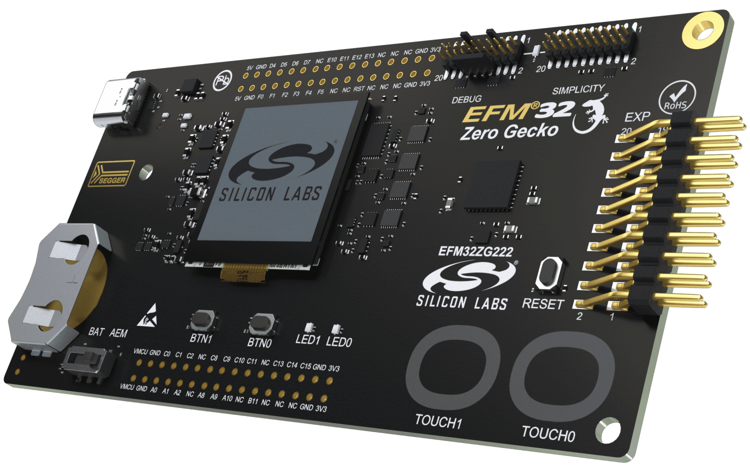
UG421: EFM32ZG Gecko Starter Kit User's Guide

The EFM32ZG-STK3200A is an excellent starting point to become familiar with the EFM32ZG™ Gecko Microcontroller.

The Starter Kit contains sensors and peripherals demonstrating some of the EFM32ZG's many capabilities. The kit provides all necessary tools for developing an EFM32ZG Gecko application.



TARGET DEVICE

- EFM32ZG Gecko Microcontroller (EFM32ZG222F32-B-QFP48)
- CPU: 32-bit ARM® Cortex-M0+®
- Memory: 32 kB flash and 4 kB RAM

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
- Ultra low power 128x128 pixel Memory LCD
- Capacitive Touch Pads
- 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™
- IAR Embedded Workbench
- Keil MDK

Table of Contents

1. Introduction

1.1 Description

The EFM32ZG-STK3200A is an ideal starting point for application development on the EFM32ZG Gecko Microcontrollers. The board features sensors and peripherals, demonstrating some of the many capabilities of the EFM32ZG Gecko Microcontroller. Additionally, the board is a fully featured debugger and energy monitoring tool that can be used with external applications.

1.2 Features

- EFM32ZG Gecko Microcontroller
  - 32 kB Flash
  - 4 kB 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 2 RGB LEDs connected to EFM32 for user interaction
- 2 capacitive touch buttons for user interaction
- Crystals for LFXO and HFXO: 32.768 kHz and 24.000 MHz.

1.3 Getting Started

Detailed instructions for how to get started with your new EFM32ZG-STK3200A can be found on the Silicon Labs Web pages:

https://www.silabs.com/mcu/32-bit/efm32-zero-gecko

2. Kit Block Diagram

An overview of the EFM32 Zero Gecko Starter Kit is shown in the figure below.

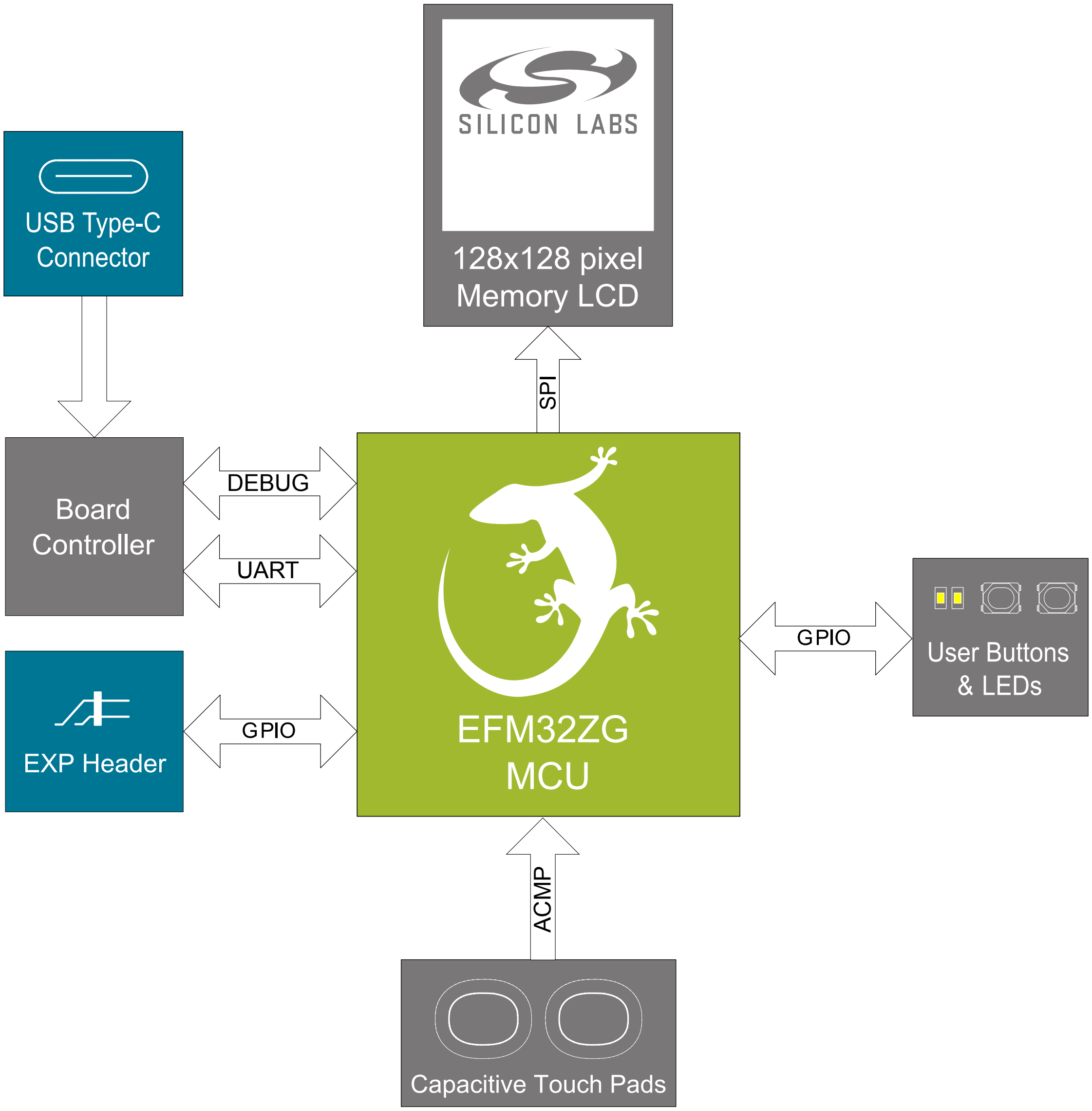


Figure 2.1. Kit Block Diagram

3. Kit Hardware Layout

The EFM32 Zero Gecko Starter Kit layout is shown below.

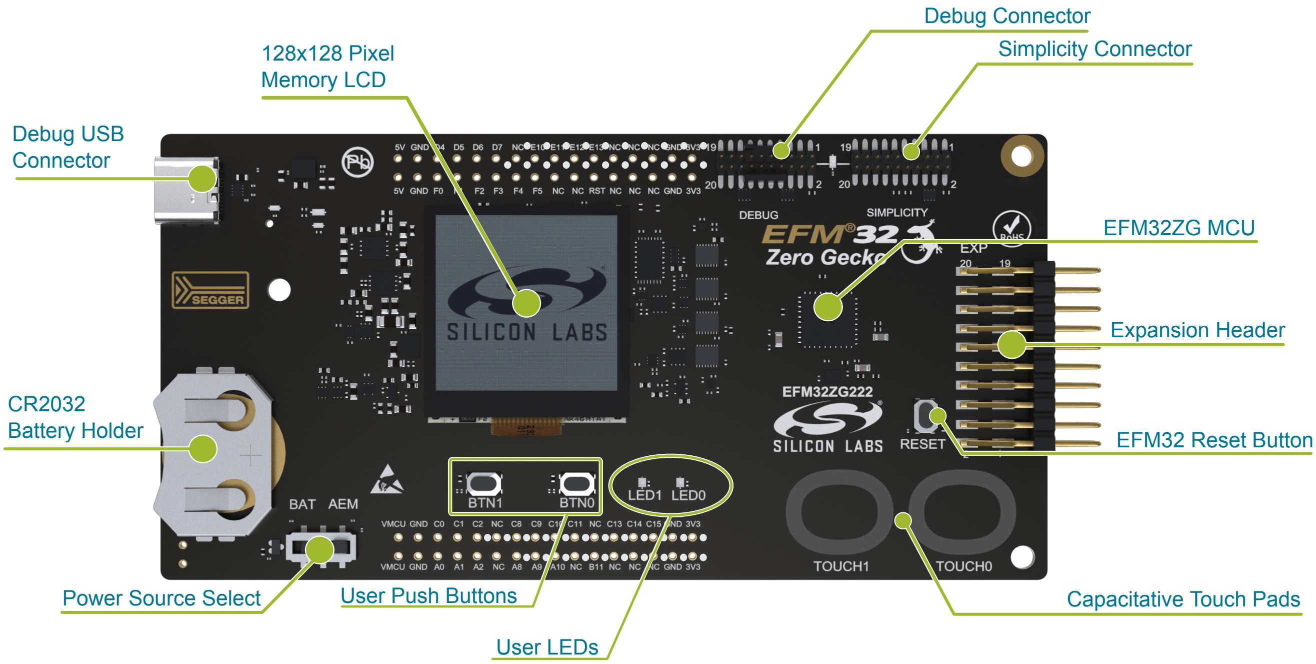


Figure 3.1. EFM32ZG-STK3200A Hardware Layout

4. Connectors

4.1 Breakout Pads

Most of the EFM32ZG'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.

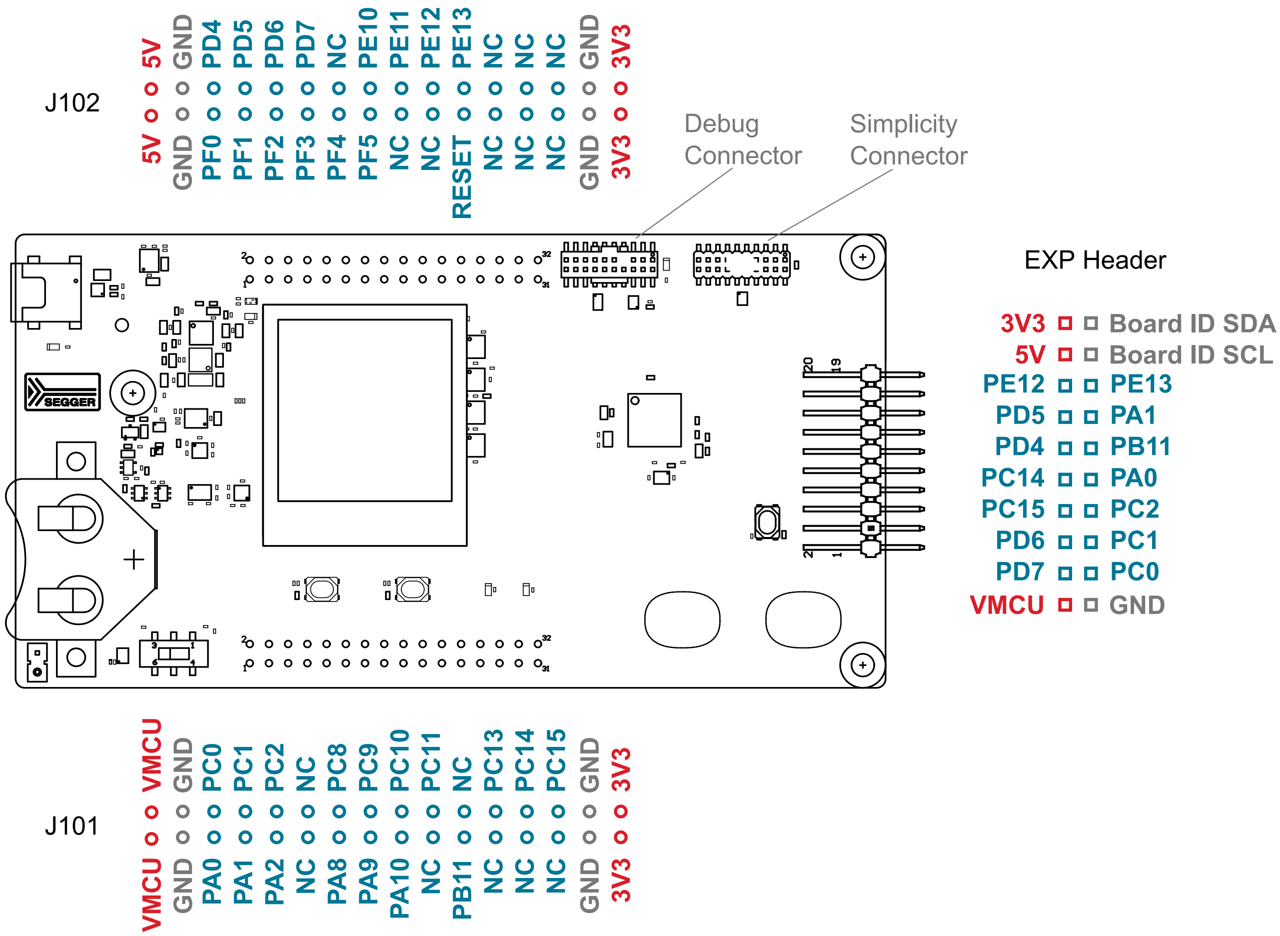


Figure 4.1. Breakout Pads and Expansion Header

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	EFM32ZG I/O pin	Shared feature		Pin	EFM32ZG I/O pin	Shared feature
1	VMCU	EFM32ZG voltage domain (measured by AEM)		2	VMCU	EFM32ZG voltage domain (measured by AEM)
3	GND	Ground		4	GND	Ground
5	PA0	EXP9		6	PC0	EXP3

Pin	EFM32ZG I/O pin	Shared feature		Pin	EFM32ZG I/O pin	Shared feature
7	PA1	EXP13		8	PC1	EXP5
9	PA2			10	PC2	EXP7
11	NC			12	NC	
13	PA8	DISP_ENABLE		14	PC8	UIF_BUTTON0
15	PA9	VCOM_ENABLE		16	PC9	UIF_BUTTON1
17	PA10	DISP_PWR_ENABLE		18	PC10	UIF_LED0
19	NC			20	PC11	UIF_LED1
21	PB11	EXP11		22	NC	
23	NC			24	PC13	
25	NC			26	PC14	EXP10
27	NC			28	PC15	EXP8, DISP_SCLK
29	GND	Ground		30	GND	Ground
31	3V3	Board controller supply		32	3V3	Board controller supply

Table 4.2. Top Row (J102) Pinout

Pin	EFM32ZG I/O pin	Shared feature		Pin	EFM32ZG I/O pin	Shared feature
1	5V	Board USB voltage		2	5V	Board USB voltage
3	GND	Ground		4	GND	Ground
5	PF0	DEBUG_SWCLK		6	PD4	EXP12, VCOM_TX
7	PF1	DEBUG_SWDIO		8	PD5	EXP14, VCOM_RX
9	PF2			10	PD6	EXP6
11	PF3			12	PD7	EXP4, DISP_SI
13	PF4			14	NC	
15	PF5			16	PE10	DISP_COM
17	NC			18	PE11	DISP_CS
19	NC			20	PE12	EXP16
21	RESET	Target reset pin		22	PE13	EXP15
23	NC			24	NC	
25	NC			26	NC	
27	NC			28	NC	
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 EFM32ZG Gecko'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 EFM32 Zero Gecko Starter Kit. Because of limitations in the number of available GPIO pins, some of the EXP header pins are shared with kit features.

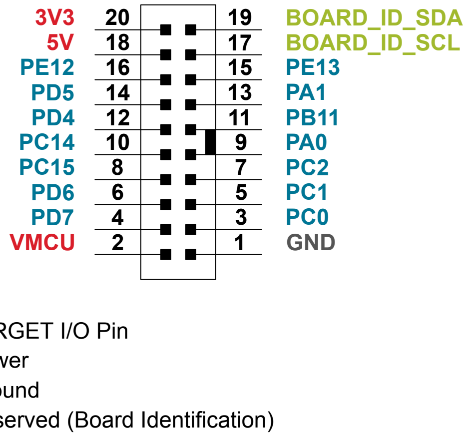


Figure 4.2. EXP Header

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	PE12	I2C_SDA		I2C0_SDA
14	PD5	UART_RX	ADC0_CH5	LEUART0_RX
12	PD4	UART_TX	ADC0_CH4	LEUART0_TX
10	PC14	SPI_CS		USART1_CS
8	PC15	SPI_SCLK		USART1_CLK
6	PD6	SPI_MISO	ADC0_CH6	USART1_RX
4	PD7	SPI_MOSI	ADC0_CH7	USART1_TX
2	VMCU	EFM32ZG 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	PE13	I2C_SCL		I2C0_SCL
13	PA1	GPIO		
11	PB11	IDAC_OUT		IDAC0_OUT
9	PA0			

Pin	Connection	EXP Header function	Shared feature	Peripheral mapping
7	PC2		ACMP0_CH2	
5	PC1		ACMP0_CH1	
3	PC0		ACMP0_CH0	
1	GND	Ground		

4.3 Debug Connector (DBG)

The Debug Connector serves a dual purpose, depending on the "debug mode", which can be set up using Simplicity Studio. In the "Debug IN" mode this connector allows an external debug emulator to be used with the on-board EFM32ZG. In the "Debug OUT" mode, this connector allows the kit to be used as a debugger towards an external target. In the "Debug MCU" (default) mode, this 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, connect directly to the appropriate breakout pins.

The connector pinout follows that of the standard ARM Cortex Debug+ETM 19-pin connector. The pinout is described in detail below. Note that when using the on-board debugger to debug an MCU on an external board, JTAG and ETM functionality are only available if the target device supports it.

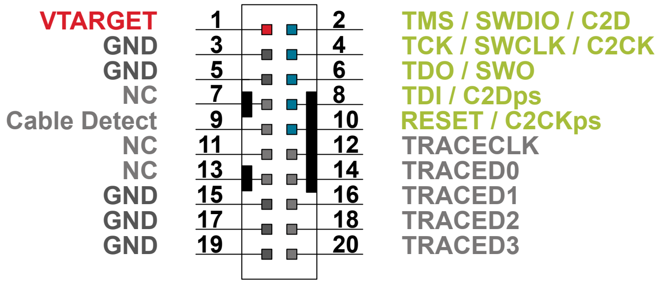


Figure 4.3. Debug Connector

Note that the pinout matches the pinout of an ARM Cortex Debug+ETM connector, but these are not fully compatible because pin 7 is physically removed from the Cortex Debug+ETM connector. Some cables have a small plug that prevent 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	TRACECLK	ETM Trace Clock
14	TRACED0	ETM Trace Data 0
16	TRACED1	ETM Trace Data 1
18	TRACED2	ETM Trace Data 2
20	TRACED3	ETM Trace Data 3
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 EFM32 Zero Gecko 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.

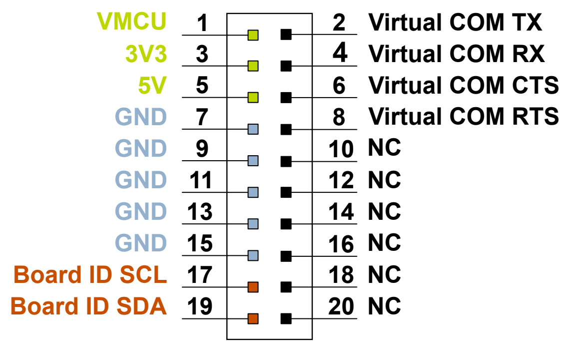


Figure 4.4. Simplicity Connector

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 EFM32ZG on the Starter Kit can be powered by one of these sources:

- The debug USB cable
- 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.

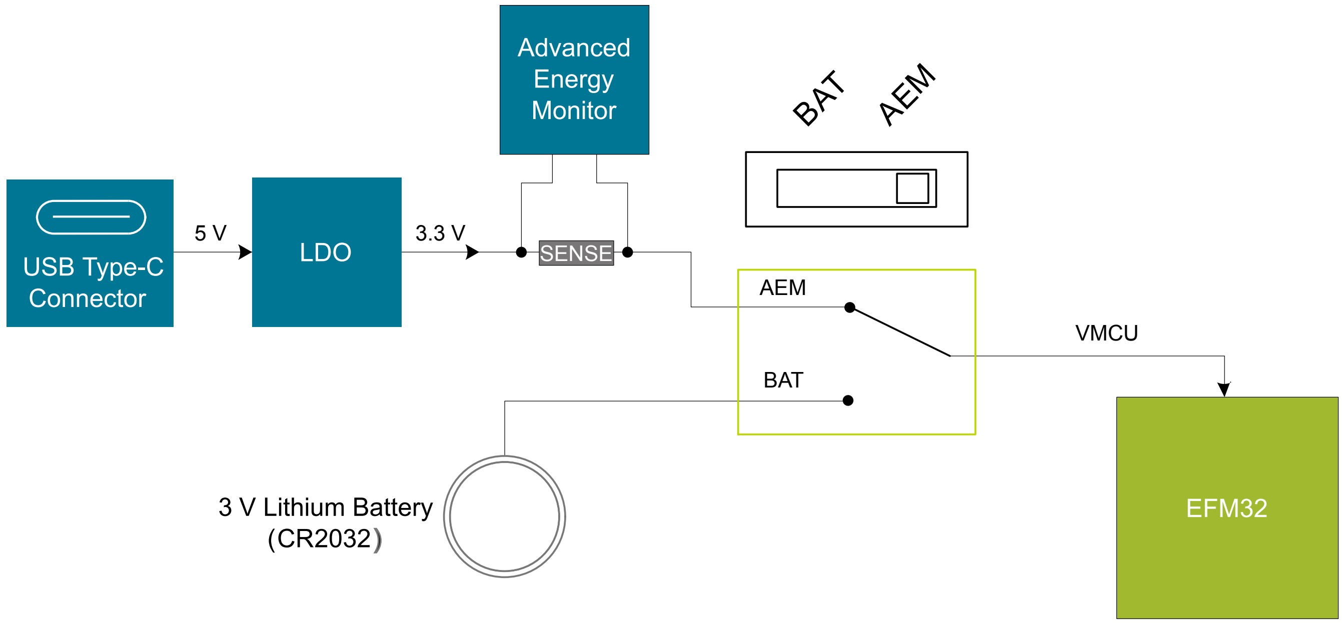


Figure 5.1. Power Switch

With the switch in the **AEM** position, a low noise 3.3 V LDO on the Starter Kit is used to power the EFM32ZG. 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 **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.

Note: The Advanced Energy Monitor can only measure the current consumption of the EFM32ZG when the power selection switch is in the **AEM** position.

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 EFM32ZG device will continue to operate in the **BAT** mode.

5.3 EFM32ZG Reset

The EFM32ZG 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 EFM32ZG 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 EFM32ZG features.

Note that most EFM32ZG 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 LEDs

The kit has two user push buttons marked BTN0 and BTN1. They are connected directly to the EFM32ZG and are debounced by RC filters with a time constant of 1 ms. The buttons are connected to pins PC8 and PC9.

The kit also features two yellow LEDs marked LED0 and LED1 that are controlled by GPIO pins on the EFM32ZG. The LEDs are connected to pins PC10 and PC11 in an active-high configuration.

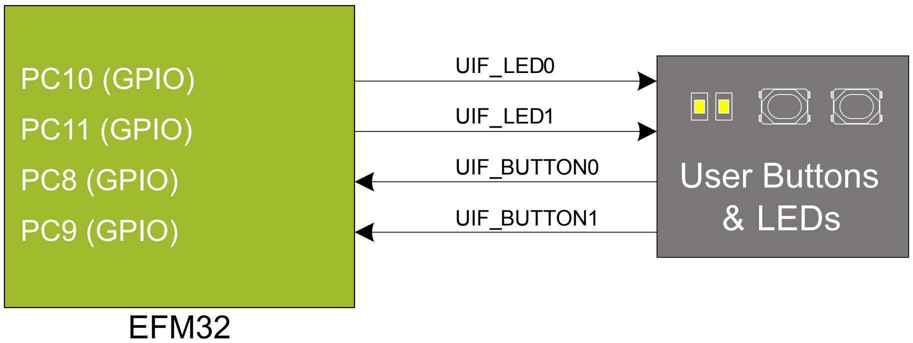


Figure 6.1. Buttons and LEDs

6.2 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 continous refreshing is required to maintain a static image.

The display interface consists of an 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 (EFM32ZG) has control of the display

EFM_DISP_PWR (PA10) enables power to the display, and must be set high to use the display. 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.

DISP_EXTCOMIN is the "COM Inversion" line, which must be pulsed periodically to prevent static build-up in the display itself. Refer to the LS013B7DH03 documentation for more information on driving the display.

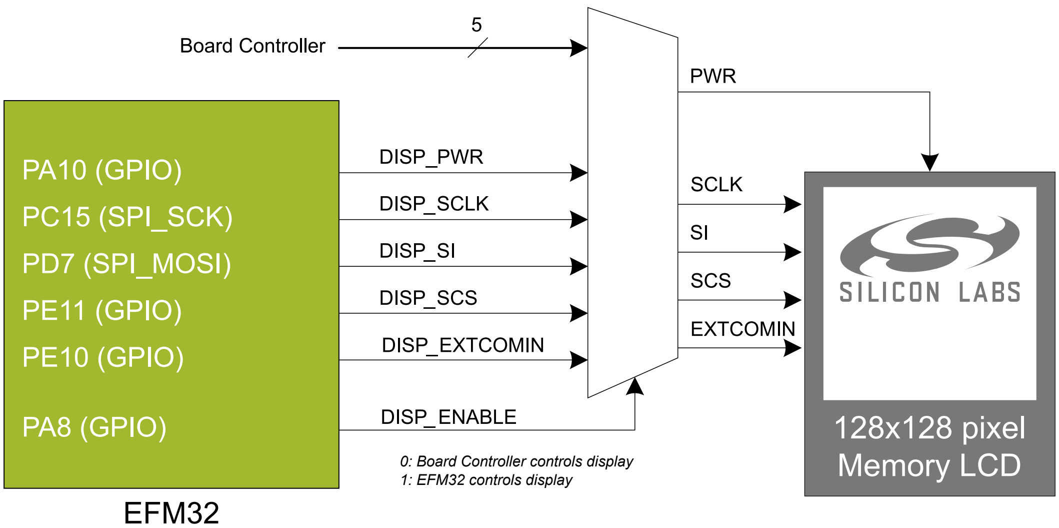


Figure 6.2. 128x128 Pixel Memory LCD

6.3 Capacitive Touch Pads

Two touch pads are available, TOUCH0 and TOUCH1, utilizing the capacitive touch capability of the EFM32ZG. They are located on the lower right side of the board, beneath the EFM32ZG. The pads are connected to PC4 and PC3.

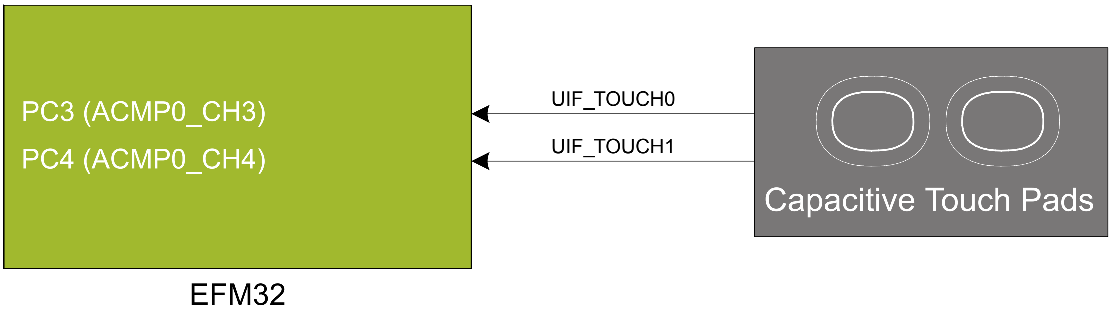


Figure 6.3. Touch Pads

The capacitive touch pads work by sensing changes in the capacitance of the pads when touched by a human finger. Sensing the changes in capacitance involves setting up the touch pad as part of an RC relaxation oscillator using the EFM32ZG's analog comparator and then counting the number of oscillations during a fixed period of time.

6.4 Virtual COM Port

An asynchronous serial connection to the board controller is provided for application data transfer between a host PC and the target EFM32ZG, which eliminates the need for an external serial port adapter.

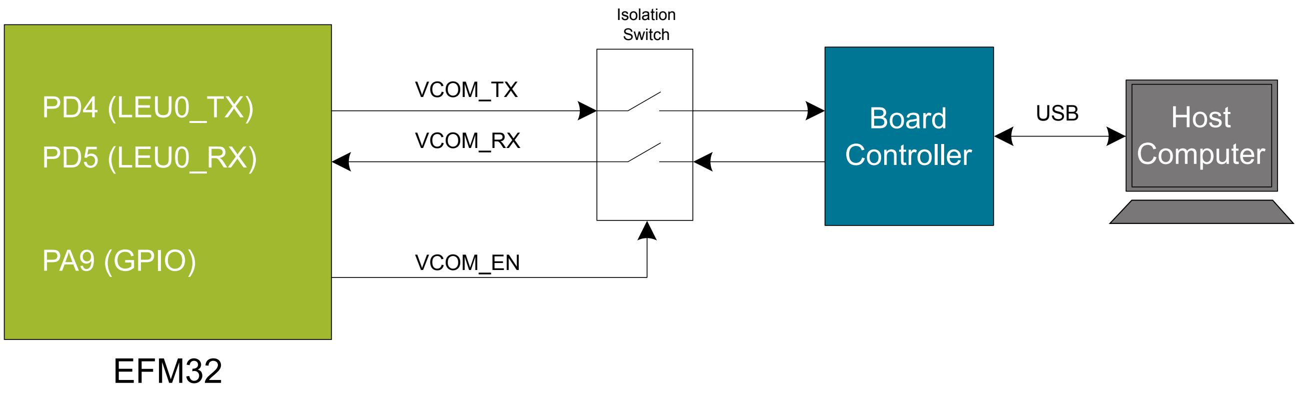


Figure 6.4. Virtual COM Port Interface

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 6.1. Virtual COM Port Interface Pins

Signal	Description
VCOM_TX	Transmit data from the EFM32ZG to the board controller
VCOM_RX	Receive data from the board controller to the EFM32ZG
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 EFM32ZG 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.

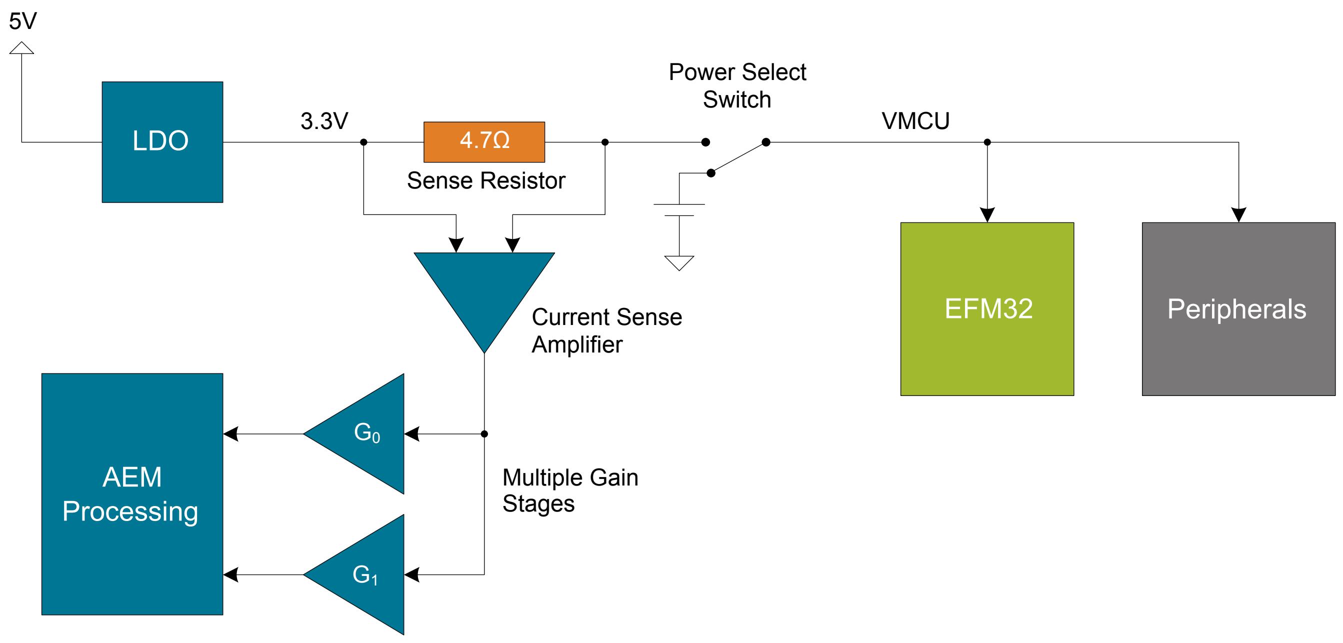


Figure 7.1. Advanced Energy Monitor

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 EFM32ZG-STK3200A contains an integrated debugger, which can be used to download code and debug the EFM32ZG. In addition to programming the EFM32ZG 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 EFM32ZG 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 EFM32ZG on the kit.

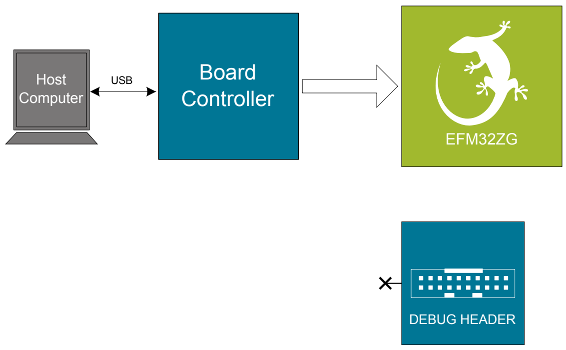


Figure 8.1. Debug MCU

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

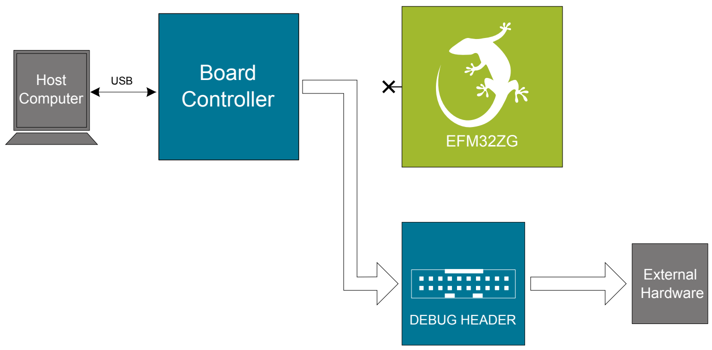


Figure 8.2. Debug OUT

Debug IN: In this mode, the on-board debugger is disconnected and an external debugger can be connected to debug the EFM32ZG on the kit.

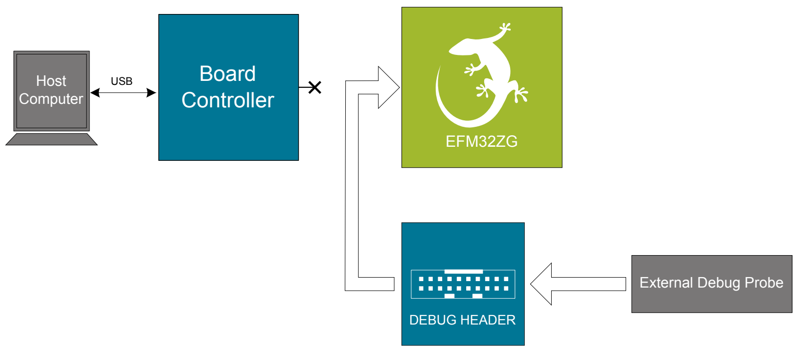


Figure 8.3. Debug IN

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 EFM32ZG 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.

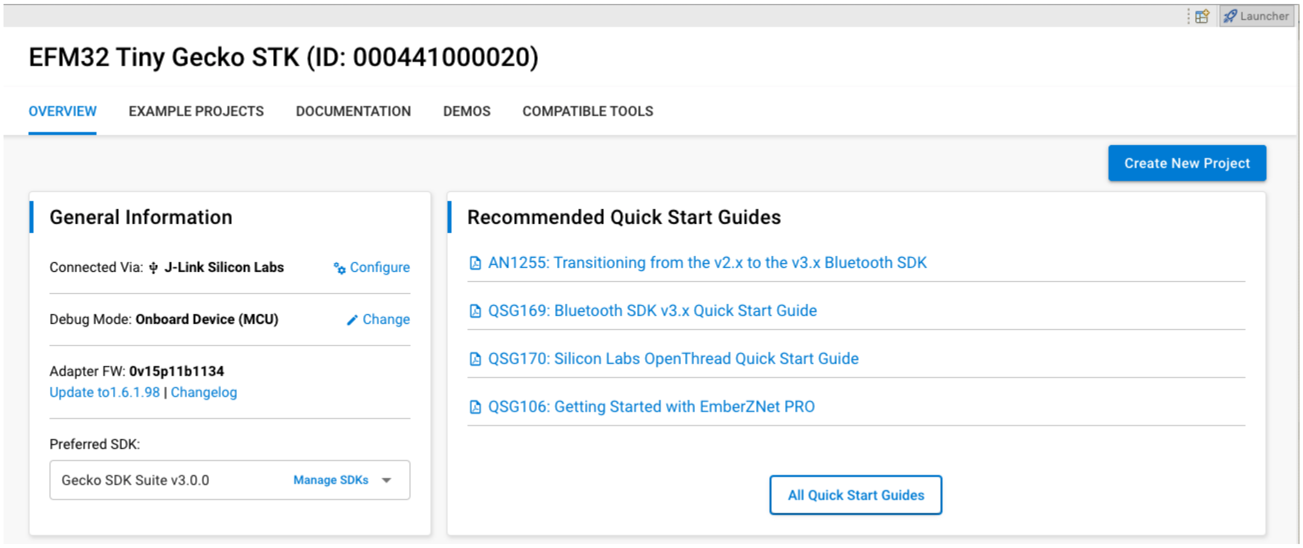


Figure 9.1. Simplicity Studio Kit Information

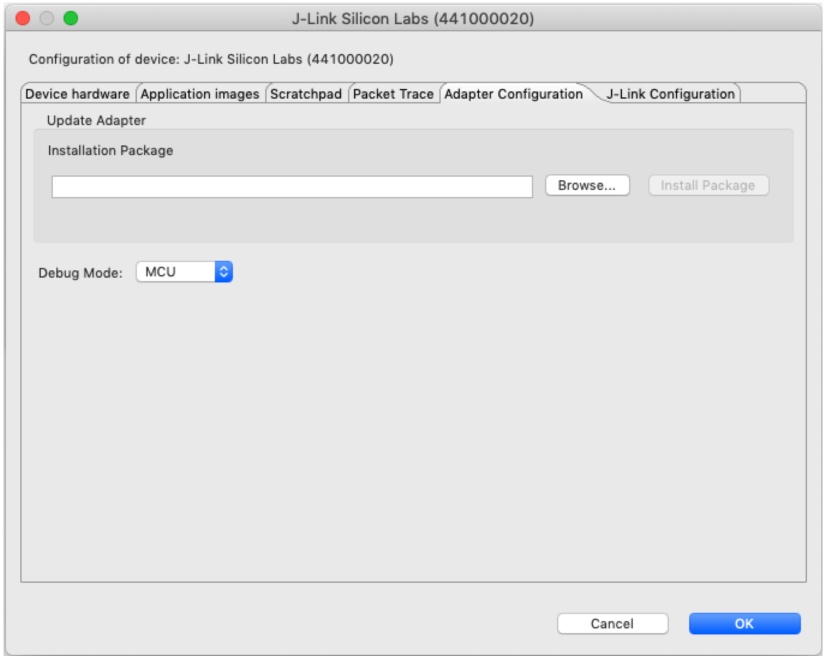


Figure 9.2. Kit Configuration Dialog

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.

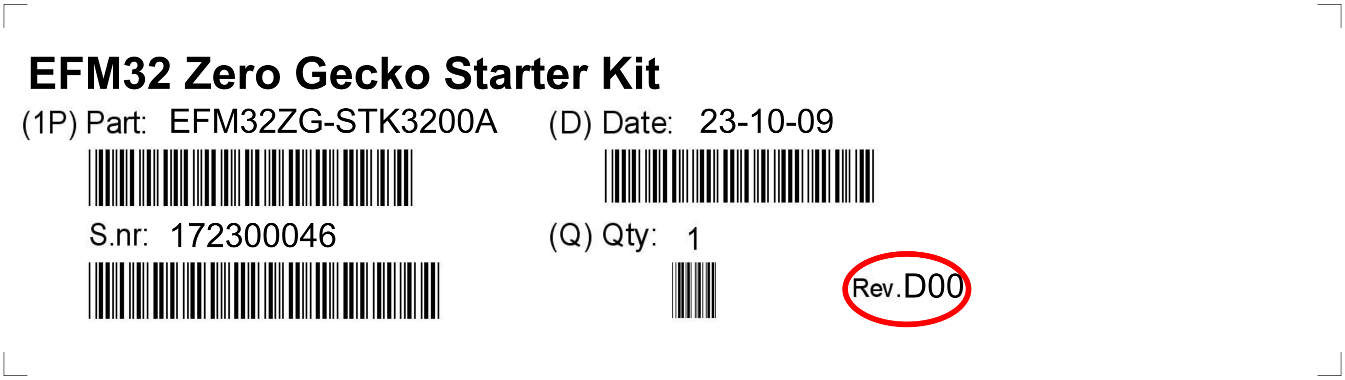


Figure 11.1. Revision Information

Table 11.1. Kit Revision History

Kit Revision	Released	Description
D00	09 October 2023	New revision to include BRD2010B Rev. A00, updated to new STK platform with USB-C.
C01	18 November 2019	Upgraded board controller section.
A00	20 September 2013	Initial Kit Revision.

11.2 Errata

There are no known errata at present.

12. Document Revision History

2.00

October, 2023

- Updated user guide to reflect new major board revision (BRD2010B).

1.01

March, 2020

- Updated document to current template.

1.00

October, 2013

- Initial document version.

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