ML510 Embedded Development Platform

User Guide

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Revision History

The following table shows the revision history for this document.

Date	Version	Revision
08/25/08	1.0	Initial Xilinx release.
08/29/08	1.0.1	Minor typographical edits.
12/11/08	1.1	• Added “System Monitor” section. • Corrected Table 1-40, page 71, pins A15 and A16. • Removed support for unbuffered DIMMs.
06/16/11	1.2	Corrected FPGA pin “H7” to pin ”J15” in section “CPU Reset (SW2),” page 58.

Table of Contents

Appendix A: References

About This Guide

This manual accompanies the ML510 series of Embedded Development Platforms and contains information about the ML510 hardware and software tools.

Guide Contents

This manual contains the following chapters:

- Chapter 1, "ML510 Embedded Development Platform" provides an overview of the embedded development platform and details the components and features of the ML510 board
- Appendix A, "References"

Additional Documentation

The following documents are also available for download at http://www.xilinx.com/virtex5.

- Virtex-5 Family Overview

  The features and product selection of the Virtex-5 family are outlined in this overview.
- Virtex-5 FPGA Data Sheet: DC and Switching Characteristics

  This data sheet contains the DC and Switching Characteristic specifications for the Virtex-5 family.
- Virtex-5 FPGA Integrated Endpoint Block User Guide for PCI Express Designs

  This guide describes the integrated Endpoint blocks in the Virtex-5 LXT and SXT platform devices that are PCI Express® compliant.
- Virtex-5 FPGA User Guide

  Chapters in this guide cover the following topics: Clocking resources, Clock Management Technology (CMT), Phase-Locked Loops (PLLs), block RAM, Configurable Logic Blocks (CLBs), SelectIO™ resources, and SelectIO logic resources
- Virtex-5 FPGA RocketIO™ GTX Transceiver User Guide

  This guide describes the RocketIO GTX transceivers available in the Virtex-5 FXT platform devices.
- Virtex-5 FPGA Embedded Tri-Mode Ethernet MAC

  This guide describes the dedicated Tri-Mode Ethernet Media Access Controller available in the Virtex-5 LXT, SXT, and FXT platform devices.

- XtremeDSP Design Considerations

  This guide describes the XtremeDSP™ slice and includes reference designs for using the DSP48E.

- Virtex-5 FPGA Configuration Guide

  This all-encompassing configuration guide includes chapters on configuration interfaces (serial and SelectMAP), bitstream encryption, Boundary-Scan and JTAG configuration, reconfiguration techniques, and readback through the SelectMAP and JTAG interfaces.

- Virtex-5 FPGA System Monitor User Guide

  The System Monitor functionality available in all the Virtex-5 devices is outlined in this guide.

- Virtex-5 FPGA Packaging Specifications

  This specification includes the tables for device/package combinations and maximum I/Os, pin definitions, pinout tables, pinout diagrams, mechanical drawings, and thermal specifications.

- Virtex-5 FPGA PCB Designer's Guide

  This guide provides information on PCB design for Virtex-5 devices, with a focus on strategies for making design decisions at the PCB and interface level.

Additional Support Resources

To search the database of silicon and software questions and answers, or to create a technical support case in WebCase, see the Xilinx website at: http://www.xilinx.com/support.

Typographical Conventions

This document uses the following typographical conventions. An example illustrates each convention.

Convention	Meaning or Use	Example
Italic font	References to other documents	See the *Virtex-5 Configuration Guide* for more information.
	Emphasis in text	The address (F) is asserted *after* clock event 2.
Underlined Text	Indicates a link to a web page.	http://www.xilinx.com/virtex5

Online Document

The following conventions are used in this document:

Convention	Meaning or Use	Example
Blue text	Cross-reference link to a location in the current document	See the section "Additional Documentation" for details.

Convention	Meaning or Use	Example
Red text	Cross-reference link to a location in another document	See Figure 5 in the *Virtex-5 Data Sheet*
Blue, underlined text	Hyperlink to a website (URL)	Go to http://www.xilinx.com for the latest documentation.

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Chapter 1

ML510 Embedded Development Platform

Overview

The ML510 series of Embedded Development Platforms offer designers a versatile Virtex®-5 FXT platform for rapid prototyping and system verification. In addition to the more than 130,000 logic cells, over 10,700 kb of block RAM, dual IBM PowerPC® 440 (PPC440) processors, and RocketIO transceivers available in the FPGA, the ML510 provides an onboard Ethernet MAC PHY, DDR2 memory, multiple PCI bus slots, and standard front panel interface ports within an ATX form factor motherboard. An integrated System ACE™ CompactFlash (CF) controller is deployed to perform board bring-up and to load applications from the CompactFlash card.

The ML510 website contains up-to-date documentation and files, including tutorials, device data sheets, reference designs, and utilities. The *Embedded Processor Block in Virtex-5 FPGAs Reference Guide* [Ref 4] should be reviewed as well as the data sheets corresponding to the devices listed in "Detailed Description."

The setup and quickstart documentation highlights the functionality of the ML510, using the applications contained on the CompactFlash card. The reference designs were produced using the Xilinx® Embedded Development Kit (EDK), ISE, and Answer Browser solution records. Tutorials, in coordination with Xilinx documentation for EDK, ISE, and the Answer Browser, describe how the reference designs and applications were produced. These tutorials can be used to re-create the provided applications and also as a basis for the development of new designs. Xilinx EDK provides for the development of basic board-specific systems, beginning with Base System Builder (BSB), to highly customized systems that leverage the flexibility of Xilinx Platform Studio (XPS) and the EDK intellectual property (IP).

Package Contents

- Xilinx Virtex-5 FPGA ML510 Embedded Development Platform
- System ACE CompactFlash card
- Power supply
- 2 x 512 MB DDR2 DIMMs
- 16-character LCD display

Additional Information

Additional information and support material is located at:

- http://www.xilinx.com/ml510

This information includes:

- Current version of this user guide in PDF format
- Example design files for demonstration of Virtex-5 FPGA features and technology
- Demonstration hardware and software configuration files for the System ACE controller, Platform Flash configuration storage device, CPLD, and linear flash chips
- EDK reference design files
- Full schematics in PDF format and ViewDraw schematic format
- PC board layout in Allegro PCB format
- Gerber files for the PC board (Many free or shareware Gerber file viewers are available on the internet for viewing and printing these files.)
- Additional documentation, errata, frequently asked questions, and the latest news

For information about the Virtex-5 family of FPGA devices, including product highlights, data sheets, user guides, and application notes, see the Virtex-5 FPGA website at www.xilinx.com/virtex5. Additional information is available from the data sheets and application notes from the component manufacturers.

Features

- ATX form factor motherboard and ATX-compliant power supply
- Dual DDR2 registered DIMMs; each 512 MB density and 72 bits wide
- 512 MB CompactFlash (CF) card and System ACE CF controller for configuration*
- Intel P30 StrataFlash linear flash chip (256 Mb)
- Two onboard 10/100/1000 Ethernet PHYs with RJ-45 connectors
- PCI Express interface and MIC2592B PCI Express power controller
- Two UARTs with RS-232 connectors
- DVI graphics interface
- LEDs, LCD*, and switches
- 32/33 PCI subsystem
  - Two 3.3V slot and two 5V slots
  - ALi South Bridge SuperIO controller
    - PS/2 mouse and keyboard connectors
    - 3.5 mm headphone and microphone connectors
    - Two USB peripheral ports
- Two serial ATA connectors
- Xilinx Personality Module (XPM) interface for access to:
  - RocketIO GTX transceivers
  - SPI4.2
  - GPIO
  - Power

- JTAG and trace debug ports
- High-speed I/O through RocketIO GTX transceivers
- Encryption battery
- Fan controller
- Onboard power regulators for all necessary voltages
- IIC/SMBus interface*
  - LTC1694 SMBus accelerator
  - RTC8566 Real Time Clock (RTC)
  - 64 kb 24LC64 EEPROM
  - LM87 voltage/temp monitor
  - Two DDR2 DIMMs with SPD EEPROMs
- SPI EEPROM (64 Kb)*

Note: * Compatible with EDK supported IP and software drivers

Block Diagram

Figure 1-1 shows a high-level block diagram of the ML510 and its peripherals.

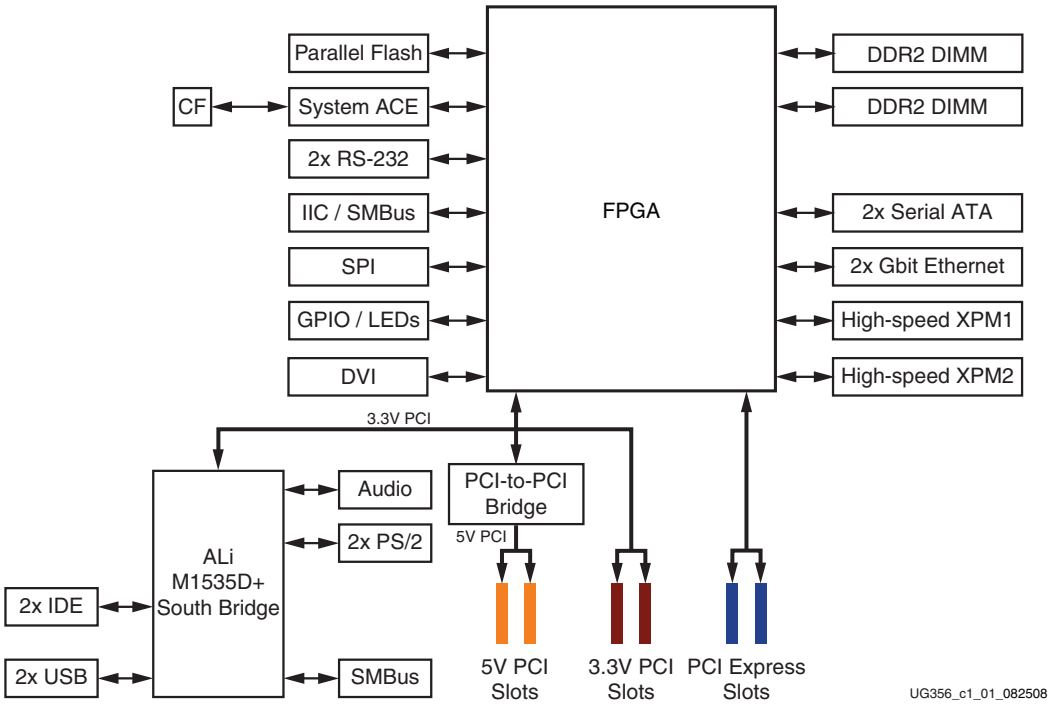


Figure 1-1: **ML510 High-Level Block Diagram**

Related Xilinx Documents

Prior to using the ML510 Embedded Development Platform, users should be familiar with Xilinx resources. See Appendix A, "References" for direct links to Xilinx documentation. See the following locations for additional documentation on Xilinx tools and solutions:

- EDK: www.xilinx.com/edk

- ISE: www.xilinx.com/ise
- Answer Browser: www.xilinx.com/support
- Intellectual Property: www.xilinx.com/ipcenter

Detailed Description

The ML510, shown in Figure 1-2, is an example of the ML510 series described in this user guide.

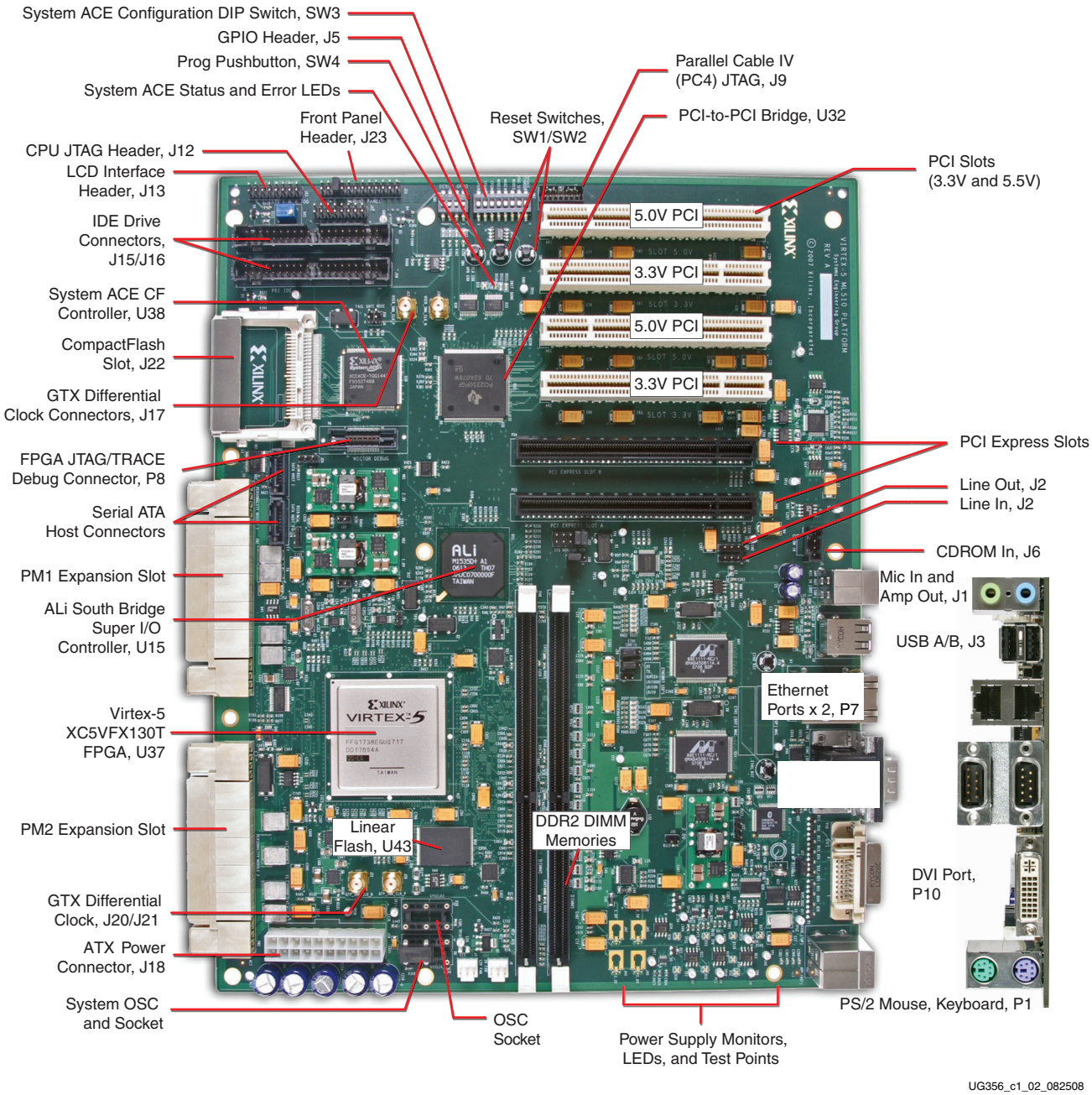


Figure 1-2: **ML510 Board and Front Panel Detail**

Virtex-5 FPGA

A Xilinx Virtex-5 FPGA, XC5VFX130T-2FFG1738C, is installed on the Embedded Development Platform (the board).

Configuration

ML510 platforms support configuration in JTAG mode only. Configuration can be accomplished by using a Xilinx download cable (such as Parallel Cable IV or Platform Cable USB) or by using the onboard System ACE CompactFlash solution. See the *System ACE Configuration Solution Data Sheet*. [Ref 12]

I/O Voltage Rails

The FPGA requires different banking voltages that are set based on the I/O voltage interface requirements of each device directly connected to the FPGA. The Virtex-5 FPGA I/O can be configured to use different I/O standards such as SSTL18 as required on the DDR2 DIMM interface. See the *Virtex-5 Data Sheet* [Ref 2] for more information regarding I/O standards.

The voltage applied to the FPGA I/O banks used by the ML510 board is summarized in Table 1-1. Some banks can support the DCI feature in Virtex-5 FPGAs.

Table 1-1: **I/O Voltage Rail of FPGA Banks**

FPGA Bank	I/O Voltage Rail	DCI-Capable	Description
1	3.3V	No	Flash
2	3.3V	No	Flash, System ACE controller, and DVI
3	2.5V	No	PCI Express controls and clocks
4	3.3V	No	Flash and DVI
5	2.5V	Yes	PMIO
6	2.5V	Yes	Debug
7	-	-	Unused
8	-	-	Unused
11	1.8V	No	DIMM0 and DIMM1
12	1.2V	Yes	PMIO
13	1.8V	Yes	DIMM0
15	1.8V	Yes	DIMM0
17	1.8V	Yes	DIMM1
18	2.5V	Yes	PMIO
19	1.8V	Yes	DIMM0
20	3.0V	No	PCI
21	1.8V	Yes	DIMM1
23	1.8V	Yes	DIMM0
24	3.0V	No	PCI

Table 1-1: **I/O Voltage Rail of FPGA Banks *(Cont'd)***

FPGA Bank	I/O Voltage Rail	DCI-Capable	Description
25	2.5V	No	PHY0 and PMIO
26	3.3V	No	System ACE controller and DVI

Clock Generation

ML510 boards are equipped with two crystal oscillator sockets (X6 and X10) each wired for standard LVTTL-type oscillators. Both sockets accept half- and full-size oscillators. See the reference design documentation on the ML510 website for examples of how to set up the clocks on ML510 boards.

X6 is populated with a 100 MHz oscillator that provides the system clock. This system clock is typically used to generate multiple other clocks with varying frequencies and phases within the FPGA fabric by using the Virtex-5 DCMs. The FPGA also generates and drives clocks required by the DDR2 DIMM memory and PCI bus interfaces. If required, a second user clock can be brought into the FPGA by installing a second oscillator in the X10 socket.

High-precision clock signals can be supplied to the FPGA using differential clock signals brought in through 50Ω SMA connectors. A single-ended clock can be connected to USER_SMA_CLK_P. Two additional single-ended clocks can be supplied through the XPM connectors. Furthermore, ML510 boards are equipped with several high-precision clocks for driving the high-speed RocketIO transceivers. These clocks can also be used to drive the global clock nets of the FPGA. See the *Virtex-5 Data Sheet* [Ref 2] for details.

Figure 1-3 is an example of the clock distribution for the ML510 board.

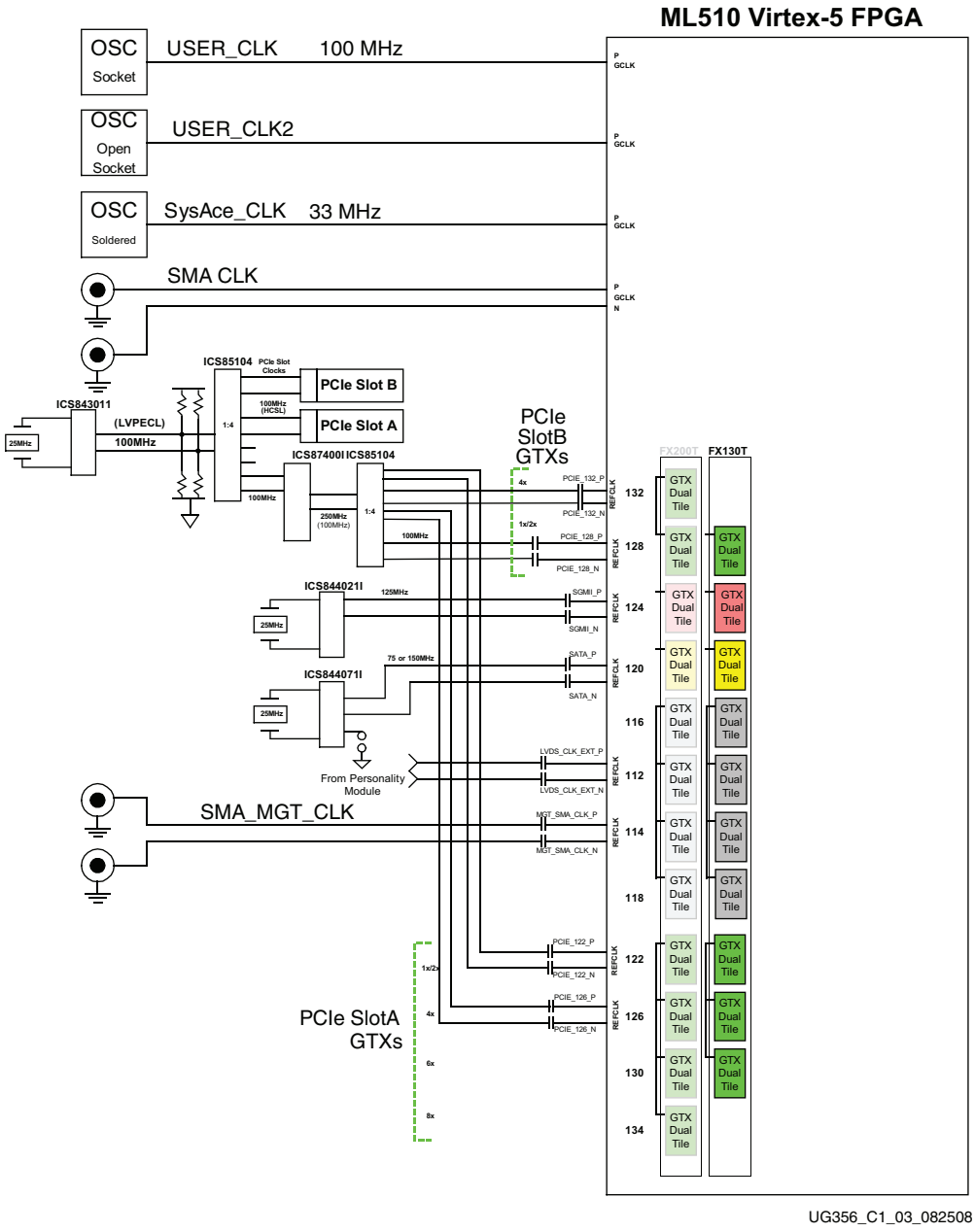


Figure 1-3: **ML510 Clock Distribution**

Table 1-2 shows the ML510 clock connections.

Table 1-2: **Clock Connections**

Schematic Net Name	Clock Source	FPGA Pin (U37)	Description
USER_CLKSYS	X6	L29	100 MHz socketed user clock oscillator (2.5V).
USER_CLK2	X10	K29	Socket for user-supplied clock oscillator (3.3V)(1).
USER_SMA_CLK_N	J36	L30	100Ω differential SMA connections that can be used as a differential pair clock.
USER_SMA_CLK_P	J17	K30	100Ω differential SMA connections that can be used as a differential pair clock. J17 can be used single ended at 50Ω
PM_CLK_TOP	PM1.F9	M27	Personality module clock (top) (2.5V)(1).
PM_CLK_BOT	PM2.F10	L14	Personality module clock (bottom) (2.5V)(1).
LVDS_CLKEXT_P_C	PM1.F12	V4	LVDS pair (2.5V)(1). Frequency is user-defined.
LVDS_CLKEXT_N_C	PM1.F11	V3	LVDS pair (2.5V)(1). Frequency is user-defined.
SGMIICLK_QO_P	X7	C4	125 MHz SMA
SGMIICLK_QO_N		C3	125 MHz SMA
GTP_SMA_CLK_P	J20	AD4	RocketIO GTX REFCLK_114 (P)
GTP_SMA_CLK_N	J21	AD3	RocketIO GTX REFCLK_114 (N)
SATACLK_QO_P	(Selectable)	F4	75 or 150 MHz jumper selectable.
SATACLK_QO_N	(Selectable)	F3	75 or 150 MHz jumper selectable.

Notes:

1. See "High-Speed I/O," page 66.

DDR2 Memory

ML510 platforms have two DDR2 SDRAM Dual Inline Memory Modules (DIMMs) that enable users to build independent systems.

MIG Compliance

The ML510 DDR2 memory interfaces are MIG-compliant, having passed simulation using standard Virtex-5 IBIS models. DDR2 routing guidelines are achieved. The DDR2 Clocks are fanned out using zero-delay buffers.

The board's DDR2 memory interfaces are designed to the requirements defined by the *Xilinx Memory Interface Generator (MIG) User Guide* [Ref 21] using the MIG tool [Ref 23]. The MIG documentation requires that designers follow the MIG pinout and layout guidelines. The MIG tool generates and ensures that the proper FPGA I/O pin selections are made in support of the board's DDR2 interfaces. The initial pin selection for the board was modified and then re-verified to meet the MIG pinout requirements. To ensure a robust interface, the ML510 DDR2 layout incorporates matched trace lengths for data signals to the corresponding data strobe signal as defined in the MIG user guide. See Appendix A, "References" for links to additional information about MIG and Virtex-5 FPGAs in general.

Dual DDR2 SDRAM DIMMs

The DDR2 DIMMs are standard 240-pin DIMM sockets, supporting standard computer DDR2 memory.

ML510 boards are shipped with dual single-rank registered 512 MB PC2-5300 DDR2-667 DIMMs. The DDR2 DIMM is commercially available from Wintec Industries. The DDR2 DIMM uses nine 32M x 8 DDR2 SDRAM devices with 14-row address lines, 10-column address lines, and two bank address lines. Read and write access is programmable in burst lengths of 4 or 8. The memory module inputs and outputs are compatible with SSTL18 signaling. Serial Presence Detect (SPD) using an IIC interface to the DDR DIMM is also supported. See the "IIC/SMBus Interface" section for more details on accessing the DIMM module's SPD EEPROM.

The DDR2 DIMM memory interface includes a 72-bit wide datapath to the DDR2 DIMM, which includes 8 bits for ECC.

DDR2 Memory Expansion

The DDR2 interface is very flexible and can accommodate different DDR2 memory requirements, such as increased memory size. Please review the *Embedded Processor Block in Virtex-5 FPGAs Reference Guide* [Ref 4] when migrating to a different DDR2 DIMM.

DDR2 Clock Signal

The DDR2 clock signal is broadcast from the FPGA as a single differential pair that drives a clock fan-out chip, which then drives the DDR2 DIMM. The delay on the clock trace is designed to match the delay of the other DDR2 control and data signals. The DDR2 clock is also fed back to the FPGA to allow for clock deskew using Virtex-5 DCMs. The board is designed so that the DDR2 clock signal reaches the FPGA clock feedback pin at the same time as it arrives at the DDR2 DIMM. This clock fanout circuit is duplicated for both DIMM interfaces.

DDR2 Signaling

Only DDR2 SDRAM control signals are terminated through 47Ω resistors to a 0.9V VTT reference voltage. The board is designed for matched length traces across all DDR2 control and data signals, except clocks. The FPGA DDR2 interface supports SSTL18 signaling. All DDR2 signals are controlled impedance and are SSTL18 at the DIMM via ODT and at the FPGA via DCI.

Table 1-3, page 18 describes all the signals associated with DDR2 DIMM component memories. Note that the DDR2_DQ signal names do not correlate because the FPGA uses IBM notation, big endian, while the DDR2 DIMM uses Intel notation, little endian.

Table 1-3: **Connections from FPGA to DDR2 DIMM0 Interface (P48)**

Schematic Net Name	FPGA Pin (U37)	DDR2 DIMM0 (P48)
DIMM0_DDR2_WE_B	Y40	73
DIMM0_DDR2_S1_B	M37	77
DIMM0_DDR2_S0_B	U32	193
DIMM0_DDR2_RAS_B	W40	192
DIMM0_DDR2_CAS_B	AA37	74
DIMM0_DDR2_PLL_CLKIN_P	AA40	138
DIMM0_DDR2_PLL_CLKIN_N	AA39	137
DIMM0_DDR2_ODT1	K35	76
DIMM0_DDR2_ODT0	U31	195
DIMM0_DDR2_DQS8_P	H40	46
DIMM0_DDR2_DQS8_N	J40	45
DIMM0_DDR2_DQS7_P	K38	114
DIMM0_DDR2_DQS7_N	J38	113
DIMM0_DDR2_DQS6_P	M38	105
DIMM0_DDR2_DQS6_N	L39	104
DIMM0_DDR2_DQS5_P	U36	93
DIMM0_DDR2_DQS5_N	V36	92
DIMM0_DDR2_DQS4_P	R35	84
DIMM0_DDR2_DQS4_N	T36	83
DIMM0_DDR2_DQS3_P	T34	37
DIMM0_DDR2_DQS3_N	U33	36
DIMM0_DDR2_DQS2_P	E32	28
DIMM0_DDR2_DQS2_N	E33	27
DIMM0_DDR2_DQS1_P	F31	16
DIMM0_DDR2_DQS1_N	F32	15
DIMM0_DDR2_DQS0_P	E34	7
DIMM0_DDR2_DQS0_N	F34	6
DIMM0_DDR2_DQM8	G39	164
DIMM0_DDR2_DQM7	W36	232
DIMM0_DDR2_DQM6	T39	223
DIMM0_DDR2_DQM5	V35	211

Table 1-3: **Connections from FPGA to DDR2 DIMM0 Interface (P48) *(Cont'd)***

Schematic Net Name	FPGA Pin (U37)	DDR2 DIMM0 (P48)
DIMM0_DDR2_DQM4	M36	202
DIMM0_DDR2_DQM3	F36	155
DIMM0_DDR2_DQM2	P33	146
DIMM0_DDR2_DQM1	L32	134
DIMM0_DDR2_DQM0	F35	125
DIMM0_DDR2_DQ63	W35	236
DIMM0_DDR2_DQ62	W37	235
DIMM0_DDR2_DQ61	T37	230
DIMM0_DDR2_DQ60	P37	229
DIMM0_DDR2_DQ59	Y34	117
DIMM0_DDR2_DQ58	AA34	116
DIMM0_DDR2_DQ57	AA36	111
DIMM0_DDR2_DQ56	AA35	110
DIMM0_DDR2_DQ55	V39	227
DIMM0_DDR2_DQ54	R37	226
DIMM0_DDR2_DQ53	R39	218
DIMM0_DDR2_DQ52	N38	217
DIMM0_DDR2_DQ51	W38	107
DIMM0_DDR2_DQ50	Y35	108
DIMM0_DDR2_DQ49	P38	99
DIMM0_DDR2_DQ48	U38	98
DIMM0_DDR2_DQ47	W33	215
DIMM0_DDR2_DQ46	Y33	214
DIMM0_DDR2_DQ45	T35	209
DIMM0_DDR2_DQ44	R34	208
DIMM0_DDR2_DQ43	AA32	96
DIMM0_DDR2_DQ42	Y32	95
DIMM0_DDR2_DQ41	W32	90
DIMM0_DDR2_DQ40	V33	89
DIMM0_DDR2_DQ39	P35	206
DIMM0_DDR2_DQ38	N36	205
DIMM0_DDR2_DQ37	L36	200
DIMM0_DDR2_DQ36	J35	199

Table 1-3: **Connections from FPGA to DDR2 DIMM0 Interface (P48) *(Cont'd)***

Schematic Net Name	FPGA Pin (U37)	DDR2 DIMM0 (P48)
DIMM0_DDR2_DQ35	U34	87
DIMM0_DDR2_DQ34	V34	86
DIMM0_DDR2_DQ33	P36	81
DIMM0_DDR2_DQ32	N35	80
DIMM0_DDR2_DQ31	J37	159
DIMM0_DDR2_DQ30	H35	158
DIMM0_DDR2_DQ29	E38	153
DIMM0_DDR2_DQ28	D37	152
DIMM0_DDR2_DQ27	K37	40
DIMM0_DDR2_DQ26	J36	39
DIMM0_DDR2_DQ25	G36	34
DIMM0_DDR2_DQ24	F37	33
DIMM0_DDR2_DQ23	T31	150
DIMM0_DDR2_DQ22	R32	149
DIMM0_DDR2_DQ21	P31	144
DIMM0_DDR2_DQ20	N34	143
DIMM0_DDR2_DQ19	T32	31
DIMM0_DDR2_DQ18	R33	30
DIMM0_DDR2_DQ17	P32	25
DIMM0_DDR2_DQ16	N33	24
DIMM0_DDR2_DQ15	N31	141
DIMM0_DDR2_DQ14	M32	140
DIMM0_DDR2_DQ13	K33	132
DIMM0_DDR2_DQ12	K32	131
DIMM0_DDR2_DQ11	M34	22
DIMM0_DDR2_DQ10	M33	21
DIMM0_DDR2_DQ9	L31	13
DIMM0_DDR2_DQ8	J33	12
DIMM0_DDR2_DQ7	H34	129
DIMM0_DDR2_DQ6	H31	128
DIMM0_DDR2_DQ5	G33	123
DIMM0_DDR2_DQ4	G32	122
DIMM0_DDR2_DQ3	H33	10

Table 1-3: **Connections from FPGA to DDR2 DIMM0 Interface (P48) *(Cont'd)***

Schematic Net Name	FPGA Pin (U37)	DDR2 DIMM0 (P48)
DIMM0_DDR2_DQ2	J31	9
DIMM0_DDR2_DQ1	G31	4
DIMM0_DDR2_DQ0	E35	3
DIMM0_DDR2_CKE1	L37	171
DIMM0_DDR2_CKE0	M31	52
DIMM0_DDR2_CB7	H39	168
DIMM0_DDR2_CB6	G38	167
DIMM0_DDR2_CB5	E39	162
DIMM0_DDR2_CB4	E40	161
DIMM0_DDR2_CB3	H38	49
DIMM0_DDR2_CB2	K40	48
DIMM0_DDR2_CB1	F39	43
DIMM0_DDR2_CB0	F40	42
DIMM0_DDR2_CAS_B	AA37	74
DIMM0_DDR2_BA2	K39	54
DIMM0_DDR2_BA1	M39	190
DIMM0_DDR2_BA0	N39	71
DIMM0_DDR2_A13	Y37	196
DIMM0_DDR2_A12	N41	176
DIMM0_DDR2_A11	N40	57
DIMM0_DDR2_A10	AA41	70
DIMM0_DDR2_A9	L40	177
DIMM0_DDR2_A8	P42	179
DIMM0_DDR2_A7	R42	58
DIMM0_DDR2_A6	P41	180
DIMM0_DDR2_A5	T40	60
DIMM0_DDR2_A4	U42	61
DIMM0_DDR2_A3	T42	182
DIMM0_DDR2_A2	U41	63
DIMM0_DDR2_A1	P40	183
DIMM0_DDR2_A0	AA42	188

Table 1-4: **Connections from FPGA to DDR2 DIMM1 Interface (P9)**

UCF Signal Name	FPGA Pin (U37)	DDR2 DIMM1 (P9)
DIMM1_DDR2_WE_B	V40	73
DIMM1_DDR2_S1_B	AE37	77
DIMM1_DDR2_S0_B	AU42	193
DIMM1_DDR2_RAS_B	V41	192
DIMM1_DDR2_CAS_B	Y42	74
DIMM1_DDR2_PLL_CLKIN_P	Y39	138
DIMM1_DDR2_PLL_CLKIN_N	Y38	137
DIMM1_DDR2_ODT1	AF37	76
DIMM1_DDR2_ODT0	AV41	195
DIMM1_DDR2_DQS8_P	AH34	46
DIMM1_DDR2_DQS8_N	AG34	45
DIMM1_DDR2_DQS7_P	AF35	114
DIMM1_DDR2_DQS7_N	AF36	113
DIMM1_DDR2_DQS6_P	AE35	105
DIMM1_DDR2_DQS6_N	AF34	104
DIMM1_DDR2_DQS5_P	AT39	93
DIMM1_DDR2_DQS5_N	AR39	92
DIMM1_DDR2_DQS4_P	AV40	84
DIMM1_DDR2_DQS4_N	AU39	83
DIMM1_DDR2_DQS3_P	AR40	37
DIMM1_DDR2_DQS3_N	AT40	36
DIMM1_DDR2_DQS2_P	AC40	28
DIMM1_DDR2_DQS2_N	AC39	27
DIMM1_DDR2_DQS1_P	AE40	16
DIMM1_DDR2_DQS1_N	AD40	15
DIMM1_DDR2_DQS0_P	AB39	7
DIMM1_DDR2_DQS0_N	AC38	6
DIMM1_DDR2_DQM8	AD33	164
DIMM1_DDR2_DQM7	AV39	232
DIMM1_DDR2_DQM6	AK35	223
DIMM1_DDR2_DQM5	AN40	211
DIMM1_DDR2_DQM4	AG37	202

Table 1-4: **Connections from FPGA to DDR2 DIMM1 Interface (P9) *(Cont'd)***

UCF Signal Name	FPGA Pin (U37)	DDR2 DIMM1 (P9)
DIMM1_DDR2_DQM3	AC36	155
DIMM1_DDR2_DQM2	AP41	146
DIMM1_DDR2_DQM1	AH41	134
DIMM1_DDR2_DQM0	AC41	125
DIMM1_DDR2_DQ63	AN34	236
DIMM1_DDR2_DQ62	AU38	235
DIMM1_DDR2_DQ61	AR37	230
DIMM1_DDR2_DQ60	AN36	229
DIMM1_DDR2_DQ59	AU37	117
DIMM1_DDR2_DQ58	AT36	116
DIMM1_DDR2_DQ57	AT37	111
DIMM1_DDR2_DQ56	AP35	110
DIMM1_DDR2_DQ55	AK34	227
DIMM1_DDR2_DQ54	AR38	226
DIMM1_DDR2_DQ53	AL36	218
DIMM1_DDR2_DQ52	AE32	217
DIMM1_DDR2_DQ51	AL34	107
DIMM1_DDR2_DQ50	AM34	108
DIMM1_DDR2_DQ49	AM36	99
DIMM1_DDR2_DQ48	AL35	98
DIMM1_DDR2_DQ47	AN39	215
DIMM1_DDR2_DQ46	AN38	214
DIMM1_DDR2_DQ45	AK38	209
DIMM1_DDR2_DQ44	AL39	208
DIMM1_DDR2_DQ43	AP38	96
DIMM1_DDR2_DQ42	AM37	95
DIMM1_DDR2_DQ41	AP40	90
DIMM1_DDR2_DQ40	AM38	89
DIMM1_DDR2_DQ39	AJ37	206
DIMM1_DDR2_DQ38	AK39	205
DIMM1_DDR2_DQ37	AG38	200
DIMM1_DDR2_DQ36	AF39	199
DIMM1_DDR2_DQ35	AM39	87

Table 1-4: **Connections from FPGA to DDR2 DIMM1 Interface (P9) *(Cont'd)***

UCF Signal Name	FPGA Pin (U37)	DDR2 DIMM1 (P9)
DIMM1_DDR2_DQ34	AL37	86
DIMM1_DDR2_DQ33	AH38	81
DIMM1_DDR2_DQ32	AJ38	80
DIMM1_DDR2_DQ31	AD37	159
DIMM1_DDR2_DQ30	AD35	158
DIMM1_DDR2_DQ29	AC35	153
DIMM1_DDR2_DQ28	AB34	152
DIMM1_DDR2_DQ27	AE38	40
DIMM1_DDR2_DQ26	AD36	39
DIMM1_DDR2_DQ25	AC34	34
DIMM1_DDR2_DQ24	AB36	33
DIMM1_DDR2_DQ23	AT41	150
DIMM1_DDR2_DQ22	AT42	149
DIMM1_DDR2_DQ21	AM41	144
DIMM1_DDR2_DQ20	AN41	143
DIMM1_DDR2_DQ19	AR42	31
DIMM1_DDR2_DQ18	AP42	30
DIMM1_DDR2_DQ17	AL42	25
DIMM1_DDR2_DQ16	AK42	24
DIMM1_DDR2_DQ15	AL41	141
DIMM1_DDR2_DQ14	AJ42	140
DIMM1_DDR2_DQ13	AH40	132
DIMM1_DDR2_DQ12	AG42	131
DIMM1_DDR2_DQ11	AJ40	22
DIMM1_DDR2_DQ10	AJ41	21
DIMM1_DDR2_DQ9	AF42	13
DIMM1_DDR2_DQ8	AE42	12
DIMM1_DDR2_DQ7	AF41	129
DIMM1_DDR2_DQ6	AF40	128
DIMM1_DDR2_DQ5	AB42	123
DIMM1_DDR2_DQ4	AB41	122
DIMM1_DDR2_DQ3	AD41	10
DIMM1_DDR2_DQ2	AD42	9

Table 1-4: **Connections from FPGA to DDR2 DIMM1 Interface (P9) *(Cont'd)***

UCF Signal Name	FPGA Pin (U37)	DDR2 DIMM1 (P9)
DIMM1_DDR2_DQ1	AB37	4
DIMM1_DDR2_DQ0	AB38	3
DIMM1_DDR2_CKE1	AE39	171
DIMM1_DDR2_CKE0	AU41	52
DIMM1_DDR2_CB7	AE33	168
DIMM1_DDR2_CB6	AE34	167
DIMM1_DDR2_CB5	AC33	162
DIMM1_DDR2_CB4	AB32	161
DIMM1_DDR2_CB3	AH36	49
DIMM1_DDR2_CB2	AG36	48
DIMM1_DDR2_CB1	AD32	43
DIMM1_DDR2_CB0	AB33	42
DIMM1_DDR2_CAS_B	Y42	74
DIMM1_DDR2_BA2	AH35	54
DIMM1_DDR2_BA1	AJ36	190
DIMM1_DDR2_BA0	AJ35	71
DIMM1_DDR2_A13	W41	196
DIMM1_DDR2_A12	F41	176
DIMM1_DDR2_A11	G41	57
DIMM1_DDR2_A10	W42	70
DIMM1_DDR2_A9	F42	177
DIMM1_DDR2_A8	G42	179
DIMM1_DDR2_A7	J42	58
DIMM1_DDR2_A6	H41	180
DIMM1_DDR2_A5	M42	60
DIMM1_DDR2_A4	L42	61
DIMM1_DDR2_A3	K42	182
DIMM1_DDR2_A2	M41	63
DIMM1_DDR2_A1	J41	183
DIMM1_DDR2_A0	R40	188

Figure 1-4 is a block diagram of the DDR2 DIMM interface.

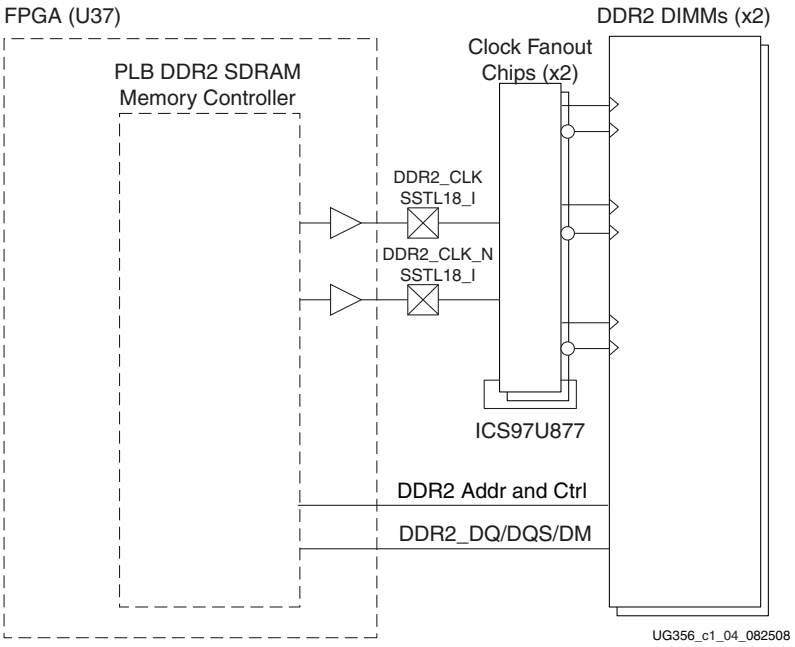


Figure 1-4: **DDR2 DIMM Block Diagram**

10/100/1000 Tri-Speed Ethernet PHY

The board contains two Marvell Alaska PHY devices (88E1111) operating at 10/100/1000 Mb/s. The board supports MII, RGMII, and SGMII interface modes on the first of two Ethernet interfaces, while the second interface only supports SGMII (Table 1-5). The two independent PHY devices are connected to independent RJ-45 connectors with built-in magnetics.

Table 1-5: **Marvell Alaska PHY Configurations**

PHY	Interface	10BASE-T	100BASE-T	1000BASE-T
PHY0	MII	x	x (Full-duplex only)	-
	RGMII	x	x	x
	SGMII	x	x	x
PHY1	SGMII	x	x	x

The PHY devices also have independent MDO connections to the FPGA. The PHY is configured to default at power-on or reset to the settings shown in Table 1-6. These settings can be overwritten via software. All modes on the first interface are selectable by the jumpers as shown in Table 1-6. The second interface is hard-wired to SGMII mode only.

Table 1-6: **Board Connections for PHY Configuration Pins**

Config Pin	Connection on Board	Bit[2] Definition and Value	Bit[1] Definition and Value	Bit[0] Definition and Value
CONFIG0	V_{CC} 2.5V	PHYADR[2] = 1	PHYADR[1] = 1	PHYADR[0] = 1
CONFIG1	Ground	ENA_PAUSE = 0	PHYADR[4] = 0	PHYADR[3] = 0

Table 1-6: **Board Connections for PHY Configuration Pins *(Cont'd)***

Config Pin	Connection on Board	Bit[2] Definition and Value	Bit[1] Definition and Value	Bit[0] Definition and Value
CONFIG2	V_{CC} 2.5V	ANEG[3] = 1	ANEG[2] = 1	ANEG[1] = 1
CONFIG3	V_{CC} 2.5V	ANEG[0] = 1	ENA_XC = 1	DIS_125 = 1
CONFIG4	V_{CC} 2.5V or LED_DUPLEX or LED_LINK1000 (Set by J23 and J24)	HWCFG_MODE[2] = 0 or 1 (Set by J23 and J24)	HWCFG_MODE[1] = 1	HWCFG_MODE[0] = 1
CONFIG5	V_{CC} 2.5V or LED_LINK10 (Set by J22)	DIS_FC = 1	DIS_SLEEP = 1	HWCFG_MODE[3] = 1
CONFIG6	LED_RX	SEL_BDT = 0	INT_POL = 1	75/50Ω = 0

Jumpers J50, J28, and J49 allow the user to select the default interface that the PHY uses (Figure 1-5 and Table 1-7). The interface can also be changed via MDIO commands.

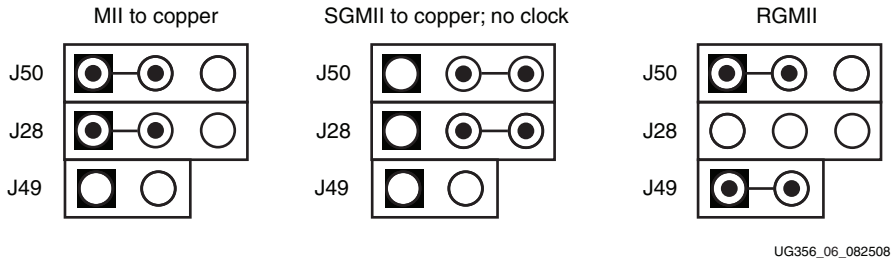


Figure 1-5: **PHY Jumpers on the Board**

Table 1-7: **PHY Default Interface Mode**

Mode	Jumper Settings		
	J50	J28	J49
MII to copper (default)	Jumper over pins 1-2	Jumper over pins 1-2	No jumper
SGMII to copper, no clock	Jumper over pins 2-3	Jumper over pins 2-3	No jumper
RGMII	Jumper over pins 1-2	No jumper	Jumper on

Figure 1-6 shows the PHY0 MII interface.

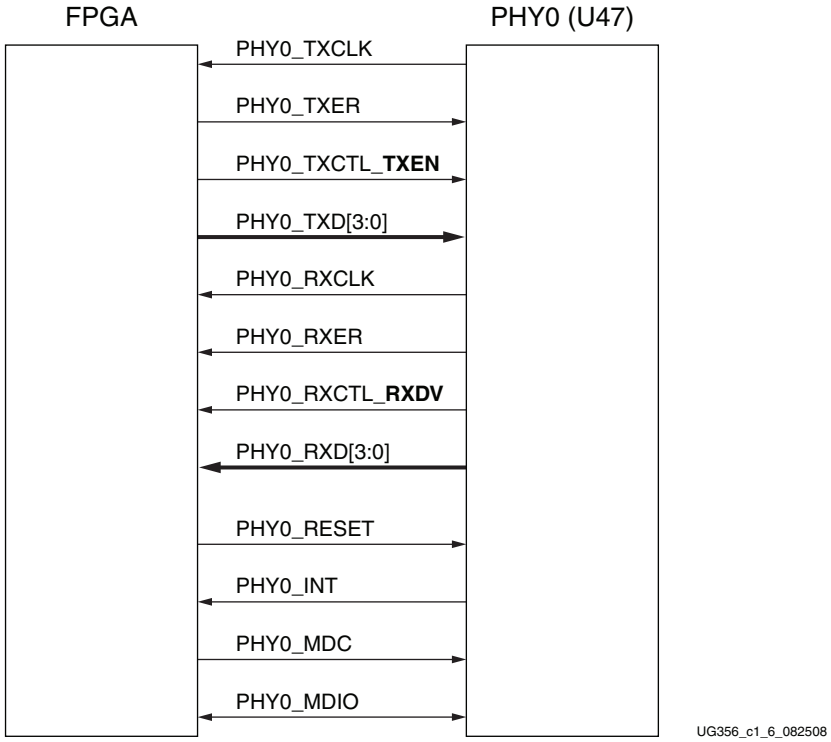


Figure 1-6: **MII Interface**

Figure 1-7 shows the PHY0 RGMII interface.

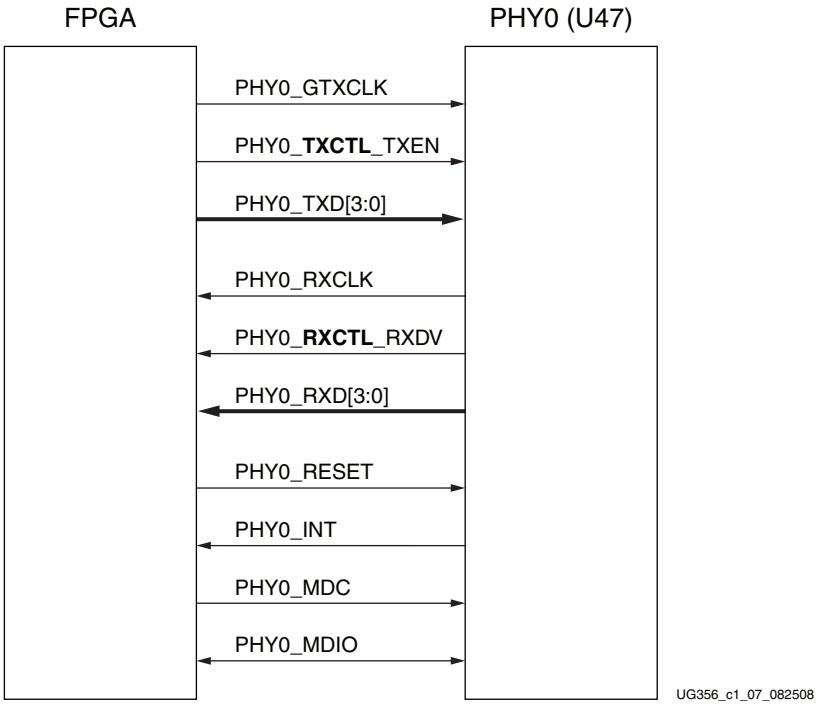


Figure 1-7: **RGMII Interface**

Figure 1-8 shows the PHY0 and PHY1 SGMII interface.

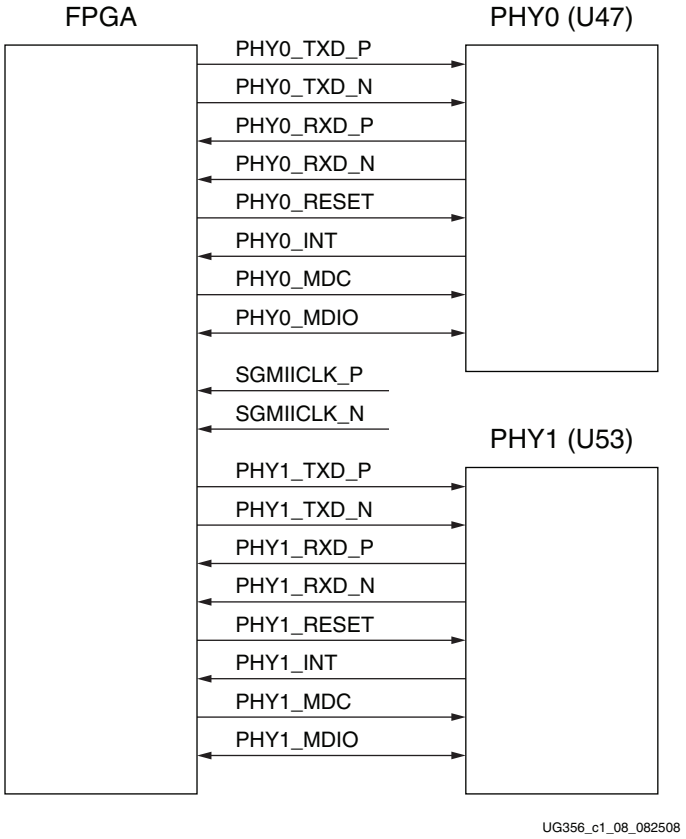


Figure 1-8: **SGMII Interface**

Table 1-8: **PHY0 MII/RGMII/SGMII Interfaces**

Signal Name	FPGA Pin	MII	RGMII	SGMII	Description
PHY0_TX_CLK	M26	x			MII transmit clock
PHY0_RXC_CLK	J17	x	x		MII/RGMII receive clock
PHY0_GTX_CLK	AM31		x		RGMII transmit clock
PHY0_TXD3	AN31	x	x		Transmit data bits
PHY0_TXD2	AR32	x	x		
PHY0_TXD1	AP32	x	x		
PHY0_TXD0	AR33	x	x		
PHY0_TXER	AT31	x			Transmit controls
PHY0_TXCTL_TXEN	AP31	x	x		
PHY0_RX_D3	AM33	x	x		Receive data bits
PHY0_RX_D2	AK33	x	x		
PHY0_RX_D1	AJ33	x	x		
PHY0_RX_D0	AJ32	x	x		

Table 1-8: **PHY0 MII/RGMII/SGMII Interfaces *(Cont'd)***

Signal Name	FPGA Pin	MII	RGMII	SGMII	Description
PHY0_RXER	AP33	x			Receive controls
PHY0_RXCTL_RXDV	AN33	x	x		
PHY0_SGMII_TX_P	B6			x	SGMII transmit pair (GTX)
PHY0_SGMII_TX_N	B5			x	
PHY0_SGMII_RX_P	A5			x	SGMII receive pair (GTX)
PHY0_SGMII_RX_N	A4			x	
PHY0_INT	AL32	x	x	x	PHY interrupt
PHY0_RESET	AK32	x	x	x	PHY reset
PHY0_MDIO	AL31	x	x	x	PHY management data input/output
PHY0_MDC	AM32	x	x	x	PHY management data clock

Table 1-9: **PHY1 SGMII Interface**

Signal Name	FPGA Pin	MII	RGMII	SGMII	Description
PHY1_SGMII_TX_P	B1			x	SGMII transmit pair (GTX)
PHY1_SGMII_TX_N	B2			x	
PHY1_SGMII_RX_P	A2			x	SGMII receive pair (GTX)
PHY1_SGMII_RX_N	A3			x	
PHY1_INT	AV31	x	x	x	PHY interrupt
PHY1_RESET	AL25	x	x	x	PHY reset
PHY1_MDIO	AT32	x	x	x	PHY management data input/output
PHY1_MDC	AU31	x	x	x	PHY management data clock
SGMIICLK_P	C4			x	SGMII REFCLK 125 MHz (GTX)
SGMIICLK_N	C3			x	

System ACE and CompactFlash Connector

The Xilinx System ACE CompactFlash (CF) configuration controller allows a Type I CompactFlash card to program the FPGA through the JTAG port. Both hardware and software data can be downloaded through the JTAG port. The System ACE controller supports up to eight configuration images on a single CompactFlash card. The configuration address switches allow the user to choose which of the eight configuration images to use.

System ACE error and status LEDs indicate the operational state of the System ACE controller:

- A blinking red error LED indicates that no CompactFlash card is present
- A solid red error LED indicates an error condition during configuration
- A blinking green status LED indicates a configuration operation is ongoing
- A solid green status LED indicates a successful download

Every time a CompactFlash card is inserted into the System ACE socket, a configuration operation is initiated. Pressing the System ACE reset button re-programs the FPGA.

The board also features a System ACE *failsafe* mode. In this mode, if the System ACE controller detects a failed configuration attempt, it automatically reboots back to a predefined configuration image. The failsafe mode is enabled by inserting two jumpers across J18 and J19 (in horizontal or vertical orientation).

> ***Caution!*** Use caution when inserting a CompactFlash card with exposed metallic surfaces. Improper insertion can cause a short with the traces or components on the board.

Note: The System ACE configuration address pins are shared with the BPI flash RS[1:0] pins on the FPGA. When manually selecting a different System ACE configuration with dual-inline package (DIP) switch SW3, users must press the PROGRAM pushbutton first and then press the SysAce Reset pushbutton. This is required only if there is a Flash interface such as the EDK XPS_EMC pcore driving the RS[1:0] pins as address lines. Configuration selections made via the MPU interface are not affected by the Flash interface already loaded in the the FPGA design.

The System ACE MPU port is connected to the FPGA. This connection allows the FPGA to use the System ACE controller to reconfigure the system or access the CompactFlash card as a generic FAT file system. The data bus for the System ACE MPU port is shared with the USB controller. See "Non-Volatile Storage through the MPU Interface," page 33.

Board Bring-Up through the JTAG Interface

The System ACE CF controller is located between the JTAG connector and the FPGA, and passes the JTAG signals back and forth between the two. During configuration, the System ACE CF controller has full control of the JTAG signals. Figure 1-9 shows the connections between the JTAG connector, System ACE CF controller, and the FPGA. The CPU JTAG header (J12) is used to access the JTAG interface when J27 is jumpered. See "JTAG Source Select," page 60.

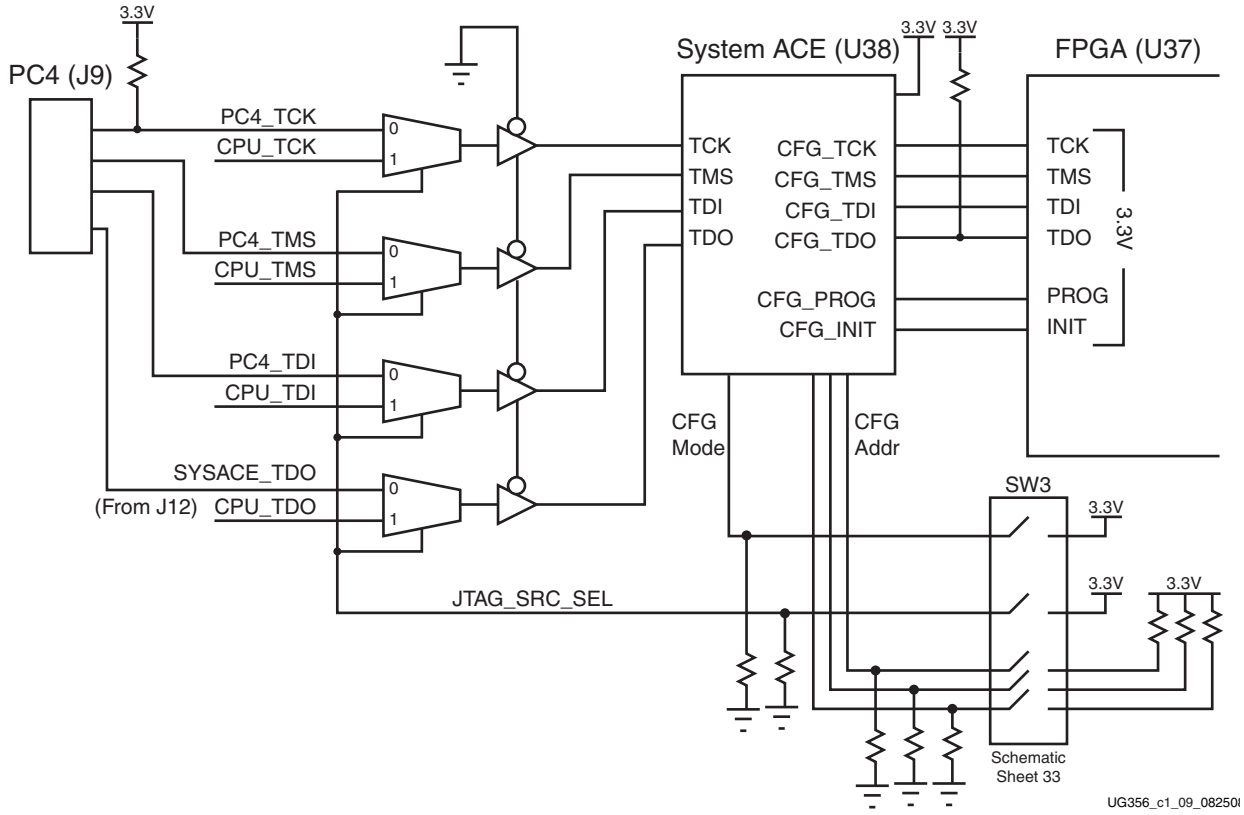


Figure 1-9: **JTAG Connections to the FPGA and System ACE CF Controller**

The pinout shown in Figure 1-10 is compatible with the Parallel Cable IV (PC4) JTAG programming solution. The J9 header is used when programming the FPGA by way of the PC4 download cable.

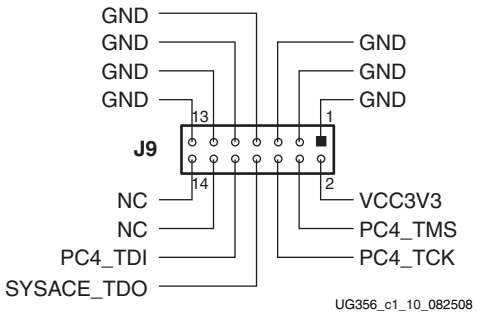


Figure 1-10: **PC4 JTAG Connector Pinout (J9)**

The JTAG configuration port on the System ACE CF controller is connected directly to the JTAG interface of the FPGA, as shown in Table 1-10.

Table 1-10: **JTAG Connection from System ACE CF to FPGA**

Signal Name	System ACE Pin (U38)	FPGA Pin (U37)
FPGA_TCK	80	AG29
FPGA_TDO	81	AJ15
FPGA_TDI	82	AH16
FPGA_TMS	85	AH15

Non-Volatile Storage through the MPU Interface

In addition to programming the FPGA and storing bitstreams, the System ACE CF controller can be used to facilitate general-use, non-volatile storage. The System ACE CF controller provides an MPU interface for allowing a microprocessor to access the CompactFlash memory, enabling the use of the CompactFlash card as a file system. The System ACE MPU interface is capable of supporting 16-bit or 8-bit modes of operation because all 16 data lines are wired to the FPGA.

Table 1-11 shows the connection between the System ACE MPU interface and the FPGA.

Table 1-11: **System ACE MPU Connection from FPGA to Controller**

Signal Name	FPGA Pin (U37)	System ACE Pin (U38)
sysace_fpga_clk	L17	93
sysace_mpa0	AR7	70
sysace_mpa1	AN6	69
sysace_mpa2	AM6	68
sysace_mpa3	AM7	67
sysace_mpa4	AM8	45
sysace_mpa5	AG12	44
sysace_mpa6	AG11	43
sysace_mpd0	AT6	66
sysace_mpd1	AR5	65
sysace_mpd2	AG9	63
sysace_mpd3	AH9	62
sysace_mpd4	AT5	61
sysace_mpd5	AU6	60
sysace_mpd6	AH10	59
sysace_mpd7	AH11	58
sysace_mpd8	AV6	56
sysace_mpd9	AV5	53

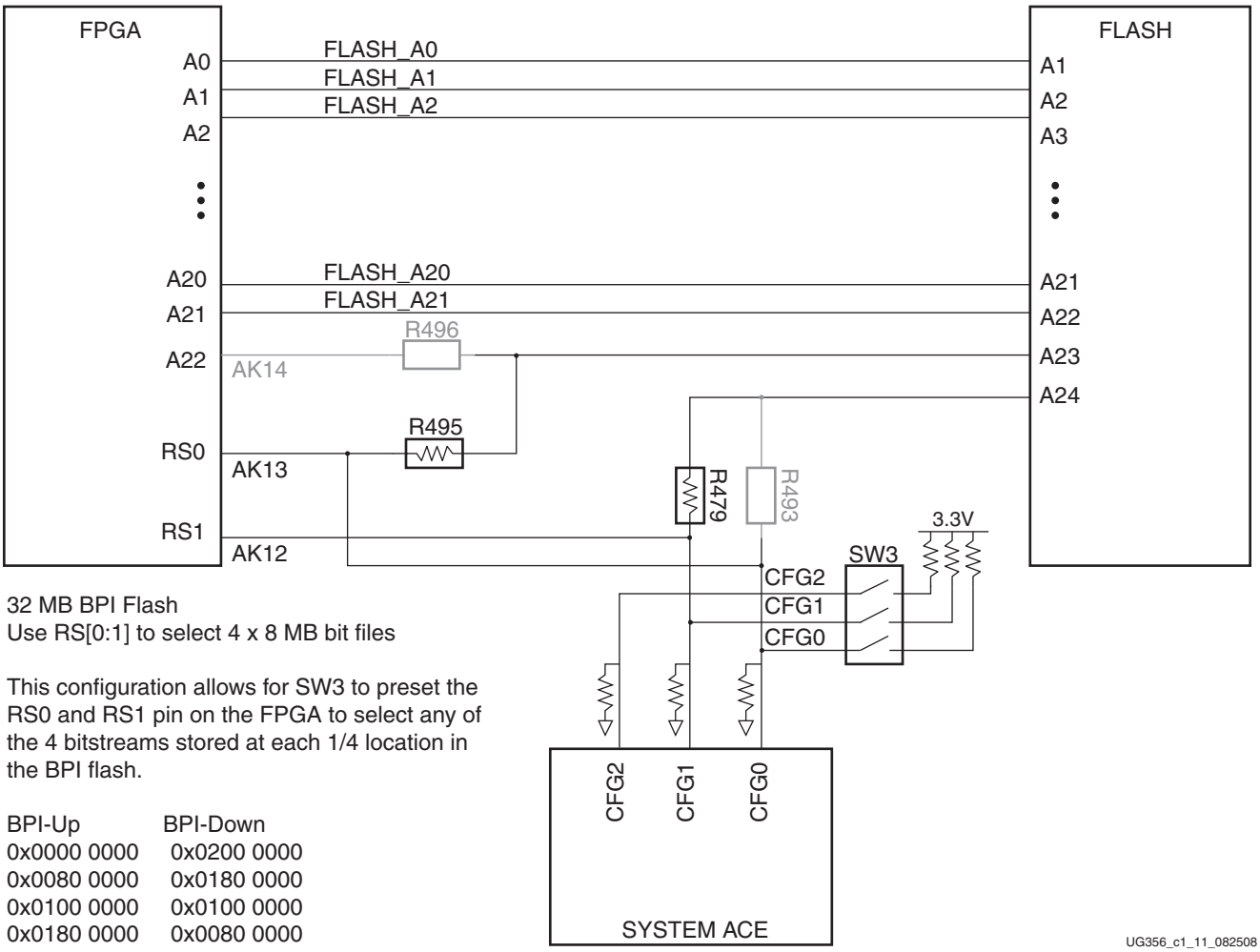
Table 1-11: **System ACE MPU Connection from FPGA to Controller *(Cont'd)***

Signal Name	FPGA Pin (U37)	System ACE Pin (U38)
SYSACE_MPD10	AJ11	52
sysace_mpd11	AJ10	51
sysace_mpd12	AJ8	50
sysace_mpd13	AT7	49
sysace_mpd14	AP8	48
sysace_mpd15	AK8	47
sysace_mpoe	AK10	77
sysace_mpce	AN18	42
sysace_mpwe	AR8	76
sysace_mpirq	AK9	41

Linear Flash Memory

A 16-bit wide NOR linear flash device (Intel JS28F256P30T95) is installed on the board to provide 256 Mb of flash memory (Figure 1-11). This memory provides non-volatile storage of data, software, or bitstreams. The flash memory can also be used to program the FPGA.

Note: The System ACE configuration address lines, CFG[0:1], are shared with the upper address lines of the BPI flash device. Because these connections are shared, before manually moving to a different System ACE configuration file the user must first pulse the PROG pushbutton before pulsing the System ACE Reset pushbutton. This is required only when the user has implemented a design that drives the flash address lines, such as the EDK EMC controller.



32 MB BPI Flash
Use RS[0:1] to select 4 x 8 MB bit files

This configuration allows for SW3 to preset the RS0 and RS1 pin on the FPGA to select any of the 4 bitstreams stored at each 1/4 location in the BPI flash.

BPI-Up	BPI-Down
0x0000 0000	0x0200 0000
0x0080 0000	0x0180 0000
0x0100 0000	0x0100 0000
0x0180 0000	0x0080 0000

Figure 1-11: **BPI Linear Flash Connectivity**

Table 1-12: **Linear Flash Connection from FPGA to Strata Flash (U43)**

Signal Name	FPGA Pin (U37)	Strata Flash (U43)
FLASH_WE_B	AM28	14
FLASH_WAIT	W11	56
FLASH_RESET_B	K7	44
FLASH_OE_B	AM13	32
FLASH_D15	AN30	54
FLASH_D14	AP30	52
FLASH_D13	AK17	50
FLASH_D12	AL17	48
FLASH_D11	AN29	42
FLASH_D10	AP28	40
FLASH_D9	AL15	37

Table 1-12: **Linear Flash Connection from FPGA to Strata Flash (U43) *(Cont'd)***

Signal Name	FPGA Pin (U37)	Strata Flash (U43)
FLASH_D8	AL16	35
FLASH_D7	AN13	53
FLASH_D6	AP13	51
FLASH_D5	AK28	49
FLASH_D4	AK29	47
FLASH_D3	AN14	41
FLASH_D2	AM14	39
FLASH_D1	AK27	36
FLASH_D0	AJ26	34
FLASH_CLK	AN28	45
FLASH_CE_B	AL14	30
FLASH_ADV_B	AL29	46
FLASH_A21	AL30	10
FLASH_A20	AM29	11
FLASH_A19	N25	16
FLASH_A18	P25	17
FLASH_A17	P18	18
FLASH_A16	P17	55
FLASH_A15	P26	1
FLASH_A14	N26	2
FLASH_A13	M16	3
FLASH_A12	N16	4
FLASH_A11	P27	5
FLASH_A10	P28	6
FLASH_A9	N15	7
FLASH_A8	N14	8
FLASH_A7	N28	19
FLASH_A6	N29	20
FLASH_A5	M14	21
FLASH_A4	M13	22
FLASH_A3	N30	23
FLASH_A2	M29	24
FLASH_A1	N13	25
FLASH_A0	P13	29

GPIO LEDs and LCD

ML510 platforms provide direct GPIO access to eight LEDs for general purpose use, and provide indirect access to a 16-pin connector (J13) that interfaces the FPGA to a 2-line by 16-character LCD display, AND491GST. A simple register interface handles access to the FPGA's GPIO signals.

Figure 1-12 shows the connectivity of the ML510 LEDs and LCD.

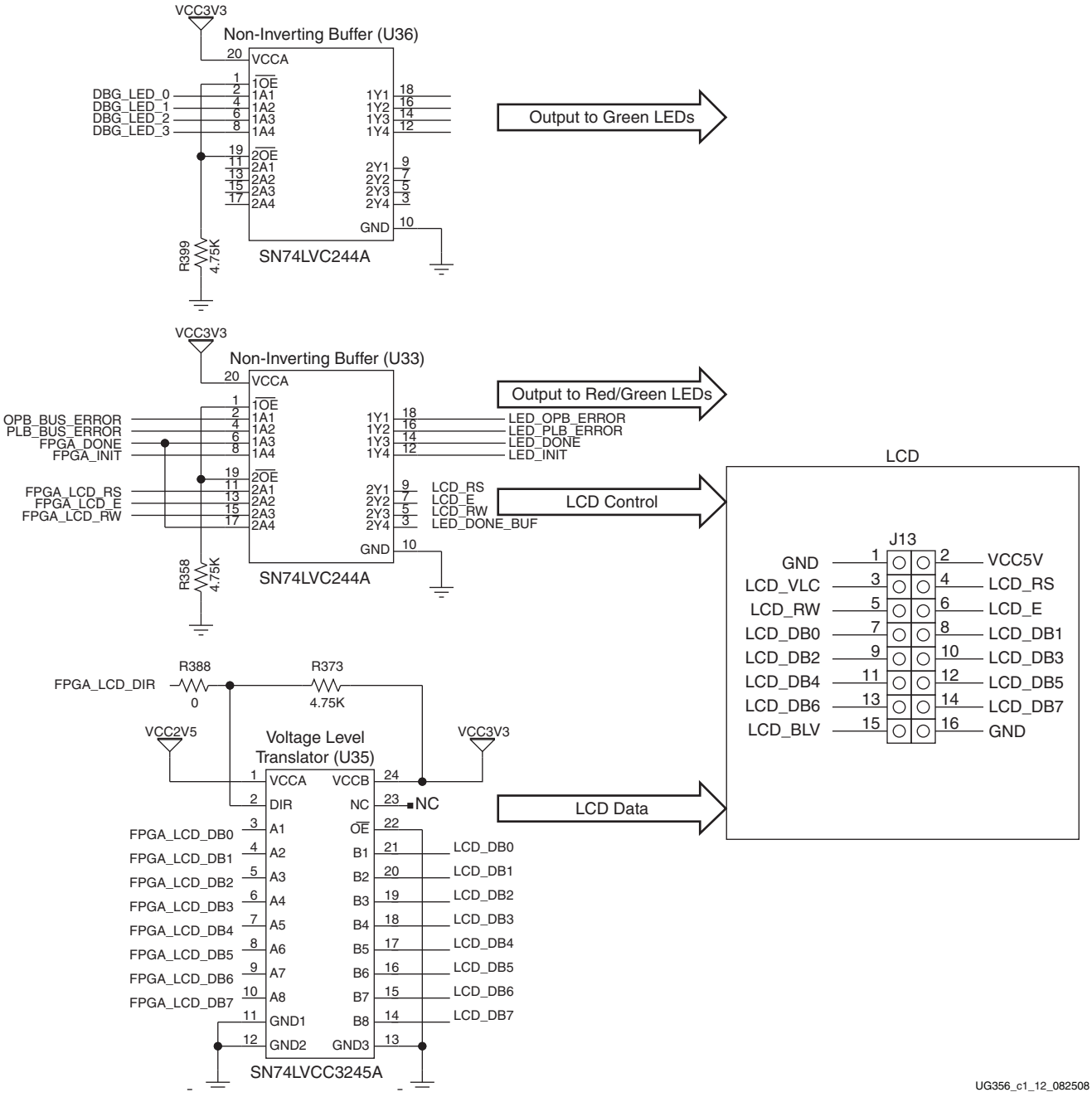


Figure 1-12: **LEDs and LCD Connectivity**

GPIO LED Interface

All LEDs connected to the GPIO lines illuminate green when driven with a logic 0 and extinguish with a logic 1. Table 1-13 shows the connections for the GPIO LEDs from the FPGA to the non-inverting buffer (U36). The FPGA GPIO lines are also wired to a DIP switch (SW5). The combinations of LEDs in parallel with a DIP switch allow users to set LEDs when the FPGA is actively driving the GPIOs as outputs. The DIP switch values are available when the GPIOs are used as inputs. Pull-up and pull-down resistors are in place to protect the FPGA pins from any contention condition.

Table 1-13: **GPIO LED Connection from FPGA to U36**

Signal Name	FPGA Pin (U37)	LVC244 Buffer (U36)	LED
DBG_LED_0	AL7	2	DS20
DBG_LED_1	AP6	4	DS19
DBG_LED_2	AN5	6	DS18
DBG_LED_3	AL6	8	DS17

GPIO LCD Interface

The GPIO LCD interface has eight input/output signals used as data and three output-only signals used as control. The data signals are controlled by the logic level of the FPGA_LCD_DIR signal. A logic 1 on FPGA_LCD_DIR configures the LVCC3245 to drive the J13 header, while a logic 0 on FPGA_LCD_DIR configures the LVCC3245 to drive the FPGA.

Table 1-14 shows the data bus signals on the GPIO LCD interface from the FPGA to U35.

Table 1-14: **GPIO LCD Data Signals from FPGA to U35**

Signal Name	FPGA Pin (U37)	LVCC3245 Translator (U61)	LCD I/F (J13)
FPGA_LCD_DB0	R4	3	7
FPGA_LCD_DB1	R5	4	8
FPGA_LCD_DB2	T5	5	9
FPGA_LCD_DB3	T4	6	10
FPGA_LCD_DB4	AA11	7	11
FPGA_LCD_DB5	AA10	8	12
FPGA_LCD_DB6	AA9	9	13
FPGA_LCD_DB7	Y10	10	14
FPGA_LCD_E	W10	2(1)	6
FPGA_LCD_RW	Y9	2(1)	5

Notes:

1. FPGA_LCD_E and FPGA_LCD_RW are logically NANDed and the output connects to U61 pin 2 (Direction control pin of U61).

The control signals allow the user to read/write the LCD character display in conjunction with the eight LCD data signals defined in Table 1-14. See the AND491GST LCD display data sheet located on the ML510 documentation CD for more information.

Table 1-15 shows the control signal connections for the GPIO LCD from the FPGA to U33.

Table 1-15: **GPIO LCD Control Signals from FPGA to U33**

Signal Name	FPGA Pin (U37)	LVC244 Buffer (U33)	LCD I/F (J13)
FPGA_LCD_E	W10	13	6
FPGA_LCD_RS	Y8	11	4
FPGA_LCD_RW	Y9	15	5

JTAG Trace/Debug

CPU Debug Description

External-debug mode can be used to alter normal program execution. It provides the ability to debug both system hardware and software. External-debug mode supports setting of multiple breakpoints, as well as monitoring processor status. Access to processor debugging resources is available through the CPU JTAG port (J12) and the Mictor connector (P8), providing the appropriate connections to the FPGA fabric are in place.

The JTAG debug port supports the four required JTAG signals: TCK, TMS, TDI, and TDO. It also implements the optional TRST signal. The frequency of the JTAG clock signal can range from 0 MHz (DC) to one-half of the processor clock frequency. The JTAG debug port logic is reset at the same time the system is reset, using TRST. When TRST is asserted, the JTAG TAP controller returns to the test-logic reset state.

Figure 1-13 shows a 38-pin Mictor connector that combines the CPU Trace and the CPU Debug interfaces for high-speed, controlled-impedance signaling.

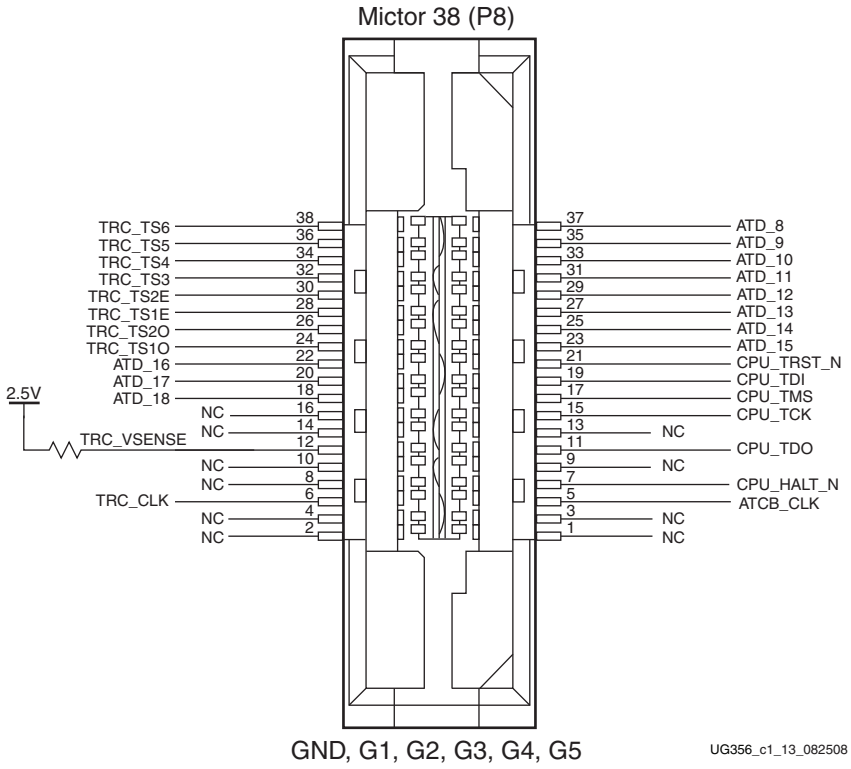


Figure 1-13: **Combined Trace/Debug Connector Pinout**

Table 1-16 shows the CPU trace/debug connections from P8 to the FPGA.

Table 1-16: **CPU Trace/Debug Connection to FPGA**

Pin Name	FPGA Pin (U37)	Connector Pin (P8)
-	NC	1
-	NC	2
-	NC	3
-	NC	4
ATCB_CLK	J16	5
TRC_CLK	AR27	6
CPU_HALT_B	AR29	7
-	-	8
-	-	9
-	-	10
CPU_TDO	AR28	11
TRC_VSENSE	-	12
-	NC	13

Table 1-16: **CPU Trace/Debug Connection to FPGA *(Cont'd)***

Pin Name	FPGA Pin (U37)	Connector Pin (P8)
-	NC	14
CPU_TCK	AT14	15
ATD_4	AM24	16
CPU_TMS	AR14	17
ATD_3	AT19	18
CPU_TDI	AR30	19
ATD_2	AP25	20
CPU_TRST_B	AT30	21
ATD_1	AN25	22
ATD_0	AP26	23
TRC_ES4	AR15	24
TRC_BS0_BR0	AN26	25
TRC_TSO	AT29	26
TRC_BS1_BR1	AM18	27
TRC_TS1	AT17	28
TRC_BS2_BR2	AN18	29
TRC_TS2	AT16	30
TRC_ES0	AN19	31
TRC_TS3	AU28	32
TRC_ES1	AN20	33
TRC_TS4	AT27	34
TRC_ES2	AT15	35
TRC_TS5	AP17	36
TRC_ES3	AT26	37
TRC_TS6	AR17	38

CPU JTAG Header Pinout

Figure 1-14 shows J12, the 16-pin header that can be used to debug the software operating in the CPU with debug tools such as Parallel Cable IV or third party tools.

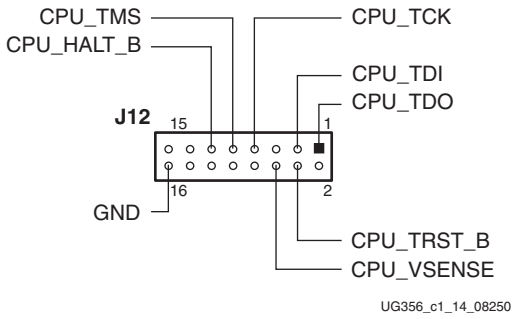


Figure 1-14: **CPU JTAG Header (J12)**

CPU JTAG Connection to FPGA

The connections between the CPU JTAG header (J12) and the FPGA are shown in Table 1-17. These are attached to the PPC440 JTAG debug resources using normal FPGA routing resources. The JTAG debug resources are not hard-wired to particular pins and are available for attachment in the FPGA fabric, making it possible to route these signals to the preferred FPGA pins.

Table 1-17: **CPU JTAG Connection to FPGA**

Pin Name	FPGA Pin (U37)	Connector Pin (J12)
CPU_TDO	AR28	1
CPU_TDI	AR30	3
CPU_TRST_B	AT30	4
CPU_TCK	AT14	7
CPU_TMS	AR14	9
CPU_HALT_B	AR29	11

DVI Output

A DVI connector (P10) is present on the board to support an external video monitor. The DVI circuitry utilizes a Chrontel CH7301C capable of 1600 X 1200 resolution with 24-bit color. The video interface chip drives both the digital and analog signals to the DVI connector. A DVI monitor can be connected to the board directly. A VGA monitor can also be connected to the board using a DVI-to-VGA adaptor. The Chrontel CH7301C is controlled by way of the video IIC bus.

The DVI connector (Table 1-18) supports the IIC protocol to allow the board to read the monitor's configuration parameters. These parameters can be read by the FPGA using the VGA IIC bus.

Table 1-18: **DVI Controller Connections**

Net Name	FPGA Pin
DVI_D0	AP15
DVI_D1	AP16
DVI_D2	AL26
DVI_D3	AL27
DVI_D4	AN16
DVI_D5	AN15
DVI_D6	AM26
DVI_D7	AM27
DVI_D8	AM16
DVI_D9	AK15
DVI_D10	AJ30
DVI_D11	AK30
DVI_XCLK_P	AG8
DVI_XCLK_N	AH8
DVI_HSYNC	AP27
DVI_VSYNC	AM17
DVI_DE	M8
DVI_RESET_B	AM9

PCI Express Interface

ML510 platforms that are equipped with PCI Express host connectors (P53 and P54) are capable of supporting PCI Express cores. Power distribution is handled by a MIC2959B dual-slot PCI Express hot-plug controller (Figure 1-15) that also provides comprehensive system protection and fault isolation. The MIC2959B controls the power delivered through MOSFETs to the Slot A (P53) and Slot B (P54) PCI Express connectors. The MIC2592B also incorporates an SMBus interface that provides control for and status of each PCI Express slot.

Although two 16x PCI Express connectors are mounted on ML510 platforms, not all 16 lanes are wired for use.

The PCI Express interface supports GTPs operating at 2.5 Gb/s. Power is activated to the PCI Express slots only when the proper MIC2959B IIC commands are delivered to the MIC2959B at address `0x8E` over the IIC interface. For more on IIC, see "IIC/SMBus Interface," page 53. For details on the power controller, see the *MIC2959B data sheet* at www.micrel.com. For more on clocking, see "Clock Generation," page 14.

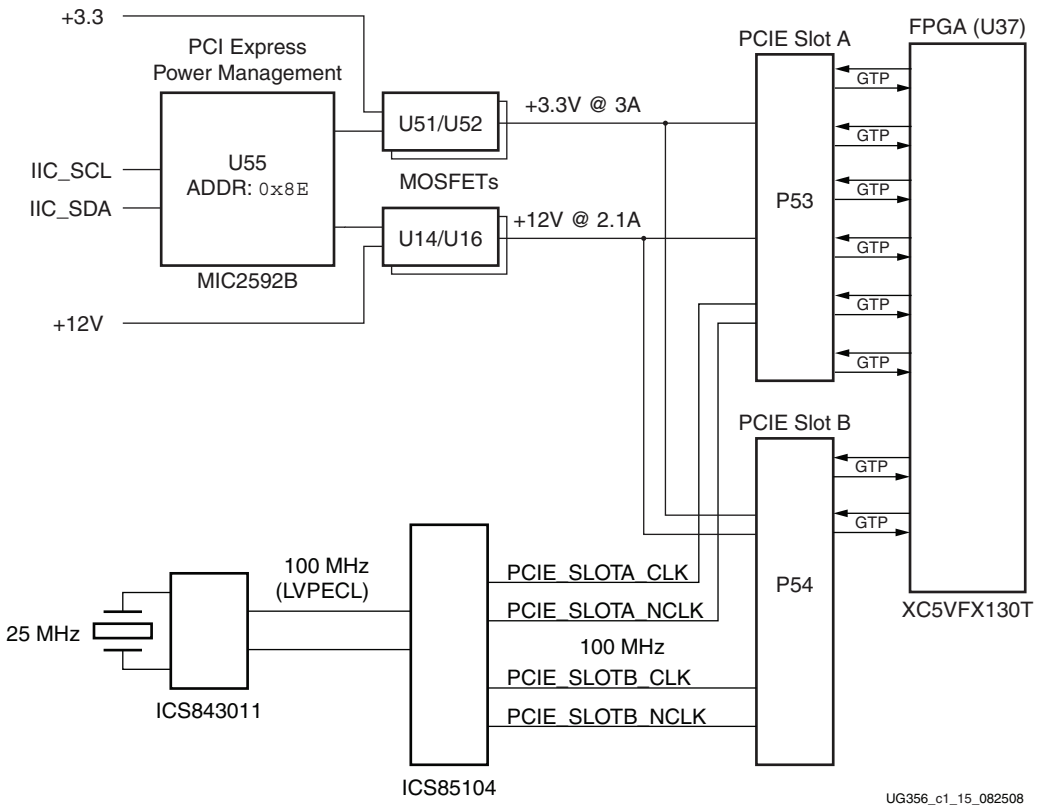


Figure 1-15: **PCI Express Power Management and Clocking**

Table 1-19 and Table 1-20, page 45 detail the connections between the FPGA and the PCI Express connectors.

Table 1-19: **Connections from FPGA to PCI Express Slot A**

Net Name	FPGA Pin (U37)	Description
GTP122_PCIE_SLOTA_CLK_P	AT4	PCIe SlotA RefCLK 122
GTP122_PCIE_SLOTA_CLK_N	AT3	PCIe SlotA RefCLK 122
GTP126_PCIE_SLOTA_CLK_P	AW4	PCIe SlotA RefCLK 126
GTP126_PCIE_SLOTA_CLK_N	AY4	PCIe SlotA RefCLK 126
PCIE_SLOTA_WAKE_B_R	K17	PCIe SlotA WAKE#
PCIE_SLOTA_PRSNT2_B_R	M28	PCIe SlotA PRSNT2#
PCIE_SLOTA_PERST_B	L27	PCIe SlotA PERST#
GTP_122_TX0_P_C	AP2	Lane 1 TX
GTP_122_TX0_N_C	AR2	Lane 1 TX
GTP_122_RX0_P	AR1	Lane 1 RX
GTP_122_RX0_N	AT1	Lane 1 RX
GTP_122_TX1_P_C	AW2	Lane 2 TX
GTP_122_TX1_N_C	AV2	Lane 2 TX

Table 1-19: **Connections from FPGA to PCI Express Slot A *(Cont'd)***

Net Name	FPGA Pin (U37)	Description
GTP_122_RX1_P	AV1	Lane 2 RX
GTP_122_RX1_N	AU1	Lane 2 RX
GTP_126_TX0_P_C	BA1	Lane 3 TX
GTP_126_TX0_N_C	BA2	Lane 3 TX
GTP_126_RX0_P	BB2	Lane 3 RX
GTP_126_RX0_N	BB3	Lane 3 RX
GTP_126_TX1_P_C	BA6	Lane 4 TX
GTP_126_TX1_N_C	BA5	Lane 4 TX
GTP_126_RX1_P	BB5	Lane 4 RX
GTP_126_RX1_N	BB4	Lane 4 RX
GTP_130_TX0_P_C	BA7	Lane 5 TX
GTP_130_TX0_N_C	BA8	Lane 5 TX
GTP_130_RX0_P	BB8	Lane 5 RX
GTP_130_RX0_N	BB9	Lane 5 RX
GTP_130_TX1_P_C	BA12	Lane 6 TX
GTP_130_TX1_N_C	BA11	Lane 6 TX
GTP_130_RX1_P	BB11	Lane 6 RX
GTP_130_RX1_N	BB10	Lane 6 RX

Table 1-20: **Connections from FPGA to PCI Express Slot B**

Net Name	FPGA Pin (U37)	Description
GTP128_PCIE_SLOTB_CLK_P	D10	PCIe SlotB RefCLK 128
GTP128_PCIE_SLOTB_CLK_N	C10	PCIe SlotB RefCLK 128
GTP132_PCIE_SLOTB_CLK_P	D16	PCIe SlotB RefCLK 132
GTP132_PCIE_SLOTB_CLK_N	C16	PCIe SlotB RefCLK 132
PCIE_SLOTB_WAKE_B_R	J30	PCIe SlotB WAKE#
PCIE_SLOTB_PRSNT2_B_R	K15	PCIe SlotB PRSNT2#
PCIE_SLOTB_PERST_B	L15	PCIe SlotB PERST#
GTP_128_TX0_P_C	B12	Lane 1 TX
GTP_128_TX0_N_C	B11	Lane 1 TX
GTP_128_RX0_P	A11	Lane 1 RX
GTP_128_RX0_N	A10	Lane 1 RX
GTP_128_TX1_P_C	B7	Lane 2 TX

Table 1-20: **Connections from FPGA to PCI Express Slot B *(Cont'd)***

Net Name	FPGA Pin (U37)	Description
GTP_128_TX1_N_C	B8	Lane 2 TX
GTP_128_RX1_P	A8	Lane 2 RX
GTP_128_RX1_N	A9	Lane 2 RX
GTP_132_TX0_P_C	B18	Lane 3 TX
GTP_132_TX0_N_C	B17	Lane 3 TX
GTP_132_RX0_P	A17	Lane 3 RX
GTP_132_RX0_N	A16	Lane 3 RX
GTP_132_TX1_P_C	B13	Lane 4 TX
GTP_132_TX1_N_C	B14	Lane 4 TX
GTP_132_RX1_P	A14	Lane 4 RX
GTP_132_RX1_N	A15	Lane 4 RX

PCI Bus

ML510 platforms provide the FPGA with access to two 33 MHz/32-bit PCI buses, a primary 3.3V PCI bus and a secondary 5V PCI bus. The FPGA is directly connected to the primary 3.3V PCI bus while the 5V PCI bus is connected to the primary PCI bus via a PCI-to-PCI bridge. Several PCI devices are available on the PCI buses as well as four PCI add-in card slots. All PCI bus signals driven by the FPGA comply with the I/O requirements specified in the *PCI Local Bus Specification, Revision 2.2* (see www.pcisig.com).

The majority of the ML510 features are accessed over the 33 MHz/32-bit PCI bus. The Virtex-5 PPC440 processors can access the primary PCI bus through the EDK PCI Host Bridge IP. All PCI configuration and control can be performed via a PCI Host Bridge implemented in the FPGA fabric. The primary PCI bus is wired so that the FPGA fabric must be used to provide PCI bus arbitration logic. EDK also provides PCI Arbiter IP. See the *Embedded Processor Block in Virtex-5 FPGAs Reference Guide* [Ref 4] for more information about the EDK IP mentioned in this section.

The FPGA is responsible generating the PCI RST signal as well as the PCI CLK signal. The FPGA fabric is used to generate several PCI clocks that drive each of the PCI devices/slots shown in Figure 1-16. All six PCI clock outputs are length matched. Because the FPGA generates all PCI clocks, the downstream PCI devices have no clock input prior to or during FPGA configuration; therefore, PCI Reset should be deasserted after the PCI CLK has stabilized. Please review the *PCI Local Bus Specification, Revision 2.2* for more information.

The onboard 33 MHz, 32-bit PCI bus is connected to fixed PCI devices that are part of the ML510. These fixed PCI devices are as follows:

- Texas Instruments, TI2250, PCI-to-PCI bridge
- ALi, M1535D+, PCI South Bridge

These devices are described in the following sections as well in their data sheets on the ML510 documentation CD.

In addition to the fixed PCI devices, there are four 33 MHz, 32-bit PCI slots available for use. For more information on the PCI slot pinouts, refer to the *PCI Local Bus Specification, Revision 2.2* and the ML510 schematics.

- Two 3.3V keyed PCI add-in card slots (P5 and P3)
- Two 5V keyed PCI add-in card slots (P6 and P4)

Figure 1-16 shows the connectivity of the PCI bus and PCI devices. For more information on the PCI slot pinouts, refer to the *PCI Local Bus Specification, Revision 2.2* or review the ML510 schematics.

Note: The 5V PCI slots differ from the 3.3V slots. See the *Important Instructions* sheet (PN 0402395) packaged with the ML510 kit before using Universal PCI add-in cards with ML510 platforms.

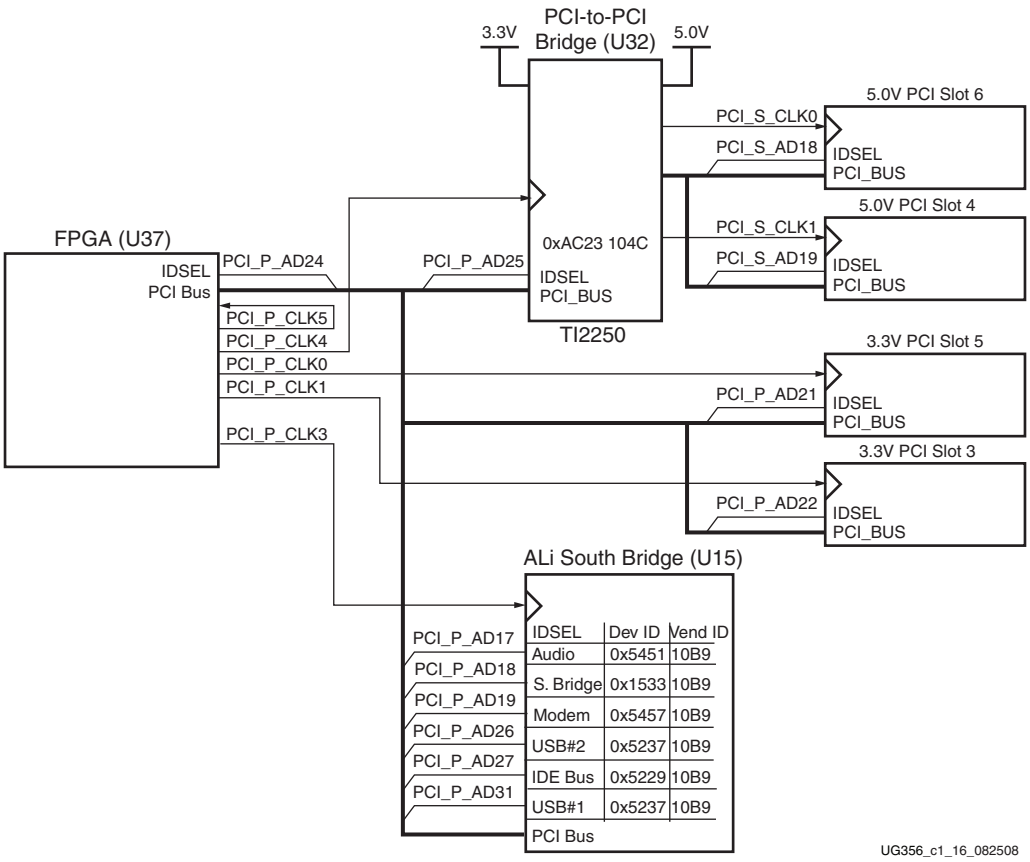


Figure 1-16: **PCI Bus and Device Connectivity**

Table 1-21 shows how the primary PCI bus interrupts are connected on ML510 platforms along with information for each device.

Table 1-21: **3.3V Primary PCI Bus Information**

Device Name	Dev. ID	Vend. ID	Bus	DEV	IDSEL	REQ	FPGA PCI CLK		PCI Interrupts on FPGA				
									A	B	C	D	ALI SBR
PCI Slot 5	N/A	N/A	0	5	AD21	0	0	PCI Device Interrupt	D	A	B	C	-
PCI Slot 3	N/A	N/A	0	6	AD22	1	1		C	D	A	B	-
U15, ALi SB	0x1533	0x10B9	0	2	AD18	3	3		-	-	-	-	(INT, NMI)
U15, ALi Pwr Mgmt	0x7101	0x10B9	0	12	AD28	3	3		-	-	-	-	(INT, NMI)
U15, ALi IDE	0x5229	0x10B9	0	11	AD27	3	3		-	-	-	-	(INT, NMI)
U15, ALi Audio	0x5451	0x10B9	0	1	AD17	3	3		-	-	-	-	(INT, NMI)
U15, ALi Modem	0x5457	0x10B9	0	3	AD19	3	3		-	-	-	-	(INT, NMI)
U15, ALi USB#1	0x5237	0x10B9	0	15	AD31	3	3		-	-	-	-	(INT, NMI)
U15, ALi USB#2	0x5237	0x10B9	0	10	AD26	3	3		-	-	-	-	(INT, NMI)
U32, PCI-PCI Brg	0xAC23	0x104C	0	9	AD25	4	4		-	-	-	-	-
U37, FPGA	0x0410	0x10EE	0	8	AD24	Int.	5		-	-	-	-	-

Notes:

The PCI ALi South Bridge device uses a separate interrupt line that connects to the FPGA via schematic net SBR_INTR. Anytime an interrupt occurs within the ALi South Bridge, it generates an interrupt on schematic net SBR_INTR.

Table 1-22 shows how the secondary PCI bus interrupts are connected on ML510 platforms along with information for each device.

Table 1-22: **5V Secondary PCI Bus Information**

Device Name	Dev. ID	Vend. ID	Bus	DEV	IDSEL	REQ	Bridge CLK		PCI Interrupts on FPGA				
									A	B	C	D	ALI SBR
PCI Slot 6	N/A	N/A	1	2	AD18	0	0	PCI Dev. Intr.	B	C	D	A	-
PCI Slot 4	N/A	N/A	1	3	AD19	1	1		A	B	C	D	-
U32, PCI-PCI Brg	N/A	N/A	N/A	7	N/A	Int.	4		-	-	-	-	-

ALi South Bridge Interface, M1535D+ (U15)

The ALi M1535D+ South Bridge Super I/O controller (Figure 1-17) augments the ML510 with many of the basic features found on legacy PCs. These basic PC features are only accessible over the PCI bus because this is the only way to access the ALI M1535D+. A brief description of the ALi M1535D+ features employed on ML510 platforms follows. Please review the ALi M1535D+ data sheet located on the ML510 documentation CD for more information.

ALi M1535D+ supports the following features:

- 2 USB ports
- 2 IDE connectors
- SMBus interface
- AC'97 audio codec
- PS/2 keyboard and mouse

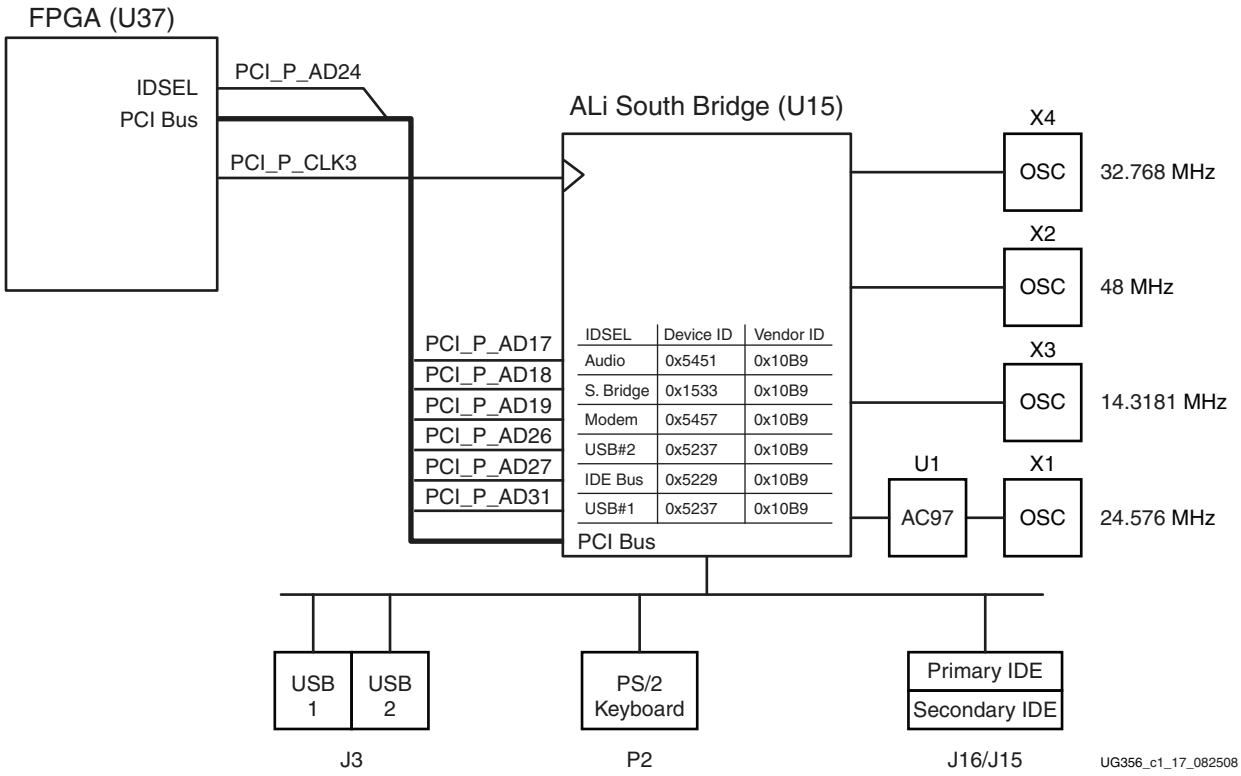


Figure 1-17: **ALi South Bridge Interface, M1535D+ (U15)**

USB Connector Assembly (J3)

The M1535D+ USB is an implementation of the *Universal Serial Bus Specification Version 1.0a* (see www.usb.org) that contains two PCI Host Controllers and an integrated Root Hub. The two USB connectors, A/B, are part of the J3 connector assembly and are USB Type-A plugs.

Table 1-23 shows the ALi USB connections to the two USB Type-A plugs (J3).

Table 1-23: **ALi South Bridge Connections to USB Type-A**

Signal Name	A/B Pin (J3)	Description
USB_VCC	1	USB Power, 5V, MOSFET Isolated
USB0_DN/USB1_DN	2	USB Data -
USB0_DP/USB1_DP	3	USB Data +
GND	4	Ground

IDE Connectors (J15 and J16)

Supports a two-channel UltraDMA-133 IDE master controller independently connected to a primary 40-pin IDE connector (J16) and a secondary 40-pin IDE connector (J15).

Table 1-24 shows the ALi Primary and Secondary IDE connections.

Table 1-24: **ALi South Bridge IDE Connections**

IDE Primary Pin (J16)	Schematic Signal	IDE Secondary Pin (J15)	Schematic Signal
1	PIDE_RESET_B	1	SIDE_RESET_B
2	GND	2	GND
3	PIDE_D7	3	SIDE_D7
4	PIDE_D8	4	SIDE_D8
5	PIDE_D6	5	SIDE_D6
6	PIDE_D9	6	SIDE_D9
7	PIDE_D5	7	SIDE_D5
8	PIDE_D10	8	SIDE_D10
9	PIDE_D4	9	SIDE_D4
10	PIDE_D11	10	SIDE_D11
11	PIDE_D3	11	SIDE_D3
12	PIDE_D12	12	SIDE_D12
13	PIDE_D2	13	SIDE_D2
14	PIDE_D13	14	SIDE_D13
15	PIDE_D1	15	SIDE_D1
16	PIDE_D14	16	SIDE_D14
17	PIDE_D0	17	SIDE_D0

Table 1-24: **ALi South Bridge IDE Connections *(Cont'd)***

IDE Primary Pin (J16)	Schematic Signal	IDE Secondary Pin (J15)	Schematic Signal
18	PIDE_D15	18	SIDE_D15
19	GND	19	GND
20	NC	20	NC
21	PIDE_DMARQ	21	SIDE_DMARQ
22	GND	22	GND
23	PIDE_DIOW_B	23	SIDE_DIOW_B
24	GND	24	GND
25	PIDE_DIOR	25	SIDE_DIOR
26	GND	26	GND
27	PIDE_IORDY	27	SIDE_IORDY
28	PIDE_CSEL	28	SIDE_CSEL
29	PIDE_DMACK_B	29	SIDE_DMACK_B
30	GND	30	GND
31	PIDE_INTRQ	31	SIDE_INTRQ
32	NC	32	NC
33	PIDE_A1	33	SIDE_A1
34	PIDE_PDIAG_B	34	SIDE_PDIAG_B
35	PIDE_A0	35	SIDE_A0
36	PIDE_A2	36	SIDE_A2
37	PIDE_CS1_B	37	SIDE_CS1_B
38	PIDE_CS3_B	38	SIDE_CS3_B
39	PIDE_DASP_B	39	SIDE_DASP_B
40	GND	40	GND

System Management Bus Controller

The SMBus host controller in the M1535D+ supports the ability to communicate with power-related devices using the SMBus protocol. It provides quick send byte/receive byte/ write byte/write word/read word/block read/block write command with clock synchronization function and 10-bit addressing ability. See "IIC/SMBus Interface," page 53 for more information regarding the devices that are connected to the SMBus.

AC'97 Audio Interface

The ALi South Bridge Super I/O controller has a built-in audio interface that is combined with a standard audio codec (AC'97), LM4550. Available features include:

- AC'97 Codec 2.1 Specification compliant
- Codec variable sample rate support
- 32-voice hardware wave-table synthesis
- 32 independent DMA channels
- 3D positioning sound acceleration
- Legacy Sound Blaster compatible
- FM OPL3 emulation
- MIDI interpretation
- MIDI MPU-401 interface

ML510 platforms employ a National Semiconductor LM4550 audio codec (U1) combined with the ALi South Bridge AC'97 interface. This interface can be used to play and record audio. The LM4550 has left and right channel line inputs, left and right CD-ROM inputs, a microphone input, left and right channel line outputs, and an amplified headphone output suitable for driving an 8Ω load using the LM4880 (U2). The microphone input and right/left amplified outputs are easily accessible via two 2.5 mm audio jacks on the J1 connector. The Line In and Line Out connections are accessible via two headers (J2 and J31).

Table 1-25 describes the audio jacks available to the user on ML510 platforms.

Table 1-25: **Audio Jacks (J1, J2, and J31)**

Audio Jack	Signal Name	Description
J1 Top	AC_AMP_OUTR AC_AMP_OUTL	AC Amplified Output, right and left channels, driven by U2, LM4880
J1 Bottom	AC_MIC_IN	Microphone Input to U1, LM4550
J31	AC_LINE_OUTR AC_LINE_OUTL	AC Line Output, right and left channels, driven by U1, LM4550
J2	AC_LINE_INR AC_LINE_INL	AC Line Input, right and left channels, driven by U1, LM4550
J6	AC_CD_INR AC_CD_INL	AC CD Input, right and left channels, driven by U1, LM4550

PS/2 Keyboard and Mouse Interface Connector (P2)

The ALi M1535D+ has a built-in PS2/AT keyboard and PS/2 mouse controller. The PS/2 keyboard and mouse ports are connected to the ALi M1535D+ through standard DIN connectors contained in the P2 connector assembly. In the event of a short circuit by the keyboard or mouse device, the 5V power provided to these devices is protected by a resettable fuse, F1.

Table 1-26 shows the PS/2 keyboard and mouse connections to the P2 connector assembly.

Table 1-26: **PS/2 Keyboard and Mouse**

Signal Name	PS2 Pin (P2)	Description
KDAT	1B	Keyboard data
KCLK	5B	Keyboard clock
MDAT	1C	Mouse data
MCLK	5C	Mouse clock
KVCC, MVCC	4B, 4C	Fuse protected power to keyboard and mouse

IIC/SMBus Interface

Introduction to IIC/SMBus

The Inter Integrated Circuit (IIC) bus provides the connection from the CPU to peripherals. It is a serial bus with a data signal, SDA, and a clock signal, SCL, both of which are bidirectional. The IIC/SMBus interface serves as an interface to one master device and multiple slave devices. The interface operates in the range of 100 kHz to 400 kHz.

The SMBus also provides connectivity from the CPU to peripherals. The SMBus is also a two wire serial bus through which simple power related devices can communicate with the rest of the system. SMBus uses IIC as its backbone. EDK provides IP that integrates the IIC interface with a microprocessor system. See the *Embedded Processor Block in Virtex-5 FPGAs Reference Guide* [Ref 4] for more details.

IIC/SMBus Signaling

The IIC bus data and clock signals operate as open-drain. By default, these signals are pulled High to 3.3V, although some devices support lower voltages. Either the master device or a slave device can drive either of the signals Low to transmit data or clock signals.

IIC/SMBus

Table 1-27 lists the function, part number, and addresses of the IIC devices. These devices include EEPROM, temperature sensors, power monitors, and a Real Time Clock.

Table 1-27: **IIC and SMBus Controller Connections**

Signal Name	FPGA Pin (U37)
FPGA_SCL	L7
FPGA_SDA	K8
IIC_IRQ_B	AK25
IIC_THERM_B(1)	AN24
IIC_SDA_VIDEO	M7
IIC_SCL_VIDEO	L9

Notes:

1. This signal connects to U20 therm_l on the LM87. See data sheet for additional details.

Figure 1-18 shows a block diagram of the FPGA in relation to the SMBus accelerator and the IIC bus.

Note: Either the FPGA or the ALi M1535D+ can master the IIC bus, but not simultaneously.

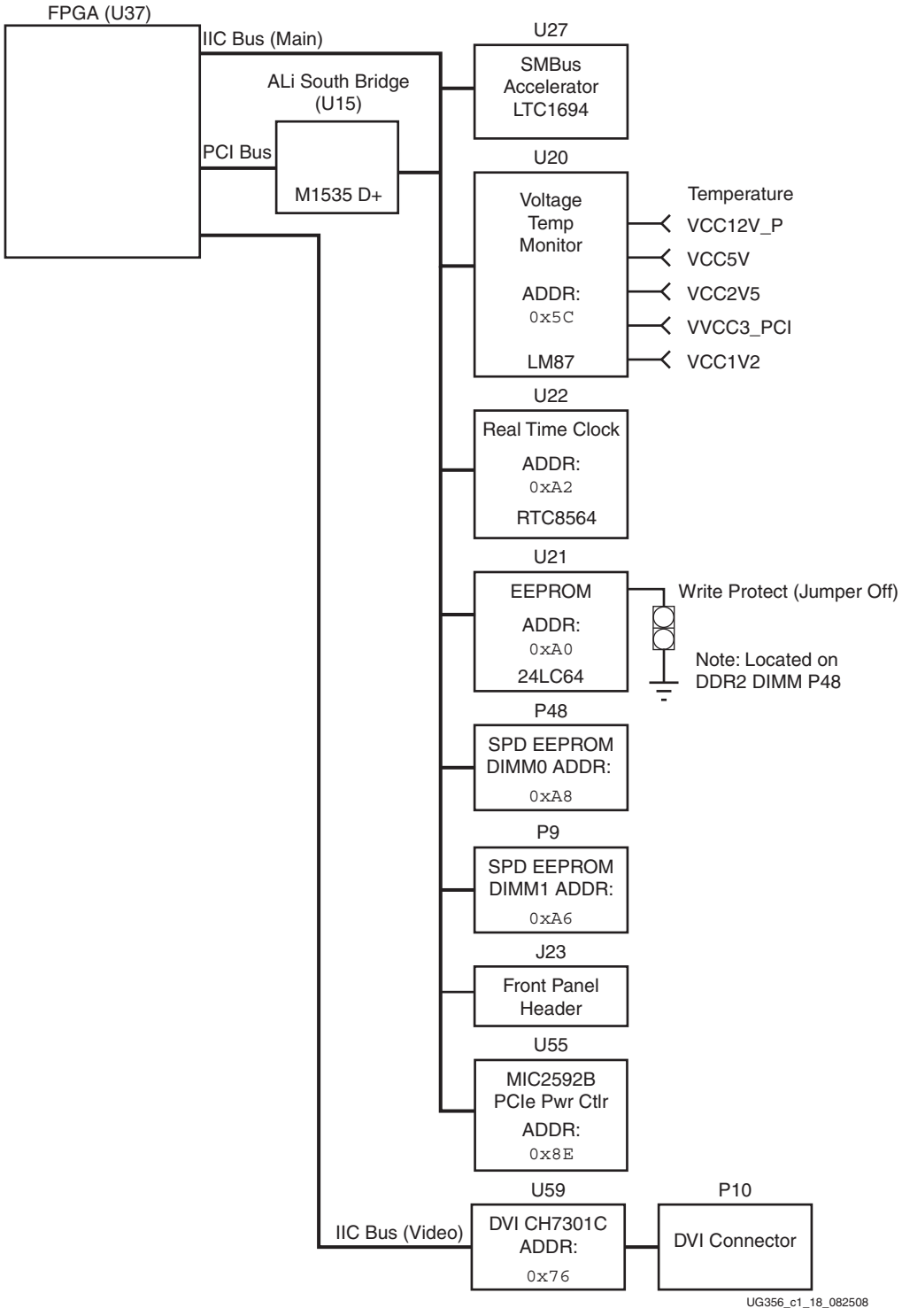


Figure 1-18: **IIC and SMBus Block Diagram**

Table 1-28 lists the IIC devices and their associated addresses.

Table 1-28: **IIC Devices and Addresses**

Device	Reference Designator	Address	Description
LTC1694	U27	N/A	SMBus accelerator that ensures data integrity with multiple devices on the SMBus. Enhances data transmission speed and reliability under all specified SMBus loading conditions and is compatible with the IIC bus.
RTC8564	U22	0xA2	IIC bus interface Real Time Clock module along with an external rechargeable battery and charging circuit.
24LC64	U21	0xA0	64 kb electrically erasable PROM (EEPROM).
LM87	U20	0x5C	Voltage/temperature monitor.
MIC2592B	U55	0x8E	Dual-slot PCI Express power controller.
DDR2_DIMM0	P48	0xA8	SPD EEPROM on DDR2 DIMM0.
DDR2_DIMM1	P9	0xA6	SPD EEPROM on DDR2 DIMM1.
Header	J23	N/A	Front panel header connectivity for expansion.
DVI Output: Codec IC	U59S	0x76	Chrontel CH7301C DVI codec chip.

Notes:

1. The IIC bus can be controlled directly by the FPGA or indirectly by the ALi bridge over the FPGA PCI interface.

Serial Peripheral Interface

Serial Peripheral Interface™ (SPI) is a serial interface similar to the IIC bus interface. There are three primary differences: the SPI operates at a higher speed, there are separate transmit and receive data lines, and the device access is chip-select based instead of address based. EDK provides IP that integrates the SPI interface with a microprocessor system. See the *Embedded Processor Block in Virtex-5 FPGAs Reference Guide* [Ref 4] and the data sheet available on the ML510 documentation CD for more details.

SPI Signaling

There are four main signals used in the SPI interface; Clock, Data In, Data Out, and Chip Select. Signaling rates on the SPI bus range from 1 MHz to 3 MHz, roughly a factor of 10 faster than the IIC bus interface. SPI continues to differ from IIC using active drivers for driving the signal High and Low, while IIC only actively drives signals Low, relying on pull-up resistors to pull the signals High.

There are four basic signals on the SPI bus:

- **Master Out Slave In (MOSI):** A data line that supplies the output data from the master device that is shifted into a slave device
- **Master In Slave Out (MISO):** A data line that supplies the output data from a slave device that is shifted into the master device

- **Serial Clock (SCK):** A control line driven by the master device to regulate the flow of data and enable a master to transmit data at a variety of baud rates
  - The SCK line must cycle once for each data bit that is transmitted
- **Slave Select (SS):** A control line dedicated to a specific slave device that allows the master device to turn the slave device on and off

SPI Addressing

The SPI does not use an addressed-based system like the IIC bus interface uses. Instead, devices are selected by dedicated Slave Select signals, comparable to a Chip Select signal. Each SPI slave device needs its own Slave Select signal driven from the SPI master. This increases the total pin count but decreases overhead and complexity, increasing the available bandwidth and decreasing bus contention.

ML510 platforms employ a 25LC640, 64 kb EEPROM SPI device. Figure 1-19 shows the FPGA and the EEPROM connected by the SPI bus.

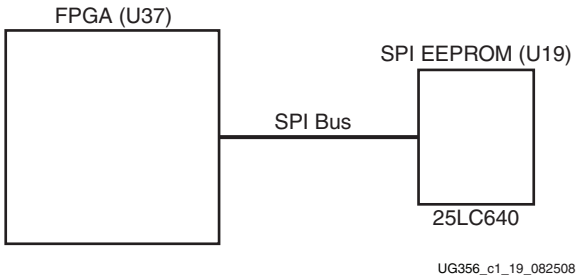


Figure 1-19: **SPI EEPROM Device Interface**

Table 1-29 shows the connections between the IIC/SMBus controller and the FPGA.

Table 1-29: **IIC and SMBus Controller Connections**

Signal Name	FPGA Pin (U37)
SPI_DATA_OUT	AP7
SPI_DATA_IN	AP5
SPI_CLK	AL9
SPI_DATA_CS_B	AL10

Serial ATA

ML510 platforms provide two Serial ATA (SATA) host port connections via J25 and J26. Each SATA host port connection provides AC-coupled connections to and from a RocketIO transceiver on the FPGA. A selectable differential reference clock, 75 MHz or 150 MHz (default) controlled by J5 (jumper on = 150 MHz; off = 75 MHz), is provided for use with the SATA GTXs and logic used to support the SATA protocol. For more information, see the *Virtex-5 RocketIO FPGA GTX Transceiver User Guide* [Ref 5].

Serial ATA Description

Serial ATA is the next generation of the ATA family of interfaces. Providing a higher throughput through a simpler and less expensive cable, Serial ATA maintains software compatibility with older ATA implementations.

FPGA to Serial ATA Connector

ML510 platforms that are equipped with RocketIO transceivers provide for operation as a Serial ATA host or device. These connections are also shown in Table 1-30.

Table 1-30: **Connections Between FPGA and Serial ATA Connector (J25 and J26)**

Signal Name	FPGA Pin (U37)	Serial ATA Pin
GTP_120_RX0_N	F1	J26.3
GTP_120_RX0_N	E1	J26.2
GTP_120_TX0_N	E2	J26.5
GTP_120_TX0_N	D2	J26.6
GTP_120_RX1_N	G1	J25.3
GTP_120_RX1_N	H1	J25.2
GTP_120_TX1_N	H2	J25.5
GTP_120_TX1_N	J2	J25.6
SATACLK_Q0P(1)	F4	-
SATACLK_Q0N(1)	F3	-

Notes:
1. 75/150 MHz

The Serial ATA connectors have different connections to the FPGA for transmit and receive differential pairs. The receive differential pair is connected by way of a 0.01 µF capacitor to AC-couple the incoming signal to the FPGA. The transmit differential pair between the FPGA and the Serial ATA connector is connected by way of a 0Ω resistor. The resistor is a place holder to allow for AC-coupling if required at a future date.

Pushbuttons, Switches, Front Panel Interface, and Jumpers

Pushbuttons

System ACE Reset (SW1)

SW1 is a manual reset switch for the System ACE CF (U38) device. When SW1 is actuated, it drives the PB_SYSTEM_ACE_RESET signal Low, which causes the LTC1326 (U31) to generate a 100 µs active-Low pulse. The active-Low output from the LTC1326 drives the reset input of the System ACE CF controller (U38) through the SYSTEMACE_RESET_N signal. When the System ACE CF device is reset, it causes the FPGA to be reconfigured. The ACE file that is used to program the device is selected via SW3 DIP switch settings.

Note: The System ACE configuration address lines, CFG[0:1], are shared with the upper address lines of the BPI flash device. Because these connections are shared, before manually moving to a different System ACE configuration file the user must first pulse the PROG pushbutton before pulsing the System ACE Reset pushbutton. This is required only when the user has implemented a design that drives the flash address lines, such as the EDK EMC controller.

The front panel interface header (J23) can also drive the PB_SYSTEM_ACE_RESET signal. For more details on J23, see the "Front Panel Interface (J23)" section.

CPU Reset (SW2)

SW2 is a manual pushbutton reset switch for the PPC440 system implemented in the FPGA. To use this switch, the user must connect the PB_FPGA_CPU_RESET signal to the PPC440 system within the FPGA fabric. EDK provides IP to perform this task. See the *Embedded Processor Block in Virtex-5 FPGAs Reference Guide* [Ref 4] for more details.

If the SW2 switch is connected in the FPGA fabric, it drives the PB_FPGA_CPU_RESET signal Low when pushed, causing the LTC1326 (U30) to generate a 100 µs active-Low pulse. The active-Low output of the LTC1326 pin drives the FPGA_CPU_RESET_N signal connected to J15 on the FPGA.

In addition to resetting the CPU, SW2 can also perform a System ACE CF reset as described in "System ACE Reset (SW1)," page 57. This can be accomplished by simply holding down the SW2 pushbutton for longer than two seconds. This action performs a CPU reset followed by a System ACE CF reset. See the ML510 schematics and the LTC1236 data sheet on the ML510 documentation CD for more details.

The front panel interface header (J23) can also drive the PB_ FPGA_CPU_RESET signal. For more details on J23, please review the "Front Panel Interface (J23)" section.

FPGA Prog (SW4)

SW4 is a pushbutton switch that grounds the FPGA Prog pin when pressed. This action clears the FPGA configuration.

Switches

Configuration Control (SW3)

The Configuration control DIP switch, SW3, controls the selection of the different configuration modes available on the ML510 board. The ML510 supports the following configuration options; JTAG, System ACE CompactFlash memory, and Linear BPI flash. Refer to "Configuration Options," page 77 for more details.

Front Panel Interface (J23)

The front panel interface connector (J23) is a 24-pin header that accepts a standard IDC 24 pin connector (0.1 inch pitch). J23 provides an optional means to control and gather status information from the ML510 if enclosed in a case similar to a desktop computer. The functionality listed below can easily be connected with a custom user-provided cable that connects to user logic designed to control and monitor the functionality available through the front panel interface.

The front panel interface provides the following control capability:

- Power ON|OFF the board
  - ML510 platforms are delivered with a jumper installed on J23
- Eight System ACE configuration selections
  - Connects to the three System ACE configuration address lines
- System ACE Reset
  - Active-Low input (pulsed)
- CPU Reset
  - Active-Low input (pulsed)

The front panel interface provides access to the following status information:

- FPGA configuration DONE output
- IDE disk access output
- ATX power output
- Two FPGA user-defined output signals
- ATX speaker output
- Keyboard inhibit input (active-Low)

Note: All front panel interface outputs, except for the speaker out, can drive LEDs.

Table 1-31 shows the signals available at the front panel interface header (J23).

Table 1-31: **Front Panel Interface Connector (J23)**

J23 Pin	Schematic Signal	Description
1	SYACE_CFGA0	Used to select System ACE configuration, CFGADDR0
2	FPGA_LED_USER1	User defined function, connects to the FPGA, U37-G15, (2.5V)
3	SYACE_CFGA1	Used to select System ACE configuration, CFGADDR1
4	FPGA_LED_USER2	User defined function, connects to the FPGA, U37-G16, (2.5V)
5	SYACE_CFGA2	Used to select System ACE configuration, CFGADDR2
6	NC	No Connect
7	LED_DONE_R	Remote FPGA DONE indicator; tie this pin to anode of user's LED and cathode to ground
8	GND	Ground
9	ATX_PWRLED	ATX 3.3V power indicator; tie this pin to anode of user's LED and cathode to ground
10	ATX_SPKR	Used to drive user-provided ATX speaker
11	SCL	IIC bus
12	SCA	IIC bus
13	GND	Ground
14	GND	Ground
15	KBINH	Tie this pin to ground to activate Keyboard Inhibit (See ALi M1536D+ data sheet for more details)
16	VCC5V	5V ATX power available to user
17	ATX_IDELED_R	ATX IDE access indicator; tie this pin to anode of user's LED and cathode to ground
18	VCC5V	5V ATX power available to user
19	GND	Ground
20	PWR_SUPPLY_ON	Jumper J20 to J19 (GND) allows the ATX power supply AC switch to control power-on of the board. Removing the jumper prevents the ATX supply from powering on.

Table 1-31: **Front Panel Interface Connector (J23) *(Cont'd)***

J23 Pin	Schematic Signal	Description
21	PB_SYSACE_RESET	Used to reset System ACE when driven Low, as described in "System ACE Reset (SW1)"
22	GND	Ground
23	PB_FPGA_CPU_RESET	Used to reset CPU when driven Low, as described in "CPU Reset (SW2)"
24	GND	Ground

Jumpers

Note: Pins should only be jumpered with the board powered off.

12V Fan (J7)

Table 1-32 shows the pinout of the 5V fan.

Table 1-32: **12V Fan Header Connections**

J7 Pin	Description
1	+12V
2	Ground
3	Fan Tachometer

5V Fan (J8)

Table 1-33 shows the pinout of the 5V fan.

Table 1-33: **5V Fan Header Connections**

J8 Pin	Description
1	+5V
2	Ground

JTAG Source Select

The JTAG source select, SW3 position 7, enables the use of either the PC4 JTAG connector (J9) or the CPU JTAG (J12) *and* FPGA JTAG/TRACE (P8) to source the FPGA JTAG pins. This is available for third-party tool support. The multiplexing is performed by an external device, 74LVC157A (U39), as shown in Figure 1-9.

Note: To avoid contention after the FPGA is configured, this functionality should not be used if logic that also drives the CPU JTAG connector (J12) or the FPGA JTAG/TRACE connector (P8) is implemented.

I/O Voltage Margining (J24 and J37)

The voltage margins on the board can be adjusted by shorting the jumpers as shown in Table 1-34. Apply shorting jumpers only when the board is powered off. For more on voltage regulation, see "ATX Power Distribution and Voltage Regulation."

Table 1-34: **Voltage Margining Jumper Settings**

Voltage Regulator	Inhibit Jumper(1)	Margin Jumper	Description
VR1	J30	J24	To adjust the 2.5V supply: • Equal to or greater than –5% margining, short pins 1–2 on J34 • Equal to or greater than +5% margining, short pins 2–3 on J34 • No margining, leave pins open on J34
VR2	-	-	No margining available on the 1.0V supply
VR3	J35	J37	To adjust the 2.0V supply: • Equal to or greater than –5% margining, short pins 1–2 • Equal to or greater than +5% margining, short pins 2–3 • No margining, leave pins open

Notes:

1. Inhibit jumpers are open by default at nominal voltage.

ATX Power Distribution and Voltage Regulation

ML510 platforms are shipped with a commercially available 250 W ATX power supply. All voltages required by the ML510 logic devices are derived from the 5V supply, except the ±12V supplies, as shown in Figure 1-20. The ATX power supply can be easily mounted in a standard ATX chassis along with the ML510 board.

The ATX power supply is a Sparkle Power Inc. model FSP250-60PLN. The *Sparkle User's Manual* is provided in the data sheet section on the ML510 documentation CD. The Sparkle power supply supports a full range input to automatically accommodate a wide range of voltage/frequency standards, such as 115V for North America, Japan, and others, and 230V for most European countries. See the *Sparkle User's Manual* for more information.

The different logic devices used on the ML510 platforms require a variety of voltages. Voltage levels are derived from the 5V supply and regulated on the board as shown in Figure 1-20.

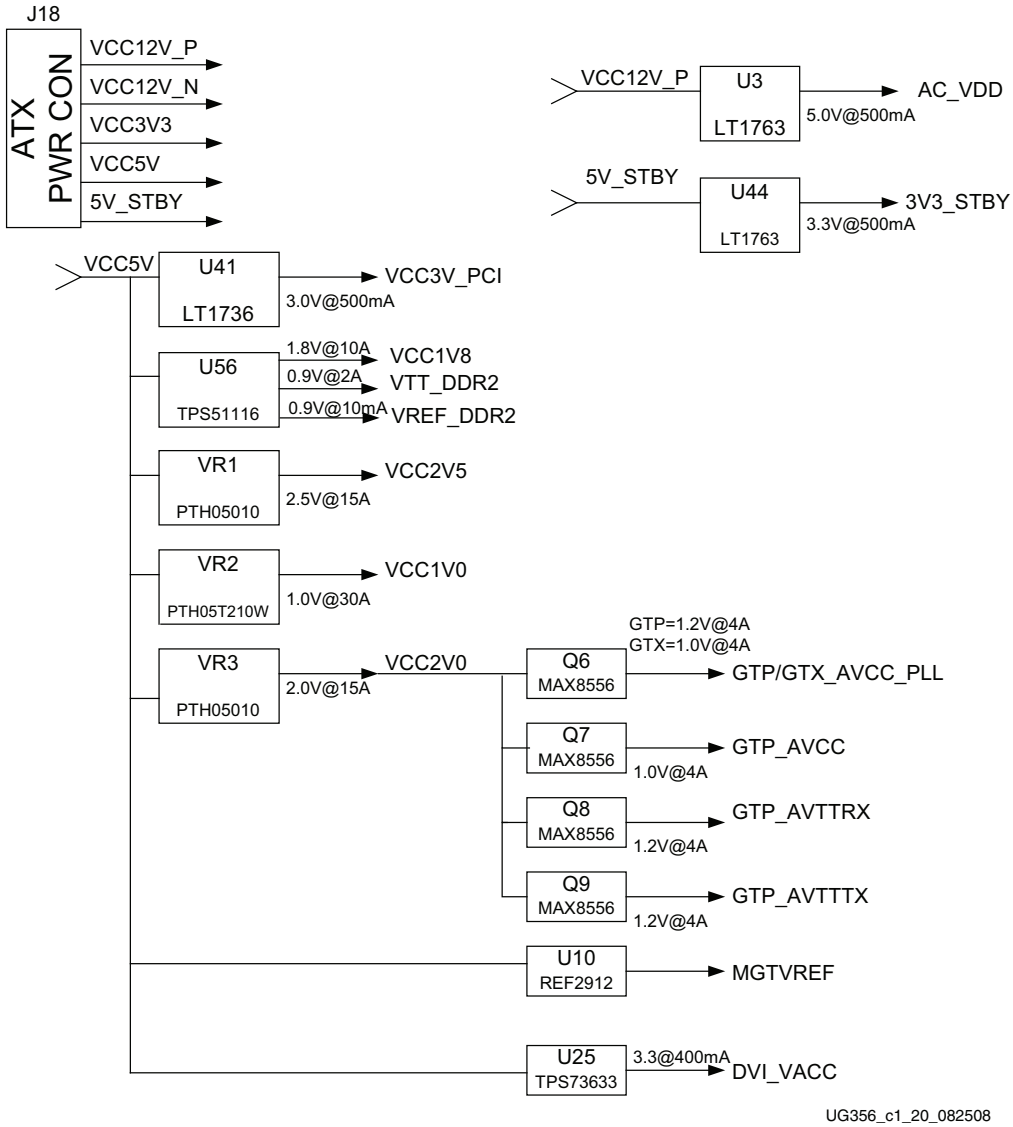


Figure 1-20: **ATX Power Distribution and Voltage Regulation**

Voltage monitors connected to power indicator LEDs monitor the regulated power on the board (see Figure 1-21). The indicator LEDs illuminate red if a regulated supply voltage is out of spec, and illuminate green if the regulated supply voltage is nominal. Each regulated supply voltage has a corresponding test point located near its indicator LED. See the ML510 schematics and the associated data sheets for more information.

In addition to the voltage monitors, the ML510 employs a SMBus device, LM87, which samples several of the same supply voltages when accessed over the System Management Bus. See the "IIC/SMBus Interface" section for more information.

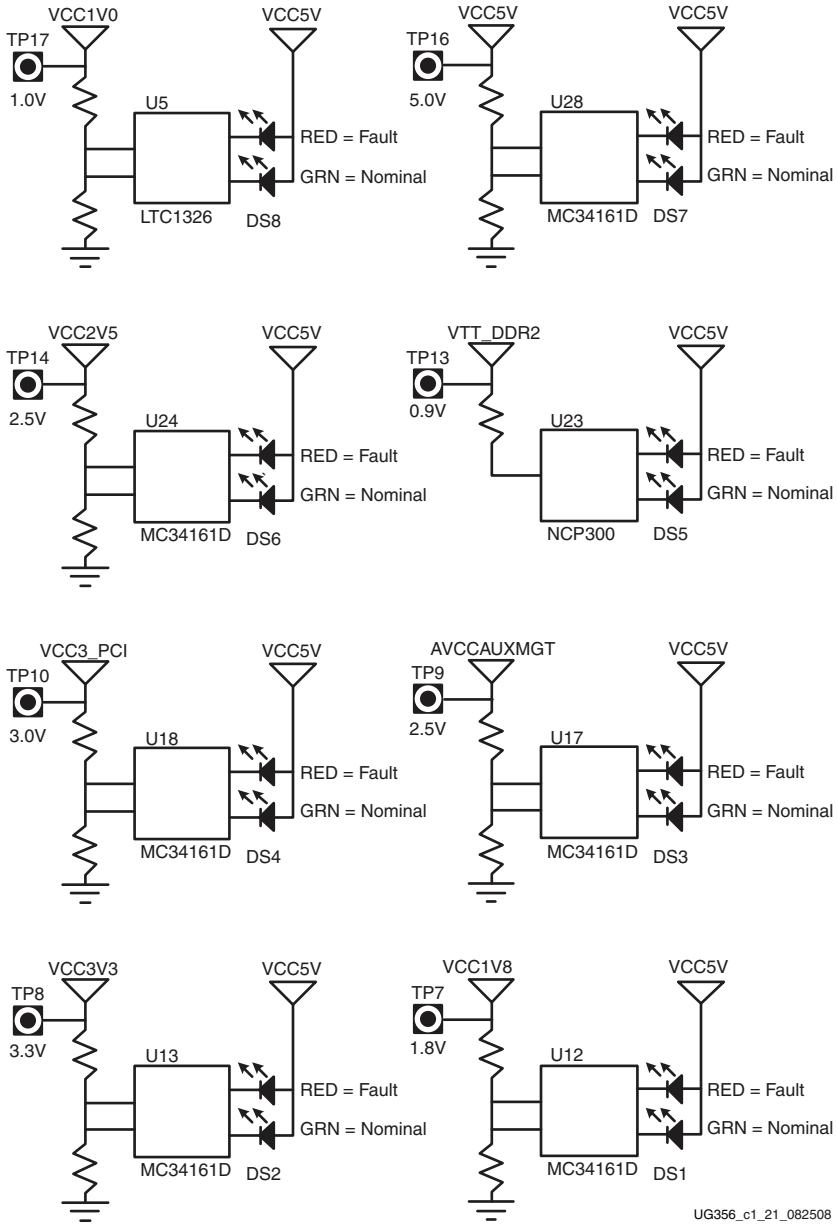


Figure 1-21: **Voltage Monitors**

Table 1-35 shows the various voltage monitor information.

Table 1-35: **Voltage Monitor Information**

Schematic Net Name	Voltage	Test Point	Indicator LED(1)	Description
VCC1V0	1.0V	TP17	DS8	Regulated FPGA core voltage
VCC1V8	1.8V	TP7	DS1	Regulated DDR2 power
VCC2V5	2.5V	TP14	DS6	Regulated FPGA/board logic and DDR power
VCC3_PCI	3.0V	TP10	DS4	Regulated FPGA PCI bank 1-2 voltage
VCC3V3	3.3V	TP8	DS2	Regulated PCI and other logic
VCC5V	5V	TP16	DS7	From ATX power supply, all regulators derive power
VTT_DDR2	0.9V	TP13	DS5	Regulated DDR2 termination (SSTL18)
VTTDDR	1.25V			Regulated DDR termination (SSTL2)
AVCCAUXMGT	2.5V	TP9	DS3	Regulated RocketIO transceiver power
VCC12V_P	+12V	TP18	N/A	Direct from ATX power supply
VCC12V_N	–12V	TP19	N/A	Direct from ATX power supply

Notes:

1. Green LED = Voltage Nominal; Red LED = Voltage Fault

System Monitor

The ML510 supports the dedicated analog inputs to the Virtex-5 FPGA System Monitor block. The VP and VN pins shown in Table 1-36, page 65 are the dedicated pins, whereas the VAUXP[*x*], VAUXN[*x*] 16 user-selectable auxiliary analog input channels are not supported as these pins are dedicated for use by the DDR2 memory interfaces. The ML510 PCB layout for the VP and VN pins is designed using differential pairs and anti-alias filtering in close proximity to the FPGA as recommended in the *Virtex-5 FPGA System Monitor User Guide* [Ref 10].

The Virtex-5 FPGA System Monitor function is built around a 10-bit, 200-kSPS (kilosamples per second) Analog-to-Digital Converter (ADC). When combined with a number of on-chip sensors, the ADC is used to measure FPGA physical operating parameters like on-chip power supply voltages and die temperatures. Access to external voltages is provided through a dedicated analog-input pair (VP/VN).

The System Monitor is fully functional on power up, and measurement data can be accessed via the JTAG port pre-configuration. The Xilinx ChipScope™ Pro tool [Ref 18] provides access to the System Monitor over the JTAG port. The System Monitor control logic implements some common monitoring features. For example, an automatic channel sequencer allows a user-defined selection of parameters to be automatically monitored, and user-programmable averaging is enabled to ensure robust noise-free measurements.

The System Monitor also provides user programmable alarm thresholds for the on-chip sensors. Thus, if an on-chip monitored parameter moves outside the user-specified operating range, an alarm logic output becomes active. In addition to monitoring the on-chip temperature for user-defined applications, the System Monitor issues a special alarm

called *Over-Temperature (OT)* if the FPGA temperature becomes critical (> 125°C). The OT signal is deactivated when the device temperature falls below a user specified lower limit. If the FPGA power-down feature is enabled, the FPGA enters power down when the OT signal becomes active. The FPGA powers up again when the alarm is deactivated.

For additional information about the System Monitor, see http://www.xilinx.com/systemmonitor and consult the Virtex-5 FPGA *System Monitor User Guide* [Ref 10]. Table 1-36 shows the System Monitor connections (J33).

The ML510 supports the measurement of the output current of the FPGA's V_{CCINT} supply (Figure 1-22). The output of the V_{CCINT} regulator is connected to a series 3W, 1%, 2.2 mΩ Kelvin resistor. The sense pin on the V_{CCINT} regulator is connected to the FPGA (load) side of the Kelvin resistor in order to compensate for the voltage drop across the Kelvin resistor, as the FPGA current consumption varies. The voltage across the Kelvin resistor can be measured at the System Monitor header, J33. The Virtex-5 FPGA System Monitor supports measuring the voltage across the Kelvin resistor by jumpering J33 pins 10 and 12 and J33 pins 9 and 11. The V_{CCINT} current can be calculated by using Ohms Law.

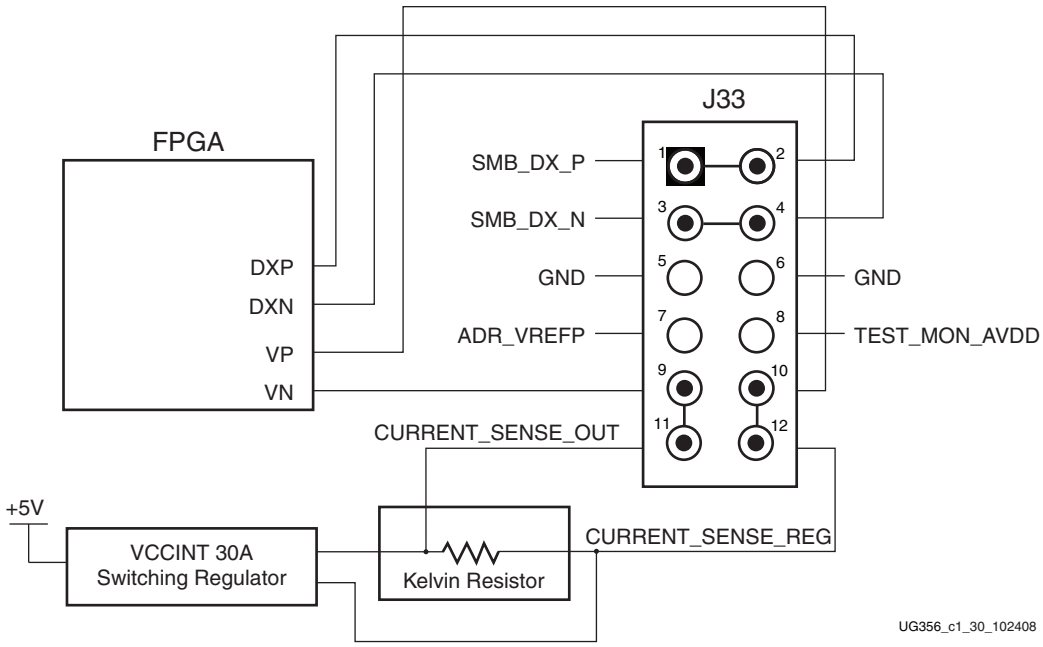


Figure 1-22: **Power Regulation and Measurement**

Table 1-36: **System Monitor Header (J33)**

J33 Pin	Schematic Signal	Description
1	SMB_DX_P	Temperature diode connection to LM87, anode connection. The LM87 is an IIC accessible device.(1)
2	FPGA_DX_P	Temperature diode connection to FPGA, annode connection.(1)
3	SMB_DX_N	Temperature diode connection to LM87, cathode connection. The LM87 is an IIC accessible device.(1)
4	FPGA_DX_N	Temperature diode connection to FPGA, cathode connection.(1)

Table 1-36: **System Monitor Header (J33) *(Cont'd)***

J33 Pin	Schematic Signal	Description
5	GND	Ground
6	GND	Ground
7	ADR_VREFP	VREFP supply
8	TEST_MON_AVDD	VDD from FPGA
9	TEST_MON_VN0_N	Dedicated FPGA analog input pair (VP/VN) for access to external voltages.(2)
10	TEST_MON_VN0_P	
11	CURRENT_SENSE_OUT	Tap used to measure current with ohm meter or System Monitor when jumpered correctly.(2) Negative side connection to the Kelvin resistor.
12	CURRENT_SENSE_REG	Tap used to measure current with ohm meter when jumpered correctly.(2) Positive side connection to the Kelvin resistor.

Notes:

1. Default setting = jumper over pins 1-2 and 3-4.
2. To measure V_{CCINT} current using the Virtex-5 FPGA System Monitor, jumper over pins 9-11 and 10-12.

High-Speed I/O

The ML510 platform's high-speed I/O is based on the RocketIO transceiver and LVDS capability of Virtex-5 FXT FPGAs. The ML510 platform RocketIO signal integrity was engineered to meet typical data channel characteristics and may not be representative of the highest performance that can be achieved. The ML52*x* series of Virtex-5 FXT RocketIO Characterization Platforms should be used for detailed RocketIO transceiver link analysis.

The high-speed I/O signals on the FPGA are accessible through two personality module (PM) connectors, referred to as Personality Module 1 and Personality Module 2, on the ML510 platforms. The PM connectors are Tyco Z-Dok+ docking connectors. See the 1367550-5 data sheet at Tyco's website (www.z-dok.com).

The ML510 is the host board, functioning as the development platform for the Virtex-5 FXT FPGA. The PM connectors on the ML510 platforms provide a means for extending the functionality of the board through high-speed I/O pins.

Figure 1-23 shows an example of a personality module connected to an embedded development platform (an ML310 in this example). The plug, located on the embedded

development platform, is referred to as the *host board connector*; the receptacle, located on the personality module, is referred to as the *adapter board connector*.

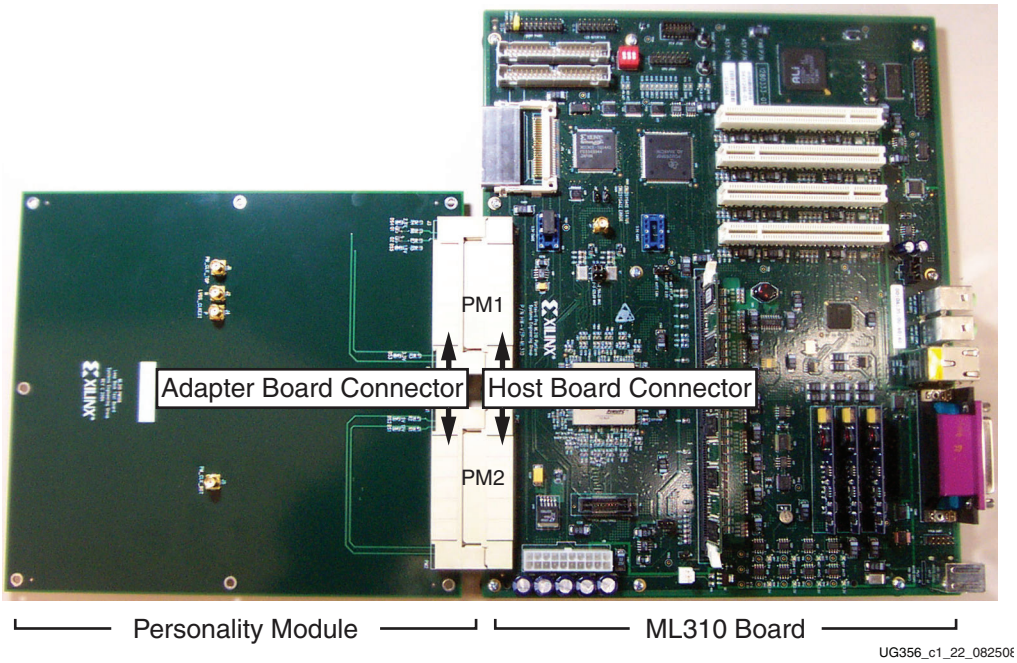


Figure 1-23: **Personality Module Connected to Embedded Development Platform**

Personality Module Connectors

Figure 1-24 shows an edge view of the PM host board connectors.

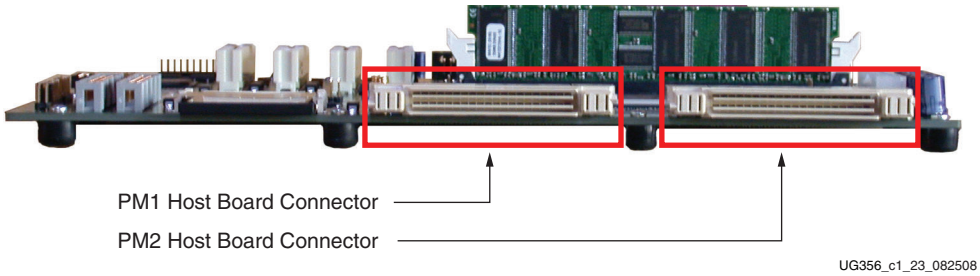


Figure 1-24: **Edge View of Host Board Connectors**

Each signal pair on the PM1 and PM2 host board connectors has a wide ground pin on the opposite side of the plastic divider, as shown in Figure 1-25. The signal pairs alternate from

side to side along the length of the divider. All of the B and E pins are grounded on the ML510. The A, C, D, and F pins are signal pins.

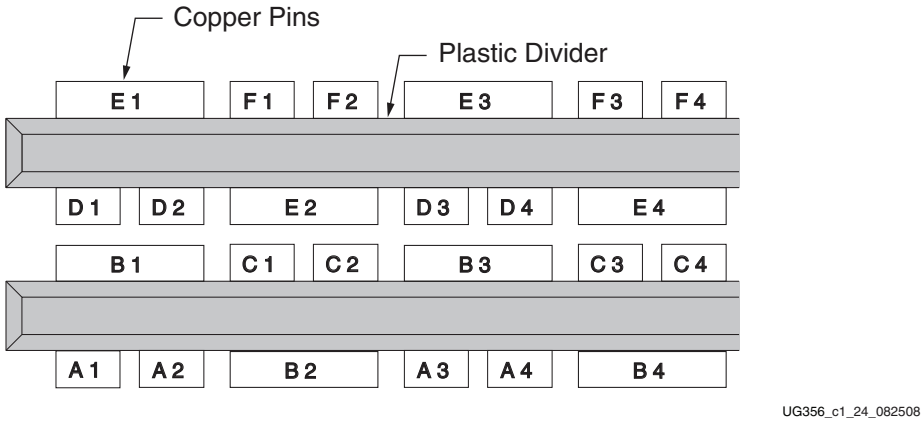


Figure 1-25: **Host Board Connector Pin Detail**

Z-Dok+ Connector Offsets

The Z-Dok+ connectors provide four rows of signals pairs. Each row has a particular propagation delay through a mated pair of connectors (Table 1-37).

Table 1-37: **Delay Offsets**

ZDOK+ Connector	Connector Propagation Delay	Physical Length
Row A	145.2 ps	830 mils
Row C	196.8 ps	1125 mils
Row D	213.3 ps	1219 mils
Row F	264.8 ps	1513 mils

Notes:

1. Propagation delay, i.e., the delay when traversing through the host board connector and the adapter board connector, was calculated assuming 175 ps/inch. Propagation delay is the total between each male and female connector pair.

All signals with length matching requirements, GTX and LVDS pairs, must include an offset to account for the Z-Dok+ propagation delays. The ML510 platforms account for one-half of the offset, while a user-designed adapter board must account for the other half. The relative offsets for the ML510 host board PM connector are included in Table 1-38. Users are required to compensate for these offsets when designing adapter boards.

Table 1-38: **Relative Offsets from the FPGA to the PM1 and PM2 Connectors**

ZDOK+ Connector	Difference	Offset	Offset/2(1)
Row A	F – A = 1513 – 830	683	342
Row C	F – C = 1513 – 1125	389	194
Row D	F – D = 1513 – 1219	294	147
Row F	F – F = 0 – 0	0	0

Notes:

1. All offsets are normalized to row F. The ML510 design is based on the data in the Offset/2 column.

PM1 Connector

The PM1 connector provides the following signals:

- 8 RocketIO 4.25 Gb/s transceivers
- 3 LVDS pairs at 2.5V (can be used as 6 single-ended I/O at 2.5V)
- 1 LVDS clock pair at 2.5V
- 12 single- ended I/O at 2.5V
- 26 single-ended I/O at 3.3V
- 1 single-ended clock at 2.5V
- 1 pin not connected

PM2 Connector

The PM2 connector on provides the following signals:

- 39 LVDS pairs at 2.5V (can be used as 78 single-ended I/O at 2.5V)
- 1 single-ended clock at 2.5V
- 1 pin not connected

Adapter Board PM Connectors

Tyco Z-Dok+ adapter board connectors (part number 1367555-1) are the receptacle connectors on the personality modules that mate to the ML510 host board connectors. See the 1367555-1 data sheet at Tyco's website (www.z-dok.com).

On the adapter board connectors, located on the personality module, each signal pair has a pair of ground pins on the opposite side of the open space, as shown in Figure 1-26, page 69. The signal pairs alternate from side to side along the length of the open space. All of the B and E pins are two contacts tied together and grounded on the personality module. The A, C, D, and F pins are signal pins.

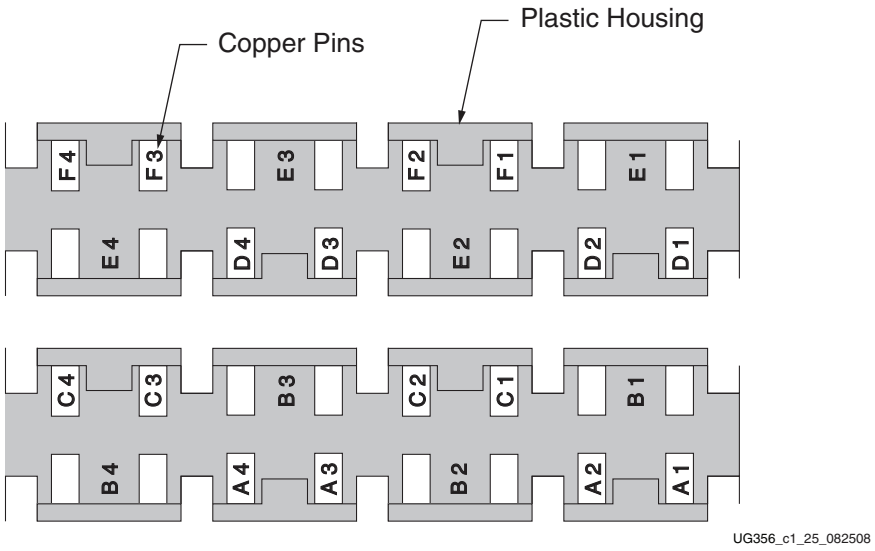


Figure 1-26: **Adapter Board Connector Pin Detail**

Z-DOK+ Utility Pins

Figure 1-27 shows the Z-DOK+ utility pins and numbering for the host board PM connector.

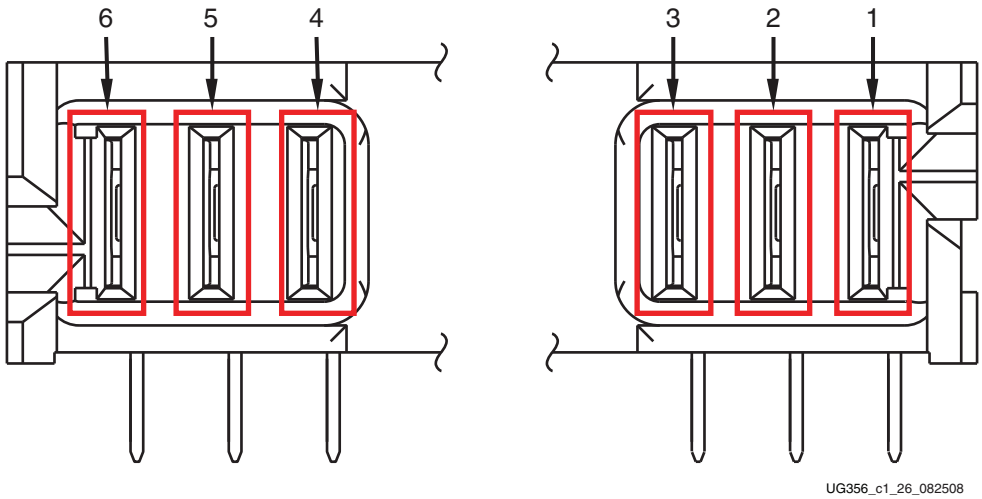


Figure 1-27: **Z-DOK+ Utility Pins (ML510 Side)**

Figure 1-28 shows the Z-DOK+ utility pins and numbering for the adapter board connector.

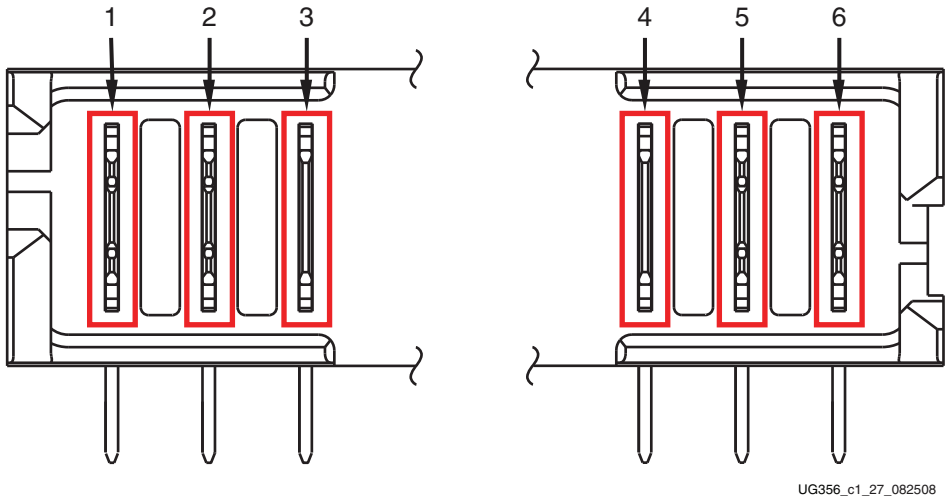


Figure 1-28: **Z-DOK+ Utility Pins (Adapter Side)**

Note: The pins on the adapter board connector are at varying heights, as shown in Table 1-39 and Table 1-40, page 71.

Contact Order

The Z-Dok+ power and ground pins contact in the following order:

- 1 and 6;
- then 2 and 5;
- then 3 and 4

PM1 Power and Ground

Table 1-39 shows the power and ground pins for the PM1 connector on the ML510.

Table 1-39: **PM1 Power and Ground Pins**

Pin Number	Description	Length	Contact Order
1, 6	Ground	Level 4	First
2, 5	2.5V	Level 3	Second
3	3.3V	Level 2	Third
4	1.2V	Level 2	Third

PM User I/O Pins

PM1 User I/O

The PM1 connector makes the GTX signals from the eight RocketIO transceivers available to the user, along with LVDS pairs and single-ended signals. Table 1-40 shows the pinout for the PM1 connector.

Table 1-40: **PM1 Pinout**

PM1 Pin	FPGA Pin	Signal Name	FPGA Bank V_{CCO}	Pin Function
A1	AV33	PM_IO_94_P	2.5V	Single-ended 50Ω impedance
A2	AV34	PM_IO_95_N	2.5V	Single-ended 50Ω impedance
A3	AU36	PM_IO_86_P	2.5V	Single-ended 50Ω impedance
A4	AT35	PM_IO_87_N	2.5V	Single-ended 50Ω impedance
A5	V6	PM_IO_3V_25_N	3V	Single-ended 50Ω impedance
A6	V5	PM_IO_3V_18_P	3V	Single-ended 50Ω impedance
A7	M6	PM_IO_3V_7_N	3V	Single-ended 50Ω impedance
A8	L6	PM_IO_3V_22_P	3V	Single-ended 50Ω impedance
A9	U6	PM_IO_3V_9_N	3V	Single-ended 50Ω impedance
A10	U7	PM_IO_3V_13_P	3V	Single-ended 50Ω impedance
A11	AH31	PM_IO_82_P	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
A12	AJ31	PM_IO_83_N	2.5V	
A13	P1	GTP_116_RX1_P	-	GTX RX pair received by host FPGA
A14	N1	GTP_116_RX1_N	-	
A15	Y1	GTP_112_RX0_P	-	GTX RX pair received by host FPGA
A16	W1	GTP_112_RX0_N	-	
A17	AG2	GTP_114_TX1_P	-	GTX TX pair driven by host FPGA
A18	AF2	GTP_114_TX1_N	-	

Table 1-40: **PM1 Pinout *(Cont'd)***

PM1 Pin	FPGA Pin	Signal Name	FPGA Bank V_{CCO}	Pin Function
A19	AN2	GTP_118_TX1_P	-	GTX TX pair driven by host FPGA
A20	AM2	GTP_118_TX1_N	-	
C1	AR35	PM_IO_90_P	2.5V	Single-ended 50Ω impedance
C2	AR34	PM_IO_91_N	2.5V	Single-ended 50Ω impedance
C3	V8	PM_IO_3V_16_N	3V	Single-ended 50Ω impedance
C4	W8	PM_IO_3V_12_P	3V	Single-ended 50Ω impedance
C5	L5	PM_IO_3V_1_N	3V	Single-ended 50Ω impedance
C6	K4	PM_IO_3V_3_P	3V	Single-ended 50Ω impedance
C7	N6	PM_IO_3V_17_N	3V	Single-ended 50Ω impedance
C8	N5	PM_IO_3V_5_P	3V	Single-ended 50Ω impedance
C9	AH33	PM_IO_80_P	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
C10	AG32	PM_IO_81_N	2.5V	
C11	T6	PM_IO_3V_19_N	3V	Single-ended 50Ω impedance
C12	T7	PM_IO_3V_24_P	3V	Single-ended 50Ω impedance
C13	L1	GTP_116_RX0_P	-	GTX RX pair received by host FPGA
C14	M1	GTP_116_RX0_N	-	
C15	U1	GTP_112_RX0_P	-	GTX RX pair received by host FPGA
C16	V1	GTP_112_RX0_N	-	
C17	AB2	GTP_114_TX0_P	-	GTX TX pair driven by host FPGA
C18	AC2	GTP_114_TX0_N	-	
C19	AH2	GTP_118_TX0_P	-	GTX TX pair driven by host FPGA
C20	AJ2	GTP_118_TX0_N	-	
D1	AU32	PM_IO_92_P	2.5V	Single-ended 50Ω impedance
D2	AU33	PM_IO_93_N	2.5V	Single-ended 50Ω impedance
D3	AV35	PM_IO_84_P	2.5V	Single-ended 50Ω impedance
D4	AV36	PM_IO_85_N	2.5V	Single-ended 50Ω impedance
D5	H5	PM_IO_3V_21_N	3V	Single-ended 50Ω impedance
D6	G6	PM_IO_3V_20_P	3V	Single-ended 50Ω impedance
D7	J5	PM_IO_3V_8_N	3V	Single-ended 50Ω impedance
D8	H6	PM_IO_3V_6_P	3V	Single-ended 50Ω impedance
D9	K5	PM_IO_3V_2_N	3V	Single-ended 50Ω impedance
D10	J6	PM_IO_3V_14_P	3V	Single-ended 50Ω impedance

Table 1-40: **PM1 Pinout *(Cont'd)***

PM1 Pin	FPGA Pin	Signal Name	FPGA Bank V_{CCO}	Pin Function
D11	AF32	PM_IO_78_P	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
D12	AG33	PM_IO_79_N	2.5V	
D13	P2	GTP_116_TX1_N	-	GTX TX pair driven by host FPGA
D14	R2	GTP_116_TX1_P	-	
D15	Y2	GTP_112_TX1_N	-	GTX TX pair driven by host FPGA
D16	AA2	GTP_112_TX1_P	-	
D17	AE1	GTP_114_RX1_N	-	GTX RX pair received by host FPGA
D18	AF1	GTP_114_RX1_P	-	
D19	AL1	GTP_118_RX1_N	-	GTX RX pair received by host FPGA
D20	AM1	GTP_118_RX1_P	-	
F1	AU34	PM_IO_88_P	2.5V	Single-ended 50Ω impedance
F2	AT34	PM_IO_89_N	2.5V	Single-ended 50Ω impedance
F3	AA6	PM_IO_3V_10_N	3V	Single-ended 50Ω impedance
F4	AA7	PM_IO_3V_4_P	3V	Single-ended 50Ω impedance
F5	W6	PM_IO_3V_15_N	3V	Single-ended 50Ω impedance
F6	W5	PM_IO_3V_0_P	3V	Single-ended 50Ω impedance
F7	L26	PM_IO_23_N	3V	Single-ended 50Ω impedance
F8	Y7	PM_IO_3V_11_P	3V	Single-ended 50Ω impedance
F9	M27	PM_CLK_TOP	2.5V	Clock
F10			NC	No Connect
F11	V3	LVDS_CLKEXT_N	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
F12	V4	LVDS_CLKEXT_P	2.5V	
F13	L2	GTP_116_TX0_N	-	GTX TX pair driven by host FPGA
F14	K2	GTP_116_TX0_P	-	
F15	U2	GTP_112_TX0_N	-	GTX TX pair driven by host FPGA
F16	T2	GTP_112_TX0_P	-	
F17	AD1	GTP_114_RX0_N	-	GTX RX pair received by host FPGA
F18	AC1	GTP_114_RX0_P	-	
F19	AK1	GTP_118_RX0_N	-	GTX RX pair received by host FPGA
F20	AJ1	GTP_118_RX0_P	-	

PM2 User I/O

The PM2 connector makes most of the LVDS pairs available to the user, along with single-ended signals. Table 1-41 shows the pinout for the PM2 connector on the ML510.

Table 1-41: **PM2 Pinout**

PM2 Pin	FPGA Pin	Signal Name	FPGA Bank VCCO	Pin Function
A1	AG7	PM_IO_63_N	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
A2	AG6	PM_IO_62_P	2.5V	
A3	AE7	PM_IO_67_N	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
A4	AF7	PM_IO_66_P	2.5V	
A5	AH4	PM_IO_55_N	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
A6	AG4	PM_IO_54_P	2.5V	
A7	AH5	PM_IO_51_N	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
A8	AH6	PM_IO_50_P	2.5V	
A9	AB8	PM_IO_45_N	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
A10	AB9	PM_IO_44_P	2.5V	
A11	AE9	PM_IO_72_P	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
A12	AE10	PM_IO_73_N	2.5V	
A13	G28	PM_IO_28_P	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
A14	H28	PM_IO_29_N	2.5V	
A15	K27	PM_IO_22_P	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
A16	L26	PM_IO_23_N	2.5V	
A17	G29	PM_IO_32_P	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
A18	F29	PM_IO_33_N	2.5V	
A19	L24	PM_IO_0_P	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
A20	M24	PM_IO_1_N	2.5V	
C1	AD11	PM_IO_53_N	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
C2	AD10	PM_IO_52_P	2.5V	
C3	AF6	PM_IO_61_N	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
C4	AF5	PM_IO_60_P	2.5V	
C5	AK7	PM_IO_39_N	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
C6	AJ7	PM_IO_38_P	2.5V	

Table 1-41: **PM2 Pinout *(Cont'd)***

PM2 Pin	FPGA Pin	Signal Name	FPGA Bank VCCO	Pin Function
C7	AC9	PM_IO_49_N	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
C8	AC8	PM_IO_48_P	2.5V	
C9	AF11	PM_IO_74_P	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
C10	AF12	PM_IO_75_N	2.5V	
C11	K18	PM_IO_20_P	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
C12	K19	PM_IO_21_N	2.5V	
C13	L20	PM_IO_34_P	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
C14	L19	PM_IO_35_N	2.5V	
C15	G18	PM_IO_14_P	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
C16	G17	PM_IO_15_N	2.5V	
C17	K24	PM_IO_4_P	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
C18	L25	PM_IO_5_N	2.5V	
C19	K25	PM_IO_8_P	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
C20	J25	PM_IO_9_N	2.5V	
D1	AF10	PM_IO_71_N	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
D2	AF9	PM_IO_70_P	2.5V	
D3	AE8	PM_IO_69_N	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
D4	AD8	PM_IO_68_P	2.5V	
D5	AC6	PM_IO_59_N	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
D6	AC5	PM_IO_58_P	2.5V	
D7	AK5	PM_IO_43_N	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
D8	AL5	PM_IO_42_P	2.5V	
D9	AB6	PM_IO_57_N	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
D10	AB7	PM_IO_56_P	2.5V	
D11	AG31	PM_IO_76_P	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
D12	AF31	PM_IO_77_N	2.5V	
D13	M19	PM_IO_26_P	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
D14	N19	PM_IO_27_N	2.5V	

Table 1-41: **PM2 Pinout *(Cont'd)***

PM2 Pin	FPGA Pin	Signal Name	FPGA Bank VCCO	Pin Function
D15	G27	PM_IO_24_P	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
D16	F27	PM_IO_25_N	2.5V	
D17	G16	PM_IO_10_P	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
D18	H16	PM_IO_11_N	2.5V	
D19	H26	PM_IO_12_P	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
D20	J26	PM_IO_13_N	2.5V	
F1	AC10	PM_IO_41_N	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
F2	AB11	PM_IO_40_P	2.5V	
F3	AD5	PM_IO_65_N	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
F4	AE5	PM_IO_64_P	2.5V	
F5	AJ5	PM_IO_47_N_J	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
F6	AJ6	PM_IO_46_P_J	2.5V	
F7	H30	PM_IO_37_N_J	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
F8	H29	PM_IO_36_P_J	2.5V	
F9			2.5V	No Connect
F10	L14	PM_CLK_BOT	2.5V	Clock
F11	F16	PM_IO_6_P	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
F12	F17	PM_IO_7_N	2.5V	
F13	M18	PM_IO_30_P	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
F14	N18	PM_IO_31_N	2.5V	
F15	J18	PM_IO_18_P	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
F16	H18	PM_IO_19_N	2.5V	
F17	E18	PM_IO_2_P	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
F18	E17	PM_IO_3_N	2.5V	
F19	J28	PM_IO_16_P	2.5V	LVDS pair 100Ω differential impedance; can also be used as single-ended
F20	J27	PM_IO_17_N	2.5V	

Configuration Options

The FPGA on the ML510 Evaluation Platform can be configured by the following major devices:

- Xilinx download cable (JTAG)
- System ACE controller (JTAG)
- Linear Flash memory byte peripheral interface (BPI)

The following section provides an overview of the possible ways the FPGA can be configured.

JTAG (Xilinx Download Cable and System ACE Controller) Configuration

The FPGA, two Platform Flash memories, and CPLD can be configured through the JTAG port. The JTAG chain of the board is illustrated in Figure 1-29.

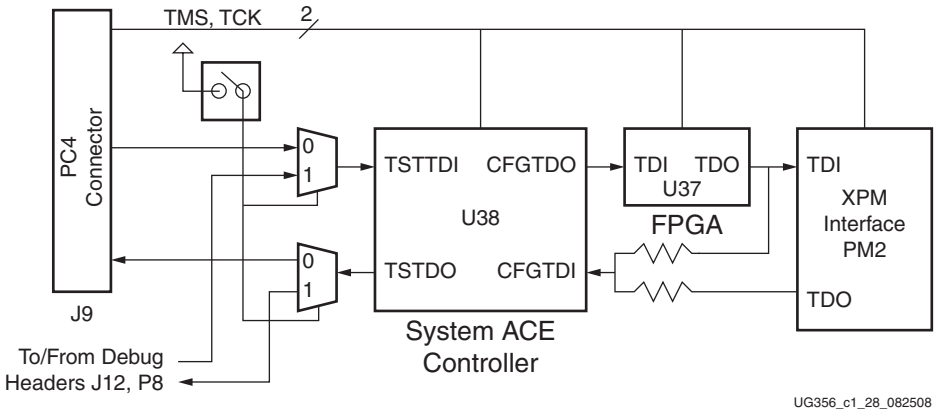


Figure 1-29: **JTAG Chain**

The chain starts at the PC4 connector and goes through the System ACE controller, the FPGA, and the XPM interface. The multiplexers shift the CPU JTAG signals from 2.5V to 3.3V. The resistors provide protection for a 2.5V JTAG probe.

The JTAG chain can be used to program the FPGA and access the FPGA for hardware and software debug.

The PC4 JTAG connection to the JTAG chain allows a host computer to download bitstreams to the FPGA using the iMPACT software tool. PC4 also allows debug tools such as the ChipScope™ Pro Analyzer or a software debugger to access the FPGA.

The System ACE controller can also program the FPGA through the JTAG port. Using an inserted CompactFlash card, configuration information can be stored and played out to the FPGA. The System ACE controller supports up to eight configuration images that can selected using the three configuration address DIP switches. Under FPGA control, the System ACE chip can be instructed to reconfigure to any of the eight configuration images.

The configuration mode should be set to **`101`** and SYSACE_MODE = 1 (enable), switch SW3 = **`00010101`** (default setting) to use System ACE configuration. When set correctly, the System ACE controller programs the FPGA upon power-up if a CompactFlash card is present or whenever a CompactFlash card is inserted. Pressing the System ACE reset button also causes the System ACE controller to program the FPGA if a CompactFlash card is present.

System ACE Controller Configuration

SW3 is a three position DIP switch that controls the three configuration address pins on the System ACE CF controller. The addresses, CFGADDR0, CFGADDR1, and CFGADDR2, are marked on SW3 as positions 1, 2, and 3 respectively. SW3 also has an ON indicator and directional arrow etched onto the plastic housing. An arrow appears on the board silkscreen, as well, to indicate the on position. When any of the three switches are moved to the ON position, the associated CFGADDR bit is set to a logic 0. When any of the three switches are moved opposite of the ON position (i.e., OFF), the associated CFGADDR bit is set to a logic 1 via a pull-up resistor.

Figure 1-30 shows the SW3 DIP switch connections to the System ACE device. One side of the DIP switch is tied to pull-up resistors that are connected to each of the CFGADDR lines while the other side of the DIP switch is connected to ground. The configuration address lines are also connected to the front panel interface. See the "Front Panel Interface (J23)" section for more details. This allows the user to manually select one of eight configurations stored on the CompactFlash card that is connected to the System ACE device. After the user makes a valid selection on SW3, the user can then depress pushbutton SW1 to command the System ACE device to reset and configure the FPGA using the configuration selected by DIP switch SW3. See the *System ACE CompactFlash Solution Data Sheet* [Ref 12] for more details.

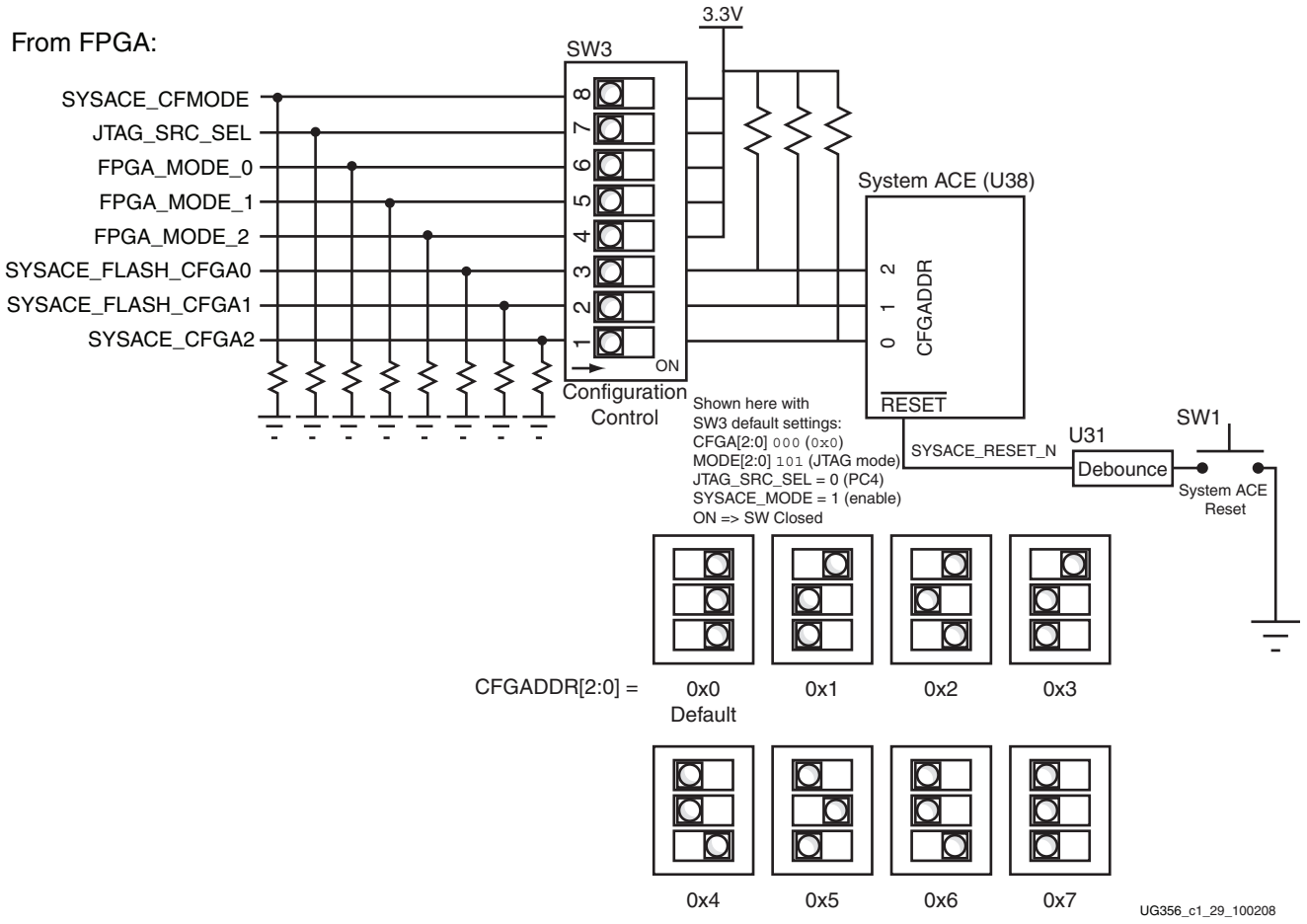


Figure 1-30: **SW3: System ACE Configuration Switch Detail**

Linear Flash Memory Configuration

Data stored in the linear flash can be used to program the FPGA (BPI mode). Up to four configuration images can theoretically be supported.

SW3 BPI default settings:

- CFGA[2:0] `000` (`0x0`)
- MODE[2:0] `010` (BPI Up mode)
- JTAG_SRC_SEL = `0` (PC4)
- SYSACE_MODE = `0` (disable)

The FPGA RS[1:0] pins can be controlled by SW3 as they are also connected to the SYSACE_CFGA[1:0] (SW3, positions 2 and 3). This allows for manual selection of bit files stored in BPI flash. See the *Virtex-5 Configuration User Guide* for more information related to configuration via the BPI interface. Refer to the BPI Linear Flash Connectivity diagram in UG191 for more details on the Linear Flash BPI interfaces. [Ref 9]

When set correctly, the FPGA is programmed upon power-up or whenever the **Prog** button is pressed.

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Appendix A

References

This section provides references to documentation supporting Virtex-5 devices, tools, and IP. For additional information, see www.xilinx.com/support/documentation/index.htm.

Documents supporting Virtex-5 FPGAs:

1. DS100, *Virtex-5 Family Overview.*
2. DS202, *Virtex-5 FPGA Data Sheet: DC and Switching Characteristics.*
3. UG190, *Virtex-5 FPGA User Guide.*
4. UG200, *Embedded Processor Block in Virtex-5 FPGAs Reference Guide.*
5. UG198, *Virtex-5 FPGA RocketIO GTX Transceiver User Guide.*
6. UG194, *Virtex-5 FPGA Embedded Tri-Mode Ethernet MAC User Guide.*
7. UG197, *Virtex-5 FPGA Integrated Endpoint Block User Guide for PCI Express Designs.*
8. UG193, *XtremeDSP Design Considerations.*
9. UG191, *Virtex-5 FPGA Configuration User Guide.*
10. UG192, *Virtex-5 FPGA System Monitor User Guide.*
11. UG195, *Virtex-5 FPGA Packaging and Pinout Specification.*
12. DS080, *System ACE CompactFlash Solution Data Sheet*.

Documents supporting Xilinx Platform Studio (XPS):

13. UG111, *Embedded System Tools Reference Manual*
14. XTP013, *EDK Concepts, Tools, and Techniques.*
15. UG081, *MicroBlaze Processor Reference Guide*.
16. OS and Libraries Document Collection.

Documents specific to the ML510 Evaluation Platform:

17. UG355, *ML510 Reference Design User Guide*.

Documents supporting IBERT:

18. UG213, *ChipScope Pro Serial I/O Toolkit.*
19. UG029, *ChipScope Pro Software and Cores User Guide.*

The Xilinx Memory Solutions Web page offers the following material supporting the Memory Interface Generator (MIG) tool:

20. WP260, *Memory Interfaces Made Easy with Xilinx FPGAs and the Memory Interface Generator.*
21. UG086, *Xilinx Memory Interface Generator (MIG) User Guide* (for registered users).
22. Demos on Demand, *Memory Interface Solutions with Xilinx FPGAs.*
23. Xilinx Support - Memory Interface Resources (for registered users).

Documents supporting the LogiCORE Endpoint block for PCIe solutions:

24. DS551, *LogiCORE Endpoint Block Plus for PCI Express Data Sheet.*
25. UG341, *LogiCORE Endpoint Block Plus for PCI Express User Guide.*
26. UG343, *LogiCORE Endpoint Block Plus for PCI Express Getting Started Guide.*

Documents supporting the LogiCORE SGMII solution:

27. DS550, *LogiCORE Virtex-5 FPGA Embedded Tri-Mode Ethernet MAC Wrapper Data Sheet.*
28. UG340, *LogiCORE Virtex-5 FPGA Embedded Tri-Mode Ethernet MAC Wrapper Getting Started Guide.*

The Xilinx DSP Resources Web page includes documents supporting the System Generator for DSP:

29. *System Generator for DSP Getting Started Guide*, http://www.xilinx.com/support/sw_manuals/sysgen_gs.pdf
30. *System Generator for DSP User Guide*, http://www.xilinx.com/support/sw_manuals/sysgen_ug.pdf
31. *System Generator for DSP Reference Guide*, http://www.xilinx.com/support/sw_manuals/sysgen_ref.pdf

Documents supporting additional embedded processor and LogiCORE IP cores:

32. DS537, *XPS_LL_TEMAC (v1.00a) Data Sheet.*
    - XAPP1026, *LightWeight IP (lwIP) Application Examples Application Note.*
33. DS581, *XPS External Peripheral Controller (EPC) (v1.00a) Data Sheet.*
    - XAPP925, *Reference System: Using the OPB EPC with the Cypress CY7C67300 USB Controller Application Note.*
34. DS531, *Processor Local Bus (PLB) v4.6 (v1.00a) Data Sheet.*
35. DS402, *Device Control Register Bus (DCR) v2.9 (v1.00a) Data Sheet.*
36. DS577, *XPS 16550 UART (v1.00a) Data Sheet.*
37. DS606, *XPS IIC Bus Interface (v1.00a) Data Sheet.*
38. DS578, *PLBV46 to DCR Bridge (v1.00a) Data Sheet.*
39. DS444, *Block RAM Block Data Sheet.*
40. DS445, *Local Memory Bus (LMB) v1.0 (v1.00a) Data Sheet.*
41. DS641, *Microprocessor Debug Module (MDM) (v1.00a) Data Sheet.*
42. DS452, *LMB Block RAM Interface Controller Data Sheet.*
43. DS583, *XPS System ACE Interface Controller (v1.00a) Data Sheet.*
44. DS573, *XPS Timer/Counter (v1.00a) Data Sheet.*
45. DS569, *XPS General Purpose Input/Output (GPIO) (v1.00a) Data Sheet.*
46. DS572, *XPS Interrupt Controller (v1.00a) Data Sheet.*
    - XAPP778, *Using and Creating Interrupt-Based Systems Application Note.*
47. DS481, *Util Vector Logic Data Sheet.*
48. DS484, *Util Bus Split Operation Data Sheet.*
49. DS575, *XPS Multi-CHannel External Memory Controller (XPS MCH EMC) (v1.00a) Data Sheet.*
50. UG081, *MicroBlaze Processor Reference Guide: MicroBlaze (v7.00a).*
51. DS614, *Clock Generator (v1.00a) Data Sheet.*
52. DS406, *Processor System Reset Module (v2.00a) Data Sheet.*
53. DS616, *PLBV46 PCI Full Bridge (v1.00a) Data Sheet.*
54. DS643, *Multi-Port Memory Controller (MPMC) Data Sheet.*