EFM32

... the world's most energy friendly microcontrollers

USER MANUAL

Starter Kit EFM32ZG-STK3200

The EFM32 Zero Gecko Starter Kit is a feature rich platform for evaluation, prototyping and application development for the EFM32 Zero Gecko MCU family with the ARM Cortex-M0+ CPU core.

Main features:

- Silicon Labs EFM32 Zero Gecko Microcontroller with 32 KB Flash and 4KB RAM - EFM32ZG222F32.
- Advanced Energy Monitoring provides real-time information about the energy consumption of an application or prototype design.
- On-board debugger with the possiblity to debug external targets.
- 128x128 pixel Memory-TFT LCD
- Expansion Header and Breakout Pads for easy prototyping of custom hardware.

1 Introduction

1.1 Description

The EFM32ZG-STK3200 is an excellent starting point to get familiar with the EFM32 Zero Gecko microcontrollers. The kit contains a few buttons and LEDs, some capactive touch pads and a very low power Memory LCD-TFT display. In addition to demonstrating the EFM32 Zero Gecko's capabilities, the kit can also serve as a good starting point for application development.

1.2 Features

- EFM32ZG222F32 MCU with 32 KB Flash and 4 KB RAM.
- Advanced Energy Monitoring system for precise current tracking.
- Integrated SEGGER J-Link USB debugger/emulator with debug out functionality.
- 20 pin expansion header.
- Breakout pads for easy access to I/O pins.
- Power sources include USB and CR2032 battery.
- 2 user buttons, 2 user LEDs
- 2 capacitve touch pads
- Ultra low power 128x128 pixel Memory-LCD
- Crystals for LFXO and HFXO: 32.768kHz and 24.000MHz.

1.3 Getting Started

The first step to get started with your new EFM32ZG-STK3200 is to go to

[http://www.energymicro.com/simplicity]

The Simplicity Studio software package contains all the tools, drivers, software examples and documentation needed to use the EFM32 Zero Gecko Starter Kit. Some important tools for use with the EFM32ZG-STK3200 are:

- *energyAware Commander*
- *energyAware Profiler*

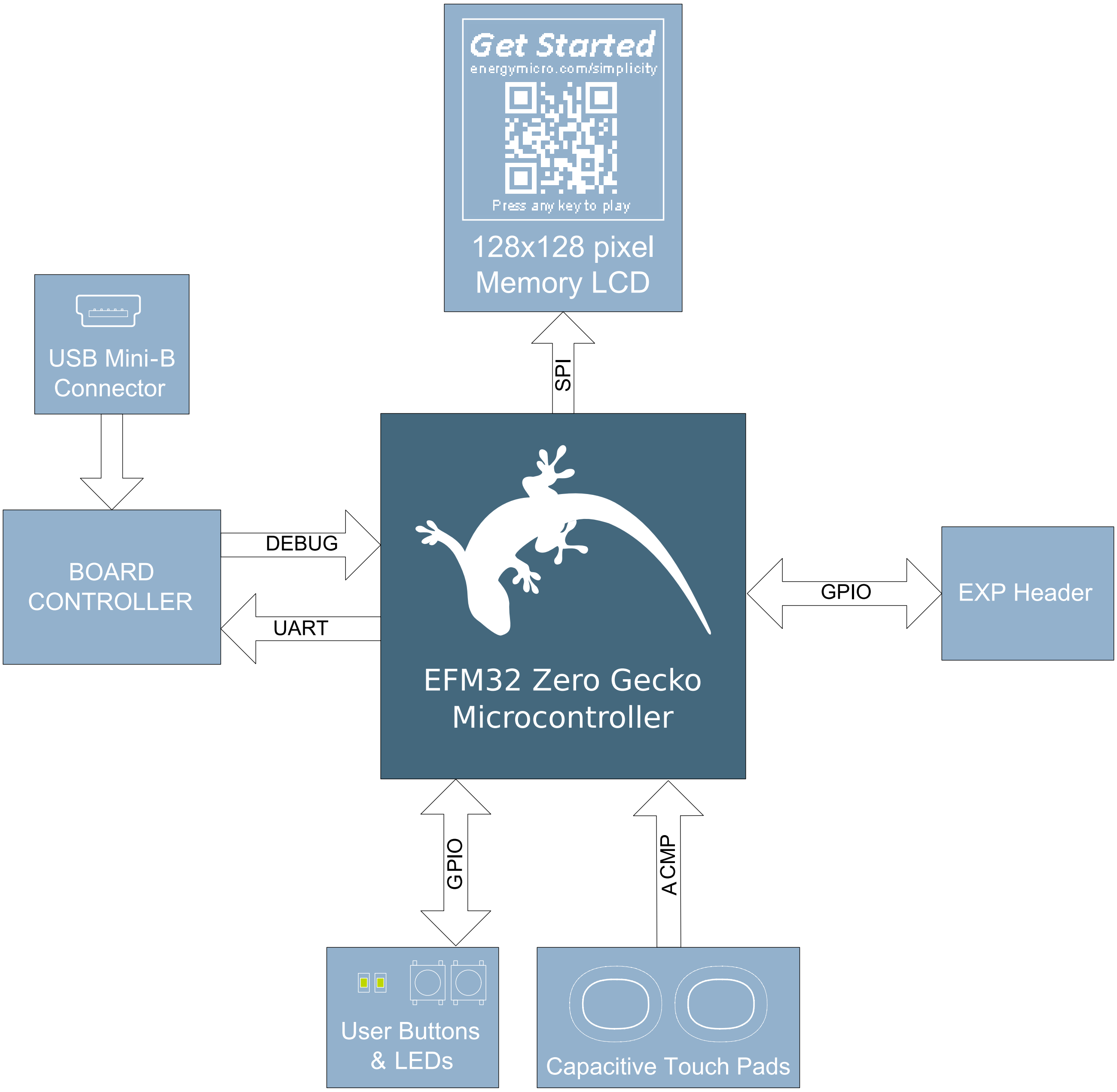
The *energyAware Commander* is a tool for updating the kit's firmware, programming the MCU and launching demos.

The *energyAware Profiler* is the PC-side interface to the Advanced Energy Monitor. It provides the possibility to do real-time voltage and current monitoring of a running user application.

2 Kit Block Diagram

An overview of the EFM32 Zero Gecko Starter Kit is shown in Figure 2.1 (p. 3)

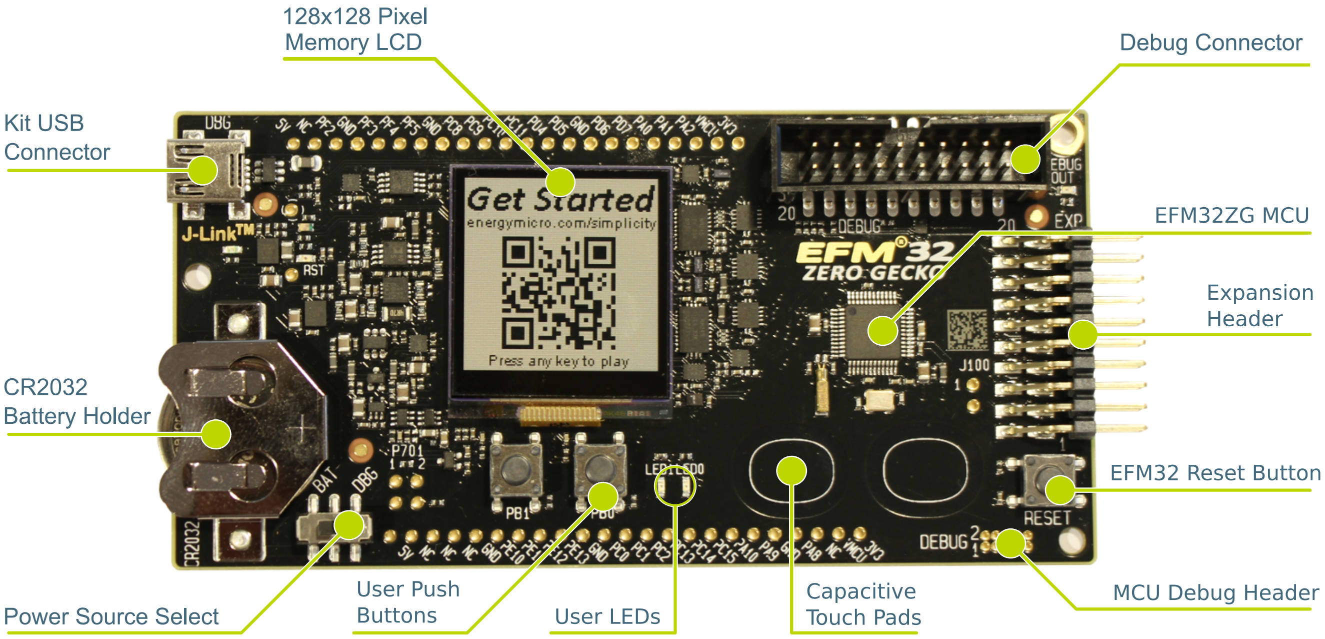
Figure 2.1. EFM32ZG-STK3200 Block Diagram



3 Kit Hardware Layout

The layout of the EFM32 Zero Gecko Starter Kit is shown below.

Figure 3.1. EFM32ZG-STK3200 hardware layout



4 Power Supply and Reset

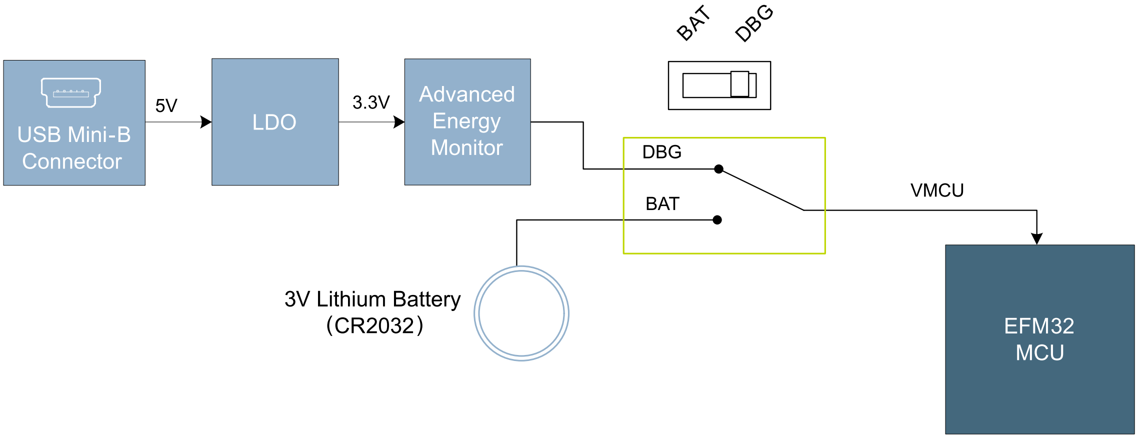
4.1 MCU Power Selection

The EFM32 Zero Gecko MCU on the EFM32ZG-STK3200 is designed to be powered by different sources:

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

Selecting the power source is done with the slide switch in the lower left corner of the board. Figure 4.1 (p. 5) shows how the different power sources can be selected with the slide switch.

Figure 4.1. EFM32ZG-STK3200 Power Switch



With the switch in the *DBG* position, an on-board low noise LDO with a fixed output voltage of 3.3V is used to power the MCU. This LDO sources power from the J-Link USB connector. The Advanced Energy Monitor is now also connected in series, allowing accurate high speed current measurements and energy debugging/profiling.

With the switch in the *BAT* position, a 20mm coin cell battery in the CR2032 socket can be used to power the device.

Finally, an external power supply can also be connected to the VMCU and GND pins either on the Expansion Header, or the breakout pads. For this to work the switch must be in the BAT position, and there should be no battery in the battery holder. See Chapter 10 (p. 14) to find the VMCU and GND pin locations.

Note

The Advanced Energy Monitor can only measure the current consumption of the EFM32 when the power selection switch is in the *DBG* position.

4.2 Board Controller Power

The Board Controller is responsible for important features such as the debugger and the Advanced Energy Monitor, 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 MCU while retaining debugging functionality. This power domain is also isolated to prevent current leakage from the MCU power domain when power to the Board Controller is removed.

4.3 MCU Reset

The EFM32 MCU can be reset by a few different sources:

- The RESET button.
- Through the debugger, either on-board or external.

4.4 Board Controller Reset

The Board Controller can be reset by removing and re-inserting the J-Link USB cable. Removing the Board Controller USB cable will not reset the EFM32, but whenever the Board Controller is powered up again, it will issue a RESET to the EFM32 through the on-board debugger.

5 Peripherals

The starter kit has a set of peripherals that showcase some of the features of the EFM32 Zero Gecko microcontroller.

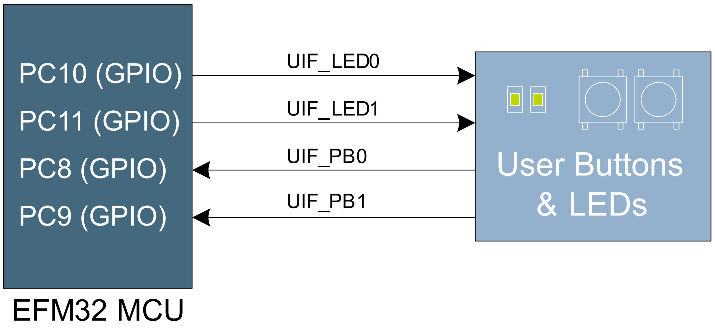
Be aware that most EFM32 I/O routed to peripherals are also routed to the breakout pads. This must be taken into consideration when using the breakout pads for your application.

5.1 Push Buttons and LEDs

The kit has two user push buttons marked PB0 and PB1. They are connected to the EFM32, and are debounced by RC filters with a time constant of 1ms. The buttons are connected to pins PC8 and PC9.

In addition to the two push buttons, the kit also features two yellow LEDs marked *LED0* and *LED1*, that are controlled by GPIO pins on the EFM32. The LEDs are connected to pins PC10 and PC11 in an active-high configuration.

Figure 5.1. Buttons/LEDs



5.2 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 is 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 usefull information when the user application is not using the display. The user application always controls ownership of the display with EFM_DISP_SELECT (PA8):

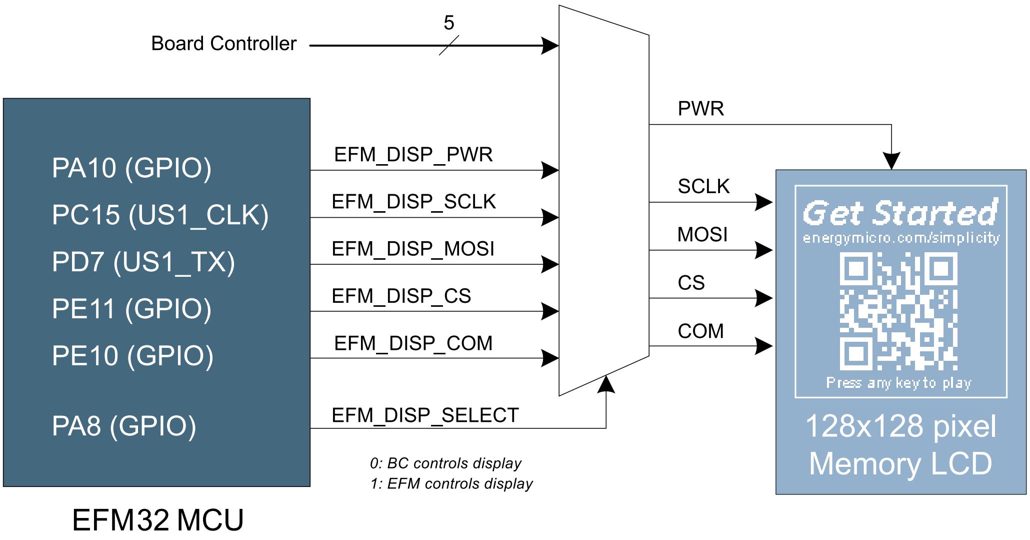
- 0: The Board Controller has control of the display
- 1: The user application (EFM32) has control of the display

EFM_DISP_PWR (PA10) enables power to the display, and must be set high in order to use the display. Data is clocked in on EFM_DISP_MOSI (PD7) when EFM_DISP_CS (PE11) is high, and the clock is sent on EFM_DISP_SCLK (PC15). The maximum supported clock speed is 1.1 MHz.

EFM_DISP_COM (PE10) is the "COM Inversion" line. It must be pulsed periodically to prevent static build-up in the display itself. Please refer to the display application information for details on driving the display:

http://www.sharpmemorylcd.com/resources/LS013B7DH03_Application_Info.pdf

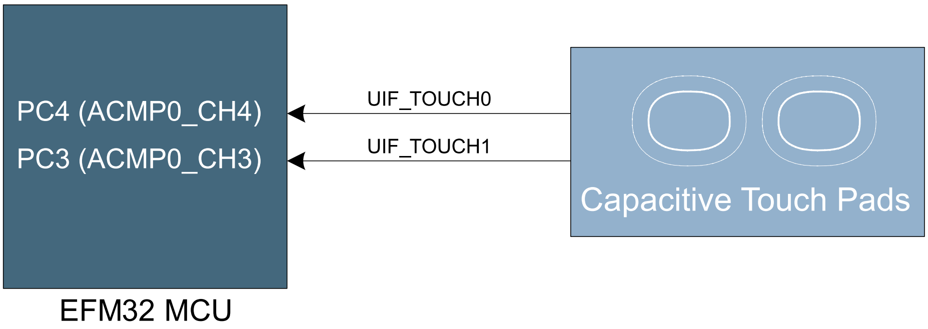
Figure 5.2. 128x128 pixel Memory LCD



5.3 Capacitive Touch Pads

Two touch pads T1 and T2 utilizing the capacitive touch capability of the EFM32 are available. They are located on the lower right side of the board, beneath the EFM32. The pads are connected to PC3 and PC4.

Figure 5.3. 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 is done by setting up the touch pad as part of an RC relaxation oscillator using the EFM32's analog comparator, and then counting the number of oscillations during a fixed period of time.

6 Advanced Energy Monitor

6.1 Usage

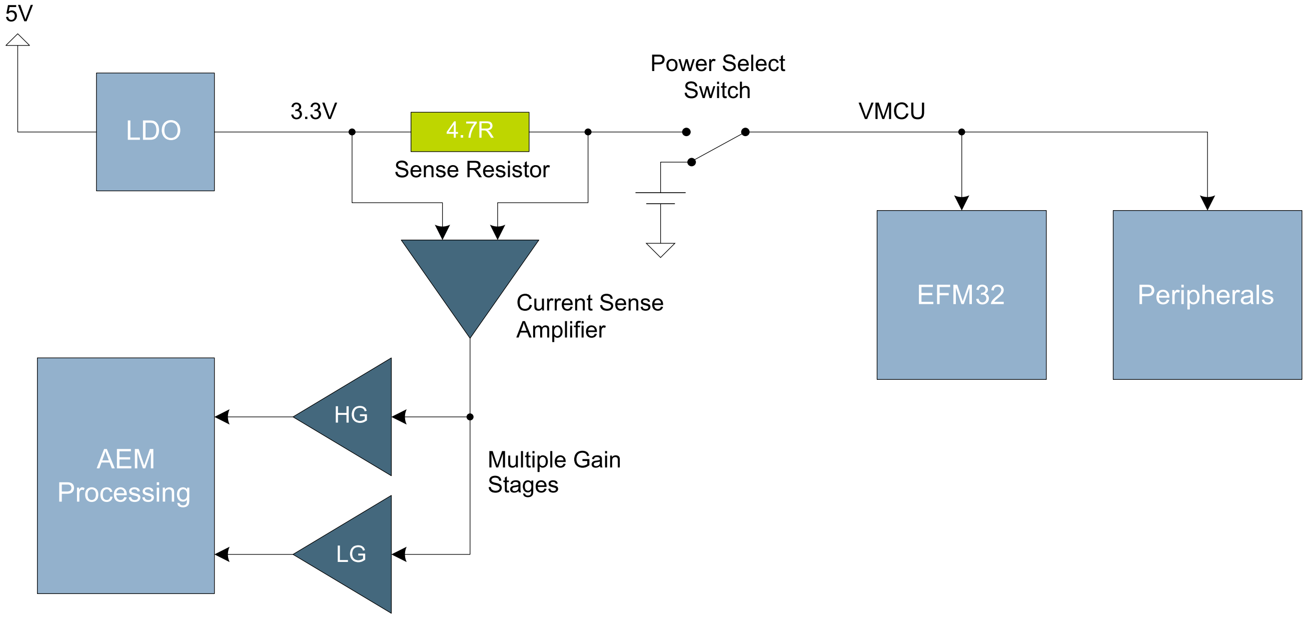
The AEM (Advanced Energy Monitor) data is collected by the board controller and can be displayed by the energyAware Profiler, available through Simplicity Studio. By using the energyAware Profiler, current consumption and voltage can be measured and linked to the actual code running on the EFM32 in realtime.

6.2 AEM theory of operation

In order to be able to accurately measure current ranging from 0.1uA to 50mA (114dB 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 250uA. Digital filtering and averaging is done within the Board Controller before the samples are exported to the energyAware 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 6.1. Advanced Energy Monitor



6.3 AEM accuracy and performance

The Advanced Energy Monitor is capable of measuring currents in the range of 0.1uA to 50mA. For currents above 250uA, the AEM is accurate within 0.1mA. When measuring currents below 250uA, the accuracy increases to 1uA. Even though the absolute accuracy is 1uA in the sub 250uA range, the AEM is able to detect changes in the current consumption as small as 100nA. The AEM produces 6250 current samples per second.

Note

The current measurement will only be correct when powering the EFM32 from USB power through the debugger (power select switch set to "DBG").

7 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 EFM32 and the board controller in the form of a UART connection. The connection is enabled by setting the EFM_BC_EN (PD7) line high, and using the lines EFM_BC_TX (PD4) and EFM_BC_RX (PD5) for communicating.

Specific library functions have been provided in the kit Board Support Package that support various requests to be made to the board controller, such as quering AEM voltage or current. To use these functions, the Board Support Package must be installed. See the Chapter 9 (p. 12) to find out more.

Note

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

8 Debugging

The EFM32ZG-STK3200 contains an integrated debugger, which can be used to download code and debug the EFM32 Zero Gecko MCU. In addition to programming the microcontroller on the kit, the debugger can also be used to program and debug external Silicon Labs EFM32 devices.

8.1 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 emulator to the EFM32 MCU on the kit, by setting the debug mode to *IN*. A summary of the different supported debug modes are described in Table 8.1 (p. 11) .

Table 8.1. Debug modes

Mode	Description
Debug MCU	In this mode the on-board debugger is connected to the EFM32 on the EFM32ZG-STK3200.
Debug IN	In this mode the on-board debugger is disconnected, and an external debugger can be connected to debug the EFM32 on the EFM32ZG-STK3200.
Debug OUT	In this mode the on-board debugger can be used to debug an EFM32 mounted in your own application.

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

8.2 Debugging during battery operation

When the EFM32 is powered by the 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 bottom right corner of the EFM32ZG-STK3200 instead of the Debug IN/OUT Connector. This header is connected directly to the EFM32's debug interface. The pinout of this header is shown in Chapter 10 (p. 14) .

9 Board Support Package

The Board Support Package (BSP) is a set of C source and header files that enables easy access to, and control over some board specific features.

Compared to the Silicon Labs EFM32 development kit, the functionality is limited. Unless you need/want some of the functions contained in the BSP, there is really no need to include or use it. The EFM32 in the Starter Kit is fully usable without BSP support, and you can use all peripherals in the emlib without the BSP.

The BSP uses EFM32 peripheral UART0, Location 1 (TX pin PD4, RX pin PD5) on baudrate 115200-8-N-1 to communicate with the board controller.

Note

> The BSP is only functional when the Starter Kit is USB-powered, using these function calls with USB disconnected will give unpredictable results.

9.1 Installation location

When installing Simplicity Studio, the BSP will be installed in the user directory, typically in a location such as

```
Win7: C:\Users\[username]\AppData\Roaming\energymicro\kits\EFM32ZG_STK3200\
```

or something similar (depending on your OS/Windows version). All files in the board support package are prefixed by stk.

9.2 Application Programming Interface

To use the BSP, include the Starter Kit header file, like this:

```
#include "bsp.h"
```

All functions in the BSP are prefixed with BSP_. The main initialization routine is defined as

```
void BSP_Init ( BSP_INIT_STK_BCUART )
```

and must be called before any access to the STK-functions. This function call will setup the UART communication channel with a 115200 baud rate. This baud rate depends on the current core clock, so correct clock configuration should be set before calling this function.

```
float BSP_CurrentGet ( void )
```

Returns instant current usage in milliamperes.

```
float BSP_VoltageGet ( void )
```

Returns instant voltage (VMCU) reading in volts.

9.3 Example Applications

Under the kits/EFM32ZG_STK3200/examples folder in your installation directory, you will find an example program using the BSP, with corresponding project/Makefiles for the supported IDEs.

The *examples* folder also contains examples showing how to use the different peripherals on the EFM32ZG-STK3200.

9.4 How to include in your own applications

The easiest way to include the BSP in your application is to base your work on the example application that uses the BSP. The following items are recommended for correct configuration:

1. Make sure you define the correct part number (i.e. EFM32ZG222F32) as a preprocessor defined symbol
2. Make sure you define the correct part number (i.e. EFM32ZG222F32) for your project file
3. Add and include the EFM32_CMSIS-files (startup_efm32.s, system_efm32.c, core_cm3.c) to your project
4. Add and include *all* BSP package .c-files, with the bsp-prefix to your project
5. Configure include paths to point at the CMSIS/CM3/CoreSupport and CMSIS/CM3/DeviceSupport/EnergyMicro/EFM32 directories
6. Configure include paths to point to the kits/EFM32ZG_STK3200/bsp directory

Make sure you call "BSP_Init()" early at startup, and you should be all set.

10 Connectors

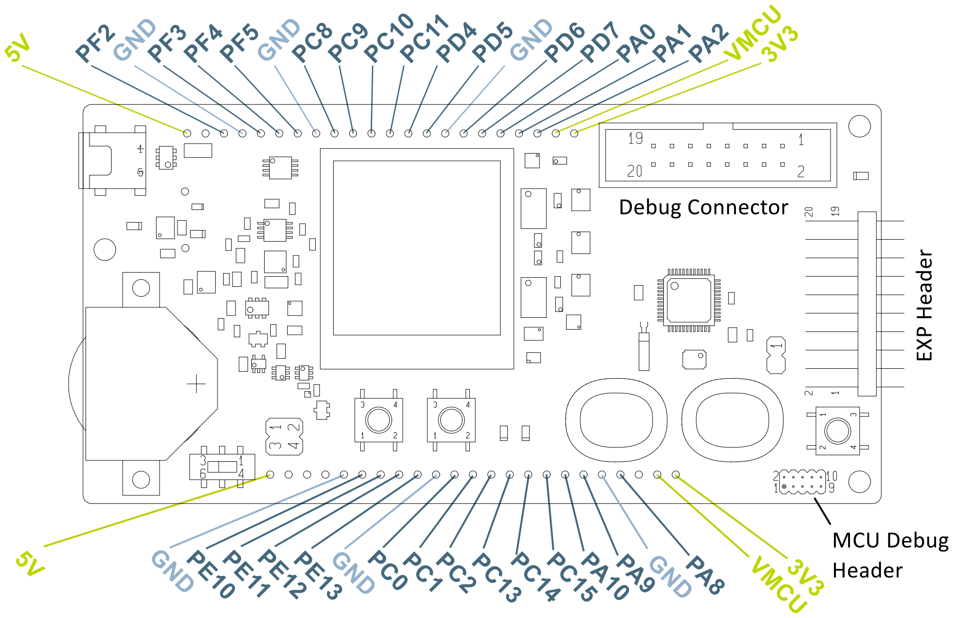
10.1 Breakout pads

Many of the EFM32's pins are routed out to "breakout pads" at the top and bottom edges of the kit. A 2.54mm pitch pin header can be soldered in for easy access to these pins. Most I/O pins are available on these pads.

Note

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

Figure 10.1. Breakout pads and Expansion Header



10.2 Expansion header

On the right hand side of the board a right angle 20-pin expansion header is provided to allow connection of peripherals or plug-in boards. The connecter contains a number of I/O pins that can be used with most of the EFM32 Zero Gecko's features. Additionally, the VMCU, 3V3 and 5V power rails are also exported.

Figure 10.1 (p. 14) shows the pin assignment of the expansion header. Although the actual pin mapping varies, the Expansion Headers are to a large extent functionally compatible across all Starter Kits.

Some of the chip peripheral functions that are available on the Expansion Header are listed in table Table 10.1 (p. 15) .

Figure 10.2. Expansion Header

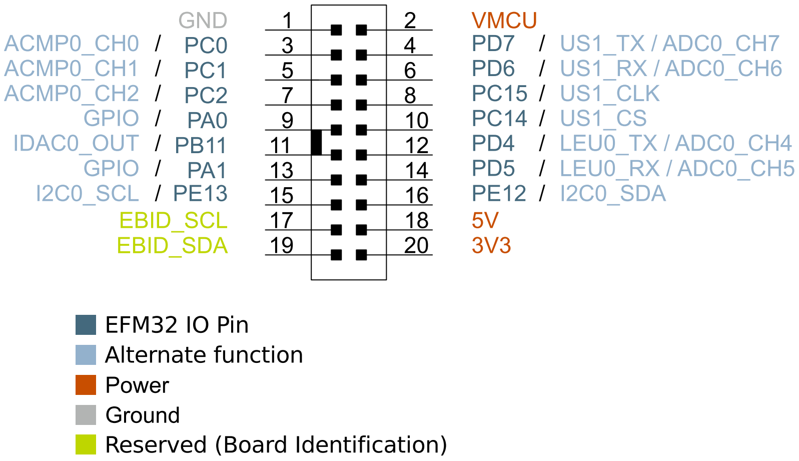

GND 1 2 VMCU
ACMP0_CH0 / PC0 3 4 PD7 / US1_TX / ADC0_CH7
ACMP0_CH1 / PC1 5 6 PD6 / US1_RX / ADC0_CH6
ACMP0_CH2 / PC2 7 8 PC15 / US1_CLK
GPIO / PA0 9 10 PC14 / US1_CS
IDAC0_OUT / PB11 11 12 PD4 / LEU0_TX / ADC0_CH4
GPIO / PA1 13 14 PD5 / LEU0_RX / ADC0_CH5
I2C0_SCL / PE13 15 16 PE12 / I2C0_SDA
EBID_SCL 17 18 5V
EBID_SDA 19 20 3V3
■ EFM32 IO Pin
■ Alternate function
■ Power
■ Ground
■ Reserved (Board Identification)

Table 10.1. Some peripheral functions available on Expansion Header

Peripheral	Peripheral pin	MCU Pin	EXP Header pin number
USART/SPI	USART1_TX	PD7	4
	USART1_RX	PD6	6
	USART1_CLK	PC15	8
	USART1_CS	PC14	10
I²C	I2C0_SDA	PE12	16
	I2C0_SCL	PE13	15
Low Energy UART	LEUART0_TX	PD4	12
	LEUART0_RX	PD5	14
Analog to Digital Converter	ADC0_CH4	PD4	12
	ADC0_CH5	PD5	14
	ADC0_CH6	PD6	6
	ADC0_CH7	PD7	4
Current DAC	IDAC0_OUT	PB11	11
Analog Comparator	ACMP0_CH0	PC0	3
	ACMP0_CH1	PC1	5
	ACMP0_CH2	PC2	7

Note

Please note that this table only sums up some of the alternate functions available on the expansion header. Consult the EFM32ZG222F32 datasheet for a complete list of alternate functions.

10.3 Debug IN/OUT Connector

This connector is used for Debug In and Debug Out (see Section 8.1 (p. 11)). The pinout is described in Table 10.2 (p. 16) .

Figure 10.3. Debug IN/OUT Connector

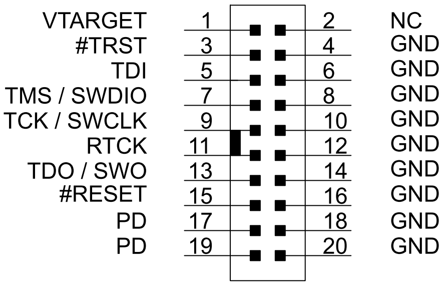


Table 10.2. Debug IN/OUT Connector Pinout

Pin number	Function	Note
1	VTARGET	Target voltage on the debugged application.
2	NC	Not Connected
3	#TRST	JTAG tap reset
5	TDI	JTAG data in
7	TMS/SWDIO	JTAG TMS or Serial Wire data I/O
9	TCK/SWCLK	JTAG TCK or Serial Wire clock
11	RTCK	JTAG RTCK
13	TDO/SWO	JTAG TDO or Serial Wire Output
15	#RESET	Target MCU reset
17	PD	This pin has a 100k pulldown.
18	Cable detect	This signal must be pulled to ground by the external debugger or application for cable insertion detection.
19	PD	This pin has a 100k pulldown.
4, 6, 8, 10, 12, 14, 16, 20	GND	

Note

Although the Debug IN/OUT Connector can support JTAG debugging of external targets, the EFM32-series of devices do not support JTAG. Any external debugger used with the Debug IN/OUT Connector in "Debug IN" mode must therefore use Serial Wire Debug.

10.4 MCU Debug Header

A header with direct connections to the EFM32 Zero Gecko MCU debug interface is provided on the lower rightmost side of the PCB. The header is not mounted by default, but a 10-pin, 1.27mm pitch through-hole header can be soldered on to allow a SWD debugger to be connected.

Since this connector is directly connected to the EFM32's debug pins, it allows debugging of the target even if the Board Controller is not powered.

Figure 10.4. MCU Debug Header

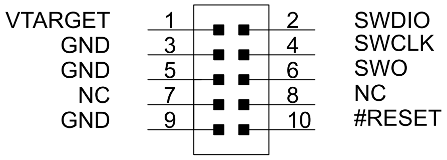


Table 10.3. MCU Debug Header Pinout

Pin number	Function	Note
1	VMCU	MCU supply voltage
2	SWDIO/TMS	Serial Wire Data Input/Output
4	SWCLK/TCK	Serial Wire Clock input
6	SWO/TDO	Not Connected on the EFM32ZG-STK3200
10	nRESET	Target CPU reset signal
7, 8	NC	Not Connected
3, 5, 9	GND	

11 Integrated Development Environments

The Energy Micro software packages contain various examples in source form to use with the Starter Kit. The following IDEs are supported.

11.1 IAR Embedded Workbench for ARM

An evaluation version of IAR Embedded Workbench for ARM is included on a CD in the EFM32ZG-STK3200 package. Check the quick start guide for where to find updates, and IAR's own documentation on how to use it. You will find the IAR project file in the

```
iar
```

subfolder of each project

11.2 Atollic TrueSTUDIO for ARM

See the quick start guide for download details for Atollic TrueSTUDIO for ARM. You will find TrueStudio project files in the

```
atollic
```

subfolder of each project.

11.3 Rowley Associates - CrossWorks for ARM

See the quick start guide for download details for CrossWorks for ARM. You will find CrossWorks project files in the

```
rowley
```

subfolder of each project.

11.4 CodeSourcery - Sourcery G++

See the quick start guide for download details for Sourcery G++. The

```
codesourcery
```

subfolder contains Makefiles for use with the Sourcery G++ development environment.

11.5 Keil - MDK-ARM

See the quick start guide for download details for evaluation versions of Keil MDK-ARM. The

```
arm
```

subfolder in each project contains project files for MDK-ARM. Please see the MDK-ARM documentation for usage details.

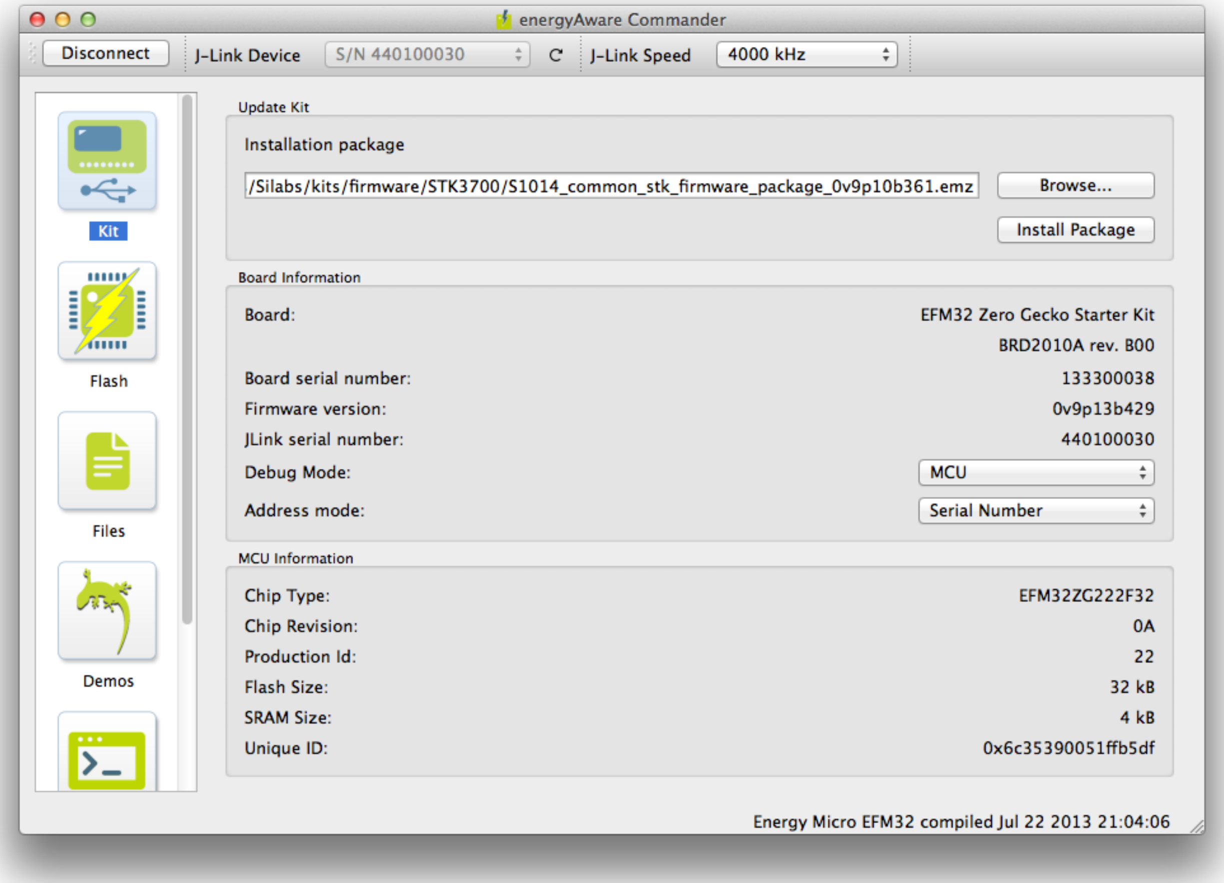
12 energyAware Commander and Upgrades

The *energyAware Commander* is a program that comes with Simplicity Studio. It can perform various kit and EFM32 specific tasks.

12.1 eA Commander Operation

This utility gives the ability to program the EFM32, upgrade the kit, lock and unlock devices and more. Some of the features will only work with Energy Micro kits, while other will work with a generic J-Link debugger connected. Press the "F1" button, or select the "Help->Help" menu item for a full description.

Figure 12.1. energyAware Commander



energyAware Commander

J-Link Device S/N 440100030

J-Link Speed 4000 kHz

Update Kit

Installation package

/Silabs/kits/firmware/STK3700/S1014_common_stk_firmware_package_0v9p10b361.emz

Board Information

Board: EFM32 Zero Gecko Starter Kit BRD2010A rev. B00

Board serial number: 133300038

Firmware version: 0v9p13b429

JLink serial number: 440100030

Debug Mode: MCU

Address mode: Serial Number

MCU Information

Chip Type: EFM32ZG222F32

Chip Revision: 0A

Production Id: 22

Flash Size: 32 kB

SRAM Size: 4 kB

Unique ID: 0x6c35390051ffb5df

Energy Micro EFM32 compiled Jul 22 2013 21:04:06

12.2 Firmware Upgrades

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

You can also use the *energyAware Commander* for manual upgrades. Select the "Kit" icon, use the "Browse" button to select the correct file ending in ".emz", and press the "Install package button".

13 Schematics, Assembly Drawings and BOM

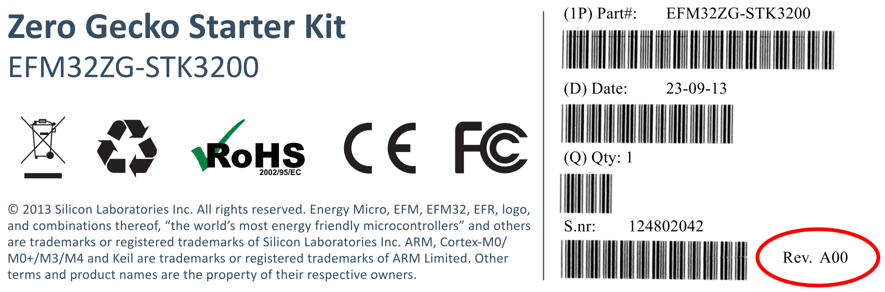
The schematics, assembly drawings and bill of materials (BOM) for the EFM32 Zero Gecko Starter Kit board are available through Simplicity Studio when the kit documentation package has been installed.

14 Kit Revision History and Errata

14.1 Revision History

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

Figure 14.1. Revision info



Zero Gecko Starter Kit
EFM32ZG-STK3200

RoHS 2002/95/EC

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(1P) Part#: EFM32ZG-STK3200
(D) Date: 23-09-13
(Q) Qty: 1
S.nr: 124802042
Rev. A00

Table 14.1. Kit Revision History

Kit Revision	Released	Description
A00	20.09.2013	Initial Kit Revision.

14.2 Errata

Table 14.2. Kit Errata

Kit Revision	Problem	Description

15 Document Revision History

Table 15.1. Document Revision History

Revision Number	Effective Date	Change Description
1.00	08.10.2013	Initial document version.

A Disclaimer and Trademarks

A.1 Disclaimer

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Table of Contents

List of Figures

List of Tables

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ZERO
ARM Cortex-M0+

TINY
ARM Cortex-M3

GECKO
ARM Cortex-M3

LEOPARD
ARM Cortex-M3

GIANT
ARM Cortex-M3

WONDER
ARM Cortex-M4