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XtremeDSP™ Solution FMC-Video Daughter Board

Technical Reference Guide

UG458 (v1.1) February 8, 2008

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Revision History

The following table shows the revision history for this document.

Date	Version	Revision
10/29/07	1.0	Initial Xilinx release.
02/08/08	1.1	Updated “Files” in Chapter 3. Added note to Table 4-2.

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About This Guide

This user guide describes how to use the FMC-Video daughter card, which is a part of the Spartan-3A DSP Video Starter Kit (VSK) for firmware development. The user guide includes descriptions of the hardware, software tools, files, and test designs that are used.

Guide Contents

This manual contains the following chapters:

- Chapter 1, "Introduction" introduces the FMC-Video daughter card, its interfaces, and hardware dependencies.
- Chapter 2, "Hardware Overview" discusses each aspect of the FMC-Video daughter board, including its several video interfaces. The board is designed to the VITA-57.1 FMC specification, which includes connectors for power, control, and data.
- Chapter 3, "Tools and Files" briefly covers the design tools and files that are available.
- Chapter 4, "Test Designs" describes the Loopback and Pass-through test designs that are used for programming and testing the hardware.

Additional Resources

To find additional documentation, see the Xilinx website at:

http://www.xilinx.com/literature.

To search the Answer Database of silicon, software, and IP questions and answers, or to create a technical support WebCase, see the Xilinx website at:

http://www.xilinx.com/support.

Glossary

The following is a list of terms used in this document:

CMOS	Complementary Metal Oxide Semiconductor
DDC	Data Display Channel
DVD	Digital Versatile Disc or Digital Video Disc
DVI	Digital Visual Interface
EDID	Extended Display Identification Data
EEPROM	Electrically Erasable Programmable Read-Only Memory

FMC	FPGA Mezzanine Card Standard (VITA-57.1)
FPGA	Field Programmable Gate Array
I^2C/I2C	Inter-Integrated Circuit
IC	Integrated Circuit
LED	Light Emitting Diode
LVDS	Low Voltage Differential Signaling
MSPS	Mega-Samples Per Second
NTSC	National Television System Committee (SDTV broadcast standard originating from U.S.)
PAL	Phase Alternating Line (international SDTV broadcast standard)
PC	Personal Computer
SDTV	Standard Definition Television
SECAM	*Sequential Couleur Avec Memoire (French) (sequential color with memory)* (An international SDTV broadcast standard originating from France)
TMDS	Transition Minimized Differential Signaling
VITA	VMEbus International Trade Association
VGA	Video Graphics Array
VSK	Spartan-3A DSP Video Starter Kit

Conventions

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

Typographical

The following typographical conventions are used in this document:

Convention	Meaning or Use	Example
`Courier font`	Messages, prompts, and program files that the system displays	`speed grade: - 100`
`Courier bold`	Literal commands that you enter in a syntactical statement	**`ngdbuild`** *design_name*
Helvetica bold	Commands that you select from a menu	**File → Open**
	Keyboard shortcuts	**Ctrl+C**

Convention	Meaning or Use	Example
Italic font	Variables in a syntax statement for which you must supply values	**ngdbuild** *design_name*
	References to other manuals	See the *Development System Reference Guide* for more information.
	Emphasis in text	If a wire is drawn so that it overlaps the pin of a symbol, the two nets are *not* connected.
Square brackets [ ]	An optional entry or parameter. However, in bus specifications, such as **bus[7:0]**, they are required.	**ngdbuild** [*option_name*] *design_name*
Braces { }	A list of items from which you must choose one or more	**lowpwr =**{**on**|**off**}
Vertical bar |	Separates items in a list of choices	**lowpwr =**{**on**|**off**}
Vertical ellipsis . . .	Repetitive material that has been omitted	IOB #1: Name = QOUT' IOB #2: Name = CLKIN' . . .
Horizontal ellipsis ...	Repetitive material that has been omitted	**allow block** *block_name loc1 loc2 ... locn;*

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 Resources" for details. Refer to "Title Formats" in Chapter 1 for details.
Red text	Cross-reference link to a location in another document	See Figure 2-5 in the *Virtex-II Platform FPGA User Guide.*
Blue, underlined text	Hyperlink to a website (URL)	Go to http://www.xilinx.com for the latest speed files.

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Chapter 1

Introduction

The FMC-Video is a hardware daughter board that includes video interfaces and the circuitry necessary for connection to an FPGA device via a daughter card connector on the carrier board. The carrier/daughter board interface is intended to follow the VITA-57.1 FPGA Mezzanine Card (FMC) standard. This board is part of the Spartan-3A DSP Video Starter Kit (VSK) for firmware development and serves as a hardware reference design.

Hardware Dependencies

The specific carrier platform that is currently validated to support the FMC-Video daughter card is the Spartan-3A DSP FPGA 3400A Development Platform (Part number HW-SD3400A-DSP-DB-UNI-G). See www.xilinx.com for details.

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Chapter 2

Hardware Overview

The FMC-Video daughter board (hereafter referred to as FMC -Video) includes several video interfaces. A DVI connector supports both analog and digital video data. SDTV input is supported through S-Video and composite inputs. Two 8P8C modular connectors are included to interface to two cameras. S-Video and composite outputs are also included. FMC-Video includes the necessary circuitry to receive or transmit on each of these interfaces. The board is designed to the VITA-57.1 FMC specification, which includes a connector for power, control, and data. Each aspect of this board is discussed more thoroughly in the following sections.

See Figure 2-1 for the block diagram and Figure 2-2 for the port diagram.

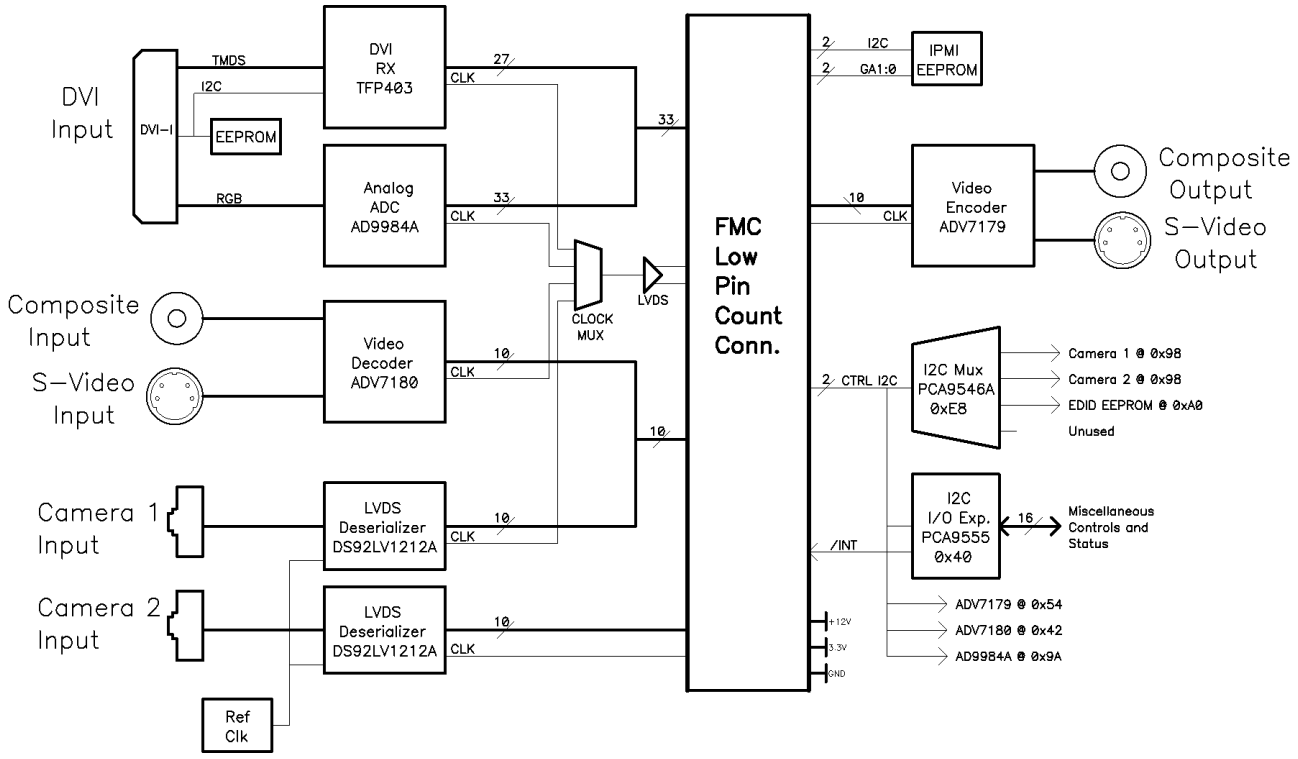


Figure 2-1: **FMC-Video Block Diagram**

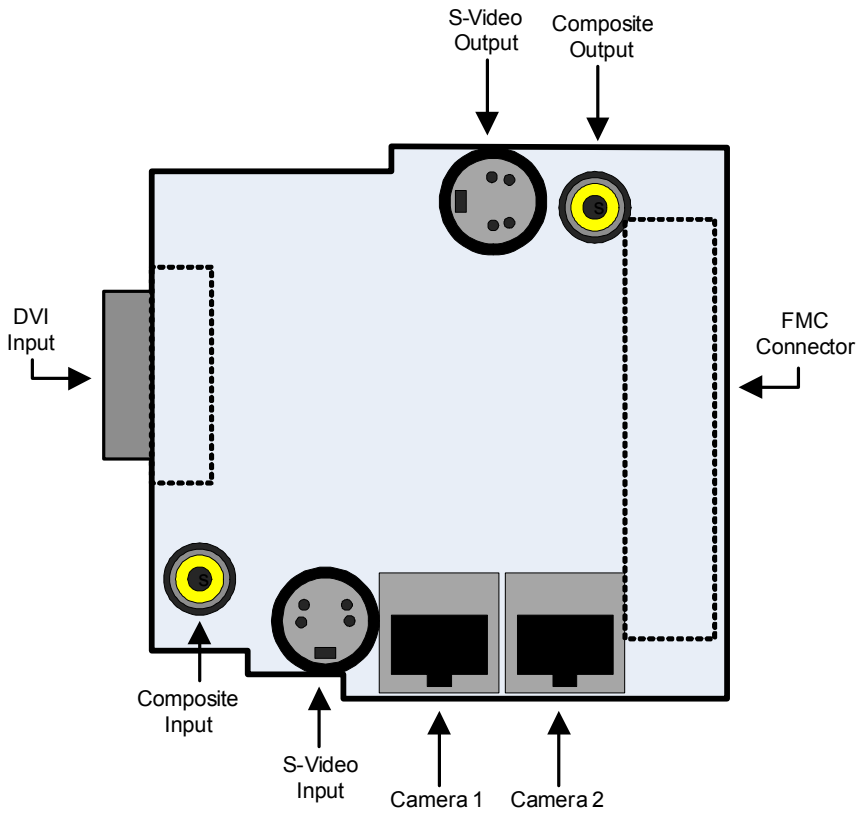


Figure 2-2: **Port Diagram**

DVI Input

The Digital Visual Interface (DVI) input on this board supports the DVI 1.0 specification for combined single-link digital and analog video.

Connector

The DVI input uses the DVI-I connector to support both digital and analog interfaces.

Analog Interface

The analog interface of the DVI input is implemented through the use of the Analog Devices AD9984A high performance 10-bit display interface IC. This part supports sample rates at up to 170 Mega-Samples Per Second (MSPS) on three 10-bit analog-to-digital converters. The AD9984A includes an on-chip Phase Locked Loop (PLL) to generate a sample clock with complete sync processing. This IC also supports offset and gain adjustments.

Digital Receiver

The Texas Instruments TFP403 DVI receiver IC is used to capture the digital Transition Minimized Differential Signaling (TMDS) signaling used by the digital interface. This part supports the full DVI single-link bandwidth of up to 165 MSPS.

DDC-EDID

The DVI input supports identification through the use of an Extended Display Identification Data (EDID) structure available through the Display Data Channel (DDC) interface. This consists of an I^2C EEPROM that is powered through the DVI connector and accessible through the connector. The FMC-Video board also includes the ability to access this EEPROM internally for programming it, as outlined in the "Control I2C" section.

Composite/S-Video Input

Connectors

This video interface is provided via two connectors: a female DIN 4 connector for S-Video and an RCA phone jack for composite signals. The pinout for the S-Video connector is given in Table 2-1. These connectors are industry standard.

Table 2-1: **S-Video Port Pinout**

Pin Number	Signal
1	Ground (Y)
2	Ground (C)
3	Intensity (Luminance)
4	Color (Chrominance)

Video Decoder

The Analog Devices ADV7180 10-bit 4x over-sampling SDTV Video Decoder IC is used to receive and digitize the composite or S-video input. This part can automatically detect and convert standard analog baseband television signals, including National Television System Committee (NTSC), Phase Alternating Line (PAL), and *Sequential Couleur Avec Memoire (Fr.)* (SECAM). The output of this device is 4:2:2 8-bit component video data.

Camera Inputs

FMC-Video includes two camera interfaces to allow the capture of data from two cameras simultaneously. The camera is a custom camera based on a Micron MT9V022 Digital CMOS image sensor.

Connector

The camera interface is based on an RJ45 connector using a proprietary pinout. At the moment the only camera that can be used with this connector is the one that is designed for the Xilinx VSK. The pinout for this connector is given in Table 2-2.

Table 2-2: **Camera Connector Pinout**

Pin Number	Signal Name	Direction
1	LVDS_P	In
2	LVDS_N	In
3	CLK_P	In

Table 2-2: **Camera Connector Pinout *(Cont'd)***

Pin Number	Signal Name	Direction
4	VCC (5V)	Out
5	SCL	I/O
6	CLK_N	In
7	SDA	I/O
8	GND	-

Warning: The RJ45 connectors on FMC-Video are ***not*** Ethernet ports. Connecting anything other than the camera supplied with VSK to these ports could result in damage to your equipment.

Deserializer

The data stream from the camera is in the form of a high-speed LVDS data stream. This stream is received and deserialized using a National DS92LV1212A deserializer. This is capable of carrying LVDS data from a camera which has a pixel rate of 26.6 MHz.

The deserializer requires a reference clock that is provided via a fixed-frequency 27 MHz oscillator.

Composite/S-Video Output

Connectors

This video interface is provided via two connectors: a female DIN 4 connector for S-Video and an RCA phone jack for composite signals. These connectors are industry standard.

Video Encoder

The Analog Devices ADV7179 PAL/NTSC Video Encoder IC is used to drive the S-Video output. This part is given 8-bit 4:2:2 component video data. The pixel clock frequency is generated by the carrier.

I^2C Buses

FMC-Video includes two completely separate I^2C buses. One is defined by the FMC specification, the other is for general control of components on the carrier card.

FMC I^2C

The FMC specification includes an I^2C bus as part of the interface. The mezzanine card is required to include an EEPROM that is read by the carrier card to identify and configure the interface for the mezzanine card. The only device connected to this I^2C bus is this EEPROM, which is powered by the 3P3VAUX power supply.

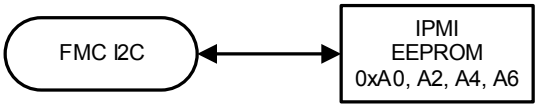


Figure 2-3: **FMC I²C Bus**

Control I²C

Two of the general-purpose I/O pins of the FMC interface are used to implement an I²C bus to be used for general configuration and status. It was necessary to separate these devices from the FMC I²C bus due to potential I²C device address conflicts that would occur with some of the IC and FMC slot configurations. Separating this bus eliminates this danger.

As shown in Figure 2-4, this I²C bus directly connects to three of the video ICs, an I/O expander, and an I²C mux. The interface to the video IC is used to configure these interfaces. The I²C multiplexer is used to access three other devices. These devices include the two cameras and the EDID EEPROM. The two cameras must be isolated behind this switch because they are at the same device address and would conflict if both connected to the same bus. The EDID EEPROM must be isolated since this bus normally has an I²C master at the DVI video source. The interface to the EDID EEPROM should only be used to program the EEPROM at times when it will not be read by the remote master.

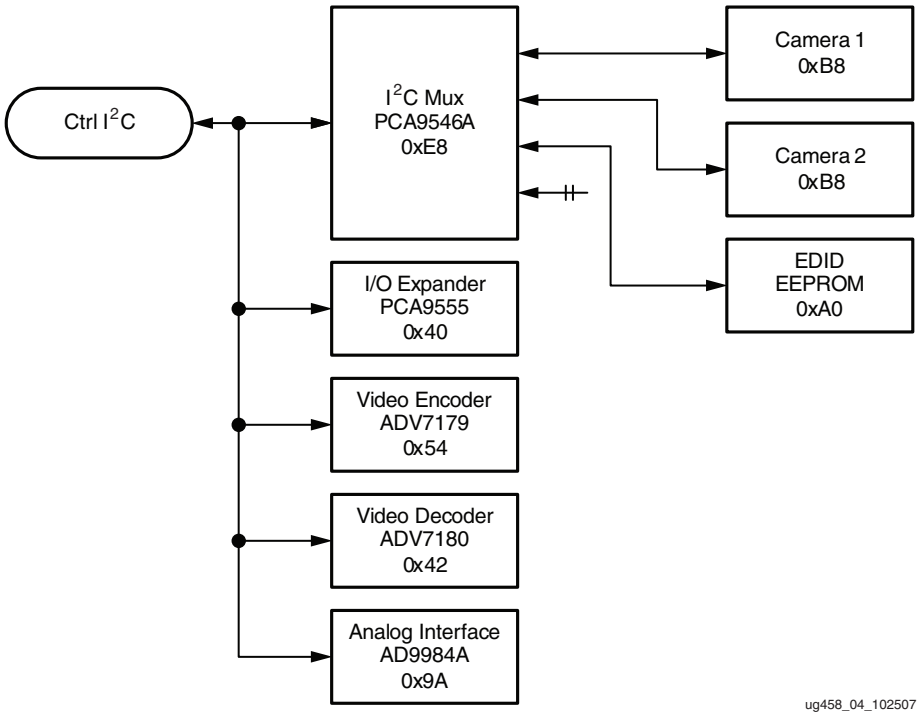


Figure 2-4: **Control I²C Bus**

The I/O expander is used to interface to miscellaneous control and status signals, as identified in Table 2-3.

Table 2-3: **I²C I/O Expander Signal List**

Signal	Name	Direction	Description
P00	/RESET	O	Reset signal to PCA9546A, ADV7179, ADV7180.
P01	/CAM2_LOCK	I	Lock signal from Camera 2 deserializer.
P02	/CAM2_PD	O	Power down control to Camera 2.
P03	/VIDIN_INT	I	Interrupt signal from ADV7180.
P04	CAM1_OE	O	Output Enable signal to Camera 1 deserializer.
P05	/CAM1_PD	O	Power down control to Camera 1.
P06	/CAM1_LOCK	I	Lock signal from Camera 1 deserializer.
P07	DVIIN_CLKINV	O	Select TFP403 Clock edge
P10	DVI_5V	I	Plug detect signal from DVI connector.
P11	DVIIN_ST	O	Select TFP403 Drive Strength
P12	DVIIN_SCDT	I	Scan detect from DVI digital receiver.
P13	DVIIN_OE	O	Output Enable signal to DVI digital receiver.
P14	CLKMUX_SEL0	O	Clock Multiplexor select bit 0.
P15	CLKMUX_SEL1	O	Clock Multiplexor select bit 1.
P16	/PGOOD	I	Power good status from Power Monitor.
P17	/STATUS_LED	O	Software Ready Status LED, low to turn on.

Clocks

FMC-Video only has one clock input and one clock output from the FMC connector.

Carrier-to-Mezzanine (C2M) Clock

The clock input to FMC-Video is used to drive the video encoder for the S-Video output, typically at 27 MHz.

Mezzanine-to-Carrier (M2C) Clock

This clock output is needed by all of the video interfaces, which includes four sources: DVI-Analog, DVI-Digital, the video decoder, and camera input 1. This requires a clock multiplexor, the ICS83054I. The select lines to this multiplexor are driven by the I²C I/O Expander. The clock multiplexor circuit is diagrammed in Figure 2-5.

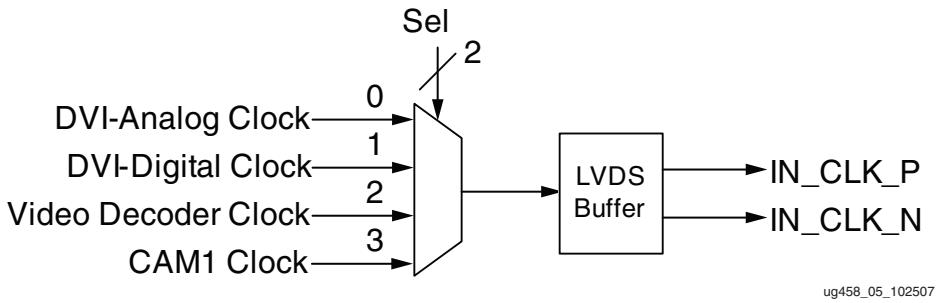


Figure 2-5: **Clock Routing**

The DVI clocks can be up to 162 MHz, the video decoder clock is 27 MHz, and the camera clock is 26.6 MHz.

To support the second camera input simultaneously, its clock is provided separately on the LA01_P_CC pin.

Power

All power to this board is provided via the FMC connector. There were two available sources for 3.3V, the main 3P3V supply, and VADJ. VADJ must be configured to 3.3V for the 3.3V LVCMOS I/O used for the FMC signal interface. VADJ was chosen to isolate the FMC-Video board from the carrier board 3.3V supply. None of the signals require a reference voltage, so VREF_A_M2C is not required and tied to ground. Table 2-4 outlines the power supply voltages on the low-pin-count FMC connector.

Table 2-4: **FMC Power Supplies**

Source	Voltage	Current	Load
3P3VAUX	3.3V	< 1 mA	IPMI EEPROM
3P3V	3.3V	0	Unused
VADJ	3.3V	< 800 mA	3.3V logic and 1.8V core
VREFA	0V	0	Unused.
12P0V	12.0V	< 128 mA	5V for Cameras

Overall current draw for each supply coming from the carrier shall not exceed limits set forth by VITA-57. Test points shall be provided for all power supplies on the board.

Table 2-5 lists the voltage rails present on FMC-Video:

Table 2-5: **FMC-Video Power Supply Voltage Rails**

Voltage	Source	Current	Load
1.8V	VADJ	450 mA	AD9884 and ADV7180 core voltage.
3.3V	VADJ	< 400mA	Miscellaneous ICs, Digital I/O
5.0V	12P0V	<128 mA	Cameras

Analog and digital power supplies are isolated using ferrites and proper grounding layout.

Signal Bus Multiplexing

Because of the large number of signals required by each of the video interfaces and the limited number of signals on the FMC connector, it is not possible to dedicate a connector pin for each of the data bits. To fit within the connector signal count, some signals must be shared. Rather than using traditional bus multiplexor ICs, which add cost, board space, and latency to the signals, some of the signals can be multiplexed by sharing nets and controlling the signal output enables. This was done with two pairs of data buses.

DVI Bus Multiplexing

The DVIIN_x signals are shared between the DVI analog interface and the DVI digital receiver. The DVI receiver outputs are high-impedance when the PDO_L pin is asserted Low. This pin is controlled by the DVIIN_OE signal on the I^2C I/O expander. The default of this is Low, not enabled. The outputs of the DVI analog interface, the AD9884A, can be disabled through its I^2C control registers. Its default state is output enabled. To prevent bus contention, only one of these interfaces can be enabled at a time.

Note: The data width from the analog interface is 10 bits, while the data width from the digital receiver is only 8 bits. This means that two of the bits are not shared. These signals were connected such that the two devices use the same bit as the most significant bit, bit 9. The digital receiver does not use bits 1 and 0.

Video Input Multiplexing

The VIDIN_x signals are shared between the video decoder and camera 1. The camera 1 signals are set to high impedance using the REN pin on the deserializer, driven by the net CAM1_OE, from the I^2C I/O expander. The default state is Low, not enabled. The outputs of the video decoder, the ADV7180, are disabled through its I^2C control registers. The default state is enabled. To prevent bus contention only one of these interfaces can be enabled at a time.

FMC Low Pin Count Connector

Standard Pinout

The VITA-57 FMC connector is of the low-pin-count (LPC) variant. All I/O on this connector shall be 3.3V single ended, with the exception of two LVDS clocks. The available pins in the LPC connector are in rows C, D, G, and H, as shown in Figure 2-6.

	K	J	H	G	F	E	D	C	B	A
1	NC	NC	VREF_A_M2C	GND	NC	NC	PG_C2M	GND	NC	NC
2	NC	NC	PRSNT_M2C_L	CLK0_C2M_P	NC	NC	GND	DP0_C2M_P	NC	NC
3	NC	NC	GND	CLK0_C2M_N	NC	NC	GND	DP0_C2M_N	NC	NC
4	NC	NC	CLK0_M2C_P	GND	NC	NC	GBTCLK0_M2C_P	GND	NC	NC
5	NC	NC	CLK0_M2C_N	GND	NC	NC	GBTCLK0_M2C_N	GND	NC	NC
6	NC	NC	GND	LA00_P_CC	NC	NC	GND	DP0_M2C_P	NC	NC
7	NC	NC	LA02_P	LA00_N_CC	NC	NC	GND	DP0_M2C_N	NC	NC
8	NC	NC	LA02_N	GND	NC	NC	LA01_P_CC	GND	NC	NC
9	NC	NC	GND	LA03_P	NC	NC	LA01_N_CC	GND	NC	NC
10	NC	NC	LA04_P	LA03_N	NC	NC	GND	LA06_P	NC	NC
11	NC	NC	LA04_N	GND	NC	NC	LA05_P	LA06_N	NC	NC
12	NC	NC	GND	LA08_P	NC	NC	LA05_N	GND	NC	NC
13	NC	NC	LA07_P	LA08_N	NC	NC	GND	GND	NC	NC
14	NC	NC	LA07_N	GND	NC	NC	LA09_P	LA10_P	NC	NC
15	NC	NC	GND	LA12_P	NC	NC	LA09_N	LA10_N	NC	NC
16	NC	NC	LA11_P	LA12_N	NC	NC	GND	GND	NC	NC
17	NC	NC	LA11_N	GND	NC	NC	LA13_P	GND	NC	NC
18	NC	NC	GND	LA16_P	NC	NC	LA13_N	LA14_P	NC	NC
19	NC	NC	LA15_P	LA16_N	NC	NC	GND	LA14_N	NC	NC
20	NC	NC	LA15_N	GND	NC	NC	LA17_P_CC	GND	NC	NC
21	NC	NC	GND	LA20_P	NC	NC	LA17_N_CC	GND	NC	NC
22	NC	NC	LA19_P	LA20_N	NC	NC	GND	LA18_P_CC	NC	NC
23	NC	NC	LA19_N	GND	NC	NC	LA23_P	LA18_N_CC	NC	NC
24	NC	NC	GND	LA22_P	NC	NC	LA23_N	GND	NC	NC
25	NC	NC	LA21_P	LA22_N	NC	NC	GND	GND	NC	NC
26	NC	NC	LA21_N	GND	NC	NC	LA26_P	LA27_P	NC	NC
27	NC	NC	GND	LA25_P	NC	NC	LA26_N	LA27_N	NC	NC
28	NC	NC	LA24_P	LA25_N	NC	NC	GND	GND	NC	NC
29	NC	NC	LA24_N	GND	NC	NC	TCK	GND	NC	NC
30	NC	NC	GND	LA29_P	NC	NC	TDI	SCL	NC	NC
31	NC	NC	LA28_P	LA29_N	NC	NC	TDO	SDA	NC	NC
32	NC	NC	LA28_N	GND	NC	NC	3P3VAUX	GND	NC	NC
33	NC	NC	GND	LA31_P	NC	NC	TMS	GND	NC	NC
34	NC	NC	LA30_P	LA31_N	NC	NC	TRST_L	GA0	NC	NC
35	NC	NC	LA30_N	GND	NC	NC	GA1	12P0V	NC	NC
36	NC	NC	GND	LA33_P	NC	NC	3P3V	GND	NC	NC
37	NC	NC	LA32_P	LA33_N	NC	NC	GND	12P0V	NC	NC
38	NC	NC	LA32_N	GND	NC	NC	3P3V	GND	NC	NC
39	NC	NC	GND	VADJ	NC	NC	GND	3P3V	NC	NC
40	NC	NC	VADJ	GND	NC	NC	3P3V	GND	NC	NC
			LPC Connector	LPC Connector			LPC Connector	LPC Connector		

Figure 2-6: **Signal Definitions for Low Pin Count Connector**

FMC-Video Assigned Signals

Table 2-6 lists the FMC-Video assigned signals and their descriptions..

Table 2-6: **FMC-Video Assigned Signals**

Net Name	FMC-LPC Signal	Direction	Description
CTRL_SCL	LA18_P_CC	C2M	Control I^2C bus clock
CTRL_SDA	LA18_N_CC	bidir	Control I^2C bus data
/IOEXP_INT	LA26_N	M2C	I/O expander change interrupt line
INCLK_P	CLK0_M2C_P	M2C	Selected Video Input Clock, LVDS+
INCLK_N	CLK0_M2C_N	M2C	Selected Video Input Clock, LVDS-
DVIIN_HS	LA22_N	M2C	DVI input HSYNC
DVIIN_VS	LA26_P	M2C	DVI input VSYNC
DVIIN_DE/FLD	LA22_P	M2C	DVI input Data Enable or Odd/Even Field
DVIIN_R9	LA05_N	M2C	DVI input most significant red data bit
DVIIN_R8	LA10_P	M2C	DVI input red data bit
DVIIN_R7	LA07_N	M2C	DVI input red data bit
DVIIN_R6	LA09_P	M2C	DVI input red data bit

Table 2-6: **FMC-Video Assigned Signals *(Cont'd)***

Net Name	FMC-LPC Signal	Direction	Description
DVIIN_R5	LA10_N	M2C	DVI input red data bit
DVIIN_R4	LA12_P	M2C	DVI input red data bit
DVIIN_R3	LA09_N	M2C	DVI input red data bit
DVIIN_R2	LA13_P	M2C	DVI input red data bit
DVIIN_R1	LA07_P	M2C	DVI input red data bit, 0 & 1 unused for digital mode
DVIIN_R0	LA06_N	M2C	DVI input least significant red data bit
DVIIN_G9	LA05_P	M2C	DVI input most significant green data bit
DVIIN_G8	LA06_P	M2C	DVI input green data bit
DVIIN_G7	LA11_P	M2C	DVI input green data bit
DVIIN_G6	LA12_N	M2C	DVI input green data bit
DVIIN_G5	LA11_N	M2C	DVI input green data bit
DVIIN_G4	LA13_N	M2C	DVI input green data bit
DVIIN_G3	LA16_P	M2C	DVI input green data bit
DVIIN_G2	LA16_N	M2C	DVI input green data bit
DVIIN_G1	LA04_N	M2C	DVI input green data bit, 0 & 1 unused for digital mode
DVIIN_G0	LA04_P	M2C	DVI input least significant green data bit
DVIIN_B9	LA15_P	M2C	DVI input most significant blue data bit
DVIIN_B8	LA17_P_CC	M2C	DVI input blue data bit
DVIIN_B7	LA15_N	M2C	DVI input blue data bit
DVIIN_B6	LA17_N_CC	M2C	DVI input blue data bit
DVIIN_B5	LA20_P	M2C	DVI input blue data bit
DVIIN_B4	LA23_P	M2C	DVI input blue data bit
DVIIN_B3	LA20_N	M2C	DVI input blue data bit
DVIIN_B2	LA23_N	M2C	DVI input blue data bit
DVIIN_B1	LA02_N	M2C	DVI input blue data bit, 0 & 1 unused for digital mode
DVIIN_B0	LA02_P	M2C	DVI input least significant blue data bit
VIDIN_HS	LA21_N	M2C	Video input HSYNC or CAM1 Line
VIDIN_FLD/VS	LA21_P	M2C	Video input FIELD/VSYNC or CAM1 Frame
VIDIN_D7	LA27_P	M2C	Video input most significant data bit
VIDIN_D6	LA27_N	M2C	Video input data bit

Table 2-6: **FMC-Video Assigned Signals *(Cont'd)***

Net Name	FMC-LPC Signal	Direction	Description
VIDIN_D5	LA25_P	M2C	Video input data bit
VIDIN_D4	LA25_N	M2C	Video input data bit
VIDIN_D3	LA24_P	M2C	Video input data bit
VIDIN_D2	LA24_N	M2C	Video input data bit
VIDIN_D1	LA29_P	M2C	Video input data bit
VIDIN_D0	LA29_N	M2C	Video input least significant data bit
CAM2_CLK	LA01_P_CC	M2C	Camera 2 Input Clock
CAM2_LINE	LA32_P	M2C	Camera 2 LINE
CAM2_FRAME	LA32_N	M2C	Camera 2 Frame
CAM2_D7	LA33_N	M2C	Camera 2 most significant data bit
CAM2_D6	LA33_P	M2C	Camera 2 data bit
CAM2_D5	LA30_N	M2C	Camera 2 data bit
CAM2_D4	LA30_P	M2C	Camera 2 data bit
CAM2_D3	LA31_N	M2C	Camera 2 data bit
CAM2_D2	LA31_P	M2C	Camera 2 data bit
CAM2_D1	LA28_P	M2C	Camera 2 data bit
CAM2_D0	LA28_N	M2C	Camera 2 least significant data bit
VIDOUT_CLK	CLK0_C2M_P	C2M	Video Output Clock
VIDOUT_HS	LA19_N	M2C	Video output HSYNC
VIDOUT_FLD/VS	LA19_P	M2C	Video output FIELD/VSYNC
VIDOUT_D7	LA14_N	M2C	Video output most significant data bit
VIDOUT_D6	LA14_P	M2C	Video output data bit
VIDOUT_D5	LA08_N	M2C	Video output data bit
VIDOUT_D4	LA08_P	M2C	Video output data bit
VIDOUT_D3	LA03_N	M2C	Video output data bit
VIDOUT_D2	LA03_P	M2C	Video output data bit
VIDOUT_D1	LA00_N_CC	M2C	Video output data bit
VIDOUT_D0	LA00_P_CC	M2C	Video output least significant data bit

LEDs

FMC-Video includes two status 2 LEDs, placed on the back of the board. These LEDs indicate that the board is being powered correctly and the software has initialized it, respectively. See Table 2-7.

Table 2-7: **Board LEDs**

Net Name	FMC-LPC Signal	Direction
1	PG	Power supplies are within regulation
2	I^2C I/O Expander	Software initialization complete

Mechanical

Wherever possible this module conforms to VITA-57 from a mechanical standpoint. It is impossible to meet the mechanical specs due to the size of the connectors that must be on the board. For instance, all the connectors cannot fit within the I/O envelope height of 9.5 mm on the front of the board. Due to this, some connectors must be put on the back of the board. However, the orientation of these connectors should still support two FMC modules installed side by side on a carrier. To this end, all connectors are oriented toward the front panel side of the board or directly vertical.

Although the mechanical spec is broken by this design, it is possible for mechanical conformance to be achieved by simply removing the connectors that are placed on the back.

Rule 25 of the VITA-57 spec requires a minimum of 500 VDC and 1 MÙ of isolation. The only S-video connectors available for this application are rated at 250 VDC isolation and, therefore, violate this rule. Even with these connectors removed, there is still only 250 VDC isolation, because the spacing between pads on the PCB artwork to accommodate this connector.

Chapter 3

Tools and Files

Design Tools

Gerber files were generated from PCAD and PDF files were published for archival purposes and for general viewing.

Files

The current revision of the design references the following files:

Filename	Revision	Software	Description
FMCVIDEOD_gerber.zip	D	Gerber viewer	Gerber files
FMCVIDEO_Sch_RevD.pdf	D	Acrobat 7.0	Schematic in PDF format
FMCVIDEO_BOM_AVL_RevD.xls	D	Excel 2003	Bill of Materials

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Chapter 4

Test Designs

This chapter covers the designs that are used for programming and testing the hardware.

Loopback Design

This is an FPGA design for an FMC-Carrier board that tests the FMC-Video board interfaces by generating test patterns on outputs and testing them on inputs. This test uses a DVI digital and analog output on the carrier board as a test source.

Test Setup

Required Hardware

- FMC-Video installed on a Spartan-3A DSP FPGA 3400A Development Platform
- DVI-I Cable (analog and digital)
- S-Video Cable
- Composite Cable (RCA)
- Two Cameras, MT9V022
- Two Cat-6 cables with 8P8C modular connectors

DVI Loopback

The DVI-I cable connects the DVI output on the carrier board to the DVI input on FMC-Video.

S-Video Loopback

The S-Video cable connects the S-Video output on FMC-Video to the S-Video input on FMC-Video.

Composite Loopback

The composite (RCA) cable connects the Composite output on FMC-Video to the Composite input on FMC-Video.

Camera Test

The camera test is not a loopback. Instead, a camera is connected to each camera port using a Cat-6 cable.

Firmware Files

Table 4-1 lists the firmware files, type, and descriptions.

Note: The PicoBlaze™ code for this design was developed using the pBlaze IDE version 3.6. For details. visit www.mediatronix.com/tools/.

Table 4-1: **Firmware Files**

Filename	Type	Description
MDSP_FMCVIDEO_LPBK.v	Verilog	Top Level wrapper for project
FMCVIDEO_LPBK_CTRL.v	Verilog	Controller module, including PicoBlaze
PB_FMCVIDEO_LPBK.v	Verilog	PicoBlaze Instruction ROM
KCPSM3.v	Verilog	PicoBlaze processor
VGA_TP_GEN.v	Verilog	VGA test pattern generator
CH7301_OUT.v	Verilog	Interface to DVI output
DVI_IN.v	Verilog	DVI input module
IMAGE_CROP.v	Verilog	Image crop module
VGA_TP_TEST.v	Verilog	VGA test pattern comparison module
FREQ_COMPARE.v	Verilog	Frequency comparison Module
YCrCb422_TP_GEN.v	Verilog	NTSC test pattern generator
YCrCb422_TP_TEST.v	Verilog	NTSC test pattern comparison module
CAM_TP_TEST.v	Verilog	MT9V022 camera test pattern comparison
MDSP_FMCVIDEO_LPBK.ucf	Constraints	Pin and Timing Constraints for Project
FMCVIDEO_LPBK.psm	PicoBlaze	PicoBlaze Processor Code
helpers.inc	PicoBlaze	Helpful Equates for PicoBlaze Code
PB_CODE_template.v	Verilog	Used by pBlazeIDE to generate PB_x.v file

Test Descriptions

All tests are selected via DIP switches on the carrier board, and errors are indicated via LEDs on the carrier board. See Table 4-2.

Table 4-2: **Test Summary**

SW[3:0]	Name	LED[7]	LED[6]	LED[5]	LED[4]
0000	DVI-Digital Test	CLK Error	Red Error	Green Error	Blue Error
0001	DVI-Analog Test	CLK Error	Red Error	Green Error	Blue Error
0010	S-Video Test	CLK Error	Data Error	Off	Off
0011	Composite Test	CLK Error	Data Error	Off	Off
0100	Camera 1 Test	CLK Error	Data Error	Off	Off
0101	Camera 2 Test	CLK Error	Data Error	Off	Off

Notes:

1. **LED[3:0] display the setting of DIP SW[3:0].**

DVI-Digital

The DVI output on the carrier board generates a VGA test pattern of red, green, and blue ramps. This is received by FMC-Video and is compared against what was sent. To pass this test, the received clock frequency must be correct and the test pattern must be received with no errors.

DVI-Analog

The DVI output on the carrier board generates a VGA test pattern of red, green, and blue ramps. This is received by FMC-Video and is compared against what was sent. To pass this test, the received clock frequency must be correct and the test pattern must closely match the test pattern. Since this is an analog interface, the digitized version will never perfectly match the sent image, so some error is acceptable. To pass, the majority of the pixels must be within a small error range of the test pattern value.

S-Video

The S-Video output on the carrier board generates an NTSC test pattern of red, green, and blue ramps. This is received by FMC-Video and is compared against what was sent. To pass this test, the received clock frequency must be correct and the test pattern must closely match the test pattern. Since this is an analog interface, the digitized version will never perfectly match the sent image, so some error is acceptable. To pass, the majority of the pixels must be within a small error range of the test pattern value.

Composite

The composite output on the carrier board generates an NTSC test pattern of red, green, and blue ramps. This is received by FMC-Video and is compared against what was sent. To pass this test, the received clock frequency must be correct and the test pattern must closely match the test pattern. Since this is an analog interface, the digitized version will never perfectly match the sent image, so some error is acceptable. To pass, the majority of the pixels must be within a small error range of the test pattern value.

Camera 1

The camera is configured to generate a test pattern. This is received by FMC-Video and is compared against what the test pattern is supposed to be. To pass this test, the received clock frequency must be correct and the test pattern must be received with no errors.

Camera 2

This test is the same as Camera 1.

Pass-Through Design

This is an FPGA design for an FMC-Carrier board that tests the FMC-Video board interfaces by passing video data through the carrier board FPGA. This test uses a DVI digital and analog output on the carrier board as an output.

Test Setup

Required Hardware

- FMC-Video installed on Spartan-3A DSP FPGA 3400A Development Platform
- Composite/S-Video source (for example, DVD player)
- Composite/S-Video display (for example, TV)
- DVI-I source (for example, PC)
- DVI-I display (for example, LCD computer monitor)
- Two DVI-I Cables (analog and digital)
- Two S-Video Cables
- Two Composite Cables (RCA)
- Two Cameras, MT9V022
- Two Cat-6 cables with 8P8C modular connectors

DVI Pass-Through

One DVI-I cable connects the DVI output on the carrier board to the DVI-I display. The other DVI-I cable connects the DVI output of the DVI-I video source to the DVI input on FMC-Video.

S-Video Pass-Through

One S-Video cable connects the S-Video output on FMC-Video to the S-Video input on the Composite/S-Video display. The other S-Video cable connects the S-Video output on the Composite/S-Video source to the S-Video input on FMC-Video.

Composite Loopback

One composite (RCA) cable connects the composite output on FMC-Video to the composite input on the Composite/S-Video display. The second composite cable connects the composite output on the Composite/S-Video source to the composite input on FMC-Video.

Camera Test

One camera is connected to each camera port using a Cat-6 cable.

Firmware Files

Table 4-3 lists the firmware files, type, and descriptions.

Note: The PicoBlaze code for this design was developed using the pBlaze IDE version 3.6. For details, visit http://www.mediatronix.com/tools/.

Table 4-3: **Firmware Files**

Filename	Type	Description
MDSP_FMCVIDEO_PASS.v	Verilog	Top Level wrapper for project
FMCVIDEO_PASS_CTRL.v	Verilog	Controller module, including PicoBlaze
PB_FMCVIDEO_PASS.v	Verilog	PicoBlaze Instruction ROM
KCPSM3.v	Verilog	PicoBlaze processor
DVI_IN.v	Verilog	DVI input module
IMAGE_CROP.v	Verilog	Image crop module
YCrCb422_IN.v	Verilog	Video input module
MICRON_IMAGE_SENSOR_IN.v	Verilog	Micron Image Sensor Input module
YCrCb422_OUT.v	Verilog	Video Output Module
CH7301_OUT.v	Verilog	Interface to DVI output
MDSP_FMCVIDEO_PASS.ucf	Constraints	Pin and Timing Constraints for Project
FMCVIDEO_PASS.psm	PicoBlaze	PicoBlaze Processor Code
helpers.inc	PicoBlaze	Helpful Equates for PicoBlaze Code
PB_CODE_template.v	Verilog	Used by pBlazeIDE to generate PB_x.v file

Mode Descriptions

All modes are selected via DIP switches on the carrier board. See Table 4-4

Table 4-4: **Mode Descriptions**

SW[3:0]	Name	Input	Output
0000	DVI-Digital <65 MHz	DVI Digital	DVI Digital & Analog
0001	DVI-Digital >65 MHz	DVI Digital	DVI Digital & Analog
0010	DVI-Analog VGA60	DVI Analog	DVI Digital & Analog
0011	DVI-Analog SVGA60	DVI Analog	DVI Digital & Analog
0100	DVI-Analog XGA60	DVI Analog	DVI Digital & Analog
0101	DVI-Analog SXGA60	DVI Analog	DVI Digital & Analog
0110	DVI-Analog UXGA60	DVI Analog	DVI Digital & Analog
1000	Camera 1	Camera 1	DVI Digital & Analog
1001	Camera 2	Camera 2	DVI Digital & Analog

Table 4-4: **Mode Descriptions *(Cont'd)***

SW[3:0]	Name	Input	Output
1010	S-Video	S-Video	S-Video and Composite
1011	Composite	Composite	S-Video and Composite

DVI-Digital

Modes 0 and 1 are both DVI-Digital input. The division at 65 MHz is required by the DVI output on the Carrier board. The captured data is output on the DVI output as both digital and analog.

DVI-Analog

Modes 2 through 6 are analog input. Each analog input resolution requires specific timing and crop settings. The captured data is output on the DVI output as both digital and analog.

Camera 1

The camera is configured and the data is captured by FMC-Video. The captured data is output on the DVI output as both digital and analog.

Camera 2

The camera is configured and the data is captured by FMC-Video. The captured data is output on the DVI output as both digital and analog.

S-Video

The Video decoder is configured to receive S-Video. This is passed to the video encoder and output as both S-Video and Composite.

Composite

The Video decoder is configured to receive Composite Video. This is passed to the video encoder and output as both S-Video and Composite.

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