ECHELON®

ShortStack 2 Nios II Example Port User's Guide

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Welcome

Echelon's ShortStack® Micro Server enables any product that contains a microcontroller or microprocessor to quickly and inexpensively become a networked, Internet-accessible device. The ShortStack Micro Server provides a simple way to add LONWORKS® networking to new or existing smart devices.

The ShortStack 2 Developer's Kit includes example ports for the Freescale™ Semiconductor M68HC908GP32 microprocessor (a member of the M68HC08 family of microprocessors) and the Microchip® PIC16F877 microprocessor (a member of the PICmicro® family of microprocessors).

This document describes the ShortStack 2 Nios II Example Port for the Altera® Nios® II embedded processor. This example port includes a ported example ShortStack application, host API, and serial driver for the Nios II processor. This example is available for free download from the Echelon ShortStack Web site, www.echelon.com/shortstack.

The ShortStack 2 Nios II Example Port requires ShortStack 2, Service Pack 3.

Audience

This document assumes that you have a good understanding of the LONWORKS platform, the ShortStack Micro Server, ShortStack API, general field programmable gate array (FPGA) design methodologies, and the Altera Nios II family of embedded processors.

If you create a serial driver for communications between the host microprocessor and the ShortStack Micro Server, you need to be familiar with either the Serial Communications Interface (SCI) or Serial Peripheral Interface (SPI) interface standard.

Related Documentation

In addition to this manual, the ShortStack 2 Developer's Kit includes the *ShortStack User's Guide*, which describes how to develop applications for LONWORKS devices that use the ShortStack 2 Micro Server. It also describes the architecture of a ShortStack device and how to develop one.

After you install the ShortStack 2 Developer's Kit, you can view the *ShortStack User's Guide* from the Windows **Start** menu: select **Programs** → **Echelon ShortStack Software** → **ShortStack User's Guide**.

The following manuals are available from the Echelon Web site (www.echelon.com) and provide additional information that can help you to develop applications for the ShortStack Micro Server:

- *Introduction to the LONWORKS System.* This manual provides an introduction to the ANSI/CEA-709.1 (EN14908) Control Networking Protocol, and provides a high-level introduction to LONWORKS networks and the tools and components that are used for developing, installing, operating, and maintaining them.

- *LONMARK® Application Layer Interoperability Guidelines.* This manual describes design guidelines for developing applications for open interoperable LONWORKS devices.

- *LONWORKS Host Application Programmer's Guide*. This manual describes how to create LONWORKS host applications. Host applications are application programs that run on hosts other than Neuron® Chips and use the ANSI/CEA-709.1 (EN14908) Control Networking Protocol to communicate with devices on a LONWORKS network.

- *NodeBuilder® User's Guide*. This manual describes how to develop a LONWORKS device using the NodeBuilder tool.

All of the ShortStack documentation, and related product documentation, is available in Adobe® PDF format. To view the PDF files, you must have a current version of the Adobe Reader®, which you can download from Adobe at: www.adobe.com/products/acrobat/readstep2.html.

Related Altera Product Documentation

For information about the Altera Nios II family of embedded processors and associated tools, see the Altera Nios II Literature page: www.altera.com/literature/lit-nio2.jsp.

Table 1 lists Altera product documents that are particularly useful for the ShortStack 2 Nios II Example Port.

Table 1. Altera Documentation

Product Category	Documentation Titles
Quartus® II software	Introduction to Quartus II Manual Quartus II Quick Start Guide Quartus II Development Software Handbook v6.1
Nios II processor	Nios II Hardware Development Tutorial Nios II Software Development Tutorial (included in the online help for the Nios II EDS integrated development environment) Nios II Flash Programmer User Guide Nios II Processor Reference Handbook Nios II Software Developer's Handbook
Cyclone® II FPGA and device configuration	Cyclone II Device Handbook Configuration Handbook

Product Category	Documentation Titles
USB-Blaster™ download cable	USB-Blaster Download Cable User Guide
Software licensing	Quartus II Installation & Licensing for Windows Manual AN 340: Altera Software Licensing

Related devboards.de Product Documentation

For information about the DBC2C20 Altera Cyclone II Development Board, including the most current data sheet for the board, see the DBC2C20 page: www.devboards.de/index.php?mode=products&kategorie=14.

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Introduction

This chapter introduces the ShortStack 2 Nios II Example Port and describes how to install the example software.

Introduction

The ShortStack 2 Nios II Example Port includes a ported example application, host API, and a serial driver for the Nios II processor. The example application implements a simple voltage amplifier. This example demonstrates a LONWORKS device running on a popular soft processor for FPGA and structured application-specific integrated circuit (ASIC) design applications.

There are two versions of the example port: one for a TP/FT-10 free-topology (FT) device and one for a PL-20C or PL-20N power-line (PL) device.

The example application implements a simple voltage amplifier. It consists of an application with two functional blocks:

- A Node Object functional block. This functional block is used by network tools to test and manage the functional blocks on a device. The example implements a skeletal Node Object functional block.
- A Controller functional block. This functional block is based on a now obsolete functional profile that should not be used for production applications. It implements two network variables, **nviVolt** for input voltage, and **nvoVolt** for output voltage.

When the example application receives an update to the **nviVolt** input network variable, the application multiplies the value by two and assigns the new value to the **nvoVolt** output network variable.

The source code for the simple voltage amplifier example application is installed in the following directories:

- [*NiosExample*]**\software\Application_FT\lon**
- [*NiosExample*]**\software\Application_PL\lon**

where [*NiosExample*] is the directory in which you installed the ShortStack 2 Nios II Example Port, which should be **C:\altera\61\nios2eds\examples\vhdl\DBC2C20\nios_II_echelon_ShortStack_EVB_application**. See *Installing the ShortStack Example Software* on page 4 for information about creating this directory.

For more information about the example application, see *Exploring the Simple Voltage Amplifier Example Application* on page 27.

Installing the Example Port

The ShortStack 2 Nios II Example Port requires the following software:

- Altera Quartus II software, Version 6.1 or later
- Altera Nios II EDS integrated development environment (IDE), Version 6.1 or later
- Driver software for the Altera USB-Blaster download cable
- FPGA configuration data and software for the DBC2C20 development board
- ShortStack 2 Nios II Example Port

You can install the example port without any other software to view the example software. However, for Nios II processor development, the Altera and DBC2C20 software is required. For more information about installing the Altera software products, see *Software Development Tools for the Nios II Processor* on page 14 and the Altera Web site for the Nios II processor, www.altera.com/products/ip/processors/nios2/ni2-index.html.

The following sections describe the hardware and software requirements, and how to install the DBC2C20 software and the example port.

Hardware Requirements

To run the ShortStack 2 Nios II Example Port, including the Altera design software, your computer system must meet the following minimum requirements:

- Intel® Pentium® III 866 MHz processor
- 256 MB RAM
- 5 GB available hard disk space (including 22.5 MB for the ShortStack 2 Nios II Example Port itself)
- CD-ROM drive
- 1 available Universal Serial Bus (USB) port

The recommended specifications for your computer system include:

- Intel Pentium 4 2.0 GHz processor
- 1 GB RAM
- 5 GB available hard disk space
- CD-ROM or DVD-ROM drive
- 2 available USB ports

In addition, you must have the following hardware for LONWORKS connectivity:

- LONWORKS compatible network interface, such as a U10 or U20 USB Network Interface or an *i*.LON® 100 Internet Server
- For FT networks, a LONWORKS TP/FT-10 network cable, with network terminator

Other hardware requirements are described in *Hardware Development Tools for the Nios II Processor* on page 6 and *Loading Your Application into the Nios II Processor* on page 15.

Software Requirements

To run the ShortStack 2 Nios II Example Port, your computer system must meet the following minimum requirement:

- Microsoft® Windows® XP, plus Service Pack 2 or later

The following software is optional, depending on your requirements:

- Adobe Reader 7.0.8 or later

- NodeBuilder Resource Editor 3.13 or later, if you need to create custom LONMARK® resource files and data type definitions

Installing the DBC2C20 Software

As described in *Hardware Development Tools for the Nios II Processor* on page 6, the ShortStack 2 Nios II Example Port uses the DBC2C20 Altera Cyclone II Development Board as the development platform for the Nios II processor. The DBC2C20 development board comes with a CD-ROM that includes software components for Nios II development.

To install the software for the DBC2C20 development board:

1. Insert the devboards.de CD-ROM that accompanies the DBC2C20 development board into a CD-ROM or DVD drive. The setup application launches a browser window. If the browser window does not open, use Windows Explorer to open the contents of the CD-ROM drive, and double-click **DBC2C20_setup.exe**.
2. From the browser window, click **DBC2C20 Reference Designs (Setup)** to start the DBC2C20 Reference Designs installer.
3. Follow the instruction dialogs to install the DBC2C20 reference designs and component software onto your computer.

Important: Be sure to install the DBC2C20 software into the following directory: **C:\altera\61\nios2eds**.

Installing the ShortStack Example Software

To install the ShortStack 2 Nios II Example Port:

1. Download the ShortStack 2 Nios II Example Port from the Echelon ShortStack Web site, www.echelon.com/shortstack.
2. From Windows Explorer, double-click **ShortStack20NiosIIExample.exe** to start the Echelon ShortStack 2 Nios II Example Port installer.
3. Follow the instruction dialogs to install the example port onto your computer. The installer installs the example port into the following directory: **C:\LonWorks\ShortStack\Examples\NiosII**.
4. Copy the **C:\LonWorks\ShortStack\Examples\NiosII\ nios_II_echelon_ShortStack_EVB_application** directory (and its contents) to the **C:\altera\61\nios2eds\examples\vhdl\DBC2C20** directory.

The ShortStack 2 Nios II Example Port installer does not install the software directly into the Altera Nios II EDS directory so that you can install the products and tools in any order, and so that you have a backup of the ShortStack serial driver and example application.

Important: Do not rename the **nios_II_echelon_ShortStack_EVB_application** directory or copy it to a directory other than **C:\altera\61\nios2eds\examples\vhdl\DBC2C20**. The Altera Quartus II software, the Altera Nios II EDS IDE. and the example application require that the application path and file names be unchanged.

2

Overview of the Hardware Environment for the Nios II Processor

This chapter describes hardware development tools for the Nios II processor and the hardware interface for the ShortStack Micro Server.

General Description of the Supported Hardware

The Nios II embedded processor is a member of the Altera Nios family of soft processor cores. The Nios II/s "standard" processor core is optimal for cost-sensitive, medium-performance applications, including those with large amounts of code or data, such as systems running a full-featured operating system. The Nios II/s processor core includes the following features:

- Instruction cache
- Up to 2 GB of external address space
- Optional tightly coupled memory for instructions
- Five-stage pipeline
- Static branch prediction
- Hardware multiply, divide, and shift options
- Up to 256 custom instructions
- JTAG debug module
- Optional JTAG debug module enhancements, including hardware breakpoints, data triggers, and real-time trace

For more information about the Nios II processor, see www.altera.com/products/ip/processors/nios2/ni2-index.html.

The Nios II processor can run on a variety of Altera devices, including FPGA and ASIC devices. The recommended hardware development platform runs the ShortStack 2 Nios II Example Port on an Altera Cyclone II FPGA device.

Hardware Development Tools for the Nios II Processor

To work with the Nios II processor, you can use any of the many available tools that support the Nios II family of embedded processors. However, this document describes only the devboards GmbH DBC2C20 Altera Cyclone II Development Board, as listed in **Table 2** on page 7.

The example port was built with the DBC2C20 development board. You could use another development board, such as the Altera Nios II Development Board, Cyclone II Edition, but because the hardware and software projects for the ShortStack 2 Nios II Example Port are customized for the DBC2C20 development board, you must create your own hardware and software projects for a different development environment.

You can obtain the DBC2C20 Altera Cyclone II Development Board from devboards GmbH, www.devboards.de. You can also contact EBV Elektronik GmbH, www.ebv.com.

Use order code **DBC2C20USBB** or **DBC2C20USBB-IPN** to obtain the DBC2C20 development board plus an Altera USB-Blaster download cable and a Nios II development license.

The DBC2C20USBB-IPN package includes a 9.6 VA, 800 mA power supply that is appropriate for European installations; for other geographies, you can use any input power supply with a 2.1 mm pin, center-negative barrel connector, from 7.5 V to 24 V, such as the 9 V Echelon 78010R power supply.

Table 2. Hardware Development Platform for the Nios II Processor

devboards DBC2C20 Altera Cyclone II Development Board
The DBC2C20 Cyclone II Development Board includes an Altera Cyclone II EP2C20 FPGA with 20 000 logic elements (LEs) that provides flexibility and performance for a wide range of applications. The board also includes: • 16 MB SDRAM • 8 MB flash memory • 16 Mbit EPCS16 configuration device • 1 MB SRAM • Twenty-four 3.3 V I/O ports • For communication tasks, one RS-232, four RS-485, and two Controller Area Network (CAN) transceivers are available • Two 10/100 Mbps Ethernet PHYs are available for Ethernet-based communication • A 24 V, 16-bit wide I/O port can connect the DBC2C20 board directly to industrial control systems • Two low-voltage differential signaling (LVDS) ports, available on RJ-45 connectors, can be used for high-speed board communication • For visualization tasks, an LVDS-based thin-film transistor (TFT) interface is available

Hardware Interface for the ShortStack Micro Server

The ShortStack 2 Nios II Example Port implements communications between the Nios II processor on the DBC2C20 development board and the ShortStack Micro Server using the RS-232 interface. The Echelon FT 3120® EVB Evaluation Board and the PL 3120 EVB Evaluation Board (included with the appropriate versions of the Echelon Mini EVK Evaluation Kit, and available separately) include an RS-232 connection socket for the ShortStack Micro Server.

The example port uses a ShortStack Micro Server with the characteristics listed in **Table 3** on page 8.

Table 3. ShortStack Micro Server Characteristics

Device Characteristic	FT 3120-E4 Smart Transceiver	PL 3120-E4 Smart Transceiver
Channel type	TP/FT-10	PL-20C or PL-20N
Clock speed	20 MHz	10 MHz
Explicit addressing	Disabled	Disabled
Device program ID	9F:FF:FF:00:00:00:04:00	9F:FF:FF:00:00:00:10:00

Although the example application is preconfigured for an FT 3120 or PL 3120 Smart Transceiver, you could alternatively use an FT 3150® or PL 3150 Smart Transceiver. And for the PL 3120 Smart Transceiver, you can use the PL 3120 EVB Evaluation Board in a PL-20N power line transceiver configuration. See the *ShortStack User's Guide* for information about reconfiguring the example application for a different Micro Server or transceiver configuration. Essentially, you need to run the ShortStack Wizard to specify the correct transceiver and channel type.

The initial configuration for the power-line example enables the Comité Européen de Normalisation Electrotechnique[1] (CENELEC) media access protocol. Power line users who are not in one of the CENELEC member countries must change the power line transceiver for this example to a PL-20N configuration to disable the CENELEC media access protocol.

Because the communications between the Nios II processor and the ShortStack Micro Server use the RS-232 interface, there are no direct pin connections between the Nios II processor and the Micro Server.

The example port defines an SCI interface for the communications between the Nios II processor and the ShortStack Micro Server. The **ldvsci.h** file defines the lower-layer SCI driver interface; see *Lower-Layer SCI Serial Driver Implementation* on page 23 for more information about the SCI serial driver.

You can change the SCI asynchronous interface to an SPI synchronous interface. To use an SPI interface for communications between the Nios II processor and the ShortStack Micro Server, you must:

- Modify the Nios II hardware design to add the appropriate parallel I/O (PIO) lines and PIO modules
- Implement a lower-layer SPI serial driver for the ShortStack Micro Server

Table 4 on page 9 shows the physical connections between the Cyclone II FPGA, the RS-232 transceiver on the DBC2C20 development board, the RS-232 transceiver on the FT 3120 or PL 3120 EVB, and the Smart Transceiver. You must add 10 kΩ pull-up resistors to all communication lines for your final design; both the FT 3120 EVB and the PL 3120 EVB already include these pull-up resistors on the communication lines from the RS-232 connection socket.

[1] European Committee for Electrotechnical Standardization

Table 4. Nios II to Micro Server Connections

Cyclone II Pin	DBC2C20 RS-232 Transceiver Pin [1]	3120 EVB RS-232 Transceiver Pin [2]	Smart Transceiver Pin
E8 (_CTS1)	23 (ROUT3)	8 (T2IN)	IO0 (_CTS)
H11 (_DSR1)	22 (DIN3)	12 (R3OUT)	IO1 (_HRDY)
N/A	N/A	N/A	IO3 (GND)
F12 (_RTS)	18 (DIN2)	13 (R2OUT)	IO4 (_RTS)
F8 (TXD1)	19 (DIN4)	14 (R1OUT)	IO8 (RXD)
F11 (RXD1)	20 (ROUT2)	7 (T1IN)	IO10 (TXD)

Notes:

1. The pin assignments for the DBC2C20 RS-232 transceiver refer to the Texas Instruments™ MAX3238 Multichannel RS-232 Line Driver/Receiver on the DBC2C20 development board.
2. The pin assignments for the 3120 EVB RS-232 transceiver refer to the Maxim® Integrated Products MAX3387E AutoShutdown Plus™ RS-232 Transceiver for the FT 3120 or PL 3120 Evaluation Board.

Pin F11 and pin F8 on the Cyclone II FPGA control the communications through the ShortStack universal asynchronous receiver/transmitter (UART) for the RS-232 serial communications port.

The RS-232 interface uses a null-modem cable that connects the RS-232 header (**P27** – see **Figure 1** on page 10) on the DBC2C20 development board to a male D-SUB9 connector for the RS-232 socket on the FT 3120 or PL 3120 EVB. This cable is not included with the ShortStack 2 Nios II Example Port.

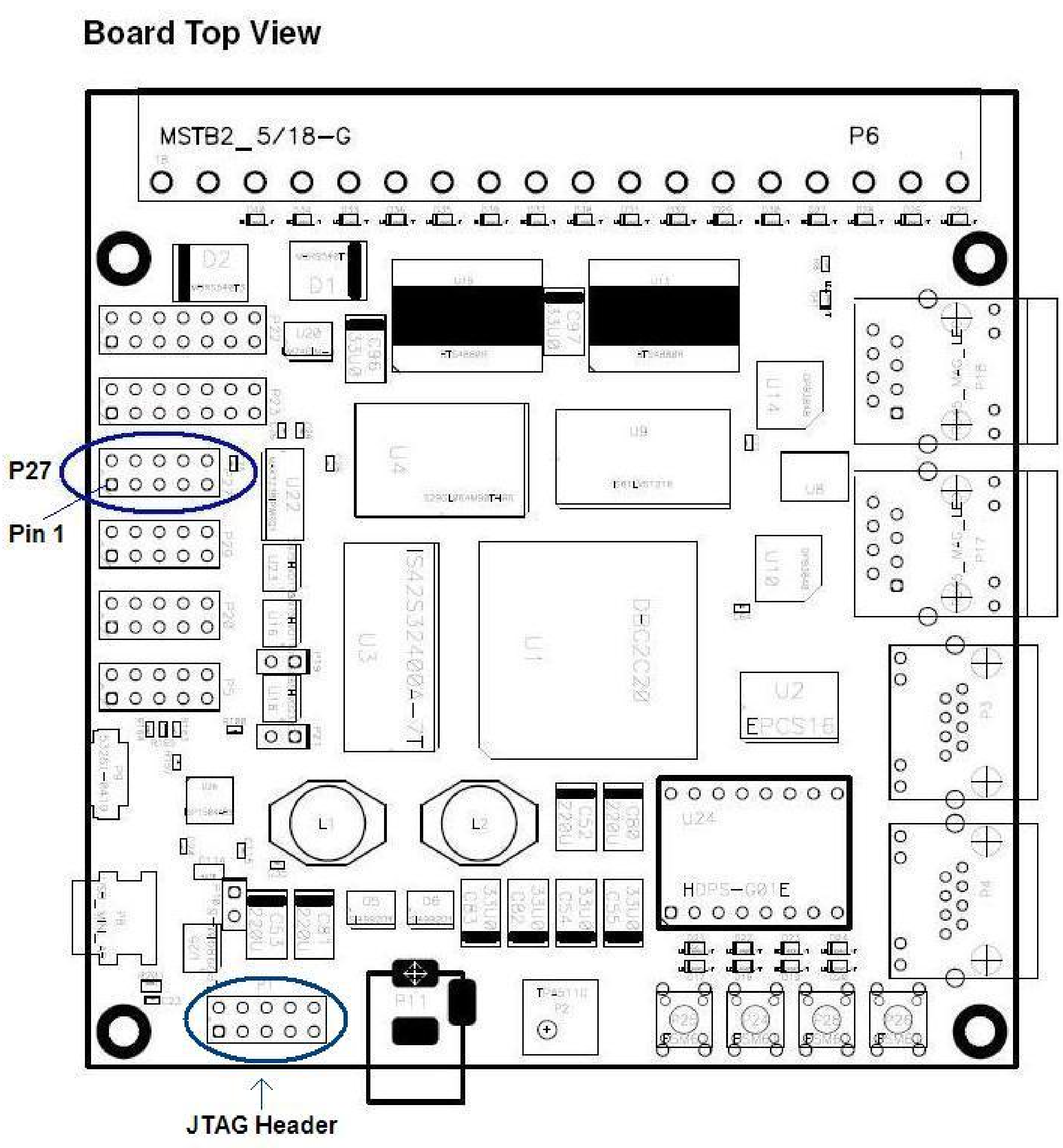


Figure 1. RS-232 Header (P27) on the DBC2C20 Development Board

To define the null-modem RS-232 interface, use the pin connections listed in **Table 5**. Keep the total cable length to a maximum of 24 inches (0.6 meters).

Table 5. RS-232 Header to D-SUB9 Connector Pin Connections

P27 Header Pin	D-SUB9 Connector Pin	Smart Transceiver Signal
1	NC	N/A
2	4	_HRDY
3	3	RXD

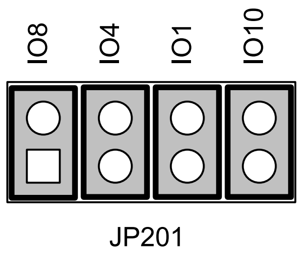
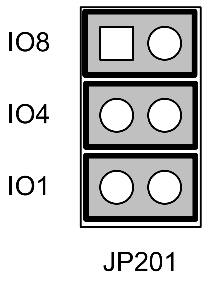
P27 Header Pin	D-SUB9 Connector Pin	Smart Transceiver Signal
4	8	_CTS
5	2	TXD
6	7	_RTS
7	NC	N/A
8	NC	N/A
9	5	GND
10	N/A	N/A

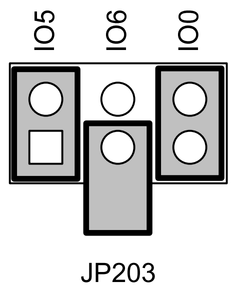
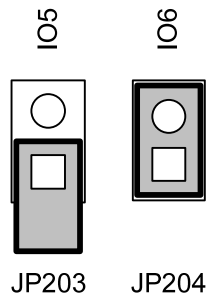
The Nios II processor communicates with the ShortStack Micro Server through the SCI interface at a 38 400 bit rate. You can change the communications interface through compilation-time configuration, as described in *Communications Configuration Options* on page 20.

To set the required bit rate for the SCI interface on an FT 3120 EVB or a PL 3120 EVB, set the jumpers for the RS-232 Enable (**JP201**) and ShortStack Enable (**JP203** and **JP204**) headers, as shown in **Table 6**. See the *Mini EVK Hardware Guide* for more information about these jumpers.

Recommendation: For both the FT 3120 and PL 3120 EVB, disconnect any peripheral I/O from the I/O Connector header (**P201**), such as the MiniGizmo board, when using these boards in ShortStack mode with an RS-232 connection.

Table 6. Jumper Settings for 3120 EVB Evaluation Boards

Function	Evaluation Board	Jumper Setting
RS-232 Enable	FT 3120	
	PL 3120	

Function	Evaluation Board	Jumper Setting
ShortStack Enable	FT 3120	
	PL 3120	

3

Developing ShortStack Applications for the Nios II Processor

This chapter describes software development tools for the Nios II processor, and tools for loading and debugging your ShortStack application.

General Description of the Supported Software and Tools

The ShortStack 2 Nios II Example Port requires development tools for both hardware design and software design.

For hardware design, the example requires development tools for FPGA soft processor design, a system-on-chip design tool, a device programmer to load the compiled hardware design into the Cyclone II FPGA, and optionally, simulation tools, a logic analyzer, a timing analyzer, and a chip planner.

For software design, it requires a C compiler, with its associated development environment, a device programmer to load the compiled program into the Nios II processor, and optionally an in-circuit debugger to debug and verify the program.

The example also requires that you load the appropriate ShortStack Micro Server firmware image into the FT Smart Transceiver or PL Smart Transceiver.

The rest of this chapter describes the tools required for development of the example application.

Software Development Tools for the Nios II Processor

To develop your ShortStack application for a Nios II processor, you can use any tools that support the Nios II family of embedded processors. However, this document describes only the Altera Complete Design Suite, as listed in **Table 7**.

The example applications were built with the Altera Complete Design Suite, Version 6.1. You can obtain the Altera Complete Design Suite on DVD-ROM from Altera Corporation, or you can download the Web Edition of the tools from https://www.altera.com/support/software/download/nios2/dnl-nios2.jsp.

Table 7. Altera Complete Design Suite

Quartus II Design Software for Windows
The Quartus II design software provides a suite of tools for system-level design, embedded software programming, FPGA and CPLD design, synthesis, place-and-route, verification, and device programming. Quartus II software supports all of Altera's current device families. The Quartus II Web Edition is a subset of the Quartus II design software that provides support for selected Altera processors. Both the Quartus II design software and the Quartus II Web Edition include the SOPC Builder tool, which is an automated system development tool that dramatically simplifies the task of creating high-performance system-on-a-programmable-chip (SOPC) designs.

ModelSim®-Altera VHDL & Verilog HDL Simulation Tool
The ModelSim-Altera software is an Altera-specific version of the Model Technology™ ModelSim simulation software, which supports behavioral simulation and testbenches for VHDL or Verilog hardware description languages (HDLs). The ModelSim-Altera software is included with Altera software subscriptions.
MegaCore IP Library
The MegaCore IP library includes some of Altera's most popular intellectual property (IP) cores, including a finite impulse response (FIR) compiler, a numerically controlled oscillator (NCO) compiler, a fast Fourier transform (FFT) compiler, several DDR SDRAM controllers, a QDRII SDRAM controller, an RLDRAM II controller, and a lightweight serial interconnect protocol. The MegaCore IP library is included with Altera software subscriptions.
Nios II Embedded Design Suite
The Nios II integrated development environment (IDE) is a graphical user interface (GUI) within which you can accomplish all Nios II embedded processor software development tasks, including editing, building, managing, and debugging embedded software programs. The Nios II IDE is included with Altera software subscriptions.

For more information about installing the Altera Complete Design Suite, see *Quartus II Installation & Licensing for Windows*, available from the Quartus II Development Software Version 6.1 Literature page at www.altera.com/literature/lit-qts.jsp.

Loading Your Application into the Nios II Processor

To load your hardware design and software application, plus the ShortStack API and serial driver, into the Nios II processor, you can use a device programmer, such as the Altera USB-Blaster download cable, as described in **Table 8**.

Table 8. Device Programmer for the Nios II Processor

Altera USB-Blaster Download Cable
The USB-Blaster download cable interfaces to a standard PC USB port. This cable drives configuration or programming data from the PC to the device. For more information about the USB-Blaster, see the *USB-Blaster Download Cable User Guide*.

The Windows driver for the USB-Blaster is in the [*Altera*]**\quartus\drivers\usb-blaster** directory, where [*Altera*] is the directory in which you installed the Altera tool chain, usually **C:\altera\61**.

To set up the programming hardware in the Quartus II software:

1. Start the Quartus II software.
2. Select **Tools → Programmer** to open the Chain Description File (*.cdf) for the project.
3. Click **Hardware Setup** to open the Hardware Setup window.
4. If you have already installed the Windows drivers for the USB-Blaster, it should appear in the **Available hardware items** area of the Hardware Setup window.
5. If the programming hardware that you want to use does not appear in the **Available hardware items** area of the Hardware Setup window, click the **Add Hardware** button to open the Add Hardware window.
    a. Select the appropriate programming cable or programming hardware from the **Hardware Type** dropdown list box.
    b. Select the appropriate port and baud rate, if necessary.
    c. Click **OK**.
6. Select the programming hardware that you want to use from the **Available hardware items** dropdown list box.
7. Click **Close** to close the Hardware Setup window.
8. Select **JTAG** from the **Mode** dropdown list box.
9. Select **File → Close** to close the Chain Description File.

You can save the Chain Description File (*.cdf) for use with other projects.

Preparing the ShortStack Micro Server

You can load the ShortStack firmware into the non-volatile memory of the FT 3120 Smart Transceiver or the PL 3120 Smart Transceiver using either ex-circuit programming or in-circuit programming.

Preparing an FT 3120 Smart Transceiver

To load the ShortStack firmware using ex-circuit programming:

- Use either an Echelon or third-party 3120 Programmer to load the [*ShortStack*]**\Firmware\Images\SS_3120E4_20000KHz.NEI** file into the non-volatile memory
- Use a PROM programmer to load the [*ShortStack*]**\Firmware\Images\SS_3120E4_20000KHz.NFI** file into the non-volatile memory

where [*ShortStack*] is the directory where you installed the ShortStack 2 software, usually **C:\LonWorks\ShortStack**.

To load the ShortStack firmware using in-circuit programming, you can use a network management tool, such as the LonMaker tool. The device interface (XIF) file for the project is [*NiosExample*]**\software\Application_FT\lon\wizard\Sample_Node.xif**.

You can also use the NodeLoad utility to load the **SS_3120E4_20000KHz.NEI** file into the FT 3120 Smart Transceiver non-volatile memory over a LONWORKS network. To use the LonMaker tool or the NodeLoad utility, you need a LONWORKS network interface, such as a U10 USB Network Interface or a PCLTA-21 PCI Network Interface.

To load an application image (NEI) file over a LONWORKS network interface named "LON1", allowing 20 seconds to press the service pin on the destination device, and specifying that the utility skip final reset after the download (to prevent NodeLoad error code 7, state failure), use the following command:

```
nodeload -Dlon1 -W20 -F -Lss_3120e4_20000khz.nei
```

The Nodeload utility is available for free download from the LonWorks Downloads page, www.echelon.com/downloads, in the Development Tools category.

See the *ShortStack User's Guide* and the *NodeLoad Utility User's Guide* for more information about loading the ShortStack Micro Server firmware images.

Preparing a PL 3120 Smart Transceiver

To load the ShortStack firmware using ex-circuit programming:

- Use either an Echelon or third-party 3120 Programmer to load the [*ShortStack*]**\Firmware\Images\SS_PL3120E4_10000KHz.NEI** file into the non-volatile memory
- Use a PROM programmer to load the [*ShortStack*]**\Firmware\Images\SS_PL3120E4_10000KHz.NFI** file into the non-volatile memory

where [*ShortStack*] is the directory where you installed the ShortStack 2 software, usually **C:\LonWorks\ShortStack**.

To load the ShortStack firmware using in-circuit programming, you can use a network management tool, such as the LonMaker tool. The device interface (XIF) file for the project is [*NiosExample*]**\software\Application_PL\lon\wizard\Sample_Node.xif**.

You can also use the NodeLoad utility to load the **SS_PL3120E4_10000KHz.NEI** file into the PL 3120 Smart Transceiver non-volatile memory over a LONWORKS network. To use the LonMaker tool or the NodeLoad utility, you need a LONWORKS network interface, such as a U20 USB Network Interface or a PCLTA-21 PCI Network Interface.

To load an application image (NEI) file over a LONWORKS network interface named "LON1", allowing 20 seconds to press the service pin on the destination device, and specifying that the utility skip final reset after the download (to prevent NodeLoad error code 7, state failure), use the following command:

```
nodeload -Dlon1 -W20 -F -Lss_pl3120e4_10000khz.nei
```

The Nodeload utility is available for free download from the LonWorks Downloads page, www.echelon.com/downloads, in the Development Tools category.

See the *ShortStack User's Guide* and the *NodeLoad Utility User's Guide* for more information about loading the ShortStack Micro Server firmware images.

Debugging Your Application

To debug your application, either the hardware design or the software, you can use the debug tools supplied with the Quartus II software and the Nios II EDS IDE, along with the USB-Blaster download cable described in *Loading Your Application into the Nios II Processor* on page 15.

4

Developing the ShortStack Driver

This chapter describes the communications configuration options for the ShortStack application and the ShortStack serial driver implementation.

Communications Configuration Options

You can set the serial interface type and the interface bit rate for the example application.

Setting the Serial Interface Type

The ShortStack 2 Nios II Example Port uses the SCI asynchronous interface, and does not include an SPI driver. If you want to use the SPI synchronous interface for communications between the Nios II processor and the ShortStack Micro Server, you must:

- Modify the Nios II hardware design to add the appropriate I/O lines and I/O modules
- Implement a lower-layer SPI serial driver for the ShortStack Micro Server
- Comment-out the SCI definition in the **lonsystem.h** file:

  [*NiosExample*]**\software\Application_FT\lon\driver\lonsystem.h**

  or

  [*NiosExample*]**\software\Application_PL\lon\driver\lonsystem.h**

Setting the Interface Bit Rate

The interface bit rate for the example application is defined in the Nios II processor design. If you want to change the application bit rate:

- Modify the hardware design for the Nios II processor
- Modify the application's source code to specify the **SS_BAUD_RATE**
- Set the ShortStack Enable jumpers (**JP203** and **JP204**) on the FT 3120 or PL 3120 EVB to match the specified bit rate

To modify the interface bit rate within the hardware design:

1. Start the Quartus II software
2. Select **File** → **Open Project** to display the Open Project window.
3. In the Open Project window, select the **dbc2c20_standard_design.qpf** hardware project file from the [*NiosExample*] directory, and click **Open** to add the project file to the Project Navigator.
4. Double-click the **dbc2c20_standard_design** in the Project Navigator to open the Block Design File for the project.
5. Within the Block Design File pane, double-click the **nios_cpu** block to open the Altera SOPC Builder window.
6. From the System Contents pane of the SOPC Builder window, right-click the **ShortStack_UART** module and select **Edit** to modify the properties for the module.

7. From the Configuration tab of the Avalon UART – ShortStack_UART dialog, select the desired bit rate from the **Baud Rate (bps)** dropdown list box. Click **Finish** to close the dialog.

After you modify the bit rate in the hardware design, you must rebuild the design, as described in *Building the Hardware Image* on page 32.

To modify the interface bit rate within the application source code, add the following statement to the **lonsystem.h** file:

```
#define SS_BAUD_RATE    0
```

The values for the **SS_BAUD_RATE** literal are defined in a set of comments in the **lonsystem.h** file. A value of 0 represents a bit rate of 38 400 bps for the SCI interface.

The selected serial interface type and interface bit rate must match the configuration of the ShortStack Micro Server to avoid communications problems. See the *ShortStack User's Guide* for more information about setting and determining the Micro Server interface bit rate. See the *Mini EVK Hardware Guide* for more information about setting the ShortStack Enable jumpers.

Serial Driver API

The example serial drivers for the Nios II processor implement two interface layers:

- An upper-layer interface to the ShortStack API
- A lower-layer interface to the hardware

The source files for the serial-driver implementations are in one of the following directories, depending on which application you are working with:

- [*NiosExample*]**\software\Application_FT\lon\driver**
- [*NiosExample*]**\software\Application_PL\lon\driver**

You can use the files in these directories as templates for developing ShortStack serial drivers for any microcontroller or microprocessor. The SCI driver supports the interface functions that the ShortStack API requires. The example application does not include an SPI driver.

The upper-layer driver interface is implemented in the **ldvintfc.c** file. The lower-layer driver interface is implemented in the **ldvsci.c** and **hndshk.c** files.

The two layers exchange data through a set of four queues. These queues are implemented in the **ldvqueue.c** file. The four queues include:

- Outgoing queue (**QOutgoing**) – contains outgoing messages. The messages in this queue are sent to the lower-layer driver to send downlink.
- Free outgoing queue (**QFreeOut**) – a free buffer pool for outgoing messages.
- Incoming queue (**QIncoming**) – contains incoming messages. The messages in this queue are received by the lower-layer driver, passed to the upper-layer driver, which in turn passes them to the application.
- Free incoming queue (**QFreeIn**) – a free buffer pool for incoming messages.

These queues are accessible from both the upper-layer driver and lower-layer driver interfaces. The critical data access synchronization is ensured by disabling and enabling interrupts while accessing the queues.

Figure 2 shows the interaction between the serial driver layers and the queues for an incoming message:

1. A message arrives from the ShortStack Micro Server
2. The lower-layer driver interface dequeues a buffer from the free incoming queue
3. The lower-layer driver interface fills the buffer with the received message and enqueues it to the incoming queue
4. When the host application reads a message, the upper-layer driver interface dequeues a buffer from the incoming queue
5. The upper-layer driver interface relays the message to the host application
6. After the host application is done with the message, the upper-layer driver interface returns the buffer to the free incoming queue

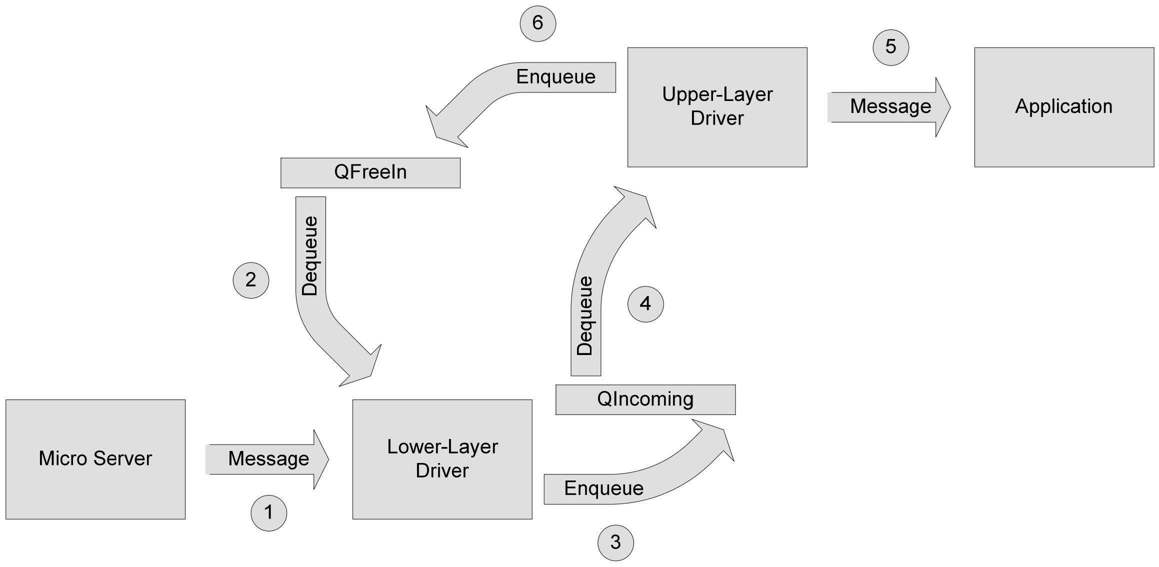


Figure 2. Processing for an Incoming Message

Figure 3 on page 23 shows the interaction between the serial driver interface layers and the queues for an outgoing message:

1. When the host application needs to send a message, it calls the upper-layer driver interface
2. The upper-layer driver interface allocates a buffer from the free outgoing queue
3. After the host application constructs the message, the upper-layer driver interface enqueues the buffer in the outgoing queue
4. When the lower-layer driver interface is ready to send a message, it frees a buffer from the outgoing queue
5. The lower-layer driver interface transmits the message to the ShortStack Micro Server

6. The lower-layer driver interface returns the buffer to the outgoing free queue after transmission is completed

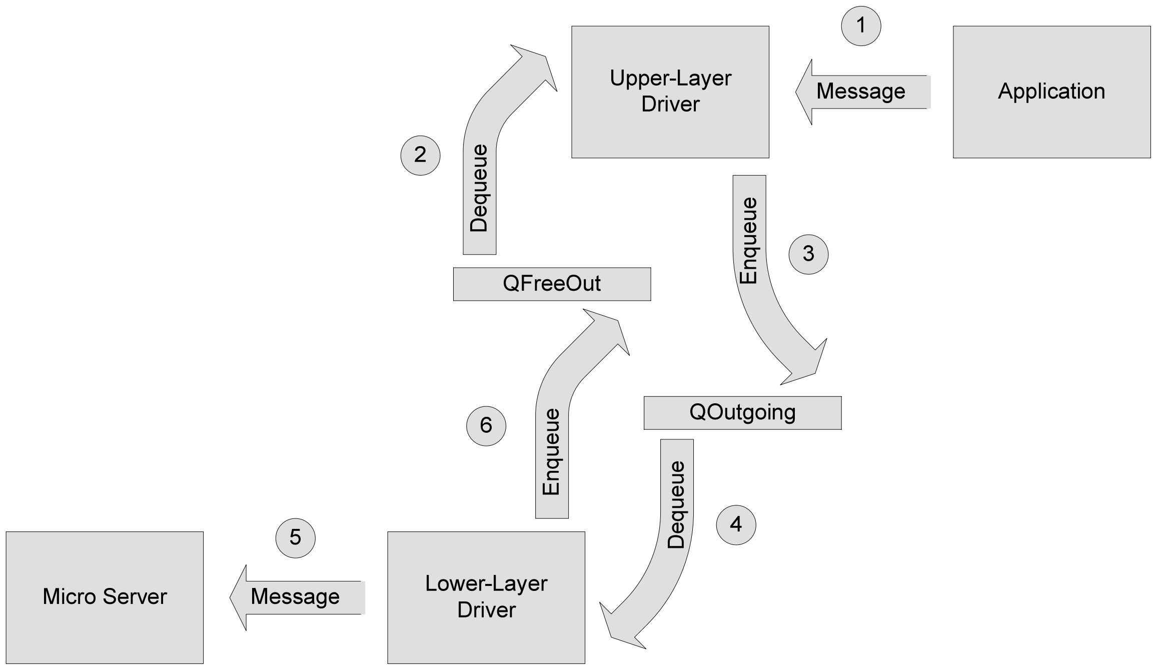


Figure 3. Processing for an Outgoing Message

Upper-Layer Serial Driver Implementation

The **ldvintfc.c** file implements the following functions:

- **ldv_init()**: Initializes the queues and the serial driver.
- **ldv_get_msg()**: Determines if there are messages waiting in the receive buffer by dequeuing an element from the incoming queue.
- **ldv_release_msg()**: Releases a receive buffer by enqueuing it to the free incoming queue.
- **ldv_allocate_msg()**: Determines if there is an available transmit buffer by dequeuing an element from the free outgoing queue.
- **ldv_put_msg()**: Sends a message downlink and frees the transmit buffer by enqueuing it to the outgoing queue.
- **ldv_put_msg_init()**: Calls the **SysPutMsgInit()** function to send messages downlink that are longer than a single transmit buffer.
- **ldv_flush_msgs()**: Calls the **SysFlushTxBuf()** function to cause the driver to transmit messages that are waiting in transmit buffers.

Lower-Layer SCI Serial Driver Implementation

The **ldvsci.c** file implements the following functions:

- **SysInit()**: Initializes the lower-layer serial driver.
- **SysEnableInterrupts()**: Enables all interrupts for the ShortStack UART.

- **SysDisableInterrupts()**: Disables all interrupts for the ShortStack UART.
- **EnableCTSIRQ()**: Enables the CTS handshake interrupt handler.
- **DisableCTSIRQ()**: Disables the CTS handshake interrupt handler.
- **EnableRxIRQ()**: Enables the receive indication interrupt handler.
- **DisableRxIRQ()**: Disables the receive indication interrupt handler.
- **EnableTxIRQ()**: Enables the transmit-ready indication interrupt handler.
- **DisableTxIRQ()**: Disables the transmit-ready indication interrupt handler.
- **SysResetSCI()**: Performs a partial reset of the Nios II processor by resetting the SCI interface. It also informs the ShortStack Micro Server that the host is not ready.
- **CTSInt()**: The CTS handshake interrupt service routine. Because the CTS line is polled for the Nios II example application, this function is obsolete.
- **UARTInt()**: The UART interrupt service routine. Because the Nios II UART shares a single interrupt service routine for both RX and TX interrupts, this function determines the reason for the interrupt and calls the appropriate service function.
- **WaitForCTSLow()**: Waits until the CTS line is low or until a timeout occurs.
- **WaitForCTSHigh()**: Waits until the CTS line is high or until a timeout occurs.
- **SysPutMsgInit()**: Sends messages downlink that are longer than a single transmit buffer.
- **SysFlushTxBuf()**: Flushes the lower-layer serial driver's transmit buffers.
- **SysTxMsgCompleted()**: Returns a buffer to the free outgoing buffer pool and resets the serial driver's status after successful message transmission.
- **RxIntService()**: The SCI interrupt handler for receiving messages.
- **TxIntService()**: The SCI interrupt handler for transmitting messages.
- **SCIERRIntService()**: The SCI interrupt handler for error conditions. This function resets the SCI interface.
- **TBInt()**: The timebase interrupt handler. This function is executed every millisecond, and ensures that the driver is running and that the 3120 EVB's RS-232 UART remains active.

The **hndshk.c** file implements the following functions to access the reset and handshake lines:

- **AssertRTS()**
- **DeassertRTS()**
- **AssertHRDY()**

- DeassertHRDY()
- ResetTransceiver()
- InitHandshake()
- CheckCTS()

5

Exploring the Simple Voltage Amplifier Example Application

This chapter describes the simple voltage amplifier example application, including the application's design, **main()** and callback functions, and Neuron C model file. This chapter also describes how to build and load the application images and run the example application.

Overview

The simple voltage amplifier example application is a very simple application that simulates a voltage amplifier device. This device receives an input voltage value, multiplies the value by 2, and returns the new output value. **Figure 4** shows the functional blocks for the application.

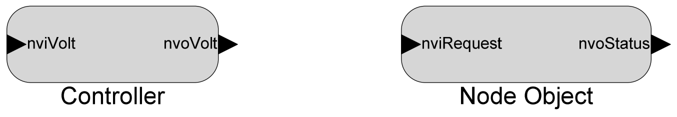


Figure 4. Voltage Amplifier Functionality

The Controller functional block defines the voltage amplification. The Node Object functional block defines an interface for device interoperability. However, because the Controller functional block is deprecated, the example is not compliant with current LONMARK® interoperability guidelines, which are available at www.lonmark.org.

Design

The design of the example application is very simple. It includes a single C source file (**main.c**), the ShortStack API files generated by the ShortStack Wizard, and the ShortStack Serial Driver.

The following sections describe the application's **main()** function, callback functions, and Neuron C model file.

Main Function

The **main()** function performs the following tasks:

1. Calls the **lonInit()** ShortStack API function to initialize the ShortStack API, the ShortStack serial driver, and the ShortStack Micro Server.
2. Runs an infinite loop to repeatedly call the **lonEventHandler()** API function to handle LONWORKS events.

Although the **main()** function for this application is an example, you can use the same basic algorithmic approach for a production-level application.

The **main.c** file in both of the following directories contains the **main()** function, which is shown below:

- [*NiosExample*]**\software\Application_FT**
- [*NiosExample*]**\software\Application_PL**

```
/*
 * Main Function
 */
int main (void)
{
    // Initialize your host-side hardware here, TBD
    // Initialize your host-side software here, TBD

    // Initialize ShortStack API, serial driver, and
    // ShortStack Micro Server

    printf ("Initializing LON...");
    lonInit();
    printf ("done.\n");
    printf ("You can use LonMaker to test your device
now.\n");

    // Handle messages in a loop

    for (;;)
    {
        /* Handle LonWorks events.
         * The corresponding callbacks are defined in
         * lon/lonapp.c
         */

        lonEventHandler();

        // Process your application, TBD

        // Sleep
        usleep (10000);
    }

    return (0); /* Pro forma */
}
```

Callback Functions

To signal to the main application the occurrence of certain types of events, the ShortStack API calls specific callback functions. For the voltage amplifier example application, only one of the API's callback functions has been implemented to provide application-specific behavior.

The **lonNvUpdateOccurred()** function, which is called when the host receives a network-variable update, contains a C **switch** statement, which performs the following tasks:

- Sets the network variables for the Node Object functional block.
- Sets the output network variable for the Controller functional block to double the value of the input network variable, and propagates the output network-variable to the network.

The two network variables are defined in the Neuron C model file, which is described in *Neuron C Model File* on page 30.

The **lonapp.c** file in both of the following directories contains the **lonNvUpdateOccurred()** function, which is shown below:

- [*NiosExample*]**\software\Application_FT\lon\api**
- [*NiosExample*]**\software\Application_PL\lon\api**

```
void lonNvUpdateOccurred(const Byte nvIndex, const
RcvAddrDtl* const pNvInAddr)
{
    switch (nvIndex)
    {
    case NVIDX_nviRequest:
        nvoStatus.object_id = nviRequest.object_id;
        nvoStatus.invalid_id = 1;
        nvoStatus.invalid_request = 1;
        break;

    case NVIDX_nviVolt:
        nvoVolt = NET_SWAB_WORD(2*NET_SWAB_WORD(nviVolt));
        if (lonPropagateNv(NVIDX_nvoVolt) != API_NO_ERROR)
        {
            // Handle error here, if desired.
        }
        break;

    default:
        break;
    }
}
```

Neuron C Model File

The Neuron C model file, **Sample_Node.nc,** defines the LONWORKS interface for the example ShortStack device. This file is in the following directories:

- [*NiosExample*]**\software\Application_FT\lon\wizard**
- [*NiosExample*]**\software\Application_PL\lon\wizard**

The model defines two functional blocks, **NodeObject** and **Volt_Amplifier**. The **Volt_Amplifier** functional block includes two network variables, **nviVolt** and **nvoVolt**. The functionality for these network variables is implemented in the **lonNvUpdateOccurred()** callback function described in *Callback Functions* on page 29.

The Neuron C model file is shown below.

```
#pragma enable_sd_nv_names
#pragma set_node_sd_string "A simple voltage amplifier"


// Node object
network input SNVT_obj_request nviRequest;
network output SNVT_obj_status nvoStatus;

fblock SFPTnodeObject {
    nviRequest implements nviRequest;
    nvoStatus  implements nvoStatus;
} NodeObject;


// Voltage-current converter
```

```
network input SNVT_volt nviVolt;
network output SNVT_volt nvoVolt;

fblock SFPTcontroller {
    nviVolt    implements nviValue;
    nvoVolt    implements nvoValue;
} Volt_Amplifier;
```

Using the **Sample_Node.nc** file as the model file, the ShortStack Wizard generated the following files: **filedir.h**, **LonDev.c**, **LonDev.h**, **NvTypes.h** and **platform.h**. For more information about creating and using a Neuron C model file, see the *ShortStack User's Guide*.

To change the LONWORKS interface and functionality of the example application, perform the following steps:

1. Define the interface in the **Sample_Node.nc** Neuron C model file.
2. Run the ShortStack Wizard and modify its output as described in *Modifying the Output of the ShortStack Wizard*.
3. Make appropriate changes to the callback functions in the **lonapp.c** file.
4. Rebuild the project.
5. Load the generated XIF file into the Smart Transceiver.
6. Load the new executable file into the Nios II processor.

Modifying the Output of the ShortStack Wizard

After you run the ShortStack Wizard to generate the **filedir.h**, **LonDev.c**, **LonDev.h**, **NvTypes.h** and **platform.h** files, you must make the following manual changes:

1. Delete the generated **platform.h** file from the directory in which you are running the ShortStack Wizard:
   - [*NiosExample*]**\software\Application_FT\lon\wizard**
   - [*NiosExample*]**\software\Application_PL\lon\wizard**
2. Copy the **platform.h** file that was installed with the ShortStack 2 Nios II Example Port to the appropriate [*NiosExample*] directory, as listed in **Table 9**.

Table 9. Copying platform.h

From	**To**
[*ShortStack*]\Examples\NiosII\nios_II_echelon_ShortStack_EVB_application\software\Application_FT\lon\wizard\platform.h	[*NiosExample*]\software\Application_FT\lon\wizard\platform.h
[*ShortStack*]\Examples\NiosII\nios_II_echelon_ShortStack_EVB_application\software\Application_PL\lon\wizard\platform.h	[*NiosExample*]\software\Application_PL\lon\wizard\platform.h

3. Modify the **NvTypes.h** file to add the packed attribute to each **struct** type definition. **Table 10** shows an example.

Table 10. Including the Packed Attribute for struct Type Definitions

From	To

`typedef struct`
`{`
`    nculong object_id;`
`    ncsInt object_request;`
`}  SNVT_obj_request;`
	`typedef struct`
	`{`
	`    nculong object_id;`
	`    ncsInt object_request;`
	`}  `**`__attribute ((__packed__))`**
	`SNVT_obj_request;`

You must make these changes each time you run the ShortStack Wizard because the Wizard overwrites the generated files.

Building the Application Image

The ShortStack 2 Nios II Example Port includes the hardware design for the Nios II processor, as well as the software for the ShortStack API, ShortStack serial driver, and simple voltage amplifier application. You must separately build the hardware image and the software image.

Building the Hardware Image

The ShortStack 2 Nios II Example Port includes a pre-built hardware design image for the Nios II processor. To use the pre-built image, see *Loading the Hardware Image* on page 36.

You might need to rebuild the hardware image, for example, if you want to modify the design, run the Nios II processor on a different device than a Cyclone II FPGA, or if your Altera tools license requires you to rebuild the image.

Before you rebuild the hardware image, ensure that the DBC2C20 components are included in the library search path for the project:

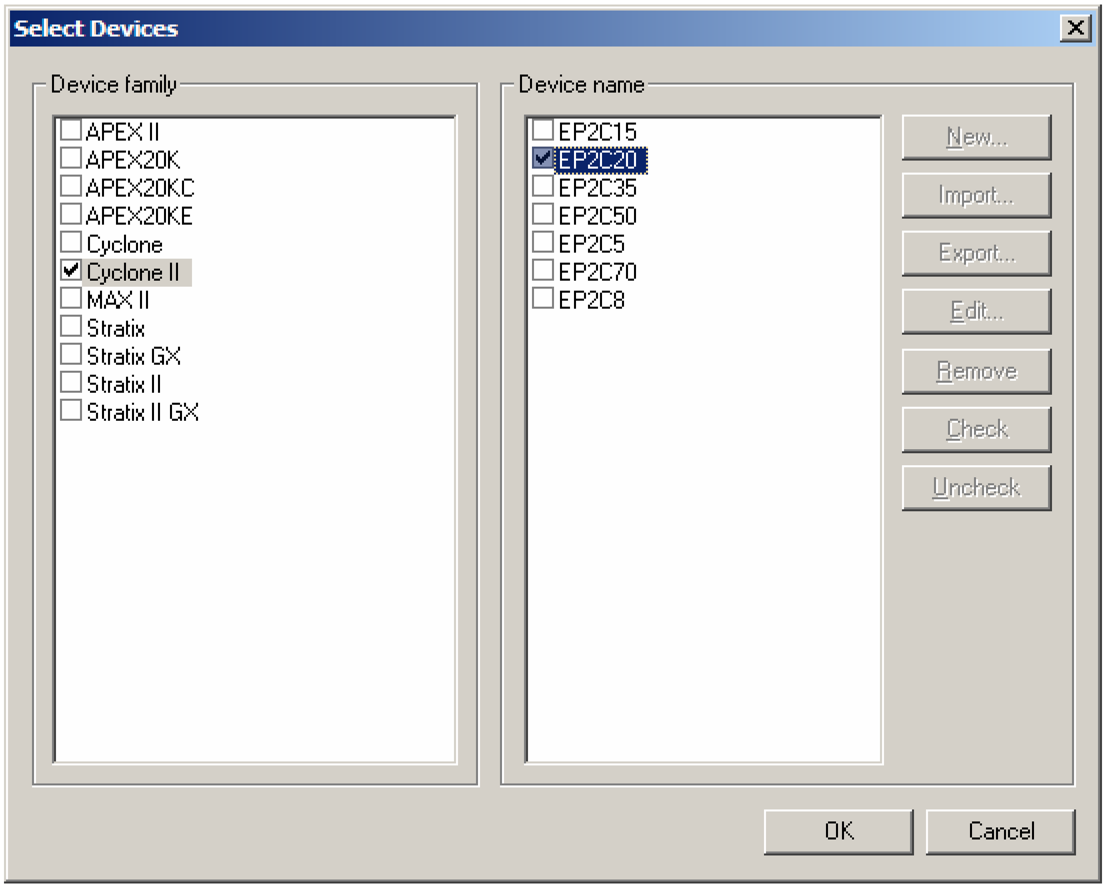
1. Start the Quartus II software.
2. Ensure that the Project Navigator utility window displays the dbc2c20_standard_design. If it does not, open the project, as described in *Loading the Hardware Image* on page 36.
3. Select **Tools → SOPC Builder** to display the Altera SOPC Builder window.
4. Select **File → SOPC Builder Setup** to display the SOPC Builder Setup window.
5. In the SOPC Builder Setup window, add the following directories to the Component/Kit Library Search Path:

```
C:/altera/61/nios2eds/components/DBC2C20_cfi_flash_interface
+
C:/altera/61/nios2eds/components/DBC2C20_sram_interface
```

6. Click **OK** to close the SOPC Builder Setup window.
7. Select **File → Exit** to close the Altera SOPC Builder window.

To rebuild the hardware image:

1. Start the Quartus II software.
1. Select **File → Open Project** to display the Open Project window.
2. In the Open Project window, select the **dbc2c20_standard_design.qpf** hardware project file from the [*NiosExample*] directory, and click **Open** to add the project file to the Project Navigator.
3. Modify the CPU design or other hardware elements as desired.
4. Select **Processing → Start Compilation** (or click the **Start Compilation** button on the toolbar) to compile the project. Compilation can take a few minutes.
5. Select **File → Convert Programming Files** to open the Convert Programming Files window. This window allows you to convert the **dbc2c20_standard_design.sof** file to the **ShortStackHardware Design.jic** file.
6. In the Convert Programming Files window:
    a. Select **JTAG Indirect Configuration File (.jic)** from the **Programming file type** dropdown list box.
    b. Select **EPCS16** from the **Configuration device** dropdown list box. The DBC2C20 development board includes an EPCS16 configuration device.
    c. Enter **ShortStackHarwareDesign.jic** in the **File name** field. Place this file in the [*NiosExample*] directory.
    d. In the Input files to convert table, select **Flash Loader**, and click **Add Device** to open the Select Devices window.
    e. In the Select Devices window, select **Cyclone II** from the Device family area, and select **EP2C20** from the Device name area, as shown in **Figure 5** on page 34. The DBC2C20 development board includes an Altera EP2C20F484 Cyclone II FPGA. Click **OK**.



Device family:

- [ ] APEX II
- [ ] APEX20K
- [ ] APEX20KC
- [ ] APEX20KE
- [ ] Cyclone
- [✓] Cyclone II
- [ ] MAX II
- [ ] Stratix
- [ ] Stratix GX
- [ ] Stratix II
- [ ] Stratix II GX

Device name:

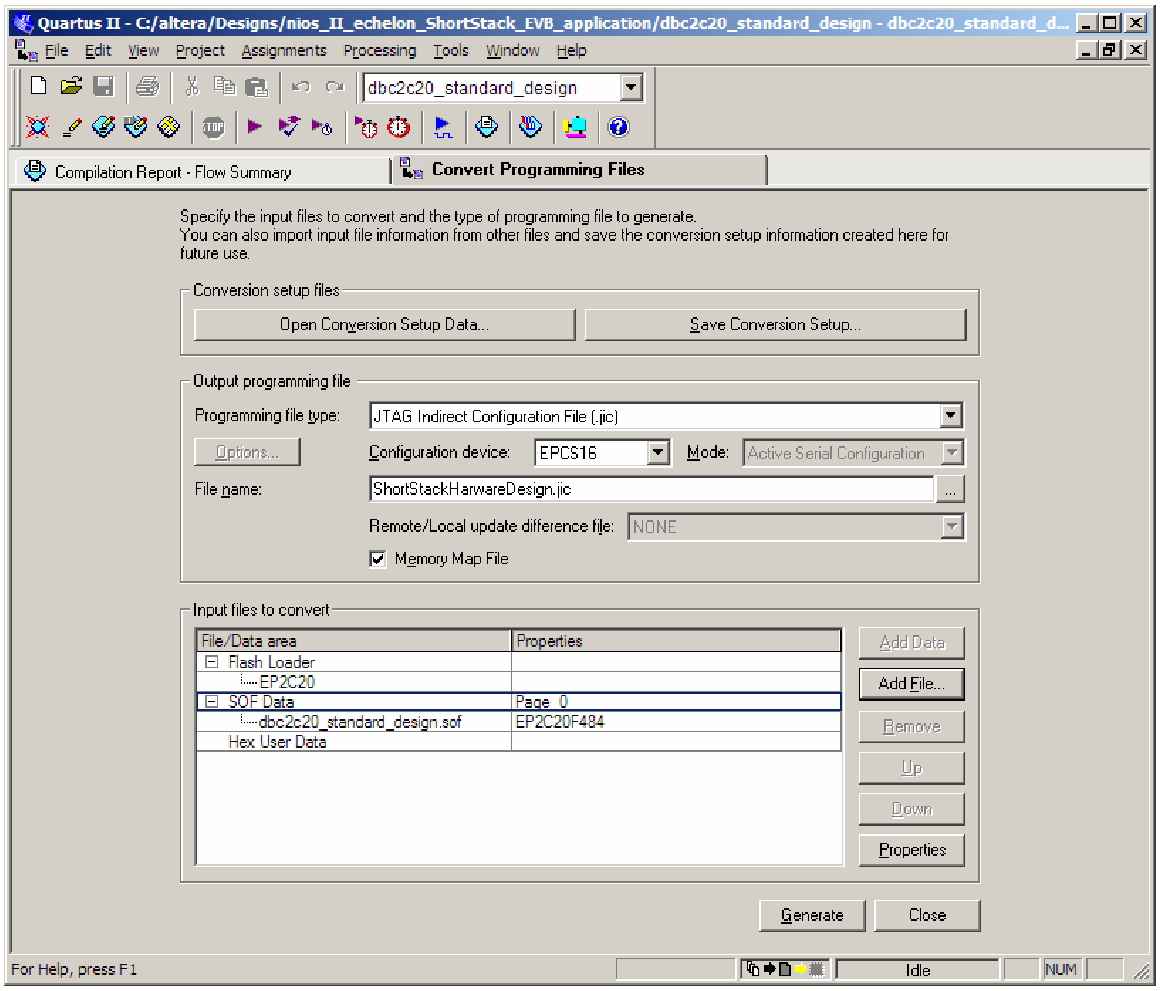
- [ ] EP2C15
- [✓] EP2C20
- [ ] EP2C35
- [ ] EP2C50
- [ ] EP2C5
- [ ] EP2C70
- [ ] EP2C8

Figure 5. Quartus II Select Devices Window

f. In the Input files to convert table, select **SOF Data**, and click **Add File** to open the Select Input File window.

g. In the Select Input File window, select the **dbc2c20_standard_design.sof** file from the [*NiosExample*] directory. Click **Open**.

h. Verify that the Convert Programming Files window looks similar to **Figure 6** on page 35.


Quartus II - C:/altera/Designs/nios_II_echelon_ShortStack_EVB_application/dbc2c20_standard_design - dbc2c20_standard_d...

Convert Programming Files

Specify the input files to convert and the type of programming file to generate.
You can also import input file information from other files and save the conversion setup information created here for future use.

Conversion setup files

Output programming file

Programming file type: JTAG Indirect Configuration File (.jic)

Configuration device: EPCS16 Mode: Active Serial Configuration

File name: ShortStackHarwareDesign.jic

Remote/Local update difference file: NONE

☑ Memory Map File

Input files to convert

File/Data area	Properties
⊟ Flash Loader	
EP2C20	
⊟ SOF Data	Page_0
dbc2c20_standard_design.sof	EP2C20F484
Hex User Data	

For Help, press F1

Figure 6. Quartus II Convert Programming Files Window

i. Click **Generate** to generate the **ShortStackHarwareDesign.jic** file.

j. Click **Close** to close the Convert Programming Files window.

7. Load the modified hardware design for the Nios II processor into the Cyclone II FPGA on the DBC2C20 development board, as described in *Loading the Hardware Image* on page 36.

Building the Software Image

To build the software image for the ShortStack 2 Nios II Example Port:

1. Start the Nios II EDS IDE.
2. If you want to work in a new workspace, select **File** → **Switch Workplace** to open the Workspace Launcher window, from which you can select a new or existing workspace.
3. Select **File** → **Import** to open the Import window.
4. In the Select page of the Import window, select **Existing Altera Nios II Project into Workspace** from the Altera folder. Click **Next**.

5. In the Import Project from File System page of the Import window, click **Browse** to open the Browse for Folder window.
6. In the Browse for Folder window, select the **Application_FT** or **Application_PL** folder from the [*NiosExample*]**\software** directory. Click **OK**.
7. In the Import Project from File System page of the Import window, click **Finish** to add the project to the workspace.
8. If you see the Remove generated folders dialog that asks whether you want to remove the project's debug directories, click **Yes**.
9. Repeat steps 3 through 8 to add the **Application_FT_syslib** or **Application_PL_syslib** project to the workspace. Do not change the selections for the Select Target Hardware area unless you have customized the hardware for the project.
10. Select **Project** → **Clean** to open the Clean window.
11. In the Clean window, ensure that the **Clean all projects** radio button is selected and that the **Start a build immediately** checkbox is selected and click **OK**. The build can take a few moments.

After you build the project, you can run it, as described in *Running the Application* on page 39, or you can load the software image into the Nios II processor, as described in *Loading the Software Image* on page 37.

Loading the Application Image

As with building the application image, because the ShortStack 2 Nios II Example Port includes the hardware design and the software, you must separately load the hardware image and the software image.

Loading the Hardware Image

To load the hardware image for the Nios II processor into the Cyclone II FPGA on the DBC2C20 development board:

1. Ensure that the DBC2C20 development board is powered on and that the USB-Blaster download cable is connected to the JTAG header connector (**P1**).
2. Start the Quartus II software.
3. Select **File** → **Open Project** to display the Open Project window.
4. In the Open Project window, select the **dbc2c20_standard_design.qpf** hardware project file in the [*NiosExample*] directory, and click **Open** to add the project file to the Project Navigator.
5. Select **Tools** → **Programmer** to open the Chain Description File view for the project.
6. Ensure that the USB-Blaster download cable is defined in the Chain Description File for the project.

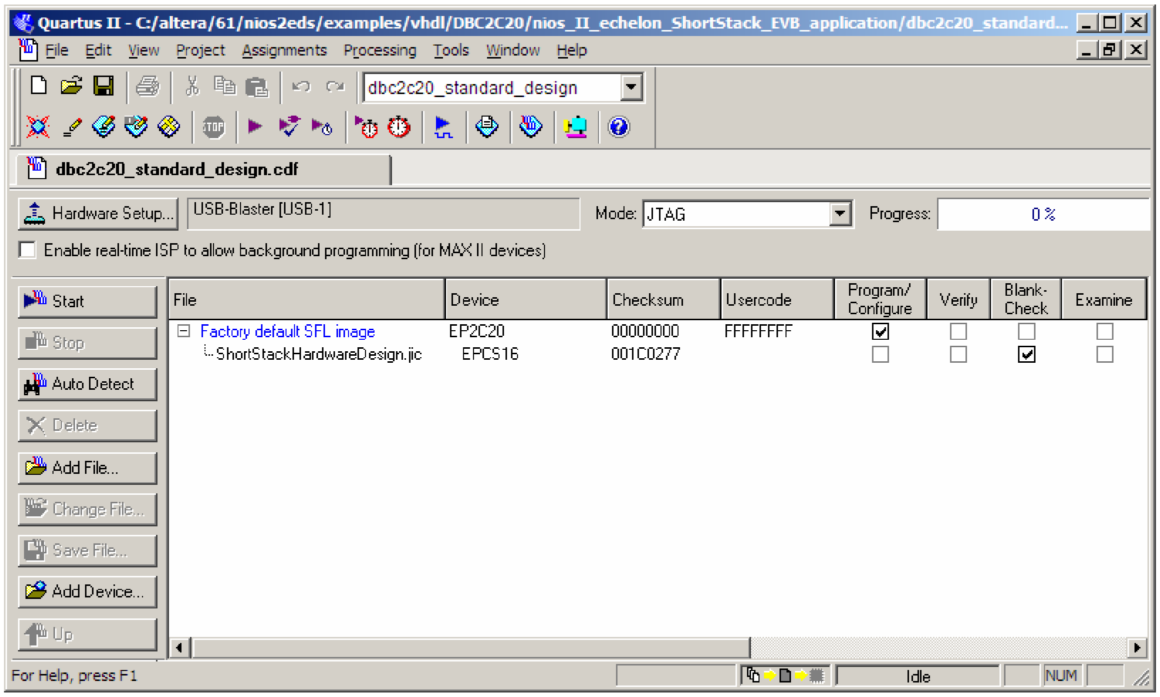
   If you have not defined the USB-Blaster download cable in the Chain Description File for the project, click **Hardware Setup**. See *Loading Your*

Application into the Nios II Processor on page 15 for more information about setting up the USB-Blaster download cable.

7. Verify that the **ShortStackHardwareDesign.jic** file is already listed in the Chain Description File view for the project.

   If the **ShortStackHardwareDesign.jic** file is not listed in the Chain Description File view for the project, click **Add File** to open the Select Programming File window. From the Select Programming File window, select the **ShortStackHardwareDesign.jic** file from the [*NiosExample*] directory, and click **Open** to add the file to the Chain Description File view for the project.

8. Verify that the **Program/Configure** and **Blank-Check** checkboxes are selected for the hardware design file, as shown in **Figure 7**. Also select the **Erase** checkbox if you want to replace an existing hardware design in the Cyclone II FPGA.


Quartus II - C:/altera/61/nios2eds/examples/vhdl/DBC2C20/nios_II_echelon_ShortStack_EVB_application/dbc2c20_standard...
File Edit View Project Assignments Processing Tools Window Help
dbc2c20_standard_design
dbc2c20_standard_design.cdf
Hardware Setup...
Start
Stop
Auto Detect
Delete
Add File...
Change File...
Save File...
Add Device...
Up
For Help, press F1
Idle
NUM

USB-Blaster [USB-1] Mode: JTAG Progress: 0 %

☐ Enable real-time ISP to allow background programming (for MAX II devices)

File	Device	Checksum	Usercode	Program/ Configure	Verify	Blank-Check	Examine
⊟ Factory default SFL image	EP2C20	00000000	FFFFFFFF	☑	☐	☐	☐
ShortStackHardwareDesign.jic	EPCS16	001C0277		☐	☐	☑	☐

Figure 7. The Chain Description File for the ShortStack 2 Nios II Example Port Project

9. Click **Start** to load the hardware design into the host processor.

10. After the Quartus II software has finished loading the hardware image into the host processor, perform a reset by disconnecting power from the DBC2C20 development board and reconnecting power to the board.

11. Select **File** → **Exit** if you want to close the Quartus II software window.

Loading the Software Image

You can load the software image into the Nios II processor if you have a development license from Altera Corporation for the Nios II processor. If you do not have a license, you can still run the example application, but you must run it from the Nios II EDS IDE while the USB-Blaster download cable remains connected to the DBC2C20 development board.

To load the software image into the Nios II processor:

1. Ensure that the DBC2C20 development board is powered on and that the USB-Blaster download cable is connected to the JTAG header connector (**P1**).
2. Start the Nios II EDS IDE.
3. Ensure that the workspace includes one of the following two sets of projects for the example application:
    - **Application_FT** and **Application_FT_syslib**
    - **Application_PL** and **Application_PL_syslib**
4. Select the **Application_FT** or **Application_PL** project from the Nios II C/C++ Projects pane.
5. Select **Tools → Quartus II Programmer** to open the open the Chain Description File view for the project.
6. Load the hardware image for the Nios II processor into the Cyclone II FPGA, as described in *Loading the Hardware Image* on page 36. Perform steps 6 through 10. Leave Quartus II Programmer window open.
7. Select **Tools → Flash Programmer** to open the Flash Programmer window.
8. In the Flash Programmer window, right-click **Flash Programmer** and select **New** to create a configuration for the selected project.
9. Select **Program software project into flash memory**. Select the **Application_FT** or **Application_PL** project from the **Project** dropdown list box.
10. Select **Program FPGA configuration data into hardware-image region of flash memory** to load the hardware design into flash along with the software design.
    a. Select the **dbc2c20_standard_design.sof** hardware design file in the [*NiosExample*] directory from the **FPGA Configuration (SOF)** dropdown list box.
    b. Select **Nios II EP1C20 epcs** from the **Hardware Image** dropdown list box.
    c. Select **epcs_controller** from the **Memory** dropdown list box.
11. Select **Validate Nios II system ID before software download**.
12. Click **Program Flash** to load the software image into the Nios II processor. Loading the software image can take a few moments.
13. If the Program Flash Now? dialog appears, click **Yes**.
14. After the software is loaded, perform a reset by disconnecting power from the DBC2C20 development board and reconnecting power to the board.
15. Close the Quartus II Programmer window. You can also close the Nios II IDE window.

The Nios II processor runs the loaded software as soon as the processor completes restart processing.

Running the Application

If you loaded the application image into the Nios II processor, the application runs automatically as soon as the ShortStack Micro Server and the Nios II processor are properly programmed and reset.

You can also run the application from the Nios II EDS IDE:

1. Ensure that the DBC2C20 development board is powered on and that the USB-Blaster download cable is connected to the JTAG header connector (**P1**).
2. Start the Nios II EDS IDE.
3. Ensure that the workspace includes one of the following two sets of projects for the example application:
   - **Application_FT** and **Application_FT_syslib**
   - **Application_PL** and **Application_PL_syslib**
4. Right-click the **Application_FT** or **Application_PL** project from the Nios II C/C++ Projects pane and select **Run As → Nios II Hardware**. The Nios II EDS IDE recompiles the project.
5. If you have a valid Nios II development license, and have already loaded the configuration data (the **ShortStackHardwareDesign.jic** file) into the Cyclone II FPGA, proceed to step 7.
6. If you do not have a valid Nios II development license, or have not loaded the configuration data into the Cyclone II FPGA:
   a. The Nios II EDS IDE displays the following text in the Console window:

      ```
      There are no Nios II CPUs with debug modules
      available which match the values specified.  Please
      check that your PLD is correctly configured,
      downloading a new SOF file if necessary.
      ```

   b. The Quartus II Programmer window opens.

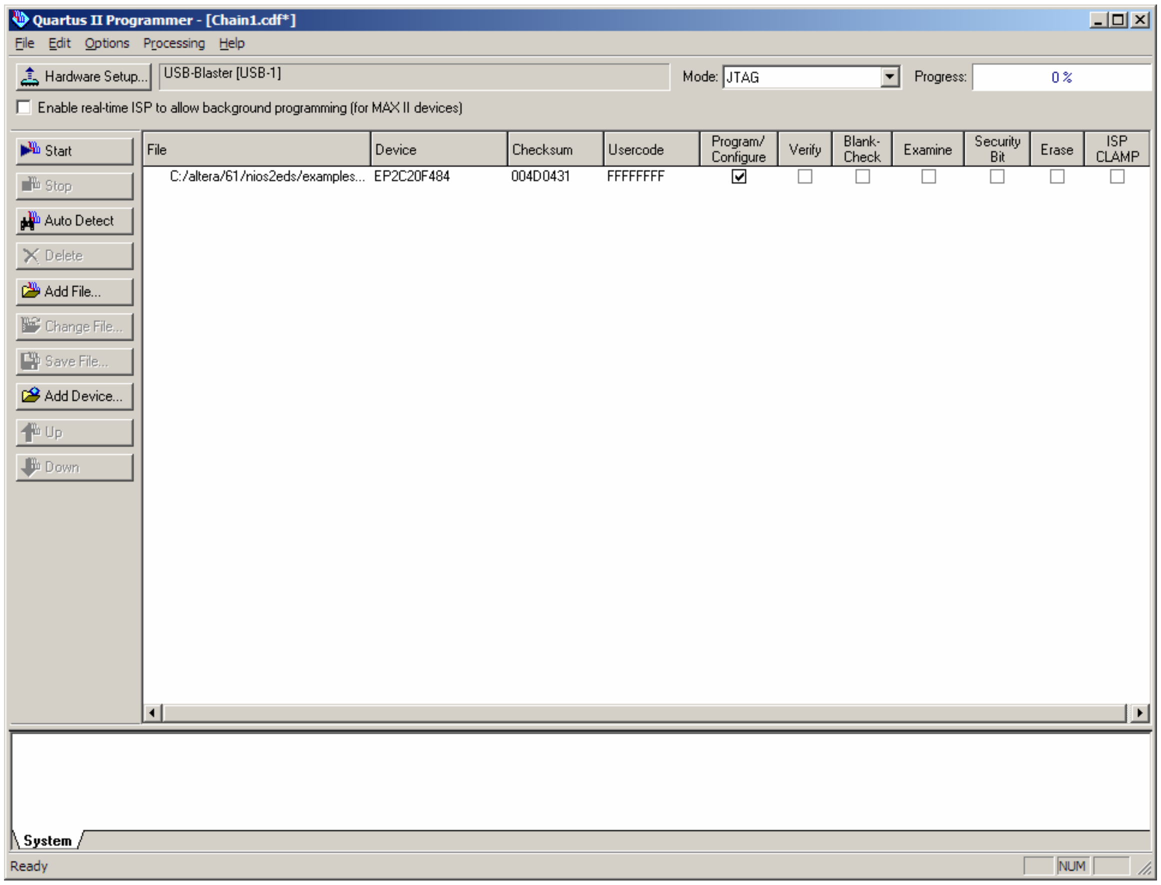
   c. In the Quartus II Programmer window, click **Add File** to open the Select Programming File dialog.

   d. In the Select Programming File dialog, select the **dbc2c20_standard_design.sof** file and click **Open**.

   e. Ensure that the USB-Blaster download cable is defined in the Chain Description File for the project.

      If you have not defined the USB-Blaster download cable in the Chain Description File for the project, click **Hardware Setup**. See *Loading Your Application into the Nios II Processor* on page 15 for more information about setting up the USB-Blaster download cable.

f. Select the **Program/Configure** checkbox for the **dbc2c20_standard_design.sof** file, as shown in **Figure** 8.



USB-Blaster [USB-1]

Mode: JTAG

Progress: 0 %

☐ Enable real-time ISP to allow background programming (for MAX II devices)

File	Device	Checksum	Usercode	Program/ Configure	Verify	Blank-Check	Examine	Security Bit	Erase	ISP CLAMP
C:/altera/61/nios2eds/examples...	EP2C20F484	004D0431	FFFFFFFF	☑	☐	☐	☐	☐	☐	☐

Figure 8. Loading the SRAM Object File into the Nios II Processor

g. Click **Start** to load the selected SRAM Object File (**dbc2c20_standard_design.sof**) into the Nios II processor.

h. Do not close the Quartus II Programmer window. You must leave this window open while you are running the example application.

i. Return to the Nios II EDS IDE, right-click the **Application_FT** or **Application_PL** project from the Nios II C/C++ Projects pane, and select **Run As** → **Nios II Hardware**. The Nios II EDS IDE recompiles the project.

7. You should see the following text in the Console window to confirm that the example application is running and communicating with the ShortStack Micro Server:

```
Initializing LON...done.
You can use LonMaker to test your device now.
```

If you do not see this text, or if you see only “`Initializing LON...`”, ensure that the ShortStack Micro Server has power, is connected to the DBC2C20 development board, and is properly configured.

To verify that the application runs as expected, connect the ShortStack Micro Server to a network management tool, such as the LonMaker tool. From the tool, modify the value for the **nviVolt** network variable and confirm that the value for the **nvoVolt** network variable is double that value.

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