

Busy Bee Family

EFM8BB3-SLSTK2022A User's Guide



The EFM8BB3-SLSTK2022A is an excellent starting point to get familiar with the EFM8 Busy Bee microcontrollers.

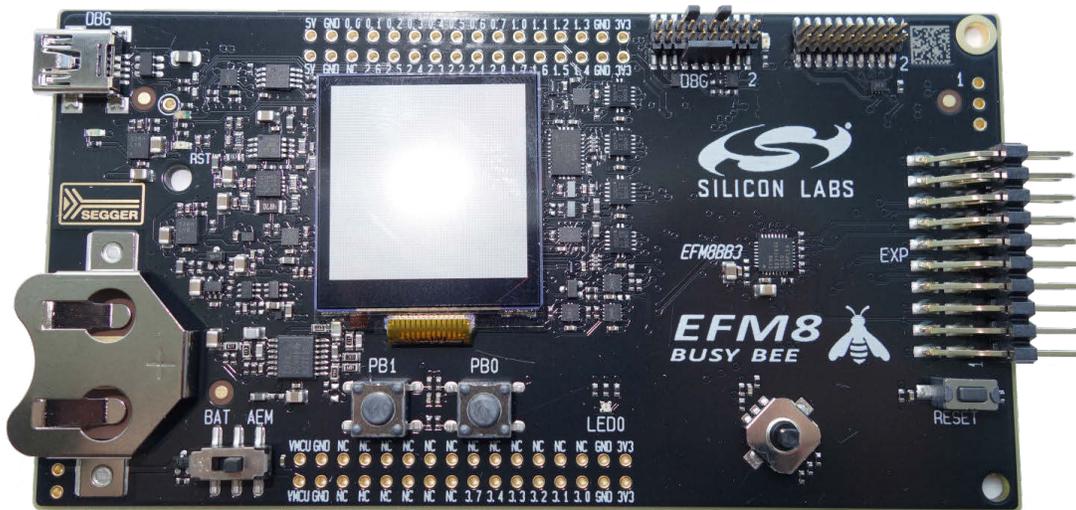
The kit contains sensors and peripherals demonstrating some of the MCU's many capabilities. The kit can also serve as a starting point for application development.

The kit includes the following:

- EFM8BB3 Busy Bee Starter Kit Board
- 1 x CR2032 battery
- Getting Started card
- 1 x mini USB cable

KEY FEATURES

- EFM8BB31F64G MCU with 64 KB Flash and 4 KB RAM.
- 20-pin expansion header.
- Power sources include USB and CR2032 battery.
- 2 user buttons, 1 tri-color LED.
- 8-direction joystick.
- Ultra low power 128x128 pixel Memory-LCD.



1. Getting Started

Hardware

To set up the hardware for the EFM8BB3-SLSTK2022A kit:

1. Provide power to the board by connecting the USB connector to the PC using the provided USB cable.
2. Move the switch to the AEM position.

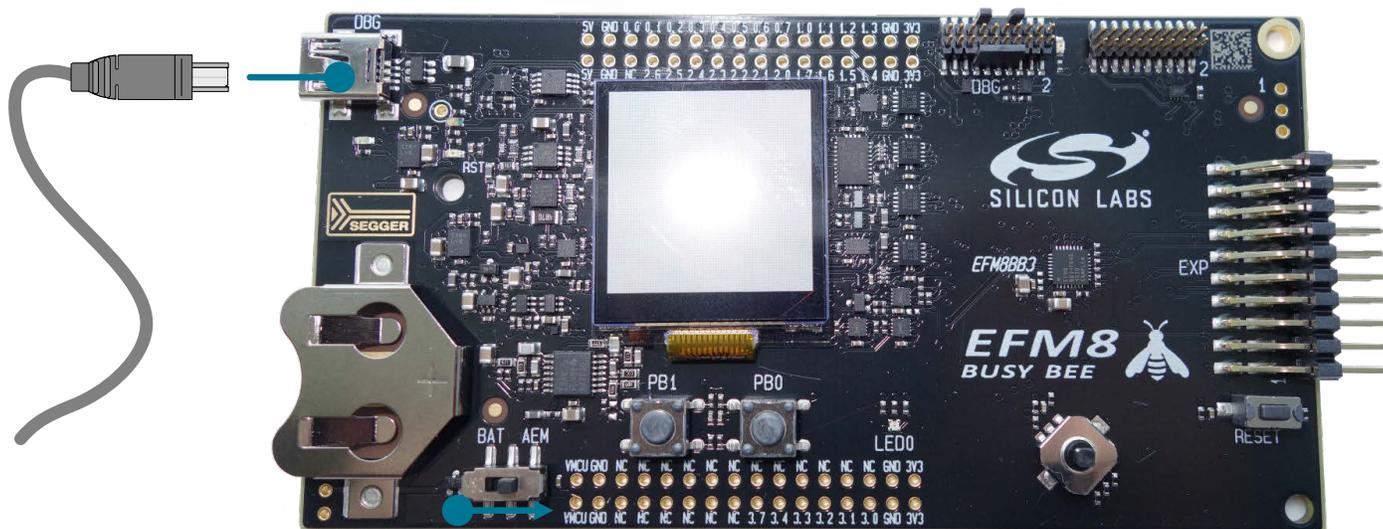


Figure 1.1. Hardware Setup

Software

The first step to get started with your new EFM8BB3-SLSTK2022A is to go to

<http://www.silabs.com/simplicity>

The Simplicity Studio software package contains all the tools, drivers, software examples and documentation needed to use the EFM8BB3 Starter Kit. The board comes pre-loaded with a default application, Space Invaders, to interact with while the software downloads.

After downloading the latest version of Simplicity Studio and installing:

1. Click the **[Refresh detected hardware]** button and select the EFM8BB3 Busy Bee Starter Kit Board under **[Detected Hardware]**.
2. Click the **[Demos]** tile under **[Tools]** to load the available demos.
3. Click the **[Space Invaders]** demo and click **[Start]** to download and run the demo.

Additional demos showcasing the various features of the EFM8 are also available under the same tile in Simplicity Studio.

2. Kit Block Diagram

An overview of the EFM8BB3 Starter Kit is shown in the figure below.

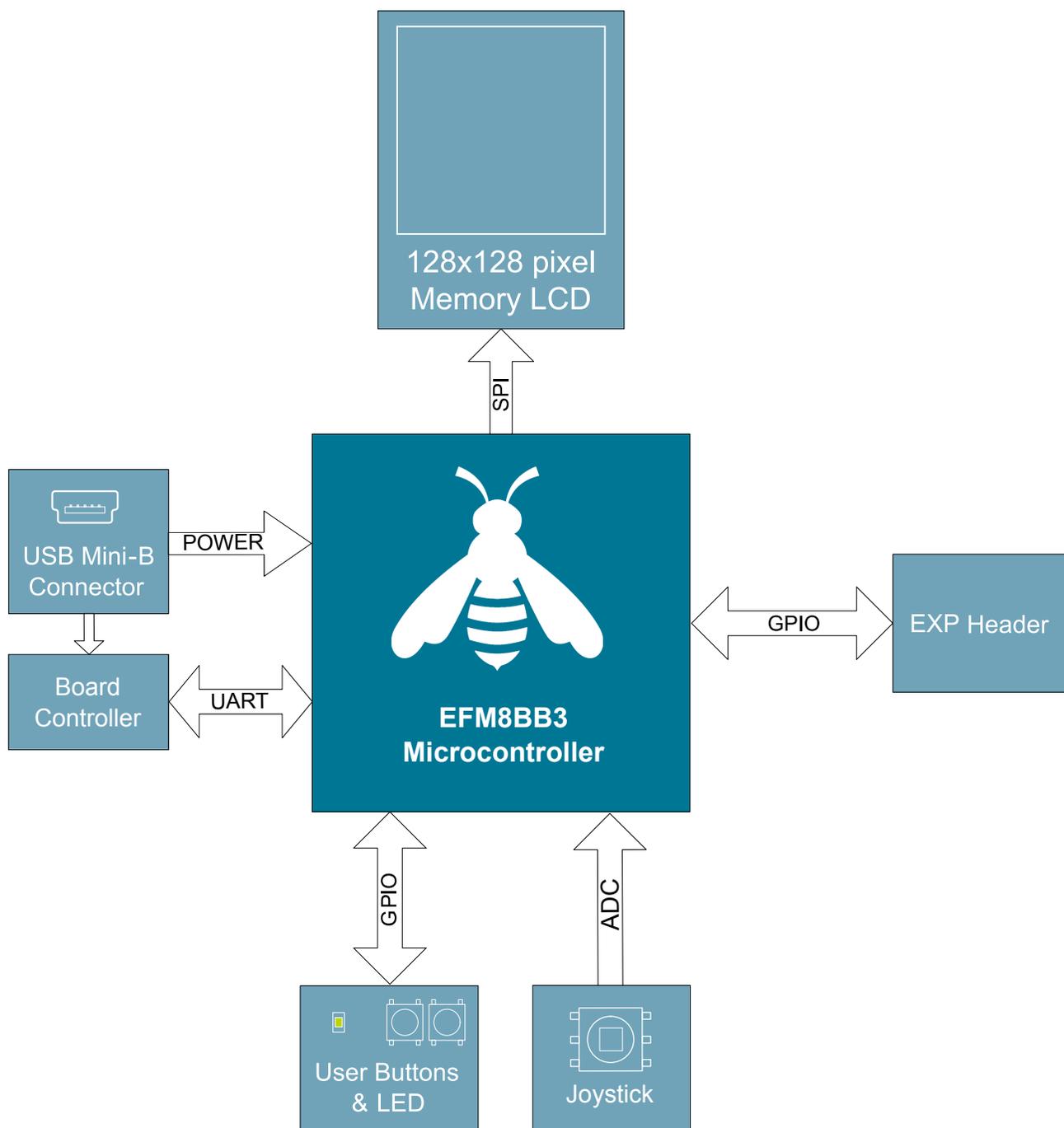


Figure 2.1. EFM8BB3-SLSTK2022A Block Diagram

3. Kit Hardware Layout

The layout of the EFM8BB3 Starter Kit is shown below.

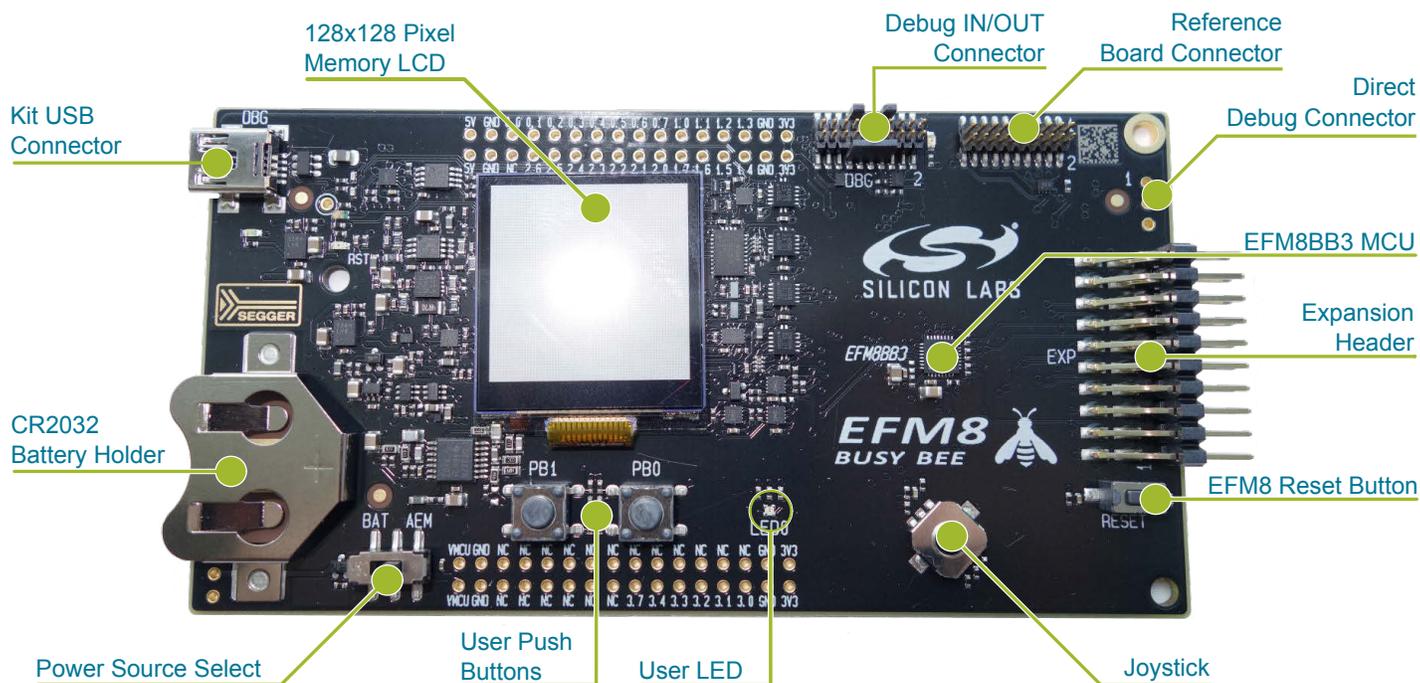


Figure 3.1. EFM8BB3-SLSTK2022A hardware layout

The EFM8 device on the kit is connected to several peripherals. The table below shows all of the external connections to the MCU.

Table 3.1. Kit MCU Connections

| MCU Port Pin | Port Pin Assigned Function | Primary Board Connection | Secondary Board Connection | Expansion Port Connection (EXP) |
|--------------|----------------------------|--------------------------|----------------------------|---------------------------------|
| P0.0 | GPIO | VREF Caps | | |
| P0.1 | GPIO | | AGND | |
| P0.2 | Port Match Input | Push Button 0 (PB0) | | |
| P0.3 | Port Match Input | Push Button 1 (PB1) | | |
| P0.4 | UART0 TX | BC - UART_TX | | |
| P0.5 | UART0 RX | BC - UART_RX | | |
| P0.6 | SPI0 SCK | DISP - SPI CLK | SPI CLK | EXP8 |
| P0.7 | SPI0 MISO | | SPI MISO | EXP6 |
| P1.0 | SPI0 MOSI | DISP - SPI MOSI | SPI MOSI | EXP4 |
| P1.1 | SPI0 NSS | | SPI CS | EXP10 |
| P1.2 | SMBus0 SDA | I2C SDA | BC - REFCLK | EXP16 |
| P1.3 | SMBus0 SCL | I2C SCL | BC - 1 kHz SINE | EXP15 |
| P1.4 | PCA0 CEX0 | RGB LED0 | | |
| P1.5 | PCA0 CEX1 | RGB LED1 | | |

| MCU Port Pin | Port Pin Assigned Function | Primary Board Connection | Secondary Board Connection | Expansion Port Connection (EXP) |
|--------------|----------------------------|--------------------------|----------------------------|---------------------------------|
| P1.6 | PCA0 CEX2 | RGB LED2 | | |
| P1.7 | ADC / CMP | Joystick | | |
| P2.0 | UART1 TX | UART1 TX | | EXP12 |
| P2.1 | UART1 RX | UART1 RX | | EXP14 |
| P2.2 | GPIO | BC - Enable | | |
| P2.3 | GPIO | DAC LOOPBACK0 | | EXP3 |
| P2.4 | GPIO | | | EXP13 |
| P2.5 | GPIO | | UFL ADC INPUT | |
| P2.6 | GPIO | DISP - SPI CS | | |
| P3.0 | GPIO | DAC LOOPBACK1 | | EXP5 |
| P3.1 | GPIO | | | EXP7 |
| P3.2 | GPIO | | | EXP9 |
| P3.3 | GPIO | | | EXP11 |
| P3.4 | GPIO | DISP - Enable | | |
| P3.7 / C2D | C2D (for debug) | | | |

4. Power Supply and Reset

4.1 MCU Power Selection

The Busy Bee MCU on the EFM8BB3-SLSTK2022A is designed to be powered by three different sources:

- Through the on-board debugger.
- By a 3 V Battery.
- An externally supplied power source.

Selecting the power source is done with the slide switch in the lower left corner of the board. The figure shows how the different power sources can be selected with the slide switch.

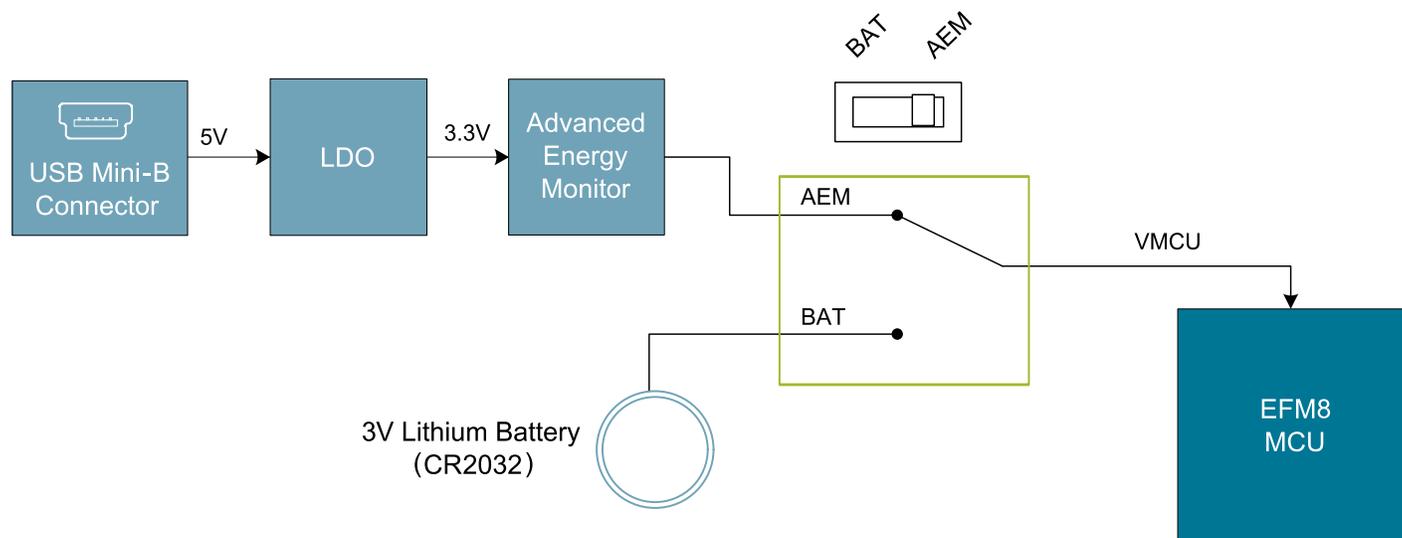


Figure 4.1. EFM8BB3-SLSTK2022A Power Switch

With the switch in the *AEM* position, an on-board low noise LDO with a fixed output voltage of 3.3 V is used to power the MCU. This LDO is powered from the "J-Link" USB cable.

With the switch in the *BAT* position, the device may be powered from either a 20 mm coin cell battery (in the CR2032 socket) or an external power supply (connected to the VMCU and GND pins on the expansion header).

4.2 MCU Reset

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

- The RESET button.
- An external debugger by pulling the RSTb pin low.

5. Peripherals

The starter kit has a set of peripherals that showcase some of the features of the EFM8 Busy Bee microcontroller.

Be aware that most EFM8 I/O routed to peripherals are also routed to the breakout pads. This must be taken into consideration when using the breakout pads for your application.

5.1 Push Buttons and LEDs

The kit has two user push buttons. They are connected 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.

In addition to the two push buttons, the kit also features a tri-color LED that is controlled by EFM8 GPIO. The LED is connected to pins P1.4, P1.5, and P1.6 in an active-low configuration.

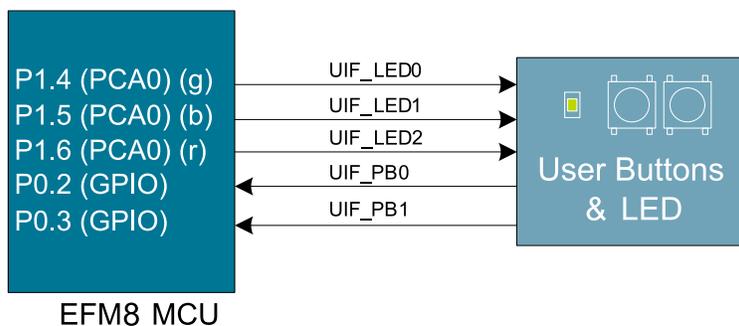


Figure 5.1. Buttons/LEDs

5.2 Joystick

The kit has an analog joystick with 8 measureable positions. This joystick is connected to the EFM8 on the P1.7 pin and uses different resistor values to create voltages measurable by the ADC0.

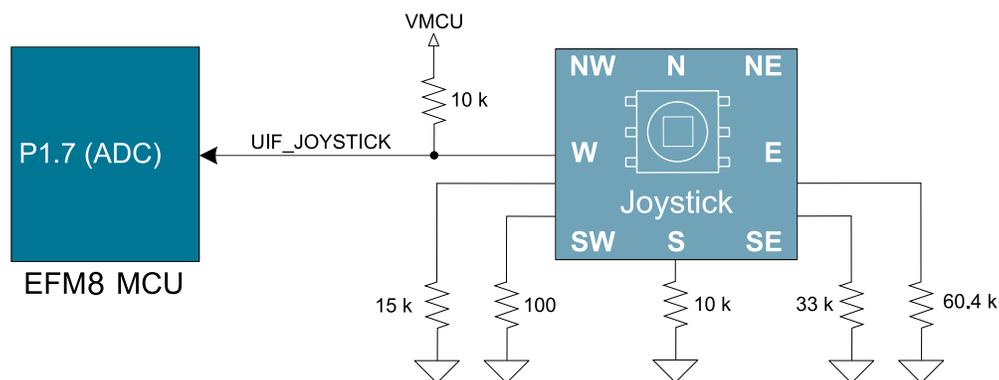


Figure 5.2. Joystick

Table 5.1. Joystick Resistor Combinations

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

Note:

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

5.3 Memory LCD-TFT Display

A 1.28-inch SHARP Memory LCD-TFT has been added to the board to enable interactive applications to be developed. The display has a high resolution of 128 by 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.

The display interface consists of an SPI-compatible serial interface and some extra control signals. Data are sent to the display one line (128 bits) at a time.

The Memory LCD-TFT display is shared with the kit Board Controller, allowing the Board Controller application to display useful information when the user application is not using the display. The EFM8 MCU always controls ownership of the display using the EFM_DISP_ENABLE signal:

- 0: The Board Controller has control of the display.
- 1: The user application (EFM8) has control of the display.

Data are clocked in on EFM_DISP_MOSI (P1.0) when EFM_DISP_CS (P2.6) is high, and the clock is sent on EFM_DISP_SCLK (P0.6). The maximum supported clock speed is 1 MHz.

Please refer to the display application information for details on driving the display:

<http://www.sharpmemorylcd.com/1-28-inch-memory-lcd.html>

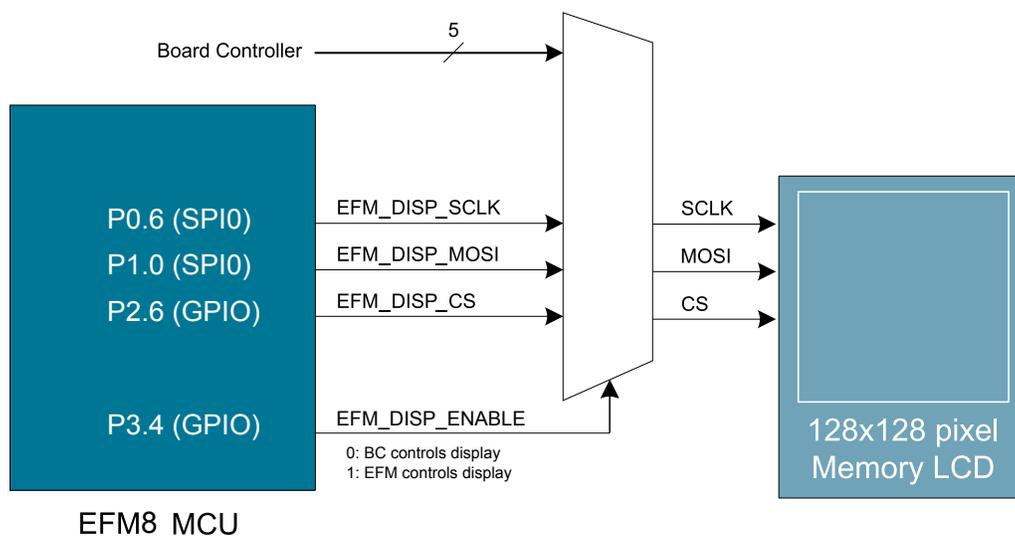


Figure 5.3. 128x128 Pixel Memory LCD

6. Connectors

6.1 Breakout pads

Many of the EFM8's pins are routed out to "breakout pads" at the top and bottom edges of the kit. A 2.54 mm pitch pin header can be soldered in for easy access to these pins. Most I/O pins are available, with the exception of pins used to drive the LCD.

Note: Some of the breakout pads are shared by on-board EFM peripherals. The schematic must be consulted to make sure that it is acceptable to use a shared pin in your application.

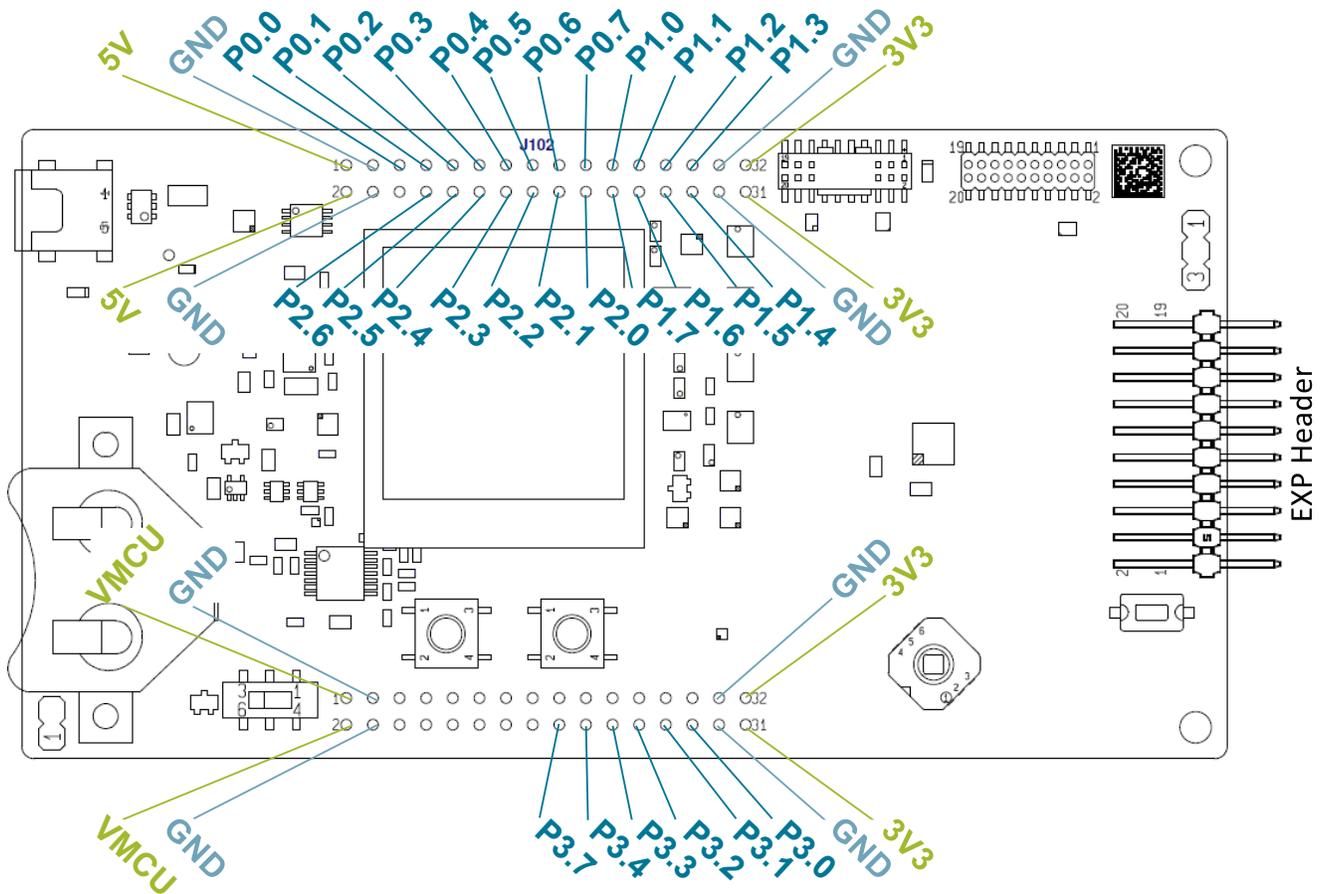


Figure 6.1. Breakout pads and Expansion Header

6.2 Expansion header

On the right hand side of the board an angled 20-pin expansion 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 Busy Bee's features. Additionally, the VMCU, 3V3 and 5V power rails are also exported.

The figure below shows the pin assignment of the expansion header. With the exception of a few pins, most of the Expansion Header's pins are the same as those on the EFM32 Gecko or EFM32 Tiny Gecko starter kits.

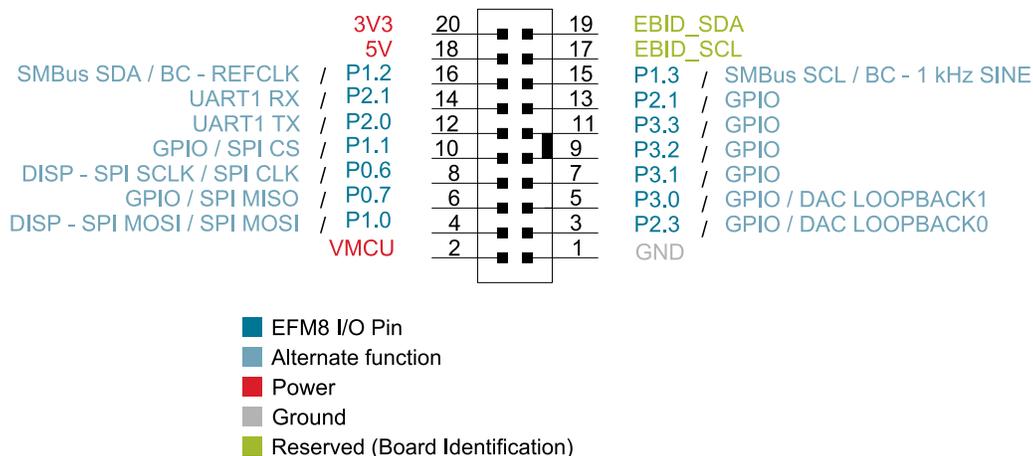


Figure 6.2. Expansion Header

Some of the chip peripheral functions that are available on the Expansion Header are listed in the table below.

Table 6.1. Some peripheral functions available on Expansion Header

| Peripheral | Peripheral pin | MCU Pin | EXP Header pin number |
|--------------|----------------------|---------------------------------------------------------------|-----------------------|
| UART1 | UART1 TX | P2.0 | 12 |
| | UART1 RX | P2.1 | 14 |
| SPI0 | SPI0 SCK | P0.6 | 8 |
| | SPI0 MISO | P0.7 | 6 |
| | SPI0 MOSI | P1.0 | 4 |
| | SPI0 CS | P1.1 | 10 |
| SMBus | SMBus0 SDA | P1.2 | 16 |
| | SMBus0 SCL | P1.3 | 15 |
| I2CSLAVE0 | I2CSLAVE0 SDA | P2.0 | 12 |
| | I2CSLAVE0 SCL | P2.1 | 14 |
| ADC0 | Input | Any supported pin (see Reference Manual for more information) | Multiple |
| | CNVSTR | P0.6 | 8 |
| Comparator 0 | CMP0P Positive Input | Any supported pin (see Reference Manual for more information) | Multiple |
| | CMP0N Negative Input | Any supported pin (see Reference Manual for more information) | Multiple |

| Peripheral | Peripheral pin | MCU Pin | EXP Header pin number |
|--------------|----------------------|---------------------------------------------------------------|-----------------------|
| Comparator 1 | CMP1P Positive Input | Any supported pin (see Reference Manual for more information) | Multiple |
| | CMP1N Negative Input | Any supported pin (see Reference Manual for more information) | Multiple |

Note: This table only sums up some of the alternate functions available on the expansion header. Consult the EFM8BB31F64G data sheet for a complete list of alternate functions.

6.3 Debug connector

This connector is used for Debug In and Debug Out (see chapter on Debugging).

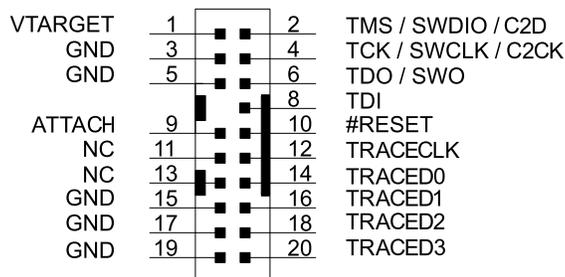


Figure 6.3. Debug Connector

Table 6.2. Debug connector pinout

| Pin number | Function | Note |
|------------------|----------------|-------------------------------------------------------------------------------------------------------------|
| 1 | VTARGET | Target voltage on the debugged application. |
| 2 | TMS/SWDIO/C2D | JTAG TMS, Serial Wire data I/O, or EFM8 C2 data I/O |
| 4 | TCK/SWCLK/C2CK | JTAG TCK, Serial Wire clock, or EFM8 C2 clock |
| 6 | TDO/SWO | JTAG TDO or Serial Wire Output |
| 8 | TDI | JTAG data in |
| 9 | ATTACH | This signal must be pulled to ground by the external debugger or application for cable insertion detection. |
| 10 | #RESET | Target MCU reset |
| 12 | TRACECLK | Trace clock |
| 14, 16, 18, 20 | TRACED0-3 | Trace data (4 lines) |
| 11, 13 | NC | Not Connected |
| 3, 5, 15, 17, 19 | GND | |

6.4 Direct debug connector

This connector is used for directly debugging the EFM8 using an external debug adapter (see chapter on Debugging). This is especially useful for debugging the MCU on the STK board when the part is battery powered or powered by an external supply.

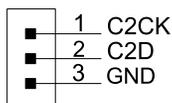


Figure 6.4. Direct Debug Connector

Table 6.3. Direct debug connector pinout

| Pin number | Function | Note |
|------------|----------|------------------|
| 1 | C2CK | EFM8 C2 clock |
| 2 | C2D | EFM8 C2 data I/O |
| 3 | GND | |

6.5 Reference board

The top-right corner of the board includes a 20-pin reference board connector. The connector contains some I/O pins that can be used with some of the EFM8 Busy Bee's features. Additionally, the 3V3 and 5V power rails are also exported.

The figure below shows the pin assignment of the reference board header.

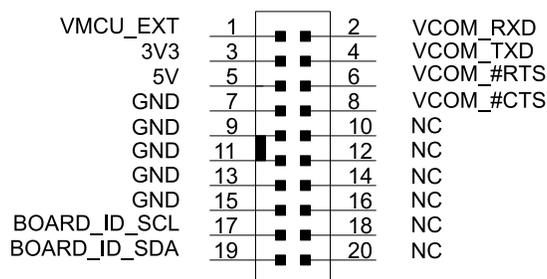


Figure 6.5. Reference Board Header

7. Integrated Development Environment

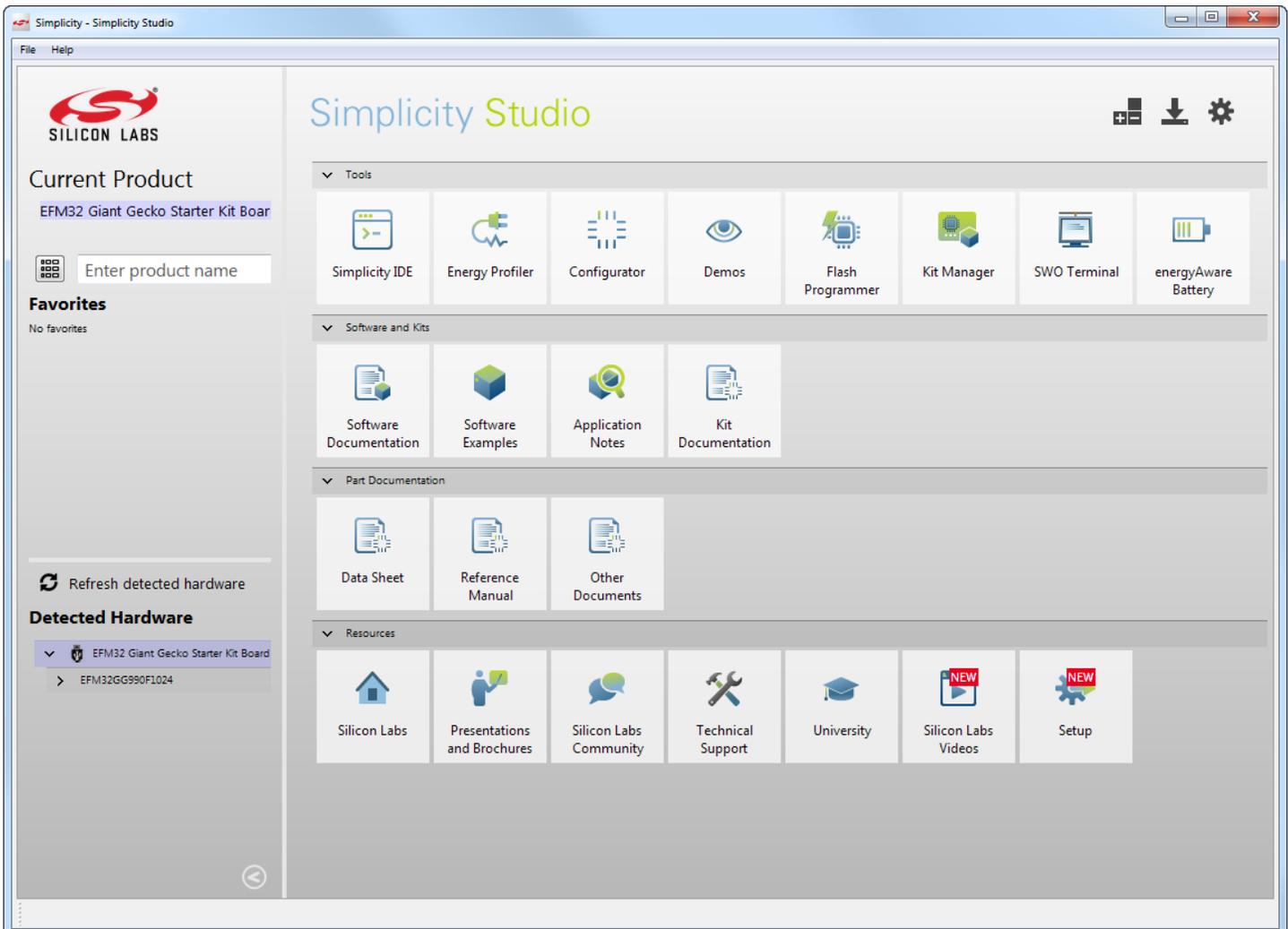


Figure 7.1. Simplicity Studio

Simplicity Studio includes various examples in source form to use with the Starter Kit. To run these examples:

1. Provide power to the board by connecting the DBG USB connector to the PC using the provided USB cable.
2. Move the switch to the AEM position.
3. Click the **[Refresh detected hardware]** button and select the EFM8BB3 Busy Bee Starter Kit Board kit under **[Detected Hardware]**.
4. Click the **[Software Examples]** tile under **[Software and Kits]**.
5. In the wizard, select the EFM8BB3 Starter Kit kit and click **[Next]**.
6. Select the desired example or demo from the list and click **[Next]**.
7. Click **[Finish]**.
8. Click the **[Debug]** button in the IDE to build and download the code to the hardware.
9. Follow the instructions at the top of the main example file to set up the hardware as needed.
10. Click the **[Resume]** button to start running the example.

8. Advanced Energy Monitor

8.1 Usage

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

8.2 AEM theory of operation

In order to be able to accurately measure current ranging from 0.1 μA to 50 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, and 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 startup of the kit, an automatic calibration of the AEM is performed. This calibration compensates for the offset error in the sense amplifiers.

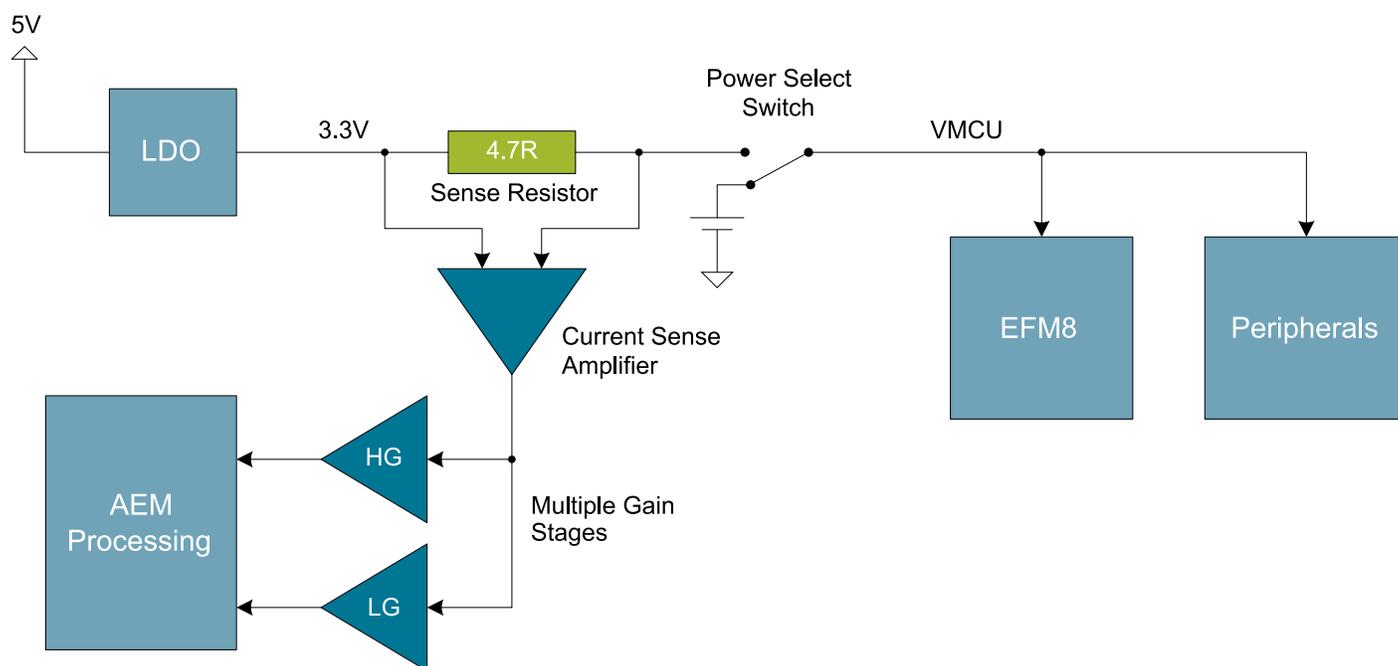


Figure 8.1. Advanced Energy Monitor

8.3 AEM accuracy and performance

The Advanced Energy Monitor is capable of measuring currents in the range of 0.1 μA to 50 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 . Even though 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.

Note: The current measurement will only be correct when powering the EFM8 from USB power through the debugger (power select switch set to DBG or AEM).

9. Board Controller

The kit contains a board controller that is responsible for performing various board-level tasks, such as handling the debugger and the Advanced Energy Monitor. An interface is provided between the EFM8 and the board controller in the form of a UART connection. The connection is enabled by setting the EFM_BC_EN (P2.2) line high, and using the lines EFM_BC_TX (P0.4) and EFM_BC_RX (P0.5) for communicating.

The BC enable signal connects the EFM8 to the board controller:

- 0: EFM8 UART pins are isolated from the Board Controller.
- 1: EFM8 UART pins are connected to the Board Controller (default upon reset).

Note: The board controller is only available when USB power is connected.

10. Debugging

The EFM8BB3-SLSTK2022A contains an integrated debugger, which can be used to download code and debug the Busy Bee EFM8 MCU. In addition to programming the MCU on the kit, the debugger can also be used to program and debug external Silicon Labs EFM8 devices.

10.1 Debug Modes

Programming external devices is done by connecting to a target board through the provided Debug IN/OUT Connector, and by setting the debug mode to **[Out]**. The same connector can also be used to connect an external debugger to the EFM8 MCU on the kit, by setting the debug mode to **[In]**. A summary of the different supported debug modes is given in [Table 10.1 Debug modes on page 16](#).

Table 10.1. Debug modes

| Mode | Description |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------------|
| Debug MCU | In this mode the on-board debugger is connected to the EFM8 on the EFM8BB3-SLSTK2022A. |
| Debug In | In this mode, the on-board debugger is disconnected, and an external debugger can be connected to debug the EFM8 on the EFM8BB3-SLSTK2022A. |
| Debug Out | In this mode, the on-board debugger can be used to debug an EFM8 mounted on a custom board. |

Selecting the active debug mode is done with a drop-down menu in the Kit Manager tool, which is available through Simplicity Studio.

When using the debug adapter in the **[Out]** mode, the end device must be manually detected before debugging and programming. To do this:

1. Right-click on the kit from the Simplicity Studio launch screen and select **[Select Target Part...]**.
2. If needed, select the appropriate **[Target Interface]** for the external device. For example, EFM8 devices will use the **[C2]** selection.
3. In the same dialog, click the **[Detect Target]** button.
4. Click **[OK]** to close the dialog. The external target can now be debugged and programmed.

10.2 Debugging during battery operation

When the EFM8 is powered by battery 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.

To enable debugging when the USB cable is removed, connect an external debugger to the MCU Debug Header in the top right corner of the EFM8BB3-SLSTK2022A instead of the Debug IN/OUT Connector. This header is connected directly to the EFM8's debug interface. The pinout of this header is shown in the Connectors chapter.

11. Kit Manager and Upgrades

The Kit Manager is a program that comes with Simplicity Studio. It can perform various kit and EFM8 specific tasks.

11.1 Kit Manager Operation

This utility gives the ability to program the EFM8, upgrade the kit, lock and unlock devices and more. Some of the features will only work with Silicon Labs kits, while other will work with a generic J-Link debugger connected.

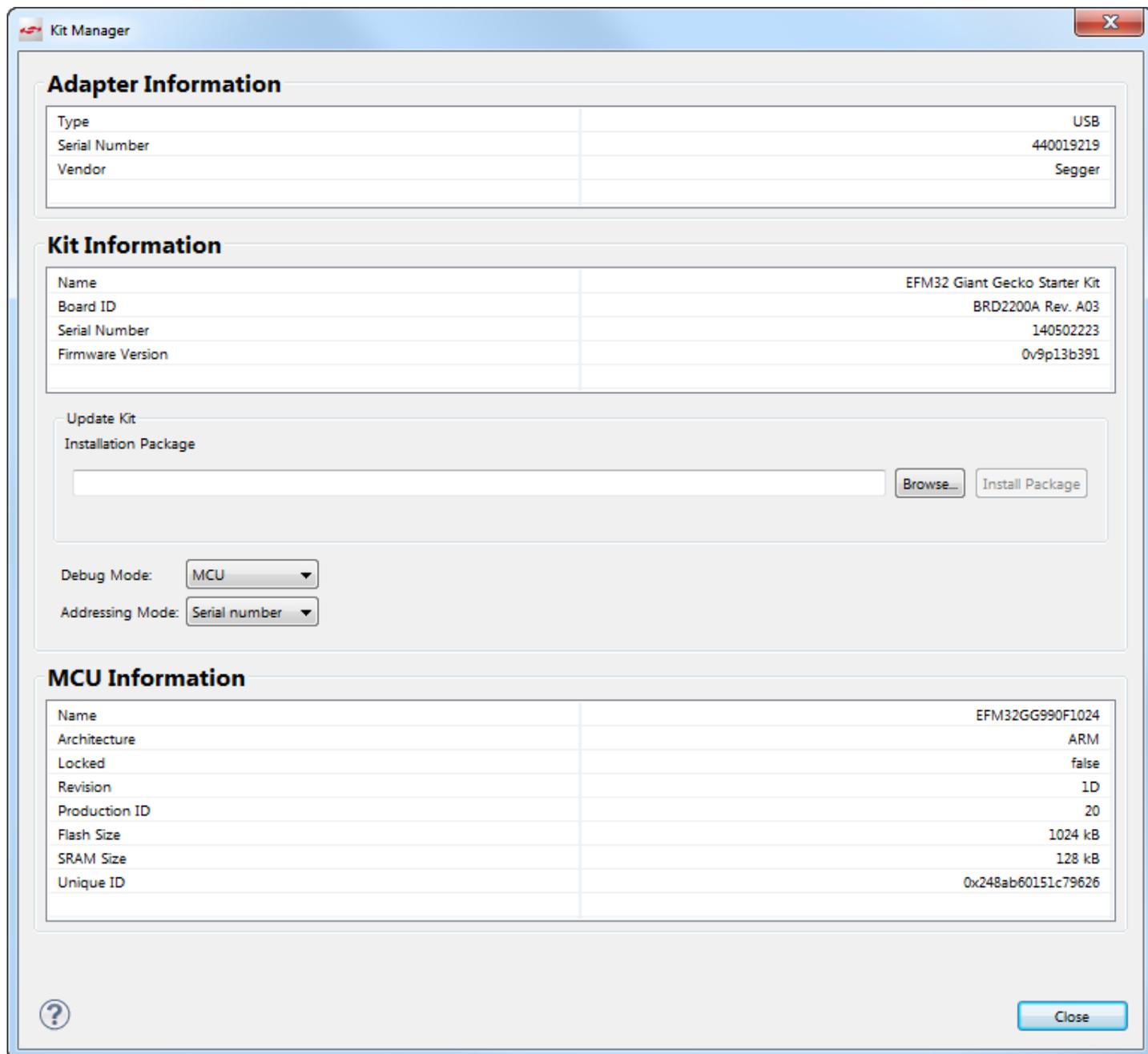


Figure 11.1. Kit Manager

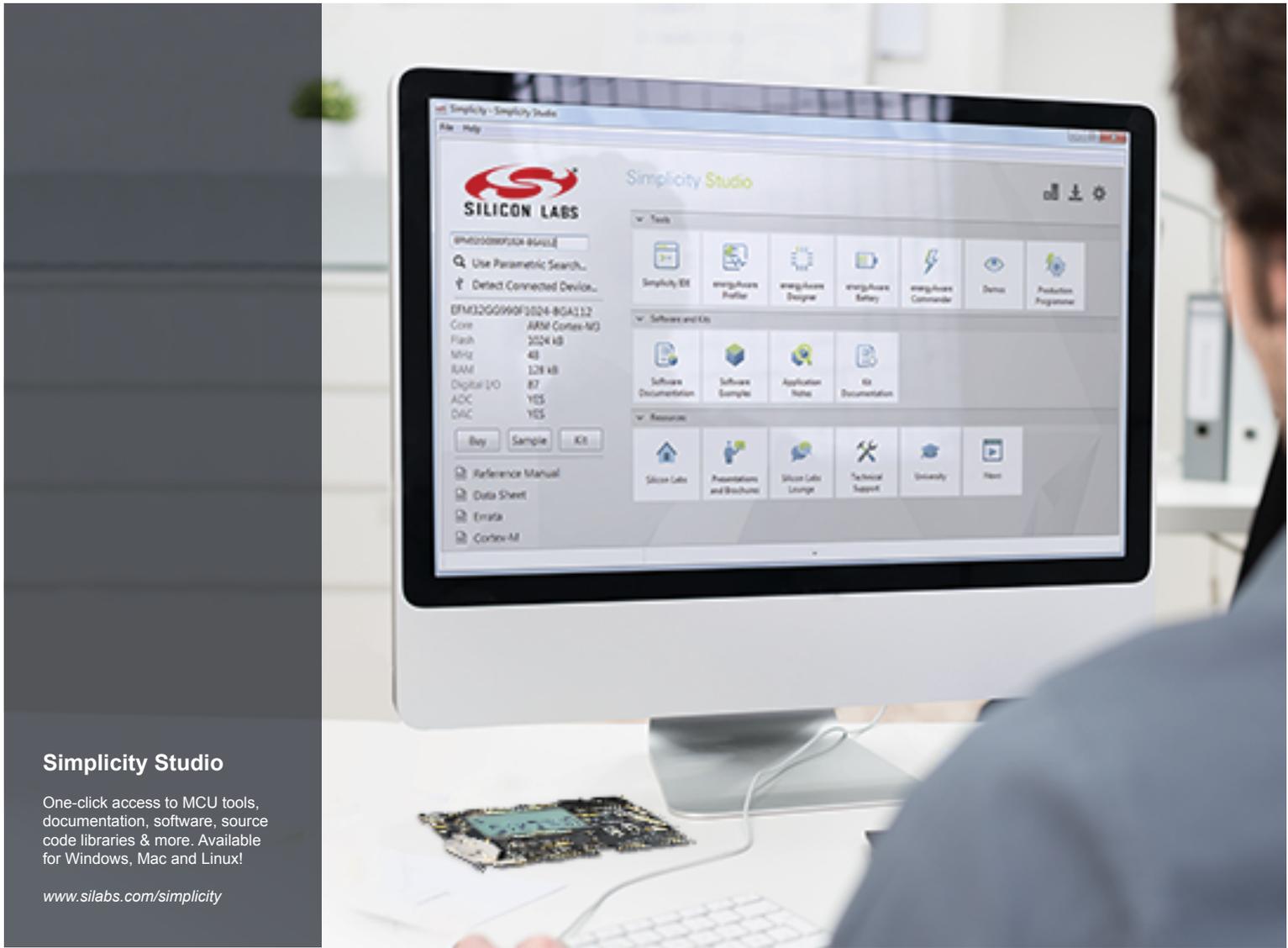
11.2 Firmware Upgrades

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 Manager for manual upgrades. Click the **[Browse]** button in the **[Update Kit]** section to select the correct file ending in ".emz". Then, click the **[Install Package]** button.

12. Schematics, Assembly Drawings and BOM

The schematics, assembly drawings and bill of materials (BOM) for the EFM8BB3 Starter Kit board are available through Simplicity Studio when the kit documentation package has been installed.



Simplify Studio

One-click access to MCU tools, documentation, software, source code libraries & more. Available for Windows, Mac and Linux!

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MCU Portfolio
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