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Cyclone II FPGA Starter Development Kit

User Guide

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Contents

Chapter 5. Using the Development Board

Chapter 6. Advanced Examples

About This User Guide

This user guide describes how to start using the Altera® Cyclone® II FPGA Starter Development Kit, including unpacking the kit, installing required software, connecting the development board to a PC, and running sample software.

For a full description of the development board and its use, refer to the *Cyclone II FPGA Starter Development Kit Reference Manual*.

The document revision history in Table 1–1 shows this document's current version. To ensure that you have the most up-to-date information on this product, refer to the **readme** file on the provided CD_ROM for late-breaking information that is not available in this document.

Table 1–1. Document Revision History

Date	Description
October 2006	Initial publication of the Cyclone II FPGA Starter Development Kit, version 1.0.0

How to Find Information

The following methods enable you to quickly find information in this Portable Document Format (PDF) type document:

- Search the contents by using the Adobe® Acrobat® or Reader® **Edit/Find** command or click on the binoculars/**Search** toolbar icon.
- The **Bookmarks** window serves as an additional table of contents. Click on a topic to jump to that section in the document.
- Thumbnail icons in the **Pages** window provide miniature previews of each page and provide a link to the pages.
- Within the text, hypertext links, highlighted in green, enable you to jump to related information.

How to Contact Altera

To get help regarding this product, use the following contact information:

- Altera Corporation
  101 Innovation Drive
  San Jose, California, 95134 USA
  www.altera.com

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: 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.
⚠ CAUTION	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.

1. Getting Started

Introduction

Welcome to the Altera Cyclone II FPGA Starter Development Kit, which includes a full-featured field-programmable gate array (FPGA) development board, hardware and software development tools, documentation, and accessories needed to begin FPGA development.

The development board includes an Altera Cyclone II 2C20 FPGA and comes preconfigured with a hardware reference design stored in flash memory. Hardware designers can use the development board as a platform to prototype complex embedded systems.

The Development Kit provides the user with an integrated control environment that includes a software controller in C++, a USB command controller, a multi-port SRAM/SDRAM/flash memory controller, and demonstration circuitry specified in Verilog code. These features enable users to implement and test designs without the need to implement complex application programming interfaces (APIs), host control software, or SRAM/SDRAM/flash memory controllers.

This user guide addresses the following topics:

- How to set up, power up, and verify correct operation of the development board
- How to install the Altera Development Suite Tools and the Cyclone II FPGA Starter Development Kit CD-ROMs
- How to set up, and use the Control Panel, a graphical user interface (GUI), to manipulate components on the board, implement applications, and display images on a VGA monitor
- How to configure the Cyclone II FPGA
- How to set up and run application examples

For complete details on the development board, refer to the *Cyclone II FPGA Starter Development Kit Reference Manual*.

Before You Begin

Before proceeding, check the contents of the Development Kit:

- Cyclone II FPGA Starter Development board

- Cyclone II FPGA Starter Development Kit CD-ROM containing the development board documentation and supporting materials, including the User Guide and Reference Manual, Control Panel utility, reference designs and demonstrations, device datasheets, tutorials, and a set of laboratory exercises
- The Altera Development Suite Tools CD-ROMs containing Altera Quartus® II 6.0 Web Edition design software and the Nios® II 6.0 embedded processor
- Bag of six rubber (silicon) covers for the development board stands and extender pins that facilitate easier probing of the board I/O expansion headers with testing equipment
- 7.5 V DC wall-mount power supply
- Clear plastic cover for the board

Other items you will want to have available to work through this user guide are:

- VGA monitor
- Audio source such as a CD player or MP3 player
- Headphones
- PS/2 keyboard

Further Information

For other related information, refer to the following websites:

- For additional daughter cards available for purchase:

  http://www.altera.com/products/devkits/kit-daughter_boards.jsp

- For on-line demonstrations & training:

  http://www.altera.com/education/demonstrations/dem-index.html and https://mysupport.altera.com/etraining/

- For Cyclone II handbook:

  http://www.altera.com/literature/lit-cyc2.jsp

- For Cyclone II reference designs:

  http://www.altera.com/end-markets/refdesigns/device/cyclone2/cyclone2-index.jsp

- For eStore if wish to purchase devices:

  http://www.altera.com/buy/devices/buy-devices.html

■ For Cyclone II Orcad symbols:

http://www.altera.com/support/software/download/pcb/pcb-pcb_index.html

■ For Nios II 32-bit embedded processor solutions:

http://www.altera.com/technology/embedded/emb-index.html

Hardware Installation

⚠ Before beginning any work, prepare the board as follows:

■ Assemble a rubber (silicon) cover (Figure 1–1) for each of the six copper stands on the board
■ Mount the clear plastic cover over the top of the board for extra protection by using additional stands and screws

Figure 1–1. Board Stand Covers
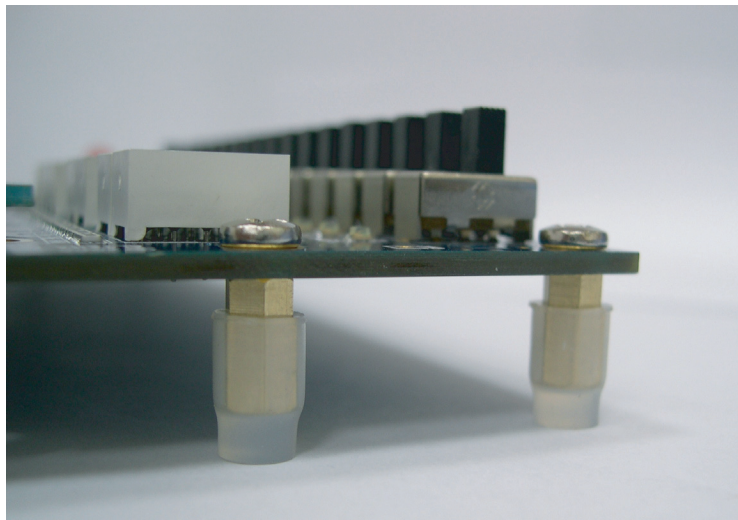
Software Installation

The instructions in this section describe how to install the following:

■ *Cyclone II FPGA Starter Development* CD-ROM
■ The Quartus II Software, Development Kit Edition

Installing the Cyclone II FPGA Starter Development Kit CD-ROM

The *Cyclone II FPGA Starter Development Kit* CD-ROM contains the following items:

■   Sample design files and board design files for the kit
■   *Cyclone II FPGA Starter Development Kit User Guide* (this document)
■   *Cyclone II FPGA Starter Development Board Reference Manual*

To install the *Cyclone II FPGA Starter Development Kit* CD-ROM, perform the following steps:

1.   Insert the *Cyclone II FPGA Starter Development Kit* CD-ROM into the CD-ROM drive.

☞   The CD-ROM should start an auto-install process. If it does not, browse to the CD-ROM drive and double-click on the **setup.exe** file.

2.   Follow the online instructions to complete the installation process. The installation program copies the Cyclone II FPGA Starter Development Kit files to the hard-disk and creates a

Programs > Altera > Cyclone II FPGA Starter Development Kit v1.0.0

icon, accessible from the Windows Start menu. Use this icon to launch the Windows-style development kit GUI.

The Cyclone II FPGA Starter Development Kit installation program creates a directory structure for the installed files (Figure 1–2), where *<path>* is the selected Cyclone II Starter Development Kit installation directory.

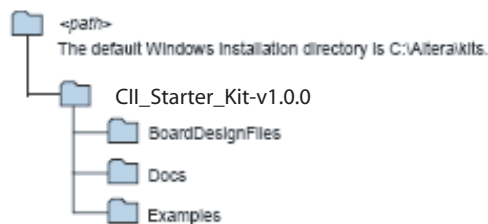*Figure 1–2. Cyclone II Starter Kit Installed Directory Structure*

Table 1–1 lists the file directory names and a description of their contents.

Table 1–1. Installed Directory Contents

Directory Name	Description of Contents
BoardDesignFiles	Contains the board design files. Use these files as a starting point for a new prototype board design.
Docs	Contains the development kit documentation
Examples	Contains the sample design files for the Cyclone II FPGA Starter Development Kit

Installing the Quartus II Software

Install the *Quartus II Web Edition Software Suite* found in the *Altera Design Software Suite* by performing the following steps:

1. Insert the *Quartus II Web Edition Software Suite* CD-ROM into the CD-ROM drive.

☞ The CD-ROM should start an auto-install process. If it does not, browse to the CD-ROM drive and double-click on the **setup.exe** file.

2. Follow the online instructions to complete the installation process.

☞ If you have difficulty installing the Quartus II software, refer to *Installing the Quartus II Software* in the *Quartus II Installation & Licensing Manual for PCs* found at www.altera.com.

The Quartus II software is the primary FPGA development tool used to create the reference designs used in this development kit.

Additionally, you may want to install the *Nios II Embedded Design Suite* package also found in the *Altera Design Software Suite*. The Nios II soft-core embedded processor runs on Altera FPGAs. Many of the reference designs included in this development kit use the Nios processor.

Development Board Overview

Altera delivers the development board (Figure 2–1) with a preloaded configuration to demonstrate features of the board. At power up, the preloaded configuration also enables users to confirm quickly that the board is operating correctly.

Figure 2–1. Cyclone II Development Board Layout and Components
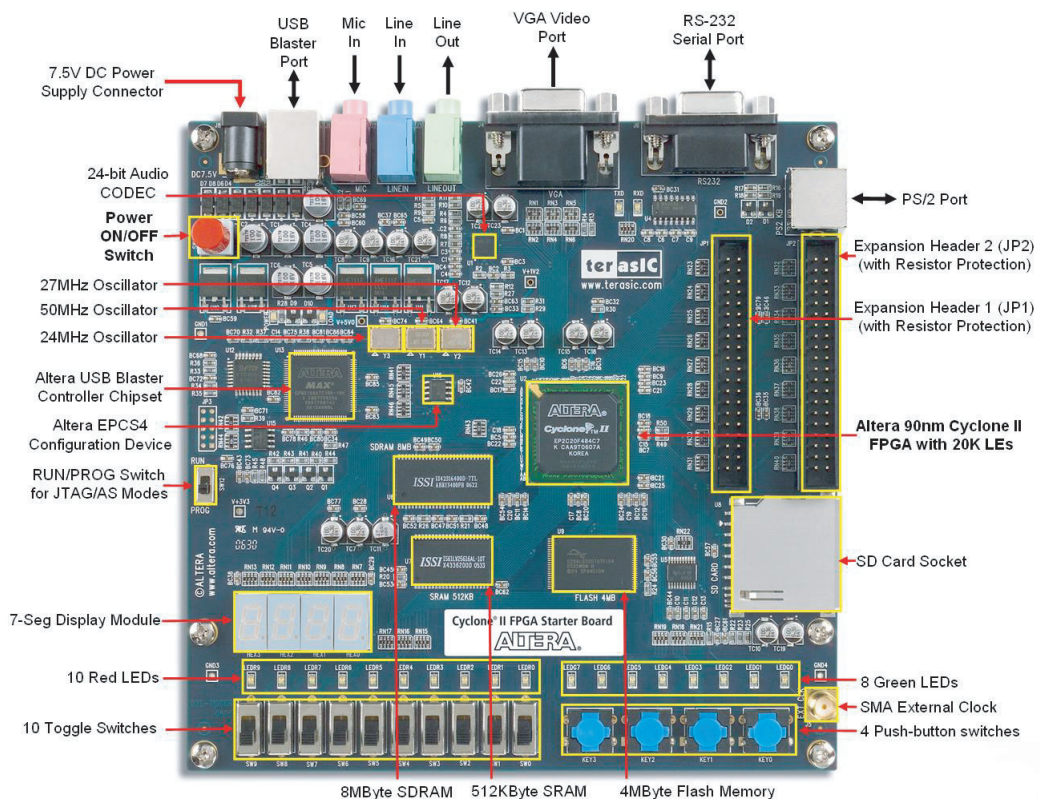
Requirements

Preparation for using the development board requires the following prerequisite actions:

■ Install the Altera Quartus® software on the host computer, if not already installed
■ The Cyclone II FPGA Starter Development Board includes an integrated USB-Blaster™ chip set for programming the FPGA. Install the Altera USB-Blaster driver software on the host computer, if not already installed.

☞ Communication between the computer host and the development board requires Altera USB-Blaster driver software already installed on the host computer.

Powering Up the Development Board

To power up the development board, perform the following steps:

1. Connect the USB-Blaster cable from the host computer to the USB-Blaster port on the development board.

2. Connect the 7.5 V DC adapter to the development board and to a power source.

3. Connect a VGA monitor to the VGA video port on the development board.

4. Connect a headset to the **Line Out** audio port on the development board.

5. Slide the **RUN/PROG** switch on the edge of the development board to the RUN position.

6. Turn the power on by depressing the **ON/OFF** switch on the development board.

Confirming Board Operation

As the development board powers on, verify correct operation by performing the following steps:

1. Confirm that all user LEDs are flashing.

2. Confirm that all 7-segment displays cycle through numbers 0 through F.

3. Confirm that the VGA monitor displays the default image (Figure 2–2) with the **SW0** switch set to the DOWN (toward the edge of the board) position.

Figure 2–2. Default VGA Output Pattern, SW0 = DOWN

4. Confirm that the VGA monitor displays the default image (Figure 2–3) with the **SW0** switch set to the UP (away from the edge of the board) position.

Figure 2–3. Default FGA Output Pattern, SW0 = UP

5. Set the toggle switch **SW9** to the DOWN position and confirm that the computer produces a 1-kHz tone.

6. Set the toggle switch **SW9** to the UP position and connect the output of an audio player (for example: MP3, PC, iPod) to the **Line In** connector on the development board. Confirm that the headset produces the expected music or recorded sounds playing on the audio player.

☞ If you also connect a microphone to the **Mic In** connector, the development board mixes the voice input with the output from the audio player.

3. Control Panel Setup

The development kit includes a Control Panel facility that enables a user to access various components on the development board from a host computer through a USB connection. For an overview of the Control Panel and its use, refer to "Using the Control Panel" chapter.

Setting up the Control Panel involves the following actions:

■ Set up the hardware
■ Configure the FPGA
■ Start the Control Panel

Requirements

Preparation for setting up and using the Control Panel requires the following prerequisite actions:

■ Install the Altera USB-Blaster driver software on the host computer, if not already installed
■ Install the Altera Quartus® software on the host computer, if not already installed

Hardware Setup

Ensure that the development board has powered up and is operating normally, as described in "Development Board Setup" on page 2–1. If the board is not powered up, but has already been set up and its operation verified, perform the following steps:

1. Check that the USB-Blaster cable connects the host computer to the the development board.

2. Check that the 7.5 V DC adapter connects the development board to a power source.

3. Set the **RUN/PROG** switch to the RUN position.

4. Turn the power on by depressing the **ON/OFF** switch on the development board.
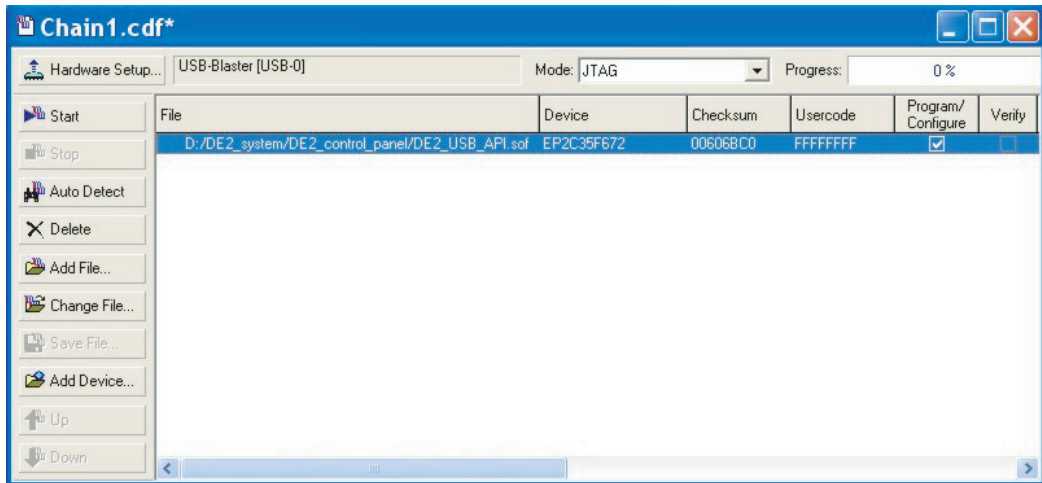
FPGA Configuration

Before using the Control Panel, configure a corresponding circuit in the Cyclone II FPGA by downloading the **CII_Starter_USB_API.sof** configuration file from the

<kit path>\Examples\CII_Starter_demonstrations\CII_Starter_USB_API_v1\HW
directory. Refer to Section 4.1 (Configuring the Cyclone II FPGA) for a
detailed description of the downloading procedure.

Perform the following steps to configure the FPGA:

1. Start the Quartus II software.

2. Select **Tools > Programmer** to reach the window in Figure 3–1.

Figure 3–1. Quartus II Programmer Window

3. Click on **Add File** and select the **CII_Starter_USB_API.sof** file in
    the pop-up window.

4. Next, click on the **Program/Configure** box to select the added file.

5. Click **Start** to download the selected configuration file into the
    FPGA.

Control Panel Start

To start the Control Panel, perform the following steps:

1. Run the **CII_Starter_control_panel.exe** program found in
    the **<kit path>\Examples\CII_Starter_demonstrations
    \CII_Starter_USB_API_v1\SW** directory to launch the Control
    Panel user interface (Figure 3–2).

Figure 3–2. Control Panel Window
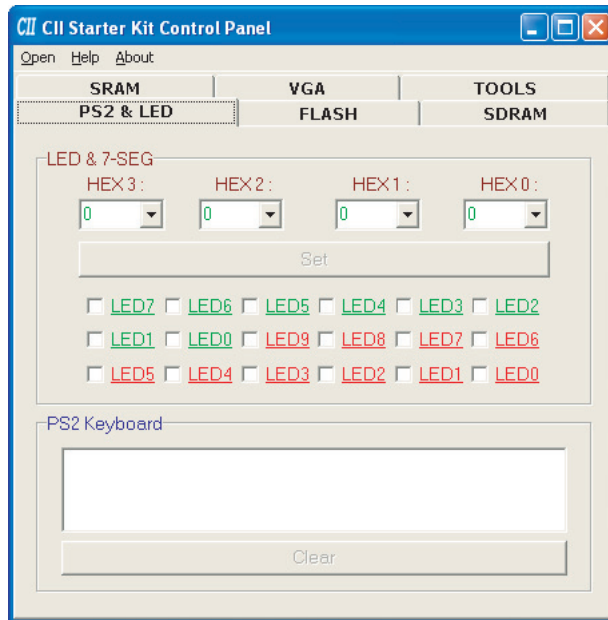
2. Select **Open** to list all USB ports connected to development boards. The Control Panel can control up to 4 development boards using the USB links.

3. Select **Open USB Port 0.** This step places the Control Panel in control of the development board.

☞ The Control Panel occupies the USB port until that port closes. Quartus II can not download a configuration file into the FPGA while the Control Panel occupies the USB port. Closing the Control Panel GUI closes the port.

4. Experiment by setting the value of some 7-segment display and observing the result on the development board.

Control Panel Overview

The Control Panel consists of two parts: the GUI on the host and circuitry specified in Verilog code downloaded to the FPGA on the development board. After the kit CD_ROM has been installed, the control panel hardware and software can be found in the **<kit path>\Examples \CII_Starter_demonstrations\CII_Starter_USB_API_v1** directory. The available Verilog code enables a knowledgeable user to change the functionality of the Control Panel.

Using the Control Panel GUI on the host computer, a user can issue commands to control circuitry on the development board through the USB-Blaster cable connection as illustrated in Figure 4–1. The design downloaded to the Cyclone II FPGA device on the development board implements a command controller that processes the commands. Then, to perform the appropriate actions, the command controller communicates with the controller of the affected input/output (I/O) device on the development board.

Figure 4–1. Control Panel Access to the Development Board
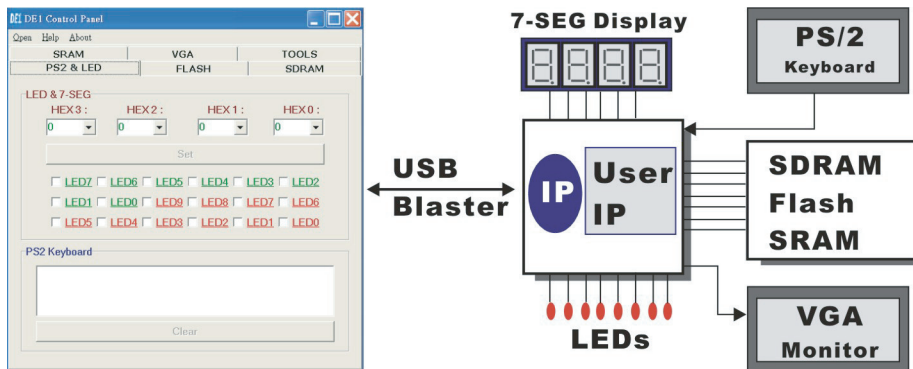
The user can perform the following actions with the Control Panel:

- Change the values that appear on the 7-segment displays
- Light up LEDs
- Communicate with the PS/2 keyboard
- Read/write from/to the SDRAM, SRAM, and flash memory

■ Configure user ports
■ Load music to memory and play music via the audio digital analog converter (DAC) output
■ Load an image pattern for VGA output

The following sections describe how to perform these actions with the Control Panel already open on the host computer. If not already open, launch the Control Panel as described in "Control Panel Start" on page 3–2.

Controlling the 7-Segment Displays

Typical design activities do not require the ability to set arbitrary values into simple display devices. However, used for troubleshooting, this ability enables the user to verify that these devices operate correctly.

To set the value of a 7-segment module to display, perform the following steps:

1. Select the **PS2 & LED** tab on the Control Panel (Figure 4–2).

Figure 4–2. Control Panel Window for 7-Segment Controls
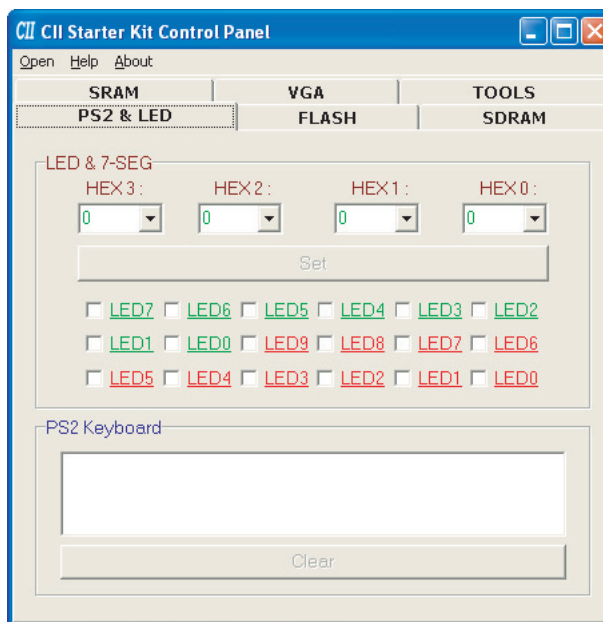
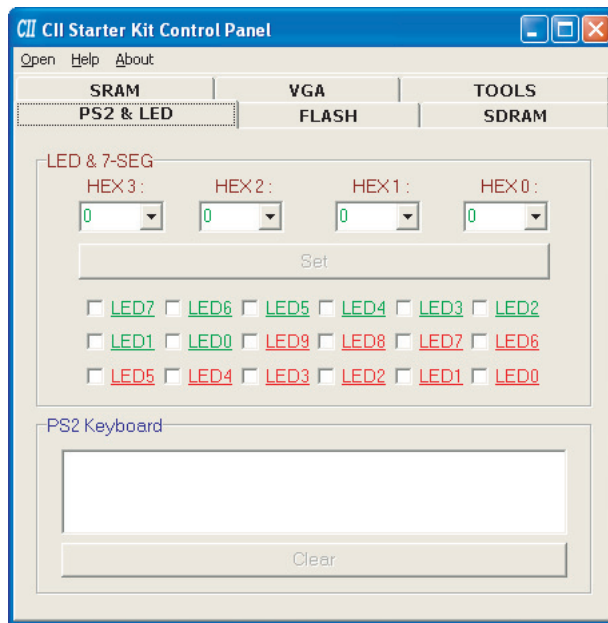2. In the **LED & 7-SEG** area, enter a value for any of the 7-segment modules labeled HEX0 through HEX3.

3. Click on the **Set** button.

Lighting the LEDs

To light an LED, perform the following steps:

1. Select the **PS2 & LED** tab on the Control Panel (Figure 4–3).

2. In the **LED & 7-SEG** area, select the individual LEDs to turn on.

3. Click on the **Set** button.

Figure 4–3. Control Panel Window for LED Controls

PS/2 Keyboard

The PS/2 keyboard in the Control Panel window (Figure 4–3) shows a working connection between the FPGA and the PS/2 port as well as the software processing the PS/2 interface commands and data.

To test the functionality of the PS/2 keyboard interface, perform the following steps:

1. Plug a PS/2 keyboard into the PS/2 port on the development board.