iCEstick Evaluation Kit

User's Guide

August 2013
EB82_01.0

Introduction

Thank you for choosing the Lattice Semiconductor iCEstick™ Evaluation Kit.

This guide describes how to start using the iCEstick Evaluation Kit, an easy-to-use USB form factor board for rapidly prototyping designs using the iCE40 FPGA. Along with the evaluation board, this kit includes a pre-loaded design that demonstrates basic board functionality.

The contents of this user's guide include demo operations, descriptions of the various portions of the evaluation board, descriptions of the on-board connectors, a complete set of schematics and bill of materials for the iCEstick Evaluation Board.

Features

The iCEstick Evaluation Kit includes:

- iCEstick Evaluation Board – features the following on-board components
  - High-performance, low-power iCE40HX1K FPGA
  - FTDI 2232H USB device allows iCE device programming and UART interface to a PC
  - Vishay TFDU4101 IrDA transceiver
  - Five user LEDs
  - 2 x 6 position Diligent Pmod™ compatible connector enables many other peripheral connections
  - Discera 12Mhz MEMS oscillator
  - Micron 32Mbit N25Q32 SPI flash
  - Supported by Lattice iCEcube2™ design software
  - USB connector provides the power supply
  - 16 LVCMOS/LVTTL (3.3V) digital I/O connections on 0.1" through-hole connections
- Pre-loaded demo design – the kit includes the pre-loaded demo design that flashes the on-board LEDs in a clockwise pattern.
- USB connector – provides a communication and debug port via a USB-to-RS-232 physical channel and programming interface to the PC.

Figure 1. iCEstick Evaluation Board

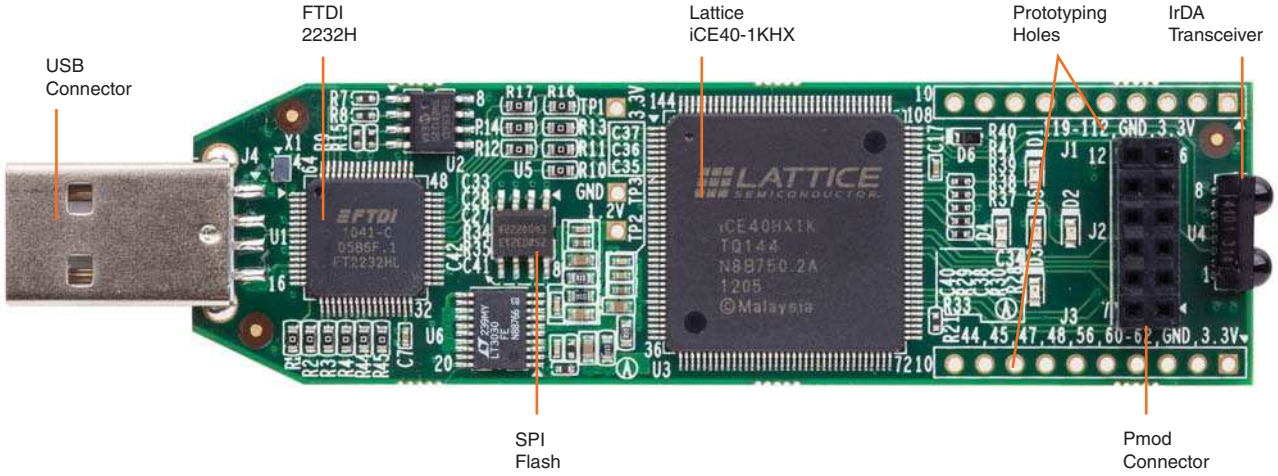
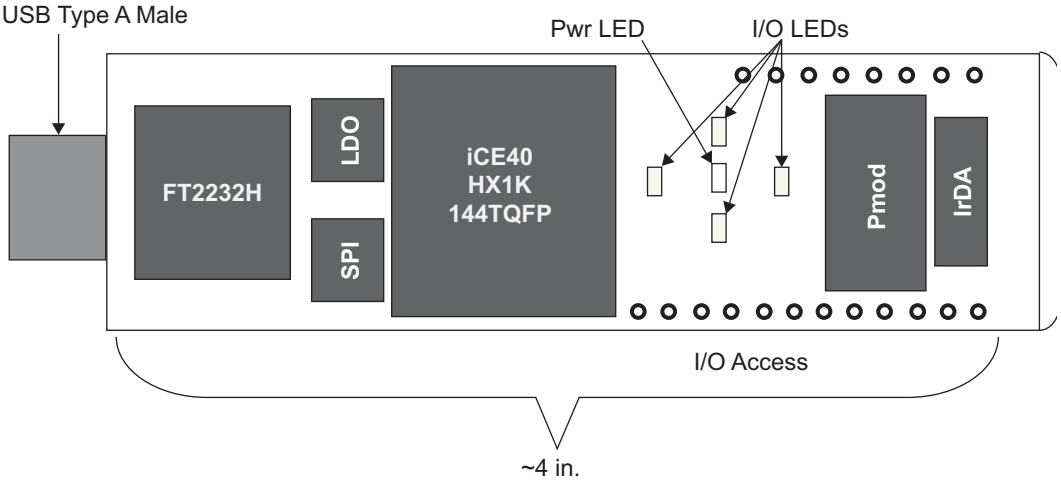


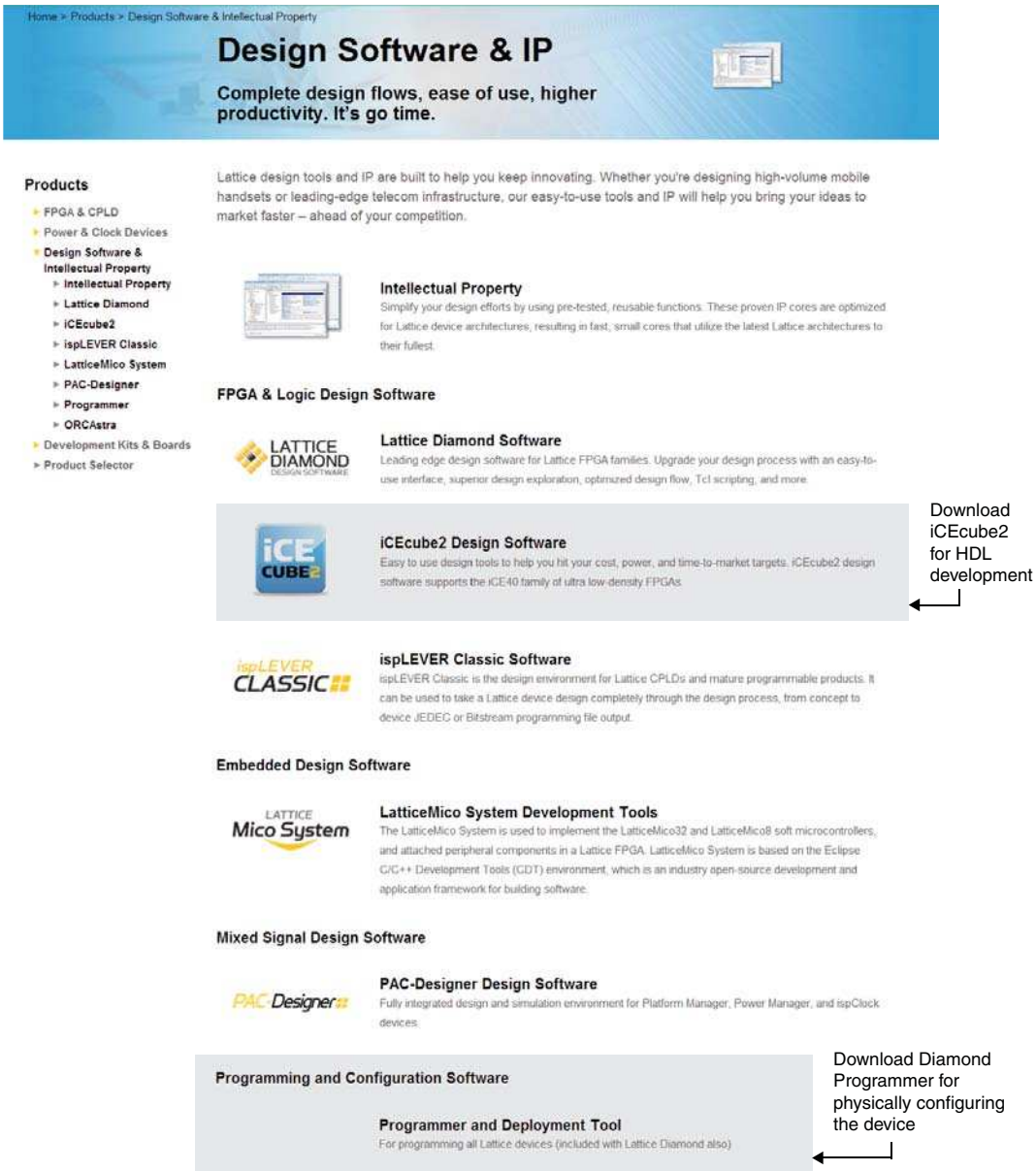
Figure 2. iCEstick Functional Block Diagram



Software Requirements

Before using the iCEstick board, download and install the latest version of Lattice iCEcube2™ and Diamond Programmer. Make sure you log in to the Lattice website, otherwise these software downloads will not be visible. These are available at http://www.latticesemi.com/Products/DesignSoftwareAndIP.aspx. If you install Diamond Programmer 2.2, you will require a software patch. This software patch is available at http://www.latticesemi.com/icestick. Go to the Downloads tab and install the appropriate patch. This patch is not required with Diamond Programmer 3.0 or higher.

Figure 3. Software Downloads



Communication Between the PC and iCEstick

Communication between the iCEstick Board and a PC is via the FTDI 2232H USB device. To enable this connection the installation of the FTDI chip USB hardware drivers is needed. This driver is installed when Diamond Programmer was installed. These drivers enable the computer to recognize and program the iCEstick board. In addition these drivers allow communication between the PC and the iCEstick board to enable further demonstrations.

Connecting the iCEstick Evaluation Board

Insert the iCEstick evaluation board to an open USB slot in a PC. The default bitstream in the SPI flash loads the iCE40HX-1k device on the iCEstick board. One should see the green LED on the board light up and continue to be lit.

Preprogrammed Design and Board LEDs

There are a total of 5 LEDs on the iCEstick board. All are controlled by I/Os of the iCE40HX-1k device. The default bitstream loads the iCE40HX-1k device and the green LED lights up signifying that the device has loaded correctly and power is good. The other four red LEDs arranged in a diamond pattern begins to flash in a clockwise direction. This is the intended function of the default bitstream.

Table 1. User I/O and LEDs

LED location	CPLD pin (All in Bank 1)	CPLD I/O	LED color
D1	99	PIO1_14	Red
D2	98	PIO1_13	Red
D3	97	PIO1_12	Red
D4	96	PIO1_11	Red
D5	95	PIO1_10	Green

Download Demo Designs

The above demo is pre-programmed into the iCEstick board. Other than the default design, Lattice also distributes source and programming files for demonstration designs compatible with this board. To download the demo designs:

1. Browse to www.latticesemi.com/icestick and click on the Downloads tab to view other design files and capabilities that the iCEstick board could implement. Various demo designs are available and can be download.
2. Extract the contents of zip files to a local hard drive.

Lattice provides the following demos based on iCEstick board:

- UART over IrDA. In this demo design, the iCEstick device communicates with a laptop or PC through UART over USB. Then, the payload is transmitted through Vishay IrDA device. This data can be locally looped back or another iCEstick board could receive the data via it's IrDA receiver.
- Diligent Pmod Accelerometer. The demo makes use of Digilent PmodAcl module which is plugged into iCEstick board. In this demo design, the accelerometer setting and reading is done by the on-board iCE device and the direction of movement is displayed with the diamond pattern LEDs.

IrDA Functionality and Demo

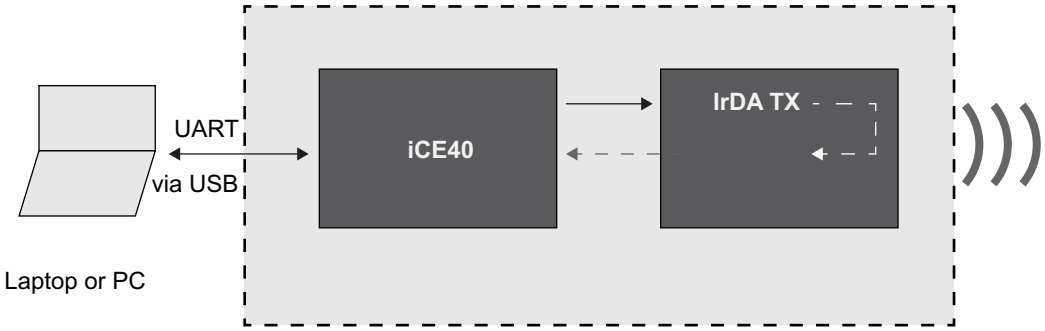
The iCEstick board has a Vishay TFDU4101 IrDA transceiver on it. This device allows transmit and receive of infrared data up to 115kbps.

Table 2. IrDA Pin Description

IrDA function	CPLD pin	CPLD I/O	Comment
RXD	106	PIO1_19	Receive data pin
TXD	105	PIO1_18	Transmit data pin
SD	107	PIO1_20	Shut down

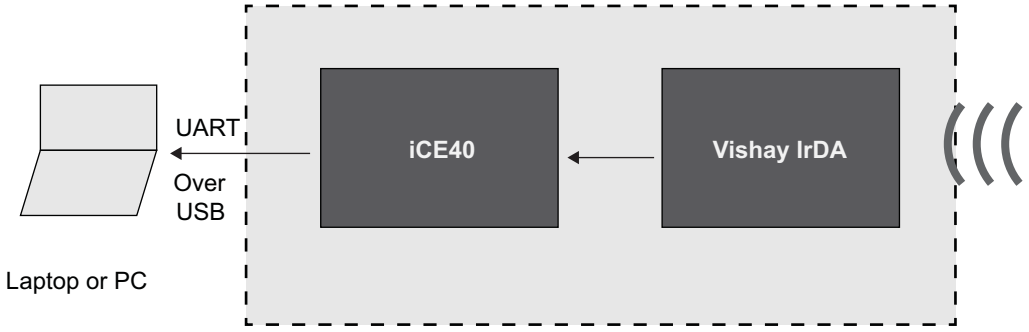
There are two possible configurations for the IrDA demo design: IrDA TX and IrDA RX. For an end to end complete IrDA link demo, two iCEstick boards are needed, however using just the IrDA Tx design can support a demo. The IrDA TX design transfers the data from the PC keyboard input in a terminal window to the IrDA Vishay device TXD. While the data is transmitted via infrared, it is also by default looped back to the receive channel of the IrDA device. In this demo the looped back data is received and before it is transmitted to the PC window the text is converted from lower case to upper case. This is the signal flow for the stand alone demo.

Figure 4. IrDA TX on iCEstick



The IrDA RX design receives infrared data from the Vishay IrDA Tx device. After the IrDA data is wirelessly received it is then sent to the iCE40 device. The iCE40 then send the character information to the open window on the PC. Thus whatever is typed in the TX terminal window is displayed in the Rx terminal window.

Figure 5. IrDA RX on iCEstick



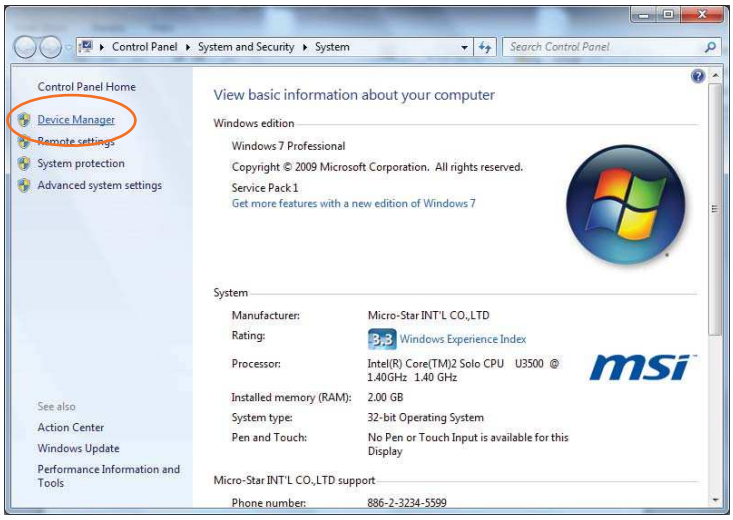
This demo requires a terminal program on PC to communicate with the iCEstick board. The following instructions describe the setup for IrDA TX stand alone demo using the Tera Term terminal emulator program on Windows 7.

Setting Up for the IrDA TX Stand Alone Demo

To set up for the IrDA TX demo:

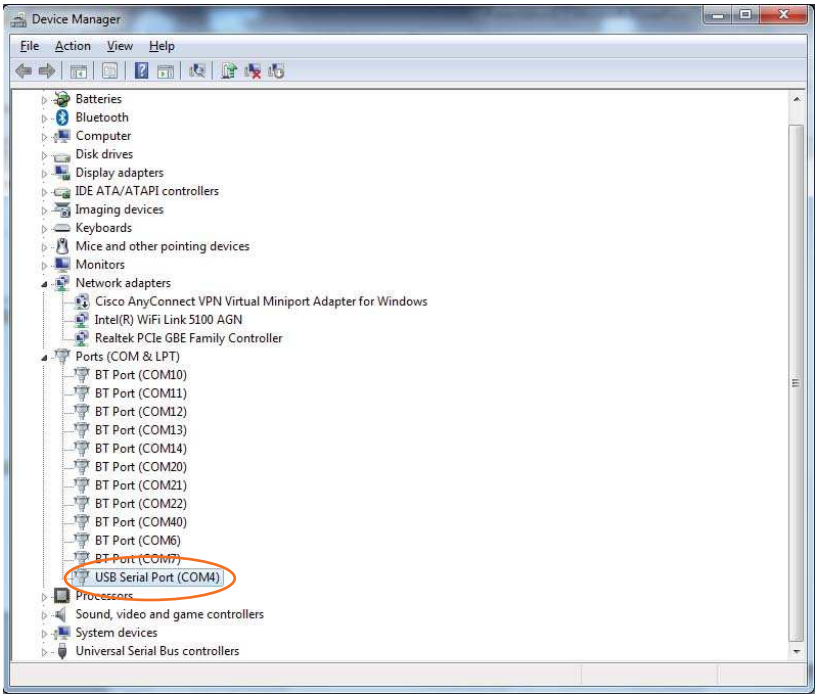
1. Program the iCE device with IrDA TX bitstream.
2. Plug iCEstick into a PC USB port.
3. Check if the USB driver is installed correctly.
   Go to **Start**, right-click **Computer** and select **Properties**. The System window is shown. Click **Device Manager**.

Figure 6. System Window



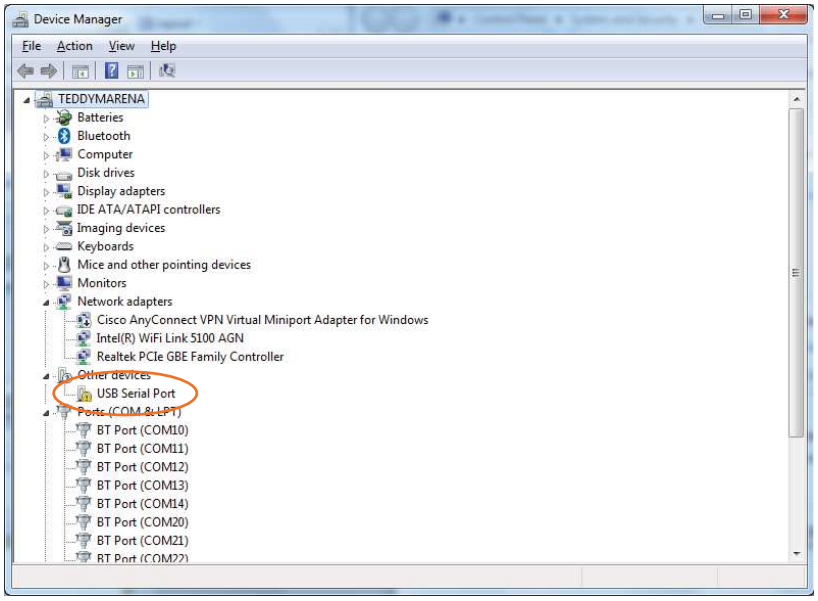
4. If the driver is installed correctly, the device is listed without an error tag under Ports (COM & LPT) as shown in Figure 7. Proceed to the next step.

Figure 7. Device Manager



If the driver is not installed correctly, the device is tagged with a yellow exclamation point as shown in Figure 8. You need to install the driver. To do this, right-click the device and select **Update Driver Software**.

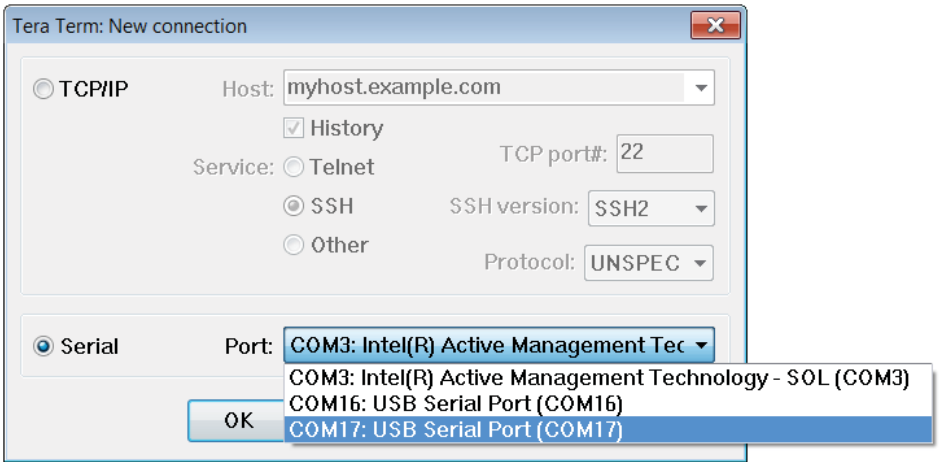
Figure 8. Device Manager with Driver Error



Request Windows to search the web for the driver. After Windows locates the FTDI driver, install it and proceed to the next step.

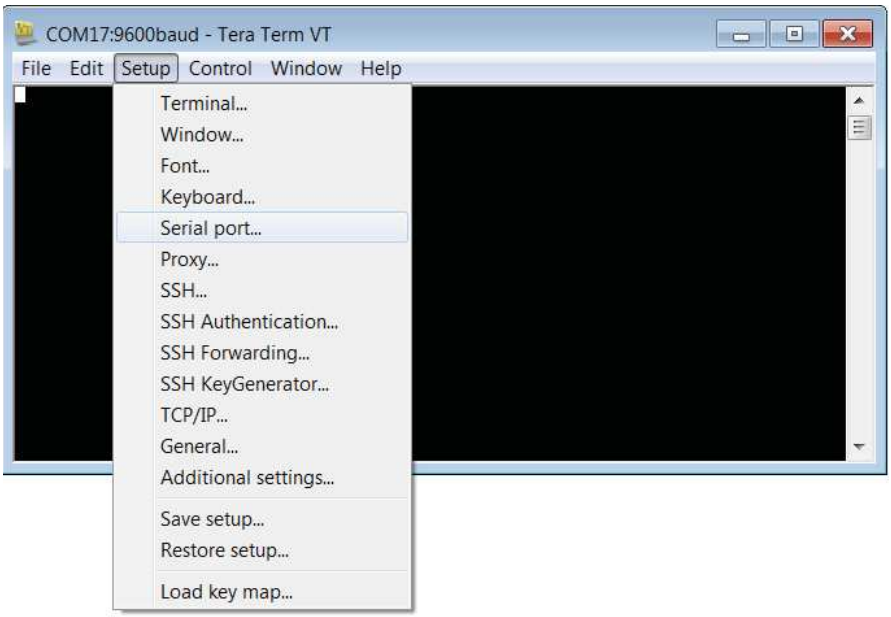
5. Install Tera Term software. The installer can be downloaded from http://download.cnet.com/Tera-Term/3000-20432_4-75766675.html.
6. Open Tera Term.
7. In the New connection dialog box, click **Serial.**
8. On the Port menu, click **COMxx: USB Serial Port (COMxx)**. If there are two or more options, select the last COM port on the list. Click **OK**.

Figure 9. New Connection Dialog Box



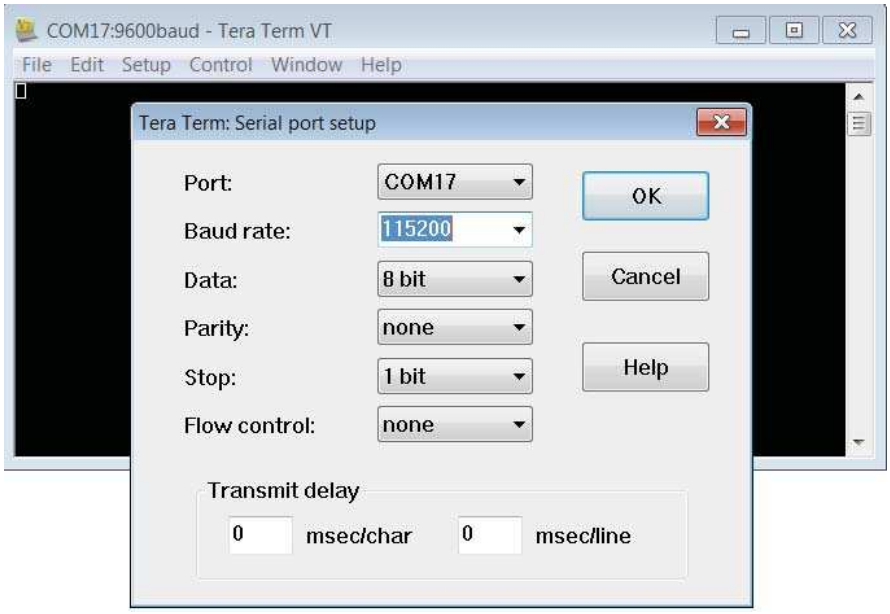
9. The selected COM port/default baud rate appear in the Tera Term VT window title bar as shown in Figure 10. On the Setup menu, click **Serial port**.

Figure 10. Tera Term VT Window with Selected COM Port /Default Baud Rate



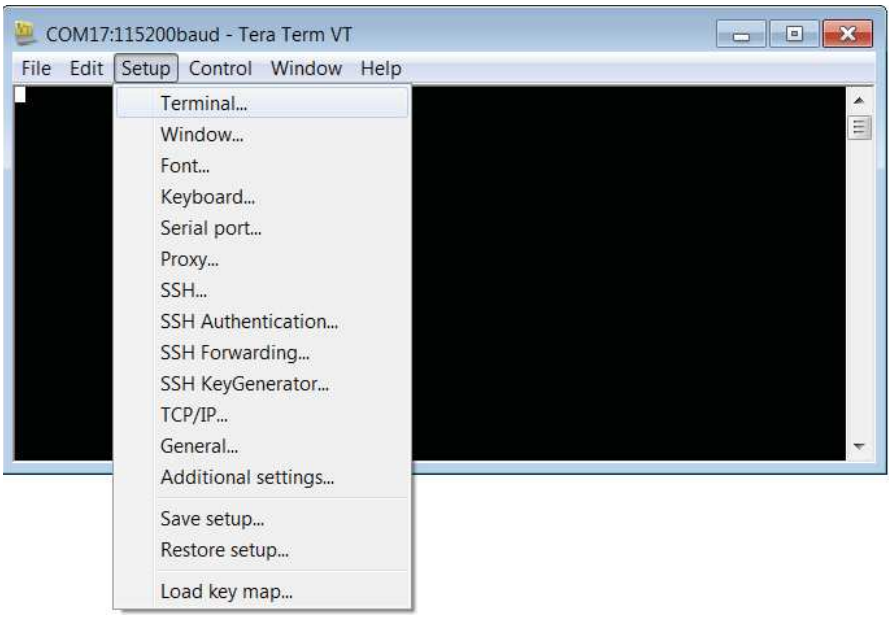
10. The Serial port setup dialog box opens. In the Baud rate menu, click **115200**. Leave other options with default settings. Click **OK**.

Figure 11. Serial Port Setup Dialog Box



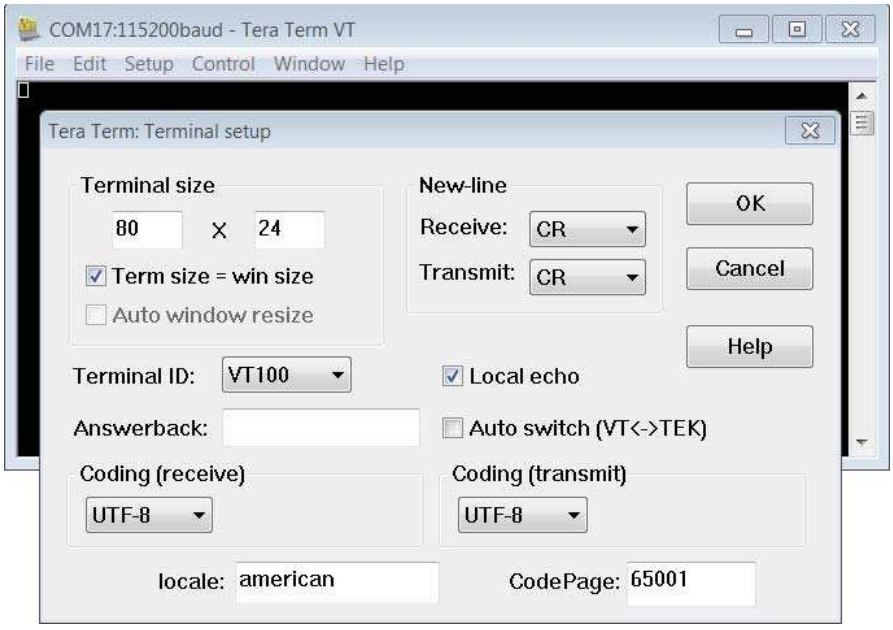
11. The selected COM port/115200 baud rate appear in the Tera Term VT window title bar as shown in Figure 12. On the Setup menu, click **Terminal**.

Figure 12. Tera Term VT Window with Selected COM Port /Baud Rate



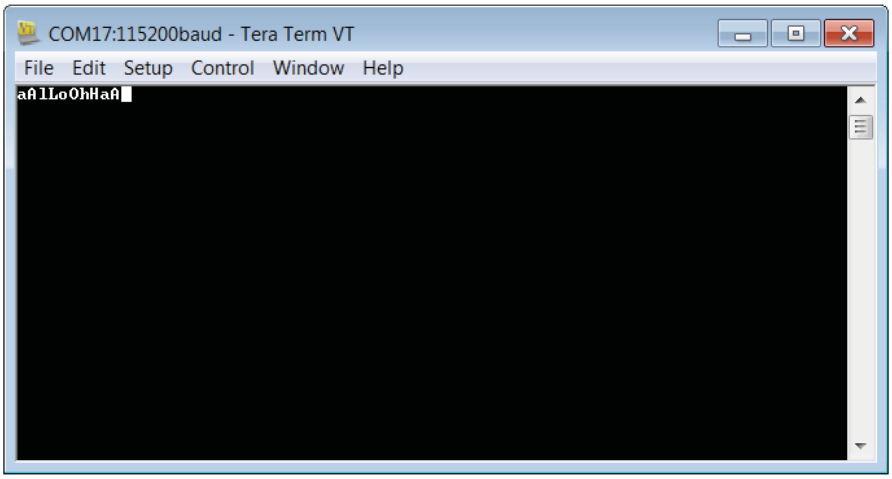
12. The Terminal setup dialog box opens. Select **Local echo**. Leave other options with default value. Click **OK**.

Figure 13. Terminal Setup Dialog Box



When you type in the Tera Term VT window using the TX design, a lower case character is echoed with a capital character from the iCE device as shown in the Figure 14.

Figure 14. Tera Term VT Window Using TX Design



For IrDA RX, the above Tera Term setting is the same but the bitstream for the iCE device is different. With a setup of two iCEstick boards facing each other, one programmed with IrDA TX and the other programmed with IrDA RX, the character typed in IrDA TX PC is transferred to and displayed on IrDA RX PC monitor. You can change the angle of the TX board facing the RX board to see when the IrDA link would break.

Diligent Pmod Connector and Accelerometer Demo

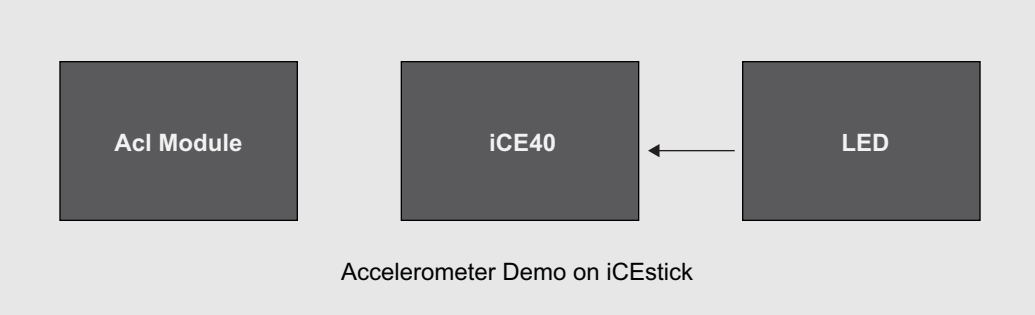
On the iCEstick board, location J2 is a 2x6 position Pmod (Peripheral MODule) Digilent connector. The iCEstick board supports a variety of Pmod peripheral modules for easy I/O expansion. Figure 3 lists the 0.1” through-hole headers on the iCEstick board that support Pmod modules. Pmod modules come in different form factors, and each Pmod header includes power and ground supplies. The easiest way to support a Pmod module is to add the appropriate female socket. Straight-through or right-angle connectors can be used. Male headers are an alternate solution when using the interface cable provided with most Pmod modules.

Table 3. Diligent Pmod Compatible Connector Description

Connection	Left Row pins	Right Row pins	Connection
PIO1_02	1	7	PIO1_06
PIO1_03	2	8	PIO1_07
PIO1_04	3	9	PIO1_08
PIO1_05	4	10	PIO1_09
Ground	5	11	Ground
3.3v	6	12	3.3v

The Accelerometer demo makes use of the Digilent PmodAcl accelerometer module from Diligent. The PmodAcl module needs to be plugged into J2 on the iCEstick board through the cable that comes with this module. The four LEDs D1, D2, D3 and D4 in the north, south, east and west pattern are configured to represent X+, Z+, X-, Z- of accelerometer movement direction respectively. When the accelerometer module is moved around, the diamond pattern LEDs on the iCEstick board goes on/off corresponding to the direction of the movement and orientation of the module. If all these LEDs light up at the same time (indicating a balance point), The D5 LED also lights up.

Figure 15. Accelerometer Demo on iCEstick



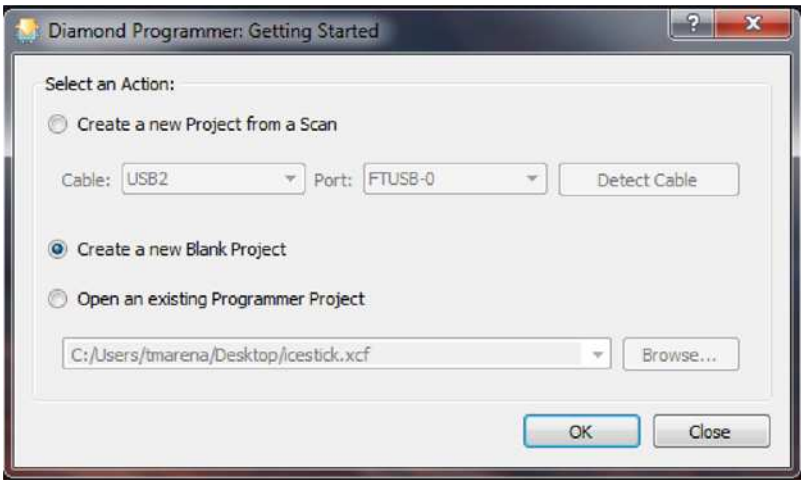
Accelerometer Demo on iCEstick

Programming Demo Designs with Lattice Programmer

To program a bitstream file to iCE device:

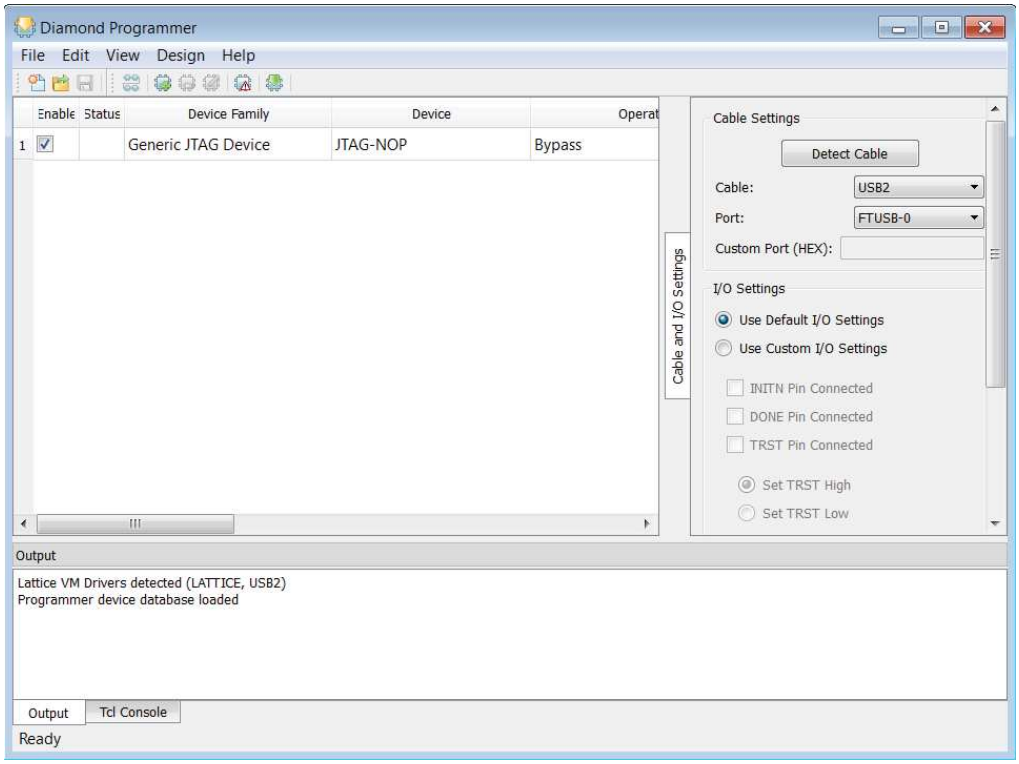
1. Plug the iCEstick board to a USB port on a host PC with Programmer installed.
2. Run Programmer. The Diamond Programmer Getting Started window opens. Under Select an Action, click **Create a new Blank Project**. Click **OK**. If you try to create a new project from a scan, you will receive an error. Please select **Create a new Blank Project**.

Figure 16. Diamond Programmer Getting Started Window



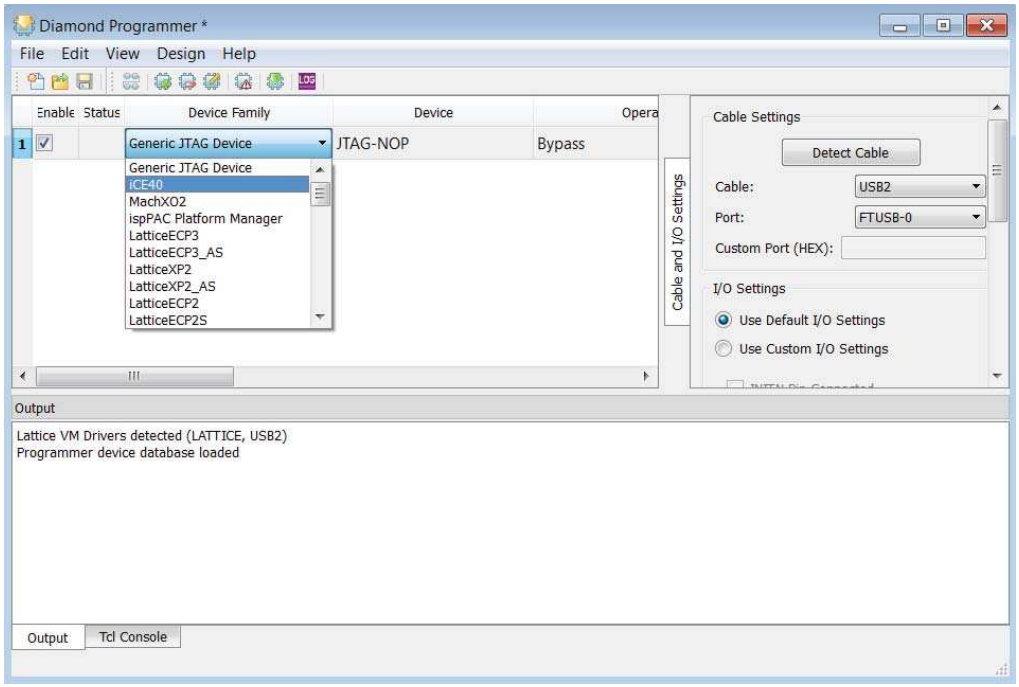
3. The Diamond Programmer interface opens. Under Cable Settings, in the Cable menu, click **USB2**. In the Port menu, click **FTUSB-0**. You can also click **Detect Cable** to set the correct cable and port.

Figure 17. Cable and Port Settings



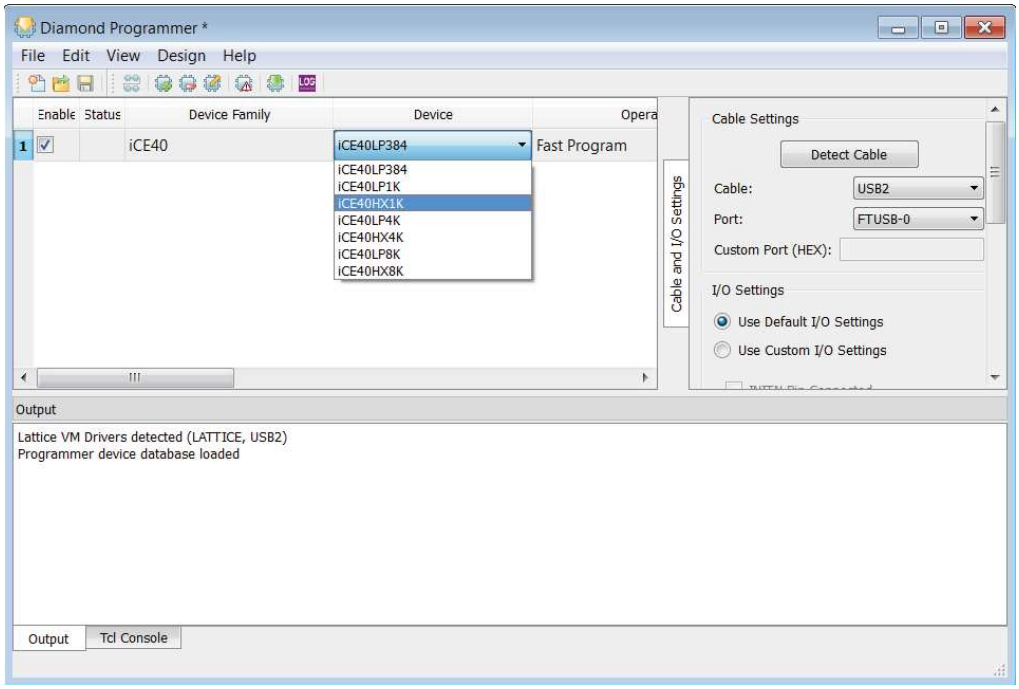
4. Select the **Enable** check box.
5. Double-click the cell under Device Family and click **iCE40**.

Figure 18. Device Family Options



6. Double-click the cell under Device and click **iCE40HX1K**.

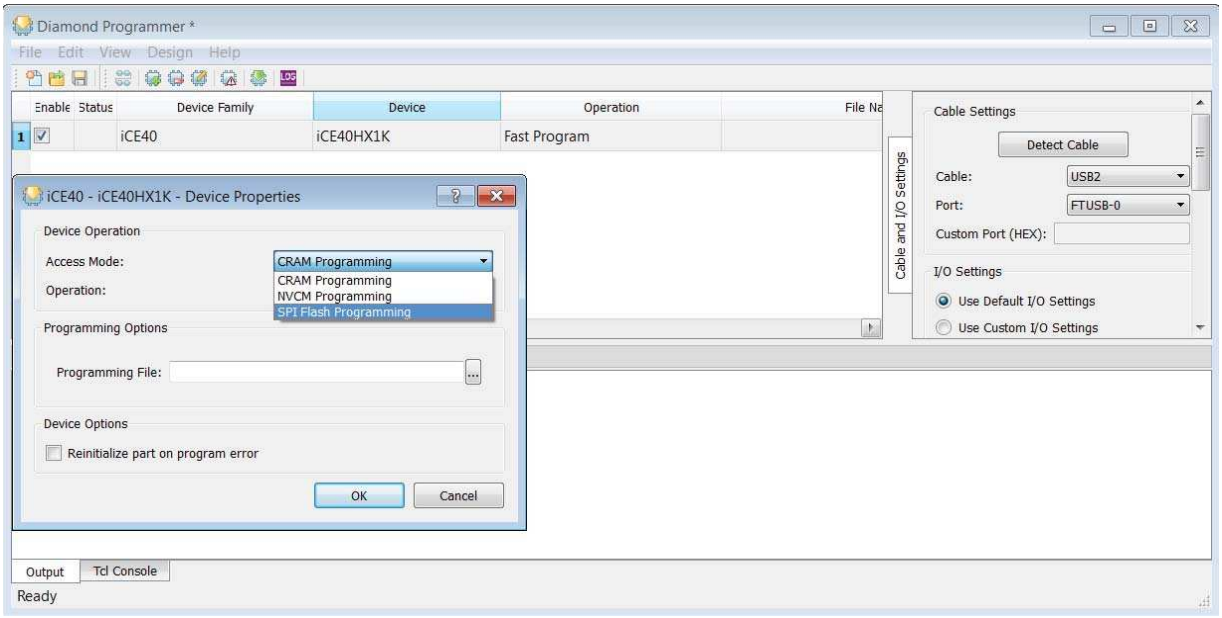
Figure 19. Device Options



7. Double-click the cell under Operation. The Device Properties dialog box opens as shown in Figure 20. On the Access Mode menu, click **SPI Flash Programming**. Click **OK**.

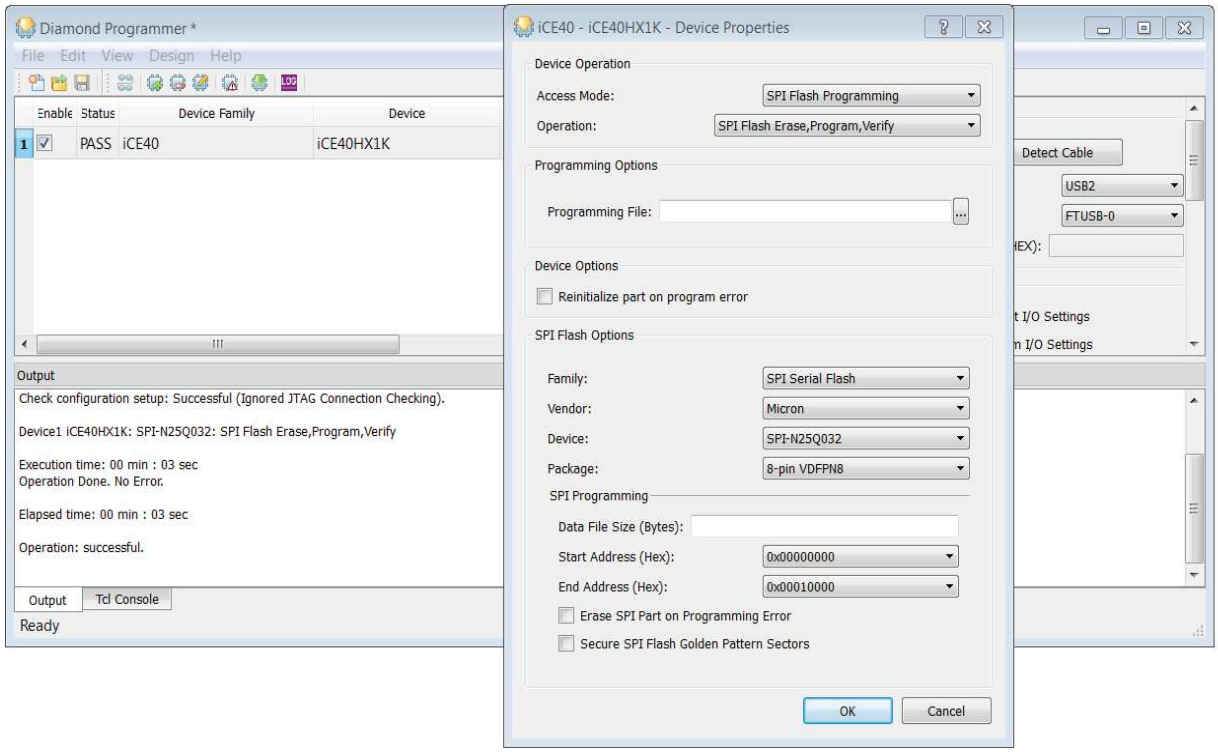
   Warning: NVCM Programming is NOT recommended. NVCM Programming is one time programming. If you use NVCM Programming to program iCE device, the iCE device can no longer be reprogrammed.

Figure 20. Device Properties Dialog Box



8. Select the SPI flash part number. For the iCEstick, this is Micron SPI-N25Q032 8-pin VDFPN8 package. Also make sure to select the programming file. Once done, click **OK**.

Figure 21. Select Serial SPI Flash



9. On the Programmer toolbar, click the **Program** button to initiate the download. The bitstream starts downloading to the iCE device. This takes a few seconds to complete.

Expansion I/O Connections

The iCEstick board contains two unpopulated 0.1” headers for users to implement their own connections. Connectors J1 and J3 each consist of 10 positions for a total of 20 connections. Two of these are tied to 3.3v and two are tied to ground. This leaves 16 general purpose I/Os that connect to the iCE40HX-1k device for user I/O.

Table 4. Expansion I/O Connections

J1 Connector			J3 Connector		
Pin	**CPLD I/O Bank 0**	**CPLD Pin**	**Pin**	**CPLD I/O Bank 2**	**CPLD Pin**
1	3.3v	-	1	3.3v	-
2	Ground	-	2	Ground	-
3	PIO0_02	112	3	PIO2_17	62
4	PIO0_03	113	4	PIO2_16	61
5	PIO0_04	114	5	PIO2_15	60
6	PIO0_05	115	6	PIO2_14	56
7	PIO0_06	116	7	PIO2_13	48
8	PIO0_07	117	8	PIO2_12	47
9	PIO0_08	118	9	PIO2_11	45
10	PIO0_09	119	10	PIO2_10	44

Test Points

There are three unpopulated test points. TP1 is tied to 3.3v, TP2 is tied to 1.2v and TP3 is connected to ground.

Lattice Demonstration Bitstreams

All demonstration bitstreams and Design files are available at www.latticesemi.com/icestick.

Technical Support Assistance

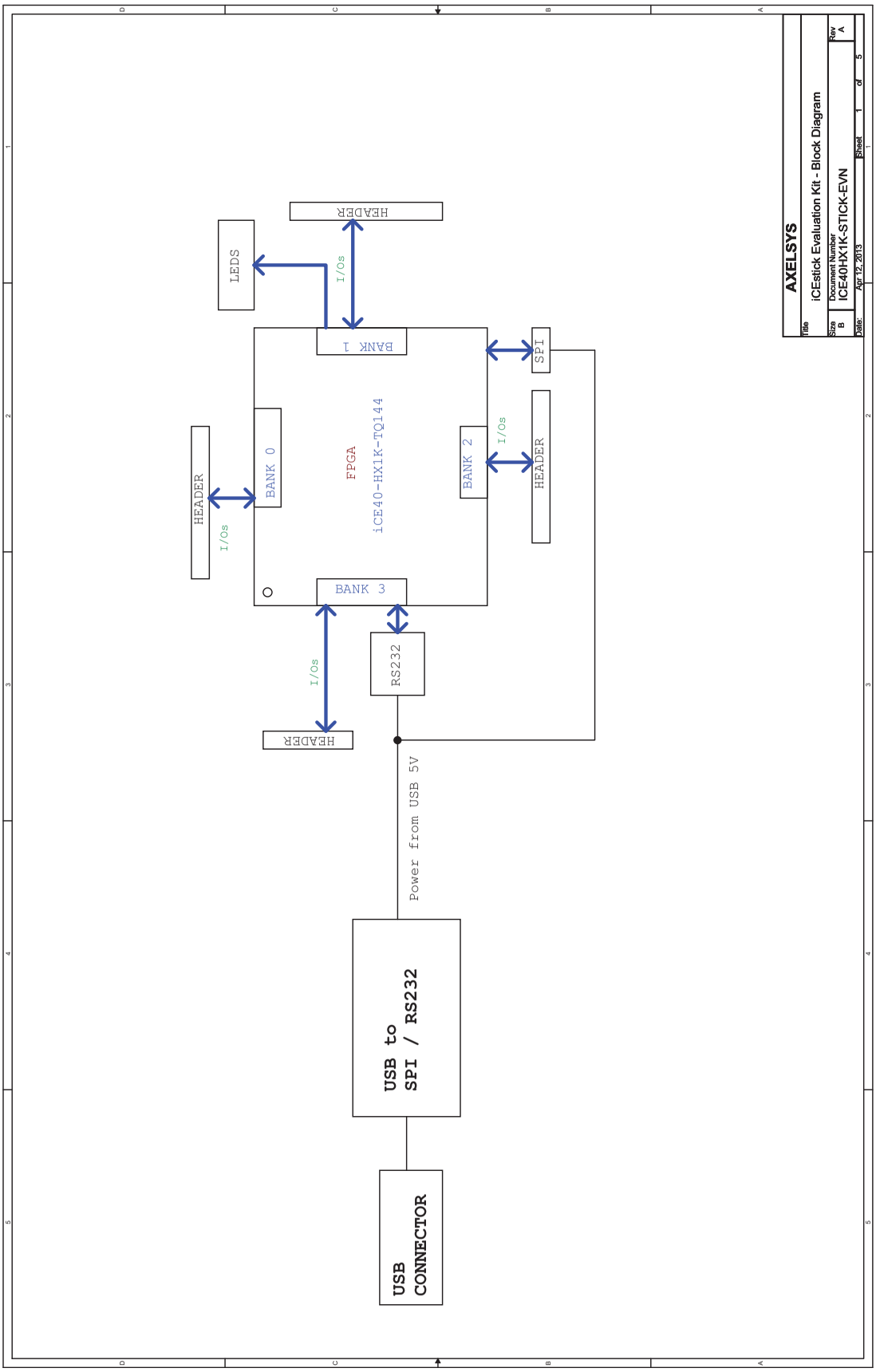
e-mail: techsupport@latticesemi.com

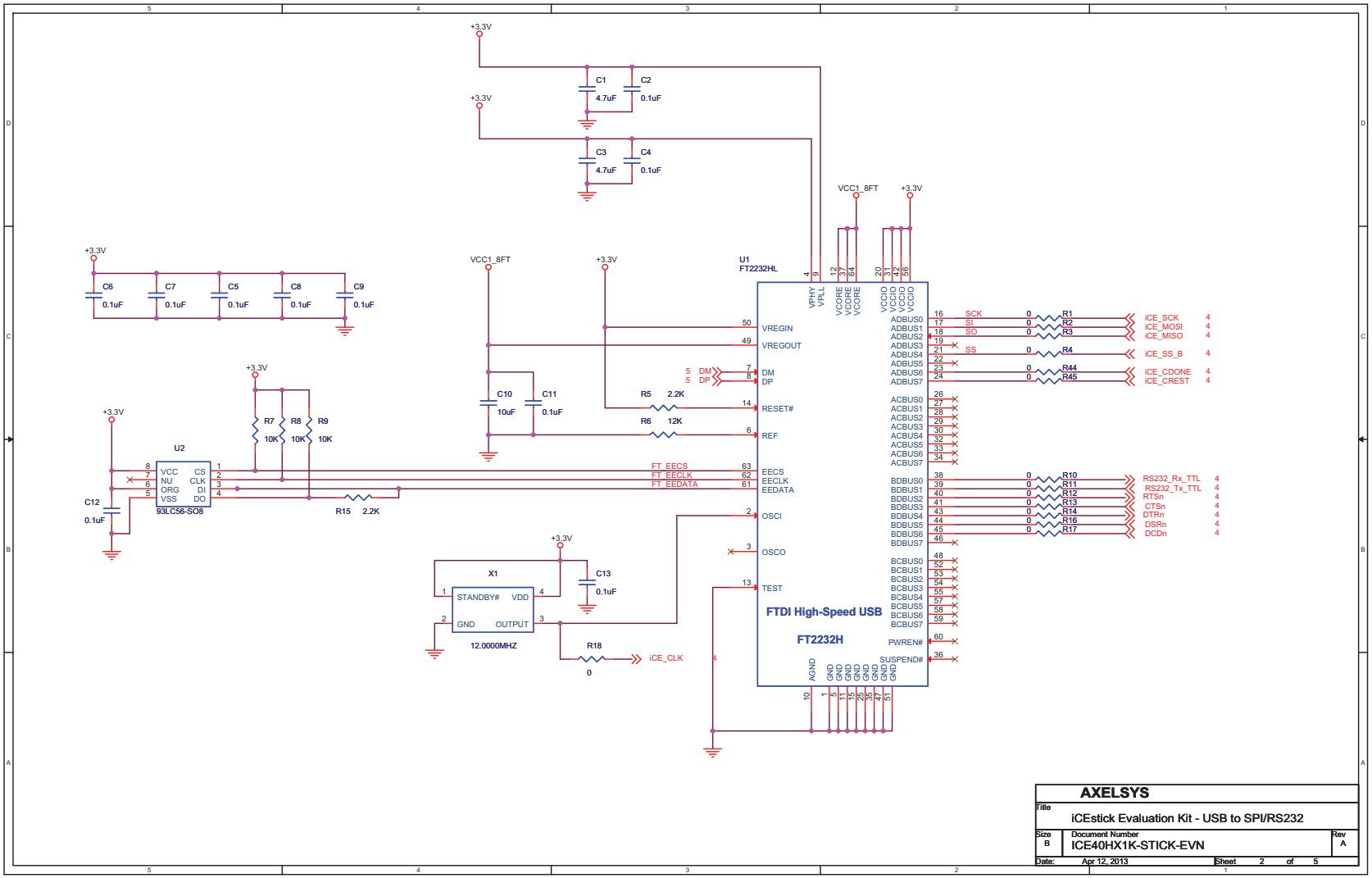
Internet: www.latticesemi.com

Revision History

Date	Version	Change Summary
August 2013	01.0	Initial release.

Appendix A. Schematic Diagrams





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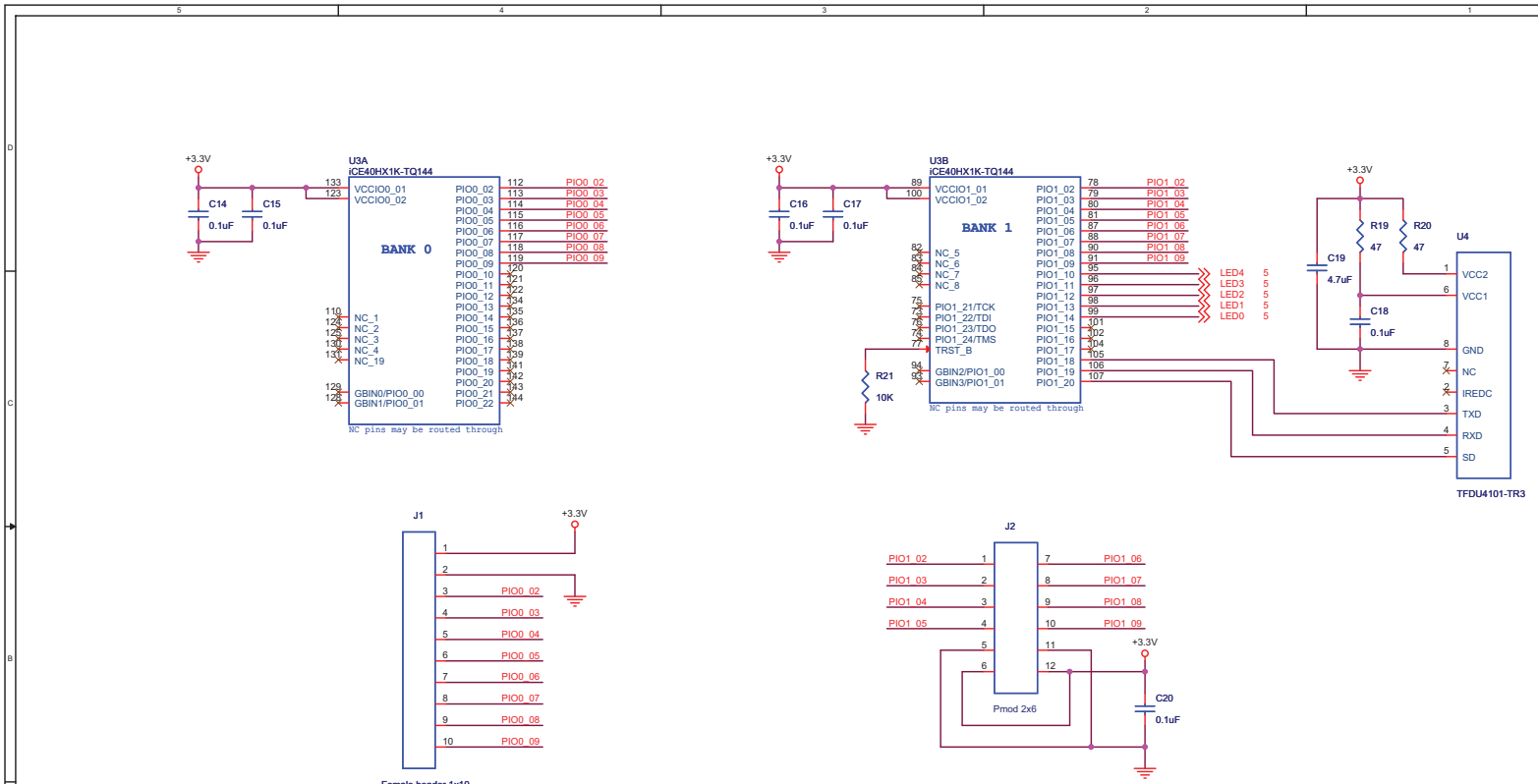
Date: Apr 12, 2013	Sheet 2 of 5	



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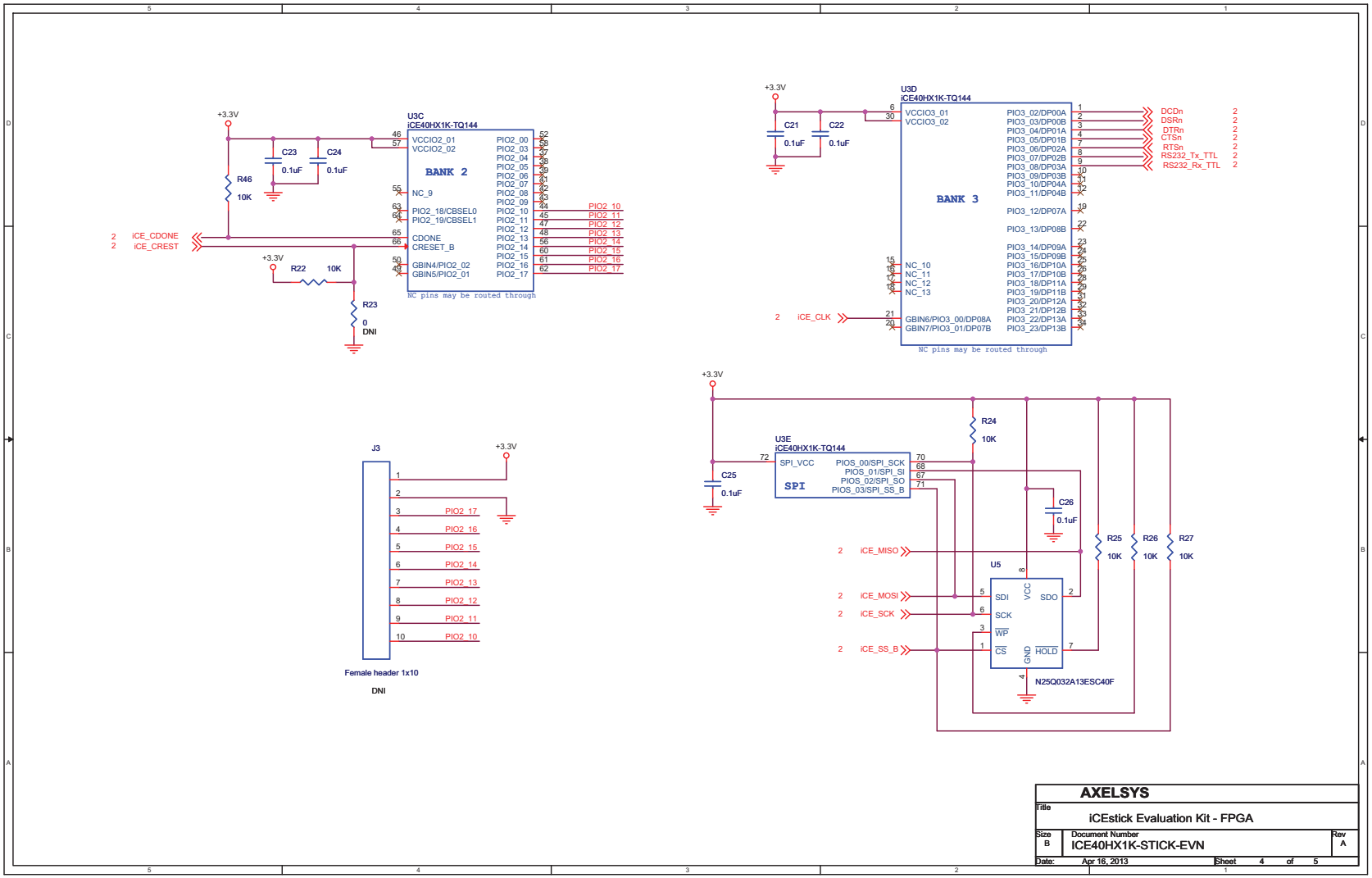
Size: B	Document Number: ICE40HX1K-STICK-EVN	Rev: A
Date: Apr 12, 2013	Sheet 3 of 5	


U3C
iCE40HX1K-TQ144
BANK 2
VCCIO2_01
VCCIO2_02
NC_9
PIO2_18/CBSEL0
PIO2_19/CBSEL1
CDONE
CRESET_B
GBIN4/PIO2_02
GBIN5/PIO2_01
PIO2_00
PIO2_03
PIO2_04
PIO2_05
PIO2_06
PIO2_07
PIO2_08
PIO2_09
PIO2_10
PIO2_11
PIO2_12
PIO2_13
PIO2_14
PIO2_15
PIO2_16
PIO2_17
NC pins may be routed through
+3.3V
C23
C24
0.1uF
0.1uF
R46
10K
2 iCE_CDONE
2 iCE_CREST
R22
10K
R23
0
DNI
U3D
iCE40HX1K-TQ144
BANK 3
VCCIO3_01
VCCIO3_02
NC_10
NC_11
NC_12
NC_13
GBIN6/PIO3_00/DP08A
GBIN7/PIO3_01/DP07B
PIO3_02/DP00A
PIO3_03/DP00B
PIO3_04/DP01A
PIO3_05/DP01B
PIO3_06/DP02A
PIO3_07/DP02B
PIO3_08/DP03A
PIO3_09/DP03B
PIO3_10/DP04A
PIO3_11/DP04B
PIO3_12/DP07A
PIO3_13/DP08B
PIO3_14/DP09A
PIO3_15/DP09B
PIO3_16/DP10A
PIO3_17/DP10B
PIO3_18/DP11A
PIO3_19/DP11B
PIO3_20/DP12A
PIO3_21/DP12B
PIO3_22/DP13A
PIO3_23/DP13B
NC pins may be routed through
C21
C22
0.1uF
0.1uF
2 iCE_CLK
DCDn
DSRn
DTRn
CTSn
RTSn
RS232_Tx_TTL
RS232_Rx_TTL
J3
Female header 1x10
DNI
U3E
iCE40HX1K-TQ144
SPI
SPI_VCC
PIO5_00/SPI_SCK
PIO5_01/SPI_SI
PIO5_02/SPI_SO
PIO5_03/SPI_SS_B
C25
0.1uF
R24
10K
C26
0.1uF
R25
10K
R26
10K
R27
10K
2 iCE_MISO
2 iCE_MOSI
2 iCE_SCK
2 iCE_SS_B
U5
SDI
SCK
WP
CS
SDO
VCC
GND
HOLD
N25Q032A13ESC40F
AXELSYS
Title
iCEstick Evaluation Kit - FPGA
Size
B
Document Number
ICE40HX1K-STICK-EVN
Rev
A
Date: Apr 16, 2013
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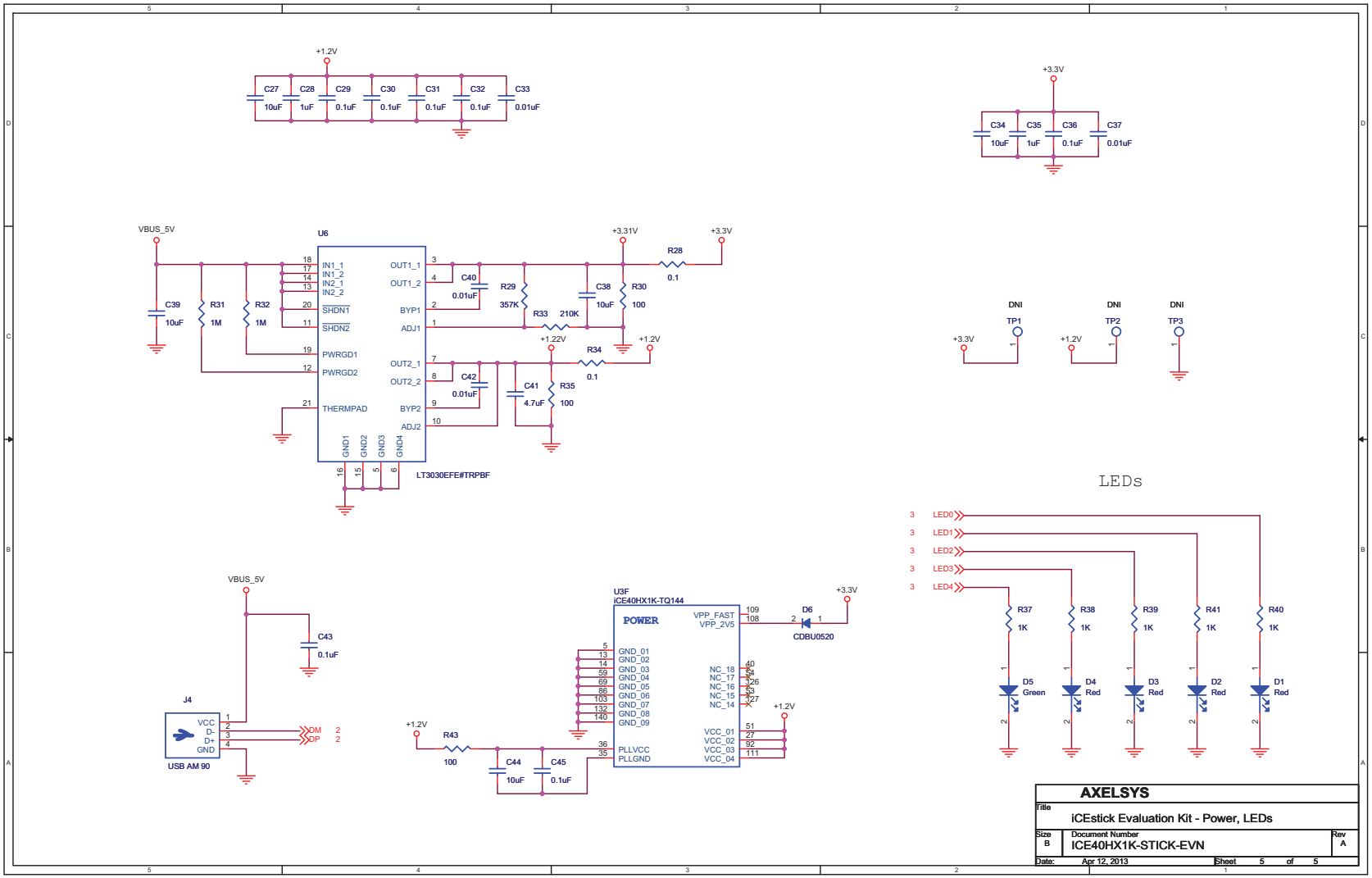
+1.2V
C27 10uF
C28 1uF
C29 0.1uF
C30 0.1uF
C31 0.1uF
C32 0.1uF
C33 0.01uF
+3.3V
C34 10uF
C35 1uF
C36 0.1uF
C37 0.01uF
VBUS_5V
U6
IN1_1
IN1_2
IN2_1
IN2_2
SHDN1
SHDN2
PWRGD1
PWRGD2
THERMPAD
OUT1_1
OUT1_2
BYP1
ADJ1
OUT2_1
OUT2_2
BYP2
ADJ2
GND1
GND2
GND3
GND4
LT3030EFE#TRPBF
C39 10uF
R31 1M
R32 1M
C40 0.01uF
R29 357K
R33 210K
C38 10uF
R30 100
+3.31V
R28 0.1
+3.3V
+1.22V
R34 0.1
+1.2V
C42 0.01uF
C41 4.7uF
R35 100
DNI
TP1
TP2
TP3
LEDs
LED0
LED1
LED2
LED3
LED4
R37 1K
R38 1K
R39 1K
R41 1K
R40 1K
D5 Green
D4 Red
D3 Red
D2 Red
D1 Red
VBUS_5V
C43 0.1uF
J4
VCC
D-
D+
GND
USB AM 90
DM
DP
U3F
iCE40HX1K-TQ144
POWER
VPP_FAST
VPP_2V5
GND_01
GND_02
GND_03
GND_04
GND_05
GND_06
GND_07
GND_08
GND_09
NC_18
NC_17
NC_16
NC_15
NC_14
VCC_01
VCC_02
VCC_03
VCC_04
PLLVCC
PLLGND
D6
CDBU0520
+3.3V
+1.2V
R43 100
C44 10uF
C45 0.1uF
AXELSYS
Title
iCEstick Evaluation Kit - Power, LEDs
Size B
Document Number
ICE40HX1K-STICK-EVN
Rev A
Date: Apr 12, 2013
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