

BeMicro FPGA Project for AD5270 with Nios driver

Supported Devices

• AD5270

Evaluation Boards

• EVAL-AD5270SDZ

Overview

This lab presents the steps to setup an environment for using the **EVAL-AD5270SDZ** evaluation board together with the **BeMicro SDK** USB stick, the Nios II Embedded Development Suite (EDS) and the Micrium μ C-Probe run-time monitoring tool. Below is presented a picture of the EVAL-AD5270SDZ Evaluation Board with the BeMicro SDK Platform.



For component evaluation and performance purposes, as opposed to quick prototyping, the user is directed to use the part evaluation setup. This consists of:

- 1. A controller board like the SDP-B (EVAL-SDP-CS1Z)
- 2. The component SDP compatible product evaluation board
- 3. Corresponding PC software (shipped with the product evaluation board)

The SDP-B controller board is part of Analog Devices System Demonstration Platform (SDP). It

provides a high speed USB 2.0 connection from the PC to the component evaluation board. The PC runs the evaluation software. Each evaluation board, which is an SDP compatible daughter board, includes the necessary installation file required for performance testing.

Note: it is expected that the analog performance on the two platforms may differ.

28 Sep 2012 08:00 · Adrian Costina

Below is presented a picture of **SDP-B** Controller Board with the **EVAL-AD5270SDZ** Evaluation Board.



The **EVAL-AD5270SDZ** evaluation board is a member of a growing number of boards available for the **SDP**. Designed to help customers evaluate performance or quickly prototype new **AD5270** circuits and reduce design time, the **EVAL-AD5270SDZ** evaluation board can operate in single-supply and dual-supply mode and incorporates an internal power supply powered from the USB.

The AD5270 is a single-channel, 1024-position digital rheostat with less than $\pm 1\%$ end-to-end resistor tolerance error and 50-time programmable memory. The AD5270 supports a dual-supply ± 2.5 V to ± 2.75 V operation and a single-supply 2.7 V to 5.5 V operation, making it suited for battery-powered applications and many other applications. The AD5270 uses a versatile 3-wire serial interface that operates at clock rates up to 50 MHz, and it is compatible with standard SPI, QSPITM, MICROWIRETM, and DSP interface standards.

More information

- AD5270 Product Info pricing, samples, datasheet
- EVAL-AD5270SDZ evaluation board user guide
- BeMicro SDK
- Nios II Embedded Development Suite (EDS)
- Micrium uC-Probe

Getting Started

The first objective is to ensure that you have all of the items needed and to install the software tools

so that you are ready to create and run the evaluation project.

Hardware Items

Below is presented the list of required hardware items:

- Arrow Electronics BeMicro SDK FPGA-based MCU Evaluation Board
- BeMicro SDK/SDP Interposer adapter board
- EVAL-AD5270SDZ evaluation board
- Intel Pentium III or compatible Windows PC, running at 866MHz or faster, with a minimum of 512MB of system memory

Software Tools

Below is presented the list of required software tools:

- Quartus II Web Edition design software v11.0
- Nios II EDS v11.0
- uC-Probe run-time monitoring tool, version 2.5

The **Quartus II** design software and the **Nios II EDS** is available via the Altera Complete Design Suite DVD or by downloading from the web.

The **Micrium uC/Probe Trial** version 2.5 is available via download from the web at http://micrium.com/tools/ucprobe/trial/. After installation add to the "Path" system variable the entry " %QUARTUS_ROOTDIR%\bin\" on the third position in the list.

Downloads

• Lab Design Files

Extract the Lab Files

Create a folder called "ADIEvalBoardLab" on your PC and extract the ad5270_evalboardlab.zip archive to this folder. Make sure that there are **NO SPACES** in the directory path. After extracting the archive the following folders should be present in the ADIEvalBoardLab folder: FPGA, Software, ucProbeInterface, NiosCpu.

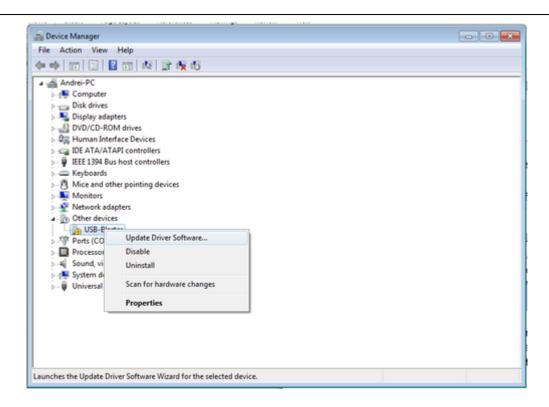
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🔆 Favorites	Name		Date modified	Туре	Size		
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Install the USB-Blaster Device Driver

After the **Quartus II** and **Nios II** software packages are installed, you can plug the BeMicro SDK board into your USB port. Your Windows PC will find the new hardware and try to install the driver.

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Since Windows cannot locate the driver for the device the automatic installation will fail and the driver has to be installed manually. In the *Device Manager* right click on the **USB-Blaster** device and select **Update Driver Software**.

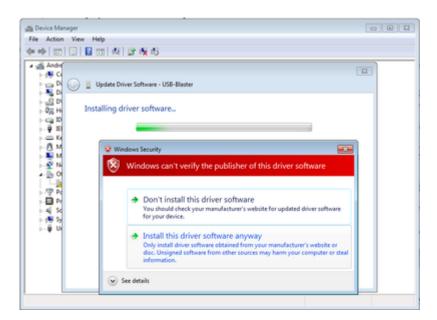


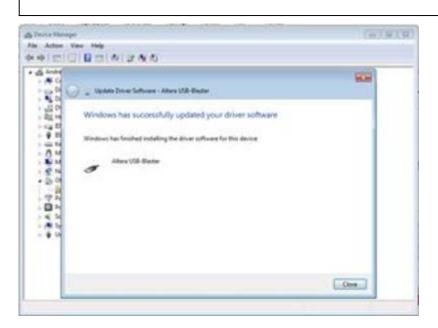
In the next dialog box select the option **Browse my computer for driver software**. A new dialog will open where it is possible to point to the driver's location. Set the location to **altera**\<**version number**>\quartus\drivers\usb-blaster and press **Next**.

01	Update Driver Software - USB-Blaster	
Но	w do you want to search for driver software?	
	 Search automatically for updated driver software Windows will search your computer and the Internet for the latest driver software for your device, unless you've disabled this feature in your device installation settings. 	
	Browse my computer for driver software Locate and install driver software manually.	
		Cancel

🕝 🧕 Update Driver Software - USB-Blaster
Browse for driver software on your computer
Search for driver software in this location: Colters/11.0/quartus/drivers/usb-blaster Browse Include subfolders
Let me pick from a list of device drivers on my computer This list will show installed driver software compatible with the device, and all driver software in the same category as the device.
Next Cancel

If Windows presents you with a message that the drivers have not passed Windows Logo testing, please click "*Install this driver software anyway*". Upon installation completion a message will be displayed to inform that the installation is finished.





15 Sep 2011 14:23 · Andrei Cozma

Quick Evaluation

The next sections of this lab present all the steps needed to create a fully functional project that can be used for evaluating the operation of the ADI platform. It is possible to skip these steps and load into the FPGA an image that contains a fully functional system that can be used together with the uC-Probe interface for the ADI platform evalution. The first step of the quick evaluation process is to program the FPGA with the image provided in the lab files. Before the image can be loaded the **Quartus II Web Edition** tool or the Quartus II Programmer must be installed on your computer. To load the FPGA image run the **program_fpga.bat** batch file located in the **ADIEvalBoardLab/FPGA** folder. After the image was loaded the system must be reset. Now the FPGA contains a fully functional system and it is possible to skip directly to the **DEMONSTRATION PROJECT USER INTERFACE** section of this lab.

15 Sep 2011 14:43 · Andrei Cozma

FPGA Design

The lab is delivered together with a set of design files that are used to evaluate the ADI part. The FPGA image that must be loaded into the BeMicroSDK FPGA is included in the design files. This section presents the components included in the FPGA image and also the procedure to load the image into the FPGA.

FPGA Components

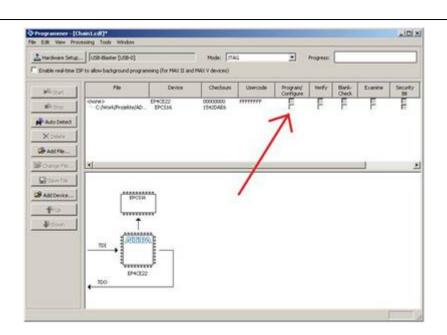
The following components are implemented in the FPGA design:

Name	Address	IRQ
CPU	800	-
Main PLL	80	-
JTAG UART	90	0
uC-Probe UART	A0	1
EPCS FLASH CONTROLLER	1800	2
OnChip RAM	10000	-
LED GPIO	100	-
SPI_0_P0	2000	4
SPI_1_P0	2040	6
GPIO	2080	-
CTRL GPIO	20A0	-
SPI_0_P1	0	5
SPI_1_P1	20	7
SYS ID	40	-
TIMER	60	3
I2C_0	C0	8
I2C_1	E0	9

Load the FPGA Image

To load the FPGA image the following steps must be performed:

- Plug in the **BeMicroSDK** Stick into a USB port
- Start Altera Quartus Web edition and start the programmer by selecting the menu option *Tools→Programmer*
- Select Add File and select the file ADIEvalBoardLab/FPGA/SDP1_bemicro2.jic
- Check the Program/Configure box and press Start



After finishing, the image is permanently loaded to the configuration Flash and the system will start with a blinking LED after reset or power up.

15 Sep 2011 14:47 · Andrei Cozma

NIOS II Software Design

This section presents the steps for developing a software application that will run on the **BeMicroSDK** system and will be used for controlling and monitoring the operation of the ADI evaluation board.

Create a new project using the NIOS II Software Build Tools for Eclipse

Launch the Nios II SBT from the Start \rightarrow All Programs \rightarrow Altera \rightarrow Nios II EDS 11.0 \rightarrow Nios II 11.0 Software Build Tools for Eclipse (SBT).

NOTE: Windows 7 users will need to right-click and select **Run as administrator**. Another method is to right-click and select **Properties** and click on the **Compatibility** tab and select the **Run This Program As An Administrator** checkbox, which will make this a permanent change.

1. Initialize Eclipse workspace

When Eclipse first launches, a dialog box appears asking what directory it should use for its workspace. It is useful to have a separate Eclipse workspace associated with each hardware project that is created in SOPC Builder. Browse to the *ADIEvalBoardLab* directory and click *Make New Folder* to create a folder for the software project. Name the new folder "*eclipse_workspace*". After selecting the workspace directory, click *OK* and Eclipse will launch and the workbench will appear in the *Nios II* perspective.

		Select Workspace Directory	
Workspace Launcher	83	Select the workspace directory to use.	
Select a workspace		ADEvalBoardLab	
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Workspace: D1/ADIEvalBoardLab/eclipse_workspace	- Browse	FPGA > NiosCpu	
		> 🎴 Software	
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Use this as the default and do not ask again		▷ Jak KIT ▷ Jak temp	-
	OK Cancel	DVD RW Drive (E)	
		Folder: eclipse_workspace	
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2. Create a new software project in the SBT

• Select File → New → Nios II Application and BSP from Template.

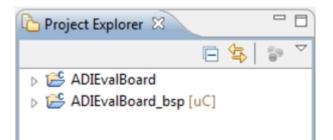
File	Edit Navigate Search Project Run Ni	os II Window Help	
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	Open File	2	Nios II Application
	Close	Ctrl+W	Nios II Board Support Package
	Close All	Ctrl+Shift+W	
	Save	Ctrl+S	
	Save As		Other Ctrl+N
	Save All	Ctrl+Shift+S	

- Click the Browse button in the SOPC Information File Name dialog box.
- Select the uC.sopcinfo file located in the ADIEvalBoardLab/FPGA directory.
- Set the name of the Application project to "ADIEvalBoard".
- Select the *Blank Project* template under *Project template*.
- Click the *Finish* button.

Nios II Application and BSP from	n Template	
Nios II Software Examples		
Create a new application and box	ard support package based on a software example template	
Target hardware information SOPC Information File name:	D:\ADIEvalBoardLab\FPGA\uC.sopcinfo	
CPU name:	cpu 🔹	
Application project		
Project name: ADIEvalBoard	I	
Use default location Project location: D:\ADI	EvalBoardLab\FPGA\software\ADIEvalBoard	הו
Project template Templates	Template description	
Blank Project	Blank Project creates an empty project to which you can	
Board Diagnostics Count Binary Hello Freestanding Hello MicroC/OS-II Hello World Small Memory Test Memory Test Small Simple Socket Server Simple Socket Server Web Server Web Server (RGMII)	add your code. For details, click Finish to create the project and refer to the readme.txt file in the project directory. The BSP for this template is based on the Altera HAL operating system. To use a BSP based on a different operating system, click Next and select the BSP from the BSP projects list. I) For information about how this software example relates to	
?	< Back Next > Finish	Cancel

The tool will create two new software project directories. Each Nios II application has 2 project directories in the Eclipse workspace.

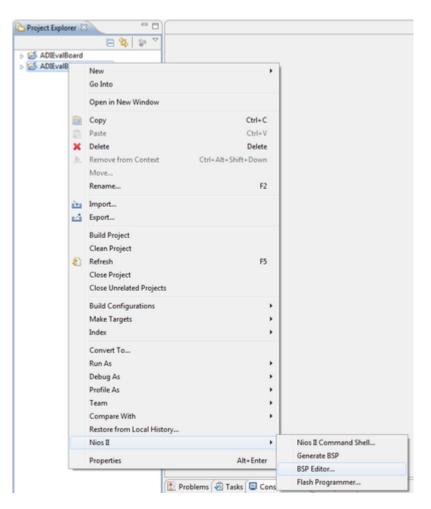
- The application software project itself this where the application lives.
- The second is the **Board Support Package (BSP)** project associated with the main application software project. This project will build the system library drivers for the specific SOPC system. This project inherits the name from the main software project and appends "**_bsp**" to that.



Since you chose the blank project template, there are no source files in the application project directory at this time. The BSP contains a directory of software drivers as well as a system.h header file, system initialization source code and other software infrastructure.

Configure the Board Support Package

- Configure the board support package to specify the properties of this software system by using the **BSP Editor** tool. These properties include what interface should be used for *stdio* and *stderr* messages, the memory in which stack and heap should be allocated and whether an operating system or network stack should be included with this BSP.
- Right click on the *ADIEvalBoard_bsp* project and select *Nios II → BSP Editor...* from the right-click menu.



The software project provided in this lab does not make use of an operating system. All *stdout*, *stdin* and *stderr* messages will be directed to the *jtag_uart*.

- Select the *Common* settings view. In the *Common* settings view, change the following settings:
 - Select the *jtag_uart* for *stdin*, *stdout* and *stderr* messages. Note that you have more than one choice.
 - Select *none* for the *sys_clk_timer* and *timestamp_timer*.

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- Select **File** \rightarrow **Save** to save the board support package configuration to the *settings.bsp* file.
- Click the *Generate* button to update the BSP.
- When the generate has completed, select **File** \rightarrow **Exit** to close the BSP Editor.

Configure BSP Project Build Properties

In addition to the board support package settings configured using the **BSP Editor**, there are other compilation settings managed by the Eclipse environment such as compiler flags and optimization level.

- Right click on the *ADIEvalBoard_bsp* software project and select *Properties* from the right-click menu.
- On the left-hand menu, select Nios II BSP Properties.
- During compilation, the code may have various levels of optimization which is a tradeoff between code size and performance. Change the **Optimization level** setting to **Level 2**
- Since our software does not make use of C++, uncheck **Support C++**.
- Check the **Reduced device drivers** option
- Check the Small C library option
- Press Apply and OK to regenerate the BSP and close the Properties window.

type filter text	Nios II BSP Properties	(+ + + + +
Resource Builders C/C++ Build C/C++ General Nios II BSP Properties Project References Run/Debug Settings Task Repository WikiText	SopcInfo: D:\ADIEvalBoardLab\FPGA\uC.s Flags Defined symbols: none Undefined symbols: none Assembler flags: -Wa,-gdwarf2 Warning flags: -Wall User flags: none Debug level: On Optimization level: Level 2 Reduced device drivers Support C++ GPROF support Small C library ModelSim only, no hardware support	BSP Editor
?		OK Cancel

Add source code to the project

In Windows Explorer locate the project directory which contains a directory called **Software**. In Windows Explorer select all the files and directories from the **Software** folder and drag and drop them into the Eclipse software project **ADIEvalBoard**.

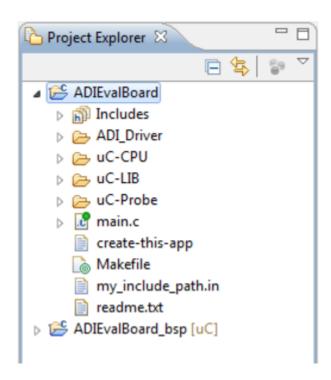
• Select all the files and folders and drag them over the **ADIEvalBoard** project in the SBT window and drop the files onto the project folder.

Nios II - Eclipse						
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😂 ADIEvalBoard_bsp (uC)	Desktop	ADI Driver	9/16/2011 2:25 PM	File folder		
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• A dialog box will appear to select the desired operation. Select the option **Copy files and folders** and press **OK**.

File and Folder Operation				
Select how files and folders should be imported into the project:				
Opy files and folders				
Cink to files and folders				
Cink to files and recreate folder structure with virtual folders				
✓ Create link locations relative to: PROJECT_LOC ▼				
Configure Drag and Drop Settings				
OK Cancel				

• This should cause the source files to be physically copied into the file system location of the software project directory and register these source files within the Eclipse workspace so that they appear in the Project Explorer file listing.



Configure Application Project Build Properties

Just as you configured the optimization level for the BSP project, you should set the optimization level for the application software project **ADIEvalBoard** as well.

- Right click on the **ADIEvalBoard** software project and select **Properties** from the right-click menu.
- On the left-hand menu, select the *Nios II Application Properties* tab

- Change the **Optimization level** setting to **Level 2**.
- Press **Apply** and **OK** to save the changes.

Resource Builders C/C++ Build C/C++ General Nios II Application Properti Project References Run/Debug Settings Task Repository WikiText User flags: Linker flags: Linker flags: Debug level: On Optimization level: Level 2 ▼ ✓ Create object dump ✓ Enable source management	Properties for ADIEvalBoard type filter text	Nine II Application Depending	
Apply	Resource Builders C/C++ Build C/C++ General Nios II Application Properti Project References Run/Debug Settings Task Repository	ELF name: ADIEvalBoard.elf Defined symbols:	
	< III >		Apply

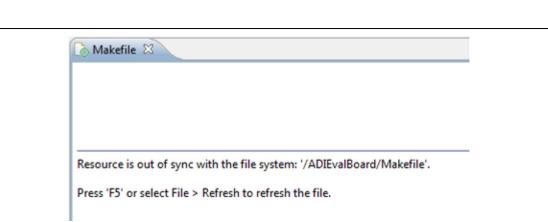
Define Application Include Directories

Application code can be conveniently organized in a directory structure. This section shows how to define these paths in the makefile.

- In the Eclipse environment double click on *my_include_paths.in* to open the file.
- Click the *Ctrl* and *A* keys to select all the text. Click the *Ctrl* and *C* keys to copy all the text.

Project Explorer 🛛 📃 🗆	my_include_path.in 😫
 ADIEvalBoard ADIEvalBoard ADI_Driver ADI_Driver CCPU CCPU CCPU CCPOBE Create-this-app Makefile my_include_path.in readme.txt ADIEvalBoard_bsp [uC] 	APP_INCLUDE_DIRS += ADI_Driver APP_INCLUDE_DIRS += uC-CPU APP_INCLUDE_DIRS += uC-CPU/BSP APP_INCLUDE_DIRS += uC-CPU/NioSII APP_INCLUDE_DIRS += uC-LIB APP_INCLUDE_DIRS += uC-LIB/Cfg APP_INCLUDE_DIRS += uC-Probe

- Double click on *Makefile* to open the file.
- If you see the message shown here about resources being out of sync, right click on the **Makefile** and select **Refresh**.



• Select the line **APP_INCLUDE_DIRS :=**

• Click the *Ctrl* and *V* keys to replace the selected line with the include paths.

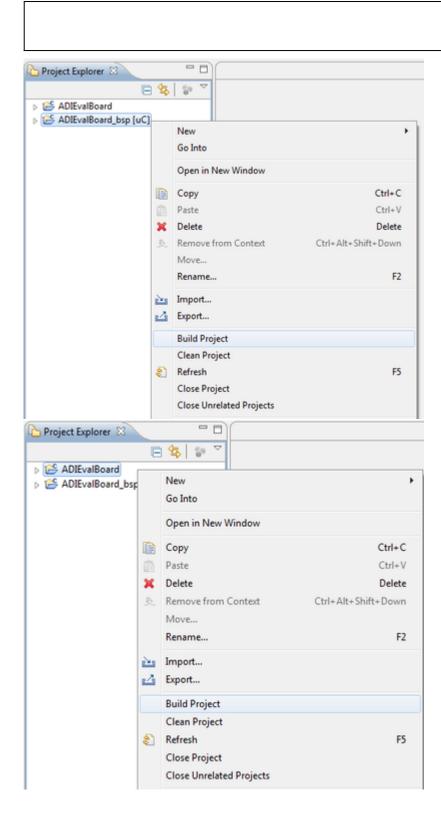
• Click the *Ctrl* and *S* keys to save the *Makefile*.

Compile, Download and Run the Software Project

1. Build the Application and BSP Projects

- Right click the *ADIEvalBoard_bsp* software project and choose *Build Project* to build the board support package.
- When that build completes, right click the **ADIEvalBoard** application software project and choose **Build Project** to build the Nios II application.

These 2 steps will compile and build the associated board support package, then the actual application software project itself. The result of the compilation process will be an *Executable and Linked Format (.elf)* file for the application, the **ADIEvalBoard.elf** file.

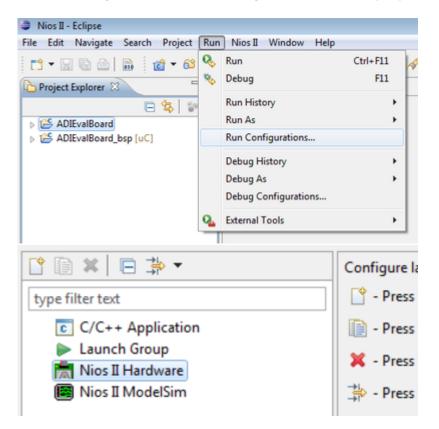


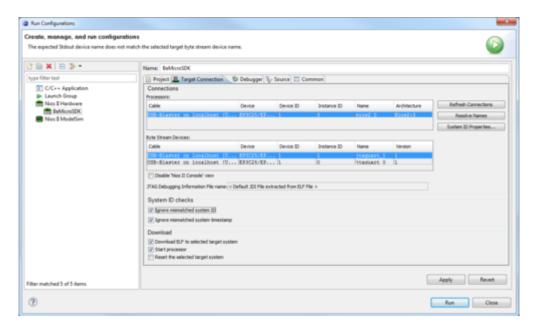
2. Verify the Board Connection

The **BeMicroSDK** hardware is designed with a *System ID* peripheral. This peripheral is assigned a unique value based on when the hardware design was last modified in the SOPC Builder tool. SOPC Builder also places this information in the *.sopcinfo* hardware description file. The BSP is built based on the information in the *.sopcinfo* file.

- Select the ADIEvalBoard application software project.
- Select Run → Run Configurations...

- Select the Nios II Hardware configuration type.
- Press the *New* button to create a new configuration.
- Change the configuration name to **BeMicroSDK** and click **Apply**.
- On the *Target Connection* tab, press the *Refresh Connections* button. You may need to expand the window or scroll to the right to see this button.
- Select the *jtag_uart* as the *Byte Stream Device* for *stdio*.
- Check the Ignore mismatched system ID option.
- Check the Ignore mismatched system timestamp option.



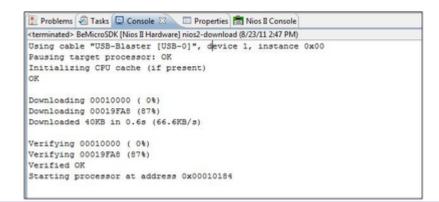


3. Run the Software Project on the Target

To run the software project on the Nios II processor:

• Press the *Run* button in the *Run Configurations* window.

This will re-build the software project to create an up-to-date executable and then download the code into memory on the **BeMicroSDK** hardware. The debugger resets the Nios II processor, and it executes the downloaded code. Note that the code is verified in memory before it is executed.





The code size and start address might be different than the ones displayed in the above screenshot.

12 Sep 2011 10:39 · Robin Getz

uC-Probe Interface

A notable challenge in embedded systems development is to overcome the lack of feedback that such systems typically provide. Many developers resort to blinking LEDs or instrumenting their code with *printf()* in order to determine whether or not their systems are running as expected. **Micrium** provides a unique tool named **µC-Probe** to assist these developers. With this tool, developers can effortlessly read and write the variables on a running embedded system. This section presents the steps required to install the **Micrium uC-Probe** software tool and to run the demonstration project for the ADI evaluation board. A description of the **uC-Probe** demonstration interface is provided.

Configure uC-Probe

Launch **uC-Probe** from the **Start** → **All Programs** → **Micrium** → **uC-Probe**.

Select **uC-Probe** options.

- Click on the **uC-Probe** icon on the top left portion of the screen.
- Click on the **Options** button to open the dialog box.

Micrium µC/Pro	be - Untitled	Workspace	:							
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Save As										-
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Set target board communication protocol as JTAG UART

- Click on the *Communication* tab icon on the top left portion of the dialog box
- Select the **JTAG UART** option.

Options	
Communication 	Settings RS-232 USB J-Link Hew Target Server TCP/IP (UDP) ITAG UART Update symbols/sec bytes/sec Slow queue update period: 10 sec. Wait Time: 0 ms.
	OK Cancel Apply

Setup JTAG UART communication settings

- Select the **JTAG-UART** option from the **Communication** tab.
- Press the **Open File** button to select the JTAG Debug Information file (.jdi)
- Navigate to the **ADIEvalBoardLab/FPGA** folder and select the BeMicroSDK.jdi file. Press Open.
- Type the value **1** in the the **Device Id** window.

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		OK Garoal	Apply	Ga Looi Disk (Q)	ere: BellovSDKjá	- tpi	• Canol

• Select *uCProbe_uart(0)* from the *Instance Id* pulldown menu.

Options		
Communication 	Settings Cable: Device Id:	USB-Blaster [USB-0]
Startup 	Instance Id:	tag uat (1) UCProbe uat (0) Open File
		OK Cancel Apply

 Press Apply and OK to exit the options menu. The embedded target has two UARTs. uC-Probe will be communicating with the uCProbe_uart.

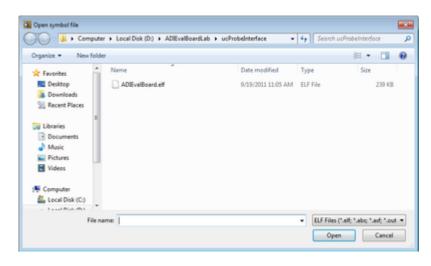
Load and Run the Demonstration Project

 Click the Open option from the uC-Probe menu and select the file ADIEvalBoardLab/ucProbeInterface/AD5270_Interface.wsp.

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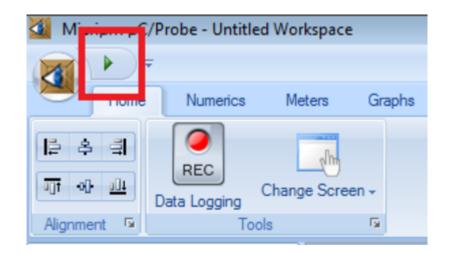
 Before opening the interface uC-Probe will ask for a symbols file that must be associated with the interface. If the lab was done according to the steps provided in the Quick Evaluation section, select the file ADIEvalBoardLab/ucProbeInterface/ADIEvalBoard.elf to be loaded as a symbol file, otherwise select the file

ADIEvalBoardLab/FPGA/software/ADIEvalBoard/ADIEvalBoard.elf to be loaded as a symbol file.



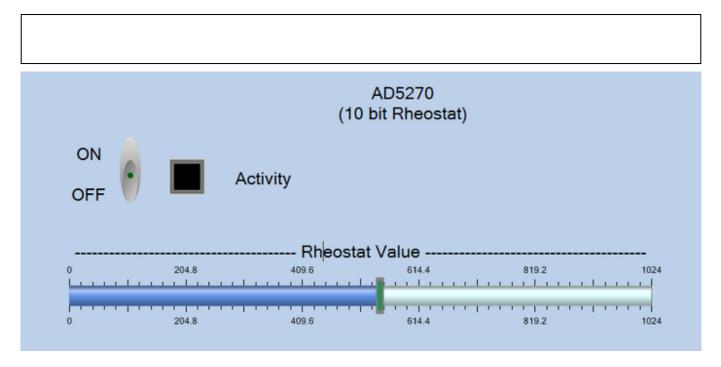
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• Run the demonstration project by pressing the *Play* button.



Demonstration Project User Interface

The following figure presents the **uC-Probe** interface that can be used for monitoring and controlling the operation of the **EVAL-AD5270SDZ** evaluation board.



The communication with the board is activated / deactivated by toggling the **ON/OFF** switch. The **Activity** LED turns green when the communication is active. If the **ON/OFF** switch is set to **ON** and the **Activity** LED is **BLACK** it means that there is a communication problem with the board. See the **Troubleshooting** section for indications on how to fix the communication problems.

The rheostat value is set by the "Rheostat Value" slider.

Troubleshooting

In case there is a communication problem with the board the following actions can be perfored in order to try to fix the issues:

- Check that the evaluation board is powered.
- Check that the USB connection cable is properly connected to the device and to the computer and that the USB Blaster Device Driver driver is installed correctly. If the deriver is not correctly installed perform the steps described in the Getting Started → Install te USB-Blaster Device Driver section.
- In uC-Probe right-click on the **System Browser** window select **Remove Symbols**. A dialog box will open to select the symbols to remove. Press OK to remove the symbols.

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 After removing the symbols a new set of symbols must be added in order for the interface to be functional. In uC-Probe right-click on the *System Browser* window select *Add Symbols*. A dialog box will open to select the symbols to be added. If the lab was done according to the steps provided in the Quick Evaluation section, select the file

ADIEvalBoardLab/ucProbeInterface/ADIEvalBoard.elf to be loaded as a symbol file, otherwise select the file ADIEvalBoardLab/FPGA/software/ADIEvalBoard/ADIEvalBoard.elf to be loaded as a symbol file.

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Symbol Browser 9	
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Symbols removed J	AG-UART USB-Blaster (USB-0) 1 0

• If the communication problem persists even after performing the previous steps, restart the uC-Probe application and try to run the interface again.

More information

- Description about the FPGA reference design
- Example questions:
 - What's the width and deepth of the FIFO in Fmcomms2 adc_dmac? by I312361206
 - Have you any JESD204B reference design that has not microblaze and MIG7 Axi_ddr_cntrl? by saban
 - FMCOMMS3 and ethernet data extraction by Cman
 - AD-FMCDAQ2 AD9680-1000 Noise Floor by Ed_V
 - FMCOMMS1 AD9548 clock derivation explanation by cherif.chibane@ll.mit.edu

21 Sep 2011 08:17 · Andrei Cozma

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