figures are highlighted in red in Figure 21.

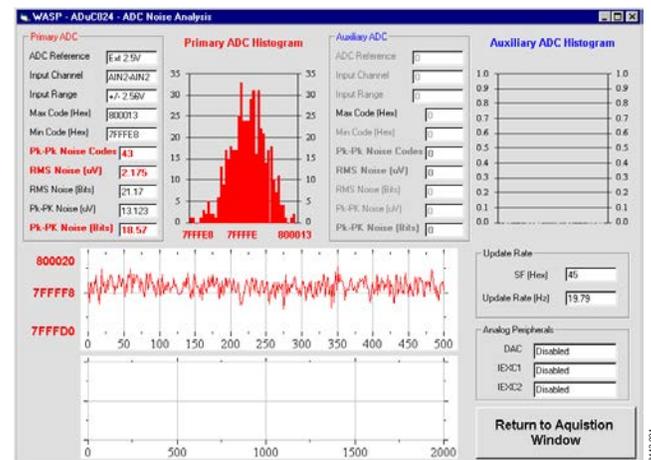


Figure 21. ADC Noise Analysis Window with Performance Highlights

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

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

## INSTALLED DOCUMENTATION AND CODE DIRECTORY

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

In the **Documentation** folder, directories for each product exist, as well as a **QuickStartTools** directory and a **TechNotes** directory. Each of the product directories follows a similar folder structure as shown in the example that follows. All technical notes for any of the MicroConverter products appear in the \TechNotes directory. Check the Analog Devices website for the latest technical notes ([www.analog.com/microconverter](http://www.analog.com/microconverter)).

C:\ADuC\Documentation\ADuC8XX\

DataSheets\ ADuC8XX_Y.pdf	ADuC8XX Data Sheet 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 provides an assembly code directory for each MicroConverter product at C:\ADuC\Code. Product directories for each MicroConverter exist with assembly code examples. For example, the product directories for the [ADuC832](#) are as follows and are located in the \832 folder.

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 I <sup>2</sup> C master and slave operation
Misc	Miscellaneous MicroConverter code example
PDown	Code example demonstrating power-down 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

Example C-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 power-down mode
PLL	Code example for changing the core execution speed
TIC	Code example for the time interval counter

## NOTES

**ESD Caution**

**ESD (electrostatic discharge) sensitive device.** Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

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