

Lattice CrossLink-NX ISP Demo Quick Start Guide

Application Note

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Acronyms in This Document

A list of acronyms used in this document.

Acronym	Definition			
AE	Auto Exposure			
AWB	Auto White Balance			
BLC	Black Level Correction			
CCM Color Correction Matrix				
CFI Color Filter Array Interpolation				
DPC	Defective Pixel Correction			
EVDK	Embedded Vision Development Kit			
GAMMA Gamma Correction				
ISP Image Signal Processing				
TMAP Tone Mapping				
VIP	Video Interface Protocol			



1. Overview

This document is intended to show you the hardware setup and operation procedures for demonstrating the Image Signal Processing (ISP) reference design features. It is assumed that you are familiar with the basic Lattice FPGA design flow.

This reference design is developed based on Lattice Embedded Vision Development Kit (EVDK) with CrossLink-NX VIP Sensor Input Board.

Lattice Embedded Vision Development Kit (EVDK) is comprised of (Figure 1.1):

- CrossLink-NX VIP Sensor Input Board
- ECP5 VIP Processor Board
- HDMI VIP Output Bridge Board



Lattice EVDK

Figure 1.1. Lattice EVDK Components

For more details regarding Lattice EVDK, refer to Lattice Embedded Vision Development Kit User Guide (FPGA-UG-02015).

For more details regarding Lattice CrossLink-NX VIP Sensor Input Board, refer to CrossLink-NX VIP Sensor Input Board User Guide (FPGA-EB-02029).



2. ISP Reference Design Block Diagram

The ISP reference design captures sensor data, converts its interfaces, implements ISP pipelines, and finally displays the video on the HDMI monitor. Figure 2.1 shows the whole ISP reference design architecture and data flow.



Figure 2.1. ISP Reference Design Architecture and Data Flow

The ISP core is implemented in the CrossLink-NX device. The CrossLink-NX device receives the MIPI sensor data, converts it to the parallel interface, implements ISP processing, and transmits the video to the HDMI transmitter. Figure 2.2 shows the Crosslink-NX ISP block diagram.



Figure 2.2. CrossLink-NX ISP Block Diagram



3. ISP Reference Design Jumper Settings

Following jumper settings for CrossLink-NX (Table 3.1) and ECP5 (Table 3.2) boards are required to enable the ISP function correctly.

Table 3.1. CrossLink-NX VIP Sensor Input Board Jumper Settings

Serial Number	Jumper Name	Status
1	JP2	Open
2	J3	Open
3	_	All other headers should be kept open.

Serial Number Jumper Name Status 1 J55 Connect 1 and 2. 2 J51 Connect 1 and 2. 3 J5 Connect 1 and 2. 4 J9 Connect 1 and 2. 6 J6 Connect 1 and 2. 7 J3 Connect 1 and 2, also 5 and 6. 8 J50 Connect 1 and 2, also 3 and 5. 9 J7 Connect 2 and 3. J52 Connect 1 and 2 for SPI 2, 2 and 3 for JTAG. 10 J53 Connect 1 and 2. 11 12 _ All other headers should be kept open.

Table 3.2. ECP5 VIP Input Bridge Board Jumper Settings

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4. ISP Reference Design Requirements

Following items are required for this reference design:

- LF-EVDK1-EVN
- CrossLink-NX VIP Sensor Input Board
- HDMI monitor
- HDMI cable
- DC power adapter (12 V)
- Laptop/PC
- Bit file
- USB 2.0 Type A to Mini-B cable*
- Lattice Diamond Programmer version 3.10 or higher*
- Lattice Radiant Programmer version 3.0 or higher*

*Note: Required only in the re-programming process.



5. Program CrossLink-NX/ECP5 Board

The following steps show you how to download the bitstream to CrossLink-NX/ECP5 board.

- 1. Connect the LF-EVDK1-EVN board to DC power adapter (12 V).
- 2. Connect the board to PC via USB mini port.
- 3. Start Radiant Programmer, Version 3.0 or a later version.
- 4. The Radiant Programmer Getting Started dialog box pops up (Figure 5.1). By default, the *Create a new project from a scan* option is selected. Check and confirm other settings are correctly reflected the real components connected (Figure 5.1). Click OK, if everything is correct.

Radiant Programmer - Getting Started	?	×
New Project:		
Project Name: Untitled		
Project Location: D:/work/project/Cosslink_NX/Crosslink_NX_ISP_Demo/Crosslink_NX_20210906_ISPip/rel_mvision/V2.0/Bitstream <	Browse	
Create a new project from a scan		
Cable: HW-USBN-2B (FTDI) V Port: FTUSB-0 V Detect Cable TCK Divider Setting (0-30x):		
O Create a new blank project		
Open Project:		
O Open an existing programmer project		
D:/work/project/Cosslink_NX/Crosslink_NX_ISP_Demo/Crosslink_NX_20210906/prj/Crosslink_NX_ISP/source/impl_1.xcf	Browse	
ОК	Cance	el

Figure 5.1. Getting Started dialog in Lattice Radiant Programmer

5. A new window pops up (Figure 5.2). Make sure the configuration settings for the CrossLink-NX Board are the same as those shown in Figure 5.2.

Device Family: LIFCL Device: LIFCL-40

Operation: Fast Program

File Name: \\rel_mvision\V2.0\Bitstream\CrossLink-NX_ISP_impl_1.bit

...

Γ	🔛 Radi	Radiant Programmer - Untitled.xcf *								
L	File Edit View Run Tools Help									
1111	🎦 📸 (🗟 😂 🖉 l 🐼 l 🕯	🎥 😓 😽 🚦	05					
L	Enable	e Status	Device Family	Device	Operation	File Name	File Date/Time	Checksum	USERCODE	
	1 🗹		LIFCL	LIFCL-40	Fast Configuration	906_ISPip/Bitstream_package/Crosslink-NX_ISP_impl_1.bit	09/07/21 09:53:23	N/A	0x0000000	

Figure 5.2. Set up Configuration Settings for CrossLink-NX Board

 Click the Program Device icon from the toolbar, or choose the Design > Program menu item from Radiant Programmer, to program the CrossLink-NX board. Check the programming status and result (Figure 5.3).



	Radiant Programmer - Untitled.xcf * ×										
	File Edit View Run Tools_Help										
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L	Enable	Status	Device Family	Device	Operation	File Name	File Date/Time	Checksum	USER	CODE	
ŀ		PASS	LIFCL	LIFCL-40	Fast Configuration	6_ISPip/rel_mvision/V2.0/Bitstream/Crosslink-NX_ISP_impl_1.bit	09/07/21 09:53:23		0x000	00000	1
Γ											
L											
(Dutput									8,	<
ľ	NFO - JTAG	Chain Ve	rification. No Erro	rs.							^
1	NFO - Cheo	k configur	ation setup: Succe	essful.							
1	NFO - Devi	ce1 LIFCL-	40: Fast Configura	ation							
1	NFO - Oper	ation Don	e. No errors.								
1	INFO - Elapsed time: 00 min : 10 sec										
1	INFO - Operation: successful.										
┝	Output	Tcl Con	sole							_	-
	output										l,

Figure 5.3 CrossLink-NX Board Programming Status and Result

Start Diamond Programmer, Version 3.10 or a later version. By default, the *Create a new project from a JTAG scan* option is selected. Check and confirm other settings are correctly reflected the real components connected (Figure 5.4). Click OK, if everything is correct.

Diamond Programmer - Getting Started ? ×						
Select an Action Create a new project from a JTAG scan 						
Cable: HW-USBN-2B (FTDI) Port: FTUSB-1 Detect Cable]					
 Create a new blank project Open an existing programmer project 						
D:/work/project/puzzle_ISP_crosslink_debug_gear8/20201014_AR0234/prj/impl1/impl1	.xcf ∨					
ОК	Cano	cel				

Figure 5.4 Getting Started dialog in Lattice Diamond Programmer

 Make sure the configuration settings for the ECP5 Board are the same as those shown in Figure 5.5. Device Family: ECP5UM Device: LFE5UM-85F Operation: Fast Program File Name: \\rel_mvision\V2.0\Bitstream\ECP5_ISP_bridge_impl1.bit ...



ſ	See Diamond Programmer - Untitled *									
File Edit View Design Help										
l	Enable	Status	Device Family	Device	Operation	File Name	File Date/Time	Checksum	USERCO	DE
l	1)	ECP5UM	LFE5UM-85F	Fast Program	ip/Bitstream_package/ECP5_ISP_bridge_impl_1.bit	02/18/20 15:26:54	N/A		

Figure 5.5. Set Up Configuration Settings for ECP5 Board

9. Click the Program icon from the toolbar, or choose the **Design > Program** menu item from Diamond Programmer, to program the ECP5 board. Check the programming status and result (Figure 5.6).

Siamon	Diamond Programmer - Untitled * – □ ×									
File Edit	View Design I	Help								
1 🗎 📸 🔚	8 😔 🖓	🐼 🥨 🖸								
Enable Stat	tus Device Family	Device	Operation	File Name		File Date/Time	hecksur	USERCODE		/I pu
1 🗹 🛛 РА	SS ECP5UM	LFE5UM-85F	Fast Program	mvision/V2.0/Bitstream/ECP5_ISP_bridge_imp	ol_1.bit	02/18/20 15:26:54		0000000		ble a
										Ö
Output										
INFO - Check of	configuration setup: 5	Successful.								^
INFO - Device1	LFE5UM-85F: Fast F	Program								
INFO - Operati	on Done. No errors.									
INFO - Flansed	l time: 00 min : 02 s	ec								
INFO - Operau	on: successiui.									
	al Consuls									~
Output 1	ci Console									

Figure 5.6. ECP5 Board Programming Status and Result



6. Display the Image Signal Processing Results

After programming the CrossLink-NX and the ECP5 boards successfully, follow the steps below to display the Image Signal Processing (ISP) results, the video of the camera, on the monitor.

- 1. Connect the HDMI monitor to the EVDK components via the HDMI cable.
- 2. Toggle the button "SW3 (SYS_RST)" on the CrossLink-NX VIP Sensor Input Board.
- 3. The video of the camera captured by the sensor can be displayed on the HDMI monitor.



7. Advanced Features and Tools

Besides those basic features of the ISP reference design discussed in the previous sections, some advanced features can also be accessed using SSP tools and running scripts.

7.1. Dynamic ISP Parameters Setup Using SSP Tools

Many registers are implemented in the ISP reference design to provide a dynamic way to control the logic and to setup ISP parameters. These registers can be accessed through the SSP tool.

Follow steps below to install and use the SSP tool in the ISP reference design.

1. Install the "mini-ssp" tool on PC.

Double click <*Drive*>:\\rel_mvision\V2.0\Tools\LSCC_SSP.msi. The SSP tool can be installed on your PC. Once the tool is installed successfully, the following six documents can be found in <*Drive*>:\ <install_folder>\<*Default_Company_Name*>\LSCC_SSP\doc\.

- SSP Demo Quick Start.pdf
- SSP Installation and Deployment Usage Guide.pdf
- SSP Operation Tool Kits Usage Guide.pdf
- SSP Register Mapping Interface Specifiction.pdf
- SSP RTL Generator Usage Guide.pdf
- SSP Simulation Platform Usage Guide.pdf

Refer to these documents for the SSP tool usage accordingly.

2. Connect Lattice HW-USBN-2B cable with J34 of the CrossLink-NX VIP Sensor Input Board. Refer to Table 7.1 for the pin connection details between the HW-USBN-2B cable and J34.

J34 Number Pins on CrossLink-NX VIP Board	USBN-2B Cable
1	SCLK
2	SO
3	N/A
4	N/A
5	GND
6	VCC
7	SI
8	ISPEN
9	N/A
10	N/A
11	GND
12	VCC

Table 7.1. J34 and HW-USBN-2B Cable Pin Connection

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3. After the configuration of the CrossLink-NX and ECP5 boards done, run RMI-based command to access registers. Four types of command are supported:

rmi_write addr (16-bit Hex) data (32-bit Hex)
rmi_read addr (16-bit Hex) data_len (4x Decimal)
cam_write addr (16-bit Hex) data (several bytes Hex)
cam_read addr (16-bit Hex) data_len (Decimal)

Examples:

```
rmi_write 0x0000 0x11223344
rmi_read 0x0000 4 (0x11223344 can be read out)
cam_write 0x0204 0x0128
    0x0204 is the sensor register address
    The command writes 0x01 => 0x0204,
        0x28 => 0x0205 into the sensor registers
        cam_read 0x0204 2 (0x0204/0x0205 sensor register values will be read out)
```

Refer to the file (\\rel_mvision\V2.0\DOC\mVision_ISP_register_map.xlsx) for the detailed register map table.

By configuring different registers, you can modify desired ISP parameters. After that, you can verify the configuration result by checking the image from the HDMI monitor.



References

- Lattice Embedded Vision Development Kit User Guide (FPGA-UG-02015)
- CrossLink-NX VIP Sensor Input Board User Guide (FPGA-EB-02029)

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Technical Support Assistance

Submit a technical support case through www.latticesemi.com/techsupport.



Revision History

Revision 1.0, September 2021

Section	Change Summary
All	Production release.



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