Nios® II

Nios II Development Kit

Getting Started User Guide

101 Innovation Drive
San Jose, CA 95134
(408) 544-7000
http://www.altera.com

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About This User Guide

This getting started user guide provides initial information about how to use the Altera® Nios® II development kit, including unpacking the kit, installing required software, connecting the Nios development board to a PC, and running sample software.

Table 1–1 shows this document's revision history.

Refer to the Nios II embedded processor **readme** file for late-breaking information that is not available in this document.

Table 1–1. Tutorial Revision History

Date	Description
May 2005	Updates for the Nios II version 5.0 release.
December 2004	Updates for the Nios II development kit version 1.1.
September 2004	Updates for the Nios II development kit version 1.01.
May 2004	Initial publication for the Nios II development kit version 1.0.

How to Find Information

- The Adobe Acrobat Find feature allows you to search the contents of a PDF file. Click the binoculars toolbar icon to open the Find dialog box
- Bookmarks serve as an additional table of contents
- Thumbnail icons, which provide miniature previews of each page, provide a link to the pages
- Numerous links, shown in green text, allow you to jump to related information

How to Contact Altera

For the most up-to-date information about Altera products, go to the Altera world-wide web site at www.altera.com. For technical support on this product, go to www.altera.com/mysupport. For additional information about Altera products, consult the sources shown below.

Information Type	USA & Canada	All Other Locations
Technical support	www.altera.com/mysupport/	www.altera.com/mysupport/
	(800) 800-EPLD (3753) (7:00 a.m. to 5:00 p.m. Pacific Time)	+1 408-544-8767 7:00 a.m. to 5:00 p.m. (GMT -8:00) Pacific Time
Product literature	www.altera.com	www.altera.com
Altera literature services	literature@altera.com	literature@altera.com
Non-technical customer service	(800) 767-3753	+ 1 408-544-7000 7:00 a.m. to 5:00 p.m. (GMT -8:00) Pacific Time
FTP site	ftp.altera.com	ftp.altera.com

Typographic Conventions

This document uses the typographic conventions shown below.

Visual Cue	Meaning
Bold Type with Initial Capital Letters	Command names, dialog box titles, checkbox options, and dialog box options are shown in bold, initial capital letters. Example: **Save As** dialog box.
bold type	External timing parameters, directory names, project names, disk drive names, filenames, filename extensions, and software utility names are shown in bold type. Examples: $\mathbf{f_{MAX}}$, **\qdesigns** directory, **d:** drive, **chiptrip.gdf** file.
Italic Type with Initial Capital Letters	Document titles are shown in italic type with initial capital letters. Example: *AN 75: High-Speed Board Design.*
Italic type	Internal timing parameters and variables are shown in italic type. Examples: t_{PIA}, $n + 1$. Variable names are enclosed in angle brackets (< >) and shown in italic type. Example: *<file name>*, *<project name>***.pof** file.
Initial Capital Letters	Keyboard keys and menu names are shown with initial capital letters. Examples: Delete key, the Options menu.
"Subheading Title"	References to sections within a document and titles of on-line help topics are shown in quotation marks. Example: "Typographic Conventions."

Visual Cue	Meaning
`Courier type`	Signal and port names are shown in lowercase Courier type. Examples: `data1`, `tdi`, `input.` Active-low signals are denoted by suffix `n`, e.g., `resetn`. Anything that must be typed exactly as it appears is shown in Courier type. For example: `c:\qdesigns\tutorial\chiptrip.gdf`. Also, sections of an actual file, such as a Report File, references to parts of files (e.g., the AHDL keyword `SUBDESIGN`), as well as logic function names (e.g., `TRI`) are shown in Courier.
1., 2., 3., and a., b., c., etc.	Numbered steps are used in a list of items when the sequence of the items is important, such as the steps listed in a procedure.
■ ● •	Bullets are used in a list of items when the sequence of the items is not important.
✓	The checkmark indicates a procedure that consists of one step only.
	The hand points to information that requires special attention.
	The caution indicates required information that needs special consideration and understanding and should be read prior to starting or continuing with the procedure or process.
	The warning indicates information that should be read prior to starting or continuing the procedure or processes
↵	The angled arrow indicates you should press the Enter key.
	The feet direct you to more information on a particular topic.

Getting Started

Introduction

Welcome to the Nios® II development kit! The Nios II development kit is a complete embedded systems development kit for the Nios II embedded processor. In addition to the full-featured Nios development board, the kit includes all the hardware and software development tools, documentation and accessories you need to begin developing Nios II embedded processor systems.

This user guide will familiarize you with the contents of the Nios II development kit and walk you through setting up your Nios II development environment. In this guide, you will:

1. Install the development tools software.
2. Set up and verify correct operation of the Nios development board.
3. Establish communication between the Nios development board and the host PC.
4. Compile C code and download the code to the Nios development board.

When you finish this guide, you will be ready to begin designing custom Nios II embedded processor systems.

Before You Begin

Before proceeding, check the contents of the kit and verify that you received the following items:

Nios Development Board and Accessories

- Nios development board
- CompactFlash card (socketed in the Nios development board)
- USB-Blaster™ download cable
- Ethernet cable
- Ethernet cross-over adapter
- LCD module
- 9-pin RS-232 serial cable
- DC power supply
- Three regional power cables

Development Tools

Included in the kit is a CD-ROM folder, containing the following:

- Nios II Embedded Processor for Windows CD-ROM
- Nios II Embedded Processor for Linux CD-ROM
- Quartus® II Design Software for PCs CD-ROM
- MegaCore® IP Library for Windows and Linux CD-ROM

See **www.altera.com** for available evaluation software by third-party Nios II Development Partners.

Documentation

- This Nios II Development Kit Getting Started User Guide
- Quartus II Installation & Licensing for PCs manual

Licensing Considerations

You need your computer's network identification card (NIC) ID to license the development tools. The NIC ID is a 12-digit hexadecimal number that identifies your computer for licensing purposes. When obtaining a license file for network licensing, use the NIC ID for the computer that will act as the license server.

To display your NIC ID, perform one of the following steps:

- On Windows PCs, open a command prompt and type:
  <*Windows installation path*>`\system32\ipconfig /all`

  Your NIC ID is the number on the line labeled **Physical Address**, minus the hyphens.

- On Linux PCs, open a shell command-prompt and type:
  `ifconfig`

  Your NIC ID is the number labeled **HWaddr**, minus the colons.

  If this command fails to display your NIC ID, make sure the `ifconfig` utility is in the search path. On many Linux installations, the `ifconfig` utility is located in the **/sbin/** directory. Typing the full path to the `ifconfig` executable file (e.g. "`/sbin/ifconfig`") may resolve the problem.

Quartus II System Requirements

The Nios II Development Kit version 5.0 requires the Quartus II software version 5.0. Your PC system must meet the Quartus II software minimum system requirements. Refer to *System Requirements* of the *Quartus II Installation & Licensing Manual for PCs* (included in the kit) for system requirements.

Installing the Development Tools

Install the development tools in the following order.

The Quartus II Design Software CD-ROM

The Quartus II design software is Altera's comprehensive environment for system-on-a-programmable-chip (SOPC) hardware design. Using the Quartus II software, you can develop hardware design files, synthesize a netlist for the design, and output a configuration file for the target FPGA. You use the Quartus II software to assign I/O pin locations, apply compilation constraints (e.g. timing requirements), and perform timing analysis on the FPGA design. The Quartus II software installation also includes the SOPC Builder system integration tool. You use SOPC Builder to define and integrate Nios II processor-based hardware systems.

Install and license the Quartus II software as described in the *Quartus II Installation & Licensing for PCs* manual or the *Quartus II Installation & Licensing for UNIX and Linux Workstations* manual.

During the Quartus II installation, do not install the Nios II Embedded Processor, Evaluation Edition, because you will install the full version separately. You can select **Custom Setup** during installation to install only the Quartus II components that you require for your Nios II development environment. For a minimal installation, install the following components:

- Quartus II software
- SOPC Builder support
- Device support for the FPGA family on your Nios development board
- Tutorial Files

You need administrative privileges to install parts of the Quartus II software on Windows XP, Windows 2000, Windows NT and Linux.

The Nios II Embedded Processor CD-ROM

The Nios II Embedded Processor CD-ROM contains the tools listed below:

- **Nios II CPU and Peripheral Components for SOPC Builder** – You use these components to generate Nios II hardware systems in SOPC Builder.
- **Nios II Integrated Development Environment (IDE)** – The Nios II IDE is the software development interface for the Nios II processor. All software development tasks can be accomplished within the Nios II IDE, including creating, editing, compiling, and debugging programs.
- **GNU toolchain** – The Nios II compiler tool chain is based on the standard GNU GCC compiler, assembler, linker, and makefile facilities.

To install the Nios II Embedded Processor CD-ROM, perform one of the following steps:

✓ On Windows PCs, insert the Nios II Embedded Processor for Windows CD-ROM into your computer. If the install program does not automatically start, browse to your CD-ROM drive and run the program **launcher.exe**. Follow the on-screen instructions. It is recommended that you accept the default install options.

If you are reinstalling the Nios II Development Kit, it is recommended that you first uninstall the previous installation.

✓ On Linux PCs, insert the Nios II Embedded Processor for Linux CD-ROM into a drive, and make sure that drive is mounted. Run the executable script **install** from the root directory of the CD filesystem. Follow the on-screen instructions and prompts.

To create new Nios II hardware designs, you must first obtain a Nios II processor core license. Visit the Altera licensing page at **www.altera.com/licensing**, and click the hyperlink for the appropriate Nios development kit. The Nios II IDE and the software tool chain do not require a license. Therefore, you do not need a license if you will only develop software for the Nios II processor.

The MegaCore IP Library CD-ROM

If you own the Nios Development Board, Cyclone II Edition, and you want to create new hardware designs that take advantage of the DDR SDRAM chip on the board, you must also install the MegaCore IP Library. This CD-ROM installs a library of ready-made intellectual

property (IP) cores that are optimized for Altera devices, and includes a DDR2 SDRAM controller. Without the MegaCore IP Library, you cannot build SOPC Builder systems that interface with DDR SDRAM.

The license for the Nios Development Kit, Cyclone II Edition includes a license for the DDR2 SDRAM Controller MegaCore. The other cores in the MegaCore IP Library are fully functional for evaluation, but have a timeout feature. You must purchase a full license to ship a product that includes any other MegaCores.

View the **readme.txt** file at the top-level of the CD-ROM for instructions on installing the MegaCore IP Library. For further information on the DDR SDRAM controller, see the Altera *DDR & DDR2 SDRAM Controller Compiler User Guide*.

The Nios Development Board

The Nios development board will be your steady companion through much of your development effort with the Nios II processor. Hardware designers can use the Nios development board as a platform to prototype complex embedded systems. Software developers can use the Nios II reference design preprogrammed on the development board to begin prototyping software immediately.

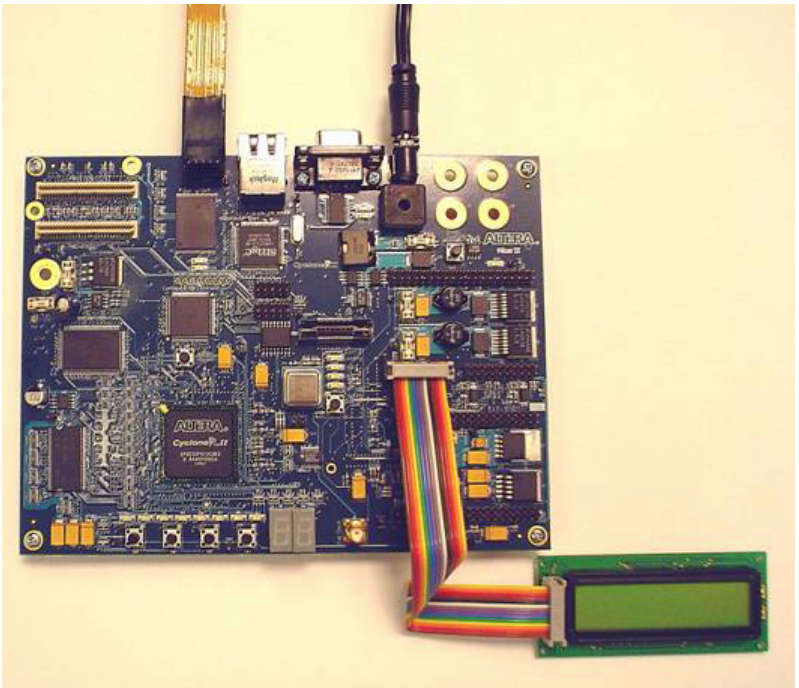
The Nios development board comes pre-configured with a Nios II processor hardware reference design and a software reference design stored in flash memory.

For complete details on the Nios development board, refer to the appropriate *Nios Development Board Reference Manual*.

Setting Up the Nios Development Board

First, you will set up the Nios development board. The Nios development board will show activity to verify that it is alive and functioning correctly. Figure 1–1 shows a Nios Development Board, Cyclone II Edition with the power cable, LCD module, and USB Blaster cable attached. For all Nios development boards, the relative location and orientation of the cables is the same.

Figure 1–1. Nios Development Board with Power, LCD, & USB-Blaster Connections



To set up the Nios development board, perform the following steps:

1. Remove the Nios development board from its anti-static shipping bag. Take care not to expose the board to electrostatic discharge (ESD) during setup or use.

2. Place the board legs-down on a flat surface. Orient the board as shown in Figure 1-1 with the dual 7-segment LEDs (U8 and U9) closest to you.

3. Connect the LCD module ribbon cable to connector J12, as shown in Figure 1–1 on page 1–6.

   Be sure to connect pin 1 on the LCD module to pin 1 of J12 by aligning the triangular marks on the ribbon cable header with the locations of pin 1 on the LCD module and the J12 header. You can identify pin 1 by its square solder pad on the bottom of the board.

CAUTION

Connecting the LCD module to any other connector will damage the LCD module. Do not mistake J12 with the similar J15 at the bottom edge of the board.

4. Remove the CompactFlash card from the CompactFlash socket on the back of the board.

The LCD screen will not function if a CompactFlash card is seated in the CompactFlash socket.

5. Connect the DC power-supply to connector J26, as shown in Figure 1–1 on page 1–13. Select the appropriate power cord for your geographic region. Connect one end to the DC power supply and the other end to a power outlet.

Verifying Correct Operation of the Nios Development Board

You will see activity on the board after applying power. As soon as you apply power to the Nios development board, the Altera FPGA is configured with a Nios II processor hardware reference design. Once the FPGA configuration is complete, the Nios II processor in the FPGA wakes up, initializes itself with boot code from flash memory, and displays "Nios II" on the LCD for 10 seconds, followed by scrolling instructions for a web server demo. You can connect the board to an Ethernet network and view web pages served from the web server reference design.

Verify the following indicators of a properly functioning Nios development board:

- The LED labeled "Power" is on
- The LED labeled "Safe" or "Factory" is on
- The LCD displays "Nios II"
- The two 7-segment LEDs are active, displaying a spinning pattern
- The LEDs D0 – D7 are active, displaying a bouncing pattern

If you are not the first user of your Nios development board, the board may no longer contain the original factory image programmed in flash memory. In this case, you will not see the same indicators noted above. The LED labeled User might be on or flashing, indicating that the development board is programmed with another designer's user image.

If you want to reprogram your board to its factory default condition, refer to the appropriate *Nios Development Board Reference Manual*.

If this is the first time you are applying power to the Nios development board and you do not see the indicators above, check all the connections and make sure that power is supplied to the board properly. For further assistance visit Altera's online technical support web site at **mysupport.altera.com**.

Establishing Board-to-PC Communication

In this section, you will connect the Nios development board to your PC via a USB cable to establish communication with the development board.

Connecting the USB-Blaster Download Cable

Connect your USB-Blaster download cable to the Nios development board as instructed below.

1. Remove power from the Nios development board by disconnecting the power cable.
2. Connect one end of the USB cable to the USB port on your PC. Connect the other end to the USB-Blaster download cable.
3. Connect the USB-Blaster download cable to the 10-pin header J24 on the Nios development board so that it extends upward away from you. See Figure 1–1 on page 1–6.
4. Re-apply power to the Nios development board.
5. Install the USB Blaster driver on the host computer.

   For Windows PCs, the driver is located in the directory <*Quartus II install path*>**\drivers\usb-blaster**. For Linux PCs, see the file **readme.txt** on the installation CD-ROM.

For details on installing the USB-Blaster driver for Windows, see the *USB Blaster Download Cable User Guide* at **www.altera.com**.

Starting the Nios II Development Tools

Once you have connected your Nios development board to your computer, you can start the Nios II IDE from the Quartus II software.

Starting the Quartus II Software

Start the Quartus II software and open a Nios II project by performing the following steps:

1. Launch the Quartus II software.

On Windows PCs, choose **Start** > **Programs** > **Altera** > **Quartus II**. On Linux PCs, type `quartus` at a shell command-prompt, assuming the Quartus II program directory is in the search path.

If prompted about software updates, click **Yes** to get updates automatically from the Altera web site.

2. When the Quartus II window appears, choose **Open Project** (File menu).

Be sure to choose **Open Project** and not **Open.**

3. Browse to the directory <*Nios II kit path*>**\examples\verilog\niosII_**<*board type*>**\standard** for your board. Replace <*board type*> with a directory name shown in Table 1–1.

Table 1–1. Design File Directory Names

Nios Development Board	Directory Name
Stratix II Edition	niosII_stratixII_2s60_es
Stratix Edition	niosII_stratix_1s10 or niosII_stratix_1s10_es
Cyclone II Edition	niosII_cycloneII_2c35
Cyclone Edition	niosII_cyclone_1c20
Stratix Professional Edition	niosII_stratix_1s40

4. Select the file **standard.qpf** and click **Open**. The **standard.qpf** file contains project definitions for the example design used in this getting started user guide.

For example, the Nios II Development Kit, Stratix Edition, Quartus II project file is located at <*Nios II kit path*>**\examples\verilog\niosII_stratix_1s10\standard\standard.qpf**.

You can use the **vhdl** directory instead of the **verilog** directory, if you prefer the VHDL language.

Downloading a Hardware Image to the FPGA

To download the Nios II SRAM Object File (**.sof**) image to the Nios development board, follow these steps:

1. Choose **Programmer** (Tools menu).

2. Click **Hardware Setup**.

3. Select **USB-Blaster** in the **Currently selected hardware** list and click **Close**.

4. Turn on **Program/Configure,** located on the same row as **standard.sof**.

5. Click **Start**.

Upon download success, the Messages window will display "Info: successfully performed operation(s)." If you do not see this message, check your cable connections and the Quartus II Programmer hardware setup.

Starting the Nios II IDE from SOPC Builder

Now that you have configured the FPGA with a Nios II system **.sof** file, you can proceed to the Nios II IDE to download software to the processor.

To start the Nios II IDE, perform the following steps:

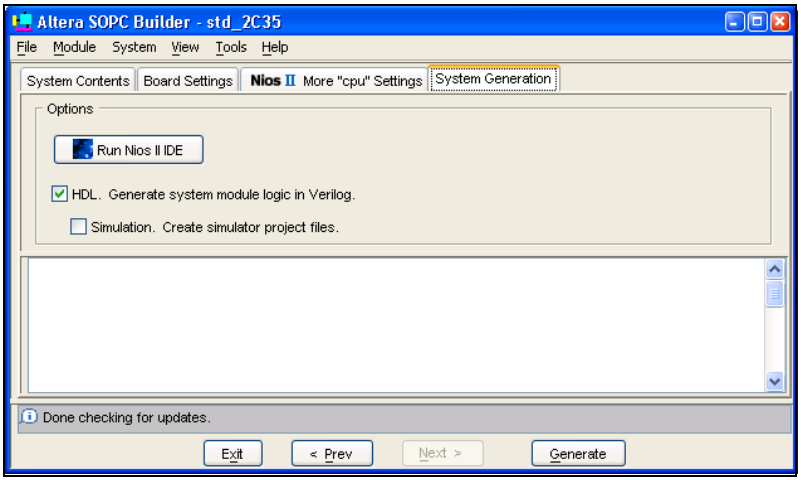
1. Choose **SOPC Builder** (Tools menu).

2. When the SOPC Builder window opens, click on the **System Generation** tab.

3. Click **Run Nios II IDE** to start the Nios II IDE. See Figure 1–2.

In the future, you can launch the Nios II IDE directly without running the Quartus II software. On Windows PCs, choose **Start** > **Programs** > **Altera** > **Nios II Development Kit > Nios II IDE**. On Linux PCs, run the executable file *<Nios II kit path>***\bin\nios2-ide**.

Figure 1–2. Starting the Nios II IDE from SOPC Builder



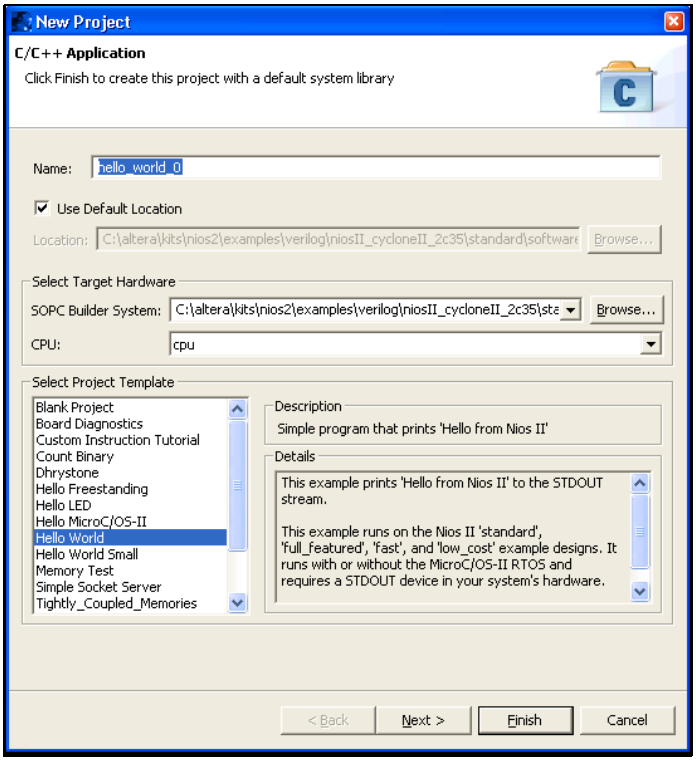
4. When the Nios II IDE starts, it displays the Workspace Launcher dialog. Click **OK** to accept the default workspace directory.

Building a First Software Project

To create a simple **Hello World** project, perform the following steps:

1. From the File menu, choose **New** > **C/C++ Application**. The New Project wizard appears. See Figure 1–3.

Figure 1–3. New Project Wizard in the Nios II IDE



2. Select **Hello World** in the **Select Project Template** list.

3. Click **Finish** to create the project **named hello_world_0**. This process also creates a system library project named **hello_world_0_syslib.**

4. In the C/C++ Projects view on the left, right-click the **hello_world_0** project and choose **Build Project**.

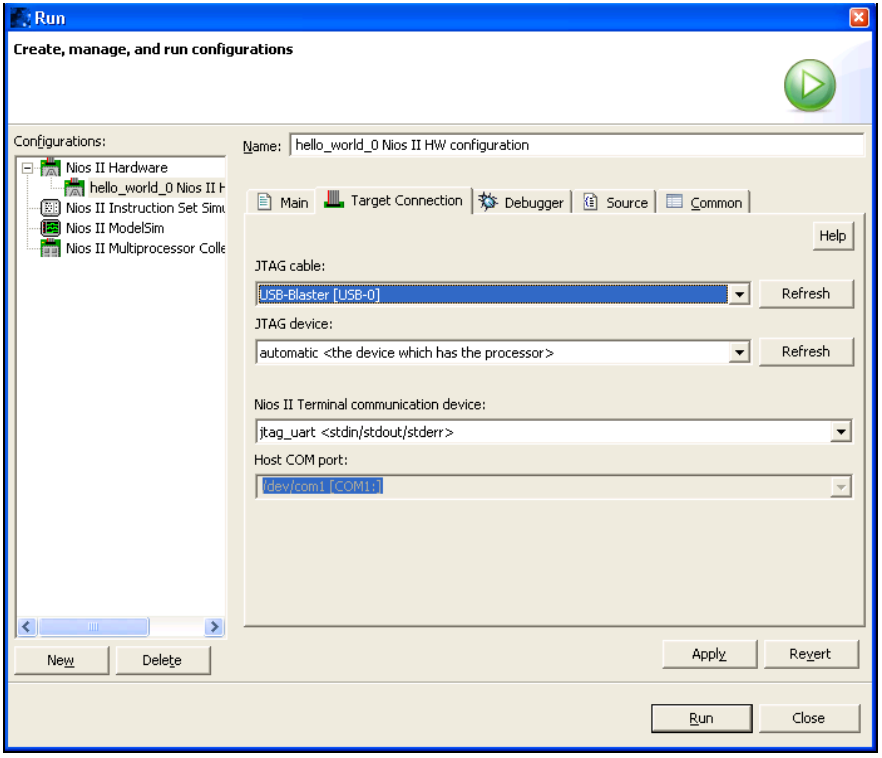
   When the build finishes, the Console view at the bottom of the workbench displays the message “Build completed.” If the Console view is not visible, click the **Console** tab.

Downloading Executable Code to the Nios Development Board

From the Nios II IDE, perform the following steps to download executable code and run it on the board.

1. Choose **Run...** (Run menu). The **Run** window opens.
2. Select **Nios II Hardware** in the **Configurations** list.
3. Click **New.**
4. Click the **Target Connection** tab.
5. From the **JTAG Cable** list, select **USB-Blaster**. In a moment, the **Run** button becomes active. See Figure 1–4.

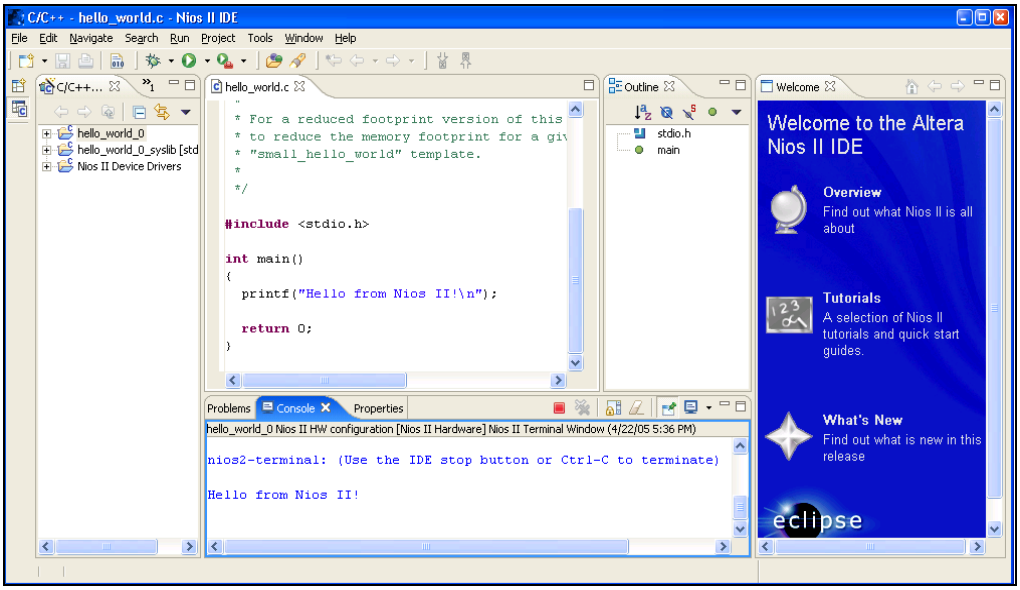
Figure 1–4. Run Window in the Nios II IDE



6. Click **Run** at the bottom of the window. The **hello_world_0** software image downloads to the Nios development board and begins running.

   "Hello from Nios II!" appears in the Console view of the Nios II IDE. See Figure 1–5. If the Console view is not visible, click on the **Console** tab to bring it to the foreground.

Figure 1–5. "Hello World" in the Nios II IDE Console View



Congratulations! You have completed the first steps to familiarize yourself with the Nios II Development Kit. If you completed all of the steps above, then you have installed your Nios II development environment, and verified that the Nios development board and tools function correctly.

Taking the Next Step

To learn more about the Nios II embedded processor, hardware designers can start with the *Nios II Hardware Development Tutorial*. Software developers can start with the *Nios II Software Development Tutorial* available within the Nios II IDE. These tutorials introduce you to the development process for the Nios II embedded processor. Each tutorial uses the Nios development board as a demonstration platform, and walks you step-by-step through the process of creating hardware and software for Nios II embedded processor systems.

Documentation Library

For complete documentation on the Nios II processor, open the file *<Nios II kit path>***documents\index.htm**. For details on the Nios II IDE, launch the IDE and see the Nios II IDE help system.