



Cyclone V E FPGA Development Board

Reference Manual



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This document describes the hardware features of the Cyclone® V E FPGA development board, including the detailed pin-out and component reference information required to create custom FPGA designs that interface with all components of the board.

General Description

The Cyclone V E FPGA development board provides a hardware platform for developing and prototyping low-power, high-performance, and logic-intensive designs using Altera's Cyclone V E FPGA. The board provides a wide range of peripherals and memory interfaces to facilitate the development of Cyclone V E FPGA designs.

One high-speed mezzanine card (HSMC) connector is available to add additional functionality via a variety of HSMCs available from Altera® and various partners.

- To see a list of the latest HSMCs available or to download a copy of the HSMC specification, refer to the [Development Board Daughtercards](#) page of the Altera website.

Design advancements and innovations, such as partial reconfiguration, ensure that designs implemented in the Cyclone V E FPGAs operate faster, with lower power, and have a faster time to market than previous FPGA families.

- For more information on the following topics, refer to the respective documents:
 - Cyclone V device family, refer to the *Cyclone V Device Handbook*.
 - HSMC Specification, refer to the *High Speed Mezzanine Card (HSMC) Specification*.

Board Component Blocks

The development board features the following major component blocks:

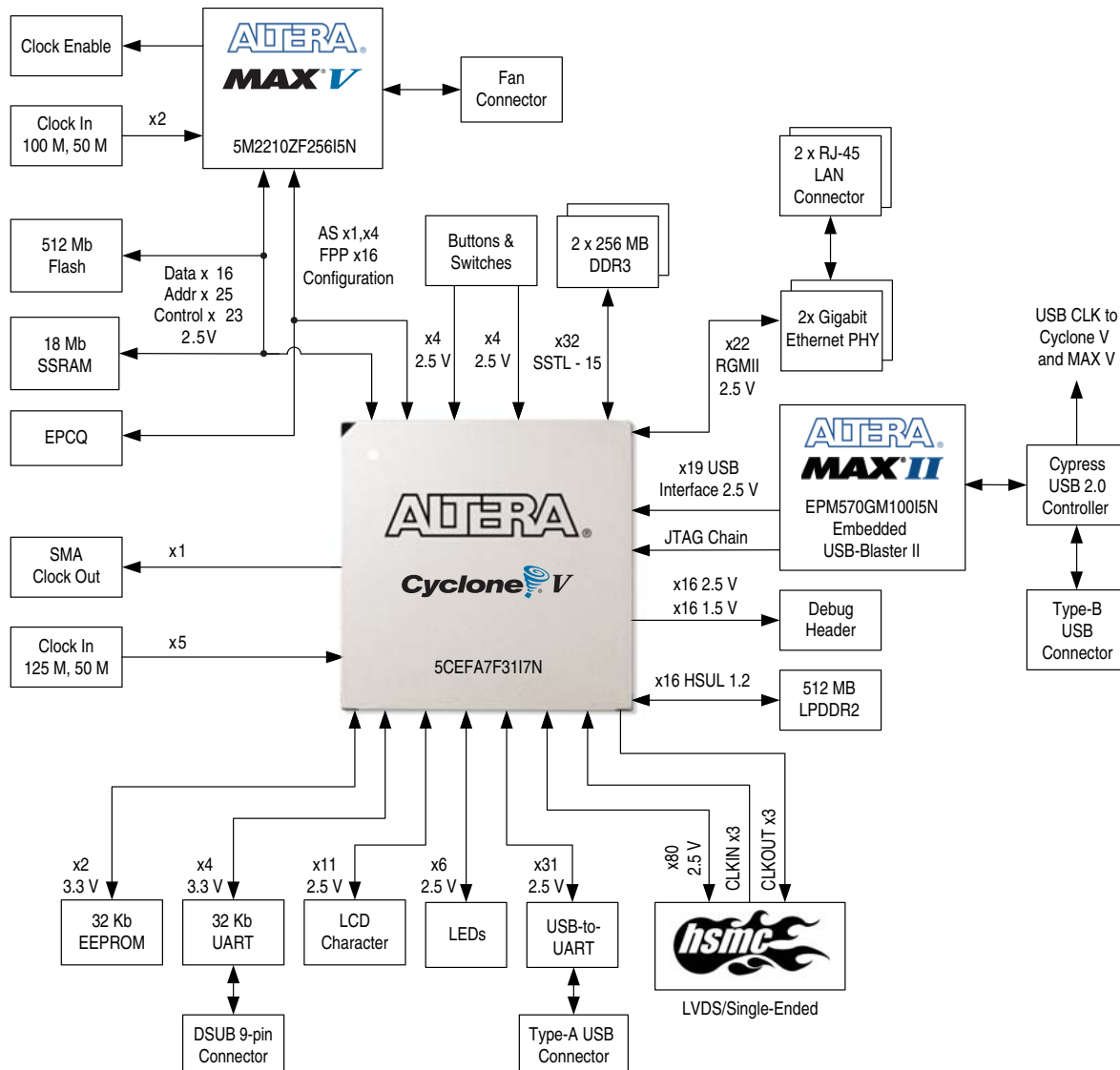
- One Cyclone V E FPGA (5CEFA7F31I7N) in a 896-pin FineLine BGA (FBGA) package
 - 149,500 LEs
 - 56,480 adaptive logic modules (ALMs)
 - 6,860 Kbit (Kb) M10K and 836 Kb MLAB memory
 - Seven fractional phase locked loops (PLLs)
 - 312 18x18-bit multipliers
 - 480 general purpose input/output (GPIO)
 - 1.1-V core voltage
- FPGA configuration circuitry
 - Active Serial (AS) x1 or AS x4 configuration (EPCQ256SI16N)
 - MAX[®] V CPLD (5M2210ZF256I5N) in a 256-pin FBGA package as the System Controller
 - Flash fast passive parallel (FPP) configuration
 - MAX II CPLD (EPM240M100I5N) in a 100-pin FBGA package as part of the embedded USB-Blaster[™] II for use with the Quartus[®] II Programmer
- Clocking circuitry
 - Programmable clock generator for the FPGA reference clock input
 - 50-MHz single-ended oscillator for the FPGA and MAX V CPLD clock input
 - 100-MHz single-ended oscillator for the MAX V CPLD configuration clock input
 - SMA input (LVDS)
- Memory
 - Two 256-Mbyte (MB) DDR3 SDRAM devices with a 16-bit data bus
 - One 18-Mbit (Mb) SSRAM
 - One 512-Mb synchronous flash
 - One 512-MB LPDDR2 SDRAM with a 32-bit data bus (only 16-bit data bus is used on this board)
 - One 64-Kb I²C serial electrically erasable PROM (EEPROM)

- General user input/output
 - LEDs and displays
 - Four user LEDs
 - One configuration load LED
 - One configuration done LED
 - One error LED
 - Three configuration select LEDs
 - Four embedded USB-Blaster II status LEDs
 - Three HSMC interface LEDs
 - Ten Ethernet LEDs
 - Two UART data transmit and receive LEDs
 - Two USB-UART interface TX / RX LEDs
 - One power on LED
 - One two-line character LCD display
 - Push buttons
 - One CPU reset push button
 - One MAX V reset push button
 - One program select push button
 - One program configuration push button
 - Four general user push buttons
 - DIP switches
 - Four MAX V CPLD System Controller control switches
 - Two JTAG chain control DIP switches
 - One fan control DIP switch
 - Four general user DIP switches
- Power supply
 - 14–20-V (laptop) DC input
- Mechanical
 - 6.5" x 4.5" size board

Development Board Block Diagram

Figure 1-1 shows a block diagram of the Cyclone V E FPGA development board.

Figure 1-1. Cyclone V E FPGA Development Board Block Diagram



Handling the Board

When handling the board, it is important to observe the following static discharge precaution:



Without proper anti-static handling, the board can be damaged. Therefore, use anti-static handling precautions when touching the board.

This chapter introduces the major components on the Cyclone V E FPGA development board. [Figure 2-1](#) illustrates the component locations and [Table 2-1](#) provides a brief description of all component features of the board.



A complete set of schematics, a physical layout database, and GERBER files for the development board reside in the Cyclone V E FPGA development kit documents directory.



For information about powering up the board and installing the demonstration software, refer to the *Cyclone V E FPGA Development Kit User Guide*.

This chapter consists of the following sections:

- “Board Overview”
- “Featured Device: Cyclone V E FPGA” on page 2-4
- “MAX V CPLD 5M2210 System Controller” on page 2-5
- “FPGA Configuration” on page 2-10
- “Clock Circuitry” on page 2-18
- “General User Input/Output” on page 2-20
- “Components and Interfaces” on page 2-24
- “Memory” on page 2-32
- “Power Supply” on page 2-41

Board Overview

This section provides an overview of the Cyclone V E FPGA development board, including an annotated board image and component descriptions. Figure 2-1 shows an overview of the board features.

Figure 2-1. Overview of the Cyclone V E FPGA Development Board Features

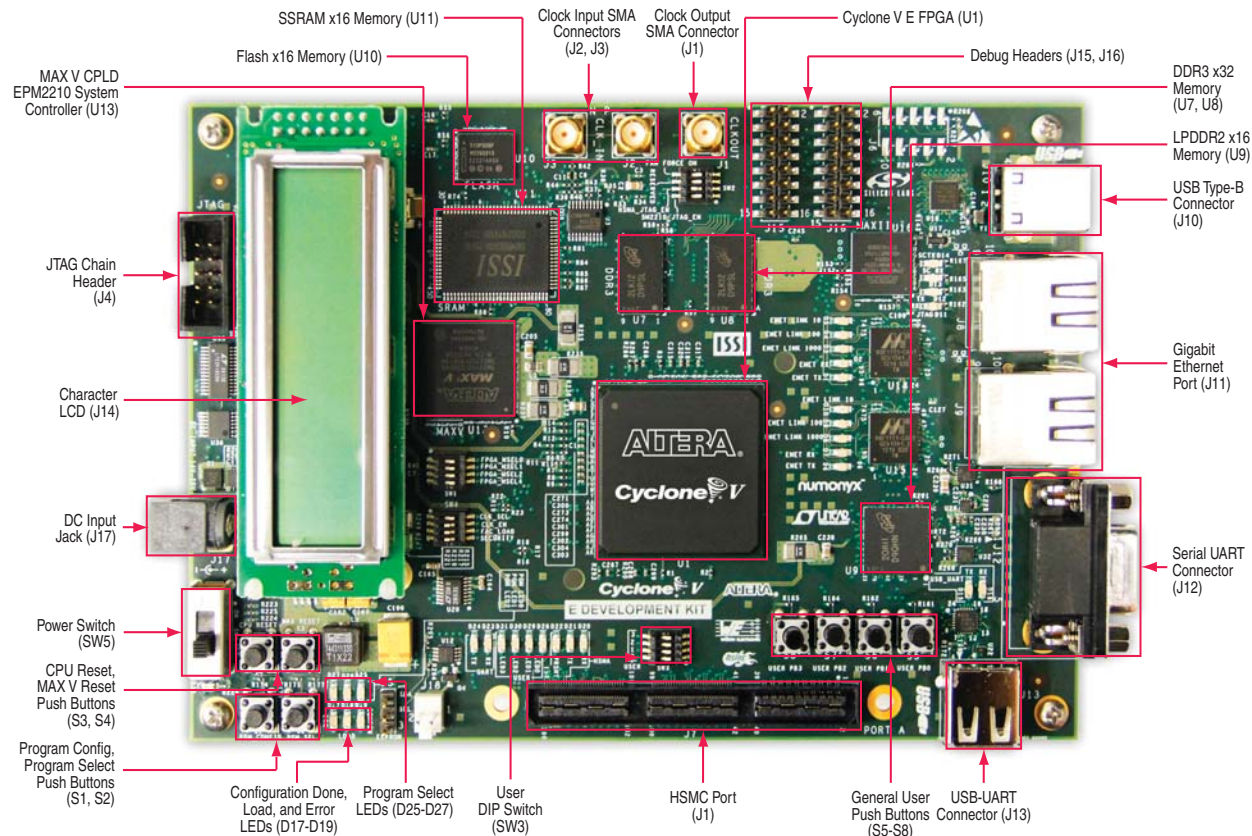


Table 2-1 describes the components and lists their corresponding board references.

Table 2-1. Board Components (Part 1 of 3)

Board Reference	Type	Description
Featured Devices		
U1	FPGA	Cyclone V E FPGA, 5CEFA7F3117N, 896-pin FBGA.
U13	CPLD	MAX V CPLD, 5M2210ZF25615N, 256-pin FBGA.
Configuration, Status, and Setup Elements		
J4	JTAG chain header	Provides access to the JTAG chain and disables the embedded USB-Blaster II when using an external USB-Blaster cable.
SW2	JTAG chain control DIP switch	Remove or include devices in the active JTAG chain.
J10	USB type-B connector	USB interface for FPGA programming and debugging through the embedded USB-Blaster II JTAG via a type-B USB cable.

Table 2-1. Board Components (Part 2 of 3)

Board Reference	Type	Description
SW3	Board settings DIP switch	Controls the MAX V CPLD 5M2210 System Controller functions such as clock enable, SMA clock input control, and which image to load from flash memory at power-up.
SW1	MSEL DIP switch	Controls the configuration scheme on the board. MSEL pins 0, 1, 2 and 4 connects to the DIP switch while MSEL pin 3 connects to ground.
S2	Program select push button	Toggles the program select LEDs, which selects the program image that loads from flash memory to the FPGA.
S1	Program configuration push button	Load image from flash memory to the FGPA based on the settings of the program select LEDs.
D19	Configuration done LED	Illuminates when the FPGA is configured.
D18	Load LED	Illuminates when the MAX V CPLD 5M2210 System Controller is actively configuring the FPGA.
D17	Error LED	Illuminates when the FPGA configuration from flash memory fails.
D35	Power LED	Illuminates when 5.0-V power is present.
D25~D27	Program select LEDs	Illuminates to show the LED sequence that determines which flash memory image loads to the FPGA when you press the program select push button. Refer to Table 2-6 for the LED settings.
D1~D10	Ethernet LEDs	Illuminates to show the connection speed as well as transmit or receive activity.
D20, D21	HSMC port LEDs	You can configure these LEDs to indicate transmit or receive activity.
D22	HSMC port present LED	Illuminates when a daughter card is plugged into the HSMC port.
D15, D16	USB-UART LEDs	Illuminates when the USB-UART transmitter and receiver are in use.
D23, D24	Serial UART LEDs	Illuminates when UART transmitter and receiver are in use.
Clock Circuitry		
X1	Programmable oscillator	Programmable oscillator with default frequencies of 125 MHz. The frequency is programmable using the clock control GUI running on the MAX V CPLD 5M2210 System Controller.
U4	50-MHz oscillator	50.000-MHz crystal oscillator for general purpose logic.
X3	100-MHz oscillator	100.000-MHz crystal oscillator for the MAX V CPLD 5M2210 System Controller.
J2, J3	Clock input SMA connectors	Drive LVDS-compatible clock inputs into the clock multiplexer buffer.
J4	Clock output SMA connector	Drive out 2.5-V CMOS clock output from the FPGA.
General User Input/Output		
D28~D31	User LEDs	Four user LEDs. Illuminates when driven low.
SW3	User DIP switch	Quad user DIP switches. When the switch is ON, a logic 0 is selected.
S4	CPU reset push button	Reset the FPGA logic.
S3	MAX V reset push button	Reset the MAX V CPLD 5M2210 System Controller.
S5~S8	General user push buttons	Four user push buttons. Driven low when pressed.
Memory Devices		
U7, U8	DDR3 x32 memory	Two 256-MB DDR3 SDRAM with a 16-bit data bus.
U9	LPDDR2 x 16 memory	512-MB LPDDR 2 SDRAM with 32-bit bus, only 16-bit bus is used on this board.

Table 2-1. Board Components (Part 3 of 3)

Board Reference	Type	Description
U10	Flash x16 memory	512-Mb synchronous flash devices with a 16-bit data bus for non-volatile memory.
U11	SSRAM x16 memory	18-Mb standard synchronous RAM with a 12-bit data bus and 4-bit parity.
U12	EEPROM	64-Mb I ² C serial EEPROM.
Communication Ports		
J1	HSMC port	Provides 84 CMOS or 17 LVDS channels per HSMC specification.
J11	Gigabit Ethernet port	RJ-45 connector which provides a 10/100/1000 Ethernet connection via a Marvell 88E1111 PHY and the FPGA-based Altera Triple Speed Ethernet MegaCore function in RGMII mode.
J12	Serial UART port	DSUB 9-pin connector with RS-232 transceiver to implement RS-232 serial UART channel.
J13	USB-UART port	USB connector with USB-to-UART bridge for serial UART interface.
J15, J16	Debug headers	Two 2×8 headers for debug purposes.
Video and Display Ports		
J14	Character LCD	Connector that interfaces to a provided 16 character × 2 line LCD module along with two standoffs.
Power Supply		
J17	DC input jack	Accepts a 14–20-V DC power supply.
SW5	Power switch	Switch to power on or off the board when power is supplied from the DC input jack.

Featured Device: Cyclone V E FPGA

The Cyclone V E FPGA development board features a Cyclone V E FPGA 5CEFA7F31I7N device (U1) in a 896-pin FBGA package.



For more information about Cyclone V device family, refer to the [Cyclone V Device Handbook](#).

[Table 2-2](#) describes the features of the Cyclone V E FPGA 5CEFA7F31I7N device.

Table 2-2. Cyclone V E FPGA Features

ALMs	Equivalent LEs	M10K RAM Blocks	Total RAM (Kbits)	18-bit × 18-bit Multipliers	PLLs	Package Type
56,480	149,500	6,860	836	312	7	896-pin FBGA

I/O Resources

The Cyclone V E FPGA 5CEFA7F31I7N device has total of 480 user I/Os. [Table 2-3](#) lists the Cyclone V E FPGA I/O pin count and usage by function on the board.

Table 2-3. Cyclone V E FPGA I/O Pin Count

Function	I/O Standard	I/O Count	Special Pins
DDR3	1.5-V SSTL	71	One differential x4 DQS pin
LPDDR2	1.2-V HSUL	37	One differential x2 DQS pin
Flash, SSRAM, EEPROM, and MAX V FSM bus	2.5-V CMOS, 3.3-V LVCMOS	69	—
HSMC port	2.5-V CMOS + LVDS	79	17 LVDS, I ² C
Gigabit Ethernet port	2.5-V CMOS	42	—
Embedded USB-Blaster II	2.5-V CMOS	20	—
Debug Header	1.5-V, 2.5-V	20	—
UART	3.3-V LVTTTL	4	—
USB-UART	2.5-V CMOS	12	—
Push buttons	2.5-V CMOS	5	One DEV_CLRn pin
DIP switches	2.5-V CMOS	4	—
Character LCD	2.5-V CMOS	11	—
LEDs	2.5-V CMOS	9	—
Clock or Oscillators	2.5-V CMOS + LVDS	12	One clock out pin
Total I/O Used:		395	

MAX V CPLD 5M2210 System Controller

The board utilizes the 5M2210 System Controller, an Altera MAX V CPLD, for the following purposes:

- FPGA configuration from flash
- Power measurement
- Control and status registers for remote system update

Figure 2–2 illustrates the MAX V CPLD 5M2210 System Controller's functionality and external circuit connections as a block diagram.

Figure 2–2. MAX V CPLD 5M2210 System Controller Block Diagram

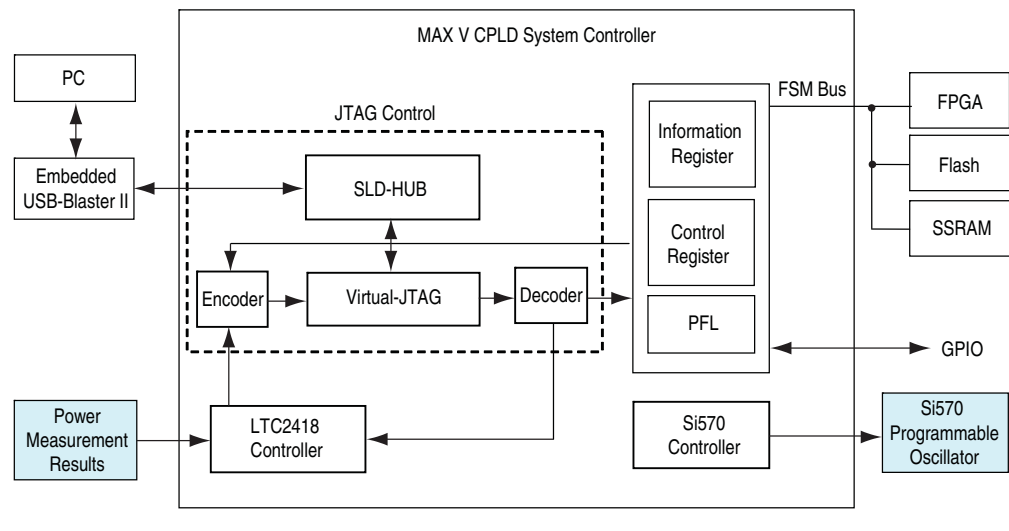


Table 2–4 lists the I/O signals present on the MAX V CPLD 5M2210 System Controller. The signal names and functions are relative to the MAX V device.


 You can download an example design with pin locations and assignments completed according to the following table from the [Altera Design Store](#). In the Cyclone V E FPGA Development Kit, under **Design Examples**, click **Cyclone V E FPGA Development Kit Baseline Pinout**.

Table 2–4. MAX V CPLD 5M2210 System Controller Device Pin-Out (Part 1 of 5)

Board Reference (U13)	Schematic Signal Name	I/O Standard	Description
N4	5M2210_JTAG_TMS	3.3-V	MAX V JTAG TMS
E9	CLK50_EN	2.5-V	50 MHz oscillator enable
H12	CLK_CONFIG	2.5-V	100 MHz configuration clock input
A15	CLK_ENABLE	2.5-V	DIP switch for clock oscillator enable
A13	CLK_SEL	2.5-V	DIP switch for clock select—SMA or oscillator
J12	CLKIN_50_MAXV	2.5-V	50 MHz clock input
D9	CLOCK_SCL	2.5-V	Programmable oscillator I ² C clock
C9	CLOCK_SDA	2.5-V	Programmable oscillator I ² C data
D10	CPU_RESETN	2.5-V	FPGA reset push button
P12	EXTRA_SIG0	2.5-V	Embedded USB-Blaster II interface. Reserved for future use
T13	EXTRA_SIG1	2.5-V	Embedded USB-Blaster II interface. Reserved for future use
T15	EXTRA_SIG2	2.5-V	Embedded USB-Blaster II interface. Reserved for future use
A2	FACTORY_LOAD	2.5-V	DIP switch to load factory or user design at power-up

Table 2-4. MAX V CPLD 5M2210 System Controller Device Pin-Out (Part 2 of 5)

Board Reference (U13)	Schematic Signal Name	I/O Standard	Description
R14	FACTORY_REQUEST	2.5-V	Embedded USB-Blaster II request to send FACTORY command
N12	FACTORY_STATUS	2.5-V	Embedded USB-Blaster II FACTORY command status
C8	FAN_FORCE_ON	2.5-V	DIP switch to on or off the fan
N7	FLASH_ADVN	2.5-V	FSM bus flash memory address valid
R5	FLASH_CEN	2.5-V	FSM bus flash memory chip enable
R6	FLASH_CLK	2.5-V	FSM bus flash memory clock
M6	FLASH_OEN	2.5-V	FSM bus flash memory output enable
T5	FLASH_RDYBSYN	2.5-V	FSM bus flash memory ready
P7	FLASH_RESETN	2.5-V	FSM bus flash memory reset
N6	FLASH_WEN	2.5-V	FSM bus flash memory write enable
K1	FPGA_CONF_DONE	3.3-V	FPGA configuration done LED
D3	FPGA_CONFIG_D0	3.3-V	FPGA configuration data
C2	FPGA_CONFIG_D1	3.3-V	FPGA configuration data
C3	FPGA_CONFIG_D2	3.3-V	FPGA configuration data
E3	FPGA_CONFIG_D3	3.3-V	FPGA configuration data
D2	FPGA_CONFIG_D4	3.3-V	FPGA configuration data
E4	FPGA_CONFIG_D5	3.3-V	FPGA configuration data
D1	FPGA_CONFIG_D6	3.3-V	FPGA configuration data
E5	FPGA_CONFIG_D7	3.3-V	FPGA configuration data
F3	FPGA_CONFIG_D8	3.3-V	FPGA configuration data
E1	FPGA_CONFIG_D9	3.3-V	FPGA configuration data
F4	FPGA_CONFIG_D10	3.3-V	FPGA configuration data
F2	FPGA_CONFIG_D11	3.3-V	FPGA configuration data
F1	FPGA_CONFIG_D12	3.3-V	FPGA configuration data
F6	FPGA_CONFIG_D13	3.3-V	FPGA configuration data
G2	FPGA_CONFIG_D14	3.3-V	FPGA configuration data
G3	FPGA_CONFIG_D15	3.3-V	FPGA configuration data
K4	FPGA_MAX_DCLK	3.3-V	FPGA configuration clock
J3	FPGA_DCLK	3.3-V	FPGA configuration clock
N1	FPGA_NCONFIG	3.3-V	FPGA configuration active
J4	FPGA_NSTATUS	3.3-V	FPGA configuration ready
H1	FPGA_PR_DONE	3.3-V	FPGA partial reconfiguration done
P2	FPGA_PR_ERROR	3.3-V	FPGA partial reconfiguration error
E2	FPGA_PR_READY	3.3-V	FPGA partial reconfiguration ready
F5	FPGA_PR_REQUEST	3.3-V	FPGA partial reconfiguration request
L5	FPGA_MAX_NCS	3.3-V	FPGA configuration chip select
E14	FSM_A1	2.5-V	FSM address bus
C14	FSM_A2	2.5-V	FSM address bus

Table 2-4. MAX V CPLD 5M2210 System Controller Device Pin-Out (Part 3 of 5)

Board Reference (U13)	Schematic Signal Name	I/O Standard	Description
C15	FSM_A3	2.5-V	FSM address bus
E13	FSM_A4	2.5-V	FSM address bus
E12	FSM_A5	2.5-V	FSM address bus
D15	FSM_A6	2.5-V	FSM address bus
F14	FSM_A7	2.5-V	FSM address bus
D16	FSM_A8	2.5-V	FSM address bus
F13	FSM_A9	2.5-V	FSM address bus
E15	FSM_A10	2.5-V	FSM address bus
E16	FSM_A11	2.5-V	FSM address bus
F15	FSM_A12	2.5-V	FSM address bus
G14	FSM_A13	2.5-V	FSM address bus
F16	FSM_A14	2.5-V	FSM address bus
G13	FSM_A15	2.5-V	FSM address bus
G15	FSM_A16	2.5-V	FSM address bus
G12	FSM_A17	2.5-V	FSM address bus
G16	FSM_A18	2.5-V	FSM address bus
H14	FSM_A19	2.5-V	FSM address bus
H20	FSM_A20	2.5-V	FSM address bus
H13	FSM_A21	2.5-V	FSM address bus
H16	FSM_A22	2.5-V	FSM address bus
J13	FSM_A23	2.5-V	FSM address bus
J16	FSM_A24	2.5-V	FSM address bus
T2	FSM_A25	2.5-V	FSM address bus
P5	FSM_A26	2.5-V	FSM address bus
J14	FSM_D0	2.5-V	FSM data bus
J15	FSM_D1	2.5-V	FSM data bus
K16	FSM_D2	2.5-V	FSM data bus
K13	FSM_D3	2.5-V	FSM data bus
K15	FSM_D4	2.5-V	FSM data bus
K14	FSM_D5	2.5-V	FSM data bus
L16	FSM_D6	2.5-V	FSM data bus
L11	FSM_D7	2.5-V	FSM data bus
L15	FSM_D8	2.5-V	FSM data bus
L12	FSM_D9	2.5-V	FSM data bus
M16	FSM_D10	2.5-V	FSM data bus
L13	FSM_D11	2.5-V	FSM data bus
M15	FSM_D12	2.5-V	FSM data bus
L14	FSM_D13	2.5-V	FSM data bus
N16	FSM_D14	2.5-V	FSM data bus

Table 2-4. MAX V CPLD 5M2210 System Controller Device Pin-Out (Part 4 of 5)

Board Reference (U13)	Schematic Signal Name	I/O Standard	Description
M13	FSM_D15	2.5-V	FSM data bus
B8	HSMA_PRSNTN	2.5-V	HSMC port present
L6	JTAG_5M2210_TDI	3.3-V	MAX V CPLD JTAG chain data in
M5	JTAG_5M2210_TDO	3.3-V	MAX V CPLD JTAG chain data out
P3	JTAG_TCK	3.3-V	JTAG chain clock
P11	M570_CLOCK	2.5-V	25-MHz clock to embedded USB-Blaster II for sending FACTORY command
M1	M570_JTAG_EN	3.3-V	Low signal to disable the embedded USB-Blaster II
P10	MAX5_BEN0	2.5-V	FSM bus MAX V byte enable 0
R11	MAX5_BEN1	2.5-V	FSM bus MAX V byte enable 1
T12	MAX5_BEN2	2.5-V	FSM bus MAX V byte enable 2
N11	MAX5_BEN3	2.5-V	FSM bus MAX V byte enable 3
T11	MAX5_CLK	2.5-V	FSM bus MAX V clock
R10	MAX5_CSN	2.5-V	FSM bus MAX V chip select
M10	MAX5_OEN	2.5-V	FSM bus MAX V output enable
N10	MAX5_WEN	2.5-V	FSM bus MAX V write enable
E11	MAX_CONF_DONEN	2.5-V	Embedded USB-Blaster II configuration done LED
A4	MAX_ERROR	2.5-V	FPGA configuration error LED
A6	MAX_LOAD	2.5-V	FPGA configuration active LED
M9	MAX_RESETN	2.5-V	MAX V reset push button
B7	OVERTEMP	2.5-V	Temperature monitor fan enable
D12	PGM_CONFIG	2.5-V	Load the flash memory image identified by the PGM LEDs
B14	PGM_LED0	2.5-V	Flash memory PGM select indicator 0
C13	PGM_LED1	2.5-V	Flash memory PGM select indicator 1
B16	PGM_LED2	2.5-V	Flash memory PGM select indicator 2
B13	PGM_SEL	2.5-V	Toggles the PGM_LED[2:0] LED sequence
H4	PSAS_CS _n	3.3-V	AS configuration chip select
G1	PSAS_DCLK	3.3-V	AS configuration clock
G4	PSAS_CONF_DONE	3.3-V	AS configuration done
H2	PSAS_CONFIG _n	3.3-V	AS configuration active
G5	PSAS_DATA1	3.3-V	AS configuration data
H3	PSAS_DATA0_ASD0	3.3-V	AS configuration data
J1	PSAS_CEn	3.3-V	AS configuration chip enable
R12	SECURITY_MODE	2.5-V	DIP switch for the embedded USB-Blaster II to send FACTORY command at power up
E7	SENSE_CS _{0N}	2.5-V	Power monitor chip select
A5	SENSE_SCK	2.5-V	Power monitor SPI clock
D7	SENSE_SDI	2.5-V	Power monitor SPI data in
B6	SENSE_SDO	2.5-V	Power monitor SPI data out

Table 2-4. MAX V CPLD 5M2210 System Controller Device Pin-Out (Part 5 of 5)

Board Reference (U13)	Schematic Signal Name	I/O Standard	Description
A9	SI570_EN	2.5-V	Si570 programmable XO enable
R4	USB_CFG0	2.5-V	Embedded USB-Blaster II interface. Reserved for future use
T4	USB_CFG1	2.5-V	Embedded USB-Blaster II interface. Reserved for future use
P8	USB_CFG2	2.5-V	Embedded USB-Blaster II interface. Reserved for future use
T7	USB_CFG3	2.5-V	Embedded USB-Blaster II interface. Reserved for future use
N8	USB_CFG4	2.5-V	Embedded USB-Blaster II interface. Reserved for future use
R8	USB_CFG5	2.5-V	Embedded USB-Blaster II interface. Reserved for future use
T8	USB_CFG6	2.5-V	Embedded USB-Blaster II interface. Reserved for future use
T9	USB_CFG7	2.5-V	Embedded USB-Blaster II interface. Reserved for future use
R9	USB_CFG8	2.5-V	Embedded USB-Blaster II interface. Reserved for future use
P9	USB_CFG9	2.5-V	Embedded USB-Blaster II interface. Reserved for future use
M8	USB_CFG10	2.5-V	Embedded USB-Blaster II interface. Reserved for future use
T10	USB_CFG11	2.5-V	Embedded USB-Blaster II interface. Reserved for future use
H5	USB_CLK	3.3-V	Embedded USB-Blaster II interface clock

FPGA Configuration

This section describes the FPGA, flash memory, and MAX V CPLD 5M2210 System Controller device programming methods supported by the Cyclone V E FPGA development board.

The Cyclone V E FPGA development board supports the following configuration methods:

- Embedded USB-Blaster II is the default method for configuring the FPGA using the Quartus II Programmer in JTAG mode with the supplied USB cable.
- Flash memory download for configuring the FPGA using stored images from the flash memory on either power-up or pressing the program configuration push button (S1).
- External USB-Blaster for configuring the FPGA using an external USB-Blaster that connects to the JTAG chain header (J4).
- EPCQ device for serial or quad-serial FPGA configuration that supports AS x1 or AS x4 configuration schemes.

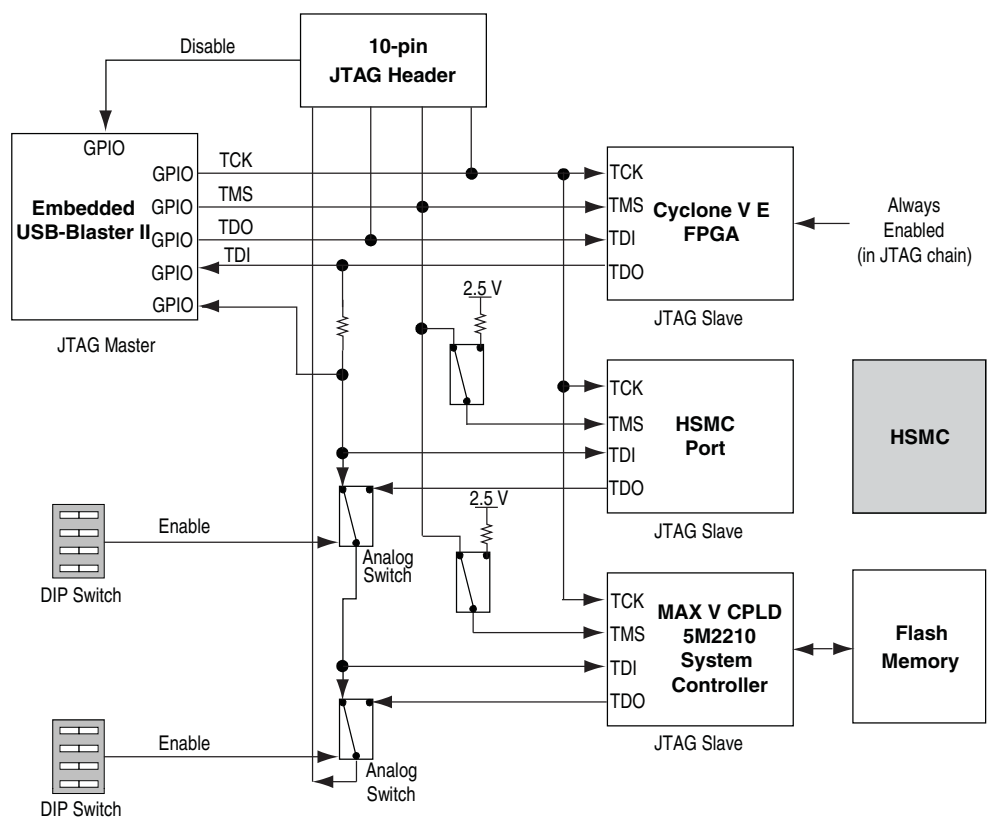
FPGA Programming over Embedded USB-Blaster II

This configuration method implements a USB type-B connector (J10), a USB 2.0 PHY device (U18), and an Altera MAX II CPLD EPM570GF100I5N (U16) to allow FPGA configuration using a USB cable. This USB cable connects directly between the USB type-B connector on the board and a USB port of a PC running the Quartus II software.

The embedded USB-Blaster II in the MAX II CPLD EPM570GF100I5N normally masters the JTAG chain.

Figure 2-3 illustrates the JTAG chain.

Figure 2-3. JTAG Chain



The JTAG chain control DIP switch (SW2) controls the jumpers shown in Figure 2-3. To connect a device or interface in the chain, their corresponding switch must be in the OFF position. Slide all the switches to the ON position to only have the FPGA in the chain.


 The MAX V CPLD 5M2210 System Controller must be in the JTAG chain to use some of the GUI interfaces.

Table 2-5 lists the USB 2.0 PHY schematic signal names and their corresponding Cyclone V E FPGA pin numbers.

Table 2-5. USB 2.0 PHY Schematic Signal Names and Functions (Part 1 of 2)

Board Reference (U18)	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard	Description
C1	24M_XTALIN	—	3.3-V	Crystal oscillator input
C2	24M_XTALOUT	—	3.3-V	Crystal oscillator output
E1	FX2_D_N	—	3.3-V	USB 2.0 PHY data
E2	FX2_D_P	—	3.3-V	USB 2.0 PHY data
H7	FX2_FLAGA	—	3.3-V	Slave FIFO output status

Table 2-5. USB 2.0 PHY Schematic Signal Names and Functions (Part 2 of 2)


Board Reference (U18)	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard	Description
G7	FX2_FLAGB	—	3.3-V	Slave FIFO output status
H8	FX2_FLAGC	—	3.3-V	Slave FIFO output status
G6	FX2_PA1	—	3.3-V	USB 2.0 PHY port A interface
F8	FX2_PA2	—	3.3-V	USB 2.0 PHY port A interface
F7	FX2_PA3	—	3.3-V	USB 2.0 PHY port A interface
F6	FX2_PA4	—	3.3-V	USB 2.0 PHY port A interface
C8	FX2_PA5	—	3.3-V	USB 2.0 PHY port A interface
C7	FX2_PA6	—	3.3-V	USB 2.0 PHY port A interface
C6	FX2_PA7	—	3.3-V	USB 2.0 PHY port A interface
H3	FX2_PB0	—	3.3-V	USB 2.0 PHY port B interface
F4	FX2_PB1	—	3.3-V	USB 2.0 PHY port B interface
H4	FX2_PB2	—	3.3-V	USB 2.0 PHY port B interface
G4	FX2_PB3	—	3.3-V	USB 2.0 PHY port B interface
H5	FX2_PB4	—	3.3-V	USB 2.0 PHY port B interface
G5	FX2_PB5	—	3.3-V	USB 2.0 PHY port B interface
F5	FX2_PB6	—	3.3-V	USB 2.0 PHY port B interface
H6	FX2_PB7	—	3.3-V	USB 2.0 PHY port B interface
A8	FX2_PD0	—	3.3-V	USB 2.0 PHY port D interface
A7	FX2_PD1	—	3.3-V	USB 2.0 PHY port D interface
B6	FX2_PD2	—	3.3-V	USB 2.0 PHY port D interface
A6	FX2_PD3	—	3.3-V	USB 2.0 PHY port D interface
B3	FX2_PD4	—	3.3-V	USB 2.0 PHY port D interface
A3	FX2_PD5	—	3.3-V	USB 2.0 PHY port D interface
C3	FX2_PD6	—	3.3-V	USB 2.0 PHY port D interface
A2	FX2_PD7	—	3.3-V	USB 2.0 PHY port D interface
B8	FX2_RESETN	V21	3.3-V	Embedded USB-Blaster hard reset
F3	FX2_SCL	—	3.3-V	USB 2.0 PHY serial clock
G3	FX2_SDA	—	3.3-V	USB 2.0 PHY serial data
A1	FX2_SLRDN	—	3.3-V	Read strobe for slave FIFO
B1	FX2_SLWRN	—	3.3-V	Write strobe for slave FIFO
B7	FX2_WAKEUP	—	3.3-V	USB 2.0 PHY wake signal
G2	USB_CLK	AA23	3.3-V	USB 2.0 PHY 48-MHz interface clock

FPGA Programming from Flash Memory

Flash memory programming is possible through a variety of methods. The default method is to use the factory design—Board Update Portal. This design is an embedded webserver, which serves the Board Update Portal web page. The web page allows you to select new FPGA designs including hardware, software, or both in an industry-standard S-Record File (.flash) and write the design to the user hardware page (page 1) of the flash memory over the network.

The secondary method is to use the pre-built parallel flash loader (PFL) design included in the development kit. The development board implements the Altera PFL megafunction for flash memory programming. The PFL megafunction is a block of logic that is programmed into an Altera programmable logic device (FPGA or CPLD). The PFL functions as a utility for writing to a compatible flash memory device. This pre-built design contains the PFL megafunction that allows you to write either page 0, page 1, or other areas of flash memory over the USB interface using the Quartus II software. This method is used to restore the development board to its factory default settings.

Other methods to program the flash memory can be used as well, including the Nios® II processor.

 For more information on the Nios II processor, refer to the [Nios II Processor](#) page of the Altera website.

On either power-up or by pressing the program configuration push button, PGM_CONFIG (S1), the MAX V CPLD 5M2210 System Controller's PFL configures the FPGA from the flash memory. The PFL megafunction reads 16-bit data from the flash memory and converts it to fast passive parallel (FPP) format. This 16-bit data is then written to the dedicated configuration pins in the FPGA during configuration.

Pressing the PGM_CONFIG push button (S1) loads the FPGA with a hardware page based on which PGM_LED[2:0] (D25, D26, D27) illuminates. [Table 2-6](#) lists the design that loads when you press the PGM_CONFIG push button.

Table 2-6. PGM_LED Settings ⁽¹⁾

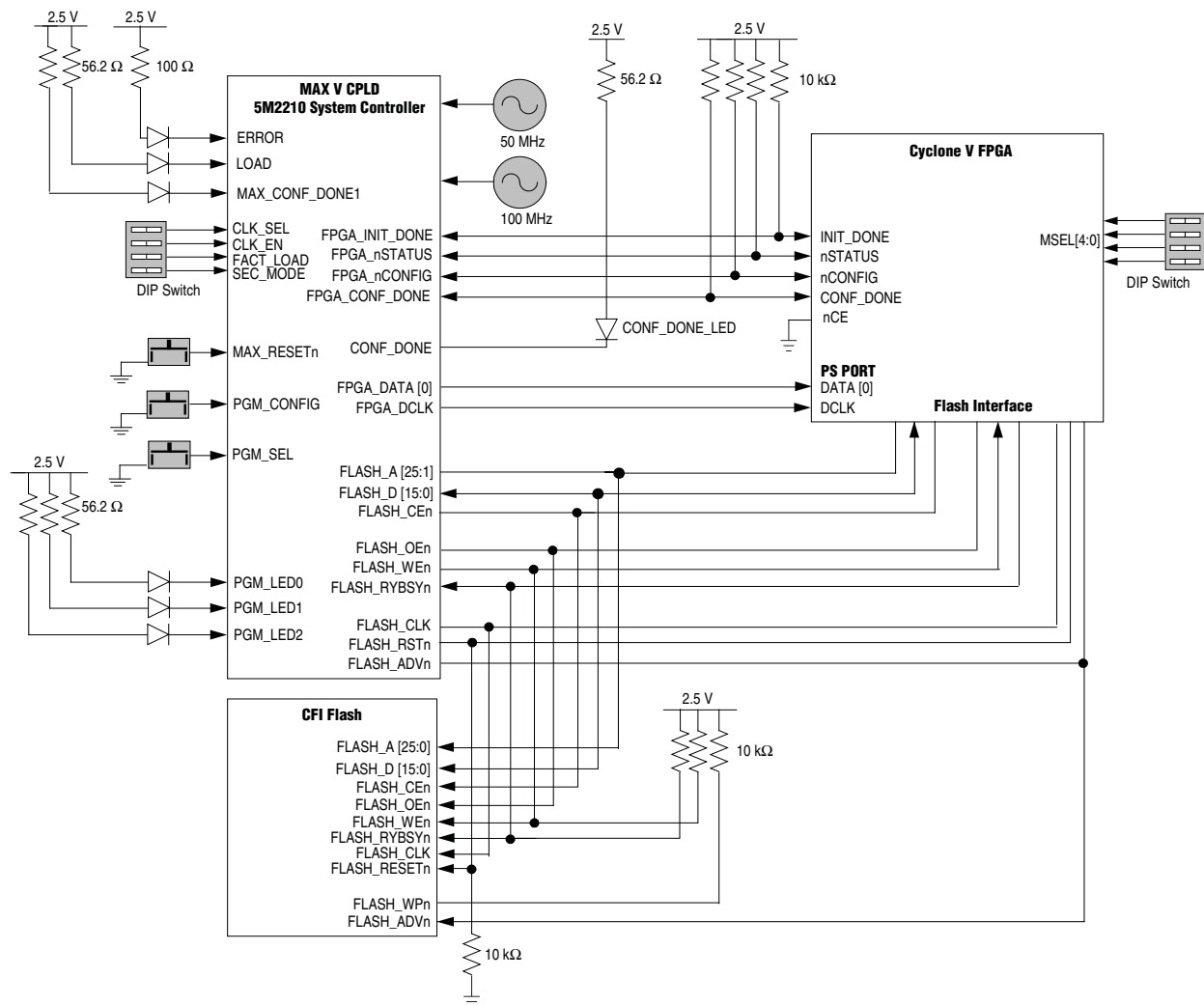
PGM_LED0 (D25)	PGM_LED1 (D26)	PGM_LED2 (D27)	Design
ON	OFF	OFF	Factory hardware
OFF	ON	OFF	User hardware 1
OFF	OFF	ON	User hardware 2

Note to [Table 2-6](#):

(1) ON indicates a setting of '0' while OFF indicates a setting of '1'.

Figure 2-4 shows the PFL configuration.

Figure 2-4. PFL Configuration



For more information on the following topics, refer to the respective documents:

- Board Update Portal, PFL design, and flash memory map storage, refer to the *Cyclone V E FPGA Development Kit User Guide*.
- PFL megafunction, refer to *Parallel Flash Loader Megafunction User Guide*.

FPGA Programming over External USB-Blaster

The JTAG chain header provides another method for configuring the FPGA using an external USB-Blaster device with the Quartus II Programmer running on a PC. To prevent contention between the JTAG masters, the embedded USB-Blaster is automatically disabled when you connect an external USB-Blaster to the JTAG chain through the JTAG chain header.

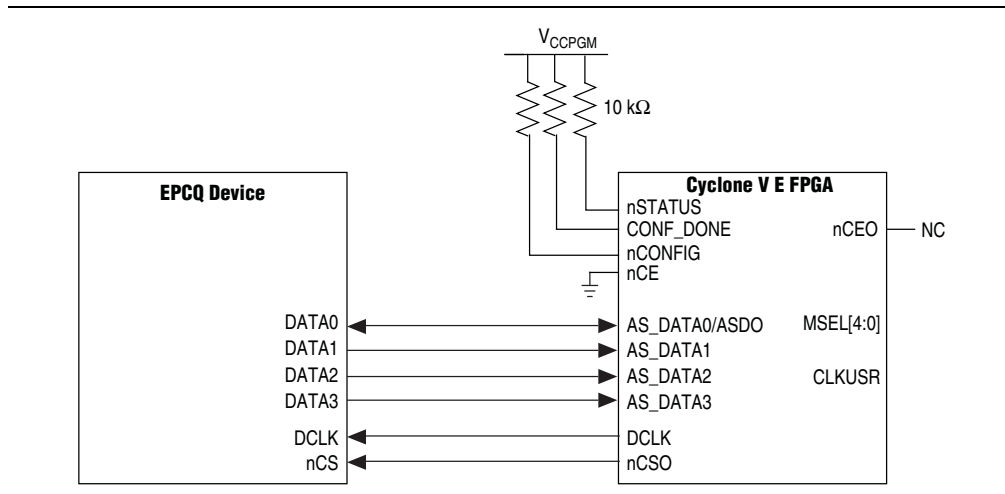
FPGA Programming using EPCQ

The low-cost ECPQ device with non-volatile memory features a simple six-pin interface and a small form factor. The ECPQ supports AS x1 and x4 modes.

By default, this board has a FPP configuration scheme setting. In order to set the configuration scheme to AS mode, resistor rework needs to be done. Configure the MSEL setting using the MSEL DIP switch (SW1) to change the configuration scheme.

Figure 2-5 shows the connection between the EPCQ and the Cyclone V E FPGA.

Figure 2-5. EPCQ Configuration



Status Elements

The development board includes status LEDs. This section describes the status elements.

Table 2-7 lists the LED board references, names, and functional descriptions.

Table 2-7. Board-Specific LEDs (Part 1 of 2)

Board Reference	Schematic Signal Name	I/O Standard	Description
D35	Power	5.0-V	Blue LED. Illuminates when 5.0 V power is active.
D19	MAX_CONF_DONE _n	2.5-V	Green LED. Illuminates when the FPGA is successfully configured. Driven by the MAX V CPLD 5M2210 System Controller.
D17	MAX_ERROR	2.5-V	Red LED. Illuminates when the MAX V CPLD 5M2210 System Controller fails to configure the FPGA. Driven by the MAX V CPLD 5M2210 System Controller.
D18	MAX_LOAD	2.5-V	Green LED. Illuminates when the MAX V CPLD 5M2210 System Controller is actively configuring the FPGA. Driven by the MAX V CPLD 5M2210 System Controller.
D25	PGM_LED [0]	2.5-V	Green LEDs. Illuminates to indicate which hardware page loads from flash memory when you press the PGM_SEL push button.
D26	PGM_LED [1]		
D27	PGM_LED [2]		

Table 2-7. Board-Specific LEDs (Part 2 of 2)

Board Reference	Schematic Signal Name	I/O Standard	Description
D11, D12 D13, D14	JTAG_RX, JTAG_TX SC_RX, SC_TX	2.5-V	Green LEDs. Illuminates to indicate USB-Blaster II receive and transmit activities.
D1	ENETA_LED_TX	2.5-V	Green LED. Illuminates to indicate Ethernet PHY transmit activity. Driven by the Marvell 88E1111 PHY.
D2	ENETA_LED_RX	2.5-V	Green LED. Illuminates to indicate Ethernet PHY receive activity. Driven by the Marvell 88E1111 PHY.
D5	ENETA_LED_LINK10	2.5-V	Green LED. Illuminates to indicate Ethernet linked at 10 Mbps connection speed. Driven by the Marvell 88E1111 PHY.
D4	ENETA_LED_LINK100	2.5-V	Green LED. Illuminates to indicate Ethernet linked at 100 Mbps connection speed. Driven by the Marvell 88E1111 PHY.
D3	ENETA_LED_LINK1000	2.5-V	Green LED. Illuminates to indicate Ethernet linked at 1000 Mbps connection speed. Driven by the Marvell 88E1111 PHY.
D19	ENETB_LED_TX	2.5-V	Green LED. Illuminates to indicate Ethernet PHY B transmit activity. Driven by the Marvell 88E1111 PHY.
D22	ENETB_LED_RX	2.5-V	Green LED. Illuminates to indicate Ethernet PHY B receive activity. Driven by the Marvell 88E1111 PHY.
D24	ENETB_LED_LINK10	2.5-V	Green LED. Illuminates to indicate Ethernet B linked at 10 Mbps connection speed. Driven by the Marvell 88E1111 PHY.
D20	ENETB_LED_LINK100	2.5-V	Green LED. Illuminates to indicate Ethernet B linked at 100 Mbps connection speed. Driven by the Marvell 88E1111 PHY.
D21	ENETB_LED_LINK1000	2.5-V	Green LED. Illuminates to indicate Ethernet B linked at 1000 Mbps connection speed. Driven by the Marvell 88E1111 PHY.
D15, D16	USB_UART_TX_TOGGLE, USB_UART_RX_TOGGLE	2.5-V	Green LED. Illuminates to indicate USB_UART receive and transmit activities.
D23, D24	UART_RXD_LED, UART_TXD_LED	2.5-V	Green LED. Illuminates to indicate UART receive and transmit activities.
D3	HSMA_PRSENTn	3.3-V	Green LED. Illuminates when HSMC port has a board or cable plugged-in such that pin 160 becomes grounded. Driven by the add-in card.

Setup Elements

The development board includes several different kinds of setup elements. This section describes the following setup elements:

- Board settings DIP switch
- JTAG settings DIP switch
- CPU reset push button
- MAX V reset push button
- Program configuration push button
- Program select push button

 For more information about the default settings of the DIP switches, refer to the *Cyclone V E FPGA Development Kit User Guide*.

Board Settings DIP Switch

The board settings DIP switch (SW4) controls various features specific to the board and the MAX V CPLD 5M2210 System Controller logic design. [Table 2-8](#) lists the switch controls and descriptions.

Table 2-8. Board Settings DIP Switch Controls

Switch	Schematic Signal Name	Description
1	CLK_SEL	ON : Select programmable oscillator clock OFF : Select SMA input clock
2	CLK_ENABLE	ON : Disable on-board oscillator OFF : Enable on-board oscillator
3	FACTORY_LOAD	ON : Load the user design from flash at power up OFF : Load the factory design from flash at power up
4	SECURITY_MODE	ON : Embedded USB-Blaster II sends FACTORY command at power up. OFF : Embedded USB-Blaster II does not send FACTORY command at power up.

JTAG Chain Control DIP Switch

The JTAG chain control DIP switch (SW2) either removes or includes devices in the active JTAG chain. The Cyclone V E FPGA is always in the JTAG chain. [Table 2-9](#) lists the switch controls and its descriptions.

Table 2-9. JTAG Chain Control DIP Switch

Switch	Schematic Signal Name	Description
1	5M2210_JTAG_EN	ON : Bypass MAX V CPLD 5M2210 System Controller OFF : MAX V CPLD 5M2210 System Controller in-chain
2	HSMC_JTAG_EN	ON : Bypass HSMC port OFF : HSMC port in-chain
3	FAN_FORCE_ON	ON : Enable fan OFF : Disable fan
4	RESERVED	Reserved

CPU Reset Push Button

The CPU reset push button, CPU_RESETh (S4), is an input to the Cyclone V E FPGA DEV_CLRn pin and is an open-drain I/O from the MAX V CPLD System Controller. This push button is the default reset for both the FPGA and CPLD logic. The MAX V CPLD 5M2210 System Controller also drives this push button during power-on-reset (POR).

MAX V Reset Push Button

The MAX V reset push button, `MAX_RESETEn (S3)`, is an input to the MAX V CPLD 5M2210 System Controller. This push button is the default reset for the CPLD logic.

Program Configuration Push Button

The program configuration push button, `PGM_CONFIG (S1)`, is an input to the MAX V CPLD 5M2210 System Controller. This input forces a FPGA reconfiguration from the flash memory. The location in the flash memory is based on the settings of `PGM_LED [2:0]`, which is controlled by the program select push button, `PGM_SEL`. Valid settings include `PGM_LED0`, `PGM_LED1`, or `PGM_LED2` on the three pages in flash memory reserved for FPGA designs.

Program Select Push Button

The program select push button, `PGM_SEL (S2)`, is an input to the MAX V CPLD 5M2210 System Controller. This push button toggles the `PGM_LED [2:0]` sequence that selects which location in the flash memory is used to configure the FPGA. Refer to [Table 2-6](#) for the `PGM_LED [2:0]` sequence definitions.

Clock Circuitry

This section describes the board's clock inputs and outputs.

On-Board Oscillators

The development board include oscillators with a frequency of 50-MHz, 100-MHz, and a programmable oscillator.

Figure 2-6 shows the default frequencies of all external clocks going to the Cyclone V E FPGA development board.

Figure 2-6. Cyclone V E FPGA Development Board Clocks

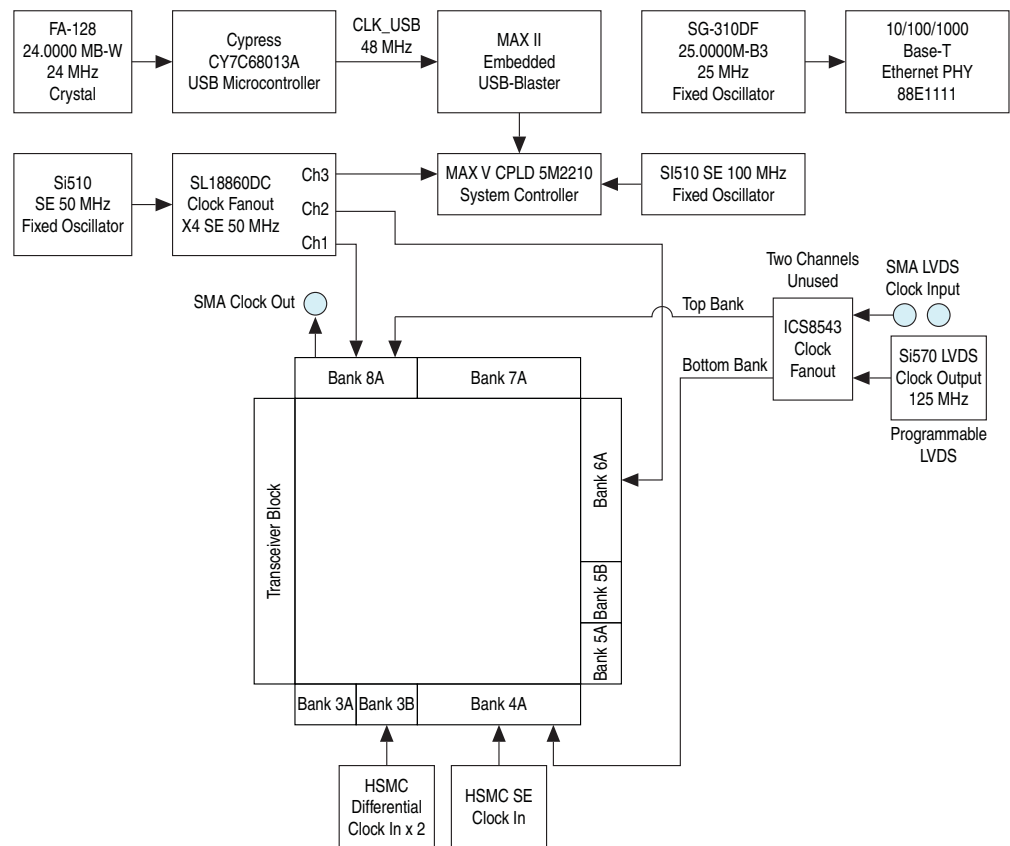


Table 2-10 lists the oscillators, its I/O standard, and voltages required for the development board.

Table 2-10. On-Board Oscillators

Source	Schematic Signal Name	Frequency	I/O Standard	Cyclone V E FPGA Pin Number	Application
U4	CLKIN_50_FPGA_TOP	50.000 MHz	Single-Ended	L14	Top and right edge
	CLKIN_50_FPGA_RIGHT			P22	
X3	CLK_CONFIG	100.000 MHz	2.5V CMOS	—	Fast FPGA configuration
X1 and U3 (buffer)	DIFF_CLKIN_TOP_125_P	125.000 MHz	LVDS	L15	Top and bottom edge
	DIFF_CLKIN_TOP_125_N			K15	
	DIFF_CLKIN_BOT_125_P			AB17	
	DIFF_CLKIN_BOT_125_N			AB18	

Off-Board Clock Input/Output

The development board has input and output clocks which can be driven onto the board. The output clocks can be programmed to different levels and I/O standards according to the FPGA device's specification.

Table 2-11 lists the clock inputs for the development board.

Table 2-11. Off-Board Clock Inputs

Source	Schematic Signal Name	I/O Standard	Cyclone V E FPGA Pin Number	Description
SMA	CLKIN_SMA_P	LVDS	—	Input to LVDS fan-out buffer.
	CLKIN_SMA_N	LVDS	—	
Samtec HSMC	HSMA_CLK_IN0	2.5-V	AB16	Single-ended input from the installed HSMC cable or board.
Samtec HSMC	HSMA_CLK_IN_P1	LVDS/2.5-V	AB14	LVDS input from the installed HSMC cable or board. Can also support 2x LVTTTL inputs.
	HSMA_CLK_IN_N1	LVDS/LVTTTL	AC14	
Samtec HSMC	HSMA_CLK_IN_P2	LVDS/LVTTTL	Y15	LVDS input from the installed HSMC cable or board. Can also support 2x LVTTTL inputs.
	HSMA_CLK_IN_N2	LVDS/LVTTTL	AA15	

Table 2-12 lists the clock outputs for the development board.

Table 2-12. Off-Board Clock Outputs

Source	Schematic Signal Name	I/O Standard	Cyclone V E FPGA Pin Number	Description
Samtec HSMC	HSMA_CLK_OUT0	2.5V CMOS	AJ14	FPGA CMOS output (or GPIO)
Samtec HSMC	HSMA_CLK_OUT_P1	LVDS/2.5V CMOS	AE22	LVDS output. Can also support 2x CMOS outputs.
	HSMA_CLK_OUT_N1	LVDS/2.5V CMOS	AF23	
Samtec HSMC	HSMA_CLK_OUT_P2	LVDS/2.5V CMOS	AG23	LVDS output. Can also support 2x CMOS outputs.
	HSMA_CLK_OUT_N2	LVDS/2.5V CMOS	AH22	
SMA	CLKOUT_SMA	2.5V CMOS	F9	FPGA CMOS output (or GPIO)

General User Input/Output

This section describes the user I/O interface to the FPGA, including the push buttons, DIP switches, LEDs, and character LCD.

User-Defined Push Buttons

The development board includes three user-defined push buttons. For information on the system and safe reset push buttons, refer to “[Setup Elements](#)” on page 2-16.

Board references S5, S6, S7, and S8 are push buttons for controlling the FPGA designs that loads into the Cyclone V E FPGA device. When you press and hold down the switch, the device pin is set to logic 0; when you release the switch, the device pin is set to logic 1. There are no board-specific functions for these general user push buttons.

Table 2-13 lists the user-defined push button schematic signal names and their corresponding Cyclone V E FPGA pin numbers.

Table 2-13. User-Defined Push Button Schematic Signal Names and Functions

Board Reference	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard
S5	USER_PB0	AB12	2.5-V
S6	USER_PB1	AB13	2.5-V
S7	USER_PB2	AF13	2.5-V
S8	USER_PB3	AG12	2.5-V

User-Defined DIP Switch

Board reference SW3 is a four-pin DIP switch. This switch is user-defined and provides additional FPGA input control. When the switch is in the OFF position, a logic 1 is selected. When the switch is in the ON position, a logic 0 is selected. There are no board-specific functions for this switch.

Table 2-14 lists the user-defined DIP switch schematic signal names and their corresponding Cyclone V E FPGA pin numbers.

Table 2-14. User-Defined DIP Switch Schematic Signal Names and Functions

Board Reference	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard
1	USER_DIPSW0	Y12	2.5-V
2	USER_DIPSW1	AA13	2.5-V
3	USER_DIPSW2	AF11	2.5-V
4	USER_DIPSW3	AG11	2.5-V

User-Defined LEDs

The development board includes general and HSMC user-defined LEDs. This section describes all user-defined LEDs. For information on board specific or status LEDs, refer to “[Status Elements](#)” on page 2-15.

General LEDs

Board references D28 through D31 are four user-defined LEDs. The status and debugging signals are driven to the LEDs from the designs loaded into the Cyclone V E FPGA. Driving a logic 0 on the I/O port turns the LED on while driving a logic 1 turns the LED off. There are no board-specific functions for these LEDs.

Table 2-15 lists the general LED schematic signal names and their corresponding Cyclone V E FPGA pin numbers.

Table 2-15. General LED Schematic Signal Names and Functions

Board Reference	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard
D28	USER_LED0	AK3	2.5-V
D29	USER_LED1	AJ4	2.5-V
D30	USER_LED2	AJ5	2.5-V
D31	USER_LED3	AK6	2.5-V

HSMC LEDs

Board references D20 and D21 are LEDs for the HSMC port. There are no board-specific functions for the HSMC LEDs. The LEDs are labeled TX and RX, and are intended to display data flow to and from the connected daughtercards. The LEDs are driven by the Cyclone V E FPGA device.

Table 2-16 lists the HSMC LED schematic signal names and their corresponding Cyclone V E FPGA pin numbers.

Table 2-16. HSMC LED Schematic Signal Names and Functions

Board Reference	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard
D1	HSMC_RX_LED	AH12	2.5-V
D2	HSMC_TX_LED	AH11	2.5-V

Character LCD

The development board includes a single 14-pin 0.1" pitch dual-row header that interfaces to a 2 line × 16 character Lumex character LCD. The character LCD has a 14-pin receptacle that mounts directly to the board's 14-pin header, so it can be easily removed for access to components under the display. You can also use the header for debugging or other purposes.

Table 2-17 summarizes the character LCD pin assignments. The signal names and directions are relative to the Cyclone V E FPGA device.

Table 2-17. Character LCD Pin Assignments, Schematic Signal Names, and Functions

Board Reference (J14)	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard	Description
7	LCD_DATA0	AJ7	2.5-V	LCD data bus
8	LCD_DATA1	AK7	2.5-V	LCD data bus
9	LCD_DATA2	AJ8	2.5-V	LCD data bus
10	LCD_DATA3	AK8	2.5-V	LCD data bus
11	LCD_DATA4	AF9	2.5-V	LCD data bus
12	LCD_DATA5	AG9	2.5-V	LCD data bus
13	LCD_DATA6	AH9	2.5-V	LCD data bus
14	LCD_DATA7	AJ9	2.5-V	LCD data bus


Table 2-17. Character LCD Pin Assignments, Schematic Signal Names, and Functions

Board Reference (J14)	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard	Description
4	LCD_D_Cn	AK11	2.5-V	LCD data or command select
5	LCD_WEn	AK10	2.5-V	LCD write enable
6	LCD_CSn	AJ12	2.5-V	LCD chip select

Table 2-18 lists the LCD pin definitions, and is an excerpt from Lumex data sheet.

Table 2-18. LCD Pin Definitions and Functions

Pin Number	Symbol	Level	Function	
1	V _{DD}	—	Power supply	5 V
2	V _{SS}	—		GND (0 V)
3	V ₀	—		For LCD drive
4	RS	H/L	Register select signal H: Data input L: Instruction input	
5	R/W	H/L	H: Data read (module to MPU) L: Data write (MPU to module)	
6	E	H, H to L	Enable	
7-14	DB0-DB7	H/L	Data bus—software selectable 4-bit or 8-bit mode	

 For more information such as timing, character maps, interface guidelines, and other related documentation, visit www.lumex.com.

Debug Header

This development board includes two 2×8 debug headers for debug purposes. The FPGA I/Os route directly to the header for design testing, debugging, or quick verification.

Table 2-19 summarizes the debug header pin assignments, signal names, and functions.

Table 2-19. Debug Header Pin Assignments, Schematic Signal Names, and Functions (Part 1 of 2)

Board Reference	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard	Description
Debug Header (J15)				
1	HEADER_D0	H21	1.5-V	Single-ended signal for debug purposes only
5	HEADER_D1	G21	1.5-V	Single-ended signal for debug purposes only
9	HEADER_D2	G22	1.5-V	Single-ended signal for debug purposes only
13	HEADER_D3	E26	1.5-V	Single-ended signal for debug purposes only
4	HEADER_D4	E25	1.5-V	Single-ended signal for debug purposes only
8	HEADER_D5	C27	1.5-V	Single-ended signal for debug purposes only
12	HEADER_D6	C26	1.5-V	Single-ended signal for debug purposes only

Table 2-19. Debug Header Pin Assignments, Schematic Signal Names, and Functions (Part 2 of 2)

Board Reference	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard	Description
16	HEADER_D7	B27	1.5-V	Single-ended signal for debug purposes only
Debug Header (J16)				
1 and 2	HEADER_P0 and HEADER_N0	H25 and H26	2.5-V	Pseudo-differential signals for debug purposes only
3 and 4	HEADER_P1 and HEADER_N1	P20 and N20	2.5-V	Pseudo-differential signals for debug purposes only
7 and 8	HEADER_P2 and HEADER_N2	J22 and J23	2.5-V	Pseudo-differential signals for debug purposes only
9 and 10	HEADER_P3 and HEADER_N3	D28 and D29	2.5-V	Pseudo-differential signals for debug purposes only
13 and 14	HEADER_P4 and HEADER_N4	E27 and D27	2.5-V	Pseudo-differential signals for debug purposes only
15 and 16	HEADER_P5 and HEADER_N5	H24 and J25	2.5-V	Pseudo-differential signals for debug purposes only

Components and Interfaces

This section describes the development board's communication ports and interface cards relative to the Cyclone V E FPGA device. The development board supports the following communication ports:

- RS-232 Serial UART
- 10/100/1000 Ethernet
- HSMC
- USB UART

10/100/1000 Ethernet

The development board supports two 10/100/1000 base-T Ethernet using two external Marvell 88E1111 PHY and Altera Triple-Speed Ethernet MegaCore MAC function. The PHY-to-MAC interfaces employ RGMII interface. The MAC function must be provided in the FPGA for typical networking applications.

The Marvell 88E1111 PHY uses 2.5-V and 1.0-V power rails and requires a 25-MHz reference clock driven from a dedicated oscillator. The PHY interfaces to a RJ45 model with internal magnetics that can be used for driving copper lines with Ethernet traffic.

Figure 2-7 shows the RGMII interface between the FPGA (MAC) and Marvell 88E1111 PHY.

Figure 2-7. RGMII Interface between FPGA (MAC) and Marvell 88E1111 PHY

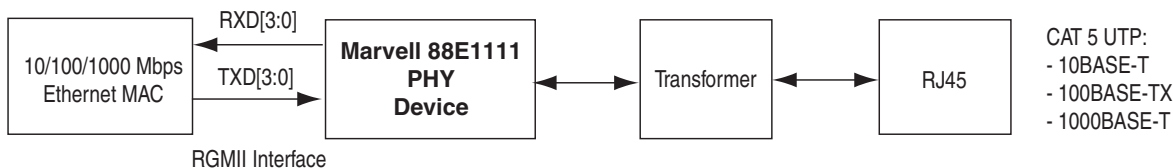


Table 2-20 lists the Ethernet PHY interface pin assignments.

Table 2-20. Ethernet PHY Pin Assignments, Signal Names and Functions (Part 1 of 3)

Board Reference	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard	Description
Ethernet PHY A (U14)				
8	ENETA_GTX_CLK	H27	2.5-V CMOS	125-MHz RGMII transmit clock
23	ENETA_INTN	J27	2.5-V CMOS	Management bus interrupt
60	ENETA_LED_DUPLEX	—	2.5-V CMOS	Duplex or collision LED. Not used
70	ENETA_LED_DUPLEX	—	2.5-V CMOS	Duplex or collision LED. Not used
76	ENETA_LED_LINK10	—	2.5-V CMOS	10-Mb link LED
74	ENETA_LED_LINK100	—	2.5-V CMOS	100-Mb link LED
73	ENETA_LED_LINK1000	—	2.5-V CMOS	1000-Mb link LED
58	ENETA_LED_RX	—	2.5-V CMOS	RX data active LED
69	ENETA_LED_RX	—	2.5-V CMOS	RX data active LED
68	ENETA_LED_TX	—	2.5-V CMOS	TX data active LED
25	ENETA_MDC	G29	2.5-V CMOS	Management bus data clock
24	ENETA_MDIO	L25	2.5-V CMOS	Management bus data
28	ENETA_RESETN	N22	2.5-V CMOS	Device reset
2	ENETA_RX_CLK	T23	2.5-V CMOS	RGMII receive clock
95	ENETA_RX_D0	N26	2.5-V CMOS	RGMII receive data bus
92	ENETA_RX_D1	N27	2.5-V CMOS	RGMII receive data bus
93	ENETA_RX_D2	N24	2.5-V CMOS	RGMII receive data bus
91	ENETA_RX_D3	N25	2.5-V CMOS	RGMII receive data bus
94	ENETA_RX_DV	L26	2.5-V CMOS	RGMII receive data valid
11	ENETA_TX_D0	J28	2.5-V CMOS	RGMII transmit data bus
12	ENETA_TX_D1	J29	2.5-V CMOS	RGMII transmit data bus
14	ENETA_TX_D2	H29	2.5-V CMOS	RGMII transmit data bus
16	ENETA_TX_D3	H30	2.5-V CMOS	RGMII transmit data bus
9	ENETA_TX_EN	F30	2.5-V CMOS	RGMII transmit enable
55	ENETA_XTAL_25MHZ	—	2.5-V CMOS	25-MHz RGMII transmit clock
29	ENETA_MDI_P0	—	2.5-V CMOS	Media dependent interface
31	ENETA_MDI_N0	—	2.5-V CMOS	Media dependent interface

Table 2-20. Ethernet PHY Pin Assignments, Signal Names and Functions (Part 2 of 3)



Board Reference	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard	Description
33	ENETA_MDI_P1	—	2.5-V CMOS	Media dependent interface
34	ENETA_MDI_N1	—	2.5-V CMOS	Media dependent interface
39	ENETA_MDI_P2	—	2.5-V CMOS	Media dependent interface
41	ENETA_MDI_N2	—	2.5-V CMOS	Media dependent interface
42	ENETA_MDI_P3	—	2.5-V CMOS	Media dependent interface
43	ENETA_MDI_N3	—	2.5-V CMOS	Media dependent interface
Ethernet PHY B (U11)				
8	ENETB_GTX_CLK	E28	2.5-V CMOS	125-MHz RGMII transmit clock
23	ENETB_INTN	K22	2.5-V CMOS	Management bus interrupt
60	ENETB_LED_DUPLEX	—	2.5-V CMOS	Duplex or collision LED. Not used
70	ENETB_LED_DUPLEX	—	2.5-V CMOS	Duplex or collision LED. Not used
76	ENETB_LED_LINK10	—	2.5-V CMOS	10-Mb link LED
74	ENETB_LED_LINK100	—	2.5-V CMOS	100-Mb link LED
73	ENETB_LED_LINK1000	—	2.5-V CMOS	1000-Mb link LED
58	ENETB_LED_RX	—	2.5-V CMOS	RX data active LED
69	ENETB_LED_RX	—	2.5-V CMOS	RX data active LED
68	ENETB_LED_TX	—	2.5-V CMOS	TX data active LED
25	ENETB_MDC	A29	2.5-V CMOS	Management bus data clock
24	ENETB_MDIO	L23	2.5-V CMOS	Management bus data
28	ENETB_RESETN	M21	2.5-V CMOS	Device reset
2	ENETB_RX_CLK	R23	2.5-V CMOS	RGMII receive clock
95	ENETB_RX_D0	F25	2.5-V CMOS	RGMII receive data bus
92	ENETB_RX_D1	F26	2.5-V CMOS	RGMII receive data bus
93	ENETB_RX_D2	R20	2.5-V CMOS	RGMII receive data bus
91	ENETB_RX_D3	T21	2.5-V CMOS	RGMII receive data bus
94	ENETB_RX_DV	L24	2.5-V CMOS	RGMII receive data valid
11	ENETB_TX_D0	F29	2.5-V CMOS	RGMII transmit data bus
12	ENETB_TX_D1	D30	2.5-V CMOS	RGMII transmit data bus
14	ENETB_TX_D2	C30	2.5-V CMOS	RGMII transmit data bus
16	ENETB_TX_D3	F28	2.5-V CMOS	RGMII transmit data bus
9	ENETB_TX_EN	B29	2.5-V CMOS	RGMII transmit enable
55	ENETB_XTAL_25MHZ	—	2.5-V CMOS	25-MHz RGMII transmit clock
29	ENETB_MDI_P0	—	2.5-V CMOS	Media dependent interface
31	ENETB_MDI_N0	—	2.5-V CMOS	Media dependent interface
33	ENETB_MDI_P1	—	2.5-V CMOS	Media dependent interface
34	ENETB_MDI_N1	—	2.5-V CMOS	Media dependent interface
39	ENETB_MDI_P2	—	2.5-V CMOS	Media dependent interface
41	ENETB_MDI_N2	—	2.5-V CMOS	Media dependent interface

Table 2-20. Ethernet PHY Pin Assignments, Signal Names and Functions (Part 3 of 3)

Board Reference	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard	Description
42	ENETB_MDI_P3	—	2.5-V CMOS	Media dependent interface
43	ENETB_MDI_N3	—	2.5-V CMOS	Media dependent interface

HSMC

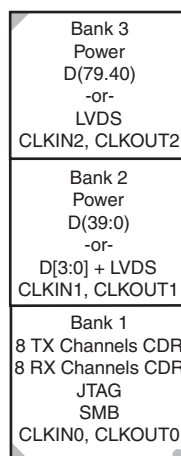
The development board supports a HSMC interface. The HSMC interface supports a full SPI4.2 interface (17 LVDS channels), three input and output clocks, as well as JTAG and SMB signals. The LVDS channels can be used for CMOS signaling or LVDS.

-  The HSMC is an Altera-developed open specification, which allows you to expand the functionality of the development board through the addition of daughtercards (HSMCs).
-  For more information about the HSMC specification such as signaling standards, signal integrity, compatible connectors, and mechanical information, refer to the *High Speed Mezzanine Card (HSMC) Specification* manual.

The HSMC connector has a total of 172 pins, including 120 signal pins, 39 power pins, and 13 ground pins. The ground pins are located between the two rows of signal and power pins, acting both as a shield and a reference. The HSMC host connector is based on the 0.5 mm-pitch QSH/QTH family of high-speed, board-to-board connectors from Samtec. There are three banks in this connector. Bank 1 has every third pin removed as done in the QSH-DP/QTH-DP series. Bank 2 and bank 3 have all the pins populated as done in the QSH/QTH series. Since the Cyclone V E FPGA development board is not a transceiver board, the transceiver pins of the HSMC is not connected to the Cyclone V E FPGA device.

Figure 2-8 shows the bank arrangement of signals with respect to the Samtec connector's three banks.

Figure 2-8. HSMC Signal and Bank Diagram



The HSMC interface has programmable bi-directional I/O pins that can be used as 2.5-V LVCMOS, which is 3.3-V LVTTTL-compatible. These pins can also be used as various differential I/O standards including, but not limited to, LVDS, mini-LVDS, and RSDS with up to 17 full-duplex channels.



As noted in the *High Speed Mezzanine Card (HSMC) Specification* manual, LVDS and single-ended I/O standards are only guaranteed to function when mixed according to either the generic single-ended pin-out or generic differential pin-out.

Table 2–21 lists the HSMC interface pin assignments, signal names, and functions.

Table 2–21. HSMC Interface Pin Assignments, Schematic Signal Names, and Functions (Part 1 of 3)

Board Reference (J7)	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard	Description
33	HSMC_SDA	AB22	2.5-V CMOS	Management serial data
34	HSMC_SCL	AC22	2.5-V CMOS	Management serial clock
35	JTAG_TCK	AC7	2.5-V CMOS	JTAG clock signal
36	HSMC_JTAG_TMS	—	2.5-V CMOS	JTAG mode select signal
37	HSMC_JTAG_TDO	—	2.5-V CMOS	JTAG data output
38	JTAG_FPGA_TDO_RETIMER	—	2.5-V CMOS	JTAG data input
39	HSMC_CLK_OUT0	AJ14	2.5-V CMOS	Dedicated CMOS clock out
40	HSMC_CLK_IN0	AB16	2.5-V CMOS	Dedicated CMOS clock in
41	HSMC_D0	AH10	2.5-V CMOS	Dedicated CMOS I/O bit 0
42	HSMC_D1	AJ10	2.5-V CMOS	Dedicated CMOS I/O bit 1
43	HSMC_D2	Y13	2.5-V CMOS	Dedicated CMOS I/O bit 2
44	HSMC_D3	AA14	2.5-V CMOS	Dedicated CMOS I/O bit 3
47	HSMC_TX_D_P0	AK27	LVDS or 2.5-V	LVDS TX bit 0 or CMOS bit 4
48	HSMC_RX_D_P0	Y16	LVDS or 2.5-V	LVDS RX bit 0 or CMOS bit 5
49	HSMC_TX_D_N0	AK28	LVDS or 2.5-V	LVDS TX bit 0n or CMOS bit 6
50	HSMC_RX_D_N0	AA26	LVDS or 2.5-V	LVDS RX bit 0n or CMOS bit 7
53	HSMC_TX_D_P1	AJ27	LVDS or 2.5-V	LVDS TX bit 1 or CMOS bit 8
54	HSMC_RX_D_P1	Y17	LVDS or 2.5-V	LVDS RX bit 1 or CMOS bit 9
55	HSMC_TX_D_N1	AK26	LVDS or 2.5-V	LVDS TX bit 1n or CMOS bit 10
56	HSMC_RX_D_N1	Y18	LVDS or 2.5-V	LVDS RX bit 1n or CMOS bit 11
59	HSMC_TX_D_P2	AG26	LVDS or 2.5-V	LVDS TX bit 2 or CMOS bit 12
60	HSMC_RX_D_P2	AA18	LVDS or 2.5-V	LVDS RX bit 2 or CMOS bit 13
61	HSMC_TX_D_N2	AH26	LVDS or 2.5-V	LVDS TX bit 2n or CMOS bit 14
62	HSMC_RX_D_N2	AA19	LVDS or 2.5-V	LVDS RX bit 2n or CMOS bit 15
65	HSMC_TX_D_P3	AJ25	LVDS or 2.5-V	LVDS TX bit 3 or CMOS bit 16
66	HSMC_RX_D_P3	Y20	LVDS or 2.5-V	LVDS RX bit 3 or CMOS bit 17
67	HSMC_TX_D_N3	AK25	LVDS or 2.5-V	LVDS TX bit 3n or CMOS bit 18
68	HSMC_RX_D_N3	AA20	LVDS or 2.5-V	LVDS RX bit 3n or CMOS bit 19
71	HSMC_TX_D_P4	AH24	LVDS or 2.5-V	LVDS TX bit 4 or CMOS bit 20

Table 2-21. HSMC Interface Pin Assignments, Schematic Signal Names, and Functions (Part 2 of 3)

Board Reference (J7)	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard	Description
72	HSMC_RX_D_P4	AA21	LVDS or 2.5-V	LVDS RX bit 4 or CMOS bit 21
73	HSMC_TX_D_N4	AJ24	LVDS or 2.5-V	LVDS TX bit 4n or CMOS bit 22
74	HSMC_RX_D_N4	AB21	LVDS or 2.5-V	LVDS RX bit 4n or CMOS bit 23
77	HSMC_TX_D_P5	AH21	LVDS or 2.5-V	LVDS TX bit 5 or CMOS bit 24
78	HSMC_RX_D_P5	AB19	LVDS or 2.5-V	LVDS RX bit 5 or CMOS bit 25
79	HSMC_TX_D_N5	AJ22	LVDS or 2.5-V	LVDS TX bit 5n or CMOS bit 26
80	HSMC_RX_D_N5	AC19	LVDS or 2.5-V	LVDS RX bit 5n or CMOS bit 27
83	HSMC_TX_D_P6	AJ23	LVDS or 2.5-V	LVDS TX bit 6 or CMOS bit 28
84	HSMC_RX_D_P6	AC21	LVDS or 2.5-V	LVDS RX bit 6 or CMOS bit 29
85	HSMC_TX_D_N6	AK23	LVDS or 2.5-V	LVDS TX bit 6n or CMOS bit 30
86	HSMC_RX_D_N6	AD20	LVDS or 2.5-V	LVDS RX bit 6n or CMOS bit 31
89	HSMC_TX_D_P7	AK21	LVDS or 2.5-V	LVDS TX bit 7 or CMOS bit 32
90	HSMC_RX_D_P7	AD19	LVDS or 2.5-V	LVDS RX bit 7 or CMOS bit 33
91	HSMC_TX_D_N7	AK22	LVDS or 2.5-V	LVDS TX bit 7n or CMOS bit 34
92	HSMC_RX_D_N7	AE20	LVDS or 2.5-V	LVDS RX bit 7n or CMOS bit 35
95	HSMC_CLK_OUT_P1	AE22	LVDS or 2.5-V	LVDS or CMOS clock out 1 or CMOS bit 36
96	HSMC_CLK_IN_P1	AB14	LVDS or 2.5-V	LVDS or CMOS clock in 1 or CMOS bit 37
97	HSMC_CLK_OUT_N1	AF23	LVDS or 2.5-V	LVDS or CMOS clock out 1 or CMOS bit 38
98	HSMC_CLK_IN_N1	AC14	LVDS or 2.5-V	LVDS or CMOS clock in 1 or CMOS bit 39
101	HSMC_TX_D_P8	AJ20	LVDS or 2.5-V	LVDS TX bit 8 or CMOS bit 40
102	HSMC_RX_D_P8	AF21	LVDS or 2.5-V	LVDS RX bit 8 or CMOS bit 41
103	HSMC_TX_D_N8	AK20	LVDS or 2.5-V	LVDS TX bit 8n or CMOS bit 42
104	HSMC_RX_D_N8	AG22	LVDS or 2.5-V	LVDS RX bit 8n or CMOS bit 43
107	HSMC_TX_D_P9	AJ19	LVDS or 2.5-V	LVDS TX bit 9 or CMOS bit 44
108	HSMC_RX_D_P9	AF20	LVDS or 2.5-V	LVDS RX bit 9 or CMOS bit 45
109	HSMC_TX_D_N9	AK18	LVDS or 2.5-V	LVDS TX bit 9n or CMOS bit 46
110	HSMC_RX_D_N9	AG21	LVDS or 2.5-V	LVDS RX bit 9n or CMOS bit 47
113	HSMC_TX_D_P10	AJ17	LVDS or 2.5-V	LVDS TX bit 10 or CMOS bit 48
114	HSMC_RX_D_P10	AF18	LVDS or 2.5-V	LVDS RX bit 10 or CMOS bit 49
115	HSMC_TX_D_N10	AJ18	LVDS or 2.5-V	LVDS TX bit 10n or CMOS bit 50
116	HSMC_RX_D_N10	AF19	LVDS or 2.5-V	LVDS RX bit 10n or CMOS bit 51
119	HSMC_TX_D_P11	AK25	LVDS or 2.5-V	LVDS TX bit 11 or CMOS bit 52
120	HSMC_RX_D_P11	AG18	LVDS or 2.5-V	LVDS RX bit 11 or CMOS bit 53
121	HSMC_TX_D_N11	AG24	LVDS or 2.5-V	LVDS TX bit 11n or CMOS bit 54
122	HSMC_RX_D_N11	AG19	LVDS or 2.5-V	LVDS RX bit 11n or CMOS bit 55
125	HSMC_TX_D_P12	AH19	LVDS or 2.5-V	LVDS TX bit 12 or CMOS bit 56
126	HSMC_RX_D_P12	AK16	LVDS or 2.5-V	LVDS RX bit 12 or CMOS bit 57
127	HSMC_TX_D_N12	AH20	LVDS or 2.5-V	LVDS TX bit 12n or CMOS bit 58

Table 2-21. HSMC Interface Pin Assignments, Schematic Signal Names, and Functions (Part 3 of 3)

Board Reference (J7)	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard	Description
128	HSMC_RX_D_N12	AK17	LVDS or 2.5-V	LVDS RX bit 12n or CMOS bit 59
131	HSMC_TX_D_P13	AG17	LVDS or 2.5-V	LVDS TX bit 13 or CMOS bit 60
132	HSMC_RX_D_P13	AF16	LVDS or 2.5-V	LVDS RX bit 13 or CMOS bit 61
133	HSMC_TX_D_N13	AH17	LVDS or 2.5-V	LVDS TX bit 13n or CMOS bit 62
134	HSMC_RX_D_N13	AG16	LVDS or 2.5-V	LVDS RX bit 13n or CMOS bit 63
137	HSMC_TX_D_P14	AJ15	LVDS or 2.5-V	LVDS TX bit 14 or CMOS bit 64
138	HSMC_RX_D_P14	AE16	LVDS or 2.5-V	LVDS RX bit 14 or CMOS bit 65
139	HSMC_TX_D_N14	AK15	LVDS or 2.5-V	LVDS TX bit 14n or CMOS bit 66
140	HSMC_RX_D_N14	AF15	LVDS or 2.5-V	LVDS RX bit 14n or CMOS bit 67
143	HSMC_TX_D_P15	AH14	LVDS or 2.5-V	LVDS TX bit 15 or CMOS bit 68
144	HSMC_RX_D_P15	AD17	LVDS or 2.5-V	LVDS RX bit 15 or CMOS bit 69
145	HSMC_TX_D_N15	AH15	LVDS or 2.5-V	LVDS TX bit 15n or CMOS bit 70
146	HSMC_RX_D_N15	AE17	LVDS or 2.5-V	LVDS RX bit 15n or CMOS bit 71
149	HSMC_TX_D_P16	AE15	LVDS or 2.5-V	LVDS TX bit 16 or CMOS bit 72
150	HSMC_RX_D_P16	AD18	LVDS or 2.5-V	LVDS RX bit 16 or CMOS bit 73
151	HSMC_TX_D_N16	AF14	LVDS or 2.5-V	LVDS TX bit 16n or CMOS bit 74
152	HSMC_RX_D_N16	AE18	LVDS or 2.5-V	LVDS RX bit 16n or CMOS bit 75
155	HSMC_CLK_OUT_P2	AG23	LVDS or 2.5-V	LVDS or CMOS clock out 2 or CMOS bit 76
156	HSMC_CLK_IN_P2	Y15	LVDS or 2.5-V	LVDS or CMOS clock in 2 or CMOS bit 77
157	HSMC_CLK_OUT_N2	AH22	LVDS or 2.5-V	LVDS or CMOS clock out 2 or CMOS bit 78
158	HSMC_CLK_IN_N2	AA15	LVDS or 2.5-V	LVDS or CMOS clock in 2 or CMOS bit 79
160	HSMC_PRSENTn	AK5	2.5-V CMOS	HSMC port presence detect

RS-232 Serial UART

A female angled DSUB 9-pin connector along with a supporting RS-232 transceiver provides support for implementing a standard RS-232 serial UART channel on this board. The connector has the same pinouts as a data terminal device and requires only a standard cable (no null modem required for PC interface). A dedicated level-shifting buffer is used to translate between LVTTTL and RS-232 levels. Board references D23 and D24 are serial UART LEDs that illuminate to indicate RX and TX activity.

Table 2-24 lists the RS-232 serial UART pin assignments, signal names, and functions. The signal names and types are relative to the Cyclone V E FPGA in terms of I/O setting and direction.

Table 2-22. RS-232 Serial UART Schematic Signal Names and Functions

Board Reference (U20)	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard	Description
14	UART_TXD	AB9	3.3-V	Transmit data
15	UART_RTS	AH6	3.3-V	Request to send

Table 2-22. RS-232 Serial UART Schematic Signal Names and Functions

Board Reference (U20)	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard	Description
16	UART_RXD	AG6	3.3-V	Receive data
13	UART_CTS	AF8	3.3-V	Clear to send

USB-UART

The development board supports UART interface through a USB connector using Silicon Labs CP2104 USB-to-UART bridge. To facilitate host communication with CP2104, you are required to use the USB-to-UART bridge Virtual COM Port (VCP) drivers.



The VCP drivers are available at:

www.silabs.com/products/mcu/Pages/USBtoUARTBridgeVCPDrivers.aspx

Table 2-23 lists the USB-UART pin assignments, signal names, and functions. The signal names and types are relative to the Cyclone V E FPGA in terms of I/O setting and direction.

Table 2-23. USB-UART Schematic Signal Names and Functions

Board Reference (U20)	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard	Description
1	USB_UART_RI	AD12	2.5-V	Ring indicator control input (active low)
24	USB_UART_DCD	AD13	2.5-V	Data carrier detect control input (active low)
22	USB_UART_DSR	V12	2.5-V	Data set ready control input (active low)
21	USB_UART_RXD	AF10	2.5-V	Asynchronous data input (UART receive)
19	USB_UART_RTS	AE12	2.5-V	Ready to send control output (active low)
12	USB_UART_GPIO2	AE13	2.5-V	User-configurable input or output.
23	USB_UART_DTR	AE10	2.5-V	Data terminal ready control output (active low)
20	USB_UART_TXD	W12	2.5-V	Asynchronous data output (UART transmit)
18	USB_UART_CTS	AJ1	2.5-V	Clear to send control input (active low)
15	USB_UART_SUSPENDn	—	2.5-V	Pin is logic low when the CP2104 is in the USB suspend state.
17	USB_UART_SUSPEND	—	2.5-V	Pin is logic high when the CP2104 is in the USB suspend state.
9	USB_UART_RSTn	—	2.5-V	Device reset

Memory

This section describes the development board's memory interface support and also their signal names, types, and connectivity relative to the Cyclone V E FPGA. The development board has the following memory interfaces:

- DDR3 SDRAM
- LPDDR2 SDRAM
- EEPROM
- Synchronous SRAM
- Synchronous flash



For more information about the memory interfaces, refer to the following documents:

- *Timing Analysis* section in the External Memory Interface Handbook.
- *DDR, DDR2, and DDR3 SDRAM Design Tutorials* section in the External Memory Interface Handbook.

DDR3 SDRAM

The development board supports two 16Mx16x8 and two 16Mx8x8 DDR3 SDRAM interfaces for very high-speed sequential memory access.

The 32-bit data bus comprises of two x16 devices using soft memory controller (SMC) interface. With SMC, this memory interface runs at a target frequency of 300 MHz for a maximum theoretical bandwidth of over 9.6 Gbps. The maximum frequency for this DDR3 device is 800 MHz with a CAS latency of 11.

[Table 2-24](#) lists the DDR3 pin assignments, signal names, and functions. The signal names and types are relative to the Cyclone V E FPGA in terms of I/O setting and direction.

Table 2-24. DDR3 Device Pin Assignments, Schematic Signal Names, and Functions (Part 1 of 4)

Board Reference	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard	Description
DDR3 x16 (U8)				
N3	DDR3_A0	A16	1.5-V SSTL Class I	Address bus
P7	DDR3_A1	G23	1.5-V SSTL Class I	Address bus
P3	DDR3_A2	E21	1.5-V SSTL Class I	Address bus
N2	DDR3_A3	E22	1.5-V SSTL Class I	Address bus
P8	DDR3_A4	A20	1.5-V SSTL Class I	Address bus
P2	DDR3_A5	A26	1.5-V SSTL Class I	Address bus
R8	DDR3_A6	A15	1.5-V SSTL Class I	Address bus
R2	DDR3_A7	B26	1.5-V SSTL Class I	Address bus
T8	DDR3_A8	H17	1.5-V SSTL Class I	Address bus
R3	DDR3_A9	D14	1.5-V SSTL Class I	Address bus
L7	DDR3_A10	E23	1.5-V SSTL Class I	Address bus

Table 2-24. DDR3 Device Pin Assignments, Schematic Signal Names, and Functions (Part 2 of 4)

Board Reference	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard	Description
R7	DDR3_A11	E20	1.5-V SSTL Class I	Address bus
N7	DDR3_A12	C25	1.5-V SSTL Class I	Address bus
T3	DDR3_A13	B13	1.5-V SSTL Class I	Address bus
M2	DDR3_BA0	J18	1.5-V SSTL Class I	Bank address bus
N8	DDR3_BA1	F20	1.5-V SSTL Class I	Bank address bus
M3	DDR3_BA2	D19	1.5-V SSTL Class I	Bank address bus
K3	DDR3_CASN	L20	1.5-V SSTL Class I	Row address select
K9	DDR3_CKE	C11	1.5-V SSTL Class I	Column address select
J7	DDR3_CLK_P	J20	Differential 1.5-V SSTL Class I	Differential output clock
K7	DDR3_CLK_N	H20	Differential 1.5-V SSTL Class I	Differential output clock
L2	DDR3_CSN	G17	1.5-V SSTL Class I	Chip select
E7	DDR3_DM0	D23	1.5-V SSTL Class I	Write mask byte lane
D3	DDR3_DM1	D18	1.5-V SSTL Class I	Write mask byte lane
E3	DDR3_DQ0	A25	1.5-V SSTL Class I	Data bus byte lane 0
H8	DDR3_DQ1	D22	1.5-V SSTL Class I	Data bus byte lane 0
F7	DDR3_DQ2	C21	1.5-V SSTL Class I	Data bus byte lane 0
H7	DDR3_DQ3	C19	1.5-V SSTL Class I	Data bus byte lane 0
F2	DDR3_DQ4	C20	1.5-V SSTL Class I	Data bus byte lane 0
G2	DDR3_DQ5	C22	1.5-V SSTL Class I	Data bus byte lane 0
F8	DDR3_DQ6	D25	1.5-V SSTL Class I	Data bus byte lane 0
H3	DDR3_DQ7	D20	1.5-V SSTL Class I	Data bus byte lane 0
A7	DDR3_DQ8	B24	1.5-V SSTL Class I	Data bus byte lane 1
C3	DDR3_DQ9	A21	1.5-V SSTL Class I	Data bus byte lane 1
A3	DDR3_DQ10	B21	1.5-V SSTL Class I	Data bus byte lane 1
D7	DDR3_DQ11	F19	1.5-V SSTL Class I	Data bus byte lane 1
A2	DDR3_DQ12	G24	1.5-V SSTL Class I	Data bus byte lane 1
C2	DDR3_DQ13	B23	1.5-V SSTL Class I	Data bus byte lane 1
B8	DDR3_DQ14	E18	1.5-V SSTL Class I	Data bus byte lane 1
C8	DDR3_DQ15	A23	1.5-V SSTL Class I	Data bus byte lane 1
F3	DDR3_DQS_P0	K20	Differential 1.5-V SSTL Class I	Data strobe P byte lane 0
G3	DDR3_DQS_N0	J19	Differential 1.5-V SSTL Class I	Data strobe N byte lane 0
C7	DDR3_DQS_P1	L18	Differential 1.5-V SSTL Class I	Data strobe P byte lane 1
B7	DDR3_DQS_N1	K18	Differential 1.5-V SSTL Class I	Data strobe N byte lane 1
K1	DDR3_ODT	H19	1.5-V SSTL Class I	On-die termination enable

Table 2-24. DDR3 Device Pin Assignments, Schematic Signal Names, and Functions (Part 3 of 4)

Board Reference	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard	Description
J3	DDR3_RASN	A24	1.5-V SSTL Class I	Row address select
T2	DDR3_RESETN	L19	1.5-V SSTL Class I	Reset
L3	DDR3_WEN	B22	1.5-V SSTL Class I	Write enable
L8	DDR3_ZQ01	—	1.5-V SSTL Class I	ZQ impedance calibration
DDR3 x16 (U7)				
N3	DDR3_A0	A16	1.5-V SSTL Class I	Address bus
P7	DDR3_A1	G23	1.5-V SSTL Class I	Address bus
P3	DDR3_A2	E21	1.5-V SSTL Class I	Address bus
N2	DDR3_A3	E22	1.5-V SSTL Class I	Address bus
P8	DDR3_A4	A20	1.5-V SSTL Class I	Address bus
P2	DDR3_A5	A26	1.5-V SSTL Class I	Address bus
R8	DDR3_A6	A15	1.5-V SSTL Class I	Address bus
R2	DDR3_A7	B26	1.5-V SSTL Class I	Address bus
T8	DDR3_A8	H17	1.5-V SSTL Class I	Address bus
R3	DDR3_A9	D14	1.5-V SSTL Class I	Address bus
L7	DDR3_A10	E23	1.5-V SSTL Class I	Address bus
R7	DDR3_A11	E20	1.5-V SSTL Class I	Address bus
N7	DDR3_A12	C25	1.5-V SSTL Class I	Address bus
T3	DDR3_A13	B13	1.5-V SSTL Class I	Address bus
M2	DDR3_BA0	J18	1.5-V SSTL Class I	Bank address bus
N8	DDR3_BA1	F20	1.5-V SSTL Class I	Bank address bus
M3	DDR3_BA2	D19	1.5-V SSTL Class I	Bank address bus
K3	DDR3_CASN	L20	1.5-V SSTL Class I	Row address select
K9	DDR3_CKE	AK18	1.5-V SSTL Class I	Column address select
K7	DDR3_CLK_P	J20	1.5-V SSTL Class I	Differential output clock
J7	DDR3_CLK_N	H20	1.5-V SSTL Class I	Differential output clock
L2	DDR3_CSN	G17	1.5-V SSTL Class I	Chip select
E7	DDR3_DM2	A19	1.5-V SSTL Class I	Write mask byte lane
D3	DDR3_DM3	B14	1.5-V SSTL Class I	Write mask byte lane
F2	DDR3_DQ16	G18	1.5-V SSTL Class I	Data bus byte lane 2
F8	DDR3_DQ17	B18	1.5-V SSTL Class I	Data bus byte lane 2
E3	DDR3_DQ18	A18	1.5-V SSTL Class I	Data bus byte lane 2
F7	DDR3_DQ19	F18	1.5-V SSTL Class I	Data bus byte lane 2
H3	DDR3_DQ20	C14	1.5-V SSTL Class I	Data bus byte lane 2
G2	DDR3_DQ21	C17	1.5-V SSTL Class I	Data bus byte lane 2
H7	DDR3_DQ22	B17	1.5-V SSTL Class I	Data bus byte lane 2
H8	DDR3_DQ23	B19	1.5-V SSTL Class I	Data bus byte lane 2
A2	DDR3_DQ24	C15	1.5-V SSTL Class I	Data bus byte lane 3

Table 2-24. DDR3 Device Pin Assignments, Schematic Signal Names, and Functions (Part 4 of 4)

Board Reference	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard	Description
C2	DDR3_DQ25	D17	1.5-V SSTL Class I	Data bus byte lane 3
D7	DDR3_DQ26	C12	1.5-V SSTL Class I	Data bus byte lane 3
A7	DDR3_DQ27	E17	1.5-V SSTL Class I	Data bus byte lane 3
A3	DDR3_DQ28	C16	1.5-V SSTL Class I	Data bus byte lane 3
C3	DDR3_DQ29	A14	1.5-V SSTL Class I	Data bus byte lane 3
B8	DDR3_DQ30	D12	1.5-V SSTL Class I	Data bus byte lane 3
C8	DDR3_DQ31	A13	1.5-V SSTL Class I	Data bus byte lane 3
F3	DDR3_DQS_P2	K16	Differential 1.5-V SSTL Class I	Data strobe P byte lane 2
G3	DDR3_DQS_N2	L16	Differential 1.5-V SSTL Class I	Data strobe N byte lane 2
C7	DDR3_DQS_P3	K17	Differential 1.5-V SSTL Class I	Data strobe P byte lane 3
B7	DDR3_DQS_N3	J17	Differential 1.5-V SSTL Class I	Data strobe N byte lane 3
K1	DDR3_ODT	H19	1.5-V SSTL Class I	On-die termination enable
J3	DDR3_RASN	A24	1.5-V SSTL Class I	Row address select
T2	DDR3_RESETN	L19	1.5-V SSTL Class I	Reset
L3	DDR3_WEN	B22	1.5-V SSTL Class I	Write enable
L8	DDR3_ZQ2	—	1.5-V SSTL Class I	ZQ impedance calibration

LPDDR2 SDRAM

The LPDDR2 is a mobile low-power DDR2 SDRAM device that operates at 1.2 V. This interface connects to the horizontal I/O banks on the top edge of the FPGA device. The device speed is 300 MHz. Only x16 configuration is used although the LPDDR2 SDRAM on the board is a x32 device.

Table 2-25 lists the LPDDR2 SDRAM pin assignments, signal names, and functions. The signal names and types are relative to the Cyclone V E FPGA in terms of I/O setting and direction.

Table 2-25. LPDDR2 SDRAM Schematic Signal Names and Functions

Board Reference (U9)	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard	Description
AC6	LPDDR2_CA0	Y30	1.2-V HSUL	Address bus
AB6	LPDDR2_CA1	T30	1.2-V HSUL	Address bus
AC7	LPDDR2_CA2	W29	1.2-V HSUL	Address bus
AB8	LPDDR2_CA3	AB29	1.2-V HSUL	Address bus
AB9	LPDDR2_CA4	W30	1.2-V HSUL	Address bus
W1	LPDDR2_CA5	U29	1.2-V HSUL	Address bus
V2	LPDDR2_CA6	AC30	1.2-V HSUL	Address bus
U1	LPDDR2_CA7	R30	1.2-V HSUL	Address bus

Table 2-25. LPDDR2 SDRAM Schematic Signal Names and Functions

Board Reference (U9)	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard	Description
T2	LPDDR2_CA8	T28	1.2-V HSUL	Address bus
T1	LPDDR2_CA9	T25	1.2-V HSUL	Address bus
Y2	LPDDR2_CK	V21	Differential 1.2-V HSUL	Differential output clock P
Y1	LPDDR2_CKN	V22	Differential 1.2-V HSUL	Differential output clock N
AC3	LPDDR2_CKE	T29	1.2-V HSUL	Clock enable
AB3	LPDDR2_CSN	R26	1.2-V HSUL	Chip select
N23	LPDDR2_DM0	AG29	1.2-V HSUL	Data mask
L23	LPDDR2_DM1	AB27	1.2-V HSUL	Data mask
AB20	LPDDR2_DM2	—	1.2-V HSUL	Data mask
B20	LPDDR2_DM3	—	1.2-V HSUL	Data mask
AA23	LPDDR2_DQ0	AG28	1.2-V HSUL	Data bus byte lane 0
Y22	LPDDR2_DQ1	AH30	1.2-V HSUL	Data bus byte lane 0
W22	LPDDR2_DQ2	AA28	1.2-V HSUL	Data bus byte lane 0
W23	LPDDR2_DQ3	AH29	1.2-V HSUL	Data bus byte lane 0
V23	LPDDR2_DQ4	Y28	1.2-V HSUL	Data bus byte lane 0
U22	LPDDR2_DQ5	AE30	1.2-V HSUL	Data bus byte lane 0
T22	LPDDR2_DQ6	AJ28	1.2-V HSUL	Data bus byte lane 0
T23	LPDDR2_DQ7	AD30	1.2-V HSUL	Data bus byte lane 0
H22	LPDDR2_DQ8	AC29	1.2-V HSUL	Data bus byte lane 1
H23	LPDDR2_DQ9	AF30	1.2-V HSUL	Data bus byte lane 1
G23	LPDDR2_DQ10	AA30	1.2-V HSUL	Data bus byte lane 1
F22	LPDDR2_DQ11	AE28	1.2-V HSUL	Data bus byte lane 1
E22	LPDDR2_DQ12	AF29	1.2-V HSUL	Data bus byte lane 1
E23	LPDDR2_DQ13	AD28	1.2-V HSUL	Data bus byte lane 1
D23	LPDDR2_DQ14	V27	1.2-V HSUL	Data bus byte lane 1
C22	LPDDR2_DQ15	W28	1.2-V HSUL	Data bus byte lane 1
AB12	LPDDR2_DQ16	—	1.2-V HSUL	Data bus byte lane 2
AC13	LPDDR2_DQ17	—	1.2-V HSUL	Data bus byte lane 2
AB14	LPDDR2_DQ18	—	1.2-V HSUL	Data bus byte lane 2
AC14	LPDDR2_DQ19	—	1.2-V HSUL	Data bus byte lane 2
AB15	LPDDR2_DQ20	—	1.2-V HSUL	Data bus byte lane 2
AC16	LPDDR2_DQ21	—	1.2-V HSUL	Data bus byte lane 2
AB17	LPDDR2_DQ22	—	1.2-V HSUL	Data bus byte lane 2
AC17	LPDDR2_DQ23	—	1.2-V HSUL	Data bus byte lane 2
B17	LPDDR2_DQ24	—	1.2-V HSUL	Data bus byte lane 3
A17	LPDDR2_DQ25	—	1.2-V HSUL	Data bus byte lane 3
A16	LPDDR2_DQ26	—	1.2-V HSUL	Data bus byte lane 3
B15	LPDDR2_DQ27	—	1.2-V HSUL	Data bus byte lane 3
B14	LPDDR2_DQ28	—	1.2-V HSUL	Data bus byte lane 3

Table 2–25. LPDDR2 SDRAM Schematic Signal Names and Functions

Board Reference (U9)	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard	Description
A14	LPDDR2_DQ29	—	1.2-V HSUL	Data bus byte lane 3
A13	LPDDR2_DQ30	—	1.2-V HSUL	Data bus byte lane 3
B12	LPDDR2_DQ31	—	1.2-V HSUL	Data bus byte lane 3
R23	LPDDR2_DQS0	V26	Differential 1.2-V HSUL	Data strobe P byte lane 0
P22	LPDDR2_DQSN0	U26	Differential 1.2-V HSUL	Data strobe N byte lane 0
J22	LPDDR2_DQS1	U27	Differential 1.2-V HSUL	Data strobe P byte lane 1
K23	LPDDR2_DQSN1	U28	Differential 1.2-V HSUL	Data strobe N byte lane 1
AB18	LPDDR2_DQS2	—	Differential 1.2-V HSUL	Data strobe P byte lane 2
AC19	LPDDR2_DQSN2	—	Differential 1.2-V HSUL	Data strobe N byte lane 2
B18	LPDDR2_DQS3	—	Differential 1.2-V HSUL	Data strobe P byte lane 3
A19	LPDDR2_DQSN4	—	Differential 1.2-V HSUL	Data strobe N byte lane 3
P1	LPDDR2_ZQ	—	1.2-V	ZQ impedance calibration

EEPROM

This board includes a 64-Kb EEPROM device. This device has a 2-wire serial interface bus I²C.

Table 2–26 lists the EEPROM pin assignments, signal names, and functions. The signal names and types are relative to the Cyclone V E FPGA in terms of I/O setting and direction.

Table 2–26. EEPROM Schematic Signal Names and Functions

Board Reference (U12)	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard	Description
1	EEPROM_A0	—	3.3-V	Chip address
2	EEPROM_A1	—	3.3-V	Chip address
3	EEPROM_A2	—	3.3-V	Chip address
5	EEPROM_SDA	AH7	3.3-V	Serial address or data
6	EEPROM_SCL	AG7	3.3-V	Serial clock
7	EEPROM_WP	—	3.3-V	Write protect input

Synchronous SRAM

The development board supports a 18-Mb standard synchronous SRAM for instruction and data storage with low-latency random access capability. The device has a 1024K x 18-bits interface. This device is part of the shared FSM bus that connects to the flash memory, SRAM, and MAX V CPLD 5M2210 System Controller.

The device speed is 250 MHz single-data-rate. There is no minimum speed for this device. The theoretical bandwidth of this interface is 4 Gbps for continuous bursts. The read latency for any address is two clocks while the write latency is one clock.

Table 2-27 lists the SSRAM pin assignments, signal names, and functions.

Table 2-27. SSRAM Pin Assignments, Schematic Signal Names, and Functions (Part 1 of 2)

Board Reference (U11)	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard	Description
86	SRAM_OEN	E7	2.5-V	Output enable
87	SRAM_WEN	D6	2.5-V	Write enable
37	FSM_A1	B11	2.5-V	Address bus
36	FSM_A2	A11	2.5-V	Address bus
44	FSM_A3	D9	2.5-V	Address bus
42	FSM_A4	C10	2.5-V	Address bus
34	FSM_A5	A10	2.5-V	Address bus
47	FSM_A6	A9	2.5-V	Address bus
43	FSM_A7	C9	2.5-V	Address bus
46	FSM_A8	B8	2.5-V	Address bus
45	FSM_A9	B7	2.5-V	Address bus
35	FSM_A10	A8	2.5-V	Address bus
32	FSM_A11	B6	2.5-V	Address bus
33	FSM_A12	A6	2.5-V	Address bus
50	FSM_A13	C7	2.5-V	Address bus
48	FSM_A14	C6	2.5-V	Address bus
100	FSM_A15	F13	2.5-V	Address bus
99	FSM_A16	E13	2.5-V	Address bus
82	FSM_A17	A5	2.5-V	Address bus
80	FSM_A18	A4	2.5-V	Address bus
49	FSM_A19	J7	2.5-V	Address bus
81	FSM_A20	H7	2.5-V	Address bus
39	FSM_A21	J9	2.5-V	Address bus
58	FSM_D0	F16	2.5-V	Data bus
59	FSM_D1	E16	2.5-V	Data bus
62	FSM_D2	M9	2.5-V	Data bus
63	FSM_D3	M8	2.5-V	Data bus
68	FSM_D4	F15	2.5-V	Data bus
69	FSM_D5	E15	2.5-V	Data bus

Table 2-27. SSRAM Pin Assignments, Schematic Signal Names, and Functions (Part 2 of 2)

Board Reference (U11)	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard	Description
72	FSM_D6	E12	2.5-V	Data bus
73	FSM_D7	D13	2.5-V	Data bus
23	FSM_D8	J15	2.5-V	Data bus
22	FSM_D9	H15	2.5-V	Data bus
19	FSM_D10	E11	2.5-V	Data bus
18	FSM_D11	D10	2.5-V	Data bus
12	FSM_D12	L10	2.5-V	Data bus
13	FSM_D13	L9	2.5-V	Data bus
8	FSM_D14	G14	2.5-V	Data bus
9	FSM_D15	F14	2.5-V	Data bus
85	SRAM_ADSCN	E6	2.5-V	Address status controller
84	SRAM_ADSPN	J10	2.5-V	Address status processor
83	SRAM_ADVN	G6	2.5-V	Address valid
93	SRAM_BWAN	A3	2.5-V	Byte write select
94	SRAM_BWBN	A2	2.5-V	Byte write select
97	SRAM_CE2	—	2.5-V	Chip enable 2
92	SRAM_CE3N	—	2.5-V	Chip enable 3
98	SRAM_CEN	D7	2.5-V	Chip enable 1
89	SRAM_CLK	K10	2.5-V	Clock
88	SRAM_GWN	—	2.5-V	Global write enable
31	SRAM_MODE	—	2.5-V	Burst sequence selection
64	SRAM_ZZ	—	2.5-V	Power sleep mode

Flash

The development board supports a 512-Mb CFI-compatible synchronous flash device for non-volatile storage of FPGA configuration data, board information, test application data, and user code space. This device is part of the shared FSM bus that connects to the flash memory, SSRAM, and MAX V CPLD 5M2210 System Controller.

This 16-bit data memory interface can sustain burst read operations at up to 52 MHz for a throughput of 832 Mbps per device. The write performance is 270 μ s for a single word buffer while the erase time is 800 ms for a 128 K array block.

Table 2-28 lists the flash pin assignments, signal names, and functions. The signal names and types are relative to the Cyclone V E FPGA in terms of I/O setting and direction.

Table 2-28. Flash Pin Assignments, Schematic Signal Names, and Functions (Part 1 of 3)

Board Reference (U10)	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard	Description
F6	FLASH_ADVN	H12	2.5-V	Address valid
B4	FLASH_CEN	H14	2.5-V	Chip enable

Table 2-28. Flash Pin Assignments, Schematic Signal Names, and Functions (Part 2 of 3)

Board Reference (U10)	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard	Description
E6	FLASH_CLK	N12	2.5-V	Clock
F8	FLASH_OEN	L11	2.5-V	Output enable
F7	FLASH_RDYBSYN	J12	2.5-V	Ready
D4	FLASH_RESETN	K11	2.5-V	Reset
G8	FLASH_WEN	P12	2.5-V	Write enable
C6	FLASH_WPN	—	2.5-V	Write protect
A1	FSM_A1	B11	2.5-V	Address bus
B1	FSM_A2	A11	2.5-V	Address bus
C1	FSM_A3	D9	2.5-V	Address bus
D1	FSM_A4	C10	2.5-V	Address bus
D2	FSM_A5	A10	2.5-V	Address bus
A2	FSM_A6	A9	2.5-V	Address bus
C2	FSM_A7	C9	2.5-V	Address bus
A3	FSM_A8	B8	2.5-V	Address bus
B3	FSM_A9	B7	2.5-V	Address bus
C3	FSM_A10	A8	2.5-V	Address bus
D3	FSM_A11	B6	2.5-V	Address bus
C4	FSM_A12	A6	2.5-V	Address bus
A5	FSM_A13	C7	2.5-V	Address bus
B5	FSM_A14	C6	2.5-V	Address bus
C5	FSM_A15	F13	2.5-V	Address bus
D7	FSM_A16	E13	2.5-V	Address bus
D8	FSM_A17	A5	2.5-V	Address bus
A7	FSM_A18	A4	2.5-V	Address bus
B7	FSM_A19	J7	2.5-V	Address bus
C7	FSM_A20	H7	2.5-V	Address bus
C8	FSM_A21	J9	2.5-V	Address bus
A8	FSM_A22	H9	2.5-V	Address bus
G1	FSM_A23	G9	2.5-V	Address bus
H8	FSM_A24	F8	2.5-V	Address bus
B6	FSM_A25	E8	2.5-V	Address bus
B8	FSM_A26	D8	2.5-V	Address bus
F2	FSM_D0	F16	2.5-V	Data bus
E2	FSM_D1	E16	2.5-V	Data bus
G3	FSM_D2	M9	2.5-V	Data bus
E4	FSM_D3	M8	2.5-V	Data bus
E5	FSM_D4	F15	2.5-V	Data bus
G5	FSM_D5	E15	2.5-V	Data bus
G6	FSM_D6	E12	2.5-V	Data bus

Table 2-28. Flash Pin Assignments, Schematic Signal Names, and Functions (Part 3 of 3)

Board Reference (U10)	Schematic Signal Name	Cyclone V E FPGA Pin Number	I/O Standard	Description
H7	FSM_D7	D13	2.5-V	Data bus
E1	FSM_D8	J15	2.5-V	Data bus
E3	FSM_D9	H15	2.5-V	Data bus
F3	FSM_D10	E11	2.5-V	Data bus
F4	FSM_D11	D10	2.5-V	Data bus
F5	FSM_D12	L10	2.5-V	Data bus
H5	FSM_D13	L9	2.5-V	Data bus
G7	FSM_D14	G14	2.5-V	Data bus
E7	FSM_D15	F14	2.5-V	Data bus

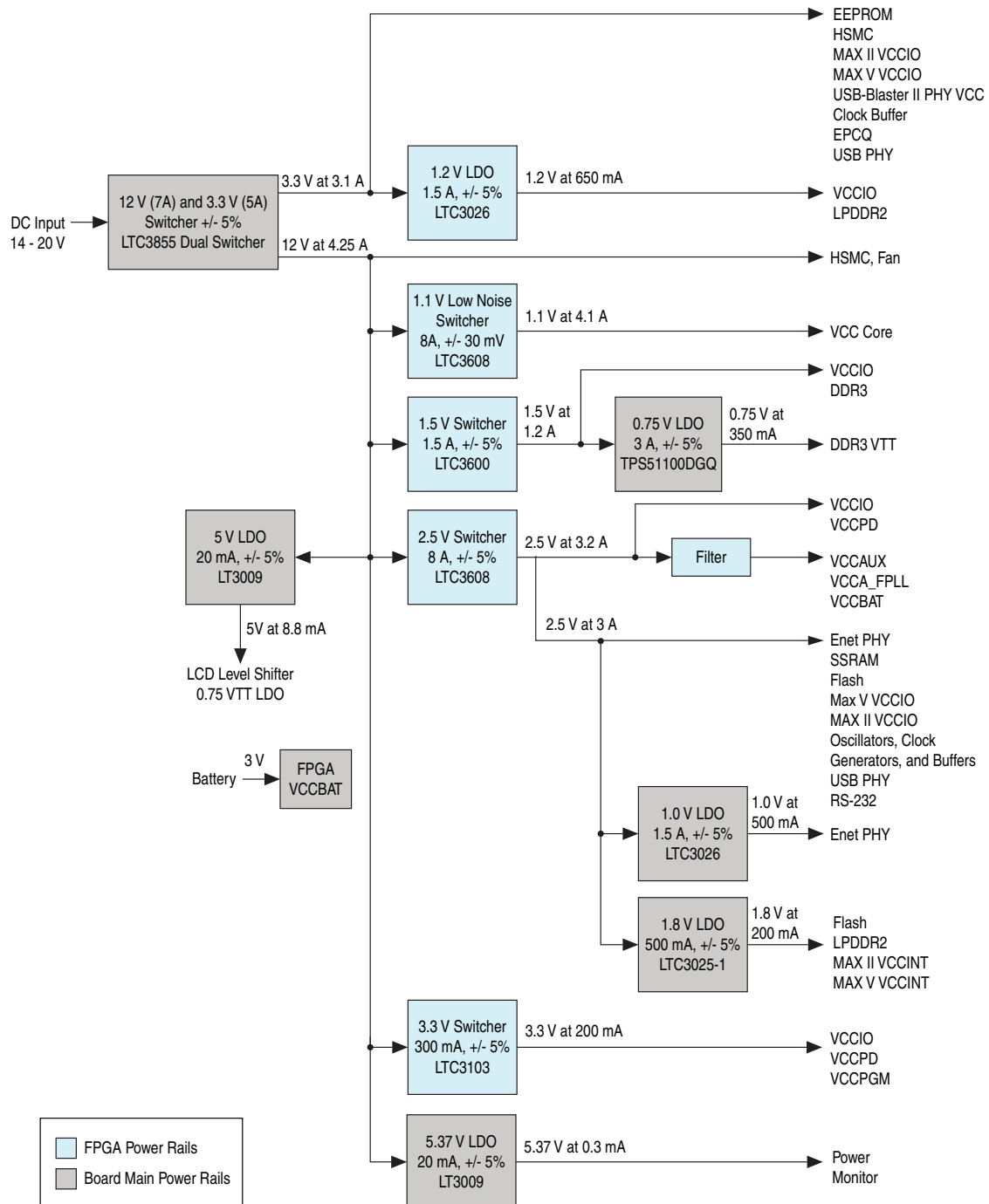
Power Supply

You can power up the development board from a laptop-style DC power input. The input voltage must be in the range of 14 V to 20 V, current of 4.3 A, and a maximum wattage of 65 W. The DC voltage is then stepped down to various power rails used by the board components and installed into the HSMC connectors. An on-board multi-channel analog-to-digital converter (ADC) measures the current for several specific board rails.

Power Distribution System

Figure 2-9 shows the power distribution system on the development board. Regulator inefficiencies and sharing are reflected in the currents shown, which are conservative absolute maximum levels.

Figure 2-9. Power Distribution System



Power Measurement

There are eight power supply rails that have on-board current sense capabilities using 24-bit differential ADC devices. Precision sense resistors split the ADC devices and rails from the primary supply plane for the ADC to measure current. A SPI bus connects these ADC devices to the MAX V CPLD 5M2210 System Controller.

Figure 2-10 shows the block diagram for the power measurement circuitry.

Figure 2-10. Power Measurement Circuit

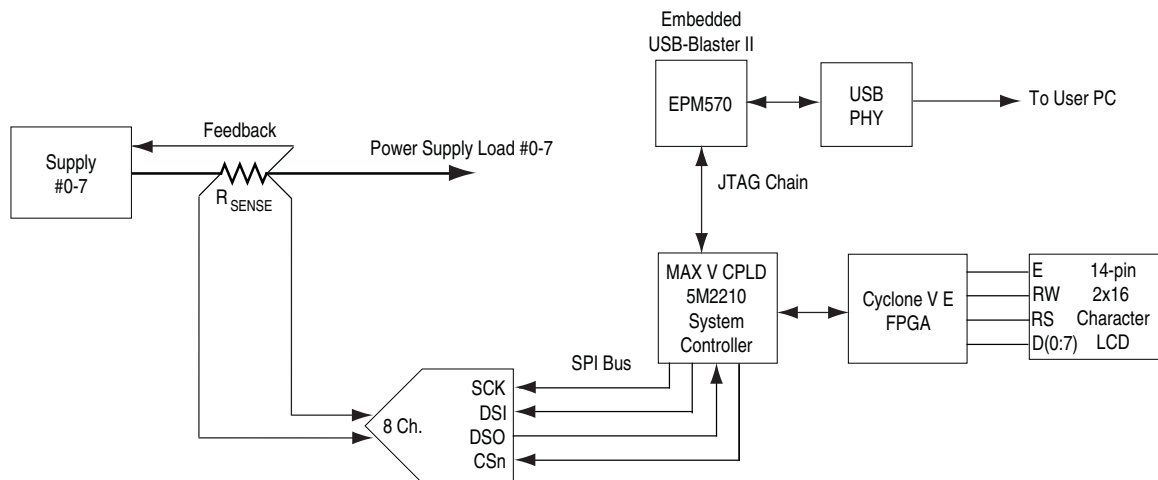


Table 2-29 lists the targeted rails. The schematic signal name column specifies the name of the rail being measured while the device pin column specifies the devices attached to the rail.

Table 2-29. Power Measurement Rails

Channel	Schematic Signal Name	Voltage (V)	Device Pin	Description
1	VCC	1.1	VCC	FPGA core power
2	VCCAUX	2.5	VCC_AUX	Auxiliary
3	VCCA_FPLL	2.5	VCCA_FPLL	PLL analog power
5	VCCIO_VCCPD_2.5V	2.5	VCCPD3B4A, VCCPD5A, VCCPD5B, VCCPD6A, VCCPD7A8A	I/O pre-drivers banks 3B, 4A, 5A, 5B, 6A, 7A, and 8A
			VCCIO3B, VCCIO6A, VCCIO7A, VCCIO8A	VCC I/O banks 3B, 6A, 7A, and 8A
7	VCCIO_1.2V	1.2	VCCIO5A, VCCIO5B,	VCC I/O banks 5A and 5B (LPDDR2)
8	VCCIO_1.5V	1.5	VCCIO_4A	VCC I/O bank 4A (DDR3)

This chapter describes the Cyclone V E FPGA development board components, the manufacturing information, and the board compliance statements.

Board Components

Table lists the component reference and manufacturing information of all the components on the development board.

Table 3–1. Component Reference and Manufacturing Information

Board Reference	Component	Manufacturer	Manufacturing Part Number	Manufacturer Website
U1	FPGA, Cyclone V E F896, 149,500 LEs, leadfree	Altera Corporation	5CEFA7F3117N	www.altera.com
U13	MAX V CPLD 5M2210 System Controller	Altera Corporation	5M2210ZF256I5N	www.altera.com
U18	High-Speed USB peripheral controller	Cypress	CY7C68013A	www.cypress.com
D1-D16, D18-D31,	Green LEDs	Lumex Inc.	SML-LXT0805GW-TR	www.lumex.com
D17	Red LED	Lumex Inc.	SML-LXT0805IW-TR	www.lumex.com
D35	Blue LED	Lumex Inc.	SML-LX0805USBC-TR	www.lumex.com
SW1–SW4	Four-position DIP switches	C&K Components/ ITT Industries	TDA04H0SB1	www.ittcannon.com
S1-S8	Push buttons	Panasonic	EVQPAC07K	www.panasonic.com
S5	Slide switch	E-switch	EG2201A	www.e-switch.com
X1	Programmable LVDS clock 125M defaults	Silicon Labs	570FAB000973DG	www.silabs.com
X3	100 MHz crystal oscillator, ±50 ppm, CMOS, 2.5 V	Silicon Labs	510GBA100M000BAGx	www.silabs.com
X2	50 MHz crystal oscillator, ±50 ppm, CMOS, 2.5 V	Silicon Labs	510GBA50M0000BAGx	www.silabs.com
J12	Female angled PCB WR-DSUB 9-pin connector	Würth Elektronik	618009231121	www.we-online.com
U21	USB-to-UART bridge	Silicon Labs	CP2104	www.silabs.com
J14	2×7 pin LCD socket strip	Samtec	TSM-107-07-G-D	www.samtec.com
	2×16 character LCD, 5×8 dot matrix	Lumex Inc.	LCM-S01602DSR/C	www.lumex.com
U14, U15	Ethernet PHY BASE-T devices	Marvell Semiconductor	88E1111-B2-CAA1C000	www.marvell.com
J8, J9	RJ-45 connectors, 10/100/1000 Mbps	Würth Elektronik	7499111001A	www.we-online.com
J7	HSMC, custom version of QSH-DP family high-speed socket.	Samtec	ASP-122953-01	www.samtec.com
U20	RS-232 dual transceiver	Linear Technology	LTC2803-1	www.linear.com

Table 3-1. Component Reference and Manufacturing Information

Board Reference	Component	Manufacturer	Manufacturing Part Number	Manufacturer Website
U12	64-Kb EEPROM	Microchip	24AA64	www.microchip.com
J15, J16	2 x 8 debug headers	Samtec	TSM-108-01-L-DV	www.samtec.com
U7, U8	16M x 16 x 8, 256-MB DDR3 SDRAM	Micron	MT41J128M16	www.micron.com
U9	16M x 32 x 8, 512-MB LPDDR2 SDRAM	Micron	MT42L128M32	www.micron.com
U11	1024K x 18 bit 18-Mb synchronous SRAM	Integrated Silicon Solution, Inc.	IS61VPS102418A-250TQL	www.issi.com
U10	512-Mb synchronous flash	Numonyx	PC28F512P30BF	www.numonyx.com
U35	16-channel differential 24-bit ADC	Linear Technology	LTC2418CGN#PBF	www.linear.com



Statement of China-RoHS Compliance

Table 3-2 lists hazardous substances included with the kit.

Table 3-2. Table of Hazardous Substances' Name and Concentration *Notes (1), (2)*

Part Name	Lead (Pb)	Cadmium (Cd)	Hexavalent Chromium (Cr6+)	Mercury (Hg)	Polybrominated biphenyls (PBB)	Polybrominated diphenyl Ethers (PBDE)
Cyclone V E development board	X*	0	0	0	0	0
15 V power supply	0	0	0	0	0	0
Type A-B USB cable	0	0	0	0	0	0
User guide	0	0	0	0	0	0

Notes to Table 3-2:

- (1) 0 indicates that the concentration of the hazardous substance in all homogeneous materials in the parts is below the relevant threshold of the SJ/T11363-2006 standard.
- (2) X* indicates that the concentration of the hazardous substance of at least one of all homogeneous materials in the parts is above the relevant threshold of the SJ/T11363-2006 standard, but it is exempted by EU RoHS.

CE EMI Conformity Caution

This development kit is delivered conforming to relevant standards mandated by Directive 2004/108/EC. Because of the nature of programmable logic devices, it is possible for the user to modify the kit in such a way as to generate electromagnetic interference (EMI) that exceeds the limits established for this equipment. Any EMI caused as the result of modifications to the delivered material is the responsibility of the user.

This chapter provides additional information about the document and Altera.

Board Revision History

The following table lists the versions of all releases of the Cyclone V E FPGA Development Board.

Release Date	Version	Description
March 2013	Production silicon	<ul style="list-style-type: none"> ■ New board revision. New device part number—5CEFA7F3117N. ■ Board passed CE compliance testing.
November 2012	Engineering silicon	Initial release.

Document Revision History











The following table lists the revision history for this document.

Date	Version	Changes
August 2017	1.4	Corrected board location for Clock Output SMA Connector in “ Overview of the Cyclone V E FPGA Development Board Features ” on page 2–2.
January 2017	1.3	Corrected ENETA_RX_DV pin number in Table 2–20 on page 2–25.
September 2015	1.2	<ul style="list-style-type: none"> ■ Added link to Altera Design Store in “MAX V CPLD 5M2210 System Controller” on page 2–5. ■ Corrected device label in Figure 2–5 on page 2–15.
March 2013	1.1	<ul style="list-style-type: none"> ■ Revised the FPGA device part number for production silicon release. ■ Added a section about “CE EMI Conformity Caution” on page 3–2.
November 2012	1.0	Initial release.

Typographic Conventions

The following table shows the typographic conventions this document uses.

Visual Cue	Meaning
Bold Type with Initial Capital Letters	Indicate command names, dialog box titles, dialog box options, and other GUI labels. For example, Save As dialog box. For GUI elements, capitalization matches the GUI.
bold type	Indicates directory names, project names, disk drive names, file names, file name extensions, software utility names, and GUI labels. For example, \qdesigns directory, D: drive, and chiptrip.gdf file.
<i>Italic Type with Initial Capital Letters</i>	Indicate document titles. For example, <i>Stratix IV Design Guidelines</i> .

Visual Cue	Meaning
<i>italic type</i>	Indicates variables. For example, $n + 1$. Variable names are enclosed in angle brackets (< >). For example, <file name> and <project name>.pdf file.
Initial Capital Letters	Indicate keyboard keys and menu names. For example, the Delete key and the Options menu.
“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, data1, tdi, and input. The suffix n denotes an active-low signal. For example, resetn. Indicates command line commands and anything that must be typed exactly as it appears. For example, c:\qdesigns\tutorial\chiptrip.gdf. Also indicates sections of an actual file, such as a Report File, references to parts of files (for example, the AHDL keyword SUBDESIGN), and logic function names (for example, TRI).
	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.
	The multimedia icon directs you to a related multimedia presentation.
 CAUTION	A caution calls attention to a condition or possible situation that can damage or destroy the product or your work.
 WARNING	A warning calls attention to a condition or possible situation that can cause you injury.
	The envelope links to the Email Subscription Management Center 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.