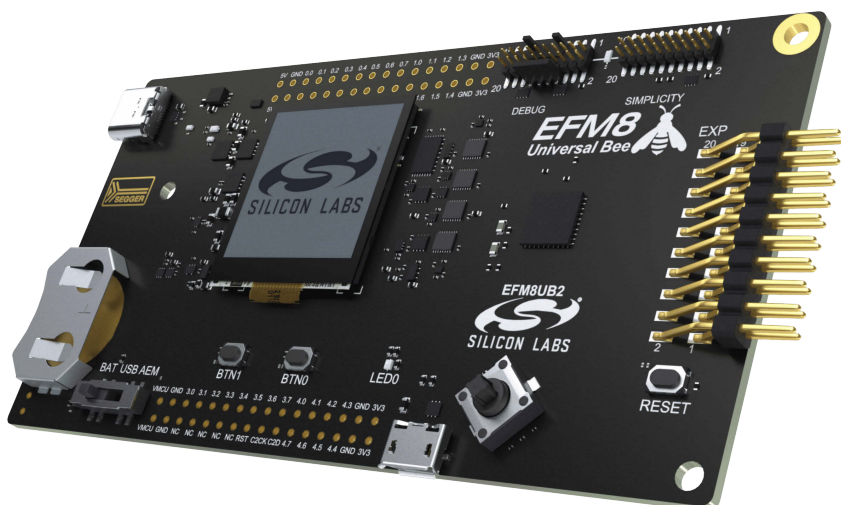# UG241: EFM8UB2-SLSTK2001A User's Guide

The SLSTK2001A is an excellent starting point to become familiar with the EFM8UB2™ Universal Bee Microcontroller.

The starter kit contains sensors and peripherals demonstrating some of the EFM8UB2's many capabilities. The kit provides all necessary tools for developing an EFM8UB2 Universal Bee application.

TARGET DEVICE

- EFM8UB2 Universal Bee Microcontroller (EFM8UB20F64G-B-QFP48)
- CPU: 8-bit CIP-51 8051 Core
- Memory: 64 kB flash and 4352 bytes RAM
- Oscillators: 48 MHz and 80 kHz

KIT FEATURES

- USB connectivity
- Advanced Energy Monitor (AEM)
- SEGGER J-Link on-board debugger
- Debug Multiplexer supporting external hardware as well as on-board MCU
- User push buttons and RGB LED
- Ultra-low-power 128x128 pixel Memory LCD
- 8-direction analog joystick
- 20-pin 2.54 mm header for expansion boards
- Breakout pads for direct access to I/O pins
- Power sources include USB and CR2032 coin cell battery

SOFTWARE SUPPORT

- Simplicity Studio™

Table of Contents

1. Introduction

1.1 Description

The SLSTK2001A is an ideal starting point for application development on the EFM8UB2 Universal Bee Microcontrollers. The board features sensors and peripherals, demonstrating some of the many capabilities of the EFM8UB2 Universal Bee Microcontroller. Additionally, the board is a fully featured debugger and energy monitoring tool that can be used with external applications.

1.2 Features

- EFM8UB2 Universal Bee Microcontroller
  - 64 kB Flash
  - 4352 bytes RAM
  - QFP48 package
- Advanced Energy Monitoring system for precise current and voltage tracking
- Integrated Segger J-Link USB debugger/emulator with the possiblity to debug external Silicon Labs devices
- 20-pin expansion header
- Breakout pads for easy access to I/O pins
- Power sources include USB and CR2032 battery
- Ultra-low-power 128x128 pixel Memory-LCD
- 2 push buttons and 1 RGB LED connected to EFM8 for user interaction
- USB Micro-AB connector
- 8-direction analog joystick for user interaction

1.3 Getting Started

Detailed instructions for how to get started with your new SLSTK2001A can be found on the Silicon Labs Web pages:

silabs.com/development-tools/mcu/8-bit

2. Kit Block Diagram

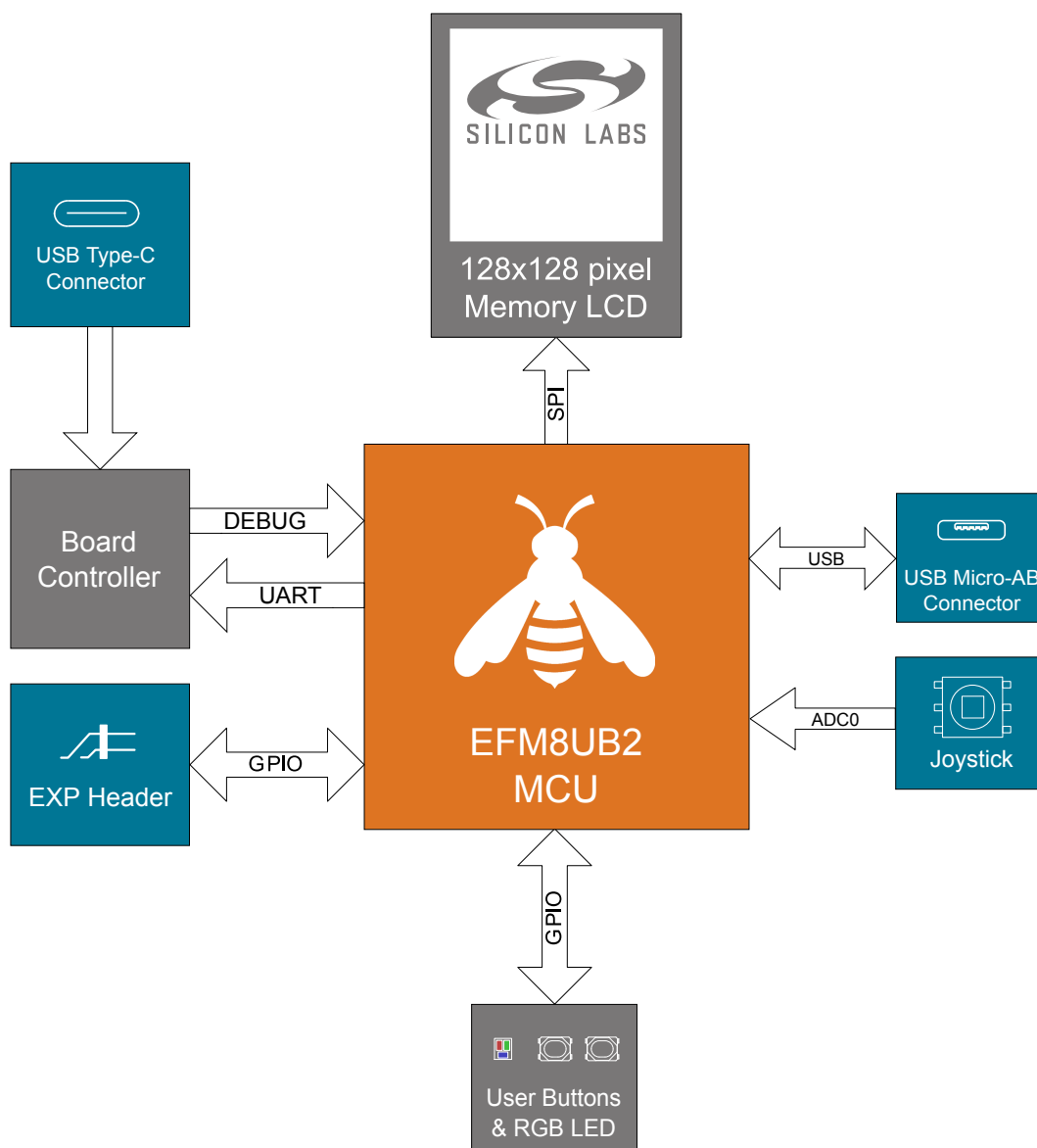An overview of the EFM8UB2 Universal Bee Starter Kit is shown in the figure below.

Figure 2.1. Kit Block Diagram

3. Kit Hardware Layout

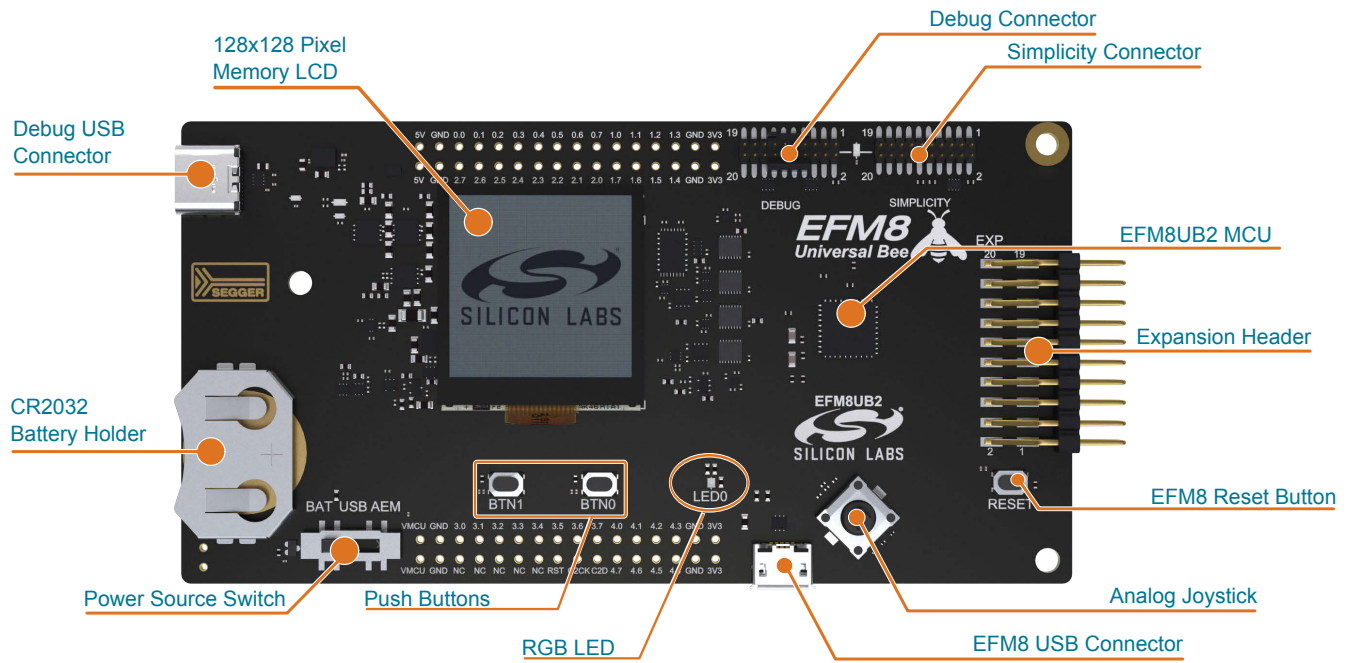The EFM8UB2 Universal Bee Starter Kit layout is shown below.

Figure 3.1. SLSTK2001A Hardware Layout

4. Connectors

4.1 Breakout Pads

Most of the EFM8UB2's GPIO pins are available on two pin header rows at the top and bottom edges of the board. These have a standard 2.54 mm pitch, and pin headers can be soldered in if required. In addition to the I/O pins, connections to power rails and ground are also provided. Note that some of the pins are used for kit peripherals or features and may not be available for a custom application without tradeoffs.

The figure below shows the pinout of the breakout pads and the pinout of the EXP header on the right edge of the board. The EXP header is further explained in the next section. The breakout pad connections are also printed in silkscreen next to each pin for easy reference.
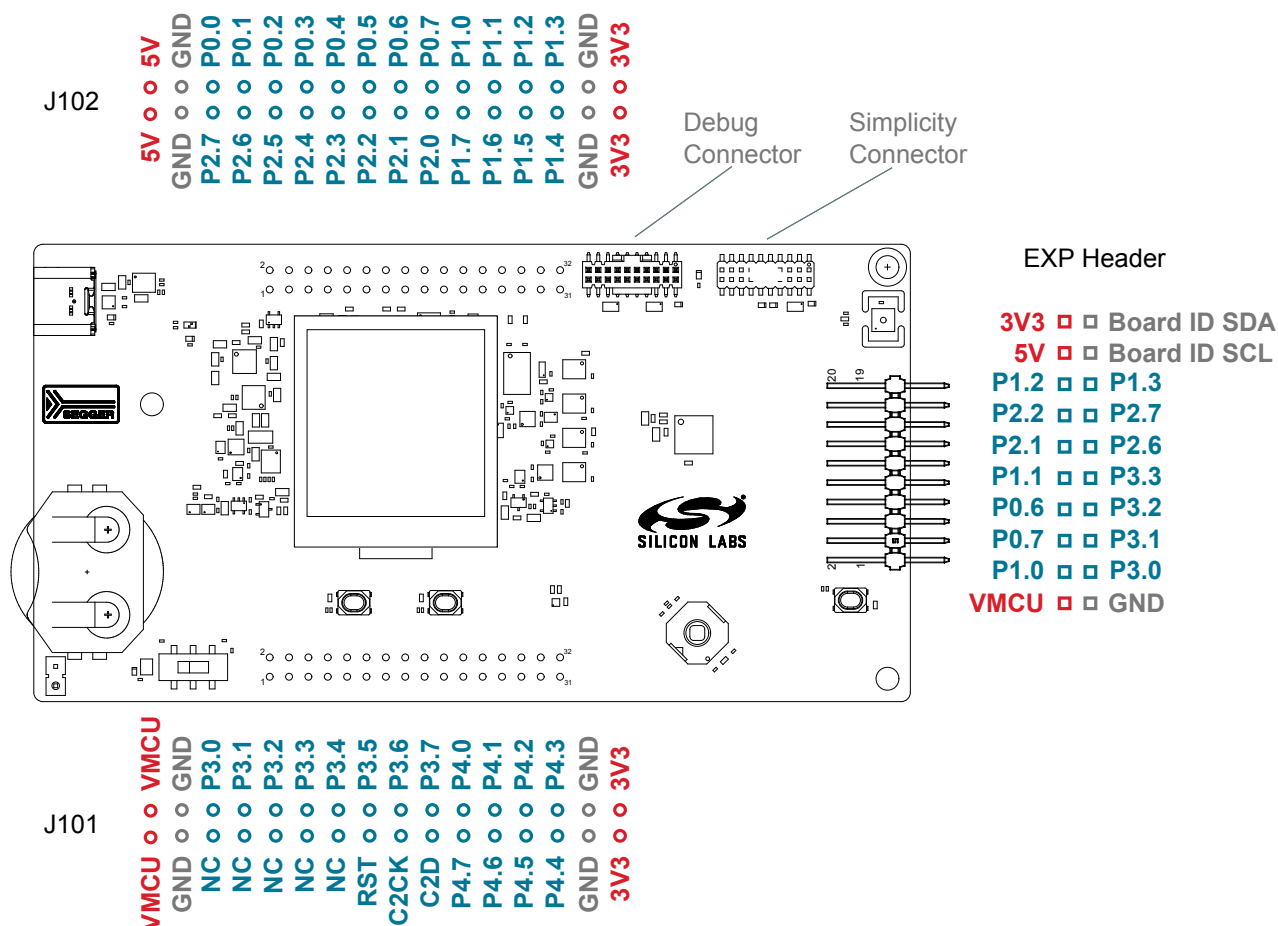
Figure 4.1. Breakout Pads and Expansion Header

The table below shows the pin connections of the breakout pads. It also shows which kit peripherals or features are connected to the different pins.

Table 4.1. Bottom Row (J101) Pinout

Pin	EFM8UB2 I/O pin	Shared Feature
1	VMCU	EFM8UB2 voltage domain (measured by AEM)
2	VMCU	EFM8UB2 voltage domain (measured by AEM)
3	GND	Ground
4	GND	Ground
5	NC	

Pin	EFM8UB2 I/O pin	Shared Feature
6	P3.0	EXP3
7	NC	
8	P3.1	EXP5
9	NC	
10	P3.2	EXP7
11	NC	
12	P3.3	EXP9
13	NC	
14	P3.4	
15	RST	DEBUG_#RESET_C2CKPS
16	P3.5	
17	C2CK	DEBUG_TCK_SWCLK_C2CK, MCU_C2CK_RESET
18	P3.6	
19	C2D	DEBUG_TMS_SWDIO_C2D, MCU_C2D
20	P3.7	
21	P4.7	
22	P4.0	
23	P4.6	
24	P4.1	
25	P4.5	
26	P4.2	
27	P4.4	
28	P4.3	
29	GND	Ground
30	GND	Ground
31	3V3	Board controller supply
32	3V3	Board controller supply

Table 4.2. Top Row (J102) Pinout

Pin	EFM8UB2 I/O pin	Shared Feature
1	5V	Board USB voltage
2	5V	Board USB voltage
3	GND	Ground
4	GND	Ground
5	P2.7	EXP13
6	P0.0	VCOM_ENABLE
7	P2.6	EXP11

Pin	EFM8UB2 I/O pin	Shared Feature
8	P0.1	DISP_CS
9	P2.5	UIF_JOYSTICK
10	P0.2	UIF_BUTTON0
11	P2.4	
12	P0.3	UIF_BUTTON1
13	P2.3	
14	P0.4	UART0_TX, VCOM_TX
15	P2.2	UART1_RX, EXP14
16	P0.5	UART0_RX, VCOM_RX
17	P2.1	UART1_TX, EXP12
18	P0.6	SPI0_SCK, DISP_SCLK, EXP8
19	P2.0	UIF_LEDR
20	P0.7	SPI0_MISO, EXP6
21	P1.7	UIF_LEDB
22	P1.0	SPI0_MOSI, DISP_SI, EXP4
23	P1.6	UIF_LEDG
24	P1.1	SPI0_CS, EXP10
25	P1.5	
26	P1.2	I2C0_SDA, EXP16
27	P1.4	DISP_ENABLE
28	P1.3	I2C0_SCL, EXP15
29	GND	Ground
30	GND	Ground
31	3V3	Board controller supply
32	3V3	Board controller supply

4.2 EXP Header

On the right side of the board, an angled 20-pin EXP header is provided to allow connection of peripherals or plugin boards. The connector contains a number of I/O pins that can be used with most of the EFM8UB2 Universal Bee's features. Additionally, the VMCU, 3V3, and 5V power rails are also exposed.

The connector follows a standard which ensures that commonly used peripherals such as a SPI, UART, and I^{2}C bus are available on fixed locations on the connector. The rest of the pins are used for general purpose I/O. This layout allows the definition of expansion boards that can plug into a number of different Silicon Labs kits.

The figure below shows the EXP header pin assignment for the EFM8UB2 Universal Bee Starter Kit. Because of limitations in the number of available GPIO pins, some of the EXP header pins are shared with kit features.
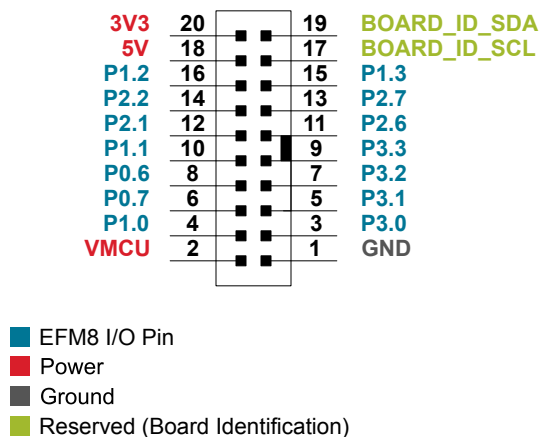

Figure 4.2. EXP Header

Table 4.3. EXP Header Pinout

Pin	Connection	EXP Header Function	Shared Feature	Peripheral Mapping
20	3V3	Board controller supply		
18	5V	Board controller USB voltage		
16	P1.2	I2C0_SDA	SENSOR_I2C_SDA	SMB0_SDA
14	P2.2	UART1_RX		UART1_RX
12	P2.1	UART1_TX		UART1_TX
10	P1.1	SPI0_CS		SPI0_CS
8	P0.6	SPI0_SCK	MCU_DISP_SCLK	SPI0_SCK
6	P0.7	SPI0_CIPO		SPI0_CIPO
4	P1.0	SPI0_COPI	MCU_DISP_COPI	SPI0_COPI
2	VMCU	EFM8UB2 voltage domain, included in AEM measurements.		
19	BOARD_ID_SDA	Connected to board controller for identification of add-on boards.		
17	BOARD_ID_SCL	Connected to board controller for identification of add-on boards.		
15	P1.3	I2C0_SCL		I2C0_SCL
13	P2.7	GPIO	EFM_USB_VBUS	
11	P2.6	GPIO	DISP_ENABLE	
9	P3.3	GPIO	UIF_LEDR	

Pin	Connection	EXP Header Function	Shared Feature	Peripheral Mapping
7	P3.2	GPIO	UIF_LEDB	
5	P3.1	GPIO	UIF_LEDG	
3	P3.0	GPIO		
1	GND	Ground		

4.3 Debug Connector (DBG)

The debug connector serves a dual purpose, based on the debug mode, which can be set up using Simplicity Studio. If the "Debug IN" mode is selected, the connector allows an external debugger to be used with the on-board EFM8UB2. If the "Debug OUT" mode is selected, the connector allows the kit to be used as a debugger towards an external target. If the "Debug MCU" mode (default) is selected, the connector is isolated from the debug interface of both the board controller and the on-board target device.

Because this connector is automatically switched to support the different operating modes, it is only available when the board controller is powered (J-Link USB cable connected). If debug access to the target device is required when the board controller is unpowered, this should be done by connecting directly to the appropriate pins on the breakout header.

The pinout of the connector follows that of the standard ARM Cortex Debug 19-pin connector. The pinout is described in detail below. Note that even though the connector supports JTAG in addition to Serial Wire Debug, it does not necessarily mean that the kit or the on-board target device supports this.
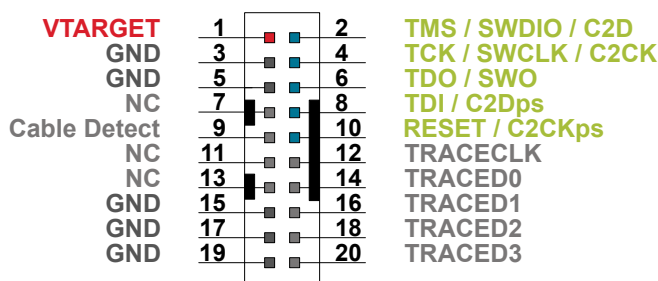

Figure 4.3. Debug Connector

Even though the pinout matches the pinout of an ARM Cortex Debug connector, these are not fully compatible as pin 7 is physically removed from the Cortex Debug connector. Some cables have a small plug that prevents them from being used when this pin is present. If this is the case, remove the plug or use a standard 2x10 1.27 mm straight cable instead.

Table 4.4. Debug Connector Pin Descriptions

Pin Number(s)	Function	Note
1	VTARGET	Target reference voltage. Used for shifting logical signal levels between target and debugger.
2	TMS / SDWIO / C2D	JTAG test mode select, Serial Wire data, or C2 data
4	TCK / SWCLK / C2CK	JTAG test clock, Serial Wire clock, or C2 clock
6	TDO/SWO	JTAG test data out or Serial Wire output
8	TDI / C2Dps	JTAG test data in or C2D "pin sharing" function
10	RESET / C2CKps	Target device reset or C2CK "pin sharing" function
12	NC	TRACECLK
14	NC	TRACED0
16	NC	TRACED1
18	NC	TRACED2
20	NC	TRACED3
9	Cable detect	Connect to ground
11, 13	NC	Not connected
3, 5, 15, 17, 19	GND	

4.4 Simplicity Connector

The Simplicity Connector featured on the EFM8UB2 Universal Bee Starter Kit enables advanced debugging features such as the AEM and Virtual COM port to be used towards an external target. The pinout is illustrated in the figure below.
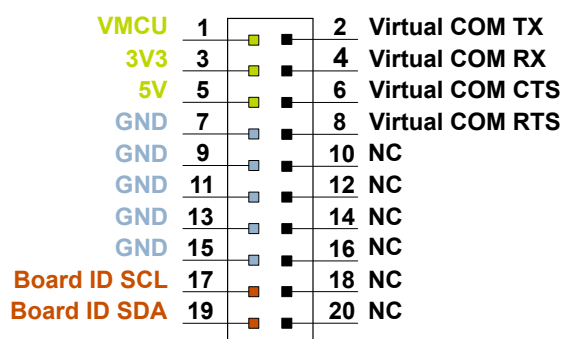
```
VMCU          1  ┌──┐  2  Virtual COM TX
 3V3          3  │  │  4  Virtual COM RX
  5V          5  │  │  6  Virtual COM CTS
 GND          7  │  │  8  Virtual COM RTS
 GND          9  │  │ 10  NC
 GND         11  │  │ 12  NC
 GND         13  │  │ 14  NC
 GND         15  │  │ 16  NC
Board ID SCL 17  │  │ 18  NC
Board ID SDA 19  └──┘ 20  NC
```

Figure 4.4. Simplicity Connector

The signal names in the figure and the pin description table are referenced from the board controller. This means that VCOM_TX should be connected to the RX pin on the external target, VCOM_RX to the target's TX pin, VCOM_CTS to the target's RTS pin, and VCOM_RTS to the target's CTS pin.

Note: Current drawn from the VMCU voltage pin is included in the AEM measurements, while the 3V3 and 5V voltage pins are not. To monitor the current consumption of an external target with the AEM, put the on-board MCU in its lowest energy mode to minimize its impact on the measurements.

Table 4.5. Simplicity Connector Pin Descriptions

Pin Number(s)	Function	Description
1	VMCU	3.3 V power rail, monitored by the AEM
3	3V3	3.3 V power rail
5	5V	5 V power rail
2	VCOM_TX	Virtual COM TX
4	VCOM_RX	Virtual COM RX
6	VCOM_CTS	Virtual COM CTS
8	VCOM_RTS	Virtual COM RTS
17	BOARD_ID_SCL	Board ID SCL
19	BOARD_ID_SDA	Board ID SDA
10, 12, 14, 16, 18, 20	NC	Not connected
7, 9, 11, 13, 15	GND	Ground

5. Power Supply and Reset

5.1 MCU Power Selection

The EFM8UB2 on the starter kit can be powered by one of these sources:

- Debug USB cable
- EFM8UB2's own USB regulator
- 3 V coin cell battery

The power source for the MCU is selected with the slide switch in the lower left corner of the starter kit. The figure below shows how the different power sources can be selected with the slide switch.
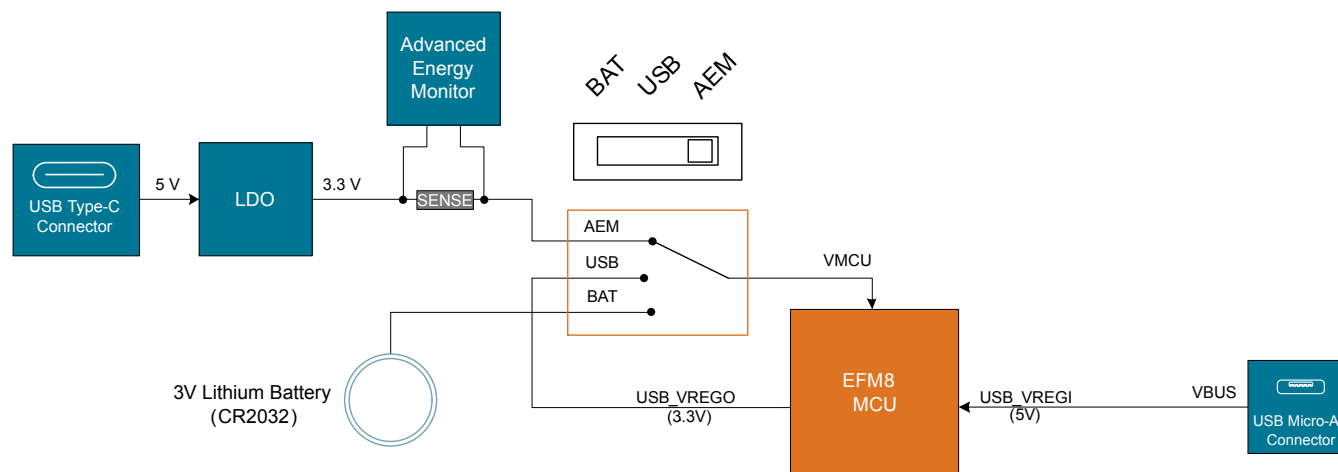

Figure 5.1. Power Switch

With the switch in the **AEM** position, a low-noise 3.3 V LDO on the starter kit is used to power the EFM8UB2. This LDO is again powered from the debug USB cable. The Advanced Energy Monitor is now connected in series, allowing accurate high-speed current measurements and energy debugging/profiling.

With the switch in the **USB** position, the integrated linear regulator in the EFM8UB2 Universal Bee MCU is used to power the rest of the chip as well as the USB PHY with the cable connected to the target USB connector. This allows a USB device application where the MCU acts as a bus powered device. Current consumption monitoring using the AEM is not available when USB is selected as power source.

Finally, with the switch in the **BAT** position, a 20 mm coin cell battery in the CR2032 socket can be used to power the device. With the switch in this position, no current measurements are active. This is the recommended switch position when powering the MCU with an external power source.

5.2 Board Controller Power

The board controller is responsible for important features, such as the debugger and the AEM, and is powered exclusively through the USB port in the top left corner of the board. This part of the kit resides on a separate power domain, so a different power source can be selected for the target device while retaining debugging functionality. This power domain is also isolated to prevent current leakage from the target power domain when power to the board controller is removed.

The board controller power domain is not influenced by the position of the power switch.

The kit has been carefully designed to keep the board controller and the target power domains isolated from each other as one of them powers down. This ensures that the target EFM8UB2 device will continue to operate in the **USB** and **BAT** modes.

5.3 EFM8UB2 Reset

The EFM8UB2 MCU can be reset by a few different sources:

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

In addition to the reset sources mentioned above, a reset to the EFM8UB2 will also be issued during board controller boot-up. This means that removing power to the board controller (unplugging the J-Link USB cable) will not generate a reset but plugging the cable back in will as the board controller boots up.

6. Peripherals

The starter kit has a set of peripherals that showcase some of the EFM8UB2 features.

Note that most EFM8UB2 I/Os routed to peripherals are also routed to the breakout pads or the EXP header, which must be taken into consideration when using these I/Os.

6.1 Push Buttons and RGB LED

The kit has two user push buttons marked BTN0 and BTN1. They are connected directly to the EFM8UB2 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 one RGB LED, marked LED0, that is controlled by a GPIO pin on the EFM8UB2. The LED is connected in an active-low configuration, and each color can be PWM controlled using the EFM8UB2's TIMER/WTIMER peripherals to generate a wide variety of colors.
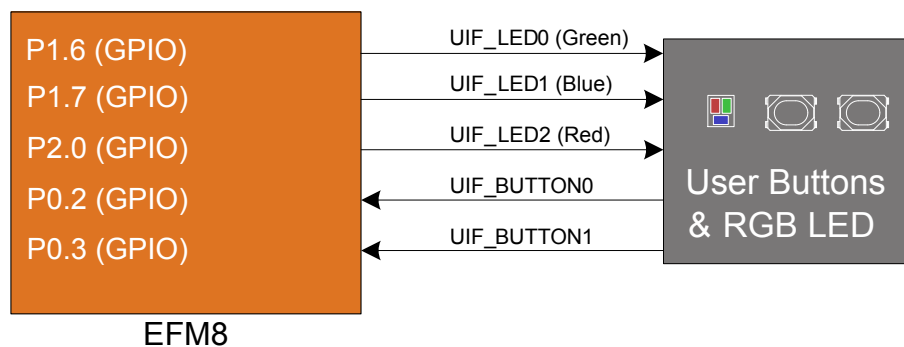
Figure 6.1. Buttons and LED

6.2 Joystick

The kit has an analog joystick with 8 measureable positions. This joystick is connected to the EFM8 on the P2.5 pin and uses different resistor values to create voltages measurable by the ADC0.
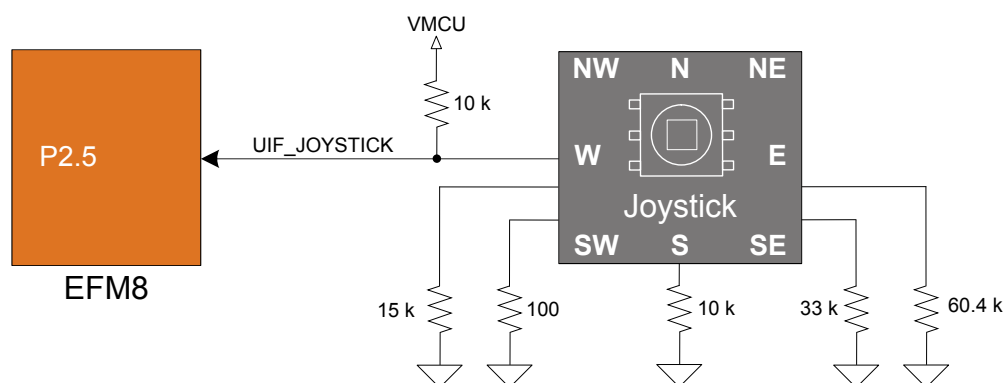
Figure 6.2. Joystick

Table 6.1. Joystick Resistor Combinations

Direction	Resistors Combinations (kΩ)	Expected UIF_JOYSTICK Voltage (V)[1]
Center press	$\dfrac{0.1}{0.1 + 10}$	0.033
Up (N)	$\dfrac{60.4}{60.4 + 10}$	2.831
Up-Right (NE)	$\dfrac{(N \mathbin{/\mkern-5mu/} E)}{(N \mathbin{/\mkern-5mu/} E) + 10} = \dfrac{21.34}{21.34 + 10}$	2.247
Right (E)	$\dfrac{33}{33 + 10}$	2.533
Down-Right (SE)	$\dfrac{(S \mathbin{/\mkern-5mu/} E)}{(S \mathbin{/\mkern-5mu/} E) + 10} = \dfrac{7.67}{7.67 + 10}$	1.433
Down (S)	$\dfrac{10}{10 + 10}$	1.650
Down-Left (SW)	$\dfrac{(S \mathbin{/\mkern-5mu/} W)}{(S \mathbin{/\mkern-5mu/} W) + 10} = \dfrac{6}{6 + 10}$	1.238
Left (W)	$\dfrac{15}{15 + 10}$	1.980
Up-Left (NW)	$\dfrac{(N \mathbin{/\mkern-5mu/} W)}{(N \mathbin{/\mkern-5mu/} W) + 10} = \dfrac{12.01}{12.01 + 10}$	1.801

Note:
   1. These calculated values assume a VMCU of 3.3 V.

6.3 Memory LCD-TFT Display

A 1.28-inch SHARP Memory LCD-TFT is available on the kit to enable interactive applications to be developed. The display has a high resolution of 128 x 128 pixels and consumes very little power. It is a reflective monochrome display, so each pixel can only be light or dark, and no backlight is needed in normal daylight conditions. Data sent to the display is stored in the pixels on the glass, which means no continuous refreshing is required to maintain a static image.

The display interface consists of a SPI-compatible serial interface and some extra control signals. Pixels are not individually addressable, instead, data is sent to the display one line (128 bits) at a time.

The Memory LCD-TFT display is shared with the kit's board controller, allowing the board controller application to display useful information when the user application is not using the display. The user application always controls ownership of the display with the DISP_ENABLE signal:

• DISP_ENABLE = LOW: The board controller has control of the display
• DISP_ENABLE = HIGH: The user application (EFM8UB2) has control of the display

Power to the display is sourced from the target application power domain when the EFM8UB2 controls the display and from the board controller's power domain when the DISP_ENABLE line is low. Data is clocked in on DISP_SI when DISP_CS is high, and the clock is sent on DISP_SCLK. The maximum supported clock speed is 1.1 MHz.
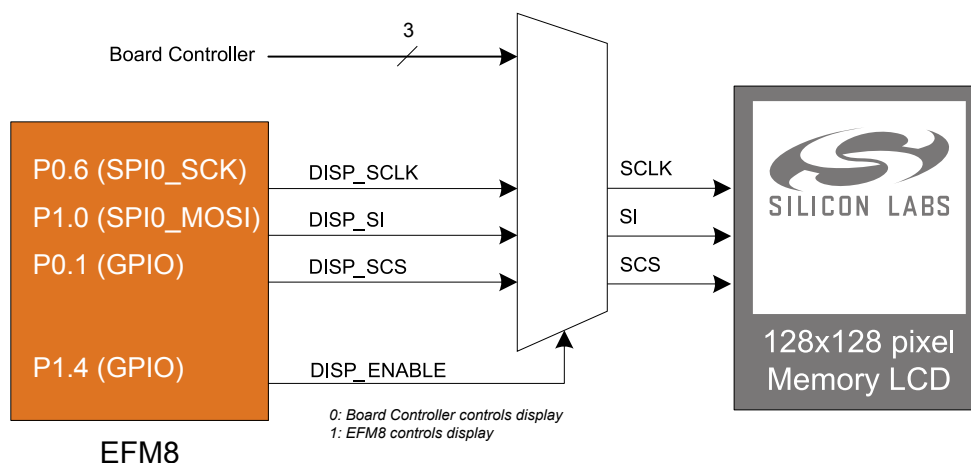
Figure 6.3. 128x128 Pixel Memory LCD

6.4 USB Micro-AB Connector

The SLSTK2001A board is equipped with a USB Micro-AB connector interfacing with the EFM8UB2's USB peripheral. The figure below shows how the USB lines are connected to the MCU.
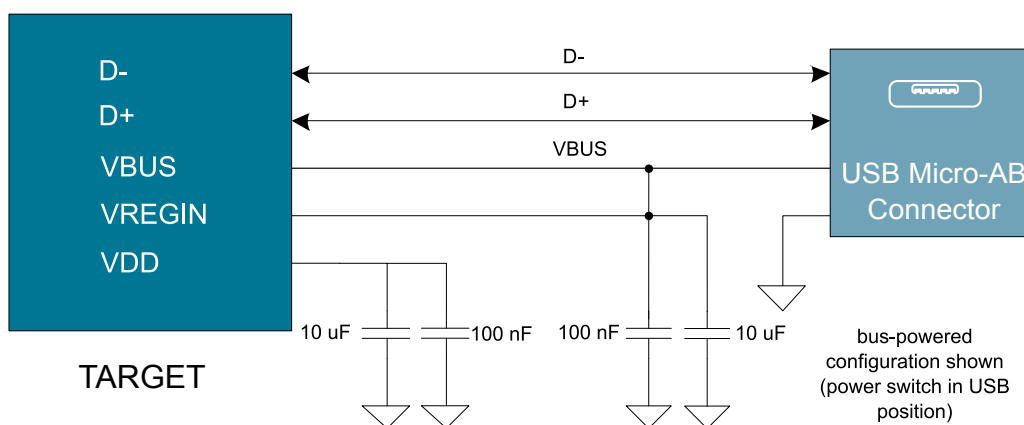
Figure 6.4. USB Connector And Power Supply

6.5 Virtual COM Port

An asynchronous serial connection to the board controller is provided for application data transfer between a host PC and the target EFM8UB2, which eliminates the need for an external serial port adapter.
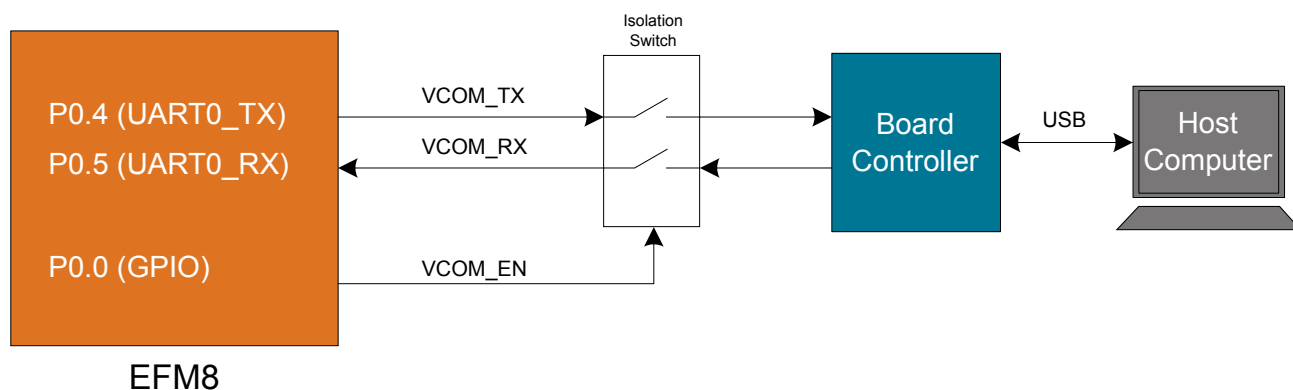
Figure 6.5. Virtual COM Port Interface

The Virtual COM port consists of a physical UART between the target device and the board controller, and a logical function in the board controller that makes the serial port available to the host PC over USB. The UART interface consists of two pins and an enable signal.

Table 6.2. Virtual COM Port Interface Pins

Signal	Description
VCOM_TX	Transmits data from the EFM8UB2 to the board controller
VCOM_RX	Receives data from the board controller to the EFM8UB2
VCOM_ENABLE	Enables the VCOM interface, allowing data to pass through to the board controller

Note: The VCOM port is only available when the board controller is powered, which requires the J-Link USB cable to be inserted.

7. Advanced Energy Monitor

7.1 Usage

The Advanced Energy Monitor (AEM) data is collected by the board controller and can be displayed by the Energy Profiler, available through Simplicity Studio. By using the Energy Profiler, current consumption and voltage can be measured and linked to the actual code running on the EFM8UB2 in realtime.

7.2 Theory of Operation

To accurately measure current ranging from 0.1 µA to 47 mA (114 dB dynamic range), a current sense amplifier is utilized together with a dual gain stage. The current sense amplifier measures the voltage drop over a small series resistor. The gain stage further amplifies this voltage with two different gain settings to obtain two current ranges. The transition between these two ranges occurs around 250 µA. Digital filtering and averaging is done within the board controller before the samples are exported to the Energy Profiler application.

During kit startup, an automatic calibration of the AEM is performed, which compensates for the offset error in the sense amplifiers.
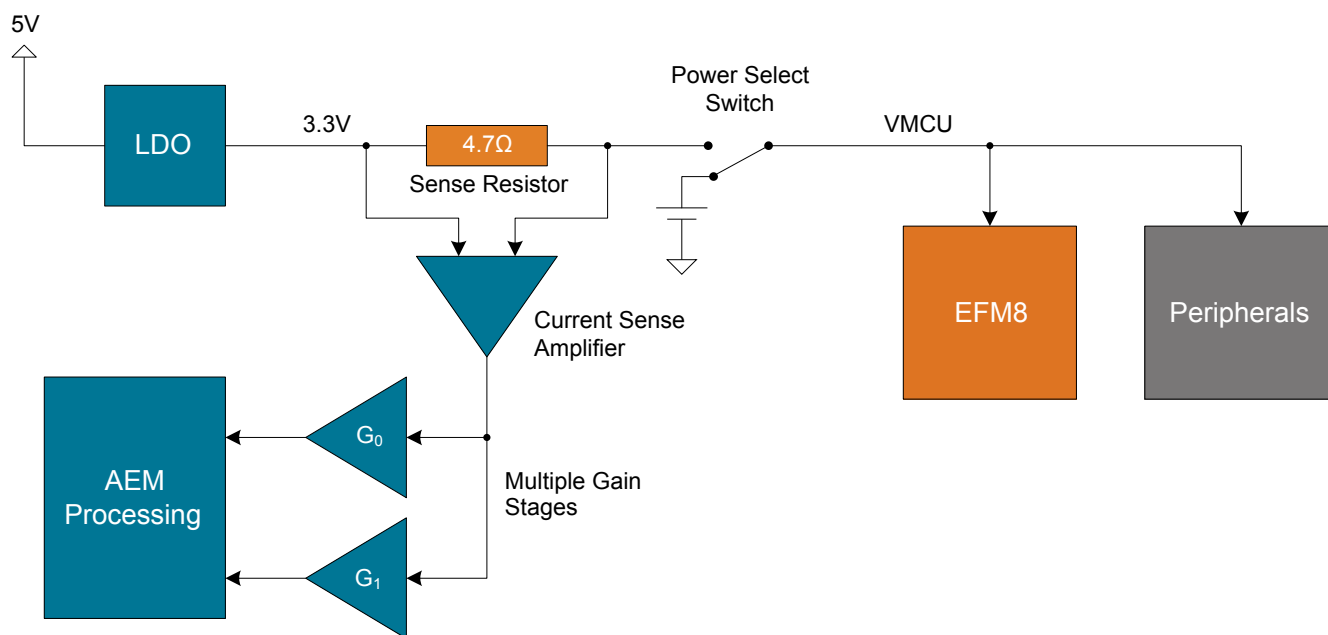
Figure 7.1. Advanced Energy Monitor

7.3 Accuracy and Performance

The AEM is capable of measuring currents in the range of 0.1 µA to 47 mA. For currents above 250 µA, the AEM is accurate within 0.1 mA. When measuring currents below 250 µA, the accuracy increases to 1 µA. Although the absolute accuracy is 1 µA in the sub 250 µA range, the AEM is able to detect changes in the current consumption as small as 100 nA. The AEM produces 6250 current samples per second.

8. On-Board Debugger

The SLSTK2001A contains an integrated debugger, which can be used to download code and debug the EFM8UB2. In addition to programming the EFM8UB2 on the kit, the debugger can also be used to program and debug external Silicon Labs EFM32, EFM8, EZR32, and EFR32 devices.

The debugger supports three different debug interfaces used with Silicon Labs devices:

• Serial Wire Debug, which is used with all EFM32, EFR32, and EZR32 devices

• JTAG, which can be used with EFR32 and some EFM32 devices

• C2 Debug, which is used with EFM8 devices

To ensure accurate debugging, use the appropriate debug interface for your device. The debug connector on the board supports all three of these modes.

8.1 Debug Modes

To program external devices, use the debug connector to connect to a target board and set the debug mode to [**Out**]. The same connector can also be used to connect an external debugger to the EFM8UB2 MCU on the kit by setting debug mode to [**In**].

Selecting the active debug mode is done in Simplicity Studio.

Debug MCU: In this mode, the on-board debugger is connected to the EFM8UB2 on the kit.
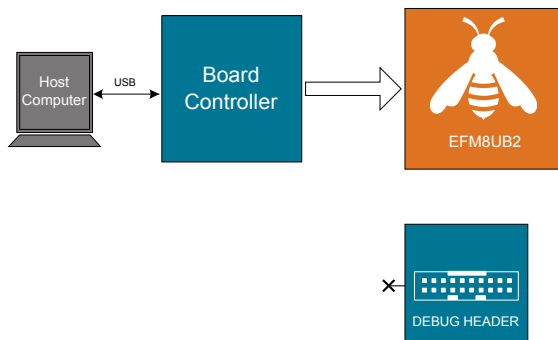
Figure 8.1. Debug MCU

Debug OUT: In this mode, the on-board debugger can be used to debug a supported Silicon Labs device mounted on a custom board.
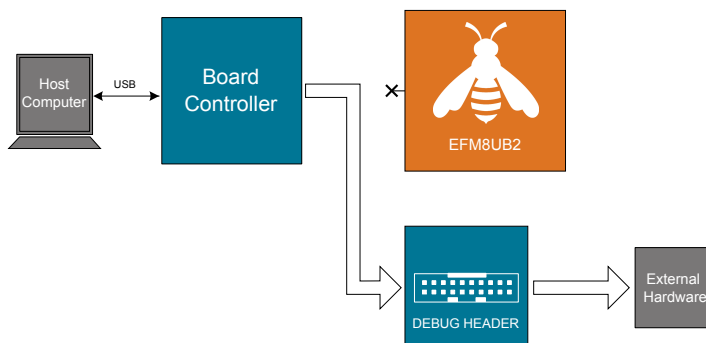
Figure 8.2. Debug OUT

Debug IN: In this mode, the on-board debugger is disconnected and an external debugger can be connected to debug the EFM8UB2 on the kit.
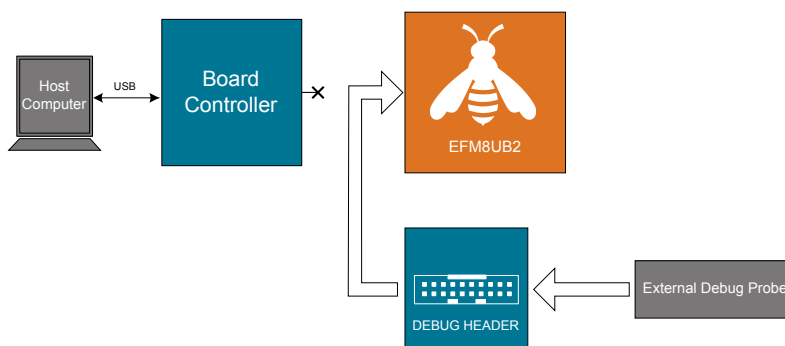
Figure 8.3. Debug IN

Note: For "Debug IN" to work, the kit board controller must be powered through the Debug USB connector.

8.2 Debugging During Battery Operation

When the EFM8UB2 is battery-powered and the J-Link USB is still connected, the on-board debug functionality is available. If the USB power is disconnected, the Debug IN mode will stop working.

If debug access is required when the target is running off another energy source, such as a battery, and the board controller is powered down, make direct connections to the GPIOs used for debugging, which are exposed on the breakout pads.

9. 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 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 are shown. Click the [**Change**] link next to any of these settings to open the kit configuration dialog.
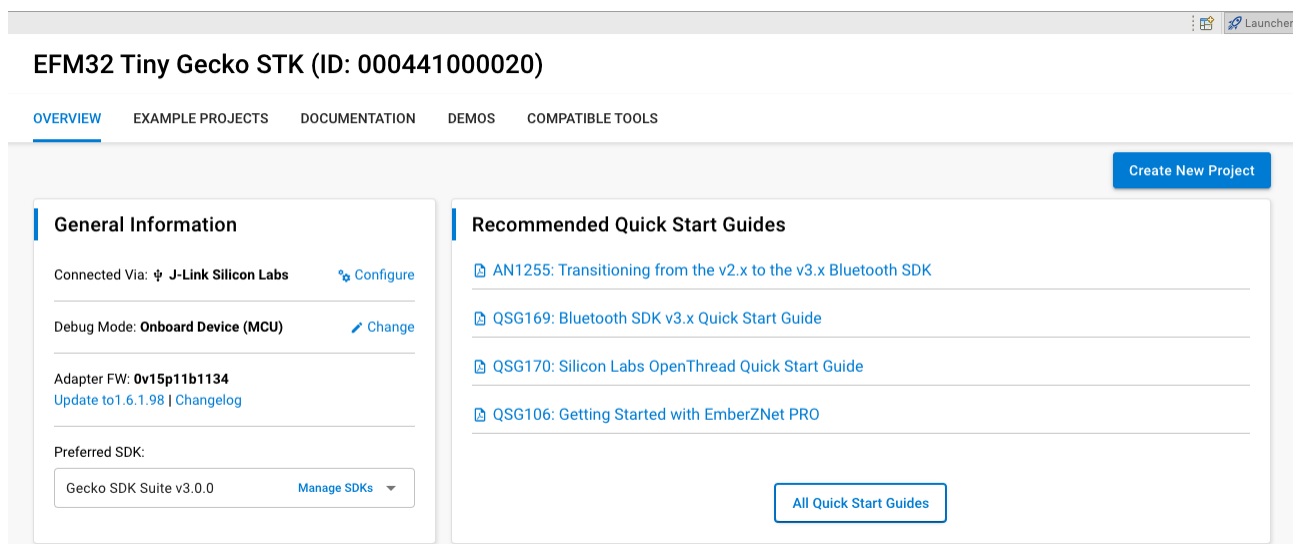
Figure 9.1. Simplicity Studio Kit Information
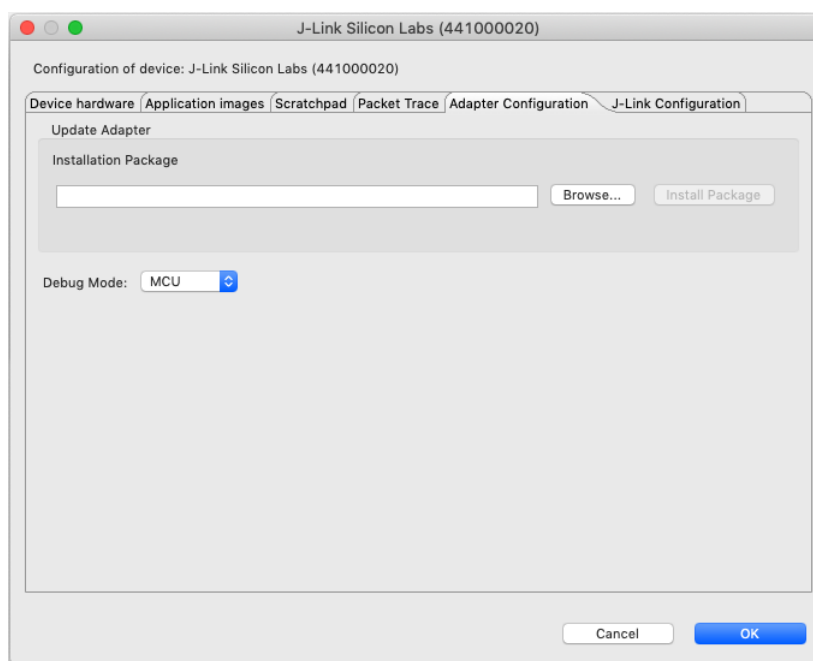
Figure 9.2. Kit Configuration Dialog

9.1 Firmware Upgrades

You can upgrade the kit firmware 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.

10. 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. They are also available from the kit page on the Silicon Labs website: silabs.com.

11. Kit Revision History and Errata

11.1 Revision History

The kit revision can be found printed on the box label of the kit, as outlined in the figure below.

Figure 11.1. Revision Information

Table 11.1. Kit Revision History

Kit Revision	Released	Description
C00	2022-07-12	New revision to include BRD5001B Rev. A01, updated to new STK platform with USB-C .
B06	2020-09-09	New revision to include BRD5001A Rev. A09.
B05	2020-09-09	New revision to include BRD5001A Rev. A08.
B04	2020-04-22	New revision to include BRD5001A Rev. A07.
B03	2020-01-14	New revision to include BRD5001A Rev. A06.
B02	2019-12-06	New revision to include BRD5001A Rev. A05.
B01	2017-12-19	New revision to include BRD5001A Rev. A04.
B00	2015-03-23	New revision to include BRD5001A Rev. A03.
A02	2015-02-11	New revision to include BRD5001A Rev. A02.
A01	2014-12-18	New revision to include BRD5001A Rev. A01.
A00	2014-12-01	Initial Kit Revision.

11.2 Errata

There are no known errata at present.

12. Document Revision History

Revision 1.0

March 2024

Updated user guide to reflect new major board revision (BRD5001B).

Revision 0.3

January 2018

Updated Expansion Header with the correct pin label for EXP13.

Revision 0.2

June 2016

Updated screenshots and instructions for Simplicity Studio v4

Added Board Revision History

Added the UG241 document reference

Added a note to 6.3 Debug Connector that VTARGET is required

Added the reference for the direct debug connector to 6.4 Direct Debug Connector

Added a note about high l;oading on the DISP CLK signal

Revision 0.1

Febreary 2015

Initial document version.

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