



Cyclone II FPGA Starter Development Board

Reference Manual



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This reference manual describes the Altera® Cyclone® FPGA Starter Development Kit. For a description of how to use the development kit, refer to the *Cyclone FPGA Starter Development Kit User Guide*.



The document revision history in [Table 2–1](#) shows the current version of this document. 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 2–1. Document Revision History

Date	Description
October 2006	Initial publication of the Cyclone II FPGA Starter Development Board Reference Manual, version 1.0.

How to Find Information

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

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Typographic Conventions

This document uses the typographic conventions shown below.

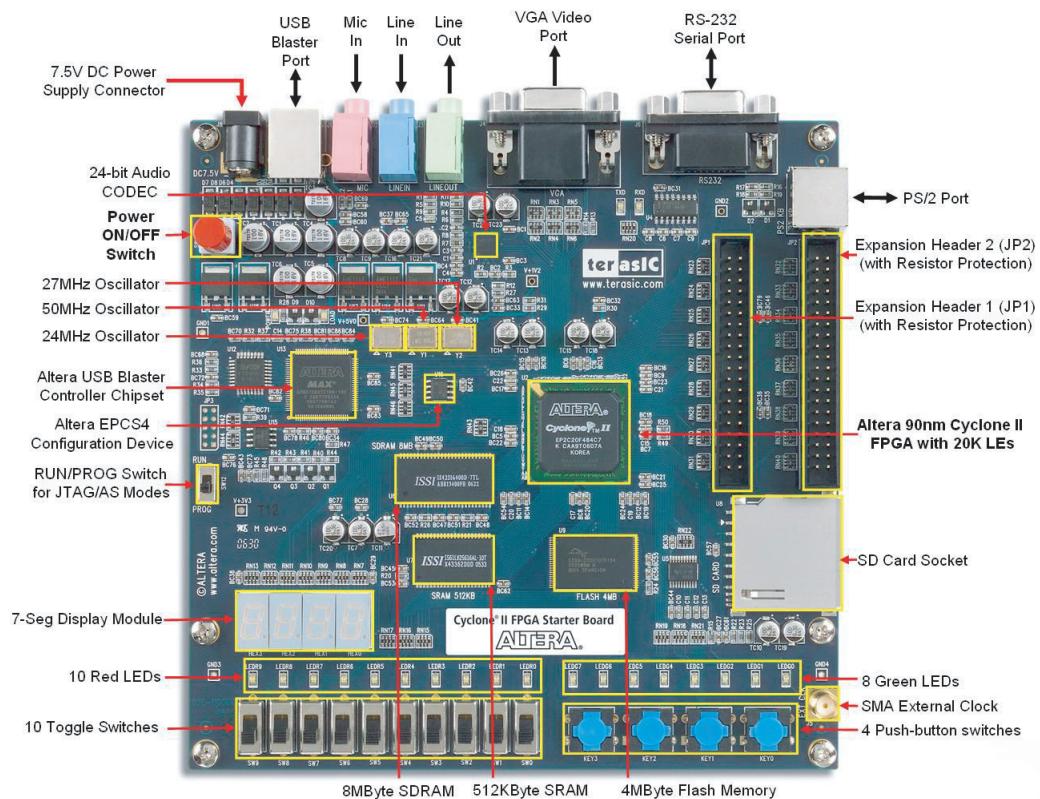
Visual Cue	Meaning
Bold Type with Initial Capital Letters	Command names, dialog box titles, checkbox options, and dialog box options are shown in bold, initial capital letters. Example: Save As dialog box.
bold type	External timing parameters, directory names, project names, disk drive names, filenames, filename extensions, and software utility names are shown in bold type. Examples: f_{MAX} , \qdesigns directory, d: drive, chiptrip.gdf file.
<i>Italic Type with Initial Capital Letters</i>	Document titles are shown in italic type with initial capital letters. Example: <i>AN 75: High-Speed Board Design</i> .
<i>Italic type</i>	Internal timing parameters and variables are shown in italic type. Examples: <i>t_{PIA}</i> , <i>n + 1</i> . Variable names are enclosed in angle brackets (< >) and shown in italic type. Example: < <i>file name</i> >, < <i>project name</i> >.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	<p>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.</p> <p>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.</p>
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.

Overview

The Cyclone II FPGA Starter Development Board (Figure 1-1) provides integrated features that enable users to develop and test designs that range from simple circuits to various multimedia projects, all without the need to implement complex application programming interfaces (APIs), host control software, or SRAM/SDRAM/flash memory controllers.

Figure 1-1. Starter Development Board



The following sections of the manual introduce the board features, describe the configuration methods available, and highlight the characteristics of the board components.

Hardware Features

The development board has the following hardware features:

- Altera Cyclone® II EP2C20 FPGA device
- Altera EPCS4 Serial Configuration device
- USB-Blaster controller chip set for programming and user API control, supporting both JTAG and Active Serial (AS) programming modes
- 512-KByte SRAM
- 8-MByte SDRAM
- 4-MByte Flash memory
- SD Flash Card socket
- 4 Push button switches
- 10 Toggle switches
- 10 Red user LEDs
- 8 Green user LEDs
- 50 MHz, 27 MHz, and 24 MHz oscillators for clock sources
- 24-bit CD-quality audio CODEC with line-in, line-out, and microphone-in jacks
- VGA DAC (4-bit resistor network) with VGA-out connector
- RS-232 transceiver and 9-pin connector
- PS/2 mouse/keyboard connector
- Two 40-pin expansion headers with resistor protection
- 7.5V DC adapter or a USB cable (provided in the kit) for power

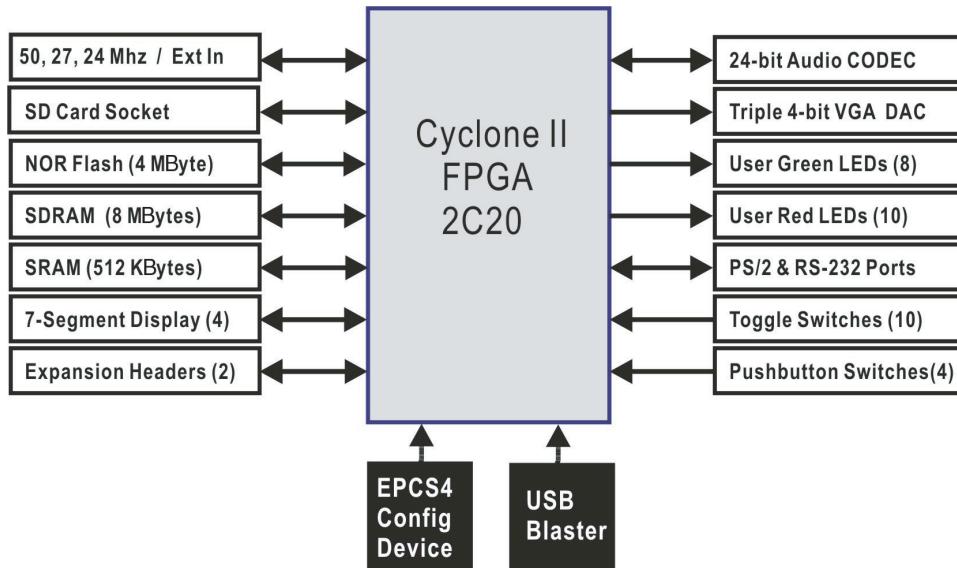
Software Features

Flexible control of the development board and Altera hardware and software tools provide an effective FPGA-based design environment. In addition to the hardware features, the development board provides software support for standard I/O interfaces and a control panel facility for accessing various components. The kit also provides software for a number of demonstrations that illustrate the advanced capabilities of the development board.

Use of the development board requires familiarity with the Altera Quartus II software. Tutorials for the Quartus II software and for the Cyclone II FPGA Starter Board are available on the Altera web site or on the included development kit CD-ROM in the **Examples** directory.

Block Diagram

The block diagram of the development board ([Figure 1-2](#)) shows that for maximum user flexibility, all the blocks connect through the Cyclone II FPGA device. Thus, the user can implement any system design by configuring the FPGA.

Figure 1–2. Development Board Block Diagram

Configuring the Cyclone II FPGA

The Cyclone II FPGA Starter Development Board has integrated the programming circuitry normally found in a USB-Blaster programming cable, as well as a serial EEPROM chip (EPCS4) that stores configuration data for the Cyclone II FPGA. This configuration data loads automatically from the EEPROM chip into the FPGA each time power is applied to the board.

Using the Quartus II software, it is possible to reprogram the FPGA at any time, and it is also possible to change the non-volatile data stored in the serial EEPROM chip. The following sections describe the two ways to program the FPGA, JTAG programming and Active Serial (AS) programming.

JTAG Programming

In this method of programming, named after the IEEE standards *Joint Test Action Group*, the configuration bit stream downloads directly into the Cyclone II FPGA through the USB-Blaster circuitry. The FPGA retains this configuration as long as power is applied to the board; the FPGA loses the configuration when the power is turned off.



*For detailed information about the USB-Blaster circuitry, refer to the Cyclone II FPGA Starter Board schematic found in the **BoardDesignFiles / Schematic** directory in the kit installation directory.*

AS Programming

In the Active Serial programming method, the configuration bit stream downloads into the Altera EPCS4 serial EEPROM chip. The EEPROM provides non-volatile storage of the bit stream, retaining the information even when power to the Cyclone II FPGA Starter board is turned off. When the board powers up, the configuration data in the EPCS4 device automatically loads into the Cyclone II FPGA.

Configuration Procedure

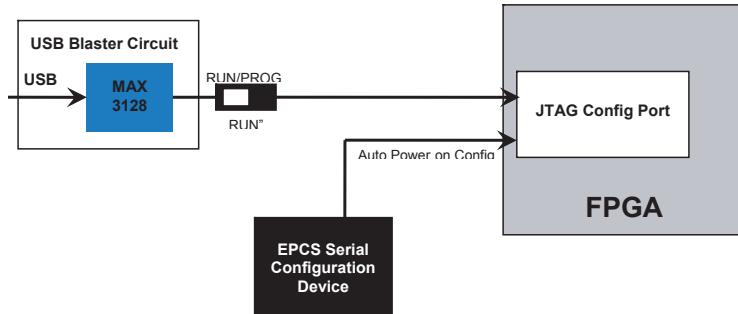
For both the JTAG and AS programming methods, the Cyclone II FPGA Starter board connects to a host computer via a USB cable. Because of this connection type, the host computer identifies the board as an Altera **USB-Blaster** device. The following sections describe the JTAG and AS programming steps.

Configuring the FPGA in JTAG Mode

Figure 1–3 illustrates the JTAG configuration setup. To download a configuration bit stream into the Cyclone II FPGA, perform the following steps:

1. Ensure that power is applied to the Cyclone II FPGA Starter board.
2. Connect the supplied USB cable to the USB-Blaster port on the board.
3. Configure the JTAG programming circuit on the board by setting the **RUN/PROG** switch (on the left side of the board) to the **RUN** position.
4. To program the FPGA, use the Quartus II Programmer module to select a configuration bit-stream file with the **.sof** filename extension.

Figure 1–3. JTAG Configuration Setup



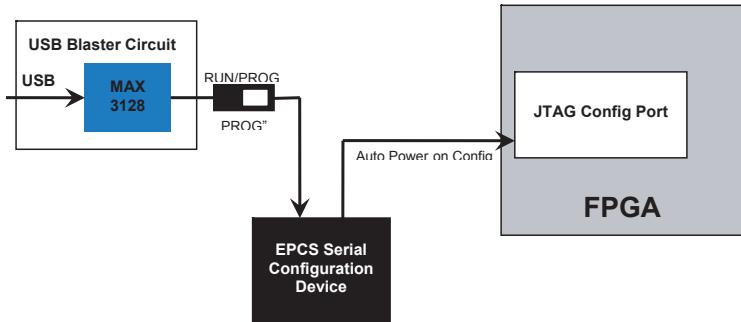
Configuring the EPICS4 Device in AS Mode

Figure 1–4 illustrates the AS configuration setup. To download a configuration bit stream into the EPICS4 serial EEPROM device, perform the following steps:

1. Ensure that power is applied to the Cyclone II FPGA Starter board.
2. Connect the supplied USB cable to the USB-Blaster port on the board.
3. Configure the JTAG programming circuit by setting the **RUN/PROG** switch (on the left side of the board) to the **PROG** position.
4. To program the EPICS4 device, use the Quartus II Programmer module to select a configuration bit-stream file with the *.pof* filename extension.
5. After the programming operation completes, set the **RUN/PROG** switch back to the **RUN** position.
6. Reset the board by turning the power switch off and then on again. This action causes the new configuration data in the EPICS4 device to load into the FPGA chip.



Refer to the *Serial Configuration Devices* chapter in the *Altera Configuration Device Handbook* for more information about the EPICS4 device.

Figure 1–4. AS Configuration Setup

Component Summary

Table 1–1 lists the components, their locations, and brief descriptions.

Table 1–1. Cyclone II FPGA Development Board Components & Interfaces (Part 1 of 2)		
Board Designation	Name	Description
U2	Cyclone II FPGA	EP2C20 device
User Interface		
KEY0 – KEY3	Push-button switches	Four momentary contact switches for user input to the FPGA
SW0 – SW9	Toggle switches	Ten toggle switches for configuration of the FPGA
LEDG0 – LEDG7	Individual LEDs	Eight green LEDs driven by the FPGA
LEDR0 – LEDR9	Individual LEDs	Ten red LEDs driven by the FPGA
HEX0 – HEX3	Seven-segment LEDs	Four seven-segment LEDs that display numeric output from the FPGA
Memory		
U7	SRAM memory	512 KBytes of SRAM
U9	Flash memory	4 MBytes of nonvolatile memory for use by both the FPGA and the configuration controller. LED7 lights whenever the flash chip-enable asserts.
U6	DDR SDRAM memory	8 MBytes of DDR SDRAM.
Connections & Interfaces		
PS2KB	PS/2 connector	PS/2 keyboard connector

Table 1–1. Cyclone II FPGA Development Board Components & Interfaces (Part 2 of 2)		
Board Designation	Name	Description
RS232	Serial connector	RS-232 9-pin serial connector with 5 V-tolerant buffers. Supports all RS-232 signals.
JP1	Expansion header connector	Expansion header 1 connecting to 40 I/O pins on the FPGA with resistor voltage protection
JP2	Expansion header connector	Expansion header 2 connecting to 40 I/O pins on the FPGA with resistor voltage protection
MIC	Microphone input	Audio CODEC connectors
LINEIN	Audio Line input	
LINEOUT	Audio line output	
VGA	VGA connector	VGA video port
SD CARD	SD card socket	Secure Data card socket
BLASTER	JTAG connector	USB Blaster Port JTAG connection to the MAX® configuration controller
Configuration & Reset		
U16	Serial configuration device	Altera EPCS4 low-cost serial configuration device to configure the FPGA
SW11	Power ON/OFF switch	Push-button switch to power up the board
Clock Circuitry		
Y1	Oscillator	50 MHz clock signal driven to FPGA
Y2	Oscillator	27 MHz clock signal driven to FPGA
Y3	Oscillator	24 MHz clock signal driven to FPGA
EXT_CLOCK	External clock input	Connector to FPGA clock pin
Power Supply		
DC7.5V	DC power jack	7.5 V DC unregulated power source

Component Features

This section summarizes characteristics of each board component. For detailed descriptions, refer to [Chapter 2, Development Board Components](#).

Cyclone II EP2C20 FPGA

- 18,752 LEs
- 52 M4K RAM blocks
- 240K total RAM bits
- 26 embedded multipliers
- 4 PLLs
- 315 user I/O pins

- FineLine BGA 484-pin package

Serial Configuration Device and USB Blaster Circuit

- Altera EPCS4 serial configuration device
- On-board USB-Blaster chip set for programming and user API control
- Selectable JTAG and AS programming modes

SRAM

- 512-KByte static RAM memory chip
- Organized as 256K x 16 bits
- Accessible as memory for the Nios II processor and by the Control Panel GUI

SDRAM

- 8-MByte single data rate synchronous dynamic RAM memory chip
- Organized as 1M x 16 bits x 4 banks
- Accessible as memory for the Nios II processor and by the Control Panel GUI

Flash Memory

- 4-MByte NOR flash memory
- 8-bit data bus
- Accessible as memory for the Nios II processor and by the Control Panel GUI

SD Card Socket

- Provides SPI mode for SD card access
- Accessible as memory for the Nios II processor with the DE1 SD Card Driver

Push Button Switches

- 4 push button switches
- Debounced by a Schmitt trigger circuit
- Normally HIGH; generates one active-LOW pulse when the switch is pressed

Toggle Switches

- 10 toggle switches for user inputs

- A switch produces logic 0 when in the DOWN (closest to the edge of the board) position and logic 1 when in the UP position

Clock Inputs

- 50-MHz oscillator
- 27-MHz oscillator
- 24-MHz oscillator
- SMA external clock input

Audio CODEC

- Wolfson WM8731 24-bit sigma-delta audio CODEC
- Line-level input, line-level output, and microphone input jacks
- Sampling frequency: 8 to 96 KHz
- Applications for MP3 players and recorders, PDAs, smart phones, voice recorders

VGA Output

- Uses a 4-bit resistor-network DAC
- 15-pin high-density D-sub connector
- Supports up to 640x480 at 60-Hz refresh rate
- Can be used with the Cyclone II FPGA to implement a high-performance TV encoder

Serial Ports

- One RS-232 port
- One PS/2 port
- DB-9 serial connector for the RS-232 port
- PS/2 connector for connecting a PS2 mouse or keyboard to the board

Dual 40-Pin Expansion Headers

- 72 Cyclone II I/O pins and 8 power and ground lines connect to two, 40-pin expansion connectors
- 40-Pin header designed to accept a standard 40-pin ribbon cable used for IDE hard drives
- Resistor protection provided

Component List

The development board comprises the following major components:

- Altera Cyclone II EP2C20 FPGA
- Altera USB-Blaster controller chip set
- Altera EPCS4 configuration device
- VGA DAC
- 24-bit Audio CODEC
- Memory
 - 8 MByte SDRAM
 - 512 KByte SRAM
 - 4 MByte flash memory
- Internal dual clock circuit
- Switches
 - Power ON/OFF switch
 - RUN/PROG mode selector switch
 - 4 momentary push button switches
 - 10 sliding toggle switches
- Displays
 - LEDs: 8 green, 10 red
 - 4 seven-segment displays
- Connectors
 - USB-Blaster port
 - Two, 40-pin expansion headers
 - SD card connector
 - RS-232 serial port
 - PS/2 port
 - VGA video port
 - Audio microphone-in, line-in, line-out ports
 - SMA external clock connector
 - 7.5 V power supply connector

Cyclone II EP2C20 FPGA

The main device that defines the starter development board is an Altera Cyclone II EP2C20 FPGA in a 484-pin FineLine BGA® package. [Table 2–1](#) lists the FPGA features.

Table 2–1. Cyclone II EP2C20 FPGA Features (Part 1 of 2)

LEs	18,752
M4K Memory Blocks	52

Table 2–1. Cyclone II EP2C20 FPGA Features (Part 2 of 2)

Total RAM Bits	240K
Embedded 18x18 Multiplier Blocks	26
PLLs	4
User I/O Pins	315

For Cyclone II-related documentation including pin out data for the EP2C20 device, refer to the Altera Cyclone II literature page at www.altera.com/literature/lit-cyc2.jsp.

USB-Blaster Controller

The Cyclone II FPGA Starter Development Board includes an integrated USB-Blaster controller. Accessed across a USB-Blaster cable connection by Altera USB-Blaster driver software on a host computer, the USB-Blaster controller enables direct programming of the FPGA.

Refer to ((section on Configuring the FPGA)) and the *Cyclone II FPGA Starter Development Kit User Guide* for further details on configuring the FPGA.

EPCS4

The Cyclone II FPGA Starter Development Board includes a serial EPCS4 EEPROM chip that stores configuration data for the Cyclone II FPGA. The EPCS4 device automatically loads stored configuration data into the FPGA each time power is applied to the board.

Quartus II software on a host computer connected to the board across a USB-Blaster cable and controller can change the non-volatile data stored in the serial EEPROM chip. The EPCS4 device can store FPGA configuration data, or program data, or both.

Refer to “Configuring the Cyclone II FPGA” on page 1–3 and the *Cyclone II FPGA Starter Development Kit User Guide* for further details on configuring the FPGA. Refer to the *Serial Configuration Devices* chapter in the *Altera Configuration Device Handbook* for more information about the EPCS4 device.

VGA DAC

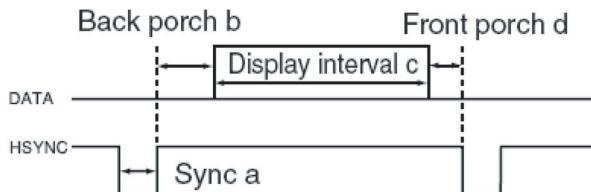
The development board includes a 4-bit VGA digital-to-analog converter (DAC) that can produce standard VGA output with a resolution of 640x480 pixels at 25 MHz. With the VGA DAC able to support a refresh rate up to 100 MHz, a user can implement a high-performance TV Encoder on the FPGA.

The FPGA provides the synchronization signals directly to the VGA port, a 16-pin D-SUB connector, VGA, located at the top edge of the board, while the DAC, using a resistor network, produces the red, green, and blue (RGB) analog data signals.

VGA Timing

[Figure 2–1](#) illustrates the basic timing requirements for each horizontal line, or row, displayed on a VGA monitor. An active-LOW pulse of time duration a ([Table 2–2](#)) applied to the horizontal synchronization input, hsync, of the monitor marks the end of one row of data and the start of the next. After the hsync pulse, the RGB data inputs on the monitor must be off, driven to 0 volts, for a backporch time period b .

Figure 2–1. VGA Horizontal Timing



The display interval starts after the backporch time period b expires. For a time duration c , the RGB data inputs turn on and RGB data drives each pixel in turn across the row. After the display completes, the RGB data inputs must again turn off for a frontporch period d before the next hsync pulse restarts the process on the next row.

The vertical synchronization timing resembles the diagram in [Figure 2–1](#), except a vsync pulse marks the end of one frame and the start of the next, and the data display refers to the set of rows in the frame.

[Table 2–2](#) lists the VGA horizontal timing specifications.

Table 2–2. VGA Horizontal Timing Specifications

Configuration	Resolution (HxV)	a (μ s)	b (μ s)	c (μ s)	d (μ s)	Pixel clock (MHz)
VGA (60 Hz)	640 x 480	3.8	1.9	25.4	0.6	25 (640/c)

Table 2–3 lists the VGA vertical timing specifications.

Table 2–3. VGA Vertical Timing Specifications					
Configuration	Resolution (HxV)	a (lines)	b (lines)	c (lines)	d (lines)
VGA (60 Hz)	640 x 480	2	33	480	10

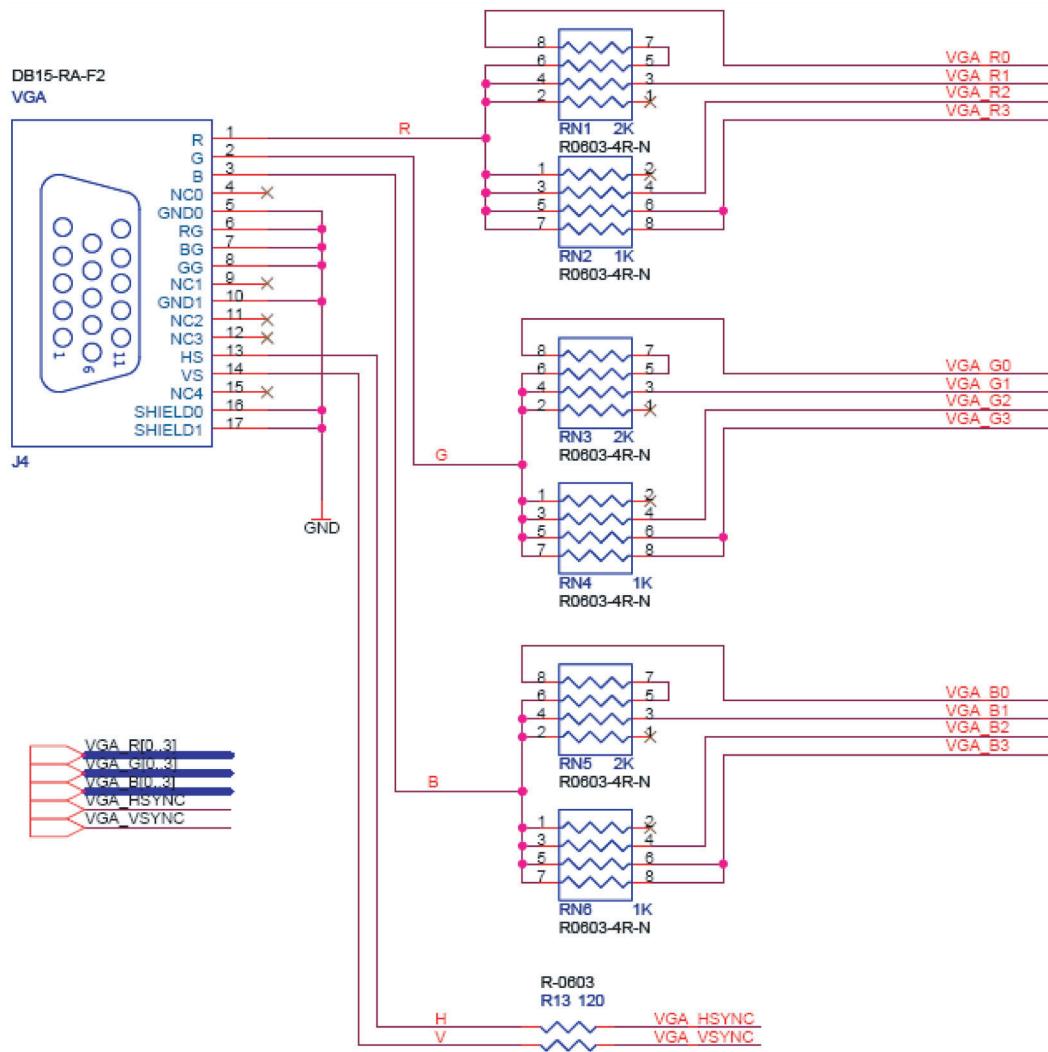
VGA Circuit Pin List

Table 2–4 lists the FPGA pins assigned to the VGA circuit.

Table 2–4. VGA Circuit FPGA Pin Connections		
Signal Name	FPGA Pin	Description
VGA_R[0]	PIN_D9	VGA Red[0]
VGA_R[1]	PIN_C9	VGA Red[1]
VGA_R[2]	PIN_A7	VGA Red[2]
VGA_R[3]	PIN_B7	VGA Red[3]
VGA_G[0]	PIN_B8	VGA Green[0]
VGA_G[1]	PIN_C10	VGA Green[1]
VGA_G[2]	PIN_B9	VGA Green[2]
VGA_G[3]	PIN_A8	VGA Green[3]
VGA_B[0]	PIN_A9	VGA Blue[0]
VGA_B[1]	PIN_D11	VGA Blue[1]
VGA_B[2]	PIN_A10	VGA Blue[2]
VGA_B[3]	PIN_B10	VGA Blue[3]
VGA_HS	PIN_A11	VGA H_SYNC
VGA_VS	PIN_B11	VGA V_SYNC

VGA Circuit Schematic

Figure 2–2 shows the VGA circuit schematic.

Figure 2–2. VGA Circuit Schematic Diagram

Audio CODEC

The development board provides a Wolfson WM8731 high-quality, 24-bit, sigma-delta audio encoder/decoder (CODEC) for applications such as MP3 players and recorders, PDAs, smart phones, and voice recorders.

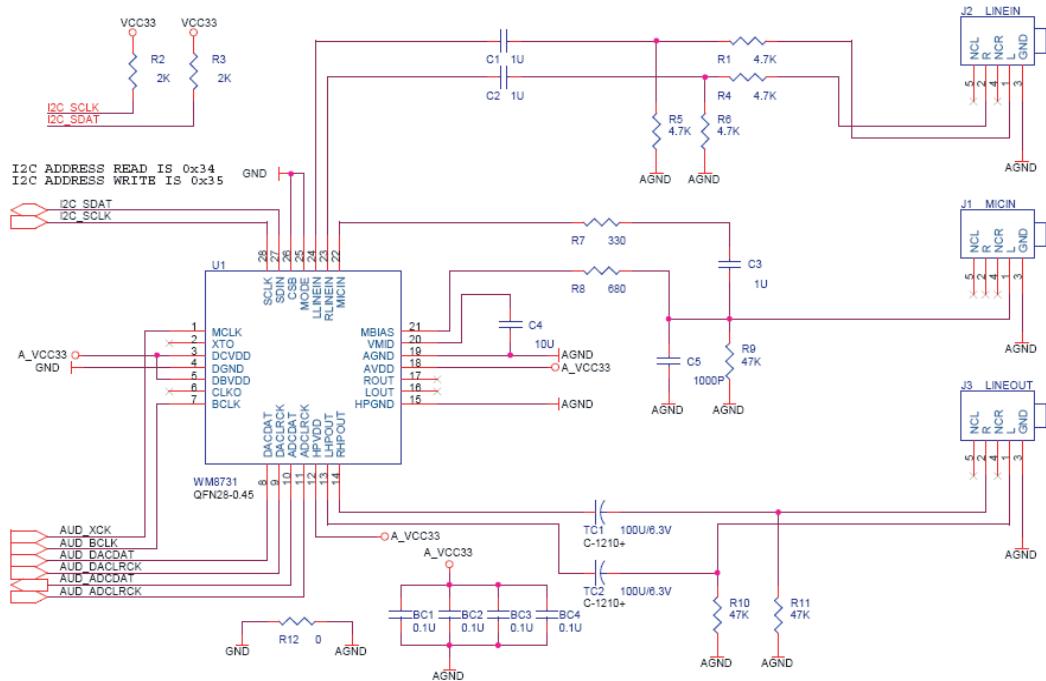
This device features microphone-in, line-in, and line-out ports, with a sample rate adjustable from 8 kHz to 96 kHz. A serial I₂C bus interface connected to FPGA pins controls the WM8731 CODEC.

For information about the WM8731 CODEC, refer to the **BoardDesignFiles\Datasheet** folder in the kit installation directory or to the manufacturer's web site.

Audio Circuit Schematic

Figure 2–3 shows the audio circuit schematic.

Figure 2–3. Audio Circuit Schematic Diagram



Audio Circuit Pin List

Table 2–5 lists the FPGA pins assigned to the audio circuit.

<i>Table 2–5. Audio Circuit FPGA Pin Connections</i>		
Signal Name	FPGA Pin	Description
AUD_ADCLRCK	PIN_A6	Audio CODEC ADC LR Clock
AUD_ADCDAT	PIN_B6	Audio CODEC ADC Data
AUD_DACLRCK	PIN_A5	Audio CODEC DAC LR Clock
AUD_DACDAT	PIN_B5	Audio CODEC DAC Data
AUD_XCK	PIN_B4	Audio CODEC Chip Clock
AUD_BCLK	PIN_A4	Audio CODEC Bit-Stream Clock
I2C_SCLK	PIN_A3	I2C Data
I2C_SDAT	PIN_B3	I2C Clock

Memory

The development board provides three types of memory:

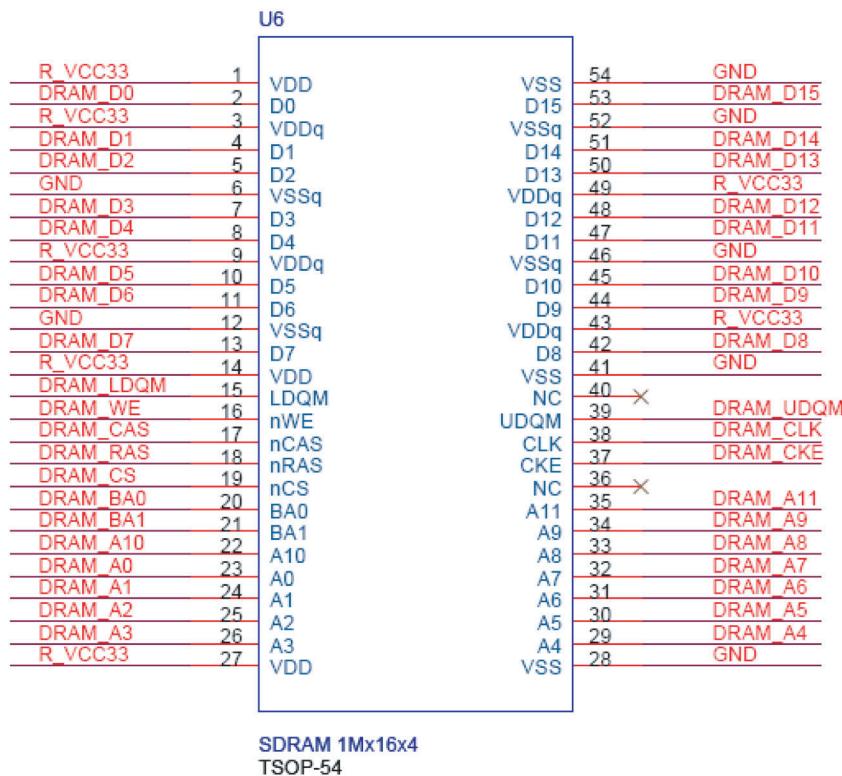
- An 8-MByte SDRAM
- A 512-KByte SRAM
- A 4-MByte flash memory



For information on the memory devices, refer to the **BoardDesignFiles\Datasheet** folder in the kit installation directory.

SDRAM Schematic and Pin List

Figure 2–4 shows the SDRAM interface signals.

Figure 2–4. SDRAM Interface Connections Diagram**Table 2–6. SDRAM FPGA Pin Connections (Part 1 of 2)**

Signal Name	FPGA Pin	Description
DRAM_ADDR[0]	PIN_W4	SDRAM Address[0]
DRAM_ADDR[1]	PIN_W5	SDRAM Address[1]
DRAM_ADDR[2]	PIN_Y3	SDRAM Address[2]
DRAM_ADDR[3]	PIN_Y4	SDRAM Address[3]
DRAM_ADDR[4]	PIN_R6	SDRAM Address[4]
DRAM_ADDR[5]	PIN_R5	SDRAM Address[5]
DRAM_ADDR[6]	PIN_P6	SDRAM Address[6]

Table 2–6. SDRAM FPGA Pin Connections (Part 2 of 2)

Signal Name	FPGA Pin	Description
DRAM_ADDR[7]	PIN_P5	SDRAM Address[7]
DRAM_ADDR[8]	PIN_P3	SDRAM Address[8]
DRAM_ADDR[9]	PIN_N4	SDRAM Address[9]
DRAM_ADDR[10]	PIN_W3	SDRAM Address[10]
DRAM_ADDR[11]	PIN_N6	SDRAM Address[11]
DRAM_DQ[0]	PIN_U1	SDRAM Data[0]
DRAM_DQ[1]	PIN_U2	SDRAM Data[1]
DRAM_DQ[2]	PIN_V1	SDRAM Data[2]
DRAM_DQ[3]	PIN_V2	SDRAM Data[3]
DRAM_DQ[4]	PIN_W1	SDRAM Data[4]
DRAM_DQ[5]	PIN_W2	SDRAM Data[5]
DRAM_DQ[6]	PIN_Y1	SDRAM Data[6]
DRAM_DQ[7]	PIN_Y2	SDRAM Data[7]
DRAM_DQ[8]	PIN_N1	SDRAM Data[8]
DRAM_DQ[9]	PIN_N2	SDRAM Data[9]
DRAM_DQ[10]	PIN_P1	SDRAM Data[10]
DRAM_DQ[11]	PIN_P2	SDRAM Data[11]
DRAM_DQ[12]	PIN_R1	SDRAM Data[12]
DRAM_DQ[13]	PIN_R2	SDRAM Data[13]
DRAM_DQ[14]	PIN_T1	SDRAM Data[14]
DRAM_DQ[15]	PIN_T2	SDRAM Data[15]
DRAM_BA_0	PIN_U3	SDRAM Bank Address[0]
DRAM_BA_1	PIN_V4	SDRAM Bank Address[1]
DRAM_LDQM	PIN_R7	SDRAM Low-byte Data Mask
DRAM_UDQM	PIN_M5	SDRAM High-byte Data Mask
DRAM_RAS_N	PIN_T5	SDRAM Row Address Strobe
DRAM_CAS_N	PIN_T3	SDRAM Column Address Strobe
DRAM_CKE	PIN_N3	SDRAM Clock Enable
DRAM_CLK	PIN_U4	SDRAM Clock
DRAM_WE_N	PIN_R8	SDRAM Write Enable
DRAM_CS_N	PIN_T6	SDRAM Chip Select

SRAM Schematic and Pin List

Figure 2–5 shows the SRAM interface signals.

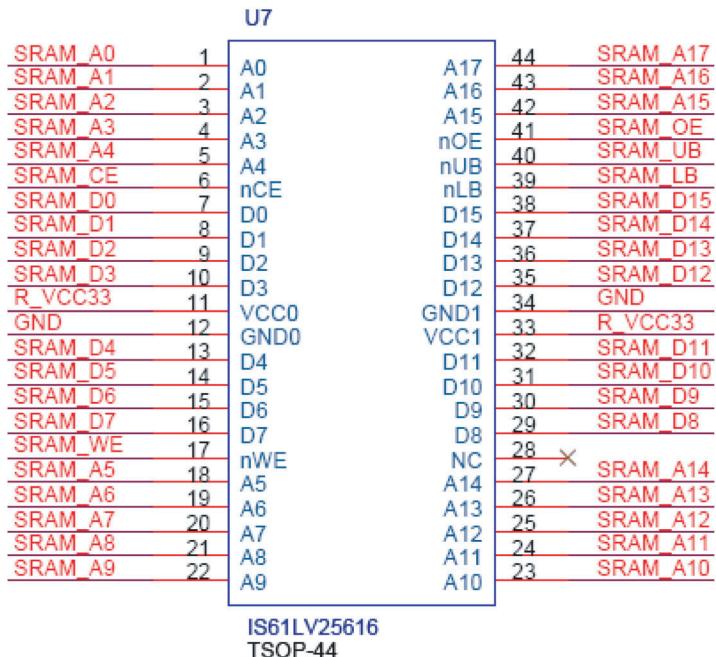
Figure 2–5. SRAM Interface Connections Diagram

Table 2–7 lists the FPGA pins assigned to the SRAM.

Table 2–7. SRAM FPGA Pin Connections (Part 1 of 2)

Signal Name	FPGA Pin	Description
SRAM_ADDR[0]	PIN_AA3	SRAM Address[0]
SRAM_ADDR[1]	PIN_AB3	SRAM Address[1]
SRAM_ADDR[2]	PIN_AA4	SRAM Address[2]
SRAM_ADDR[3]	PIN_AB4	SRAM Address[3]
SRAM_ADDR[4]	PIN_AA5	SRAM Address[4]
SRAM_ADDR[5]	PIN_AB10	SRAM Address[5]
SRAM_ADDR[6]	PIN_AA11	SRAM Address[6]
SRAM_ADDR[7]	PIN_AB11	SRAM Address[7]
SRAM_ADDR[8]	PIN_V11	SRAM Address[8]
SRAM_ADDR[9]	PIN_W11	SRAM Address[9]

Table 2–7. SRAM FPGA Pin Connections (Part 2 of 2)

Signal Name	FPGA Pin	Description
SRAM_ADDR[10]	PIN_R11	SRAM Address[10]
SRAM_ADDR[11]	PIN_T11	SRAM Address[11]
SRAM_ADDR[12]	PIN_Y10	SRAM Address[12]
SRAM_ADDR[13]	PIN_U10	SRAM Address[13]
SRAM_ADDR[14]	PIN_R10	SRAM Address[14]
SRAM_ADDR[15]	PIN_T7	SRAM Address[15]
SRAM_ADDR[16]	PIN_Y6	SRAM Address[16]
SRAM_ADDR[17]	PIN_Y5	SRAM Address[17]
SRAM_DQ[0]	PIN_AA6	SRAM Data[0]
SRAM_DQ[1]	PIN_AB6	SRAM Data[1]
SRAM_DQ[2]	PIN_AA7	SRAM Data[2]
SRAM_DQ[3]	PIN_AB7	SRAM Data[3]
SRAM_DQ[4]	PIN_AA8	SRAM Data[4]
SRAM_DQ[5]	PIN_AB8	SRAM Data[5]
SRAM_DQ[6]	PIN_AA9	SRAM Data[6]
SRAM_DQ[7]	PIN_AB9	SRAM Data[7]
SRAM_DQ[8]	PIN_Y9	SRAM Data[8]
SRAM_DQ[9]	PIN_W9	SRAM Data[9]
SRAM_DQ[10]	PIN_V9	SRAM Data[10]
SRAM_DQ[11]	PIN_U9	SRAM Data[11]
SRAM_DQ[12]	PIN_R9	SRAM Data[12]
SRAM_DQ[13]	PIN_W8	SRAM Data[13]
SRAM_DQ[14]	PIN_V8	SRAM Data[14]
SRAM_DQ[15]	PIN_U8	SRAM Data[15]
SRAM_WE_N	PIN_AA10	SRAM Write Enable
SRAM_OE_N	PIN_T8	SRAM Output Enable
SRAM_UB_N	PIN_W7	SRAM High-byte Data Mask
SRAM_LB_N	PIN_Y7	SRAM Low-byte Data Mask
SRAM_CE_N	PIN_AB5	SRAM Chip Enable

Flash Schematic and Pin List

Figure 2–6 shows the Flash memory interface signals.

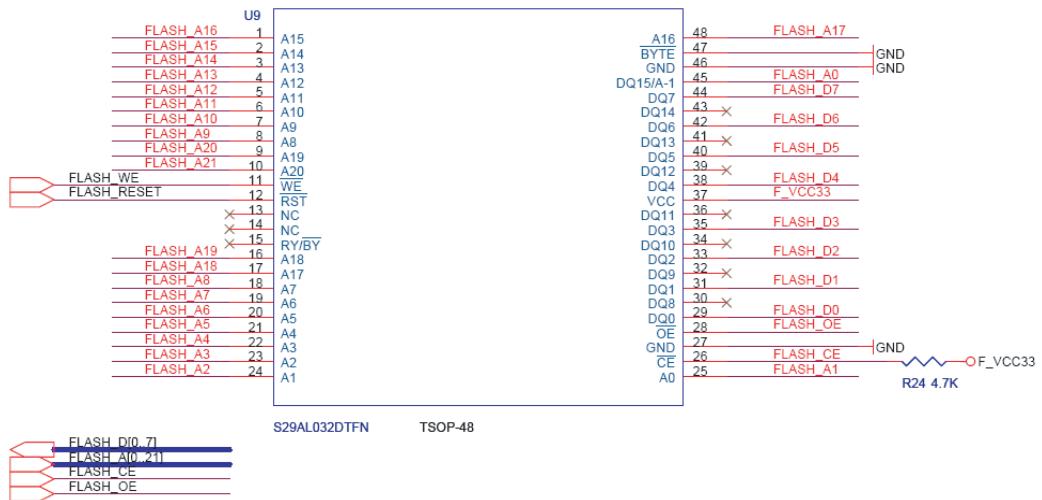
Figure 2–6. Flash Memory Interface Connections Diagram

Table 2–8 lists the FPGA pins assigned to the flash memory.

Table 2–8. Flash Memory FPGA Pin Connections (Part 1 of 2)

Signal Name	FPGA Pin	Description
FL_ADDR[0]	PIN_AB20	FLASH Address[0]
FL_ADDR[1]	PIN_AA14	FLASH Address[1]
FL_ADDR[2]	PIN_Y16	FLASH Address[2]
FL_ADDR[3]	PIN_R15	FLASH Address[3]
FL_ADDR[4]	PIN_T15	FLASH Address[4]
FL_ADDR[5]	PIN_U15	FLASH Address[5]
FL_ADDR[6]	PIN_V15	FLASH Address[6]
FL_ADDR[7]	PIN_W15	FLASH Address[7]
FL_ADDR[8]	PIN_R14	FLASH Address[8]
FL_ADDR[9]	PIN_Y13	FLASH Address[9]
FL_ADDR[10]	PIN_R12	FLASH Address[10]
FL_ADDR[11]	PIN_T12	FLASH Address[11]
FL_ADDR[12]	PIN_AB14	FLASH Address[12]
FL_ADDR[13]	PIN_AA13	FLASH Address[13]
FL_ADDR[14]	PIN_AB13	FLASH Address[14]

Table 2–8. Flash Memory FPGA Pin Connections (Part 2 of 2)

Signal Name	FPGA Pin	Description
FL_ADDR[15]	PIN_AA12	FLASH Address[15]
FL_ADDR[16]	PIN_AB12	FLASH Address[16]
FL_ADDR[17]	PIN_AA20	FLASH Address[17]
FL_ADDR[18]	PIN_U14	FLASH Address[18]
FL_ADDR[19]	PIN_V14	FLASH Address[19]
FL_ADDR[20]	PIN_U13	FLASH Address[20]
FL_ADDR[21]	PIN_R13	FLASH Address[21]
FL_ADDR[0]	PIN_AB20	FLASH Address[0]
FL_ADDR[1]	PIN_AA14	FLASH Address[1]
FL_DQ[0]	PIN_AB16	FLASH Data[0]
FL_DQ[1]	PIN_AA16	FLASH Data[1]
FL_DQ[2]	PIN_AB17	FLASH Data[2]
FL_DQ[3]	PIN_AA17	FLASH Data[3]
FL_DQ[4]	PIN_AB18	FLASH Data[4]
FL_DQ[5]	PIN_AA18	FLASH Data[5]
FL_DQ[6]	PIN_AB19	FLASH Data[6]
FL_DQ[7]	PIN_AA19	FLASH Data[7]
FL_OE_N	PIN_AA15	FLASH Output Enable
FL_RST_N	PIN_W14	FLASH Reset
FL_WE_N	PIN_Y14	FLASH Write Enable

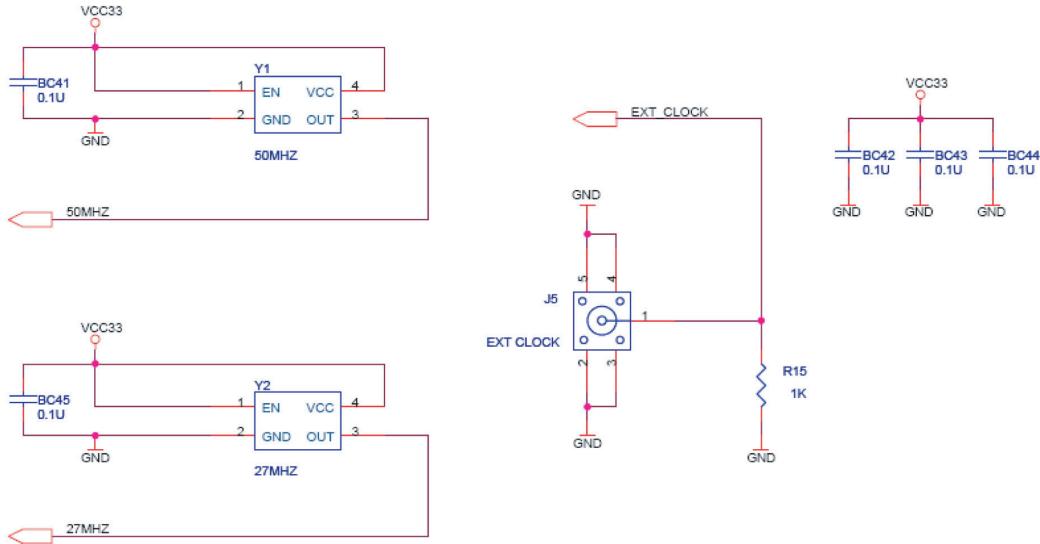
Clock Circuit

The development board has four clock sources:

- Two on-board oscillators produce 27 MHz and 50 MHz clock signals.
- A SubMiniature version A (SMA) connector, **EXT CLK**, located near the right bottom corner of the board enables an external clock source to provide clocking.
- Input through the USB-Blaster port can provide a 24 MHz clock.

Clock Circuit Schematic

Figure 2–7 shows the clock circuit schematic.

Figure 2–7. Clocking Circuit Schematic Diagram

Clock Input Pin List

Table 2–9 lists the FPGA pins assigned to the display segments.

Table 2–9. Clock Circuit FPGA Pin Connections

Signal Name	FPGA Pin	Description
CLOCK_27	PIN_D12	27 MHz clock input
CLOCK_50	PIN_L1	50 MHz clock input
CLOCK_24	PIN_B12	24 MHz clock input from USB Blaster
EXT_CLOCK	PIN_M21	External (SMA) clock input

Switches

The development board provides the following user switches:

- Power ON/OFF switch
- RUN/PROG switch
- 4 push button switches
- 10 Toggle switches

Power ON/OFF Switch

The Cyclone II FPGA Starter board receives its power from either the USB port directly or the included 7.5V power adapter. The Power On/Off switch gates the power from both of these sources to the rest of the board.

RUN/PROG Switch

The RUN/PROG switch directs the JTAG signals from the USB-Blaster circuit to the FPGA directly when in the RUN position (Figure 2–8) or to the EPICS4 Serial EEPROM configuration device when in the PROG position (Figure 2–9).

Figure 2–8. RUN/PROG Switch in RUN Position

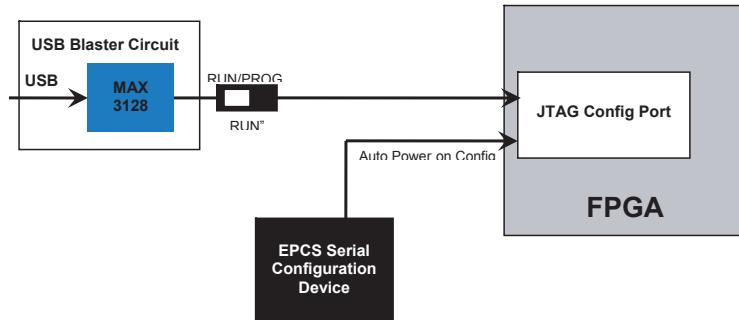
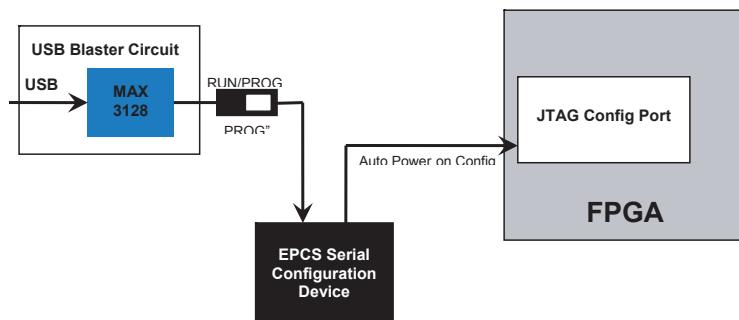


Figure 2–9. RUN/PROG Switch in PROG Position



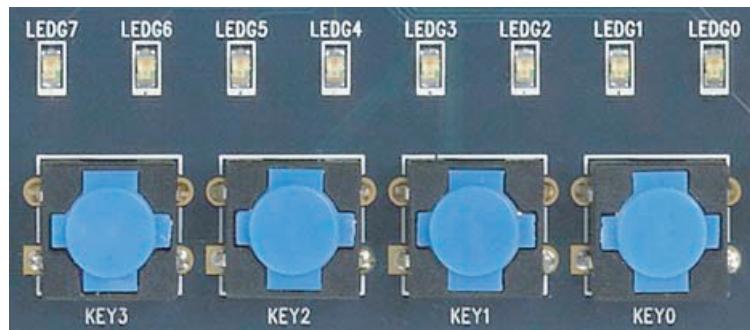
With the RUN/PROG switch in the RUN position, the FPGA configures from the EPICS4 device on power up.

Additionally, with the switch in the RUN position, the Quartus II Programmer can program the FPGA directly through the USB Blaster circuit. With the switch in the PROG position, the Quartus II Programmer can program the EPCS4 device.

Push Button Switches

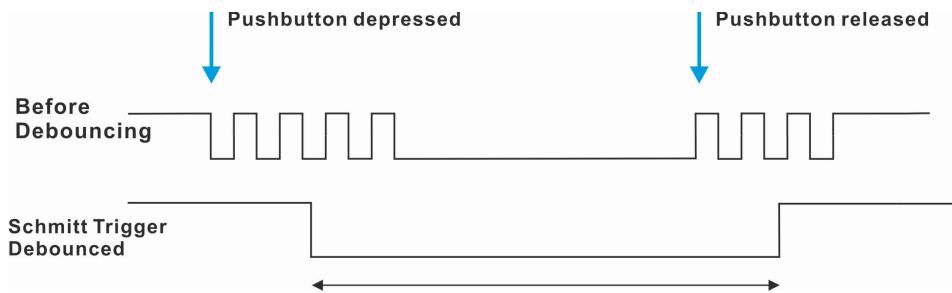
The development board provides four push button switches, KEY0–KEY3, located at the bottom right on the development board below the green LEDs, LEDG0–LEDG7 (Figure 2–10). The momentary-contact switches provide stimulus to designs in the FPGA.

Figure 2–10. Push Button Switches and Green LEDs



A switch generates an active-LOW pulse at 0 volts when pressed, returning to a HIGH logic level at 3.3 volts when released. A Schmitt Trigger circuit on each switch debounces the signal (Figure 2–11).

Figure 2–11. Switch Debouncing



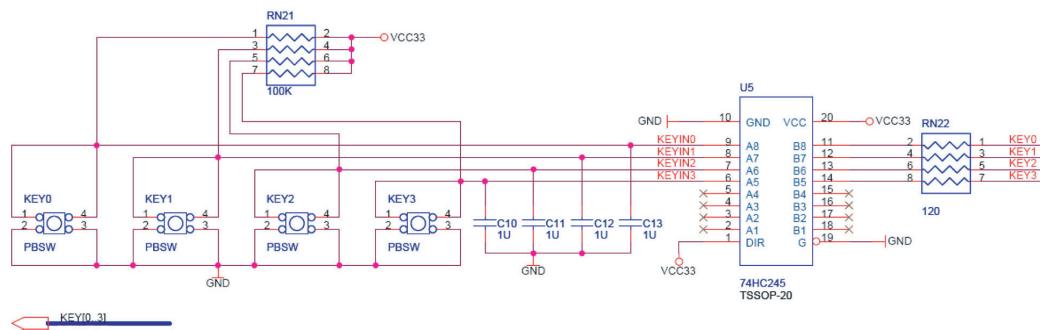
The switches connect to an FPGA general-purpose I/O pin with a pull-up resistor through the Schmitt Trigger outputs, **KEY0**, ..., **KEY3**. Each I/O pin senses a logic level 0 when the corresponding switch is pressed.

The debounced outputs enable users to use the push buttons as clock or reset inputs for a circuit.

Push Button Switch Schematic

Figure 2–12 shows a schematic diagram of the push button switches.

Figure 2–12. Push Button Switch Schematic Diagram



Push Button Switch Pin List

Table 2–10 lists the FPGA pins assigned to the push button switches.

Table 2–10. Push Button Switch FPGA Pin Connections

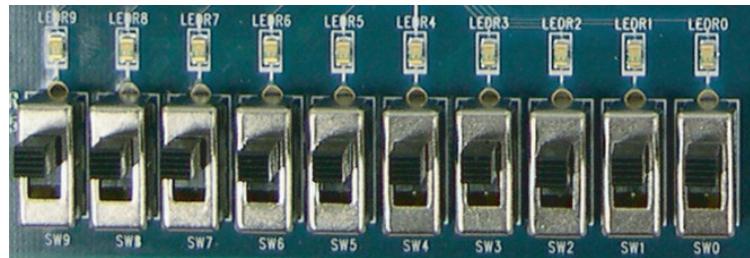
Switch	FPGA Pin	Description
KEY[0]	PIN_R22	Pushbutton[0]
KEY[1]	PIN_R21	Pushbutton[1]
KEY[2]	PIN_T22	Pushbutton[2]
KEY[3]	PIN_T21	Pushbutton[3]

Toggle Switches

The development board provides ten sliding toggle switches, **SW0**–**SW9**, located at the bottom left on the development board below the red LEDs, **LEDR0**–**LEDR9** (Figure 2–13). Not debounced, these switches provide level-sensitive data inputs to a circuit. Each switch

connects directly to a pin on the FPGA. In the DOWN or OFF position (closest to the edge of the board), a switch provides a LOW logic level (0 volts) to the FPGA. In the UP position a switch provides a HIGH logic level (3.3 volts).

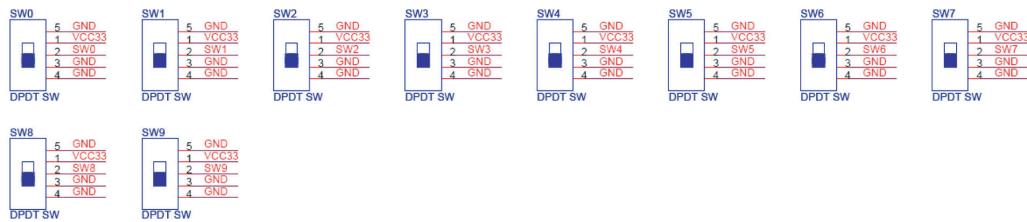
Figure 2–13. Toggle Switches SW0–SW9 and Red LEDs LEDR0–LEDR9



Toggle Switch Schematic

Figure 2–14 shows a schematic diagram of the toggle switches.

Figure 2–14. Toggle Switch Schematic Diagram



Toggle Switch Pin List

Table 2–11 lists the FPGA pins assigned to the toggle switches.

Table 2–11. Toggle Switch FPGA Pin Connections		
Switch	FPGA Pin	Description
SW[0]	PIN_L22	Toggle Switch[0]
SW[1]	PIN_L21	Toggle Switch[1]
SW[2]	PIN_M22	Toggle Switch[2]
SW[3]	PIN_V12	Toggle Switch[3]
SW[4]	PIN_W12	Toggle Switch[4]
SW[5]	PIN_U12	Toggle Switch[5]
SW[6]	PIN_U11	Toggle Switch[6]
SW[7]	PIN_M2	Toggle Switch[7]
SW[8]	PIN_M1	Toggle Switch[8]
SW[9]	PIN_L2	Toggle Switch[9]

Displays

The development board provides the following displays:

- LEDs
- Seven-segment displays

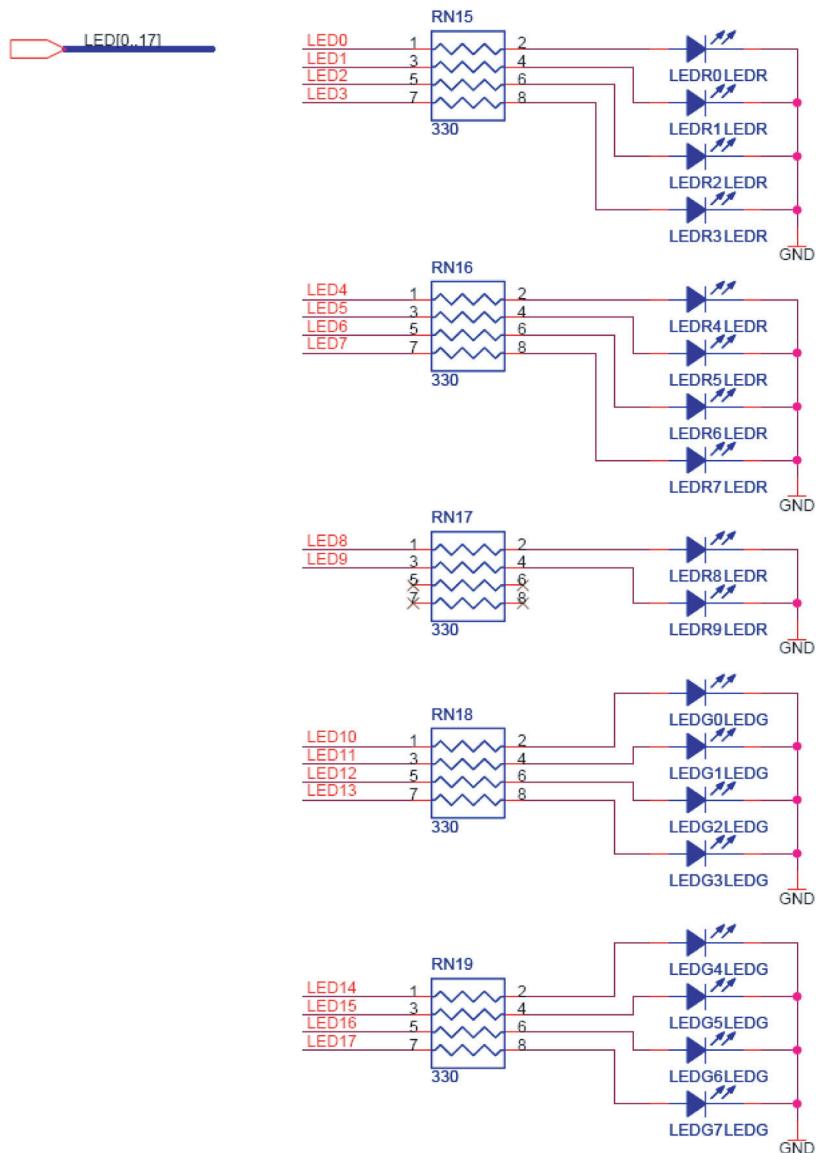
LEDs

The development board provides 18 user-controllable LEDs, 10 red LEDs, **LEDR0–LEDR9**, above the toggle switches (Figure 2–13) and 8 green LEDs, **LEDG0–LEDG7**, above the four push button switches (Figure 2–10). Each LED connects directly to an FPGA general purpose I/O pin. A HIGH logic level on a pin turns the LED on; a LOW logic level on a pin turns the LED off.

LED Schematic

Figure 2–15 shows a schematic diagram of the LEDs.

Figure 2–15. LED Schematic Diagram



LED Pin List

Table 2–12 lists the FPGA pins assigned to the LEDs.

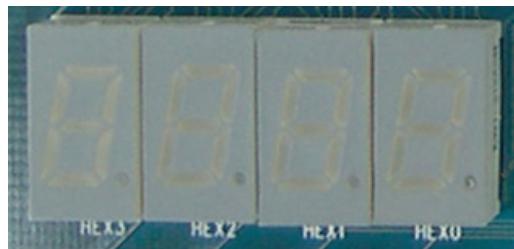
Table 2–12. LED FPGA Pin Connections

Signal Name	FPGA Pin	Description
LEDR[0]	PIN_R20	LED Red[0]
LEDR[1]	PIN_R19	LED Red[1]
LEDR[2]	PIN_U19	LED Red[2]
LEDR[3]	PIN_Y19	LED Red[3]
LEDR[4]	PIN_T18	LED Red[4]
LEDR[5]	PIN_V19	LED Red[5]
LEDR[6]	PIN_Y18	LED Red[6]
LEDR[7]	PIN_U18	LED Red[7]
LEDR[8]	PIN_R18	LED Red[8]
LEDR[9]	PIN_R17	LED Red[9]
LEDG[0]	PIN_U22	LED Green[0]
LEDG[1]	PIN_U21	LED Green[1]
LEDG[2]	PIN_V22	LED Green[2]
LEDG[3]	PIN_V21	LED Green[3]
LEDG[4]	PIN_W22	LED Green[4]
LEDG[5]	PIN_W21	LED Green[5]
LEDG[6]	PIN_Y22	LED Green[6]
LEDG[7]	PIN_Y21	LED Green[7]

Seven-Segment Displays

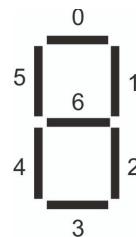
The development board provides four adjacent 7-segment displays, **HEX0–HEX3**, (Figure 2–16) for reporting numerical values from the FPGA. Each segment connects to an FPGA general-purpose I/O pin. A LOW logic level applied at the pin lights up the segment; a HIGH logic level turns the segment off.

Figure 2–16. Seven-Segment Displays



An index from 0 to 6 identifies each segment and its position (Figure 2–17). The development board does not connect or use the dot in the display.

Figure 2–17. Segment Index and Position



Seven-Segment Display Schematic

Figure 2–18 shows a schematic diagram of the LEDs.

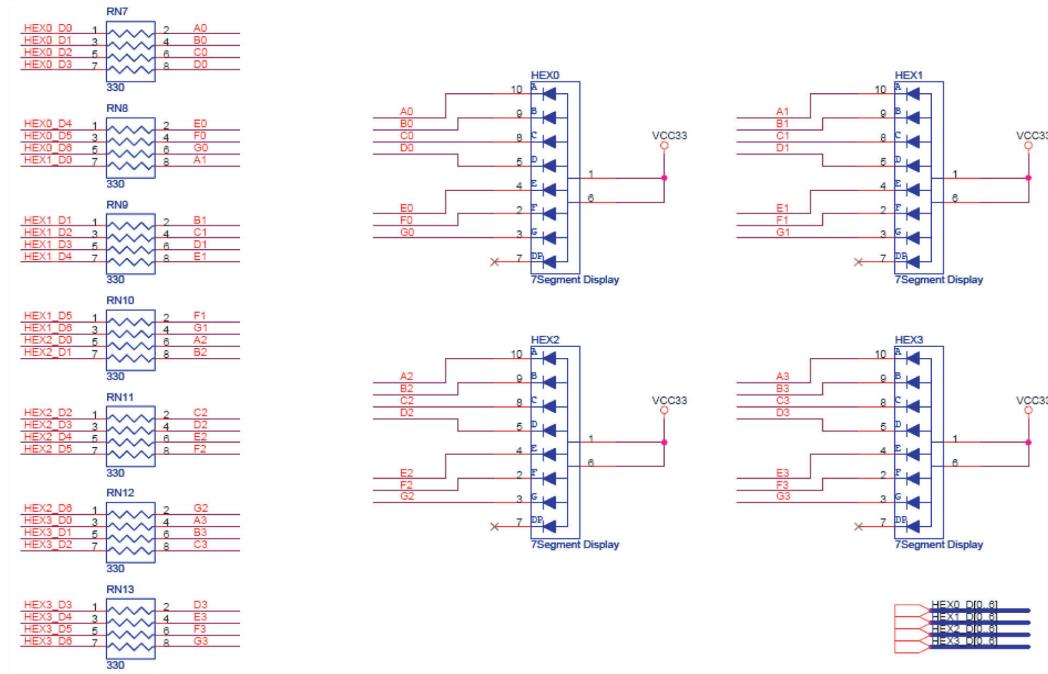
Figure 2–18. Seven-Segment Display Schematic Diagram**Seven-Segment Display Pin List**

Table 2–13 lists the FPGA pins assigned to the display segments.

Table 2–13. Seven-Segment Display FPGA Pin Connections (Part 1 of 2)

Signal Name	FPGA Pin	Description
HEX0[0]	PIN_J2	Seven-Segment segment 0[0]
HEX0[1]	PIN_J1	Seven-Segment segment 0[1]
HEX0[2]	PIN_H2	Seven-Segment segment 0[2]
HEX0[3]	PIN_H1	Seven-Segment segment 0[3]
HEX0[4]	PIN_F2	Seven-Segment segment 0[4]
HEX0[5]	PIN_F1	Seven-Segment segment 0[5]
HEX0[6]	PIN_E2	Seven-Segment segment 0[6]
HEX1[0]	PIN_E1	Seven-Segment segment 1[0]
HEX1[1]	PIN_H6	Seven-Segment segment 1[1]

Table 2–13. Seven-Segment Display FPGA Pin Connections (Part 2 of 2)

Signal Name	FPGA Pin	Description
HEX1[2]	PIN_H5	Seven-Segment segment 1[2]
HEX1[3]	PIN_H4	Seven-Segment segment 1[3]
HEX1[4]	PIN_G3	Seven-Segment segment 1[4]
HEX1[5]	PIN_D2	Seven-Segment segment 1[5]
HEX1[6]	PIN_D1	Seven-Segment segment 1[6]
HEX2[0]	PIN_G5	Seven-Segment segment 2[0]
HEX2[1]	PIN_G6	Seven-Segment segment 2[1]
HEX2[2]	PIN_C2	Seven-Segment segment 2[2]
HEX2[3]	PIN_C1	Seven-Segment segment 2[3]
HEX2[4]	PIN_E3	Seven-Segment segment 2[4]
HEX2[5]	PIN_E4	Seven-Segment segment 2[5]
HEX2[6]	PIN_D3	Seven-Segment segment 2[6]
HEX3[0]	PIN_F4	Seven-Segment segment 3[0]
HEX3[1]	PIN_D5	Seven-Segment segment 3[1]
HEX3[2]	PIN_D6	Seven-Segment segment 3[2]
HEX3[3]	PIN_J4	Seven-Segment segment 3[3]
HEX3[4]	PIN_L8	Seven-Segment segment 3[4]
HEX3[5]	PIN_F3	Seven-Segment segment 3[5]
HEX3[6]	PIN_D4	Seven-Segment segment 3[6]

Connectors

The development board provides the following connectors:

- USB Type B connector port
- Expansion headers
- SD card connector
- RS-232 serial port
- PS/2 port
- VGA video port
- Audio microphone-in, line-in, line-out ports
- SMA external clock connector
- Power supply connector

USB-Blaster Port

The Cyclone II FPGA Starter Board includes USB-Blaster circuitry used for programming the FPGA or the EPCS4 device. A USB type B connector ([Figure 2–19](#)) provides the connection to this programming circuitry. Refer to “[USB-Blaster Controller](#)” on page [2–2](#) for more information about the USB Blaster circuitry.

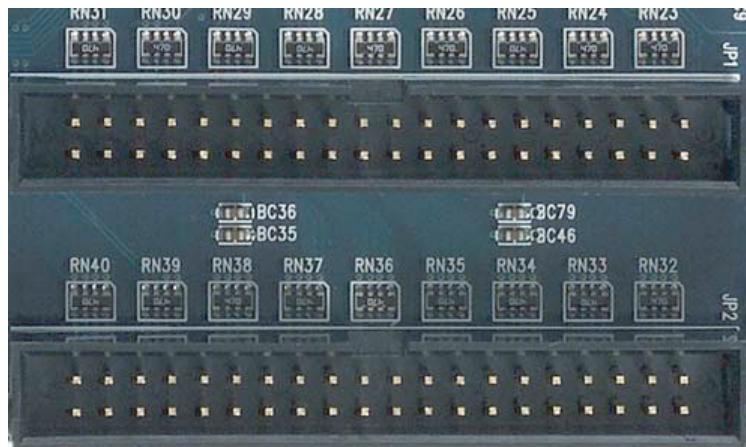
Figure 2–19. USB Type B Connector



Expansion Headers

The development board provides two, 40-pin expansion headers, **JP2**, located on the right edge of the board, and **JP1**, located next to it ([Figure 2–20](#)). Each header connects directly to 36 pins on the FPGA, and also provides DC +5V (VCC5), DC +3.3V (VCC33), and two GND pins. Each pin on the expansion header connects to a resistor that provides protection from high and low voltages. The 40-pin header accepts a standard 40-pin ribbon cable used for IDE hard drives.

Figure 2–20. Expansion Headers



Expansion Header Schematics

Figure 2–21 shows the JP1 expansion header schematic.

Figure 2–21. Expansion Header JP1 Schematic Diagram

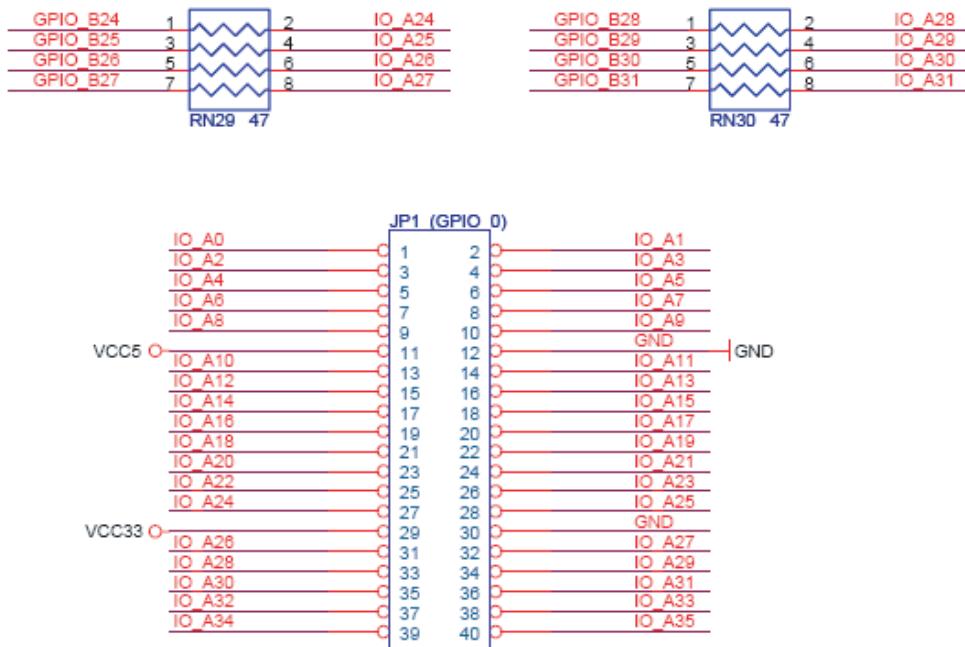
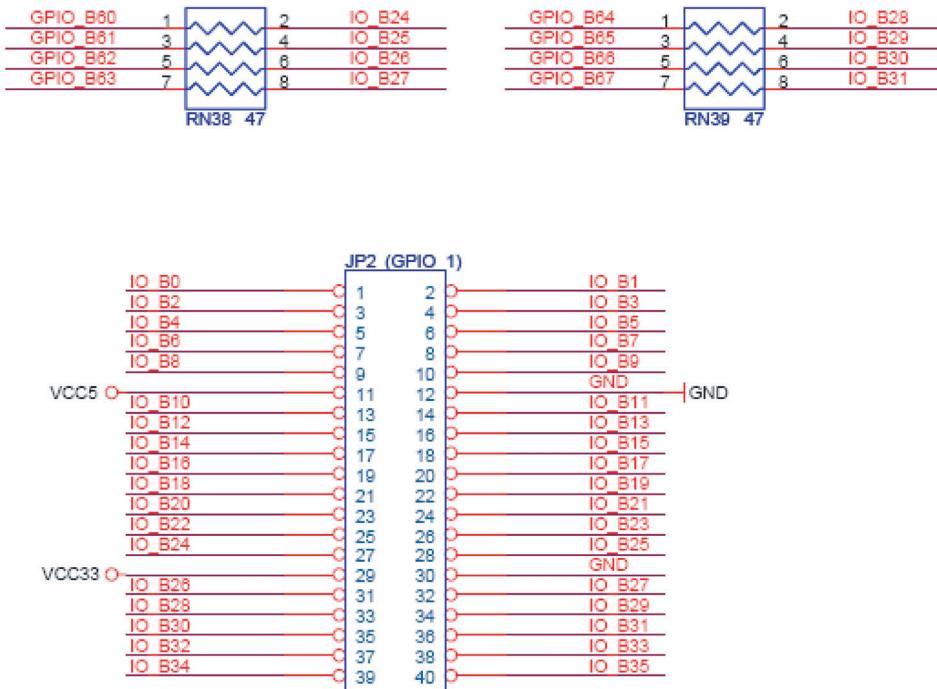


Figure 2–22 shows the JP2 expansion header schematic.

Figure 2–22. Expansion Header JP2 Schematic Diagram

As examples, the figures show the protection circuitry for 4 of the pins on each header, but all 72 data pins include this circuitry. For complete information, refer to the schematic found in **BoardDesignFiles\Schematic** in the kit installation directory.

Expansion Header Pin List

Table 2–14 lists the FPGA pins assigned to the expansion headers.

Table 2–14. Expansion Header FPGA Pin Connections (Part 1 of 3)

Signal Name	FPGA Pin	Description
GPIO_0[0]	PIN_A13	GPIO Connection 0[0]
GPIO_0[1]	PIN_B13	GPIO Connection 0[1]
GPIO_0[2]	PIN_A14	GPIO Connection 0[2]
GPIO_0[3]	PIN_B14	GPIO Connection 0[3]

Table 2–14. Expansion Header FPGA Pin Connections (Part 2 of 3)

Signal Name	FPGA Pin	Description
GPIO_0[4]	PIN_A15	GPIO Connection 0[4]
GPIO_0[5]	PIN_B15	GPIO Connection 0[5]
GPIO_0[6]	PIN_A16	GPIO Connection 0[6]
GPIO_0[7]	PIN_B16	GPIO Connection 0[7]
GPIO_0[8]	PIN_A17	GPIO Connection 0[8]
GPIO_0[9]	PIN_B17	GPIO Connection 0[9]
GPIO_0[10]	PIN_A18	GPIO Connection 0[10]
GPIO_0[11]	PIN_B18	GPIO Connection 0[11]
GPIO_0[12]	PIN_A19	GPIO Connection 0[12]
GPIO_0[13]	PIN_B19	GPIO Connection 0[13]
GPIO_0[14]	PIN_A20	GPIO Connection 0[14]
GPIO_0[15]	PIN_B20	GPIO Connection 0[15]
GPIO_0[16]	PIN_C21	GPIO Connection 0[16]
GPIO_0[17]	PIN_C22	GPIO Connection 0[17]
GPIO_0[18]	PIN_D21	GPIO Connection 0[18]
GPIO_0[19]	PIN_D22	GPIO Connection 0[19]
GPIO_0[20]	PIN_E21	GPIO Connection 0[20]
GPIO_0[21]	PIN_E22	GPIO Connection 0[21]
GPIO_0[22]	PIN_F21	GPIO Connection 0[22]
GPIO_0[23]	PIN_F22	GPIO Connection 0[23]
GPIO_0[24]	PIN_G21	GPIO Connection 0[24]
GPIO_0[25]	PIN_G22	GPIO Connection 0[25]
GPIO_0[26]	PIN_J21	GPIO Connection 0[26]
GPIO_0[27]	PIN_J22	GPIO Connection 0[27]
GPIO_0[28]	PIN_K21	GPIO Connection 0[28]
GPIO_0[29]	PIN_K22	GPIO Connection 0[29]
GPIO_0[30]	PIN_J19	GPIO Connection 0[30]
GPIO_0[31]	PIN_J20	GPIO Connection 0[31]
GPIO_0[32]	PIN_J18	GPIO Connection 0[32]
GPIO_0[33]	PIN_K20	GPIO Connection 0[33]
GPIO_0[34]	PIN_L19	GPIO Connection 0[34]
GPIO_0[35]	PIN_L18	GPIO Connection 0[35]
GPIO_1[0]	PIN_H12	GPIO Connection 1[0]
GPIO_1[1]	PIN_H13	GPIO Connection 1[1]

Table 2–14. Expansion Header FPGA Pin Connections (Part 3 of 3)

Signal Name	FPGA Pin	Description
GPIO_1[2]	PIN_H14	GPIO Connection 1[2]
GPIO_1[3]	PIN_G15	GPIO Connection 1[3]
GPIO_1[4]	PIN_E14	GPIO Connection 1[4]
GPIO_1[5]	PIN_E15	GPIO Connection 1[5]
GPIO_1[6]	PIN_F15	GPIO Connection 1[6]
GPIO_1[7]	PIN_G16	GPIO Connection 1[7]
GPIO_1[8]	PIN_F12	GPIO Connection 1[8]
GPIO_1[9]	PIN_F13	GPIO Connection 1[9]
GPIO_1[10]	PIN_C14	GPIO Connection 1[10]
GPIO_1[11]	PIN_D14	GPIO Connection 1[11]
GPIO_1[12]	PIN_D15	GPIO Connection 1[12]
GPIO_1[13]	PIN_D16	GPIO Connection 1[13]
GPIO_1[14]	PIN_C17	GPIO Connection 1[14]
GPIO_1[15]	PIN_C18	GPIO Connection 1[15]
GPIO_1[16]	PIN_C19	GPIO Connection 1[16]
GPIO_1[17]	PIN_C20	GPIO Connection 1[17]
GPIO_1[18]	PIN_D19	GPIO Connection 1[18]
GPIO_1[19]	PIN_D20	GPIO Connection 1[19]
GPIO_1[20]	PIN_E20	GPIO Connection 1[20]
GPIO_1[21]	PIN_F20	GPIO Connection 1[21]
GPIO_1[22]	PIN_E19	GPIO Connection 1[22]
GPIO_1[23]	PIN_E18	GPIO Connection 1[23]
GPIO_1[24]	PIN_G20	GPIO Connection 1[24]
GPIO_1[25]	PIN_G18	GPIO Connection 1[25]
GPIO_1[26]	PIN_G17	GPIO Connection 1[26]
GPIO_1[27]	PIN_H17	GPIO Connection 1[27]
GPIO_1[28]	PIN_J15	GPIO Connection 1[28]
GPIO_1[29]	PIN_H18	GPIO Connection 1[29]
GPIO_1[30]	PIN_N22	GPIO Connection 1[30]
GPIO_1[31]	PIN_N21	GPIO Connection 1[31]
GPIO_1[32]	PIN_P15	GPIO Connection 1[32]
GPIO_1[33]	PIN_N15	GPIO Connection 1[33]
GPIO_1[34]	PIN_P17	GPIO Connection 1[34]
GPIO_1[35]	PIN_P18	GPIO Connection 1[35]

SD Card Connector

The Cyclone II FPGA Starter board includes an SD Card connector (U8) (Figure 2–23) to interface with SD Card devices including flash storage.

Figure 2–23. SD Card Connector

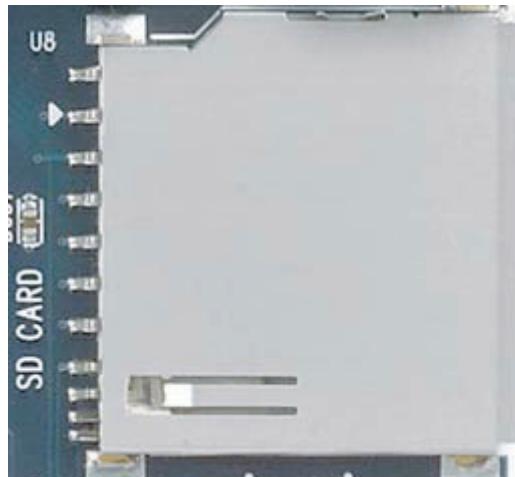


Figure 2–24 shows the schematic diagram of the SD Card interface.

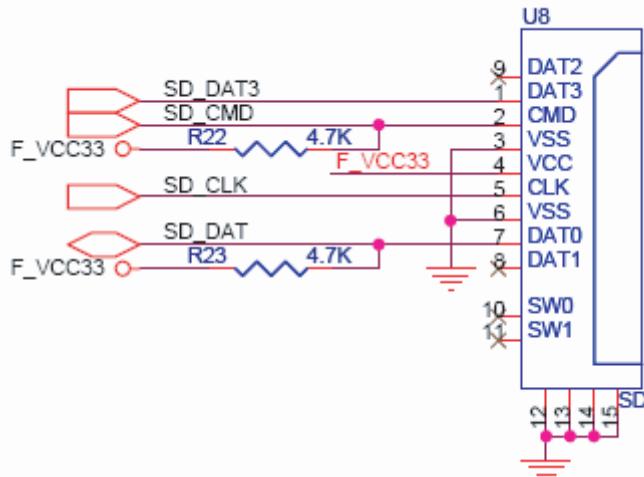
Figure 2–24. SD Card Interface Schematic

Table 2–15 lists the SD Card signal connections to FPGA pins.

Table 2–15. SD Card FPGA Connections

Signal Name	FPGA Pin	Description
SD_DAT	W20	Data to/from SD Card
SD_DAT3	U20	SD Card Chip Select
SD_CMD	Y20	Command line for SD Card
SD_CLK	V20	SD Card Clock

RS-232 Serial Port

The development board uses a MAX232 transceiver chip and a 9-pin D-SUB connector (Figure 2–25) for RS-232 communications.

For detailed information on how to use the transceiver, refer to the **BoardDesignFiles\Datasheet** folder in the kit installation directory or connect to the manufacturer's web site.

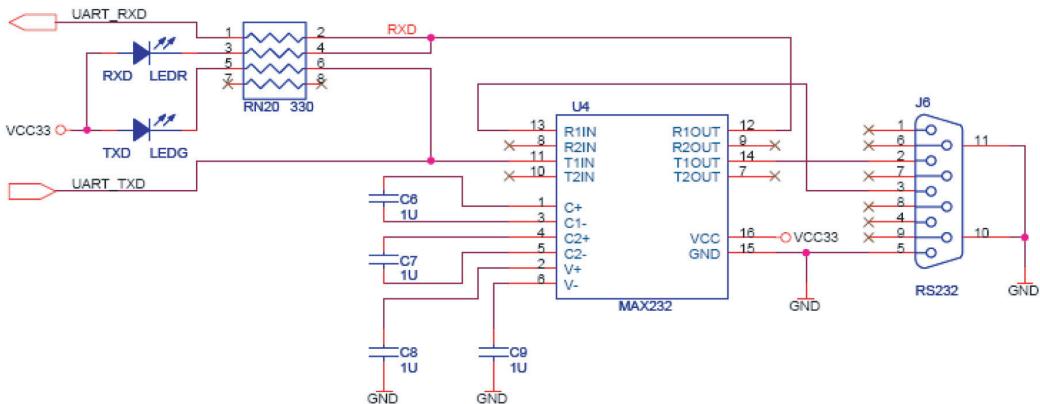
Figure 2–25. RS-232 Serial Connector



RS-232 Circuit Schematic

Figure 2–26 shows the RS-232 serial circuit schematic.

Figure 2–26. RS-232 Serial Circuit Schematic Diagram



RS-232 Serial Circuit Pin List

Table 2–16 lists the FPGA pins assigned to the RS-232 serial circuit.

Table 2–16. RS-232 Serial Circuit FPGA Pin Connections

Signal Name	FPGA Pin	Description
UART_RXD	PIN_F14	UART Receiver
UART_TXD	PIN_G12	UART Transmitter

PS/2 Port

The development board includes a standard PS/2 interface and a connector for a PS/2 keyboard or mouse.

PS/2 Circuit Schematic

Figure 2–27 shows the PS/2 serial circuit schematic.

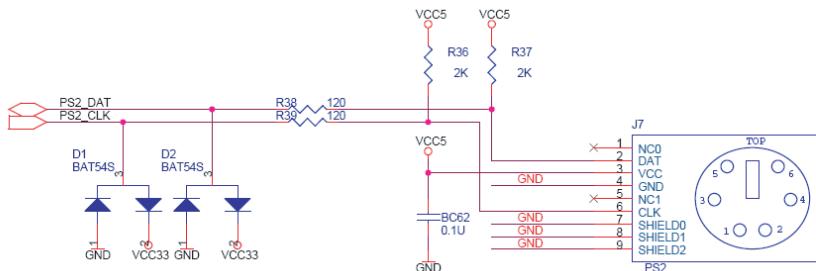
Figure 2–27. PS/2 Serial Circuit Schematic Diagram*PS/2 Serial Circuit Pin List*

Table 2–17 lists the FPGA pins assigned to the PS/2 serial circuit.

Table 2–17. PS/2 Serial Circuit FPGA Pin Connections

Signal Name	FPGA Pin	Description
PS2_CLK	PIN_H15	PS/2 Clock
PS2_DAT	PIN_J14	PS/2 Data

VGA Video Port

The Cyclone II FPGA Starter board includes a video connector ([Figure 2–28](#)) that connects to an on-board 4-bit video DAC. The connector is a standard DB15 15-pin analog VGA connector. Refer to “[VGA DAC](#)” on page [2–2](#) for a description of the circuitry attached to this connector.

Figure 2–28. VGA Connector



Audio Ports

The audio circuit provides the following ports ([Figure 2–29](#)):

- Microphone-in, MIC
- Line-in, LINEIN
- Line-out, LINEOUT

These are standard analog audio connectors. Refer to “[Audio CODEC](#)” on page [2–5](#) for a description of the circuitry attached to these connectors.

Figure 2–29. Audio Connectors



SMA External Clock Connector

An external clock input (Figure 2–30) is available to drive different clock frequencies into the FPGA. The input is a standard SMA coaxial cable connector (J5). Refer to “Clock Circuit” on page 2–13 for a description of the circuitry attached to this connector.

Figure 2–30. SMA Connector for External Clock Input



Power Supply Connector

The Cyclone II FPGA Starter board receives its power from either the USB port directly or the included 7.5V power adapter, which plugs into power connector J8 (Figure 2–31).

Figure 2-31. Power Supply Connector



