



# Stratix V Advanced Systems Development Kit

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## User Guide



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The Altera® Stratix® V Advanced Systems Development Kit is a complete design environment that includes both the hardware and software you need to develop Stratix V GX FPGA designs.

## Kit Features

This section briefly describes the development kit contents.



For a complete list of this kit's contents and capabilities, refer to the [Stratix V Advanced Systems Development Kit](#).

## Hardware

The Stratix V Advanced Systems Development Kit includes the following hardware:

- Stratix V GX advanced systems board—A development platform that allows you to develop and prototype hardware designs running on the Stratix V GX FPGA.



For detailed information about the board components and interfaces, refer to the [Stratix V Advanced Systems Development Board Reference Manual](#).

- HSMC loopback board—A daughtercard that allows for loopback testing all signals on the HSMC interface using the Board Test System.
- Power supply and cables—The kit includes the following items:
  - Power supply and AC adapters for North America/Japan, Europe, and the United Kingdom
  - Standard USB A to mini-USB cable

## Software

The software for this kit, described in the following sections, is available on the Altera website for immediate downloading. You can also request to have Altera mail the software to you on DVDs.

### Quartus II Software

Your kit includes a license for the Development Kit Edition (DKE) of the Quartus II software (Windows platform only). For one year, this license entitles you to most of the features of the Subscription Edition (excluding the IP Base Suite).



After the year, your DKE license will no longer be valid and you will not be permitted to use this version of the Quartus II software. To continue using the Quartus II software, you should download the free Quartus II Web edition or purchase a subscription to Quartus II software. For more information, refer to the [Design Software](#) page of the Altera website.

The Quartus II Development Kit Edition (DKE) software includes the following items:

- Quartus II Software—The Quartus II software, including the Qsys system integration tool, provides a comprehensive environment for network on a chip (NoC) design. The Quartus II software integrates into nearly any design environment and provides interfaces to industry-standard EDA tools.
- MegaCore® IP Library—A library that contains Altera IP MegaCore functions. You can evaluate MegaCore functions by using the OpenCore Plus feature to do the following:
  - Simulate behavior of a MegaCore function within your system.
  - Verify functionality of your design, and quickly and easily evaluate its size and speed.
  - Generate time-limited device programming files for designs that include MegaCore functions.
  - Program a device and verify your design in hardware.



The OpenCore Plus hardware evaluation feature is an evaluation tool for prototyping only. You must purchase a license to use a MegaCore function in production.



For more information about OpenCore Plus, refer to [AN 320: OpenCore Plus Evaluation of Megafunctions](#).

- Nios® II Embedded Design Suite (EDS)—A full-featured set of tools that allows you to develop embedded software for the Nios II processor, which you can include in your Altera FPGA designs.


## The Kit Installer

The license-free Stratix V Advanced Systems Development Kit installer includes all the documentation and design examples for the kit.

For information on installing the Development Kit Installer, refer to [“Software Installation” on page 3-1](#).

The remaining chapters in this user guide lead you through the following Stratix V GX advanced systems board setup steps:

- Inspecting the contents of the kit
- Installing the design and kit software
- Setting up, powering up, and verifying correct operation of the advanced systems board
- Configuring the Stratix V GX FPGA
- Running the Board Test System designs

 For complete information about the advanced systems board, refer to the *Stratix V Advanced Systems Development Board Reference Manual*.

### Before You Begin

Before using the kit or installing the software, check the kit contents and inspect the board to verify that you received all of the items listed in “[Kit Features](#)” on page 1–1. If any of the items are missing, contact Altera before you proceed.

### Inspect the Board


To inspect the board, perform the following steps:


1. Place the board on an anti-static surface and inspect it to ensure that it has not been damaged during shipment.



Without proper anti-static handling, you can damage the board.

2. Verify that all components are on the board and appear intact.

 For information about measuring board and FPGA temperature in real time, refer to “[The Power Monitor](#)” on page 5–13.

 For information about power consumption and thermal modeling, refer to [AN 358: Thermal Management for FPGAs](#).

### References

Use the following links to check the Altera website for other related information:

- For the latest board design files and reference designs, refer to the [Stratix V Advanced Systems Development Kit](#) page.
- For additional daughter cards available for purchase, refer to the [Development Board Daughtercards](#) page.

- For the Stratix V GX device documentation, refer to the [Literature: Stratix V Devices](#) page.
- To purchase devices from the eStore, refer to the [Devices](#) page.
- For Stratix V GX OrCAD symbols, refer to the [Capture CIS Symbols](#) page.
- For Nios II 32-bit embedded processor solutions, refer to the [Embedded Processing](#) page.




This chapter explains how to install the following software:

- Quartus II Subscription Edition Software
- Stratix V Advanced Systems Development Kit
- USB-Blaster™ II driver

## Installing the Quartus II Subscription Edition Software


Included in the Quartus II Subscription Edition Software are the Quartus II software (including Qsys), the Nios II EDS, and the MegaCore IP Library. To install the Altera development tools, perform the following steps:

1. Download the Quartus II Subscription Edition Software from the [Quartus II Subscription Edition Software](#) page of the Altera website. Alternatively, you can request a DVD from the [Altera IP and Software DVD Request Form](#) page of the Altera website.
2. Follow the on-screen instructions to complete the installation process. Choose an installation directory that is relative to the Quartus II software installation directory.

 If you have difficulty installing the Quartus II software, refer to the [Altera Software Installation and Licensing Manual](#).

## Licensing Considerations


Purchasing this kit entitles you to a one-year license for the Development Kit Edition (DKE) of the Quartus II software.

 After the year, your DKE license will no longer be valid and you will not be permitted to use this version of the Quartus II software. To continue using the Quartus II software, you should download the free Quartus II Web edition or purchase a subscription to Quartus II software.

Before using the Quartus II software, you must activate your license, identify specific users and computers, and obtain and install a license file.

If you already have a licensed version of the subscription edition, you can use that license file with this kit. If not, you need to obtain and install a license file. To begin, go to the [Self Service Licensing Center](#) page of the Altera website, log into or create your myAltera account, and take the following actions:

1. On the [Activate Products](#) page, enter the serial number provided with your development kit in the **License Activation Code** box.

 Your serial number is printed on the development kit box below the bottom bar code. The number consists of alphanumeric characters, such as 5SGXASxxxxxxx, and does not contain hyphens.

2. Consult the Activate Products table, to determine how to proceed.
  - a. If the administrator listed for your product is someone other than you, skip the remaining steps and contact your administrator to become a licensed user.
  - b. If the administrator listed for your product is you, proceed to step 3.
  - c. If the administrator listed for your product is *Stocking*, activate the product, making you the administrator, and proceed to step 3.
3. Use the [Create New License](#) page to license your product for a specific user (you) on specific computers. The [Manage Computers](#) and [Manage Users](#) pages allow you to add users and computers not already present in the licensing system.



To license the Quartus II software, you need your computer's network interface card (NIC) ID, a number that uniquely identifies your computer. On the computer you use to run the Quartus II software, type `ipconfig /all` at a command prompt to determine the NIC ID. Your NIC ID is the 12-digit hexadecimal number on the **Physical Address** line.

4. When licensing is complete, Altera emails a **license.dat** file to you. Store the file on your computer and use the **License Setup** page of the **Options** dialog box in the Quartus\_II software to enable the software.



For complete licensing details, refer to the [Altera Software Installation and Licensing Manual](#).

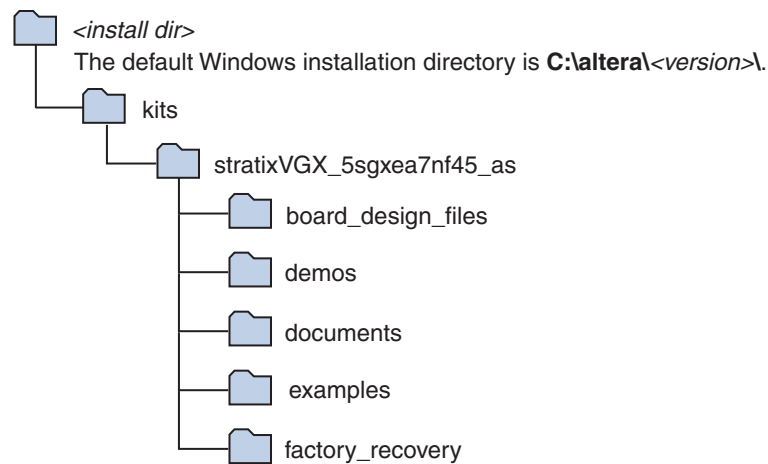
## Installing the Stratix V Advanced Systems Development Kit

To install the Stratix V Advanced Systems Development Kit, perform the following steps:

1. Download the Stratix V Advanced Systems Development Kit installer from the [Stratix V Advanced Systems Development Kit](#) page of the Altera website. Alternatively, you can request a development kit DVD from the [Altera Kit Installations DVD Request Form](#) page of the Altera website.
2. Run the Stratix V Advanced Systems Development Kit installer.
3. Follow the on-screen instructions to complete the installation process. Be sure that the installation directory you choose is in the same relative location to the Quartus II software installation.

The installation program creates the Stratix V Advanced Systems Development Kit directory structure shown in [Figure 3-1](#).

**Figure 3-1. Stratix V Advanced Systems Development Kit Installed Directory Structure <sup>(1)</sup>**



**Note to Figure 3-1:**

(1) Early-release versions might have slightly different directory names.


[Table 3-1](#) lists the file directory names and a description of their contents.

**Table 3-1. Installed Directory Contents**

Directory Name	Description of Contents
<b>board_design_files</b>	Contains schematic, layout, assembly, and bill of material board design files. Use these files as a starting point for a new prototype board design.
<b>demos</b>	Contains demonstration applications when available.
<b>documents</b>	Contains the kit documentation.
<b>examples</b>	Contains the sample design files for the Stratix V Advanced Systems Development Kit.
<b>factory_recovery</b>	Contains the original data programmed onto the board before shipment. Use this data to restore the board with its original factory contents.

## Installing the USB-Blaster II Driver

The Stratix V GX advanced systems board includes integrated On-Board USB-Blaster II circuitry for FPGA programming. However, for the host computer and board to communicate, you must install the USB-Blaster II driver on the host computer.

 Installation instructions for the USB-Blaster II driver for your operating system are available on the Altera website. On the [Altera Programming Cable Driver Information](#) page of the Altera website, locate the table entry for your configuration and click the link to access the instructions.



The instructions in this chapter explain how to set up the Stratix V GX advanced systems board.

### Setting Up the Board

To prepare and apply power to the board, perform the following steps:

1. The Stratix V GX advanced systems board ships with its board switches preconfigured to support the design examples in the kit. If you suspect your board might not be currently configured with the default settings, follow the instructions in [“Factory Default Switch and Jumper Settings”](#) on page 4-2 to return the board to its factory settings before proceeding.
2. The advanced systems board ships with design examples stored in the flash memory device. Verify the DIP switch SW4.6 is set to the on (0) position to load the design stored in the factory portion of flash memory. [Figure 4-2](#) shows the DIP switch location on the back of the board.
3. Verify that the HSMC card is installed on connector J1 of the board.
4. Ensure that the power switch SW2 is in the off position.
5. Connect the Power Adapter +15 V, 8.00 A to the DC Power Jack (J7) on the advanced systems board and plug the cord into a power outlet.



Use only the supplied power supply. Power regulation circuitry on the board can be damaged by power supplies with greater voltage.




For designs requiring more than 120 W, a PCIe 2x4 ATX connector (J10) providing an additional 12 V and 12.5 A is also available. This is the standard PCIe 2x4 connector in a chassis or available with an ATX power supply.




Alternatively, the board can be powered by the PCIe host adapter or the laptop power adapter. If you want to power the board by the PCIe host system, plug the FPGA development card into a standard PCIe connector.

6. Set the POWER switch (SW2) to the on position. When power is supplied to the board, the blue LED (D27) illuminates indicating that the board has power.

The MAX V device on the board contains (among other things) a parallel flash loader (PFL) megafunction. When the board powers up, the PFL reads a design from flash memory and configures the FPGA. DIP switch SW4.6 controls whether the PFL is active and loads the designs from flash into the Stratix V devices. When the switch is in the on (0) position, the PFL loads the design from flash memory. For PFL to function properly, the MSEL pins for both FPGAs must be set for PFL x8 on MSEL DIP switches SW5 and SW6.

 The kit includes a MAX V design which contains the MAX V PFL megafunction. The design resides in the `<install_dir>\kits\stratixVGX_5sgxea7nf45_as\examples\max5` directory.

When configuration is complete, the Config Done LED (D13) illuminates, signaling that the Stratix V GX devices configured successfully.

 For more information about the PFL megafunction, refer to [AN 386: Parallel Flash Loader Megafunction User Guide](#).

## Factory Default Switch and Jumper Settings

This section shows the factory switch and jumper settings for the Stratix V GX advanced systems board.

[Figure 4-1](#) shows the switch locations and the default position of each switch and jumper on the top side of the board.

**Figure 4-1. Default Settings on the Board Top (Detail)**

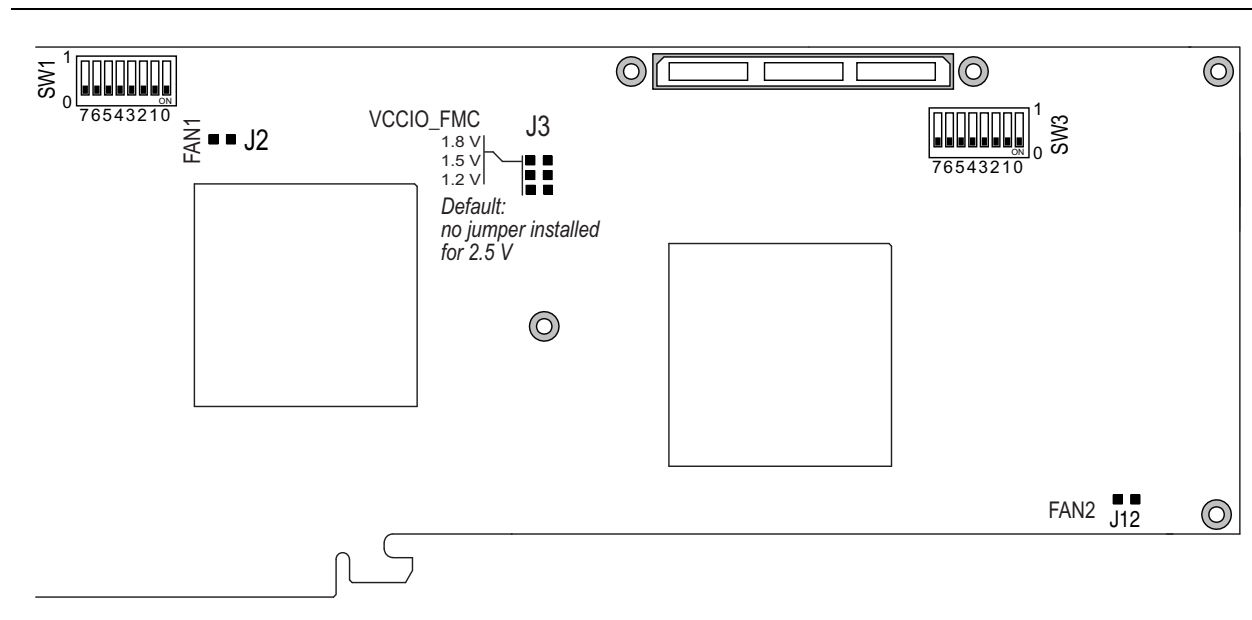
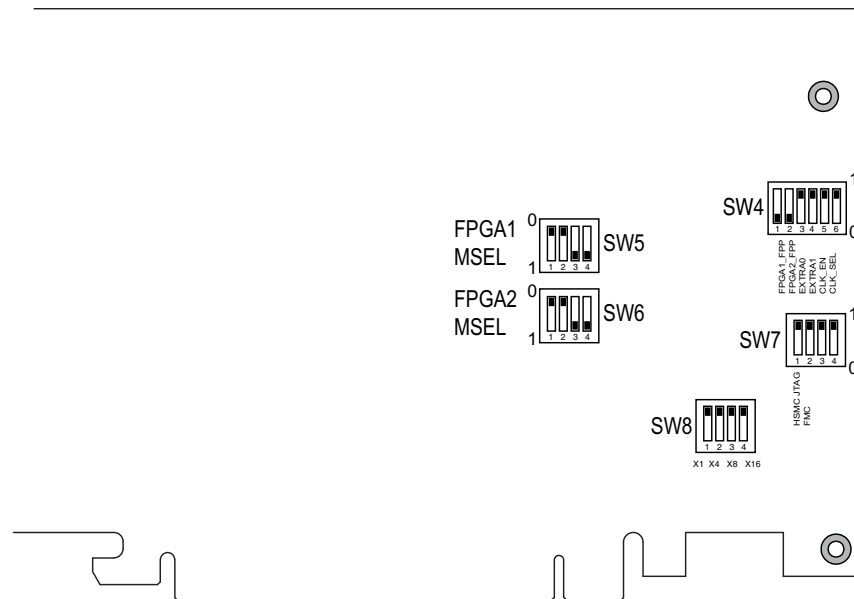


Figure 4-2 shows the switch locations and the default position of each switch on the bottom side of the board.

**Figure 4-2. Default Settings on the Board Bottom (Detail)**



To restore the switches to their factory default settings, perform the following steps:

1. Set DIP switch (SW4) to match Table 4-1 and Figure 4-2 on page 4-3.

**Table 4-1. SW4 DIP Switch Settings**

Switch	Board Label	Function	Default Position
1	FPGA1_FPP	Switch 1 has the following options: <ul style="list-style-type: none"> <li>■ When on (0), FPP x8 is enabled to configure FPGA1 from flash location 0 and FPGA2 from flash location 1. FPGA1 MSEL (SW5) pins and FPGA2 MSEL (SW6) pins must be set correctly.</li> <li>■ When off (1), no design is configured to FPGA1 or FPGA2 using FPP x8.</li> </ul>	On
2	FPGA2_FPP	—	On
3	EXTRA0	—	Off
4	EXTRA1	—	Off
5	CLK_EN	Switch 5 has the following options: <ul style="list-style-type: none"> <li>■ When on (0), the on-board oscillator is disabled.</li> <li>■ When off (1), the on-board oscillator is enabled.</li> </ul>	Off
6	CLK_SEL	Switch 6 has the following options: <ul style="list-style-type: none"> <li>■ When on (0), the SMA input clock is selected.</li> <li>■ When off (1), the programmable oscillator clock is selected.</li> </ul>	On

2. Set DIP switch (SW5) to match [Table 4-2](#) and [Figure 4-2](#) on page 4-3.

**Table 4-2. SW5 FPGA1 MSEL DIP Switch Settings** <sup>(1)</sup> <sup>(2)</sup> <sup>(3)</sup>

Switch	Board Label	Function	Default Position
1	FPGA1 MSEL0	FPGA1 MSEL bit 0 configuration setting	On (0)
2	FPGA1 MSEL1	FPGA1 MSEL bit 1 configuration setting	On (0)
3	FPGA1 MSEL2	FPGA1 MSEL bit 2 configuration setting	Off (1)
4	—	—	—

**Notes to Table 4-2:**

- (1) FPGA1 MSEL[4:3]=10 is hard wired on the board.
- (2) FPGA1 MSEL[4:0] to valid configuration schemes as listed in the *Stratix V Device Handbook*.
- (3) By default, FPGA1 MSEL is set for FPP x8.

3. Set DIP switch (SW6) to match [Table 4-3](#) and [Figure 4-2](#) on page 4-3.

**Table 4-3. SW6 FPGA2 MSEL DIP Switch Settings** <sup>(1)</sup> <sup>(2)</sup> <sup>(3)</sup>

Switch	Board Label	Function	Default Position
1	FPGA2 MSEL0	FPGA2 MSEL bit 0 configuration setting	On (0)
2	FPGA2 MSEL1	FPGA2 MSEL bit 1 configuration setting	On (0)
3	FPGA2 MSEL2	FPGA2 MSEL bit 2 configuration setting	Off (1)
4	—	—	—

**Notes to Table 4-3:**

- (1) FPGA2 MSEL[4:3]=10 is hard wired on the board.
- (2) FPGA2 MSEL[4:0] to valid configuration schemes as listed in the *Stratix V Device Handbook*.
- (3) By default, FPGA2 MSEL is set for FPP x8.

4. Set DIP switch (SW7) to match [Table 4-4](#) and [Figure 4-2](#) on page 4-3.


**Table 4-4. SW7 JTAG DIP Switch Settings** <sup>(1)</sup>

Switch	Board Label	Function	Default Position
1	HSMC	Switch 1 has the following options: <ul style="list-style-type: none"> <li>■ When on (1), removes the HSMC from the JTAG chain.</li> <li>■ When off (0), includes the HSMC in the JTAG chain.</li> </ul>	On (1)
2	FMC	Switch 1 has the following options: <ul style="list-style-type: none"> <li>■ When on (1), removes the FMC from the JTAG chain.</li> <li>■ When off (0), includes the FMC in the JTAG chain.</li> </ul>	On (1)
3	—	—	—
4	—	—	—

**Note to Table 4-4:**

- (1) If you plug in an external USB-Blaster cable to the JTAG header (J11), the On Board USB-Blaster II is disabled. The JTAG chain is normally mastered by the On-board USB-Blaster II.



 For details on the JTAG chain, refer to the *Stratix V Advanced Systems Development Board Reference Manual*.

5. Set DIP switch (SW8) to match [Table 4-5](#) and [Figure 4-2](#) on page 4-3.

**Table 4-5. SW8 PCIe DIP Switch Settings**

Switch	Board Label	Function	Default Position
1	X1	Switch 1 has the following options: <ul style="list-style-type: none"> <li>■ When on, x1 presence detect is available.</li> <li>■ When off, x1 presence detect is unavailable.</li> </ul>	Off
2	X4	Switch 2 has the following options: <ul style="list-style-type: none"> <li>■ When on, x4 presence detect is available.</li> <li>■ When off, x4 presence detect is unavailable.</li> </ul>	Off
3	X8	Switch 3 has the following options: <ul style="list-style-type: none"> <li>■ When on, x8 presence detect is available.</li> <li>■ When off, x8 presence detect is unavailable.</li> </ul>	Off
4	X16	Switch 4 has the following options: <ul style="list-style-type: none"> <li>■ When on, x16 presence detect is available.</li> <li>■ When off, x16 presence detect is unavailable.</li> </ul>	Off

6. Set jumper blocks (J2, J3, and J12) to match [Table 4-6](#) and [Figure 4-1](#) on page 4-2.

**Table 4-6. Jumper Settings**

Board Reference	Description	Shunt Position
J2	Fan 1 — 5 V and GND power	Fan 1 power connected
J3	VCCIO_FMC 1.8 V	Pins 1-2
J3	VCCIO_FMC 1.5 V	Pins 3-4
J3	VCCIO_FMC 1.2 V	Pins 5-6
J3	VCCIO_FMC 2.5 V	Not installed (Default)
J12	Fan 2 — 5 V and GND power	Fan 2 power connected

 For more information about the FPGA board settings, refer to the *Stratix V Advanced Systems Development Board Reference Manual*.



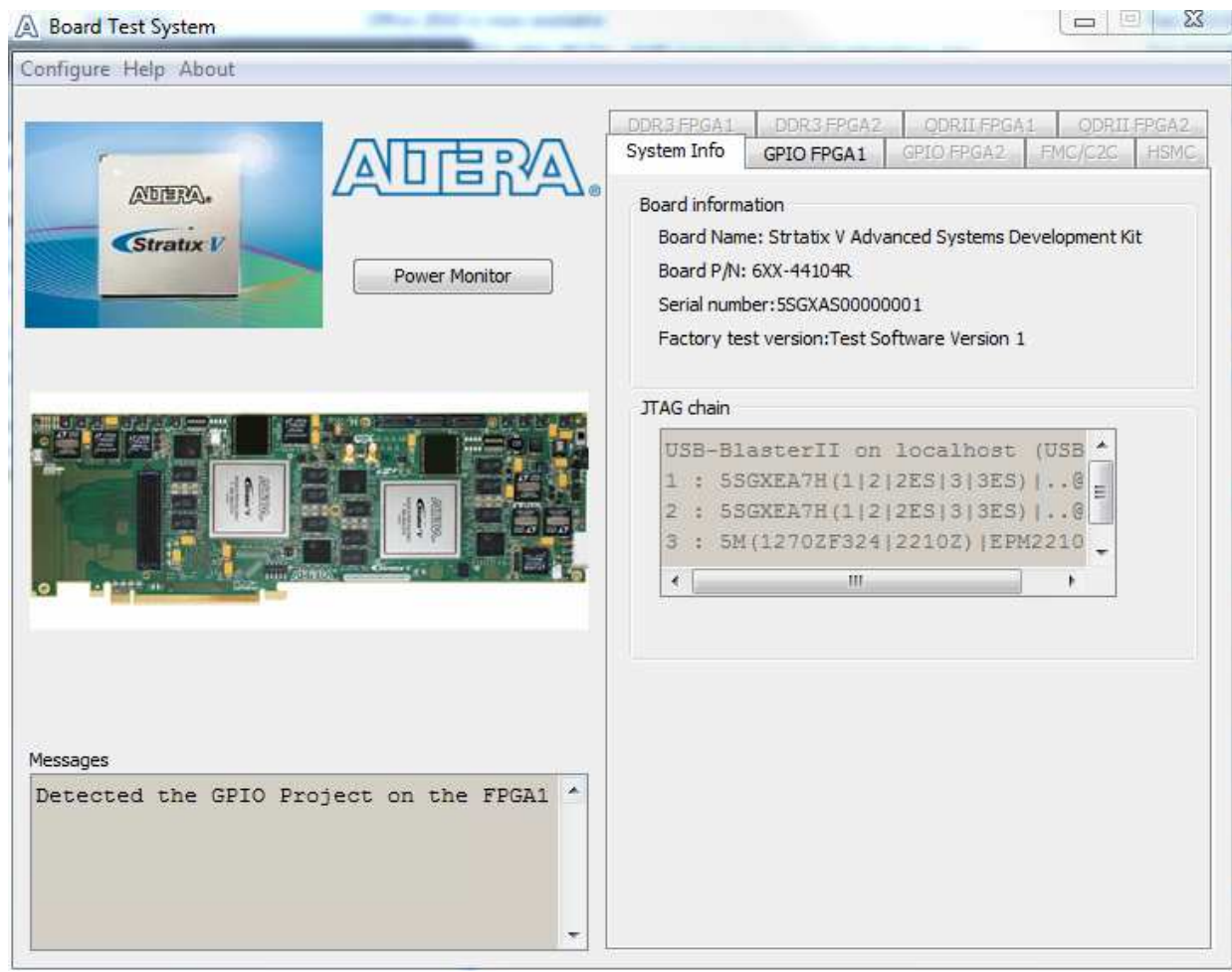
The Stratix V Advanced Systems Development Kit includes an application called the Board Test System (BTS) with related design examples. The BTS provides an easy-to-use interface to alter functional settings and observe the results.

You can use the BTS to test board components, modify functional parameters, observe performance, and measure power usage. While using the BTS, you reconfigure the FPGA several times with test designs specific to the functionality you are testing. The BTS is also useful as a reference for designing systems.

To install the BTS, follow the steps in “Installing the Stratix V Advanced Systems Development Kit” on page 3–2.

The Board Test System communicates over the JTAG bus to a test design running in the Stratix V GX device. Figure 5–1 shows the initial GUI for a board that is in the factory configuration.


**Figure 5–1. Board Test System Graphical User Interface**



Several designs are provided to test the major board features. Each design provides data for one or more tabs in the application. The Configure menu identifies the appropriate design to download to the FPGA for each tab.

After successful FPGA configuration, the appropriate tab appears and allows you to exercise the related board features. Highlights appear in the board picture around the corresponding components.


The **Power Monitor** button starts the Power Monitor application that measures and reports current power and temperature information for the board. Because the application communicates over the JTAG bus to the MAX V device, you can measure the power of any design in the FPGA, including your own designs.

 The Board Test System and Power Monitor share the JTAG bus with other applications like the Nios II debugger and the SignalTap® II Embedded Logic Analyzer. Because the Quartus II programmer uses most of the bandwidth of the JTAG bus, other applications using the JTAG bus might time out. Be sure to close the other applications before attempting to reconfigure the FPGA using the Quartus II Programmer.

## Preparing the Board

With the power to the board off, follow these steps:

1. Connect the mini-USB cable to the board.
2. Ensure that the board DIP switches are set to default positions as shown in the “[Factory Default Switch and Jumper Settings](#)” section starting on page 4-2.

 For more information about the board’s DIP switch and jumper settings, refer to the *Stratix V Advanced Systems Development Board Reference Manual*.

 FPP x8 mode must be enabled for the BTS functionality to work.

3. Turn on the power to the board. By default, the board loads FPGA1 with the design stored in the factory hardware 0 portion of flash memory and FPGA2 with the factory hardware 1 portion of flash memory. If your board is still in the factory configuration, the design loads the FPGA1 GPIO tests.




To ensure operating stability, keep the USB cable connected and the board powered on when running the demonstration application. The application cannot run correctly unless the USB cable is attached and the board is on.

## Running the Board Test System

To run the application, navigate to the `<install dir>\kits\stratixVGX_5sgxea7nf45_as\examples\board_test_system` directory and run the **BoardTestSystem.exe** application.

 On Windows, click **Start > All Programs > Altera > Stratix V Advanced Systems Development Kit <version> > Board Test System** to run the application.

A GUI appears, displaying the application tab that corresponds to the design running in the FPGA. The Stratix V GX advanced systems board's flash memory ships preconfigured with the design that corresponds to the GPIO and Flash tabs.

 If you power up your board with the DIP switch SW4.6 in a position other than the on (factory default) position, or if you load your own design into the FPGA with the Quartus II Programmer, you receive a message prompting you to configure your board with a valid Board Test System design. Refer to [“The Configure Menu”](#) for information about configuring your board.

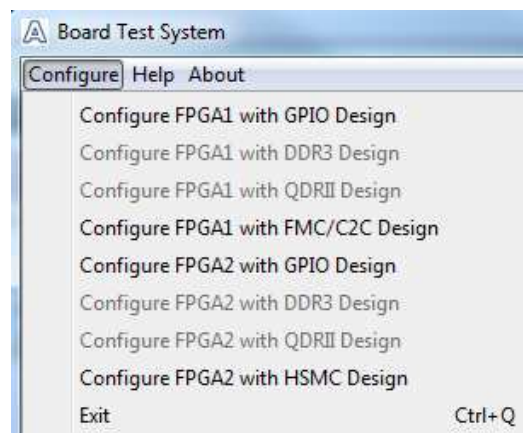
## Using the Board Test System

This section describes each control in the Board Test System application.

### The Configure Menu


Use the Configure menu ([Figure 5-2](#)) to select the design you want to use. Each design example tests different functionality that corresponds to one or more application tabs.

**Figure 5-2. The Configure Menu**



To configure the FPGA with a test system design, perform the following steps:

1. Make sure there are no conflicts between the Quartus II software version and the Board Test System GUI version. For example, BTS version 12.1.xx requires Quartus II software version 12.1.
2. On the Configure menu, click the configure command that corresponds to the functionality you wish to test.
3. When configuration finishes, close the Quartus II Programmer if open. The design begins running in the FPGA. The corresponding GUI application tabs that interface with the design are now enabled.

 If the Board Test System is open while you configure FPGAs with the Quartus II Programmer, to use the BTS again, you may need to restart it.

## The System Info Tab

The **System Info** tab shows information about the board's current configuration. [Figure 5-1 on page 5-1](#) shows the **System Info** tab. The tab displays the contents of the MAX V registers, the JTAG chain, the flash memory map, and other details stored on the board.

The following sections describe the controls on the **System Info** tab.

### Board Information

The **Board information** control displays static information about your board.

- **Board Name**—Indicates the official name of the board.
- **Board P/N**—Indicates the part number of the board.
- **Serial number**—Indicates the serial number of the board.
- **Factory test version**—Indicates the version of the Board Test System currently running on the board.

### JTAG Chain

The **JTAG chain** control shows all the devices currently in the JTAG chain. The Stratix V GX devices are always the first devices in the chain, and the MAX V is always the last device in the chain. The JTAG chain is normally mastered by the On-board USB-Blaster II.



If you plug in an external USB-Blaster cable to the JTAG header (J11), the On-Board USB-Blaster II is disabled.



DIP switch SW7 selects which interfaces are in the chain. Set SW7 switch positions in the off position to include the interface in the JTAG chain. Refer to [Table 4-4 on page 4-4](#) for detailed settings.

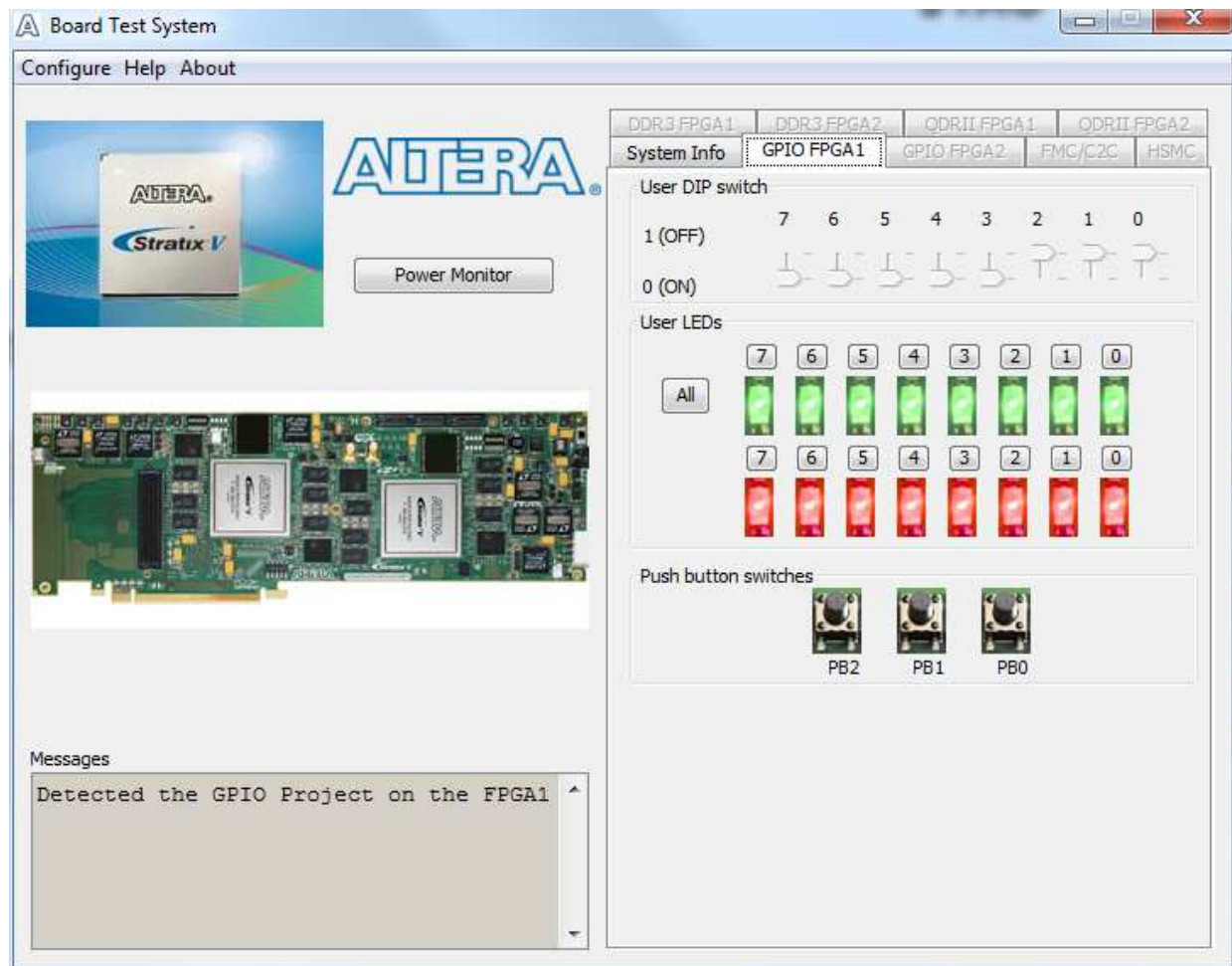


For details on the JTAG chain, refer to the *Stratix V Advanced Systems Development Board Reference Manual*. For USB-Blaster II configuration details, refer to the [On-Board USB-Blaster II](#) page.

## The GPIO FPGA1 Tab

The **GPIO FPGA1** tab allows you to interact with all the general purpose user I/O components on your board associated with FPGA1 (U29). You can read DIP switch settings, turn LEDs on or off, and detect push button presses. This test erases FPGA2. [Figure 5-3](#) shows the **GPIO FPGA1** tab.

Figure 5-3. The GPIO FPGA1 Tab



The following sections describe the controls on the **GPIO FPGA1** tab.

### User DIP Switches

The read-only **User DIP switch** control displays the current positions of the switches in the user DIP switch bank (SW1). Change the switches on the board to see the graphical display change accordingly.

### User LEDs

The **User LEDs** control displays the current state of the user LEDs. To toggle the board LEDs, click the 0 to 7 buttons to toggle red or green LEDs, the **All** button, and the graphical representation of the LEDs.



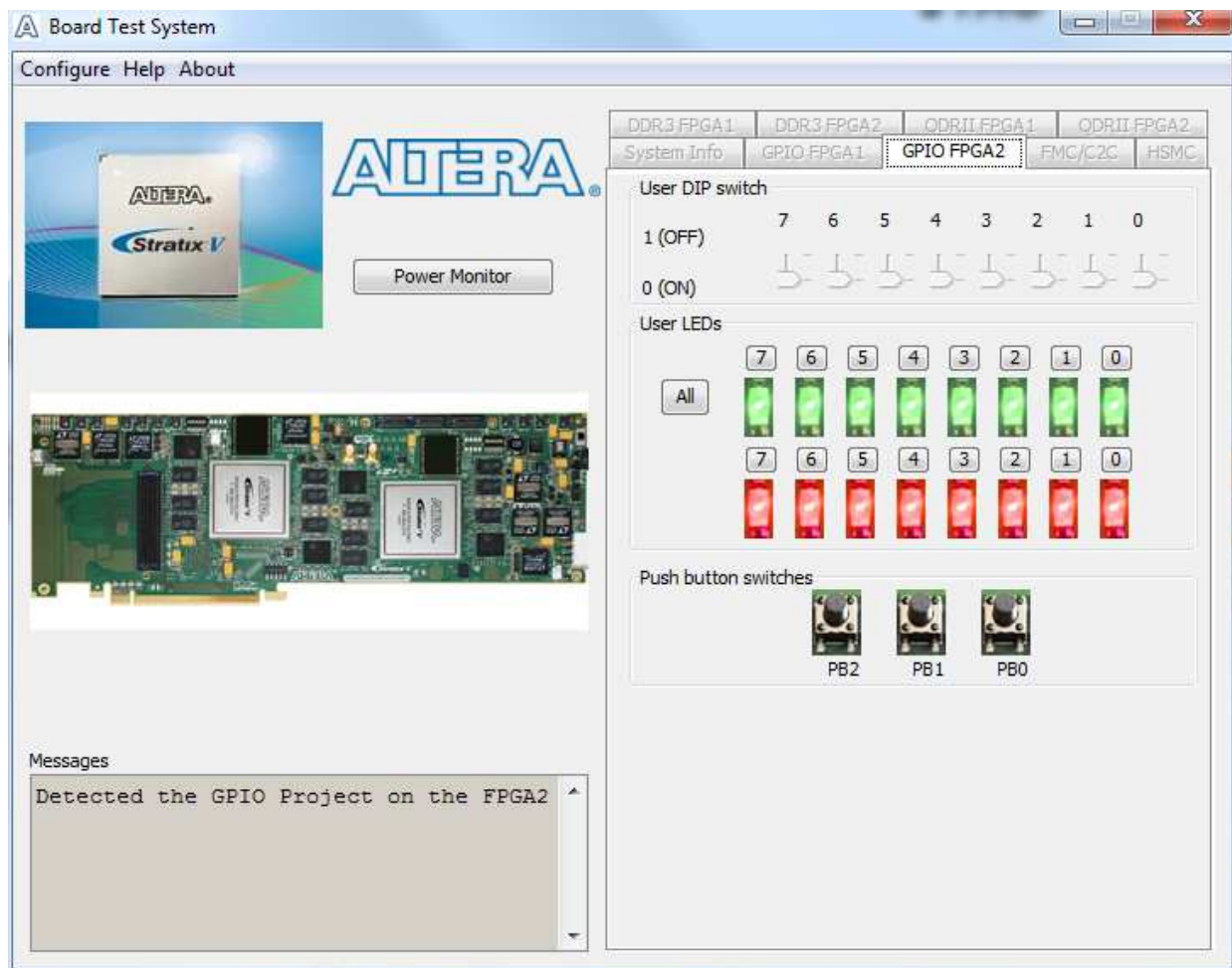
## Push Button Switches

The read-only **Push button switches** control displays the current state of the board user push buttons. Press a push button on the board to see the graphical display change accordingly.

## The GPIO FPGA2 Tab

The **GPIO FPGA2** tab allows you to interact with all the general purpose user I/O components on your board associated with FPGA2 (U35). You can read DIP switch settings, turn LEDs on or off, and detect push button presses. This test erases FPGA1. [Figure 5-4](#) shows the **GPIO FPGA2** tab.

**Figure 5-4. The GPIO FPGA2 Tab**



The following sections describe the controls on the **GPIO FPGA2** tab.

### User DIP Switches

The read-only **User DIP switch** control displays the current positions of the switches in the user DIP switch bank (SW3). Change the switches on the board to see the graphical display change accordingly.



## User LEDs

The **User LEDs** control displays the current state of the user LEDs. To toggle the board LEDs, click the **0** to **7** buttons to toggle red or green LEDs, the **All** button, and the graphical representation of the LEDs.

## Push Button Switches

The read-only **Push button switches** (S8-S10) control displays the current state of the board user push buttons. Press a push button on the board to see the graphical display change accordingly.

## The FMC/C2C Tab

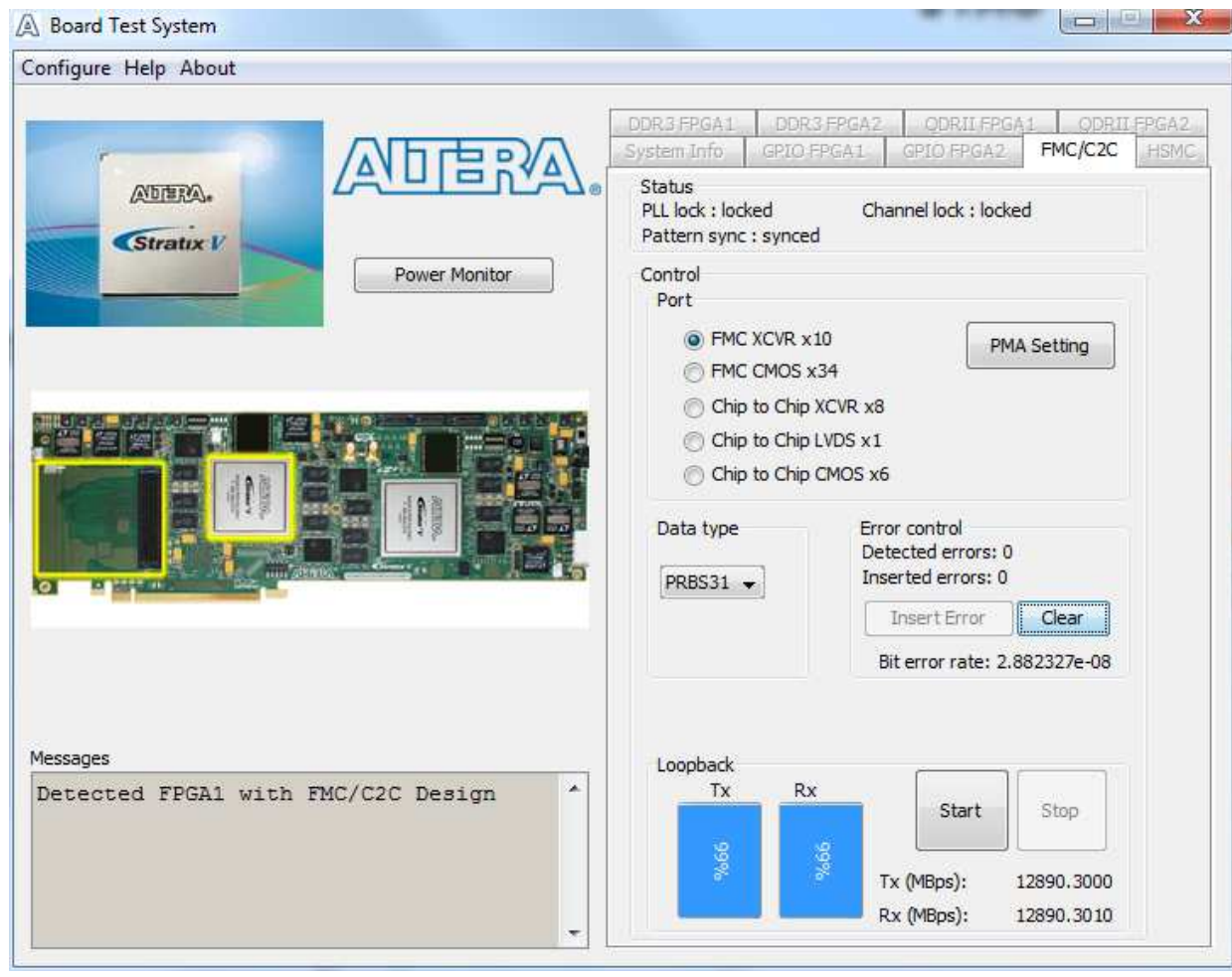
The **FMC/C2C** tab allows you to perform loopback tests on the FMC XCVR and FMC parallel ports, Chip-to-Chip (C2C) XCVR, C2C LVDS, and C2C single-ended loopback. FPGA 1 is configured with a design for FMC testing and C2C testing. FPGA2 is configured with a design for C2C testing.




Altera recommends loading the C2C loopback design without Nios configured to FPGA2. Configuring the FPGAs through the BTS GUI handles this by default.

Figure 5-5 shows the FMC/C2C tab.

Figure 5-5. The FMC/C2C Tab



 For factory testing, you must have an FMC loopback card installed on the FMC connector (J8) for this test to work correctly. Altera recommends the Acquiretek FMC Loopback Test Mezzanine (part number AF101). Otherwise, set the PMA setting tab to test internal loopback mode (serial loopback = 1).

The following sections describe the controls on the **FMC/C2C** tab.

### Status

The **Status** control displays the following status information during the loopback test:

- **PLL lock**—Shows the PLL locked or unlocked state.
- **Channel lock**—Shows the channel locked or unlocked state. When locked, all lanes are word aligned and channel bonded.
- **Pattern sync**—Shows the pattern synced or not synced state. The pattern is considered synced when the start of the data sequence is detected.

## Port

The **Port** control allows you to specify which interface to test. The following port tests are available:

- **FMC XCVR x10** (10.3125 Gpbs+)
- **FMC CMOS x34** (25 MHz)
- **Chip to Chip XCVR x8** (12.5 Gbps)
- **Chip to Chip LVDS x1** (1.375 Gbps)
- **Chip to Chip CMOS x6** (25 MHz)

## PMA Setting

The **PMA Setting** button allows you to make changes to the PMA parameters that affect the active transceiver interface. The following settings are available for analysis:

- **Serial Loopback**—Routes signals between the receiver to the transmitter. Enter the following values to enable the serial loopbacks:
  - 0 = high speed serial transceiver signals to loopback on the board
  - 1 = serial loopback
  - 2 = reverse serial loopback pre-CDR
  - 4 = reverse serial loopback post-CDR
- **VOD**—Specifies the voltage output differential of the transmitter buffer.
- **Pre-emphasis tap**
  - **Pre**—Specifies the amount of pre-emphasis on the pre-tap of the transmitter buffer.
  - **First post**—Specifies the amount of pre-emphasis on the first post tap of the transmitter buffer.
  - **Second post**—Specifies the amount of pre-emphasis on the second post tap of the transmitter buffer.
- **Equalizer**—Specifies the setting for the receiver equalizer.
- **DC gain**—Specifies the DC portion of the receiver equalizer.

## Data Type

The **Data type** control specifies the type of data contained in the transactions. The following data types are available for analysis:

- **PRBS7**—Selects pseudo-random 7-bit sequences.
- **PRBS15**—Selects pseudo-random 15-bit sequences.
- **PRBS23**—Selects pseudo-random 23-bit sequences.
- **PRBS31**—Selects pseudo-random 31-bit sequences.
- **HF1**—highest frequency divide-by-2 data pattern "10101010"
- **HF2**—next highest frequency divide-by-6 data pattern "111000111000"
- **HF3**—second lowest frequency divide-by-22 data pattern

- **LF** —lowest frequency divide by 33 data pattern



Settings HF1, HF2, HF3, LF are for transmit observation only and are not used in the receiver data detection circuitry.

## Error Control

This control displays data errors detected during analysis and allows you to insert errors:

- **Detected errors**—Displays the number of data errors detected in the hardware.
- **Inserted errors**—Displays the number of errors inserted into the transmit data stream.
- **Insert Error**—Inserts a one-word error into the transmit data stream each time you click the button. **Insert Error** is only enabled during transaction performance analysis.
- **Clear**—Resets the **Detected errors** and **Inserted errors** counters to zeros.

## Start

The **Start** control initiates transaction performance analysis.



Always click **Clear** before **Start**.

## Stop

The **Stop** control terminates transaction performance analysis.

## Loopback

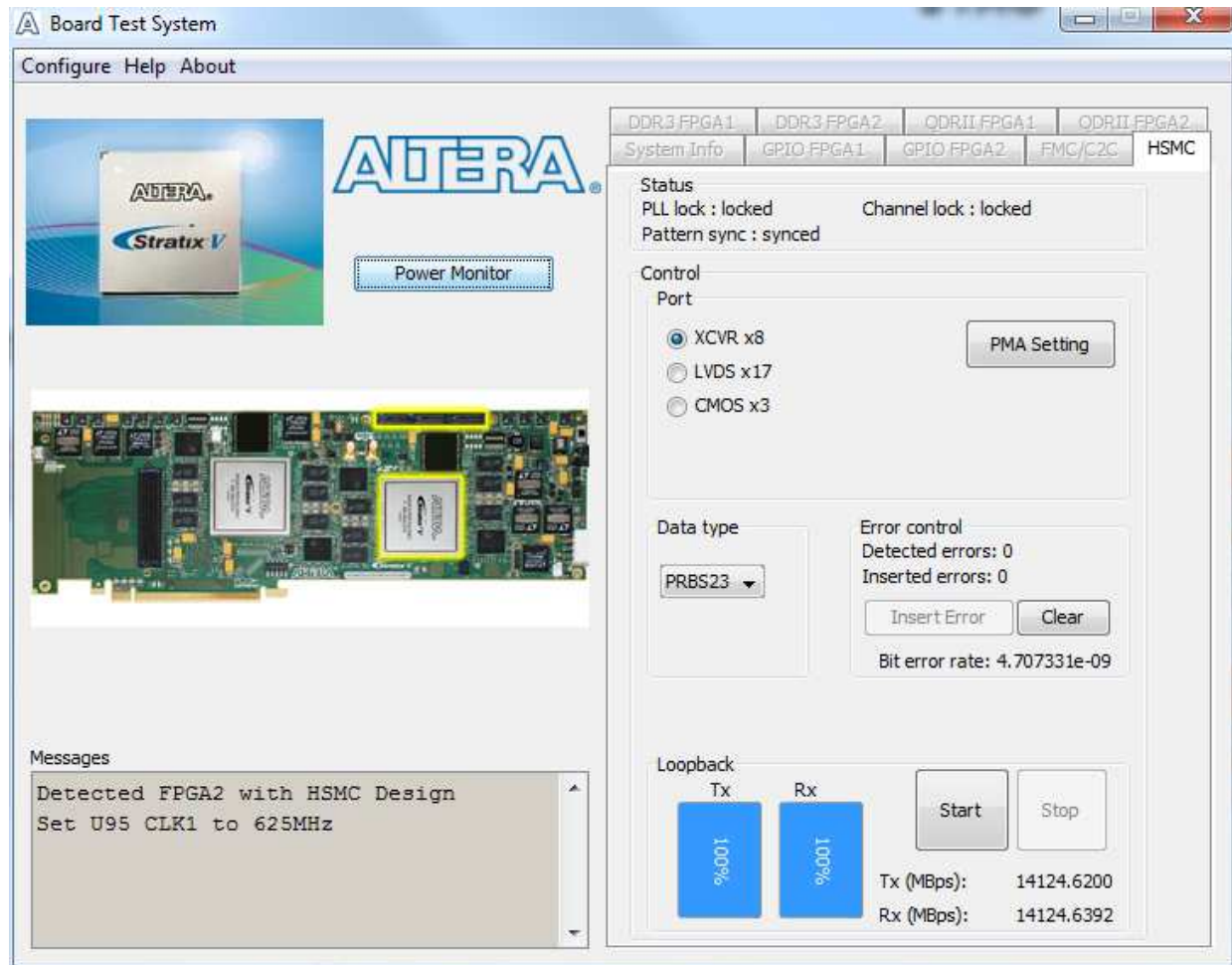
These controls display current transaction performance analysis information collected since you last clicked **Start**:


- **TX** and **RX** performance bars—Show the percentage of maximum theoretical data rate that the requested transactions are able to achieve.
- **Tx (MBps)** and **Rx (MBps)**—Show the number of bytes of data analyzed per second.

## The HSMC Tab

The HSMC tab allows you to perform loopback tests on HSMC ports. This test erases FPGA1. Figure 5-6 shows the HSMC tab.

Figure 5-6. The HSMC Tab



 You must have the loopback HSMC installed on the HSMC connector for this test to work correctly. Otherwise, set the PMA setting tab to test internal loopback mode (serial loopback = 1).

The following sections describe the controls on the HSMC tab.

### Status

The Status control displays the following status information during the loopback test:

- **PLL lock**—Shows the PLL locked or unlocked state.
- **Channel lock**—Shows the channel locked or unlocked state. When locked, all lanes are word aligned and channel bonded.
- **Pattern sync**—Shows the pattern synced or not synced state. The pattern is considered synced when the start of the data sequence is detected.

## Port

The **Port** control allows you to specify which interface to test. The following port tests are available:

- **XCVR x7** (11.3 Gbps)
- **LVDS x17** (1.375 Gbps)
- **CMOS x3** (25 MHz)

## PMA Setting


The **PMA Setting** button allows you to make changes to the PMA parameters that affect the active transceiver interface. The following settings are available for analysis:

- **Serial Loopback**—Routes signals between the receiver to the transmitter. Enter the following values to enable the serial loopbacks:
  - 0 = high speed serial transceiver signals to loopback on the board
  - 1 = serial loopback
  - 2 = reverse serial loopback pre-CDR
  - 4 = reverse serial loopback post-CDR
- **VOD**—Specifies the voltage output differential of the transmitter buffer.
- **Pre-emphasis tap**
  - **Pre**—Specifies the amount of pre-emphasis on the pre-tap of the transmitter buffer.
  - **First post**—Specifies the amount of pre-emphasis on the first post tap of the transmitter buffer.
  - **Second post**—Specifies the amount of pre-emphasis on the second post tap of the transmitter buffer.
- **Equalizer**—Specifies the setting for the receiver equalizer.
- **DC gain**—Specifies the DC portion of the receiver equalizer.

## Data Type

The **Data type** control specifies the type of data contained in the transactions. The following data types are available for analysis:

- **PRBS7**—Selects pseudo-random 7-bit sequences.
- **PRBS15**—Selects pseudo-random 15-bit sequences.
- **PRBS23**—Selects pseudo-random 23-bit sequences.
- **PRBS31**—Selects pseudo-random 31-bit sequences.
- **HF1**—highest frequency divide-by-2 data pattern "10101010"
- **HF2**—next highest frequency divide-by-6 data pattern "111000111000"
- **HF3**—second lowest frequency divide-by-22 data pattern
- **LF**—lowest frequency divide by 33 data pattern

 Settings HF1, HF2, HF3, LF are for transmit observation only and are not used in the receiver data detection circuitry.

## Error Control

This control displays data errors detected during analysis and allows you to insert errors:

- **Detected errors**—Displays the number of data errors detected in the hardware.
- **Inserted errors**—Displays the number of errors inserted into the transmit data stream.
- **Insert Error**—Inserts a one-word error into the transmit data stream each time you click the button. **Insert Error** is only enabled during transaction performance analysis.
- **Clear**—Resets the **Detected errors** and **Inserted errors** counters to zeros.

## Start

The **Start** control initiates transaction performance analysis.

 Always click **Clear** before **Start**.

## Stop

The **Stop** control terminates transaction performance analysis.


## Loopback

These controls display current transaction performance analysis information collected since you last clicked **Start**:

- **TX** and **RX** performance bars—Show the percentage of maximum theoretical data rate that the requested transactions are able to achieve.
- **Tx (MBps)** and **Rx (MBps)**—Show the number of bytes of data analyzed per second.

## The Power Monitor

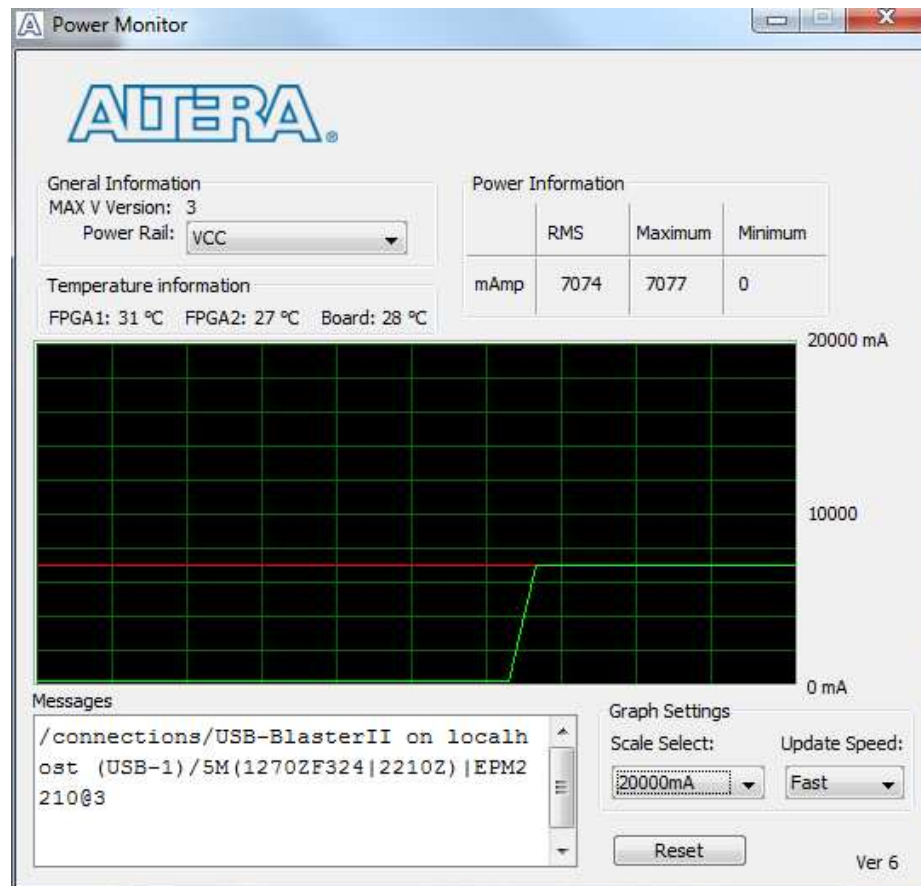
The Power Monitor measures and reports current power and temperature information for the board. To start the application, click **Power Monitor** in the Board Test System application.

 You can also run the Power Monitor as a stand-alone application. **PowerMonitor.exe** resides in the `<install dir>\kits\stratixVGX_5sgxea7nf45_as\examples\board_test_system` directory. On Windows, click **Start > All Programs > Altera > Stratix V Advanced Systems Development Kit <version> > Power Monitor** to start the application.



The Power Monitor communicates with the MAX V device on the board through the JTAG bus. A power monitor circuit attached to the MAX V device allows you to measure the power that each Stratix V GX FPGA device is consuming. Figure 5-7 shows the Power Monitor.

**Figure 5-7. The Power Monitor**




The following sections describe the Power Monitor controls.

### General Information

The **General information** controls display the following information about the MAX V device:

- **MAX V version**—Indicates the version of MAX V code currently running on the board. The MAX V code resides in the `<install dir>\kits\stratixVGX_5sgxea7nf45_as\factory_recovery` and `<install dir>\kits\stratixVGX_5sgxea7nf45_as\examples\max5` directories. Newer revisions of this code might be available on the [Stratix V Advanced Systems Development Kit](#) page of the Altera website.
- **Power rail**—Selects the power rail to measure. After setting the **Power rail** list to the desired rail, click **Reset** to refresh the screen with new board readings.

 All rails use a 0.003 ohm resistor, except S5\_VCC that uses 0.001 ohms.



- For detailed information on how power rails are shared between FPGA1 and FPGA2, see the power rail table or the power tree diagram available in the *Stratix V Advanced Systems Development Board Reference Manual*.

### Temperature Information

The **Temperature information** controls display the following temperature readings for the board and the FPGA on the board:

- **FPGA1**—Indicates the temperature of the FPGA1 (U29) device.
- **Board**—Indicates the overall board temperature.
- **FPGA2**—Indicates the temperature of the FPGA2 (U35) device.

### Power Information

The **Power information** control displays current, maximum, and minimum power readings for the following units:

- **mAmp**

### Power Graph

The power graph displays the mA power consumption of your board over time. The green line indicates the current value. The red line indicates the maximum value read since the last reset. The yellow line indicates the minimum value read since the last reset.

### Graph Settings

The following **Graph settings** controls allow you to define the look and feel of the power graph:

- **Scale select**—Specifies the amount to scale the power graph. Select a smaller number to zoom in to see finer detail. Select a larger number to zoom out to see the entire range of recorded values.
- **Update speed**—Specifies how often to refresh the graph.

### Reset

This **Reset** control clears the graph, resets the minimum and maximum values, and restarts the Power Monitor.

## The Clock Control

The Clock Control application sets the five Si5338 programmable oscillators. Each Si5338 devices each have four independently programmable outputs. All four outputs are programmable between 16 KHz and 350 MHz. All four outputs can support the higher frequencies, but they cannot be programmed for multiple frequencies above 350 MHz. If you want multiple outputs above 350 MHz, all outputs above 350 MHz must be the same frequency, and must be frequencies from 367 MHz to 473.33 MHz or from 550 MHz to 710 MHz.

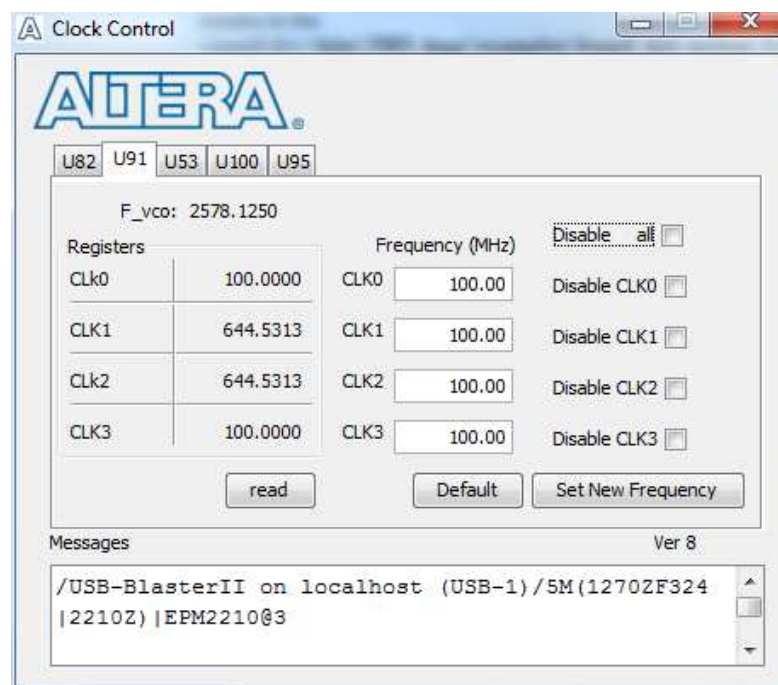
The Clock Control application runs as a stand-alone application. **ClockControl.exe** resides in the

`<install dir>\kits\stratixVGX_5sgxea7nf45_as\examples\board_test_system` directory. On Windows, click **Start > All Programs > Altera > Stratix V Advanced Systems Development Kit <version> > Clock Control** to start the application.

For more information about the Si5338 oscillator and the Stratix V GX advanced systems board's clocking circuitry, default frequencies, and clock input pins, refer to the *Stratix V Advanced Systems Development Board Reference Manual*.

The Clock Control communicates with the MAX V device on the board through the JTAG bus. The Si5338 (U53, U82, U91, U95, and U100) programmable oscillators are connected to the MAX V device through a 2-wire serial bus. Clock frequencies will return to the default values after power cycling the board. **Figure 5-8** shows the Clock Control.

**Figure 5-8. The Clock Control**



The following sections describe the Clock Control controls.

### Read

The **read** control reads the current frequency setting for the oscillator associated with the active tab.

### Default

The **Default** control sets the frequency for the oscillator associated with the active tab back to its default value. This can also be accomplished by power cycling the board.

## Set New Frequency


The **Set New Frequency** control sets the programmable oscillator frequency for the selected clock to the value in the **Frequency (MHz)** fields. Frequency changes might take several milliseconds to take effect. You might see glitches on the clock during this time. Altera recommends resetting the FPGA logic after changing frequencies.


## Configuring the FPGA Using the Quartus II Programmer

You can use the Quartus II Programmer to configure the FPGA with a specific **.sof**. Before configuring the FPGA, ensure that the Quartus II Programmer and the USB-Blaster II driver are installed on the host computer, the mini-USB cable is connected to the Stratix V GX advanced systems board, power to the board is on, and no other applications that use the JTAG chain are running.

To configure the Stratix V GX FPGA, perform the following steps:

1. Start the Quartus II Programmer.
2. Click **Auto Detect** to display the devices in the JTAG chain.
3. Click **Add File** and select the path to the desired **.sof**.
4. Turn on the **Program/Configure** option for the added file.
5. Click **Start** to download the selected file to the FPGA. Configuration is complete when the progress bar reaches 100%.


 Using the Quartus II programmer to configure a device on the board causes other JTAG-based applications such as the Board Test System, the Clock Control, and the Power Monitor to lose their connection to the board. Restart those applications after configuration is complete.

 If the Quartus II programming window is already open, then you power cycle the board, you may be required to click **Hardware Setup** in the Quartus II Programmer window and reselect USB-Blaster II in order to properly detect the JTAG chain.



As you develop your own project using the Altera tools, you can program the flash memory device so that your own design loads from flash memory into the FPGA on power up. This appendix describes the preprogrammed contents of the common flash interface (CFI) flash memory device on the Stratix V GX advanced systems board and how to reprogram the user portions of the flash memory device.

The Stratix V GX advanced systems board ships with the CFI flash device preprogrammed with a default factory FPGA configuration for running the Board Test System demonstration.

 For more information about Altera development tools, refer to the [Design Software](#) page of the Altera website.

## CFI Flash Memory Map

[Table A-1](#) shows the default memory contents of the 1-Gb CFI flash devices. The flash device has a 16-bit data bus connected to the Max V System Controller that is used to configure FPGA1 or FPGA2 using FPP x8.

For the FPP to function correctly, the memory map PFL option bits should not be altered.

**Table A-1. Byte Address Flash Memory Map**

Block Description	Size (KB)	Address Range
Unused	128	0x07FE.0000 - 0x07FF.FFFF
User software	24,320	0x0716.0000 - 0x07F7.FFFF
Factory software	8,192	0x0696.0000 - 0x0715.FFFF
zipfs (html, web content)	8,192	0x0616.0000 - 0x0695.FFFF
Unused	33,152	0x0410.0000 - 0x0615.FFFF
FPGA2 Hardware	33,152	0x020A.0000 - 0x040F.FFFF
FPGA1 Hardware	33,152	0x0002.0000 - 0x0209.FFFF
PFL option bits	32	0x0001.8000 - 0x0001.FFFF
Board information	32	0x0001.0000 - 0x0001.7FFF
Ethernet option bits	32	0x0000.8000 - 0x0000.FFFF
User design reset vector	32	0x0000.0000 - 0x0000.7FFF




Altera recommends that you do not overwrite the factory hardware and factory software images unless you are an expert with the Altera tools.

## Converting .sof Files to a .pof

To generate a programming file with different compression features, you must convert the .sof files to a .pof. To convert the .sof files to a .pof, follow these steps:

1. On the File menu of the Quartus II Programmer, click **Convert Programming Files**.

 For more information, refer to the [Quartus II Programmer](#) chapter in volume 3 of the *Quartus II Handbook*.

2. For **Programming file type**, specify **Programmer Object File (.pof)** and name of the file.
3. For **Configuration device**, select CFI\_1Gb.
4. For **Mode**, select Fast Passive Parallel x8.
5. To add the configuration data, under **Input files to convert**, select **SOF Data**.
6. Click **Add File** and browse to the .sof files you want to add.

If you want to store the data from other .sof files in a different page, click **Add SOF page**. Add the .sof files to the new page. You can use Sof Data Page\_0 to configure FPGA1 and Sof Data Page\_1 to configure FPGA2. From the factory, your board will have contents written to flash memory in Page\_0.

7. Select **SOF Data** and click **Properties** to set the page number and name. Under **Address mode for selected pages**, select **Block** with the following address ranges:
  - For Page\_0, the **Start Address** is 0x0020000. The **End Address** is 0x209FFFF.
  - For Page\_1, the **Start Address** is 0x20A0000. The **End Address** is 0x40FFFFFF.

[Table A-1 on page A-1](#) shows the complete CFI flash memory mapping.
8. Click **OK**.
9. Click **Options** to specify the start address to store the option bits. The start address for this kit is 0x018000. This start address must be identical to the address you specify when creating the PFL megafunction. Ensure that the option bits sector does not overlap with the configuration data pages and that the start address resides on an 8-KB boundary.
10. Click **Generate** to create the .pof.

Once you have the necessary .pof files, you can use the MAX V based PFL to reprogram the flash memory.

## Programming Altera CPLDs and Flash Memory

Using the Quartus II Programmer, you can program Altera CPLDs and flash memory device, allowing you to program, verify, erase, blank-check, or examine the configuration data page, the user data page, and the option bits sector separately, provided the CPLD contains the PFL megafunction.

The Quartus II programmer erases the flash memory device if you select the **.pof** of the flash memory device before programming. To prevent the Quartus II Programmer from erasing other sectors in the flash memory device, select only the pages, **.hex** data, and option bits.

To program the CPLD and the flash memory devices separately, follow these steps:

1. Open the Quartus II Programmer window.
2. Click **Auto Detect**.
3. Highlight the row with the 5M2210 device, click **Add File**. The **Add Programming File Window** dialog box appears.
4. Add the targeted `<install dir>\kits\stratixVGX_5sgxea7nf45_as\examples\memory\flash\pfl_m5.pof`, and click **OK**.
5. Check the boxes under the **Program/Configure** column of the **.pof**.
6. Click **Start** to program the CPLD.
7. After the programming progress bar reaches 100%, click **Auto Detect**. The programmer window shows a CFI\_1Gb flash in the chain.  
  
Alternatively, you can add the flash memory device to the programmer manually. Right-click the CPLD **pfl\_m5.pof** and click **Attach Flash Device**. In the **Attach Flash Device** dialog box, select the CFI\_1Gb device.
8. Right-click the necessary flash memory device density and click **Change File**.
9. Select the **.pof** generated for the flash memory device. The **.pof** for the flash memory device is attached to the **.pof** of the CPLD. The **sv\_as\_dk\_factory.pof** is the default file loaded to flash from the factory.
10. Check the boxes under the **Program/Configure** column for the added **.pof** and click **Start** to program the flash memory devices.

## Restoring the MAX V CPLD to the Factory Settings

This section describes how to restore the original factory contents to the MAX V CPLD on the advanced systems board. Make sure you have the Nios II EDS installed, and perform the following instructions:

1. Set the board switches to the factory default settings described in “[Factory Default Switch and Jumper Settings](#)” on page 4–2.
2. Launch the Quartus II Programmer.
3. Click **Auto Detect**.
4. Click **Add File** and select `<install dir>\kits\stratixVGX_5sgxea7nf45_as\factory_recovery\max5.pof`.
5. Turn on the **Program/Configure** option for the added file.
6. Click **Start** to download the selected configuration file to the MAX V CPLD. Configuration is complete when the progress bar reaches 100%.

- To ensure that you have the most up-to-date factory restore files and information about this product, refer to the [Stratix V Advanced Systems Development Kit](#) page of the Altera website.



This chapter provides additional information about the document and Altera.

## Document Revision History

The following table shows the revision history for this document.

Date	Version	Changes
February 2013	1.0	Initial release.

## How to Contact Altera

To locate the most up-to-date information about Altera products, refer to the following table.

Contact <sup>(1)</sup>	Contact Method	Address
Technical support	Website	<a href="http://www.altera.com/support">www.altera.com/support</a>
Technical training	Website	<a href="http://www.altera.com/training">www.altera.com/training</a>
	Email	<a href="mailto:custrain@altera.com">custrain@altera.com</a>
Product literature	Website	<a href="http://www.altera.com/literature">www.altera.com/literature</a>
Nontechnical support (general) (software licensing)	Email	<a href="mailto:nacomp@altera.com">nacomp@altera.com</a>
	Email	<a href="mailto:authorization@altera.com">authorization@altera.com</a>










**Note to Table:**

(1) You can also contact your local Altera sales office or sales representative.

## Typographic Conventions

The following table shows the typographic conventions this document uses.

Visual Cue	Meaning
<b>Bold Type with Initial Capital Letters</b>	Indicate command names, dialog box titles, dialog box options, and other GUI labels. For example, <b>Save As</b> dialog box. For GUI elements, capitalization matches the GUI.
<b>bold type</b>	Indicates directory names, project names, disk drive names, file names, file name extensions, software utility names, and GUI labels. For example, <code>\qdesigns</code> directory, <b>D:</b> drive, and <code>chiptrip.gdf</code> file.
<i>Italic Type with Initial Capital Letters</i>	Indicate document titles. For example, <i>Stratix IV Design Guidelines</i> .
<i>italic type</i>	Indicates variables. For example, $n + 1$ . Variable names are enclosed in angle brackets (< >). For example, <file name> and <project name>.pof file.
Initial Capital Letters	Indicate keyboard keys and menu names. For example, the Delete key and the Options menu.

Visual Cue	Meaning
"Subheading Title"	Quotation marks indicate references to sections in a document and titles of Quartus II Help topics. For example, "Typographic Conventions."
Courier type	Indicates signal, port, register, bit, block, and primitive names. For example, <code>data1</code> , <code>tdi</code> , and <code>input</code> . The suffix <code>n</code> denotes an active-low signal. For example, <code>resetn</code> . Indicates command line commands and anything that must be typed exactly as it appears. For example, <code>c:\qdesigns\tutorial\chiptrip.gdf</code> . Also indicates sections of an actual file, such as a Report File, references to parts of files (for example, the AHDL keyword <code>SUBDESIGN</code> ), and logic function names (for example, <code>TRI</code> ).
	An angled arrow instructs you to press the Enter key.
1., 2., 3., and a., b., c., and so on	Numbered steps indicate a list of items when the sequence of the items is important, such as the steps listed in a procedure.
	Bullets indicate a list of items when the sequence of the items is not important.
	The hand points to information that requires special attention.
	The question mark directs you to a software help system with related information.
	The feet direct you to another document or website with related information.
	A caution calls attention to a condition or possible situation that can damage or destroy the product or your work.
	A warning calls attention to a condition or possible situation that can cause you injury.
	The envelope links to the <a href="#">Email Subscription Management Center</a> page of the Altera website, where you can sign up to receive update notifications for Altera documents.
	The feedback icon allows you to submit feedback to Altera about the document. Methods for collecting feedback vary as appropriate for each document.