

UG308: Thunderboard EFM8UB3 User's Guide



The Thunderboard EFM8UB3 is a low cost, small form factor development and evaluation platform for the EFM8™ Universal Bee Microcontroller.

The Thunderboard contains an EFM8UB3 MCU together with an on-board SEGGER J-Link debugger for easy debugging through the USB Micro-B debugging connector. All of the EFM8 I/Os are routed to breakout pads on the sides of the board making it easy to expand on the board features and evaluate the EFM8 Universal Bee's features with custom hardware.



TARGET DEVICE

- EFM8 Universal Bee Microcontroller (EFM8UB31F40G-A-QFN24)
- Pipelined 8-bit C8051 core with 48 MHz maximum operating frequency
- 40 kB flash memory and 3328 bytes RAM
- USB feature set

KIT FEATURES

- USB connectivity
- SEGGER J-Link on-board debugger
- Virtual COM port
- User RGB LED and pushbuttons
- 2.54 mm breakout pads to EFM8
- Flat flexible cable connector for external Silicon Labs "postage-stamp" sized boards
- Optional Mini-Simplicity connector for Advanced Energy Monitoring using external Silicon Labs debugger

SOFTWARE SUPPORT

- Simplicity Studio™

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1. Introduction

The Thunderboard EFM8UB3 (OPN: SLTB005A) is an excellent starting point to get familiar with the EFM8 Universal Bee Microcontrollers. The Thunderboard contains an EFM8UB3 MCU together with an on-board SEGGER J-Link debugger for easy programming and debugging through the USB Micro-B debug connector. The debugger also provides a USB virtual COM port for serial connection to the target application.

All of the EFM8 I/Os are routed to breakout pads on the sides of the board making it easy to expand on the board features and evaluate the EFM8 Universal Bee's features with custom hardware.

1.1 Kit Contents

The following items are included in the box:

- 1x Thunderboard EFM8UB3 board (BRD5002A)
- 1x Micro USB 2.0 to USB A male cable

1.2 Getting Started

Detailed instructions for how to get started with your new Thunderboard EFM8UB3 can be found on the Silicon Labs web pages:

<http://www.silabs.com/start-efm8>

1.3 Kit Hardware Layout

The layout of the Thunderboard EFM8UB3 is shown below.

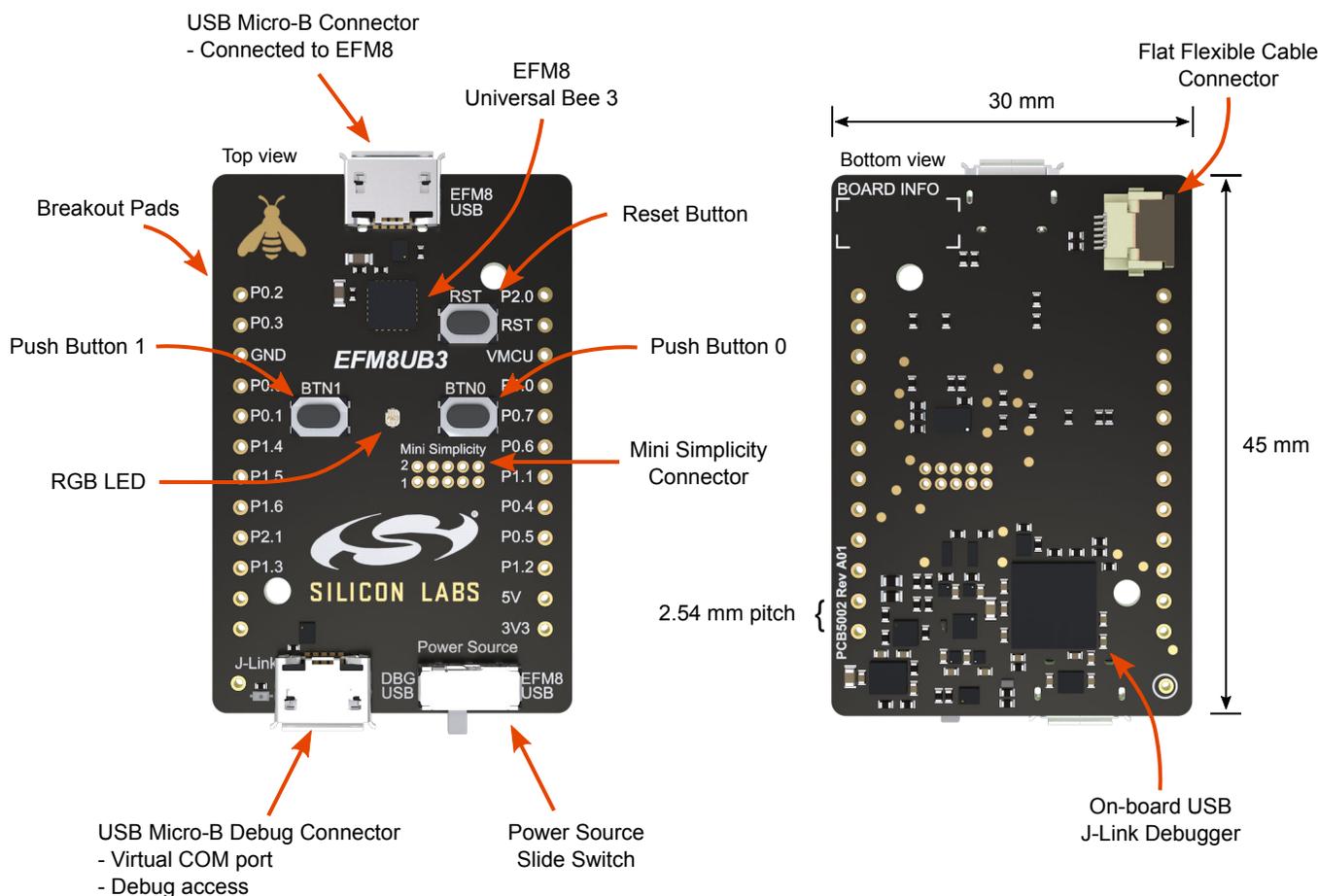


Figure 1.1. Thunderboard EFM8UB3 Hardware Layout

2. Electrical Specifications

2.1 Absolute Maximum Ratings

Parameter	Condition	Min	Typ	Max	Unit
Input voltage on EFM8 USB connector		-0.3	-	+5.8	V
Input voltage on debug USB connector		0	-	+5.5	V
Output current	Power-Source switch = EFM8 USB	-	-	100	mA
	Power-Source switch = DBG USB	-	-	300	mA
Voltage on any breakout pad (excluding P0.4, P0.5, P2.0 and RST)	VMCU > 3.3 V	-0.3	-	5.8	V
	VMCU < 3.3 V	-0.3	-	VMCU + 2.5	V
Voltage on P0.4, P0.5, P2.0 and RST breakout pad ¹		-0.3	-	VMCU + 0.3	V
Current per EFM8 I/O pin		-100	-	100	mA
Total current for all EFM8 I/O pins		-400	-	400	mA

¹ Limited by the debugger.

3. Hardware

3.1 Block Diagram

An overview of the Thunderboard EFM8UB3 is illustrated in the figure below.

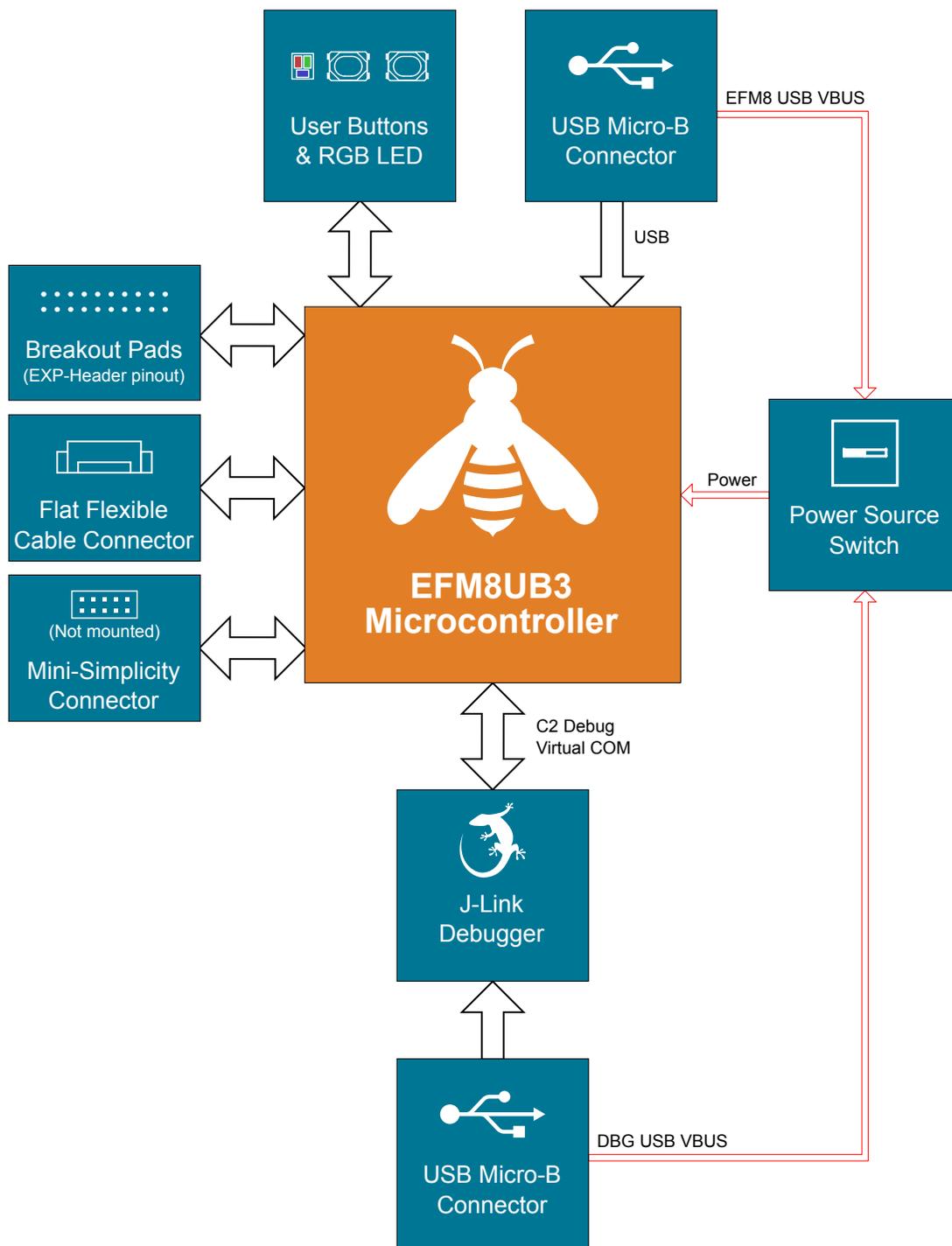


Figure 3.1. Kit Block Diagram

3.2 Power Supply

The EFM8 on the kit can be bus-powered, using its internal 5V-to-3.3 V regulator to provide power to itself and the VMCU net, or the EFM8 can be self-powered with its internal regulator disabled. In self-powered mode, the EFM8 and the VMCU net are powered by an on-board regulator, which draws power from the USB Micro-B debugging connector. Configuring the kit is done using the slide switch marked "Power Source" located in the lower right corner of the board.

3.2.1 Self-Powered Mode

When the "Power Source" slide switch is in the "DBG USB" position, the EFM8 is connected in self-powered mode with its internal regulator disabled. In this configuration, the EFM8 and the VMCU net are powered by an on-board regulator, which draws power from the USB Micro-B debugging connector. The low-dropout regulator has a total output current capacity of 300 mA, in which some is being used to power the on-board debugger through the 3V3 net.

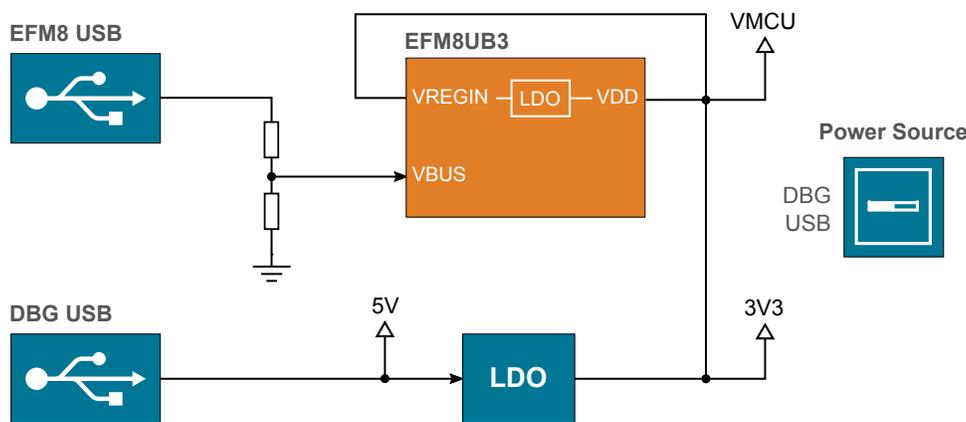


Figure 3.2. Self-powered Mode

3.2.2 Bus-Powered Mode

When the "Power Source" slide switch is in the "EFM8 USB" position, the EFM8 is connected in bus-powered mode. In this configuration, the EFM8 and the VMCU net are powered by the EFM8UB3's internal 5V-to-3.3 V regulator. The input of the internal regulator (VREGIN) is connected to the VBUS line of the USB Micro-B connector that is connected to the EFM8's USB peripheral.

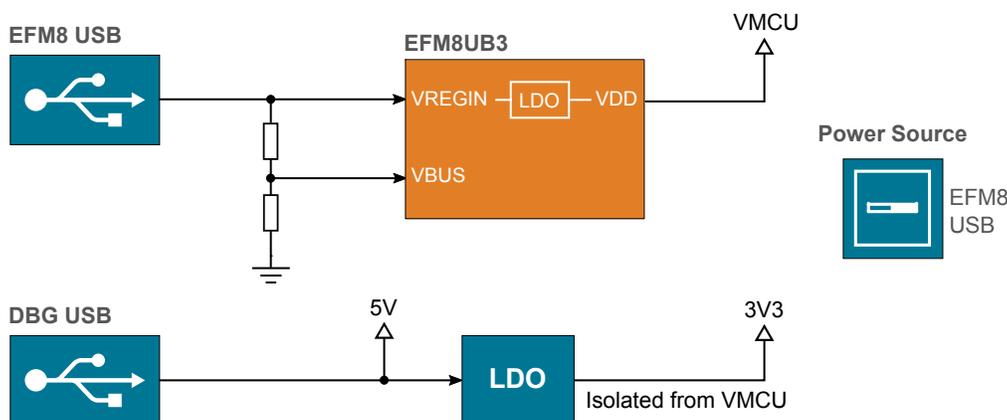


Figure 3.3. Bus-powered Mode

3.3 Universal Serial Bus

The Thunderboard EFM8UB3 board is equipped with a USB Micro-B connector interfacing with the EFM8's USB peripheral. The figure below shows how the USB lines are connected to the MCU. Note that the figure shows the bus-powered configuration, applicable when the "Power Source" slide switch is in the "EFM8 USB" position. When the switch is in the "DBG USB" position, VREGIN is disconnected from the VBUS-line and VDD is shorted to VREGIN. For more information, see Section 3.2 Power Supply.

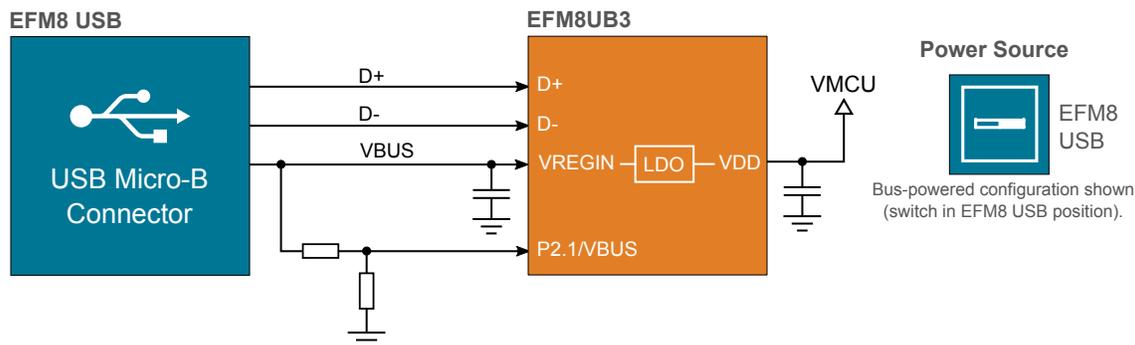


Figure 3.4. Universal Serial Bus

3.4 Push Buttons and RGB LED

The kit has two user push buttons marked BTN0 and BTN1. They are connected directly to the EFM8 and are debounced by RC filters with a time constant of 1 ms. The buttons are connected to pins P0.2 and P0.3.

The kit also features an RGB LED placed between the two push buttons that is controlled by GPIO pins on the EFM8. The LEDs are connected in an active-low configuration, and each color can be PWM controlled using the EFM8's Programmable Counter Array (PCA0) peripheral to generate a wide variety of colors.

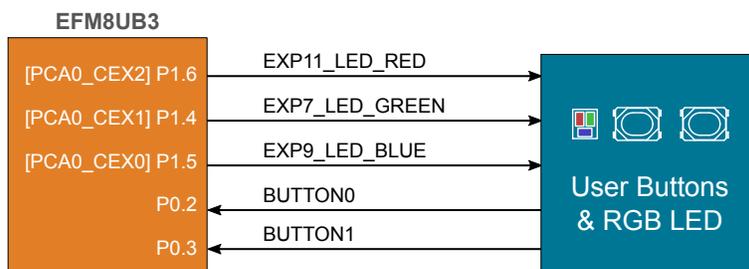


Figure 3.5. Buttons and LEDs

3.5 On-board Debugger

The Thunderboard EFM8UB3 contains a microcontroller separate from the EFM8 Universal Bee that provides the user with a on-board J-Link debugger through the USB micro-B debugging port. This microcontroller is referred to as the "On-board Debugger", and is not programmable by the user.

In addition to providing code download and debug features, the on-board debugger also presents a virtual COM port for general purpose application serial data transfer.

Figure 3.6 On-Board Debugger Connections on page 8 shows the connections between the target EFM8 device and the on-board debugger. The figure also shows the presence of the Mini Simplicity Connector, and how this is connected to the same I/O pins. Please refer to section 4. Debugging and section 5. Kit Configuration and Upgrades for more details on debugging.

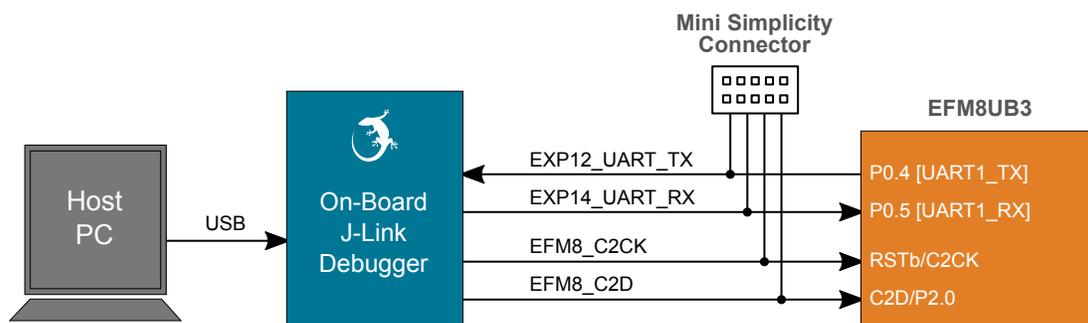


Figure 3.6. On-Board Debugger Connections

3.6 EFM8 Reset

The EFM8 MCU can be reset by a few different sources:

- A user pressing the RESET button.
- The on-board debugger pulling the EFM8 RSTb pin low.
- An external debugger pulling the EFM8 RSTb pin low.

In addition to the reset sources mentioned above, the debugger will also issue a reset to the EFM8 when starting up. This means that removing power to the debugger (unplugging the USB Micro-B cable) will not generate a reset, but plugging the cable back in will cause a reset as the debugger starts up.

3.7 Connectors

Featured on the Thunderboard EFM8UB3 is a Mini Simplicity connector, two USB Micro-B connectors, a ribbon connector, and 24 breakout pads. Of the breakout pads, 20 follow the Silicon Labs EXP header pinout that provides a fixed feature set across Silicon Labs starter kits.

The placement and pinout of the connectors can be seen in the figure below. See the following sub chapters for additional information on the connectors.

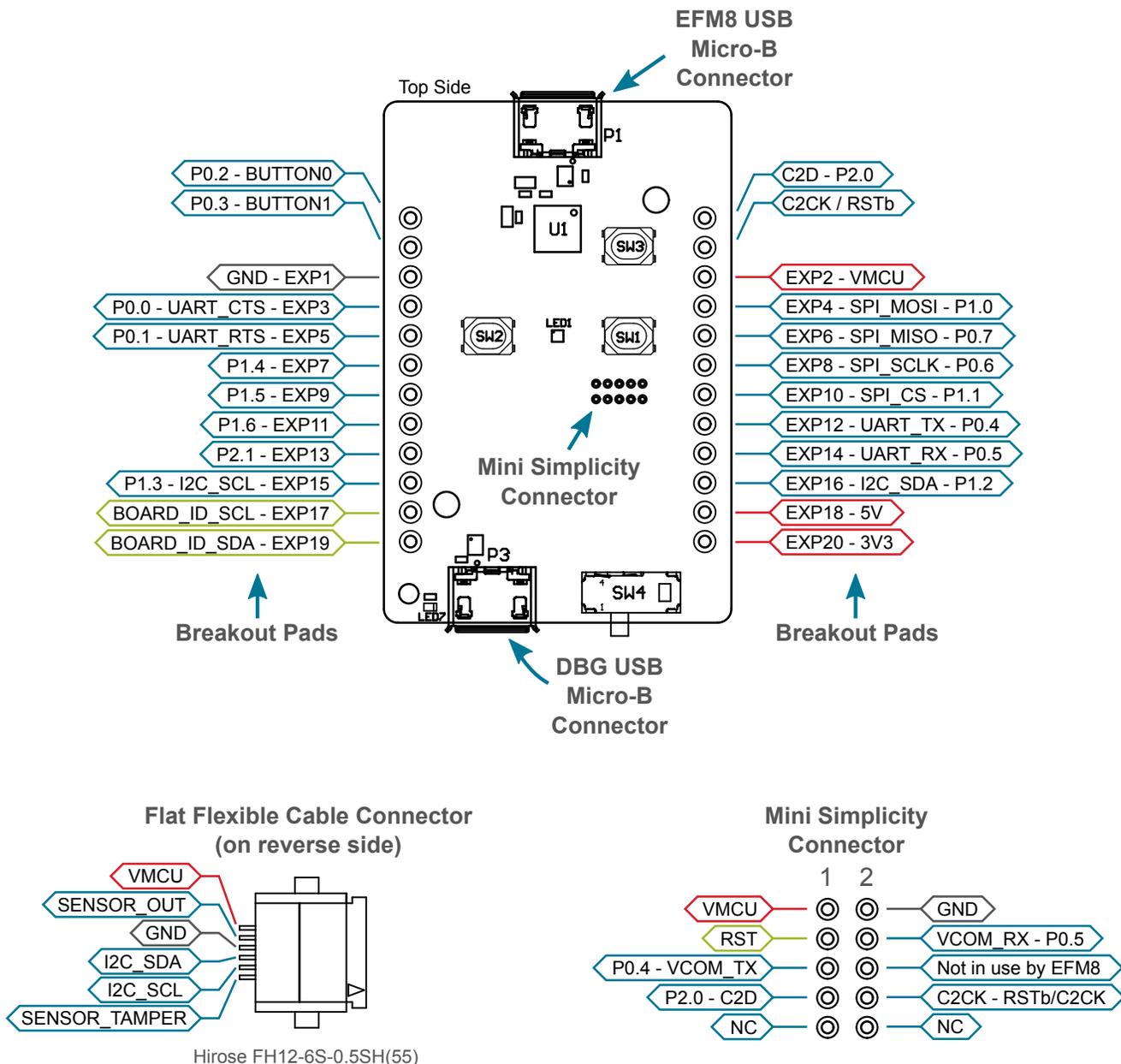


Figure 3.7. Thunderboard EFM8UB3 Connectors

3.7.1 Breakout Pads

The board provides access to every I/O pin of the EFM8 through 24 breakout pads. Twelve of these are located along the left side of the board while the remaining twelve are located on the right side of the board. The breakout pads contain a number of I/O pins that can be used with most of the EFM8 Universal Bee's features. Additionally, the VMCU (EFM8 power rail), 3.3V (debug LDO regulator output), and 5V power rails are also exported.

20 of the breakout pads are pinned out similar to the EXP header found on Silicon Labs Starter Kits, which ensures that commonly used peripherals such as SPI, UART and I²C buses are available on fixed locations. The rest of the pins are used for general purpose IO. This allows the definition of expansion boards that can be used in conjunction with a number of different Silicon Labs starter kits.

The pin-routing on the EFM8 is very flexible, so most peripherals can be routed to any pin. However, some pins are shared between the breakout pads and other functions on the Thunderboard EFM8UB3. The table below shows an overview of the breakout pads and functionality that is shared with the kit.

Note: The breakout tab labeled P2.1 in the silkscreen (number 9 on the left side) is connected to a resistor divider on the EFM8 USB VBUS line. Voltages above VMCU may appear on this pad.

Table 3.1. Breakout Pads Pinout

Number	EFM8 Connection	EXP Header Pin	Shared Feature on Kit	Peripheral Mapping
Left Side Breakout Pads (top to bottom)				
1	P0.2	-	Button	
2	P0.3	-	Button	
3	GND	EXP1 - Ground	Ground	
4	P0.0	EXP3	SENSOR_OUT	
5	P0.1	EXP5	SENSOR_TAMPER	
6	P1.4	EXP7	LED	PCA0_CEX0
7	P1.5	EXP9	LED	PCA0_CEX1
8	P1.6	EXP11	LED	PCA0_CEX2
9 ¹	P2.1 / VBUS	EXP13	Connected to EFM8 USB 5V through resistor divider	
10	P1.3	EXP15 - I2C_SCL	SENSOR_SCL	SMBUS0_SCL
11	NC	EXP17 - Connected to Board Controller for identification of add-on boards		
12	NC	EXP19 - Connected to Board Controller for identification of add-on boards		
Right Side Breakout Pads (top to bottom)				
1	C2D / P2.0	-	C2D	
2	RSTb / C2CK	-	C2CK / RST	
3	VDD	EXP2 - VMCU	EFM8 voltage domain, included in AEM measurements	
4	P1.0	EXP4 - SPI_MOSI		SPI0_MOSI
5	P0.7	EXP6 - SPI_MISO		SPI0_MISO
6	P0.6	EXP8 - SPI_SCLK		SPI0_SCK
7	P1.1	EXP10 - SPI_CS		SPI0_NSS
8	P0.4	EXP12 - UART_TX	Virtual COM Port	UART1_TX0
9	P0.5	EXP14 - UART_RX	Virtual COM Port	UART1_RX0
10	P1.2	EXP16 - I2C_SDA	SENSOR_SDA	SMBUS0_SDA

Number	EFM8 Connection	EXP Header Pin	Shared Feature on Kit	Peripheral Mapping
11	NC	EXP18 - 5V	Connected to Board Controller USB voltage	
12	VDD ²	EXP20 - 3V3	Board controller supply voltage	

- 1 Voltages above VMCU may appear on this pad.
- 2 VDD on the EFM8 is only connected to this pad if the "Power Source" switch is in the "DBG USB" position, and the debug USB cable is inserted.

3.7.2 Mini Simplicity Connector

The Mini Simplicity connector that can be soldered in on the Thunderboard EFM8UB3 allows the use of an external debugger such as a Silicon Labs Wireless Starter Kit (WSTK) with the board. In addition to providing the 2-Wire (C2) debug interface and virtual COM port functionality, the WSTK can also support Advanced Energy Monitoring (AEM). The pinout is described in section [3.7.2 Mini Simplicity Connector](#), and the signal names are referenced from the EFM8.

Note: The 10 pin, 1.27 mm pitch Mini Simplicity connector is not provided in the kit and needs to be soldered in by the user.

Table 3.2. Mini Simplicity Connector Pin Descriptions

Pin number	Connection	Function	Description
1	VMCU	VAEM	Target voltage on the debugged application. Supplied and monitored by the AEM when power selection switch is in the "AEM" position.
2	GND	GND	Ground
3	NC	NC	Not connected
4	P0.5	VCOM_RX	Virtual COM Rx
5	P0.4	VCOM_TX	Virtual COM Tx
6	NC	NC	Not connected
7	C2D/P2.0	C2D	Serial Wire Data
8	RSTb/C2CK	RSTb/C2CK	Serial Wire Clock
9	NC	NC	Not connected
10	NC	NC	Not connected

3.7.3 EFM8 USB Micro-B Connector

The EFM8 USB port is connected to the Universal Serial Bus (USB0) peripheral on the EFM8. More information is available in section [3.3 Universal Serial Bus](#).

3.7.4 Debug USB Micro-B Connector

The debug USB port can be used for uploading code, debugging, and as a Virtual COM port. More information is available in section [4. Debugging](#).

3.7.5 Flat Flexible Cable Connector

A small, 6-position connector with 0.50 mm pitch for flat flexible cables (FFC) can be found on the secondary side of the board. The connector (P/N: FH12-6S-0.5SH(55)) allows connections of external Silicon Labs "postage-stamp" (PS) sized evaluation boards to the kit. Some examples of such boards are the Si7201-B01V-EB Switch PS Board, the Si7210-B00V-EB I2C PS Board, and the Si7211-B00V-EB Analog PS Board.

The pinout of the FFC connector is described in the table below.

Table 3.3. Flat Flexible Cable Connector Pin Descriptions

Pin number	Connection	Function	Description
1	P1.3	I2C_SCL	The I2C SCL line is pulled up to VMCU with a 4.7 kΩ resistor.
2	P0.1	TAMPER	General purpose input/output.
3	P1.2	I2C_SDA	The I2C SDA line is pulled up to VMCU with a 4.7 kΩ resistor.
4	GND	GND	Ground.
5	P0.0	CS/Analog	Chip select or analog output.
6	VMCU	VMCU	EFM8 voltage domain.

4. Debugging

The Thunderboard EFM8UB3 contains an on-board fully functional SEGGER J-Link Debugger that interfaces to the target EFM8 using the Silicon Labs 2-Wire (C2) debug interface. The debugger allows the user to download code and debug applications running in the target EFM8. Additionally, it also provides a virtual COM port (VCOM) to the host computer that is directly connected to the target device's serial port, for general purpose communication between the running application and the host computer.

An external Silicon Labs debugger can also be used with the board by connecting it to the Mini Simplicity connector. This allows advanced debugging features as described in section 4.3 [Mini Simplicity Connector](#). A Silicon Labs Starter Kit (STK) is a good example of a debugger that can be used with the Thunderboard EFM8UB3 when connected through a debug adapter.

Note: When using an external debugger, the "Power Source" slide switch must be placed in the "DBG USB" position, and the debug USB cable must be removed to ensure correct operation.

Figure 4.1 Thunderboard EFM8UB3 Debugging Possibilities on page 13 shows the possible debug options.

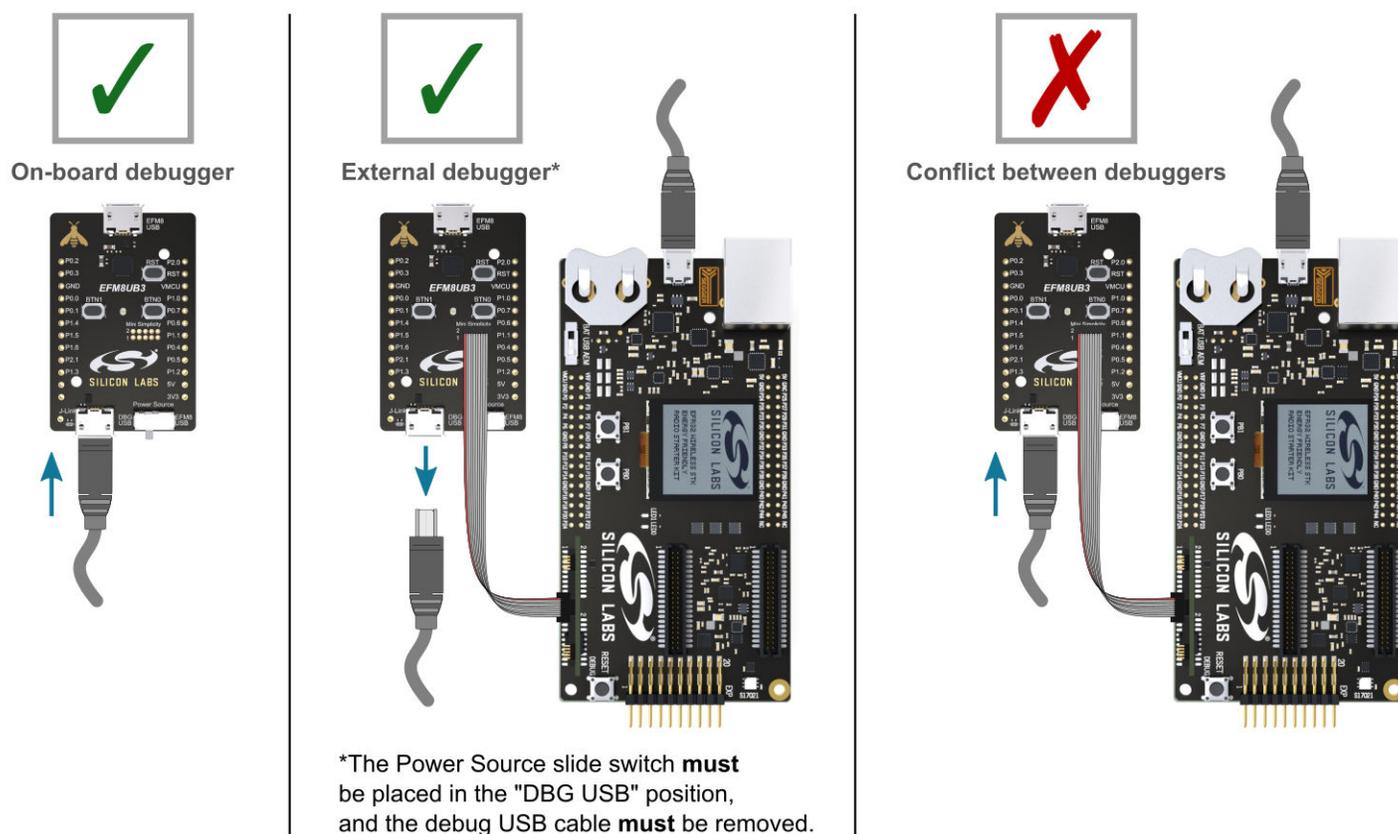


Figure 4.1. Thunderboard EFM8UB3 Debugging Possibilities

4.1 On-board Debugger Considerations

The on-board debugger is a SEGGER J-Link debugger running on an EFM32 Giant Gecko. The debugger is connected to the C2 and VCOM pins of the target EFM8 through a level shift and isolation circuit. When the debug USB cable is inserted, the on-board debugger is automatically active and takes control of the C2 and VCOM interfaces. This means that serial wire debug and communication will *not* work with an external STK connected through the Mini Simplicity connector at the same time.

When the debug USB cable is connected, the target EFM8 voltage domain (VMCU) is used to power parts of the level shift and isolation circuit. Furthermore, depending on the "Power Source" slide switch position, the debugger itself may also be powered from the VMCU rail. These considerations should be taken into account when trying to measure the EFM8 current consumption on the kit while using the on-board debugger.

When the debug USB cable is disconnected, the on-board debugger is powered down and the level shift and isolation circuit is put in a partially powered down state, minimizing both leakage current and quiescent current from the target EFM8 voltage domain (VMCU). This means that high performance power measurements of the EFM8 with either Advanced Energy Monitoring or other external hardware should be obtained with the debug USB cable disconnected.

4.2 Virtual COM Port

The virtual COM port is a connection to a UART of the target EFM8, and allows serial data to be sent and received from the device. The on-board debugger presents this as a virtual COM port on the host computer that shows up when the USB cable is inserted. Alternatively, the VCOM port can also be used through the Mini Simplicity Connector with an external WSTK.

Data is transferred between the host computer and the debugger through the USB connection, which emulates a serial port using the USB Communication Device Class (CDC). From the debugger, the data is passed on to the target device through a physical UART connection.

The serial format is 115200 bps, 8 bits, no parity, and 1 stop bit.

Using the VCOM port through the Mini Simplicity Connector with an external WSTK works in a similar way, but requires that the on-board debugger is unplugged. The board controller on the WSTK then makes the data available over USB (CDC) or an IP socket.

Note: Changing the baud rate for the COM port on the PC side does not influence the UART baud rate between the debugger and the target device.

4.3 Mini Simplicity Connector

The Mini Simplicity connector is a 10-pin 1.27 mm pitch connector that gives access to advanced debugging features using an external debugger. Debugging with an external debugger such as a Silicon Labs Starter Kit (STK) or Wireless Starter Kit (WSTK) allows:

- Debugging of the target device through the C2 interface
- Communication using the VCOM port
- Advanced Energy Monitor

Please note that the Mini Simplicity Connector *cannot* be used at the same time as the on-board debugger is active (debug USB cable is plugged in). The "Power Source" slide switch must furthermore be placed in the "DBG USB" position, as the Mini Simplicity connector injects a voltage into the target EFM8 voltage domain. For information on how to correctly connect to the kit, see [Figure 4.1 Thunderboard EFM8UB3 Debugging Possibilities on page 13](#). The recommended way to power the board when using the Mini Simplicity Connector is to use the AEM voltage supply of the STK or WSTK. Power-cycling of the board, if necessary, can easily be done by flipping the power switch on the WSTK to "BAT" and back to "AEM".

5. Kit Configuration and Upgrades

The kit configuration dialog in Simplicity Studio allows you to change the J-Link adapter debug mode, upgrade its firmware, and change other configuration settings. To download Simplicity Studio, go to <http://www.silabs.com/simplicity>.

In the main window of the Simplicity Studio's Launcher perspective, the debug mode and firmware version of the selected J-Link adapter is shown. Click the **[Change]** link next to any of them to open the kit configuration dialog.

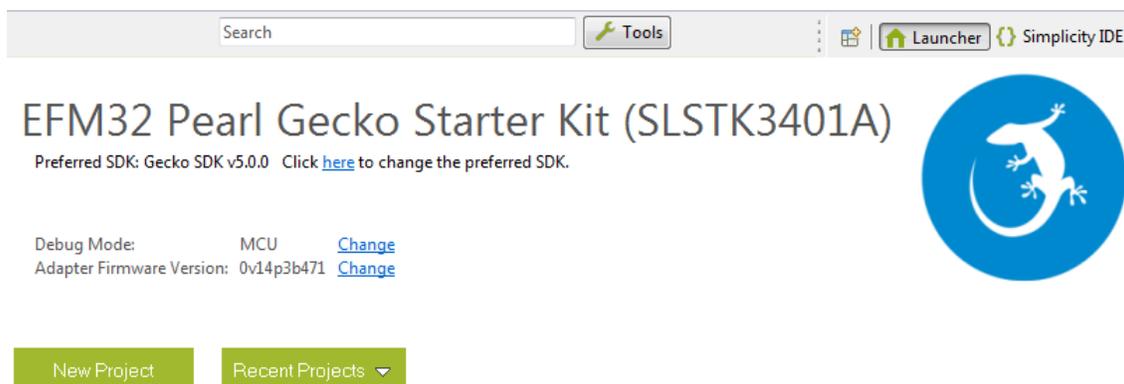


Figure 5.1. Simplicity Studio Kit Information

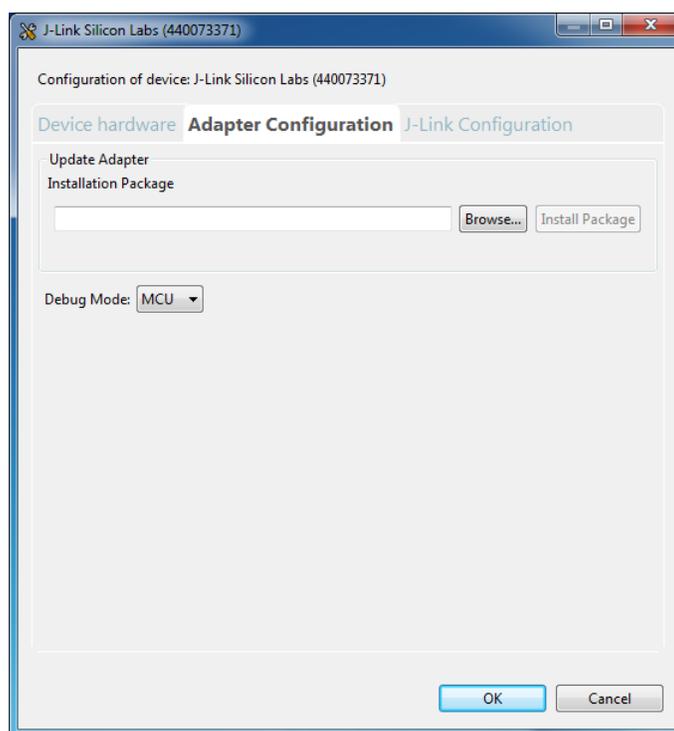


Figure 5.2. Kit Configuration Dialog

5.1 Firmware Upgrades

Upgrading the kit firmware is done through Simplicity Studio. Simplicity Studio will automatically check for new updates on startup.

You can also use the kit configuration dialog for manual upgrades. Click the **[Browse]** button in the **[Update Adapter]** section to select the correct file ending in `.emz`. Then, click the **[Install Package]** button.

6. Schematics, Assembly Drawings and BOM

Schematics, assembly drawings and bill of materials (BOM) are available through Simplicity Studio when the kit documentation package has been installed.

7. Kit Revision History and Errata

7.1 Revision History

The kit revision can be found printed on the box label of the kit, as outlined in the figure below. The kit revision history is summarised in [Table 7.1 Kit Revision History on page 17](#).

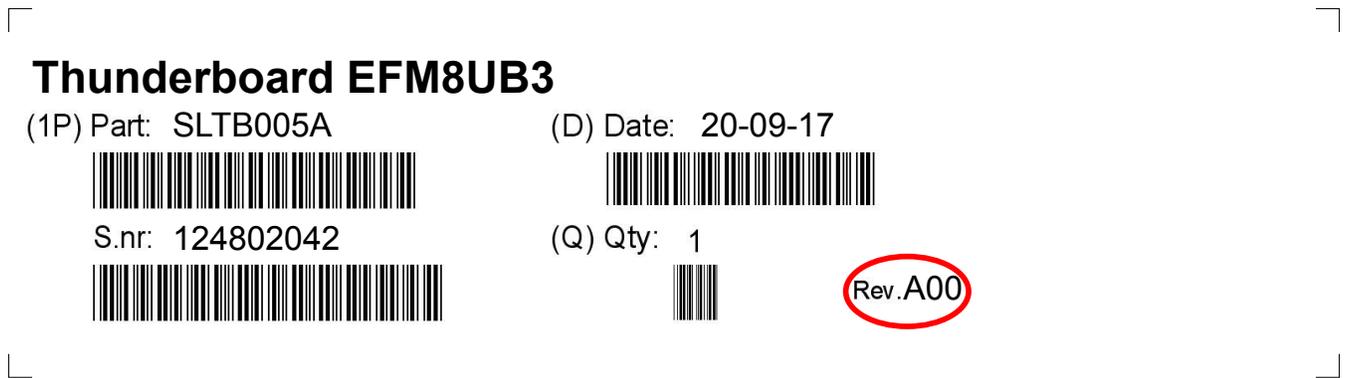


Figure 7.1. Revision Info

Table 7.1. Kit Revision History

Kit Revision	Released	Description
A00	2017-09-20	Initial kit revision.

7.2 Errata

There are no known errata at present.

8. Board Revision History and Errata

8.1 Revision History

The board revision can be found laser printed on the board, and the board revision history is summarised in [Table 8.1 Board Revision History on page 18](#).

Table 8.1. Board Revision History

Revision	Released	Description
A02	2017-09-19	Initial production version.

8.2 Errata

There are no known errata at present.

9. Document Revision History

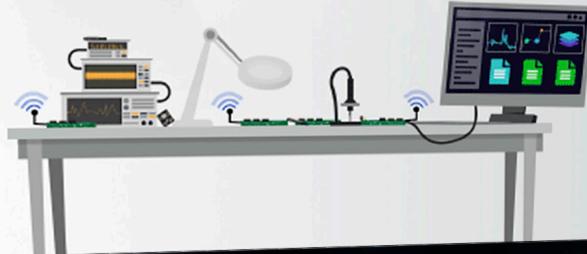
Revision 1.0

December, 2017

- Initial document release.

Silicon Labs

Simplicity Studio™4



Simplicity Studio

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Silicon Laboratories Inc.
400 West Cesar Chavez
Austin, TX 78701
USA

<http://www.silabs.com>