Programming Cables

User Guide

FPGA-UG-02042 Version 26.1

May 2018

Contents

1. Features 4
2. Programming Cables 4
3. Programming Cable Pin Definitions 5
4. Programming Software 7
5. Target Board Design Considerations 7
6. Programming Flywire and Connection Reference 8
7. Connecting the Programming Cable 10
8. Programming Cable TRST Pin 10
9. Programming Cable ispEN Pin 10
10. Ordering Information 11
Appendix A. Troubleshooting the USB Driver Installation 12
Technical Support 16
Revision History 16

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Figures

Figure 1.1. USB Cable – HW-USBN-2B 4
Figure 3.1. Programming Cable In-System Programming Interface for the PC (HW-USBN-2B)* 5
Figure 3.2. Programming Cable In-System Programming Interface for the PC (HW-USB-1A or HW-USB-2A)* 6
Figure 3.3. Programming Cable In-System Programming Interface for the PC (HW-DLN-3C and Equivalents)* 6
Figure 3.4. Programming Cable In-System Programming Interface for the PC (pDS4102-DL2 or pDS4102- DL2A) 6
Figure 3.5. Programming Cable In-System Programming Interface for the PC (HW7265-DL2 or HW7265-DL2A)* 6
Figure A.1. Device Manager 12
Figure A.2. Unknown Device Properties 12
Figure A.3. Update Driver Software 13
Figure A.4. Lattice EzUSB Driver 13
Figure A.5. FTDI FTUSB Driver 13
Figure A.6. Windows Security 14
Figure A.7. USB Installation Completed 14
Figure A.8. Installation Completed 14
Figure A.9. Installation Completed 15

Tables

Table 3.1. Programming Cable Pin Definitions 5
Table 6.1. Pin and Cable Reference 8
Table 10.1. Programming Cable Feature Summary 11
Table 10.2. Ordering Information 11

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1. Features

- Support for all Lattice programmable products
  - 1.2 V to 3.3 V programming (HW-USBN-2B)
  - 1.2 V to 5 V programming (All other cables)
  - Ideal for design prototyping and debugging
- Connect to multiple PC interfaces
  - USB (v.1.0, v.2.0)
  - PC Parallel Port
- Easy-to-use programming connectors
  - Versatile flywire, 2 x 5 (.100”) or 1 x 8 (.100”) connectors
  - 6 feet (2 meters) or more of programming cable length (PC to DUT)
- Lead-free/RoHS compliant construction

Figure 1.1. USB Cable – HW-USBN-2B

2. Programming Cables

Lattice Programming Cable products are the hardware connection for in-system programming of all Lattice devices. After you complete your logic design and create a programming file with the Lattice Diamond®/ispLEVER® Classic development tools, you can use Diamond Programmer or ispVM™ System software ispVM™ System software or Diamond Programmer to program devices on your board. The ispVM System/Diamond Programmer software automatically generates the appropriate programming commands, programming addresses and programming data based on information stored in the programming file and parameters you set in Diamond Programmer/ispVM System. Programming signals are then generated from the USB or parallel port of a PC and directed through the Programming Cable to the device. No additional components are required for programming.

Diamond Programmer/ispVM System software is included with all Lattice design tool products and is available for download from the Lattice web site at www.latticesemi.com/software.

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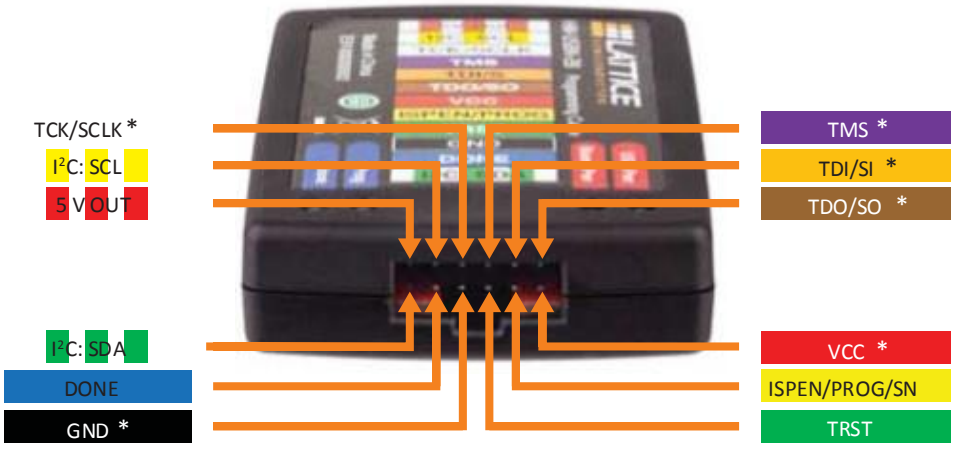
3. Programming Cable Pin Definitions

The functions provided by the Programming cables correspond with available functions on Lattice programmable devices. Since some devices contain different programming features, the specific functions provided by the Programming cable may depend on the selected target device. ispVM System/Diamond Programmer software will automatically generate the appropriate functions based on the selected device. See Table 3.1 for an overview of the Programming cable functions.

Table 3.1. Programming Cable Pin Definitions

Programming Cable Pin	Name	Programming Cable Pin Type	Description
VCC	Programming Voltage	Input	Connect to V_{CC} or V_{CCJ} plane of the target device. Typical ICC = 10 mA. Your board design supplies the power for V_{CC}. Note: This may not be the same as a target device's V_{CCO} plane.
TDO/SO	Test Data Output	Input	Used to shift data out via the IEEE1149.1 (JTAG) programming standard.
TDI/SI	Test Data Input	Output	Used to shift data in via the IEEE1149.1 programming standard.
ispEN/PROG/SN	Enable	Output	Enable device to be programmed. SN = SSPI Chip select for HW-USBN-2B
TRST	Test Reset	Output	Optional IEEE 1149.1 state machine reset.
DONE	DONE	Input	DONE indicates status of configuration
TMS	Test Mode Select Input	Output	Used to control the IEEE1149.1 state machine.
GND	Ground	Input	Connect to ground plane of the target device
TCK/SCLK	Test Clock Input	Output	Used to clock the IEEE1149.1 state machine
INIT	Initialize	Input	Indicates device is ready for configuration to begin. INITN is only found on some devices.
I2C: SCL[1]	I^2C SCL	Output	Provides the I^2C signal SCL
I2C: SDA[1]	I^2C SDA	Output	Provides the I^2C signal SDA.
5V Out[1]	5 V Out	Output	Provides a 5 V signal for the iCEprog M1050 Programmer.

***Note**: Only found on the HW-USBN-2B cable.



* Indicates flywire connections required for most basic JTAG programming.

Figure 3.1. Programming Cable In-System Programming Interface for the PC (HW-USBN-2B)*

***Note**: Requires Diamond Programmer 3.1 or later.

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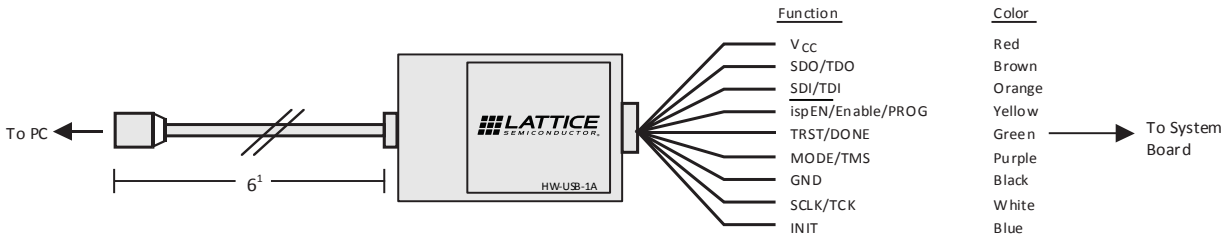

Figure 3.2. Programming Cable In-System Programming Interface for the PC (HW-USB-1A or HW-USB-2A)*

***Note**: Lattice PAC-Designer® software does not support programming with USB cables. To program ispPAC devices with these cables, use the Diamond Programmer/ispVM System software.

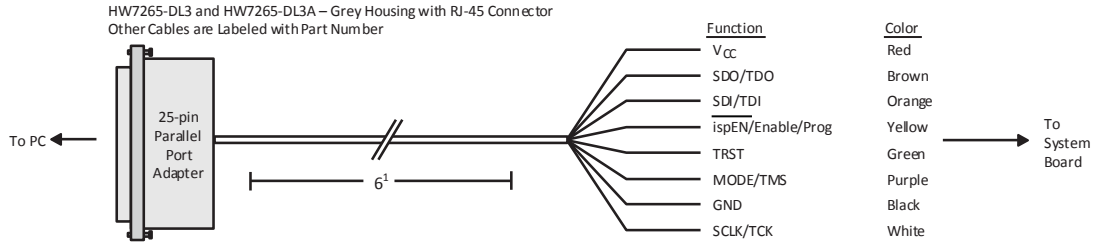

Figure 3.3. Programming Cable In-System Programming Interface for the PC (HW-DLN-3C and Equivalents)*

***Note**: HW7265-DL3, HW7265-DL3A, HW-DL-3B, HW-DL-3C and HW-DLN-3C are functionally equivalent products.

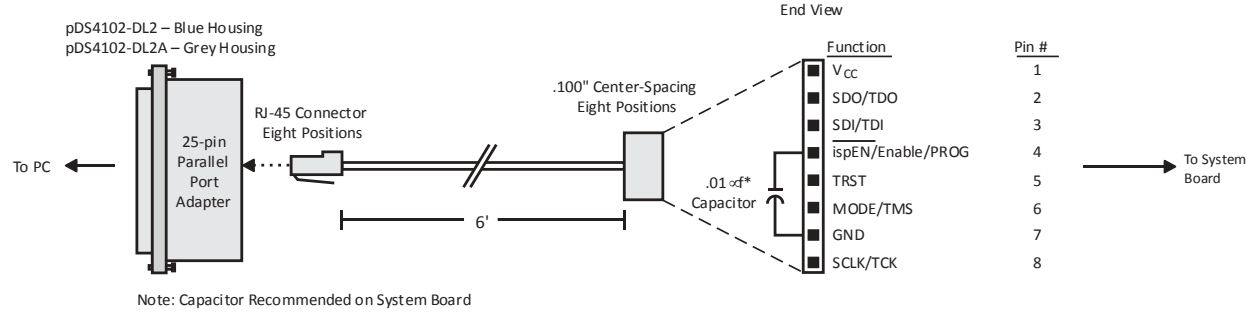

Figure 3.4. Programming Cable In-System Programming Interface for the PC (pDS4102-DL2 or pDS4102- DL2A)

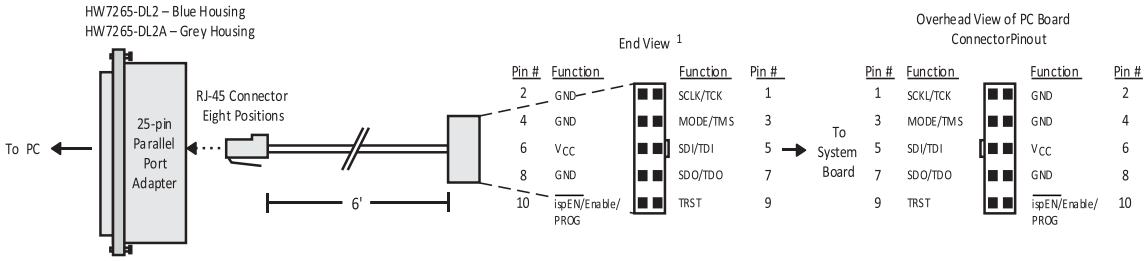

Figure 3.5. Programming Cable In-System Programming Interface for the PC (HW7265-DL2 or HW7265-DL2A)*

***Note**: For reference purposes, the 2 x 10 connector on the HW7265-DL2 or HW7265-DL2A is equivalent to Tyco 102387-1. This will interface to standard 100-mil spacing 2 x 5 headers, or a 2 x 5 keyed, recessed male connector such as the 3M N2510-5002RB.

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4. Programming Software

Diamond Programmer and ispVM System for Classic devices is the preferred programming management software tool for all Lattice devices and download cables. The latest version of Lattice Diamond Programmer or ispVM System software is available for download from the Lattice web site at www.latticesemi.com/software.

5. Target Board Design Considerations

A 4.7K pull-down resistor is recommended on the TCK connection of the target board. This pull-down is recommended to avoid inadvertent clocking of the TAP controller induced by fast clock edges or as VCC ramps up. This pull-down is recommended for all Lattice programmable families.

The I^2C signals SCL and SDA are open drain. A 2.2K pull-up resistor to VCC is required on the target board.

For Lattice device families that feature low power, it is recommended to add a 500 Ohm resistor between VCCJ and GND during the programming interval when a USB Programming cable is connected to a very low power board design. A FAQ is available that discusses this in more depth at:
http://www.latticesemi.com/en/Support/AnswerDatabase/2/2/0/2205

The JTAG programming port speed may need to be governed when using the Programming cables connected to customer PCBs. This is especially important when there is long PCB routing or with many daisy-chained devices. The Lattice programming software can adjust the timing of TCK applied to the JTAG programming port from the cable. This low-precision port setting of TCK depends on many factors, including the PC speed and the type of cable used (parallel port, USB or USB2). This software feature provides an option to slow the TCK for debug or noisy environments. A FAQ is available that discusses this in more depth at: http://www.latticesemi.com/en/Support/AnswerDatabase/9/7/974.aspx

The USB Download Cable can be used to program Power Manager or ispClock products with Lattice programming software. When using the USB cable with the Power Manager I devices, (POWR604, POWR1208, POWR1208P1), you must slow do TCK by a factor of 2. A FAQ is available that discusses this in more depth at:
http://www.latticesemi.com/en/Support/AnswerDatabase/3/0/306.aspx

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6. Programming Flywire and Connection Reference

Refer to Table 6.1 to identify, per Lattice device, how to connect various Lattice Programming Cable Flywires. JTAG, SPI and I²C configuration ports are unambiguously identified. Legacy cables and hardware are included for reference. In addition, various header configurations are tabulated.

Table 6.1. Pin and Cable Reference

HW-USBN-2B Flywire color	**TDI/SI** Orange	**TDO/SO** Brown	**TMS** Purple	**TCK/SCLK** White	**ISPEN/PROG** Yellow	**DONE** Blue	**TRST(OUTPUT)** Green	**VCC** Red	**GND** Black	**I2C: SCL** Yellow/White	**I2C: SDA** Green/White	**5V Out** Red/White
HW-USBN-2A Flywire color	**TDI** Orange	**TDO** Brown	**TMS** Purple	**TCK** White	**ispEN/PROG** Yellow	**INIT** Blue	**TRST(OUTPUT)/DONE(INPUT)** Green	**VCC** Red	**GND** Black	na		
HW-DLN-3C Flywire color	**TDI** Orange	**TDO** Brown	**TMS** Purple	**TCK** White	**ispEN/PROG** Yellow	**na**	**TRST(OUTPUT)** Green	**VCC** Red	**GND** Black	na		
Programming cable pin type	Output	Input	Output	Output	Output	Input	Input/Output	Input	Input	Output	Output	Output
Target Board Recommendation			4.7 kOhm Pull-Up	4.7 kOhm Pull-Down	(Note 1)			(Note 2)		(Note 3)	(Note 3)	
	Connect the Programming Cable wires (above) to the corresponding Device or Header pins (below)											
JTAG Port Devices												
ECP5™	TDI	TDO	TMS	TCK	*Optional Connections to device ispEN, PROGRAMN, INITN, DONE and/or TRST signals (Define in Custom I/O settings in ispVM System or Diamond Programmer software. Not all devices have these pins available)*			Required	Required	—	—	—
LatticeECP3™ / LatticeECP2M™/LatticeECP2™ / LatticeECP™/LatticeEC™	TDI	TDO	TMS	TCK				Required	Required	—	—	—
LatticeXP2™ / LatticeXP™	TDI	TDO	TMS	TCK				Required	Required	—	—	—
LatticeSC™/LatticeSCM™	TDI	TDO	TMS	TCK				Required	Required	—	—	—
MachXO2™/MachXO3™	TDI	TDO	TMS	TCK				Required	Required	—	—	—
MachXO™	TDI	TDO	TMS	TCK				Required	Required	—	—	—
ORCA®/FPSC	TDI	TDO	TMS	TCK				Required	Required	—	—	—
ispXPGA® / ispXPLD™	TDI	TDO	TMS	TCK				Required	Required	—	—	—
ispMACH® 4000/ ispMACH/ispLSI® 5000	TDI	TDO	TMS	TCK				Required	Required	—	—	—
MACH®4A	TDI	TDO	TMS	TCK				Required	Required	—	—	—
ispGDX2™	TDI	TDO	TMS	TCK				Required	Required	—	—	—
ispClock™ (Note 4)	TDI	TDO	TMS	TCK				Required	Required	—	—	—
Platform Manager™ / Power Manager / Power Manager II (Note 4)	TDI	TDO	TMS	TCK				Required	Required	—	—	—
ispPAC®	TDI	TDO	TMS	TCK				Required	Required	—	—	—
Slave SPI Port Devices												
ECP5™	MOSI	MISO	—	CCLK	SN	*Optional Connections to device PROGRAMN, INITN and/or DONE signals*		Required	Required	—	—	—
LatticeECP3™	MOSI	MISO	—	CCLK	SN			Required	Required	—	—	—
MachXO2™/MachXO3™	SI	SO	—	CCLK	SN			Required	Required	—	—	—
CrossLink™ LIF-MD6000	MOSI	MISO	—	SPI_SCK	SPI_SS	*Opt. CDONE*	CRESET_B	Required	Required	—	—	—
iCE40™/iCE40LM/iCE40 Ultra™/iCE40 UltraLite™	SPI_SI	SPI_SO	—	SPI_SCK	SPI_SS_B	*Opt. CDONE*	CRESET_B	Required	Required	—	—	—
I²C Port Devices												
MachXO2™/MachXO3™	—	—	—	—	*Optional Connections to device PROGRAMN, INITN and/or DONE signals*			Required	Required	SCL	SDA	—
Power Manager II	—	—	—	—				Required	Required	SCL_M + SCL_S	SCL_M + SCL_M	—
ASC	—	—	—	—	—	—	—	Required	Required	SCL	SDA	—
CrossLink™ LIF-MD6000	—	—	—	—	—	*Opt. CDONE*	—	Required	Required	SCL	SDA	—
Headers												
1 x 10 conn (various cables)	3	2	6	8	4	9 or 10	5 or 9	1	7	—	—	—
1 x 8 conn (see Fig 5)	3	2	6	8	4	—	5	1	7	—	—	—
2 x 5 conn (see Fig 6)	5	7	3	1	10	—	9	6	2, 4,or 8	—	—	—
Programmers												
Model 300	5	7	3	1	10	—	9	6	2, 4,or 8	—	—	—
iCEprog M1050	8	5	—	7	9	3	1	6	10	—	—	4 (Note 5)

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Notes:

1. For older Lattice ISP devices, a 0.01 µF decoupling capacitor is required on ispEN/ENABLE of the target board.
2. For HW-USBN-2A/2B, the target board supplies the power - Typical ICC = 10 mA. For devices that have a VCCJ pin, the VCCJ must be connected to the cable's VCC. For other devices, connect the appropriate bank VCCIO to the cable's VCC. A 0.1 µF decoupling capacitor is required on VCCJ or VCCIO close to the device. Please refer to the device data sheet to determine if the device has a VCCJ pin or what VCCIO bank governs the target programming port (this may not be the same as a target device's core VCC/VSS plane).
3. Open drain signals. External pull-up ~2.2 kOhm resistor to the appropriate bank VCCIO or VCCJ is required.
4. When using PAC-Designer® software to program ispPAC devices, do not connect TRST/DONE.
5. If using a cable older than HW-USBN-2B, connect a +5 V external supply between iCEprog M1050 pin 4 (VCC) and pin 2 (GND).

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7. Connecting the Programming Cable

The target board must be un-powered when connecting, disconnecting, or reconnecting the Programming Cable. Always connect the Programming Cable's GND pin (black wire) before connecting any other JTAG pins. Failure to follow these procedures can result in damage to the target programmable device.

8. Programming Cable TRST Pin

Connecting the board TRST pin to the cable TRST pin is not recommended. Instead, connect the board TRST pin to Vcc. If the board TRST pin is connected to the cable TRST pin, instruct ispVM/Diamond Programmer to drive the TRST pin high.

To configure ispVM/Diamond Programmer to drive TRST pin high:

1. Select the **Options** menu item.
2. Select **Cable and I/O Port Setup**.
3. Select the **TRST/Reset Pin Connected** checkbox.
4. Select the **Set High** radio button.

If the proper option is not selected, the TRST pin will be driven low by ispVM/Diamond Programmer. Consequently, the BSCAN chain will not work because the chain will be locked into RESET state.

9. Programming Cable ispEN Pin

The following pins should be grounded:

- BSCAN pin of the 2000VE devices
- ENABLE pin of MACH4A3/5-128/64, MACH4A3/5-64/64 and MACH4A3/5-256/128 devices.

However, the user has the option of having the BSCAN and ENABLE pins driven by the ispEN pin from the cable. In this case, ispVM/Diamond Programmer must be configured to drive the ispEN pin low as follows:

To configure ispVM/Diamond Programmer to drive ispEN pin low:

1. Select the **Options** menu item.
2. Select **Cable and I/O Port Setup**.
3. Select the **ispEN/BSCAN Pin Connected** checkbox.
4. Select the **Set Low** radio button.

Each Programming Cable ships with two small connectors that help you keep the flywires organized. The following manufacturer and part number is one possible source for equivalent connectors:

- 1 x 8 Connector (e.g. Samtec SSQ-108-02-T-S)
- 2 x 5 Connector (e.g. Samtec SSQ-105-02-T-D)

The Programming Cable flywire or headers are intended to connect to standard 100-mil spacing headers (pins spaced 0.100 inch apart). Lattice recommends a header with length of 0.243 inches or 6.17 mm. Though, headers of other lengths may work equally well.

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10. Ordering Information

Table 10.1. Programming Cable Feature Summary

Feature	HW-USBN-2B	HW-USBN-2A	HW-USB-2A	HW-USB-1A	HW-DLN-3C	HW7265-DL3, HW7265-DL3A, HW-DL-3B, HW-DL-3C	HW7265-DL2	HW7265-DL2A	PDS4102-DL2	PDS4102-DL2A
USB	X	X	X	X	—	—	—	—	—	—
PC-Parallel	—	—	—	—	X	X	X	X	X	X
1.2 V Support	X	X	X	—	—	—	—	—	—	—
1.8 V Support	X	X	X	X	X	X	—	X	—	X
2.5-3.3 V Support	X	X	X	X	X	X	X	X	X	X
5.0 V Support	—	X	X	X	X	X	X	X	X	X
2 x 5 Connector	—	X	X	X	X	X	X	X	—	—
1 x 8 Connector		X	X	X	X	X	—	—	X	X
Flywire	X	X	X	X	X	X	—	—	—	—
Lead-free Construction	X	X	—	—	X	—	—	—	—	—
Available for order	X	—	—	—	X	—	—	—	—	—

Table 10.2. Ordering Information

Description	Ordering Part Number	China RoHS Environment- Friendly Use Period (EFUP)
Programming cable (USB). Contains 6' USB cable, flywire connectors, 8-position (1 x 8) adapter and 10-position (2 x 5) adapter, lead-free, RoHS compliant construction.	HW-USBN-2B	
Programming cable (PC only). Contains parallel port adapter, 6' cable, flywire connectors, 8-position (1 x 8) adapter and 10-position (2 x 5) adapter, lead-free, RoHS compliant construction.	HW-DLN-3C	

***Note:** Additional cables are described in this document for legacy purposes only, these cables are no longer produced. The cables currently available for order are fully equivalent replacement items.

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Appendix A. Troubleshooting the USB Driver Installation

It is essential that you install the drivers before connecting your PC to the USB cable. If the cable is connected before installing the drivers, Windows will try to install its own drivers that may not work.

If you have attempted to connect the PC to the USB cable without first installing the appropriate drivers, or have trouble communicating with the Lattice USB cable after installing the drivers, follow the steps below:

1. Plug in the Lattice USB cable. Choose Start > Settings > Control Panel > System.
2. In the System Properties dialog box, click the Hardware tab and Device Manager button. Under Universal Serial Bus controllers, you should see **Lattice USB ISP Programmer**. If you do not see this, look for the Unknown Device with the yellow flag. Double click on the **Unknown Device** icon.

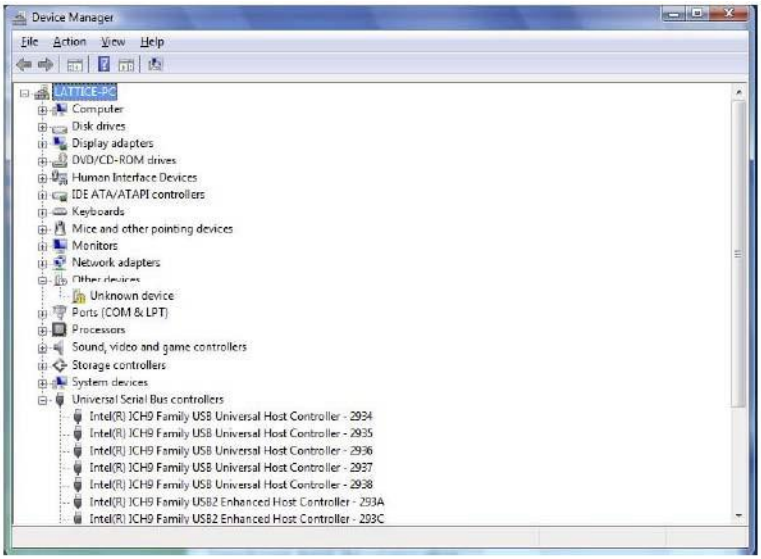

Figure A.1. Device Manager

3. In the **Unknown device Properties** dialog box, click **Reinstall Driver**.

Figure A.2. Unknown Device Properties

4. Select **Browse my computer for driver software**.

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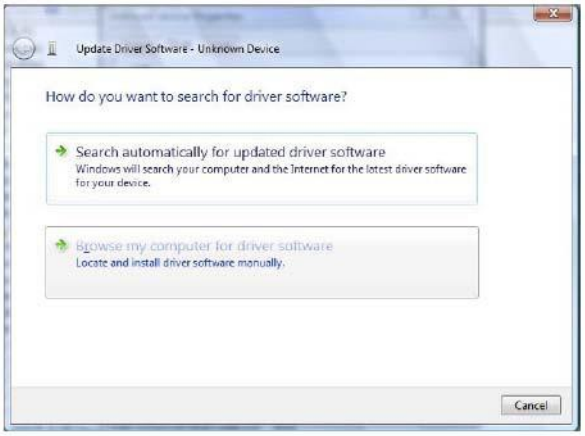

Figure A.3. Update Driver Software

Browse to the `isptools\ispvmsystem` directory for the Lattice EzUSB driver.

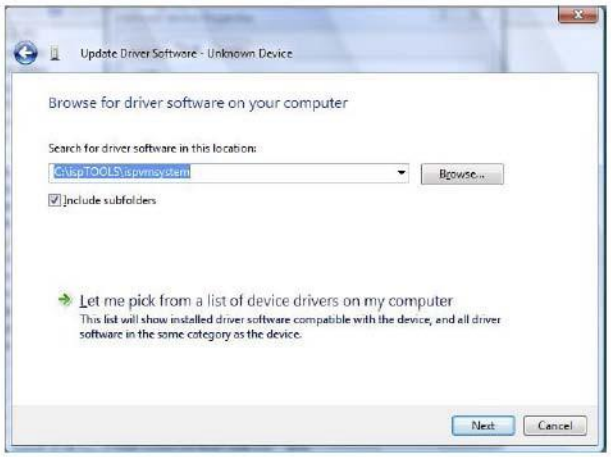

Figure A.4. Lattice EzUSB Driver

Browse to the `isptools\ispvmsystem\Drivers\FTDIUSBDriver` directory for the FTDI FTUSB driver.

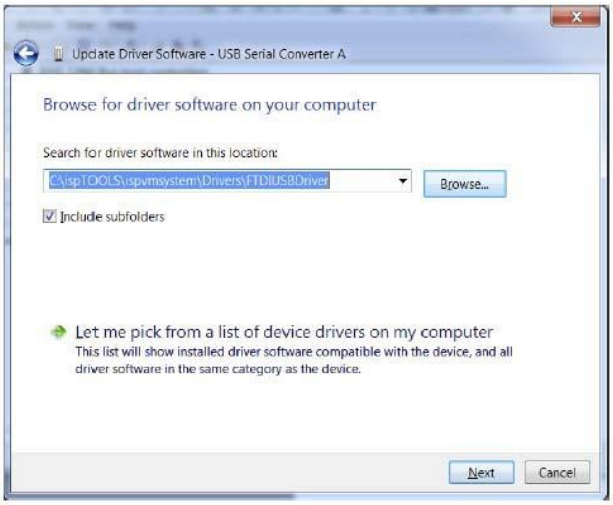

Figure A.5. FTDI FTUSB Driver

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5. For Diamond installations, browse to `lscc/diamond/data/vmdata/drivers`. Click **Next**.
6. Select **Install this Driver software anyway**. The system will update the driver.

Figure A.6. Windows Security

7. Click **Close** and finish installing the USB driver.

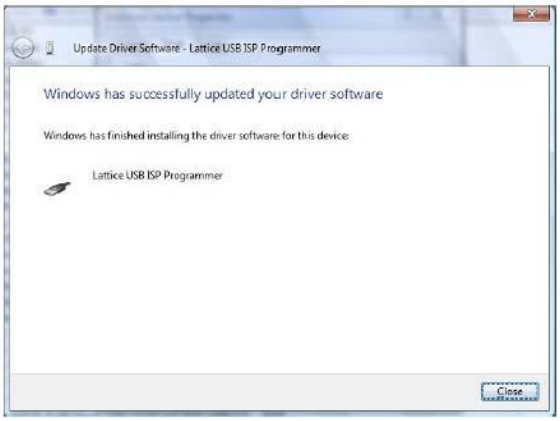

Figure A.7. USB Installation Completed

8. Under **Control Panel >System >Device Manager > Universal Serial Bus Controllers** should include the following:
   For the Lattice EzUSB Driver: Lattice USB ISP Programmer device installed.

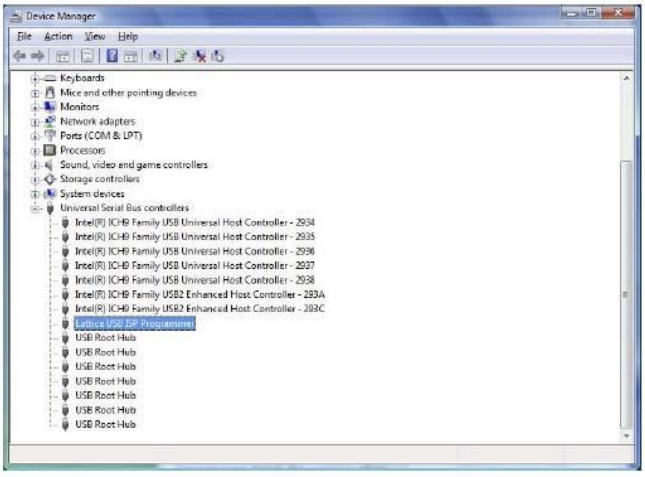

Figure A.8. Installation Completed

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For the FTDI FTUSB Driver: USB Serial Converter A and Converter B devices installed.

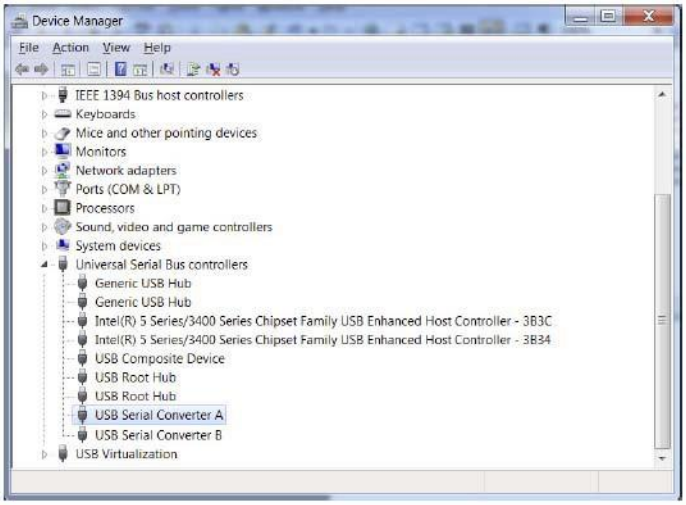

Figure A.9. Installation Completed

If you are experiencing problems or need additional information, contact Lattice Technical Support.

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Technical Support

For assistance, submit a technical support case at www.latticesemi.com/techsupport.

Revision History

Date	Version	Change Summary
May 2018	26.1	Corrected entries in the Slave SPI Port Devices section of Table 6.1.
April 2018	26.0	Changed document number from UG48 to FPGA-UG-02024.
		Updated document template.
		Revised Programming Cables section. Removed redundant information and changed link to www/latticesemi.com/software.
		Updated Programming Cable Pin names in Table 3.1. Programming Cable Pin Definitions.
		Updated Programming Flywire and Connection Reference Section. Replaced Table 2. Flywire Conversion Reference and Table 3 Recommended Pin Connections with a single Table 6.1 Pin and Cable Reference.
		Moved Table 10.1. Programming Cable Feature Summary under Ordering Information.
November 2016	25.0	Updated Programming Flywire and Connection Reference section. • Revised Table 3, Recommended Pin Connections. Added CrossLink device.
October 2015	24.9	Updated Programming Flywire and Connection Reference section. • Revised Table 3, Recommended Pin Connections. Added CRESET-B column. Added iCE40 UltraLite device.
		Updated Technical Support Assistance section.
March 2015	24.8	Updated Programming Cable Pin Definitions section. • Revised description of INIT in Table 1, Programming Cable Pin Definitions.
January 2015	24.7	Updated Programming Cable Pin Definitions section. • In Table 1, Programming Cable Pin Definitions, ispEN/Enable/PROG changed to ispEN/Enable/PROG/SN and its description revised. • Updated Figure 2, Programming Cable In-System Programming Interface for the PC (HW-USBN-2B).
		Updated Programming Cable ispEN Pin section. In Table 4, Programming Cable Feature Summary, HW-USBN-2B marked as available for order.
		Updated Ordering Information section. HW-USBN-2A changed to HW- USBN-2B
July 2014	24.6	Changed document title to Programming Cables User's Guide
		Changed ispDOWNLOAD Cables to Programming Cables.
		Updated Target Board Design Considerations section. Updated FAQ link on ispVM tool control of TCK duty cycle and/or frequency.
		Updated Table 3, Recommended Pin Connections. Added ECP5, iCE40LM, iCE40 Ultra, and MachXO3 device families.
		Updated Technical Support Assistance information.
October 2012	24.5	Added iCE40 configuration port pin names to the Flywire Conversion Reference table.
		Added iCE40 information to Recommended Cable Connections table.
February 2012	24.4	Updated document with new corporate logo.

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Date	Version	Change Summary
November 2011	24.3	Document transferred to user's guide format.
		Added Figure USB Cable – HW-USBN-2A.
		Updated Recommend Cable Connections table for MachXO2 devices.
		Updated Target Board Design Considerations section.
		Added Appendix A.
October 2009	24.2	Added information related to the physical specifications of the flywire connectors.
July 2009	24.1	Added Target Board Design Considerations text section.
		Added Programming Flywire and Connection Reference section heading.
—	—	Previous Lattice releases.

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