ispMACH® 4256V Breakout Board Evaluation Kit User Guide

EB104 Version 1.0, December 2015

Introduction

Thank you for choosing the Lattice Semiconductor ispMACH® 4256V Breakout Board Evaluation Kit!

This user guide describes how to start using the ispMACH 4256V Breakout Board, an easy-to-use platform for evaluating and designing with the ispMACH 4256V CPLD. Along with the board and accessories, this kit includes a pre-loaded hardware test program. You may also reprogram the on-board ispMACH 4256V device to review your own custom designs.

Note: Static electricity can severely shorten the lifespan of electronic components. See the Storage and Handling section for handling and storage tips.

Features

The ispMACH 4256V Breakout Board Evaluation Kit includes:

- **ispMACH 4000V Breakout Board** – The board is a 3" x 3" form factor that features the following on-board components and circuits:
    - ispMACH 4256V CPLD (LC4256V-5TN144C)
    - USB mini-B connector for power and programming
    - Eight LEDs
    - 4 x 15 prototype area
    - Four 2 x 20 expansion header landings for general I/O, JTAG, and external power
    - 1x8 expansion header landing for JTAG
    - 3.3 V supply rails

- **Pre-loaded Demo** – The kit includes a pre-loaded counter design that highlights use of an external oscillator and programmable I/Os configured for LED drive.

- **USB Connector Cable** – The board is powered from the USB mini-B socket when connected to a host PC. The USB channel also provides a programming interface to the ispMACH 4256V JTAG port.

- **Lattice Breakout Board Evaluation Kits Web Page** – Visit www.latticesemi.com/breakoutboards for the latest documentation (including this guide), demo designs, and drivers for the kit.

The content of this user guide includes demo operation, programming instructions, top-level functional descriptions of the Breakout Board, descriptions of the on-board connectors, and a complete set of schematics.

Figure 1. ispMACH 4256V Breakout Board, Top Side
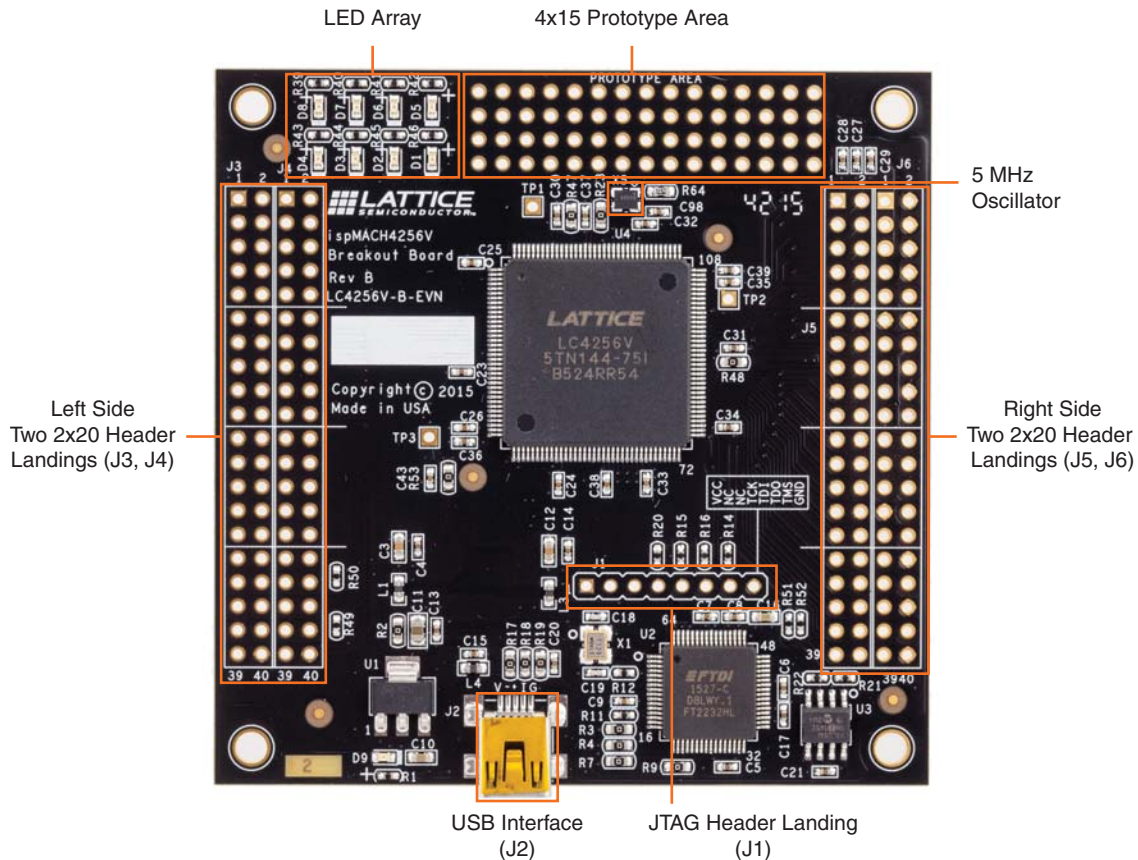
Storage and Handling

Static electricity can shorten the lifespan of electronic components. Please observe these tips to prevent damage that could occur from electro-static discharge:

- Use anti-static precautions such as operating on an anti-static mat and wearing an anti-static wrist-band.

- Store the evaluation board in the packaging provided.

- Touch a metal USB housing to equalize voltage potential between you and the board.

Software Requirements

You should install the following software before you begin developing new designs for the Breakout Board:

- FTDI USB Hardware Drivers (www.latticesemi.com/breakoutboards) or Diamond Programmer (required for re-programming)

- Optional: ispLEVER Classic 1.4 (ispMACH 4000V CPLD support)

Demonstration Design

Lattice provides a pre-programmed demo to illustrate basic operation of the ispMACH 4256V CPLD device. The design integrates an up-counter which uses an external 5 MHz SiTIME oscillator. The design alternates to CPLD outputs, illuminating LEDs D1, D3, D5 and D7 then LEDs D2, D4, D6 and D8.

Note: To restore the factory default demo or program it with other Lattice-supplied examples see the Download Demo Designs section of this document.

3

The preprogrammed demonstration design is an up counter which is used to drive an LED array. The demo uses the external 5 MHz SiTIME oscillator to run the counter. The 23-bit up counter advances each second. The output of the counter is used to drive the LED array. The resulting light pattern will appear as an alternating pair of lit LEDs per row.

Figure 2. Counter Demo Block Diagram
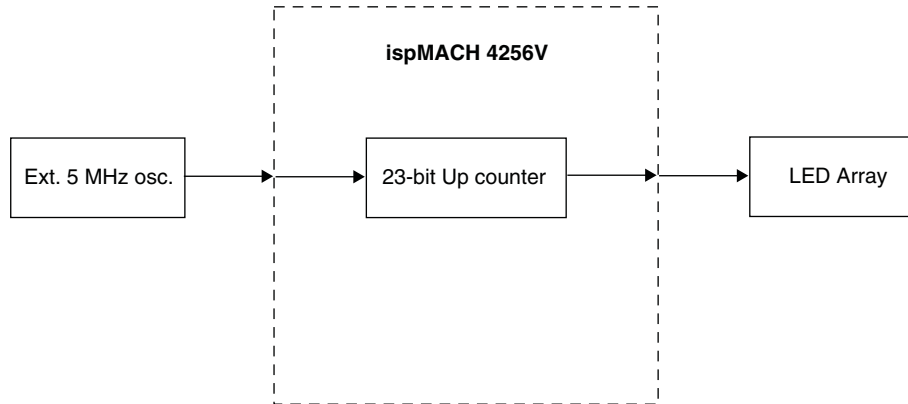
Run the Demonstration Design

NOTE: If you have already installed Lattice software tools, you can skip the following installation step.

WARNING: Do not connect the Breakout Board to your PC before you follow the driver installation procedure of this section.

Communication with the Breakout Board with a PC via the USB connection cable will require the FTDI chip USB hardware drivers contained in the Software Requirements section. Loading these drivers enables the computer to reliably recognize and program the Breakout Board. Drivers can be loaded as part of the installation of Lattice Diamond® design software or Diamond Programmer or a stand-alone package.

To load the FTDI chip USB hardware drivers as part of the Lattice Diamond installation:

1. Select **Programmer Drivers** in the Product Options of Lattice Diamond Setup.

2. Select **FTDI Windows USB Driver** or **All Drivers** in the LSC Drivers Install/Uninstall dialog box..

3. Click **Finish** to install the USB driver.

4. Connect the USB cable from a USB port on your PC to the board's USB mini-B socket (J2). After connection is made, a green Power LED (D9) will light indicating the board is powered on.

5. Red LEDs will light and start to flash according to the preprogrammed demonstration design.
See the Troubleshooting section of this guide if the board does not function as expected.

To load the FTDI chip USB hardware drivers via the stand-alone package:

1. Browse to www.latticesemi.com/breakoutboards and download the FTDI chip USB Hardware driver package.

2. Extract the FTDI chip USB Hardware driver package to your PC hard drive.

3. Connect the USB cable from a USB port on your PC to the board's USB mini-B socket (J2). After connection is made, a green Power LED (D9) will light indicating the board is powered on.

4. If you are prompted, "Windows may connect to Windows Update" select **No, not this time** from available options and click **Next** to proceed with the installation. Choose the **Install from specific location (Advanced)** option and click **Next**.

5. Search for the best driver in these locations and click the **Browse** button to browse to the Windows driver folder created in the Download Windows USB Hardware Drivers section. Select the **CDM 2.04.06 WHQL Certified** folder and click **OK**.

6. Click **Next**. A screen will display as Windows copies the required driver files. Windows will display a message indicating that the installation was successful.

7. Click **Finish** to install the USB driver.

8. Red LEDs will light and start to flash according to the preprogrammed demonstration design.
See the Troubleshooting section of this guide if the board does not function as expected.

Download Demo Designs

A demo is preprogrammed into the Breakout Board, however over time it is likely your board will be modified. Lattice distributes source and programming files for demonstration designs compatible with the Breakout Board.

To download demo designs:

1. Browse to the Lattice Breakout Board web page (www.latticesemi.com/breakoutboards). Select the ispMACH 4256V Demo Application download and save the file.

2. Extract the contents of **Demo_ispMACH4256V.zip** to an accessible location on your hard drive.

The demo design directory, Demo_ispMACH4256V, is unpacked.

Recompile a Demonstration Project with ispLEVER Classic

Use the procedure described below to recompile a demo project for the Breakout Board.

1. Install and license ispLEVER Classic software.

2. Run the ispLEVER Classic Project Navigator.

3. Browse to the demo design directory, **Demo_ispMACH4256V**, and open the **Demo_ispMACH4256V.syn** project file.

4. From the Source in project window, select the target device.
The Fit Design process appears in the Processes for current source window.

5. Select **Fit Design**, right-click and choose **Start**.
After a few moments the JEDEC programming file is output.

6. See the Programming with Lattice Diamond Programmer section for details on downloading a programming file to the board.

Programming with Lattice Diamond Programmer

A demonstration design is pre-programmed into the ispMACH 4256V Breakout Board by Lattice. To restore the Breakout Board to factory settings or load an alternative demo design, use the procedures in this section.

To install Lattice Diamond Programmer tool:

1. Install license and run Lattice Diamond Programmer software. See http://www.latticesemi.com/Products/DesignSoftwareAndIP/ProgrammingAndConfigurationSw/Programmer.aspx for download information.

2. Connect the board to a host PC using the USB port header connection.

3. Follow the USB Cable Interface procedure below to program the evaluation board.
The Breakout Board is equipped with a built-in USB-based programming circuit. This consists of a USB PHY and a USB connector. When the board is connected to a PC with a USB cable, it is recognized by the ispVM System software as a USB Download Cable. The ispMACH 4256V can then be scanned and programmed using the ispVM System software.

To program a demo programming file:

1. Once you open Diamond Programmer tool, the first thing that it will do is detect the USB cable.

2. Click **Detect Cable**. The Programmer will detect the cable.

3. Make the following selections:
Cable Type: **HW-USBN-2b (FTDI)**
Port Setting: **FTUSB-0**

    Click **OK**. If the cable is not detected, see the Troubleshooting section.

4. The Programmer automatically scans the device attached to the USB cable.

5. Once the device is detected, the **LC4256V(B)** option is selected by default. To choose the correct device, click **LC4256V(B)** and a device drop-down menu appears. From the drop-down menu select **LC4256V** device.

6. From the **File Name** section, click the **Browse** button.
The Open Data File dialog appears.

7. Browse to the **<Demo Dir>** folder, select **<Demo>.jed**, and click **Open**. From the **Operation** list choose **Erase, Program, Verify** and click **OK**.

8. Click the **Program** icon. When complete, PASS is displayed in the Status column.

Programming requires about 10 seconds. A small timer window will appear to show elapsed programming time. At the end of programming, the configuration setup window should show a "PASS" in the Status column.

ispMACH 4256V Breakout Board

This section describes the features of the ispMACH 4256V Breakout Board in detail.

Overview

The ispMACH 4256V Breakout Board is a complete development platform for the ispMACH 4256V CPLD. The board includes a prototyping area, a USB program/power port, an LED array, and header landings with electrical connections to most of the CPLDs programmable I/O, power and JTAG pins. The board is powered by the PC's USB port or optionally with external power. You may create or modify CPLD program files using ispLEVER Classic software and reprogram the board using ispVM software.
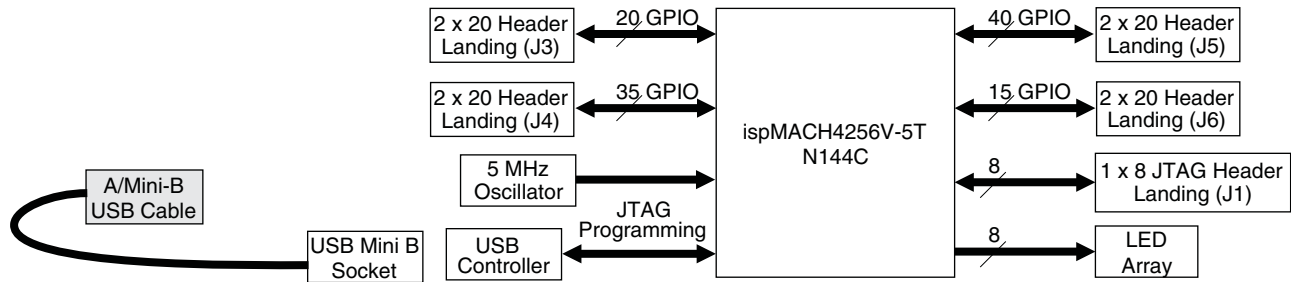
Figure 3. ispMACH 4256V Breakout Board Block Diagram

Table 1 describes the components on the board and the interfaces it supports.

Table 1. Breakout Board Components and Interfaces

Component/Interface	Type	Schematic Reference	Description
Circuits			
USB Controller	Circuit	U2: FT2232H	USB-to-JTAG interface and dual USB UART/FIFO IC
USB Mini-B Socket	I/O	J1:USB_MINI_B	Programming and debug interface
Components			
LC4256V	CPLD	U4: LC4256V-5TN144C	256-macrocell CPLD packaged in a 20 mm x 20 mm, 144-pin TQFP
SiTIME5.00000M	Oscillator	X5: SIT8918AE-13-33E-5.000000G	SiTIME 5 MHz external SMD oscillator
Interfaces			
LED Array	Output	D8-D1	Red LEDs
Four 2x20 header landings	I/O	J3: header_2x20 J4: header_2x20 J5: header_2x20 J6: header_2x20	User-definable I/O
1 x 8 header landing	I/O	J1: header_1x8	Optional JTAG interface
4 x 15 prototype area		J9	Prototype area 100mil centered holes

Subsystems

This section describes the principle subsystems for the ispMACH 4256V Breakout Board in alphabetical order.

Clock Sources

All clocks for the counter demonstration design originates from an external 5 MHz oscillator connected to Pin 128 of ispMACH 4256V chip. You may use an expansion header landing to drive a CPLD input with an alternate clock source. To drive Pin 128 from header J4, disconnect X5 from the circuit by removing R23.

Expansion Header Landings

The expansion header landings provide access to user GPIOs, primary inputs, clocks, and Bank 0/1 VCCO pins of the ispMACH 4256V. The remaining pins serve as power supplies for external connections. Each landing is configured as one 2 x 20 100 mil.

Table 2. Expansion Connector Reference

Item	Description
Reference Designators	J3, J4, J5, J6
Part Number	header_2x20

Table 3. Expansion Header Pin Information (J3)

Pin Number	Function	LC4256V Pin
1	IO_C12	4
2	GND	n/a
3	IO_C10	5
4	GND	n/a
5	IO_C8	6
6	GND	n/a
7	IO_C6	7
8	GND	n/a
9	IO_C4	8
10	GND	n/a
11	IO_C2	9
12	GND	n/a
13	IO_D14	11
14	GND	n/a
15	IO_D12	12
16	GND	n/a
17	IO_D10	13
18	GND	n/a
19	IO_D8	14
20	GND	n/a
21	IO_D6	15
22	GND	n/a
23	IO_D4	16
24	GND	n/a
25	IO_IA1	17IN
26	GND	n/a
27	IO_IA2	20IN
28	GND	n/a
29	IO_E2	21
30	GND	n/a
31	IO_E4	22
32	GND	n/a
33	IO_E6	23
34	GND	n/a
35	IO_E8	24
36	GND	n/a
37	IO_E10	25
38	GND	n/a
39	IO_E12	26
40	GND	n/a

Table 4. Expansion Header Pin Information (J4)

Pin Number	Function	LC4256V Pin
1	IO_F2	28
2	IO_A2	130
3	IO_F4	29
4	IO_A4	131
5	IO_F6	30
6	IO_A6	132
7	IO_F8	31
8	IO_A8	133
9	IO_F10	32
10	IO_A10	134
11	IO_F12	33
12	IO_A12	135
13	IO_G12	39
14	IO_B2	138
15	IO_G10	40
16	IO_B4	139
17	IO_G8	41
18	IO_B6	140
19	IO_G6	42
20	IO_B8	141
21	IO_G4	43
22	IO_B10	142
23	IO_G2	44
24	IO_B12	143
25	IO_IA3	38IN
26	IO_IA5	144IN
27	IO_IA4	45IN
28	GND	n/a
29	IO_H12	48
30	NC	n/a
31	IO_H10	49
32	GND	n/a
33	IO_H8	50
34	CLK1	54CLK
35	IO_H6	51
36	GND	n/a
37	IO_H4	52
38	CLK0	128CLK
39	IO_H2	53
40	GND	n/a

Table 5. Expansion Header Pin Information (J5)

Pin Number	Function	LC4256V Pin
1	IO_P2	125
2	IO_M12	98
3	IO_P4	124
4	IO_M10	97
5	IO_P6	123
6	IO_M8	96
7	IO_P8	122
8	IO_M6	95
9	IO_P10	121
10	IO_M4	94
11	IO_P12	120
12	IO_M2	93
13	IO_IB10	117IN
14	IO_IB8	92IN
15	IO_IB9	110IN
16	IO_IB7	89IN
17	IO_O2	116
18	IO_L4	88
19	IO_O4	115
20	IO_L6	87
21	IO_O6	114
22	IO_L8	86
23	IO_O8	113
24	IO_L10	85
25	IO_O10	112
26	IO_L12	84
27	IO_O12	111
28	IO_L14	83
29	IO_N12	105
30	IO_K2	81
31	IO_N10	104
32	IO_K4	80
33	IO_N8	103
34	IO_K6	79
35	IO_N6	102
36	IO_K8	78
37	IO_N4	101
38	IO_K10	77
39	IO_N2	100
40	IO_K12	76

Table 6. Expansion Header Pin Information (J6)

Pin Number	Function	LC4256V Pin
1	VCC_3.3V	VCCO_33
2	GND	GND
3	VCC_3.3V	VCCO_33
4	GND	GND
5	VCC_3.3V	VCCO_33
6	GND	GND
7	NC	NC
8	GND	GND
9	NC	NC
10	VCC_3.3V	VCC_EXT
11	GND	GND
12	GND	GND
13	IO_J2	66
14	V_ext_B0	VCCO_EXT_0
15	IO_J4	67
16	V_ext_B1	VCCO_EXT_1
17	IO_J6	68
18	GND	GND
19	IO_J8	69
20	NC	NC
21	IO_J10	70
22	NC	NC
23	IO_J12	71
24	NC	NC
25	IO_IB6	72IN
26	NC	NC
27	GND	GND
28	NC	NC
29	IO_I2	58
30	NC	NC
31	IO_I4	59
32	GND	GND
33	IO_I6	60
34	CLK3	126CLK
35	IO_I8	61
36	GND	GND
37	IO_I10	62
38	CLK2	56CLK
39	IO_I12	63
40	GND	GND

Figure 4. J3/J4 Header Landing Callout

J3 1	J3 2	J4 1	J4 2
4	GND	28	130
5	GND	29	131
6	GND	30	132
7	GND	31	133
8	GND	32	134
9	GND	33	135
11	GND	39	138
12	GND	40	139
13	GND	41	140
14	GND	42	141
15	GND	43	142
16	GND	44	143
17 IN	GND	38 IN	144 IN
20 IN	GND	45 IN	GND
21	GND	48	NC
22	GND	49	GND
23	GND	50	54 CLK
24	GND	51	GND
25	GND	52	128 CLK
26	GND	53	GND
39	40	39	40
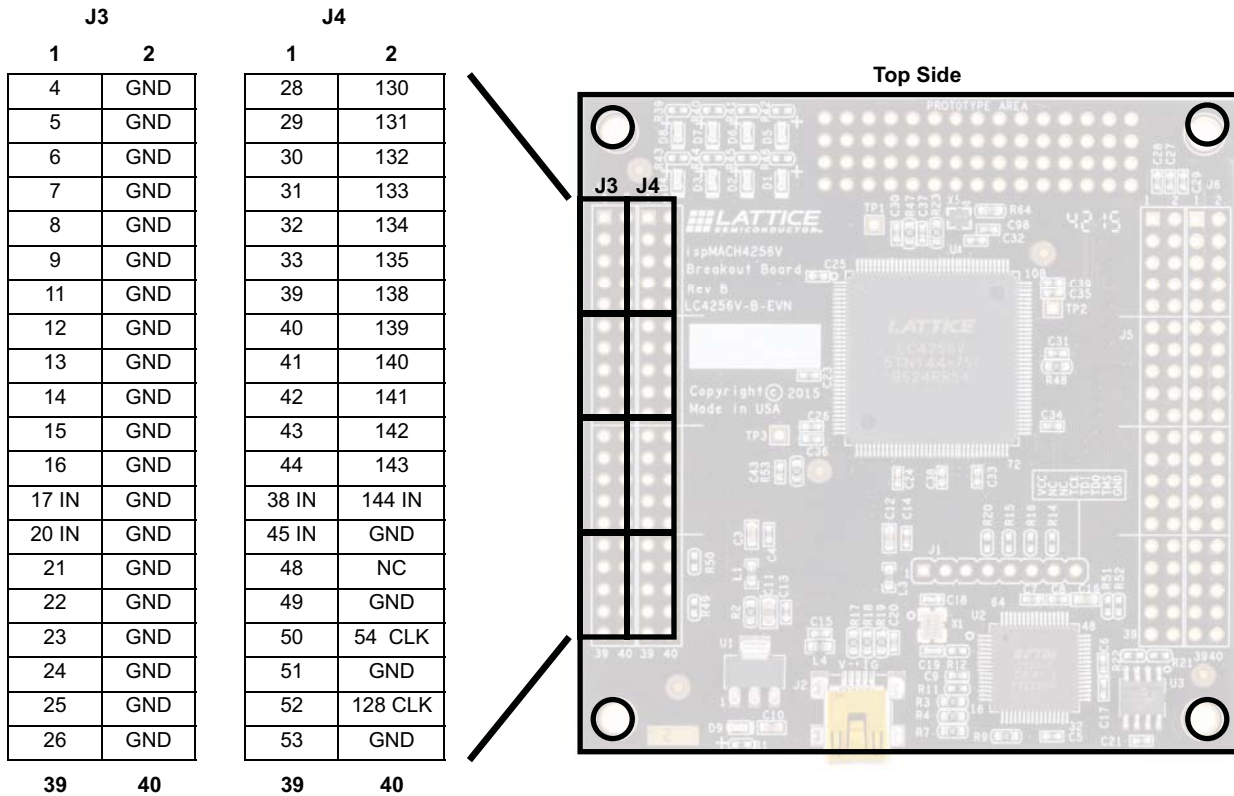
Figure 5. J5/J6 Header Landing Callout

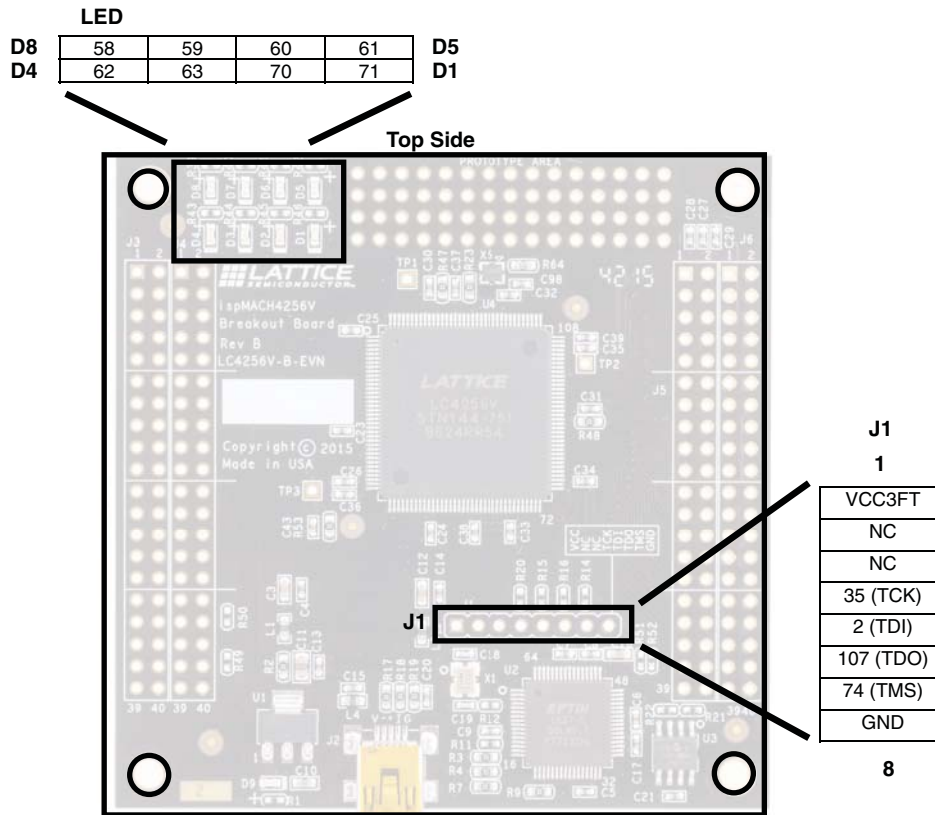| J5 1	J5 2	J6 1	J6 2
125	98	VCCO_33	GND
124	97	VCCO_33	GND
123	96	VCCO_33	GND
122	95	NC	GND
121	94	NC	VCC_EXT
120	93	GND	GND
117 IN	92 IN	66	VCCO_EXT_0
110 IN	89 IN	67	VCCO_EXT_1
116	88	68	GND
115	87	69	NC
114	86	70	NC
113	85	71	NC
112	84	72 IN	NC
111	83	GND	NC
105	81	58	NC
104	80	59	GND
103	79	60	56 CLK
102	78	61	GND
101	77	62	126 CLK
100	76	63	GND
39	40	39	40
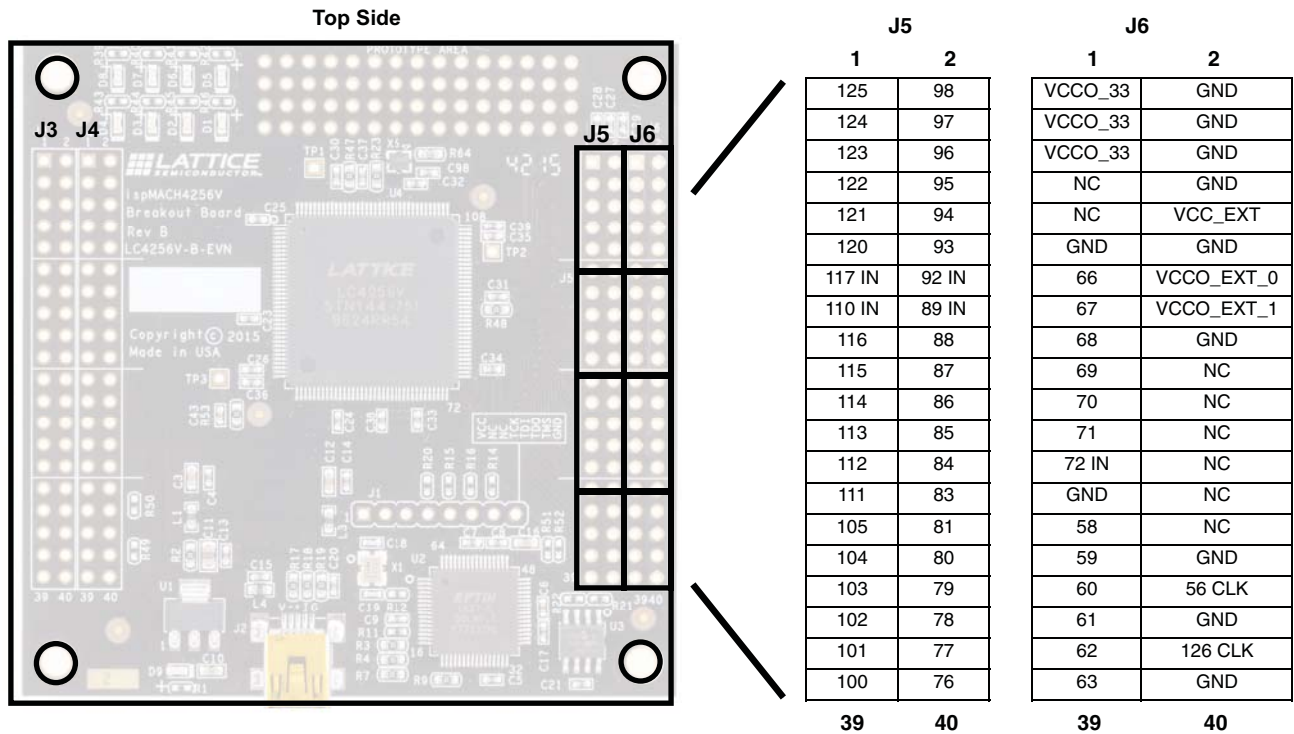
Figure 6. J1 Header Landing and LED Array Callout

ispMACH4256V-TN144 CPLD

The board features the ispMACH 4256V CPLD which is ideal for low-power, high-volume portable applications. The on-board ispMACH 4256V is the highest capacity device of the family with 256 macrocells (equivalent to about 450 FPGA LUTs). The 144-pin TQFP package provides 96 user I/Os and 4 dedicated inputs in a 20 mm x 20 mm package. The ispMACH 4256V consumes standby current as low as 15 µA. A complete description of this device can be found in DS1020, ispMACH 4000V/B/C/Z Family Data Sheet.

Table 7. ispMACH 4256V CPLD Interface Reference

Item	Description
Reference Designator	U4
Part Number	LC4256V-5TN144C
Manufacturer	Lattice Semiconductor
Web Site	www.latticesemi.com

JTAG Interface Circuits

For power and programming, a FTDI chip USB UART/FIFO IC converter provides a communication interface between a PC host and the JTAG programming chain of the Breakout Board. The USB 5 V supply is also used as a source for the 3.3 V supply rails. A USB mini-B socket is provided for the USB connector cable.

Table 8. JTAG Interface Reference

Item	Description
Reference Designator	U2
Part Number	FT2232HL
Manufacturer	Future Technology Devices International (FTDI)
Web Site	www.ftdichip.com

Table 9. JTAG Programming Pin Information

Description	ispMACH 4256V Pin
Test Data Output	107:TDO
Test Data Input	2:TDI
Test Mode Select	74:TMS
Test Clock	35:TCK

LEDs

A green LED (D9) is used to indicate USB 5V power. Eight red LEDs are driven by I/O pins of the ispMACH 4256V CPLD.

Table 10. Power and User LEDs Reference

Item	Description
Reference Designators	D1, D2, D3, D4, D5, D6, D7, D8, D9
Part Number	LTST-C190KRKT (D1-D8) LTST-C190KGKT (D9)
Manufacturer	Lite-On It Corporation
Web Site	www.liteonit.com

Power Supply

3.3 V supply rail is converted from the USB 5 V interface when the board is connected to a host PC.

Test Points

In order to check the various voltage levels used, test points are provided:

- TP1, VCC3D (VCCO Bank 0)
- TP2, VCC3D (VCCO Bank 1)
- TP3, VCC3D (VCC Core)

USB Programming and Debug Interface

The USB mini-B socket of the Breakout Board serves as the programming and debug interface.

JTAG Programming: For JTAG programming, a preprogrammed USB PHY peripheral controller is provided on the Breakout Board to serve as the programming interface to the ispMACH 4256V CPLD.

Programming requires the ispVM System software.

Table 11. USB Interface Reference

Item	Description
Reference Designator	U2
Part Number	FT2232HL
Manufacturer	Future Technology Devices International (FTDI)
Web Site	www.ftdichip.com

External Oscillator

A 5 MHz external oscillator is used to provide clock input to the ispMACH 4256V chip.

Table 12. External Oscillator Reference

Item	Description
Reference Designator	X5
Part Number	SIT8918AE-13-33E-5.000000G
Manufacturer	SiTIME (SIT)
Web Site	www.sitime.com

Board Modifications

This section describes modifications to the board to change or add functionality.

Bypassing the USB Programming Interface

The USB programming interface circuit (section 6.2.8 USB Programming and Debug Interface) may be optionally bypassed by removing the 0 ohm resistors: R3, R4, R7, and R9 (See Schematic Sheet 2 of 4, Appendix A. Schematics). Header landing J1 provides JTAG signal access for jumper wires or a 1 x 8 pin header.

Applying External Power

The Breakout Board is powered by the circuit of Schematic Sheet 2 of 4 based on the 5 V USB power source. You may disconnect this power source by removing the 0 ohm resistors: R47 (VCCO 3.3 V, Bank 0), R48 (VCCO 3.3 V, Bank 1), and R53 (VCC 3.3 V, Core). Power connections are available from the expansion header landing, J6, Schematic Sheet 3 of 4.

Measuring Bank and Core Voltages

Test points (TP1, TP2, and TP3) provide access to bank VCCO and VCC core power supplies of the ispMACH 4256V CPLD. 0 Ohm resistors: R47 (VCCO 3.3 V, Bank 0), R48 (VCCO 3.3 V, Bank 1), and R53 (VCC 3.3 V, Core) can be removed to add a current meter inline or add a resistor shunt to measure voltage across.

Mechanical Specifications

Dimensions: 3 in. [L] x 3 in. [W] x 1/2 in. [H]

Environmental Requirements

The evaluation board must be stored between -40° C and 100° C. The recommended operating temperature is between 0° C and 90° C.

The board can be damaged without proper anti-static handling.

Glossary

CPLD: Complex Programmable Logic Device

LED: Light Emitting Diode

LUT: Look-Up Table

PCB: Printed Circuit Board

RoHS: Restriction of Hazardous Substances Directive

SMD: Surface Mount Device

TQFP: Thin Quad Flat Pack

USB: Universal Serial Bus

Troubleshooting

Use the tips in this section to diagnose problems with the ispMACH 4256V Breakout Board.

LEDs Do Not Flash

If power is applied but the board does not flash according to the preprogrammed counter demonstration then it is likely that the board has been reprogrammed with a new design. Follow the directions in the Demonstration Design section of this document to restore the factory default.

USB Cable Not Detected

If Lattice Diamond Programmer does not recognize the USB cable even after installing the Lattice USB Port Drivers and rebooting, the incorrect USB driver may have been installed. This usually occurs if you attach the board to your PC prior to installing the USB driver.

To access the Troubleshooting the USB Driver Installation Guide for Diamond software and standalone Diamond Programmer:

1. Start Diamond or Diamond Programmer and choose **Help**.

2. Search for **USB driver** or **Troubleshooting**, then select the **Troubleshooting the USB Driver** topic.
    The Troubleshooting the USB Driver Installation Guide document appears in your system's PDF file reader.

3. Follow the directions of the guide to install the Lattice USB driver.

Ordering Information

Description	Ordering Part Number	China RoHS Environment-Friendly Use Period (EFUP)
ispMACH 4256V Breakout Board Evaluation Kit	LC4256V-B-EVN	

Technical Support Assistance

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

Revision History

Date	Version	Change Summary
December 2015	1.0	Initial release.

Appendix A. Schematics

Figure 7. ispMACH 4256V Breakout Board, Cover

Figure 8. USBIF to JTAG

Figure 9. Connectors and LEDs

Figure 10. ispMACH 4000V
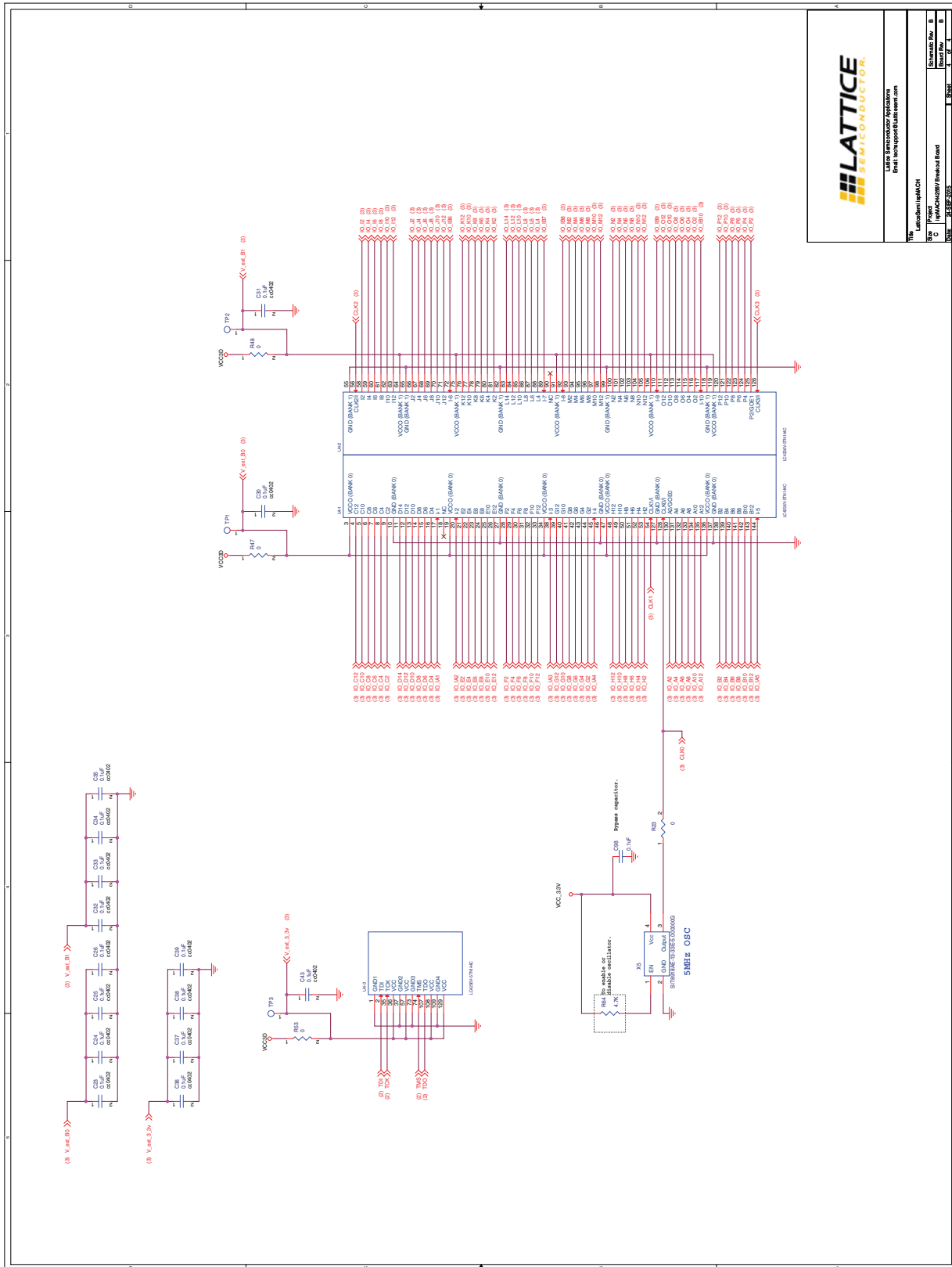
Appendix B. Bill of Materials

Table 13. Bill of Materials, ispMACH 4256V Breakout Board

Item	Quantity	Reference	Part Number
1	31	C4, C5, C6, C7, C8, C9, C13, C14, C15, C17, C20, C21, C23, C24, C25, C26, C27, C28, C29, C30, C31, C32, C33, C34, C35, C36, C37, C38, C39, C43, C98	C0402C104K4RACTU
2	2	C3, C12	ECJ-1VB0J475K
3	2	C10, C16	ECJ-1VB0J106M
4	1	C11	LMK212BJ226MG-T
5	2	C18, C19	C0402C180K3GACTU
6	8	D1, D2, D3, D4, D5, D6, D7, D8	LTST-C190KRKT
7	1	D9	LTST-C190KGKT
8	1	J1	DNI
9	1	J2	5075BMR-05-SM-CR
10	4	J3, J4, J5, J6	DNI
11	1	J9	DNI
12	3	L1, L3, L4	BLM18AG601SN1D
13	1	R1	RC0402FR-071KL
14	12	R2, R3, R4, R7, R9, R17, R18, R19, R23, R47, R48, R53	RC0603JR-070RL
15	5	R11, R14, R15, R16, R20	RC0402FR-075K1L
16	1	R12	RC0402FR-0712KL
17	1	R21	RC0402FR-0710KL
18	1	R22	RC0402FR-072K2L
19	8	R39, R40, R41, R42, R43, R44, R45, R46	RC0402FR-07470RL
20	4	R49, R50, R51, R52	RC0402FR-0710RL
21	1	R64	RC0603JR-074K7LI
22	3	TP1, TP2, TP3	DNI
23	1	U1	NCP1117ST33T3G
24	1	U2	FT2232HL
25	1	U3	93LC56T-I/SN
26	1	U4	LC4256V-5TN144C
27	1	X1	7M-12.000MAAJ-T
28	1	X5	SIT8918AE-13-33E-5.000000G