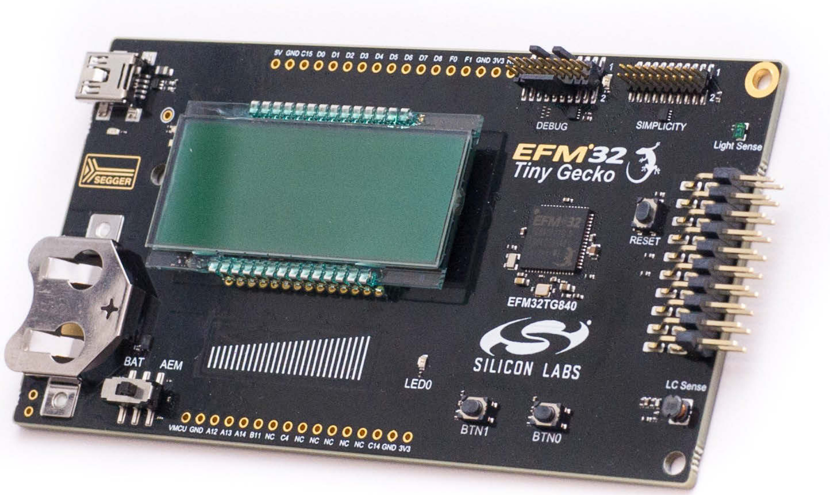
UG420: EFM32TG Gecko Starter Kit User's Guide

The EFM32TG-STK3300 Starter Kit is an excellent starting point to become familiar with the EFM32TG™ Gecko Microcontroller.

The Starter Kit contains sensors and peripherals demonstrating some of the EFM32TG's many capabilities. The kit provides all necessary tools for developing an EFM32TG Gecko application.



TARGET DEVICE

- EFM32TG Gecko Microcontroller (EFM32TG840F32-D-QFN64)
- CPU: 32-bit ARM® Cortex-M3
- 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
- User LED and push buttons
- 8x20 segment LCD
- Inductive LC sensor
- Photo transistor for light sensing applications
- 4-segment capacitive touch slider
- 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

Table of Contents

1. Introduction

1.1 Description

The EFM32TG-STK3300 can serve as a starting point for application development. The board features sensors and peripherals, demonstrating some of the many capabilities of the EFM32TG Gecko Microcontroller. Additionally, the board is a fully featured debugger and energy monitoring tool that can be used with external applications.

1.2 Features

- EFM32TG Gecko Microcontroller
  - 32 kB Flash
  - 4 kB RAM
  - QFN64 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
- 8x20 segment LCD
- 2 push buttons and 1 LED connected to EFM32 for user interaction
- 4-segment capacitive touch slider
- LC tank circuit for inductive proximity sensing of metallic objects
- Photo transistor for light sensing applications
- Crystals for LFXO and HFXO: 32.768 kHz and 32.000 MHz

1.3 Getting Started

Detailed instructions for how to get started with your new EFM32TG-STK3300 can be found on the Silicon Labs Web pages:

silabs.com/mcu/32-bit/efm32-tiny-gecko

2. Kit Block Diagram

An overview of the EFM32TG Gecko Starter Kit is shown in the figure below.

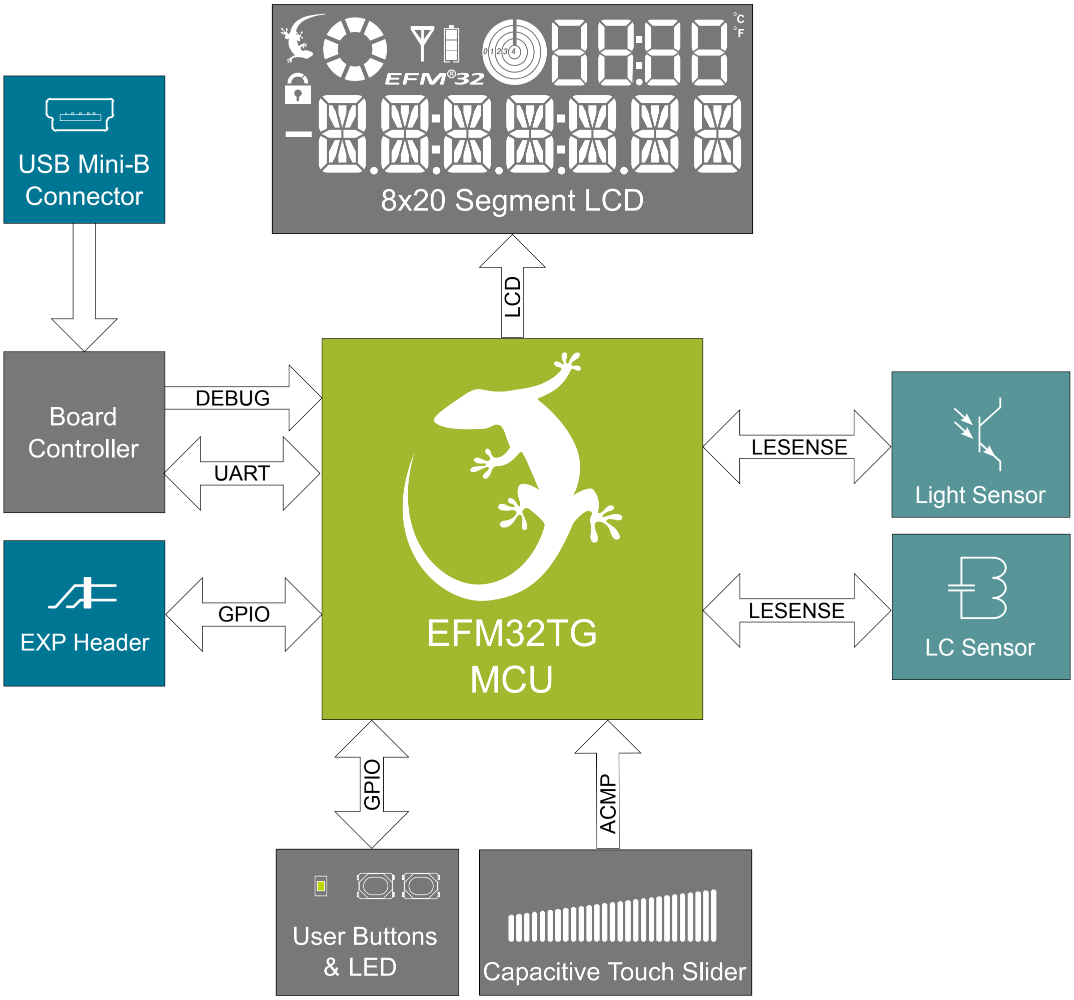


Figure 2.1. Kit Block Diagram

3. Kit Hardware Layout

The layout of the EFM32TG Gecko Starter Kit is shown below.

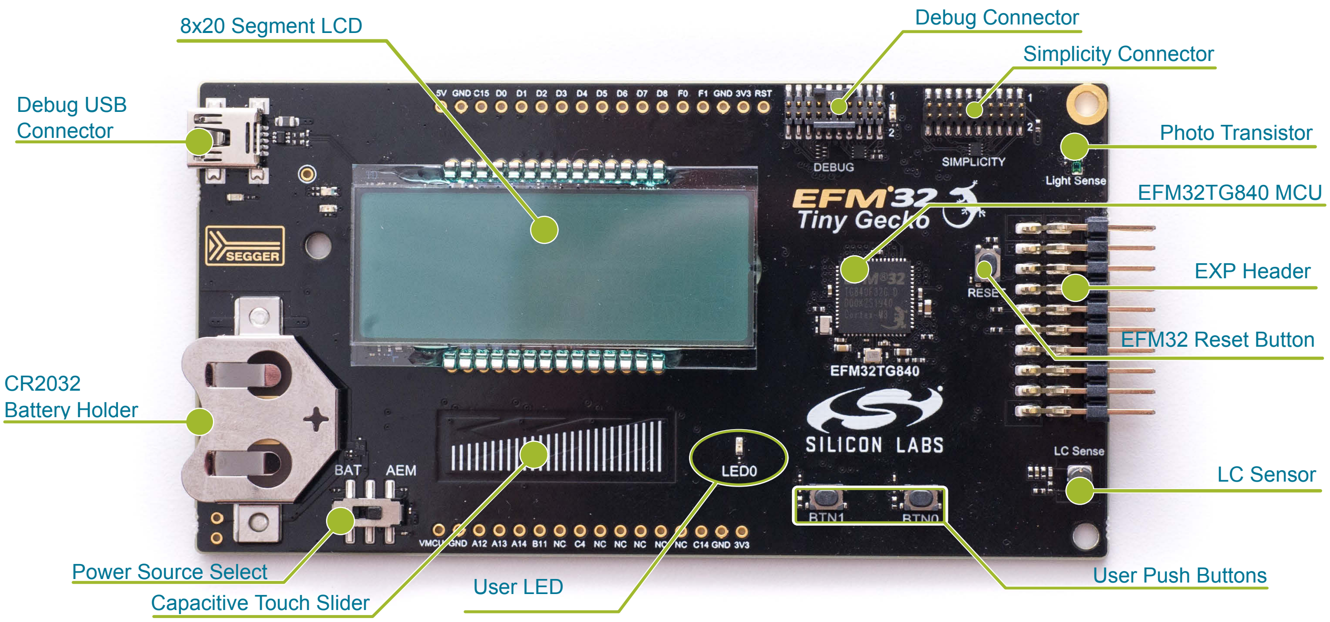


Figure 3.1. EFM32TG-STK3300 Hardware Layout

4. Connectors

4.1 Breakout Pads

Most of the EFM32TG'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 silk screen next to each pin for easy reference.

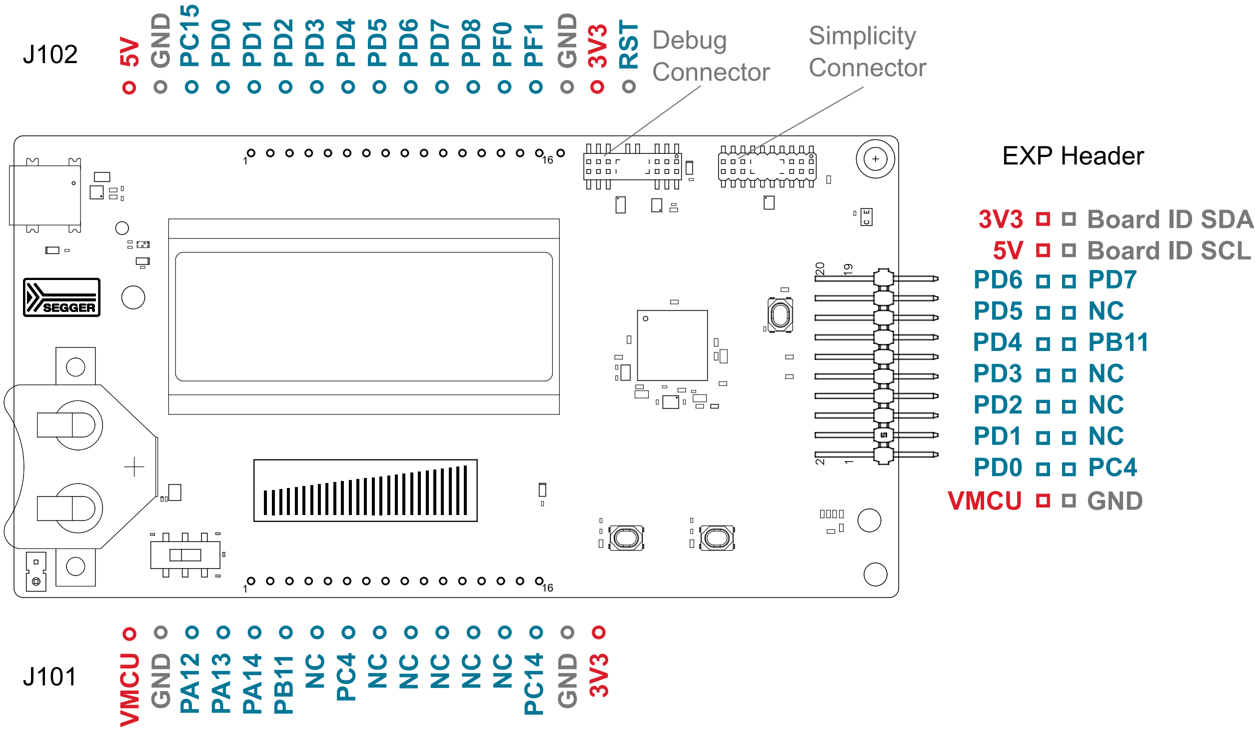


Figure 4.1. Breakout Pads and Expansion Header

The table below shows the connections of each pin 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	EFM32TG I/O pin	Shared Feature
1	VMCU	EFM32TG voltage domain (measured by AEM)
2	GND	Ground
3	PA12	LCD_BCAP_P
4	PA13	LCD_BCAP_N
5	PA14	LCD_BEXT
6	PB11	BTN1 / EXP11
7	NC	
8	PC4	LES_LIGHT_SENSE / EXP3
9	NC	

Pin	EFM32TG I/O pin	Shared Feature
10	NC	
11	NC	
12	NC	
13	NC	
14	PC14	VCOM_ENABLE
15	GND	Ground
16	3V3	Board controller supply

Table 4.2. Top Row (J102) Pinout

Pin	EFM32TG I/O pin	Shared Feature
1	5V	Board USB voltage
2	GND	Ground
3	PC15	DEBUG_SWO
4	PD0	EXP4
5	PD1	EXP6
6	PD2	EXP8
7	PD3	OPAMP2_NEG / EXP10
8	PD4	OPAMP2_POS / EXP12
9	PD5	OPAMP2_OUT / EXP14
10	PD6	LES_LIGHT_EXCITE / VCOM_RX / EXP16
11	PD7	LED0 / VCOM_TX / EXP15
12	PD8	BUTTON0
13	PF0	DEBUG_SWCLK
14	PF1	DEBUG_SWDIO
15	GND	Ground
16	3V3	Board controller supply

4.2 EXP Header

On the right hand 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 EFM32TG Gecko's features. Additionally, the VMCU, 3V3 and 5V power rails are also exported.

The connector follows a standard which ensures that commonly used peripherals such as a SPI, a UART, and I²C bus are available on fixed locations in the connector. The rest of the pins are used for general purpose I/O. This allows the definition of expansion boards that can plug into a number of different Silicon Labs starter kits.

The figure below shows the pin assignment of the EXP header for the EFM32TG Gecko Starter Kit. Because of limitations in the number of available GPIO pins, some of the EXP header pins are shared with kit features.

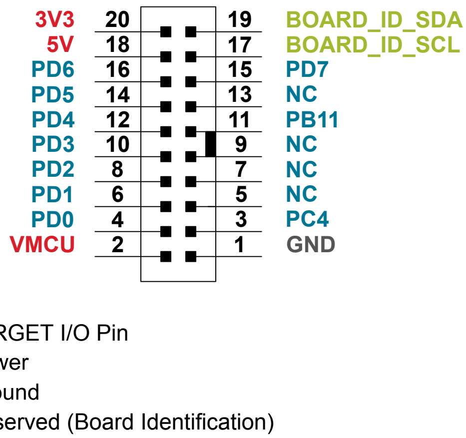


Figure 4.2. EXP Header

Table 4.3. EXP Header Pinout

Pin	Connection	EXP Header Function	Analog Peripheral	Peripheral Mapping
20	3V3	Board controller supply		
18	5V	Board controller USB voltage		
16	PD6	I2C_SDA		I2C0_SDA #1
14	PD5	UART_RX	ADC0_CH5	LEUART0_RX #0
12	PD4	UART_TX	ADC0_CH4	LEUART0_TX #0
10	PD3	SPI_CS	ADC0_CH3	USART1_CS #1
8	PD2	SPI_SCLK	ADC0_CH2	USART1_CLK #1
6	PD1	SPI_MISO	ADC0_CH1	USART1_RX #1
4	PD0	SPI_MOSI	ADC0_CH0	USART1_TX #1
2	VMCU	EFM32TG 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	PD7	I2C_SCL	ADC0_CH7	I2C0_SCL #1
13	NC			
11	PB11	GPIO	DAC0_OUT0	
9	NC			

Pin	Connection	EXP Header Function	Analog Peripheral	Peripheral Mapping
7	NC			
5	NC			
3	PC4	GPIO	ACMP0_CH4	
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 EFM32TG. 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.

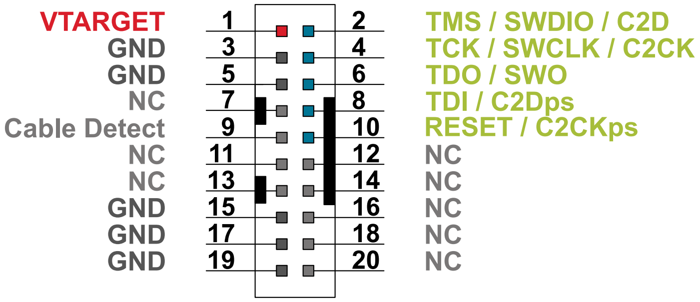


Figure 4.3. Debug Connector

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 Starter Kit enables advanced debugging features such as the AEM and the Virtual COM port to be used towards an external target. The pinout is illustrated in the figure below.

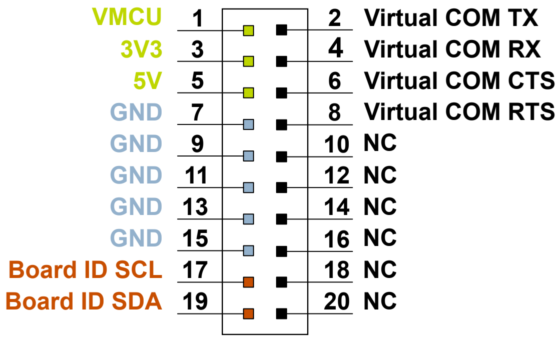


Figure 4.4. Simplicity Connector

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	EXT_ID_SCL	Board ID SCL
19	EXT_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 EFM32TG 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.

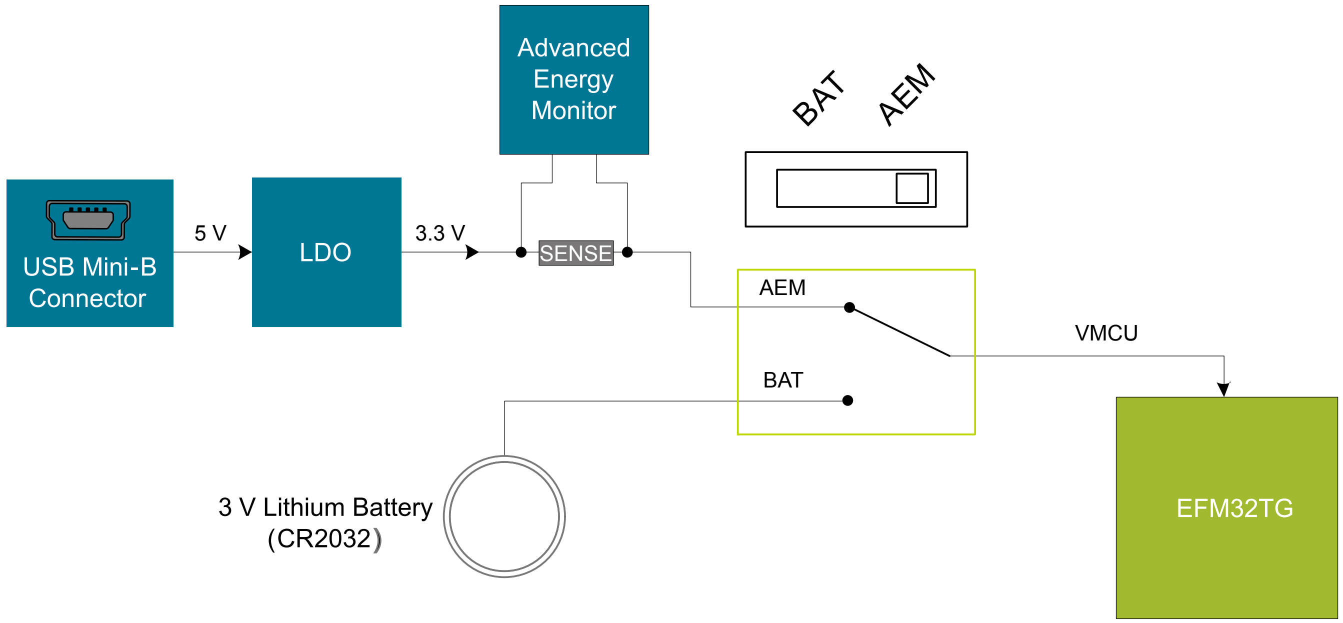


Figure 5.1. Power Switch

With the switch in the **AEM** position, a low noise 3.3 V LDO on the Starter Kit is used to power the EFM32TG. 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 EFM32TG 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 EFM32TG device will continue to operate in the **BAT** mode.

5.3 EFM32TG Reset

The EFM32TG 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 EFM32TG 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 features of the EFM32TG.

Note that most EFM32TG I/O routed to peripherals are also routed to the breakout pads or the EXP header, which must be taken into consideration when using these.

6.1 Push Buttons and LEDs

The kit has two user push buttons marked BTN0 and BTN1. They are connected directly to the EFM32TG and are debounced by RC filters with a time constant of 1 ms. The buttons are connected to pins PD8 and PB11.

The kit also features a yellow LED marked LED0, which is controlled by a GPIO pin on the EFM32TG. The LED is connected to pin PD7 in an active-high configuration.

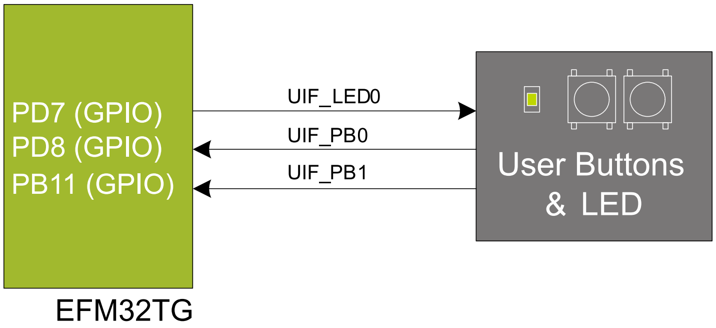


Figure 6.1. Buttons and LEDs

6.2 LCD

A 28-pin segment LCD is connected to the EFM32's LCD peripheral. The LCD has 8 common lines and 20 segment lines, giving a total of 160 segments in octaplex mode. These lines are not shared on the breakout pads. Refer to the kit schematic for information on signals to segments mapping.

A capacitor connected to the EFM32 LCD peripheral's voltage boost pin is also available on the kit.

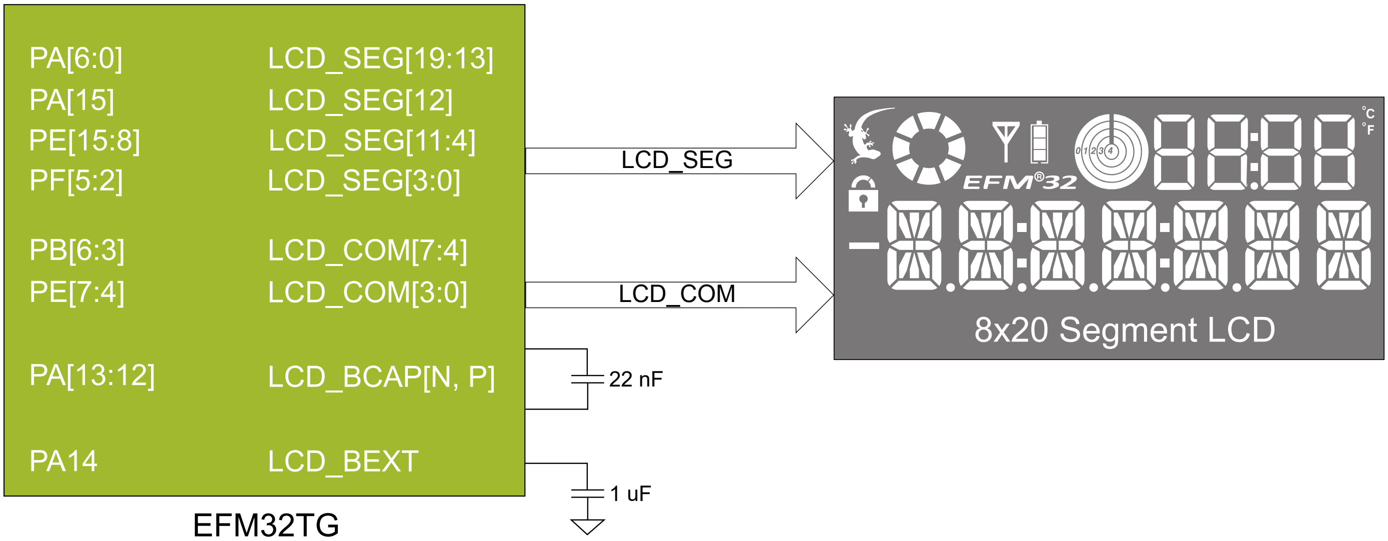


Figure 6.2. Segment LCD

6.3 Capacitive Touch Slider

A touch slider utilizing the capacitive touch capability of the EFM32TG's analog comparator (ACMP) is located on the bottom side of the board. It consists of four interleaved pads which are connected to PC5, PC7, PC12, and PC13.

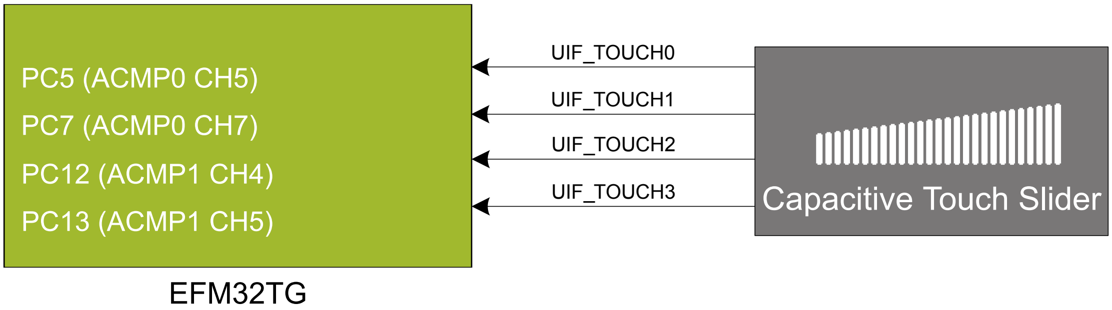


Figure 6.3. Touch Slider

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 is done by setting up the EFM32TG's analog comparator (ACMP) in capacitive touch sensing mode. For low-power operation, the Low Energy Sensor Interface (LESENSE) can be configured to continuously scan all pads.

Sensing change in capacitance is done by setting up the touch pad as part of an RC relaxation oscillator, where the analog comparator counts the number of oscillations for a fixed period of time.

For more information about usage and theory of low-energy capacitive sensing, refer to application note, AN0028: Low Energy Sensor Interface -- Capacitive Sense, which is available in Simplicity Studio or in the document library on the Silicon Labs website.

6.4 LC Sensor

In the bottom right corner of the board there is an inductive-capacitive sensor for demonstrating the Low Energy Sensor Interface (LE-SENSE). The LESENSE peripheral uses the voltage digital-to-analog converter (VDAC) to set up an oscillating current through the in-ductor and then uses the analog comparator (ACMP) to measure the oscillation decay time. The oscillation decay time will be affected by the presence of metal objects within a few millimeters of the inductor.

The LC sensor can be used for implementing a sensor that wakes up the EFM32TG from sleep when a metal object comes close to the inductor, which again can be used as a utility meter pulse counter, door alarm switch, position indicator or other applications where one wants to sense the presence of a metal object.

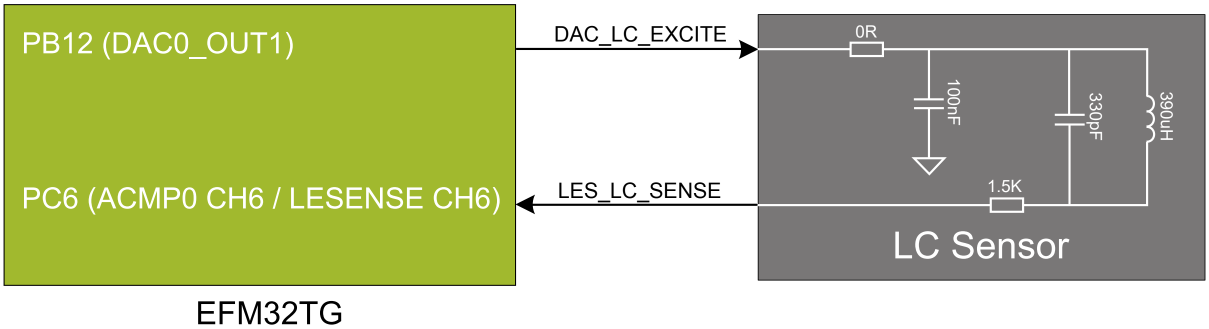


Figure 6.4. LC Metal Sensor

For more information about usage and theory of operation of the LC sensor, refer to application note, AN0029: Low Energy Sensor Interface -- Inductive Sense, which is available in Simplicity Studio or in the document library on the Silicon Labs website.

6.5 Ambient Light Sensor

In the top right corner of the board there is an ambient light sensor implemented using a TEMT6200FX01 photo transistor connected to the EFM32TG's Low Energy Sensor Interface (LESENSE) peripheral as a resistive sensor element. One pin is used for excitation of the transistor, while another senses the state of the sensor. LESENSE can take care of both the excitation and sensing part of the operation.

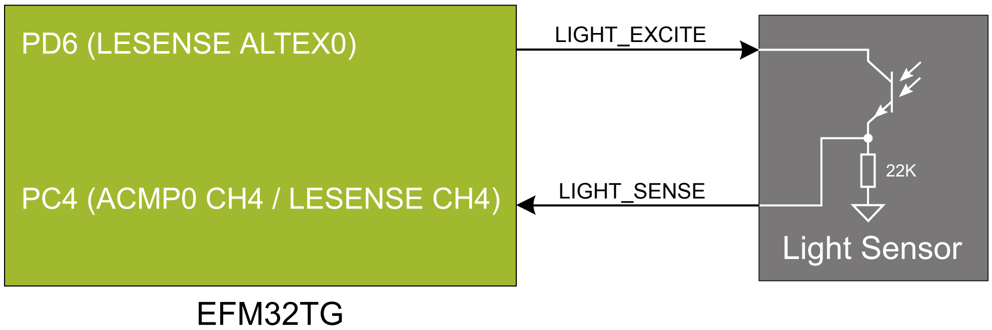


Figure 6.5. Ambient Light Sensor

For more information about using LESENSE for resistive sensor applications, refer to application note, AN0036: Low Energy Sensor Interface -- Resistive Sense, which is available in Simplicity Studio or in the document library on the Silicon Labs website.

6.6 Virtual COM Port

An asynchronous serial connection to the board controller is provided for application data transfer between a host PC and the target EFM32TG, which eliminates the need for an external serial port adapter.

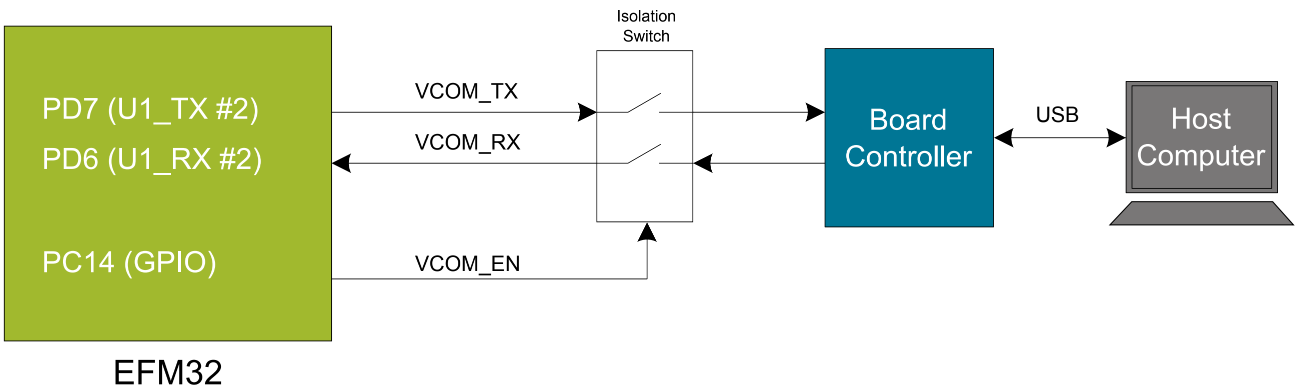


Figure 6.6. Virtual COM Port Interface

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 EFM32TG to the board controller
VCOM_RX	Receive data from the board controller to the EFM32TG
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 EFM32TG 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.

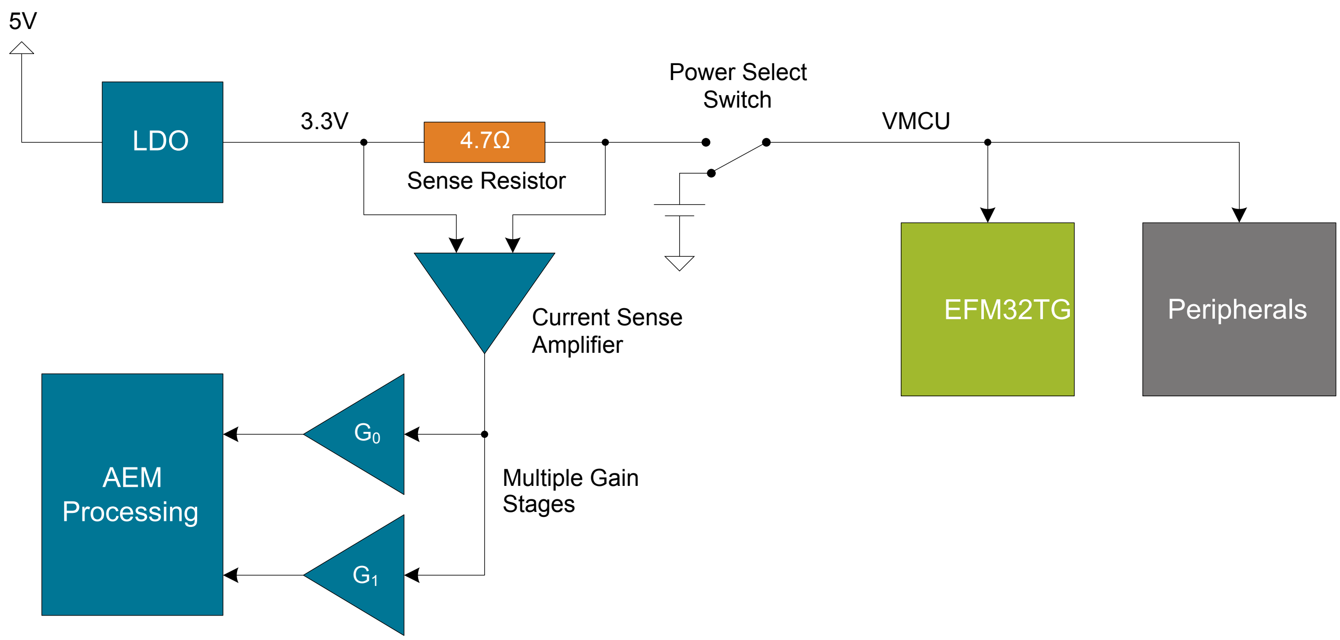


Figure 7.1. Advanced Energy Monitor

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 EFM32TG-STK3300 contains an integrated debugger, which can be used to download code and debug the EFM32TG. In addition to programming the EFM32TG 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 EFM32TG 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 EFM32TG on the kit.

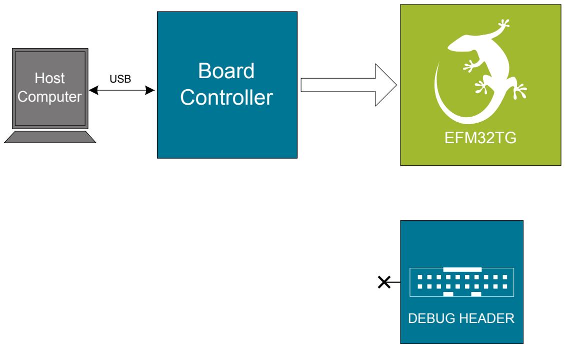


Figure 8.1. Debug MCU

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

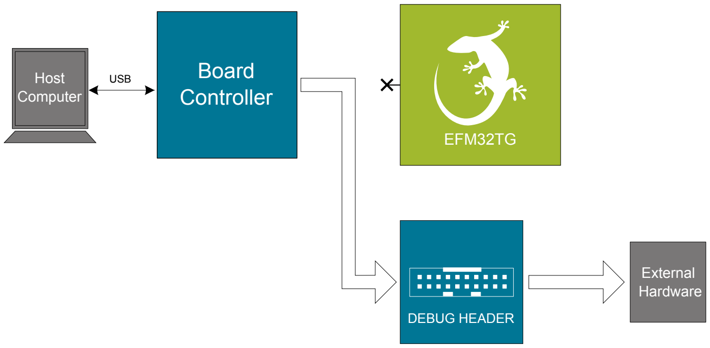


Figure 8.2. Debug OUT

Debug IN: In this mode, the on-board debugger is disconnected, and an external debugger can be connected to debug the EFM32TG on the kit.

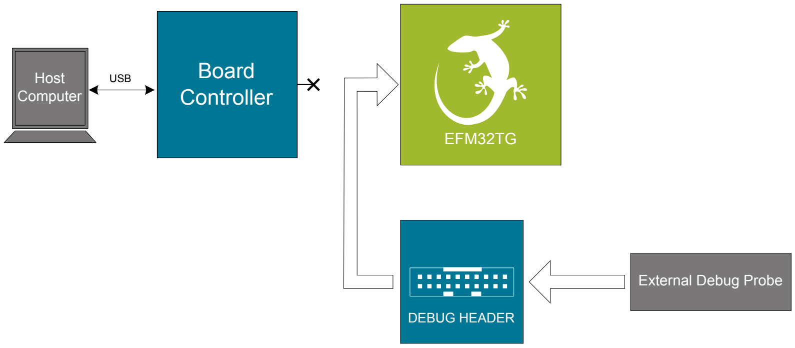


Figure 8.3. Debug IN

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 EFM32TG 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 GPIO used for debugging. This can be done by connecting to the appropriate pins of the breakout pads. Some Silicon Labs kits provide a dedicated pin header for this purpose.

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 them to open the kit configuration dialog.

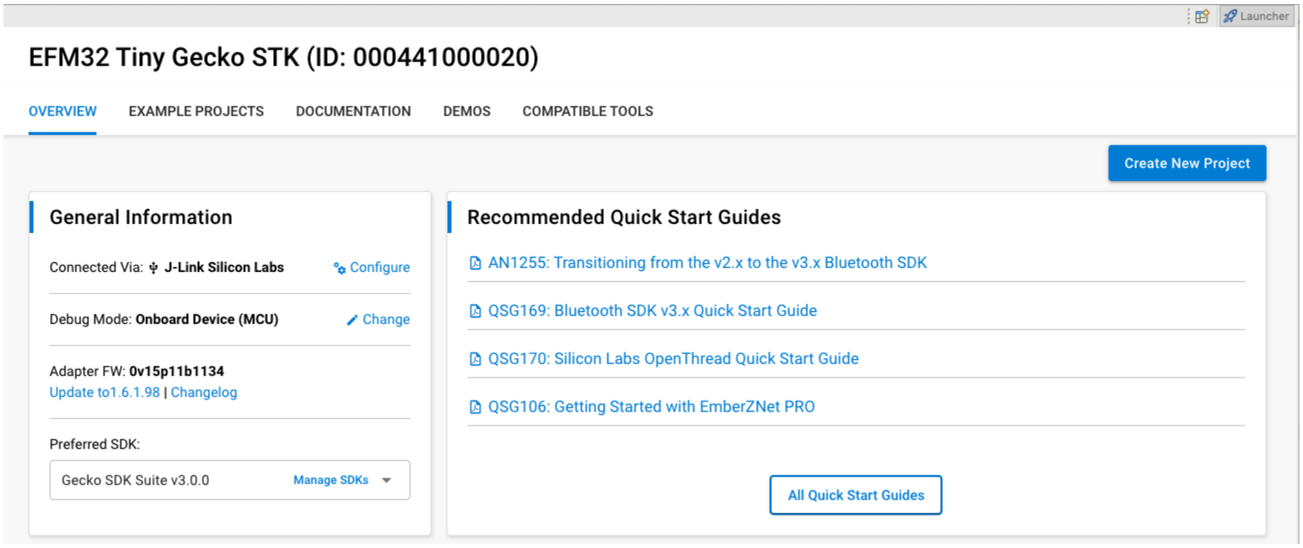


Figure 9.1. Simplicity Studio Kit Information

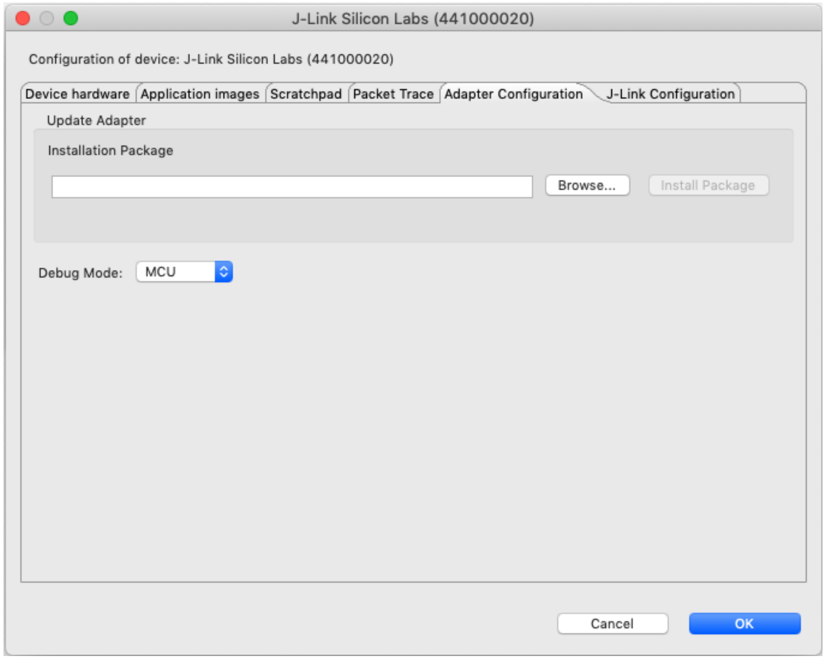


Figure 9.2. Kit Configuration Dialog

9.1 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.

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: http://www.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 Info

Table 11.1. Kit Revision History

Kit Revision	Released	Description
C01	26 August 2020	Upped BRD2100A to revision B02. First kit revision after major board update.
B00	28 September 2016	Removed coin cell battery from kit packaging contents.
A06	12 September 2013	Changed kit packaging contents.
A05	20 December 2012	Upped BRD2100A to revision A05.
A04	10 August 2011	Changed kit packaging contents.
A03	6 April 2011	Initial kit revision,featuring BRD2100A revision A03.

11.2 Errata

There are currently no known issues with this kit.

12. Document Revision History

2.00

September 2020

- First document revision with major kit update
- Updated document to Silicon Labs Format

1.00

May 2011

- Initial document version

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