

# EFM<sup>®</sup>32

... the world's most energy friendly microcontrollers

## USER MANUAL

Starter Kit EFM32-G8XX-STK

A decorative graphic on the right side of the page consisting of concentric circles. The outermost circle is light green and contains the number '0'. The next circle inward is a darker green and contains the number '1'. The third circle is blue and contains the number '2'. The fourth circle is a darker blue and contains the number '3'. The innermost circle is black and contains the number '4'. The circles are arranged in a way that they appear to be part of a larger, partially visible circular structure.

*Feature rich starter kit for evaluation, prototyping and application development for the EFM32 Gecko MCU family with the ARM Cortex-M3 CPU core.*

### *Main features;*

- Advanced Energy Monitoring provides real-time visibility into the energy consumption of an application or prototype design.
- On-board debugger with debug out functionality
- 160-segment Energy Micro LCD



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# 1 Introduction

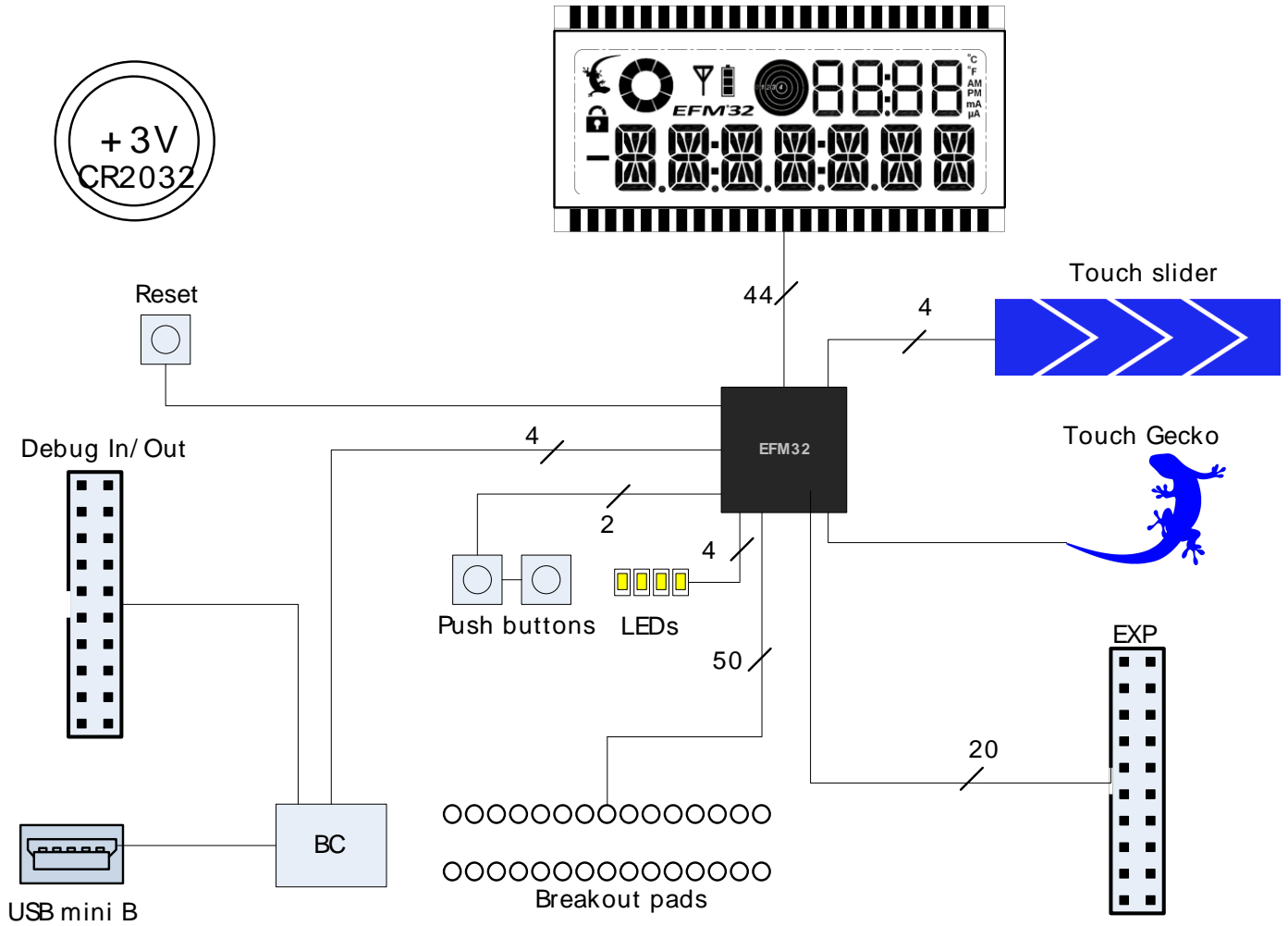
## 1.1 Features

- Advanced Energy Monitoring system for precise current tracking.
- Special hardware configuration for isolation of the MCU power domain.
- Full feature USB debugger with debug out functionality.
- 160 segment Energy Micro LCD.
- 20 pin expansion header.
- Breakout pads for easy access to I/O pins.
- Powered by USB or CR2032 battery.
- 2 user buttons, 4 user LEDs and touch slider.
- 32MHz and 32.768kHz crystal oscillators.

## 2 STK block diagram

An overview of the Kit is shown in the block diagram below.

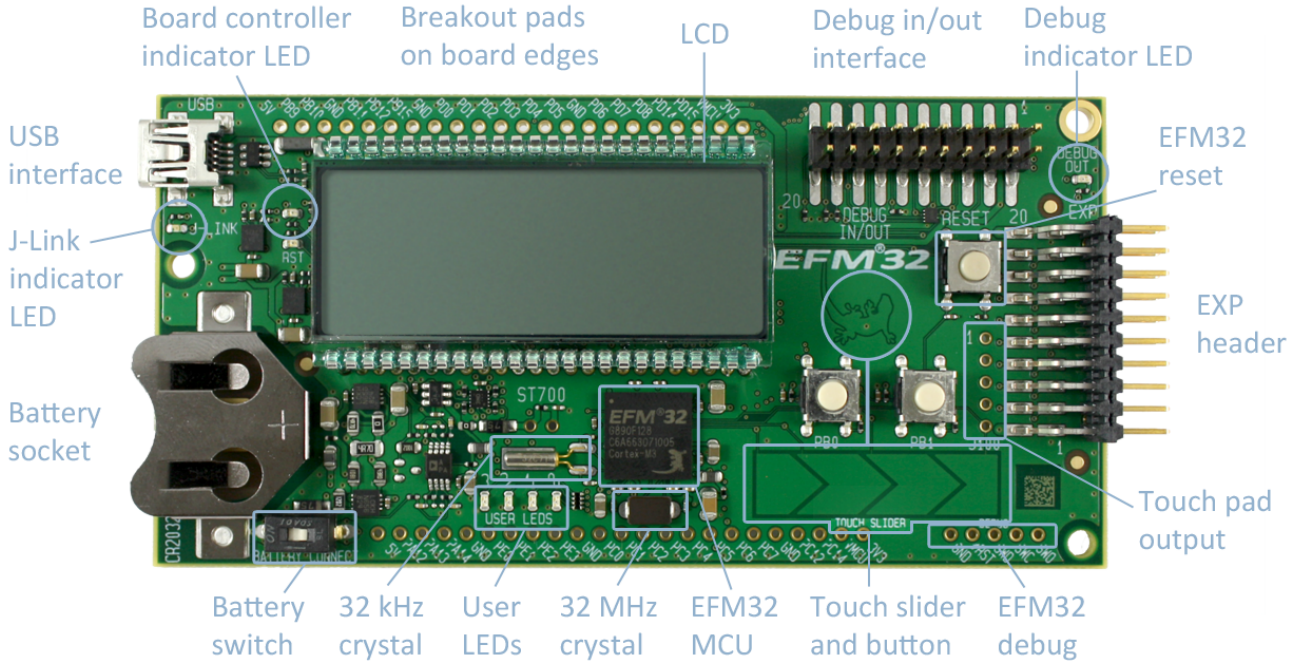
Figure 2.1. EFM32-G8XX-STK Block Diagram



### 3 Hardware layout

The layout of the EFM32-G8XX-STK is shown below.

**Figure 3.1. EFM32-G8XX-STK hardware layout**



## 4 Power supply

### 4.1 USB

The EFM32-G8XX-STK can get its power from the standard USB mini port. The MCU voltage will be 3.15 volts when USB is connected.

### 4.2 Battery

There is a socket for a 20mm coin cell battery, which can be used to power the kit. When the USB is disconnected and the battery connect switch is turned on, the EFM and its peripherals is powered by the battery. The VMCU voltage is 2.85 or lower when powered by the battery, depending on the battery voltage. There is a 0.15V drop down from the battery voltage. The board controller/AEM is not powered by the battery, so the BSP software support library cannot be used on battery power.

## 5 Reset infrastructure

### 5.1 MCU

The primary user reset for the MCU is the reset button on the MCU board. This will only reset the MCU. The MCU can also be reset by debuggers.

### 5.2 Board controller

The board controller can only be reset by pulling and reinserting the USB cable.

## 6 Peripherals

The starter kit has a set of peripherals that showcase some of the features of the EFM32G.

Be aware that most EFM 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.

### 6.1 Pushbuttons

The kit has two user pushbuttons marked PB0 and PB1. They are connected to the EFM, and are debounced by RC filters with a time constant of 1ms.

### 6.2 LEDs

There are four LEDs on the kit marked LED0 to LED3. An active high on the respective pins will light the LEDs.

### 6.3 LCD

An Energy Micro LCD display is connected to the EFM. These lines are not shared on the breakout pads. Capacitors for the EFM32G LCD boost function is available on the EFM32-G8XX-STK.

### 6.4 Touch slider

A touch slider utilizing the capacitive touch capability is available. It is placed under the two push buttons on the kit, above the "TOUCH SLIDER" print.

### 6.5 Touch Gecko

The Gecko above the pushbuttons, and below the EFM32 logo, can also be used as a capacitive touch button.

## 7 Advanced Energy Monitor

### 7.1 Usage

The AEM data is collected by the board controller and can be displayed by a PC application. For instance, the "Gecko commander" utility contains a "power" command which can dump power data to file. A GUI application for displaying power usage will be available for download from the Energy Micro download section later.

### 7.2 AEM theory of operation

In order to be able to measure currents ranging from 0.1uA to 50mA (114dB dynamic range), two current sense amplifiers are utilized. The amplifiers measure voltage drop over a small series resistor and translates this into a current. Each amplifier is adjusted for current measurement in a specific range. The ranges for the amplifiers overlap and a change between the two occurs when the current is 200uA. To reduce noise, averaging of the samples is performed before the current measurement is presented in the AEM GUI.

During startup of the kit, a calibration of the AEM is performed. This calibration compensates for the offset error in the sense amplifiers.

### 7.3 AEM accuracy and performance

The Advanced Energy Monitor is capable of measuring currents in the range of 0.1uA to 50mA. For currents above 200uA, the AEM is accurate within 0.1mA. When measuring currents below 200uA, the accuracy increases to 1uA. Even though the absolute accuracy is 1uA in the sub 200uA range, the AEM is able to detect changes in the current consumption as small as 100nA. The measurement bandwidth of the AEM is 60Hz when measuring currents below 200uA and 120Hz when measuring currents above 200uA. The table below summarizes accuracy of the two current sense amplifiers in different ranges.

**Table 7.1. AEM accuracy**

Current range	Low gain amplifier accuracy	High gain amplifier accuracy
50mA	0.1mA	-
1mA	0.1mA	-
200uA	0.01mA	1uA
10uA	-	0.1uA
1uA	-	0.1uA

**Note**

Having both USB and battery connected may increase the AEM readings.



## 8 Board controller

The control MCU can act as a board controller (BC). There is a UART connection between the EFM and the BC. The connection is made by setting the `bc_en` line high. The EFM can then use the BSP to send commands to the BC. When `bc_en` is low, `bc_tx` and `bc_rx` can be used by other applications.

To use the board controller for your application, the Board Support Package (BSP) must be installed. See the BSP chapter to find out how.

**Note**

The board controller is only available when the STK is powered by USB.

## 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 Energy Micro 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 can be fully usable without BSP support, and you can use all peripherals in the

```
C:\Program Files\Energy Micro\EFM32 Gecko DK\boards\EFM32_Gxxx_STK\drivers
```

folder without the BSP.

The BSP use EFM32 peripheral UART0 (TX pin PE0, RX pin PE1) 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 under battery power will give unpredictable results.

### 9.1 Installation location

When installing the complete software package for the kit, the BSP will be installed under the main installation directory, typically in a location such as

```
C:\Program Files\Energy Micro\EFM32 Gecko DK\boards\EFM32_Gxxx_STK\bsp\
```

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

### 9.2 Application Programming Interface

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

```
#include "stk.h"
```

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

```
void STK_Init(void);
```

and must be called before any access to the STK-functions. This function call will setup the UART communication channel with a 115800 baud rate. This baud rate depends on the current core clock, so correct clock configuration should be set before calling this function.

```
bool STK_Ready(void);
```

Returns *true* if the board controller is responding. A non-responding board will either return false, or hang (i.e. if the EFM32 is powered by the CR2032 battery cell).

```
float STK_Current(void);
```

Returns instant current usage in milliamperes.

```
float STK_Voltage(void);
```

Returns instant voltage (VMCU) reading in volt.

```
bool STK_EnergyMode(uint8_t em);
```

Informs the board controller about the Energy Mode (sleep mode) we are going into. This information can be used by the board controller to present a richer visual graph for illustrating what the EFM32 is currently doing.

In addition to these main functions, full documentation of the complete API is included in the Doxygen/HTML documentation of the installed package.

## 9.3 Example Applications

Under the EFM32\_Gxxx\_STK/examples folder in your installation directory, you will find an example program using the BSP, with corresponding project/Makefiles for the supported IDEs.

## 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 use the BSP. The following items are recommended for correct configuration:

1. Make sure you define the correct part number (i.e. EFM32G890F128) as a preprocessor defined symbol
2. Make sure you define the correct part number (i.e. EFM32G890F128) 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 stk-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 EFM32\_Gxxx\_STK/bsp directory

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

## 9.5 Chip errata

Early versions of the development kit are shipped with EFM32 Engineering Samples on the MCU modules. There has been updates to configuration and reset values that needs to be configured correctly on these early parts. We recommend always starting your application with a call to

```
#include "chip.h"

void CHIP_init(void);
```

to ensure correct and stable behavior. See the BSP examples for details. We recommend also to download and read the latest errata from the Energy Micro website for your part number.

# 10 Connectors

## 10.1 Breakout pads

Most I/O except the LCD pins are routed to the breakout pads at the top and bottom edge of the kit. A 2.54mm (100 mil) pitch pin header can be soldered in place on the pads for easier access.

### Note

Some of the breakout pads are shared by on-board EFM peripherals. The shared pins can be identified by looking at the Shared by column in the tables below. The schematic must be consulted to make sure that it is OK to use a shared pin in your application.

**Table 10.1. Bottom breakout pad row**

Pin	Alternative Functions	Shared by
5V	-	-
PA12	TIM2_CC0	LCD Boost capacitor
PA13	TIM2_CC1	LCD Boost capacitor
PA14	TIM2_CC2	LCD Boost capacitor
GND	-	-
PE0	U0_TX/PCNT0_S0	BC_TX
PE1	U0_RX/PCNT0_S1	BC_RX
PE2	ACMP0_O	EXP header
PE3	ACMP1_O	-
GND	-	-
PC0	ACMP0_CH0/US1_TX/PCNT0_S0	User LED 0
PC1	ACMP0_CH1/US1_RX/PCNT0_S1	User LED 1
PC2	ACMP0_CH2/US2_TX	User LED 2
PC3	ACMP0_CH3/US2_RX	User LED 3
PC4	ACMP0_CH4/LET0_O0/US2_CLK/PCNT1_S0	EXP header
PC5	ACMP0_CH5/LET0_O1/US2_CS/PCNT1_S1	EXP header
PC6	ACMP0_CH6/LEU1_TX/I2C0_SDA	-
PC7	ACMP0_CH7/LEU1_RX/I2C0_SCL	-
PC8	ACMP1_CH0/TIM2_CC0/US0_CS	Touch slider segment 0
PC9	ACMP1_CH1/TIM2_CC1/US0_CLK	Touch slider segment 1
PC10	ACMP1_CH2/TIM2_CC2/US0_RX	Touch slider segment 2
PC11	ACMP1_CH3/US0_TX	Touch slider segment 3
PC12	ACMP1_CH4/CMU_OUT0	EXP header
PC13	ACMP1_CH5/TIM1_CC0/TIM0_CDTI0/PCNT0_S0	Touch Gecko
PC14	ACMP1_CH6/TIM1_CC1/TIM0_CDTI1/PCNT0_S1	-
VMCU	-	-
3V3	-	-

**Table 10.2. Top breakout pad row**

Pin	Alternative Functions	Shared by
5V	-	-
PB9	-	User button 0
PB10	-	User button 1
GND	-	-
PB11	DAC_OUT0/LET0_O0	EXP header
PB12	DAC_OUT1/LET0_O1	EXP header
PB15	-	-
GND	-	-
PD0	US1_TX/PCNT2_S0	EXP header
PD1	TIM0_CC0/US1_RX/PCNT2_S1	EXP header
PD2	TIM0_CC1/US1_CLK	EXP header
PD3	TIM0_CC2/US1_CS	EXP header
PD4	LEU0_TX	EXP header
PD5	LEU0_RX	EXP header
GND	-	-
PD6	ACMP0_CH6/LET0_O0/I2C0_SDA	EXP header
PD7	ACMP0_CH7/LET0_O1/I2C0_SCL	EXP header
PD8	ADC0_VCM/CMU_OUT1	EXP header
PD14	I2C0_SDA	-
PD15	I2C0_SCL	-
VMCU	-	-
3V3	-	-

## 10.2 Expansion header

A 20 pin expansion header can be used to connect plugin boards. This contains a selection of I/O plus powers and ground. See the pinout in the table below.

**Table 10.3. Expansion header pinout**

I/O	#	#	I/O
GND	1	2	VMCU
PC4	3	4	PD0
PC5	5	6	PD1
PC12	7	8	PD2
PE2	9	10	PD3
PB11	11	12	PD4
PB12	13	14	PD5
PD7	15	16	PD6
PD8	17	18	5V
GND	19	20	3V3

## 10.3 Debug connector

This connector is used for Debug In and Debug Out (see Debug chapter). The pinout is described in the table.

**Table 10.4. Debug connector pinout**

Pin number	Function	Note
1	VTARGET	Target voltage on the debugged application.
2	NC	
3	/TRST	JTAG tap reset
4	GND	
5	TDI	JTAG data in
6	GND	
7	TMS/SWDIO	JTAG TMS or Serial Wire data I/O
8	GND	
9	TCK	JTAG TCK or Serial Wire clock
10	GND	
11	RTCK	JTAG RTCK
12	GND	
13	TDO/SWO	JTAG TDO or Serial Wire Output
14	GND	
15	/RESET	Target MCU reset
16	GND	
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.
20	GND	

# 11 Debugging

The EFM32-G8XX-STK has an on-board debugger, and it can be used in different ways to debug the EFM, both on and off kit. Below are descriptions on the different modes. Check the configuration chapter to find out how to change the debug setting.

**Table 11.1. Debug modes**

Mode	Description
Debug MCU	In this mode the on-board debugger is connected to EFM on the EFM32-G8XX-STK.
Debug IN	In this mode the on-board debugger is disconnected, and an external debugger can be connected to debug the EFM on the EFM32-G8XX-STK.
Debug OUT	In this mode the on-board debugger can be used to debug an EFM mounted in your own application.

## 11.1 Debugging during battery operation

When the EFM is powered by the battery (i.e. the USB is disconnected), the on-board debug functionality is not available. To enable debugging in this mode, connect an external debugger (e.g. another EFM32-G8XX-STK) to the debug pads in the bottom right corner of the EFM32-G8XX-STK. These pads are connected directly to the EFM32 debug interface.

### Note

When the on-board debugger is active, a current of approximately 1.6uA will be added to the AEM measurements.



## 12 IDEs

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

### 12.1 IAR Embedded Workbench for ARM

An evaluation version of IAR Embedded Workbench for ARM is included on a CD in the EFM32-G8XX-STK 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

### 12.2 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.

### 12.3 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.

### 12.4 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.

## 13 Gecko Commander and Upgrades

Gecko Commander is a command line utility that comes with the Gecko DK Installer package. It can perform various kit and EFM32 specific tasks. Press "h" for help at the prompt for a listing of available commands. Press "h command" for help for a specific command, listing arguments and options.

### 13.1 Available commands

**Table 13.1. Gecko Commander**

Command	Description
ping	"Ping" kit, i.e. verify that target kit is up and running
speed	Sets the link speed for the serial wire debug interface from the kit, towards the EFM32
reset	Reset kit, which also implies a reset of the EFM32 as well
usb	Change J-Link USB port used, default is port 0. Unless you have multiple J-Link debuggers there should be no reason to change this
version	Get PCB and firmware versions of kit
install	Install an application or boot package. This command, with a filename ending with .emz as an option upgrades the kit software
ls	List directory, shows which binary files has been uploaded to the kit, which can be flashed with the GUI
put	Copy a binary file from host to target, that can be used to flash directly from the kit GUI (Flash submenu)
rm	Remove file
flash	Flashes the EFM32 program memory with binary file, starting from flash address 0x0000000. Enter filename as argument.
verify	Verifies correct installation of a binary into flash
dumpbin	Dumps content of memory of the EFM32 to file
erase	Erases the entire flash
unlock	Unlocks a locked chip and performs a device erase
lock	Locks the chip, prevents reading out the flash over debugger interface
protect	Write-protects pages in flash
uprotect	Clears all write protection lock bits
power	Dump power measurements from the running application to file. Enter filename as argument.
mode	Sets the mode of the on-board debugger. Available modes:  <i>mcu</i> - Debug the EFM32 using the on-board debugger <i>in</i> - Debug the EFM32 using an external debugger <i>out</i> - Use the STK as an external debugger <i>off</i> - Disable the debugger

### 13.2 Upgrades

Upgrading the kit can be done by using the "Upgrade Kit" script in the start menu. New versions can be downloaded from <http://www.energymicro.com/downloads/>. The script will use Gecko commander to install the latest available Kit SW package. It is important to upgrade the kit when installing a new SW package, as new Gecko commander functionality might require kit controller software upgrades.

## 14 Version information

The current version information can be read from Gecko Commander.

**Table 14.1. Current versions**

Type	Version	Released
Firmware revision	1v0	2010-04-09
Hardware version	1v0	2010-04-09

## 15 Schematic

On the next pages you can find the schematic and the assembly drawings of the main board.



## EFM32 Starter Kit

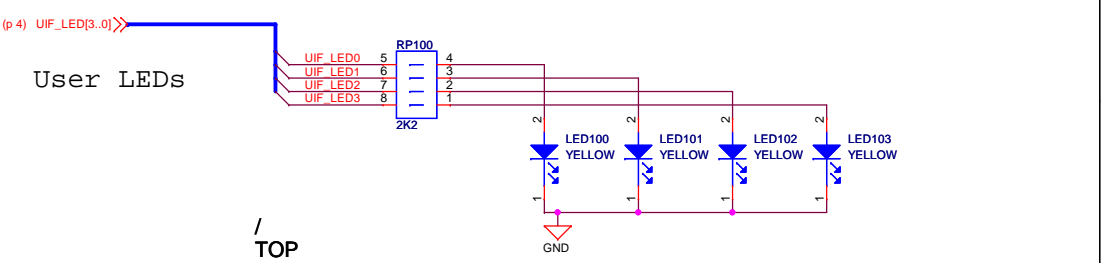
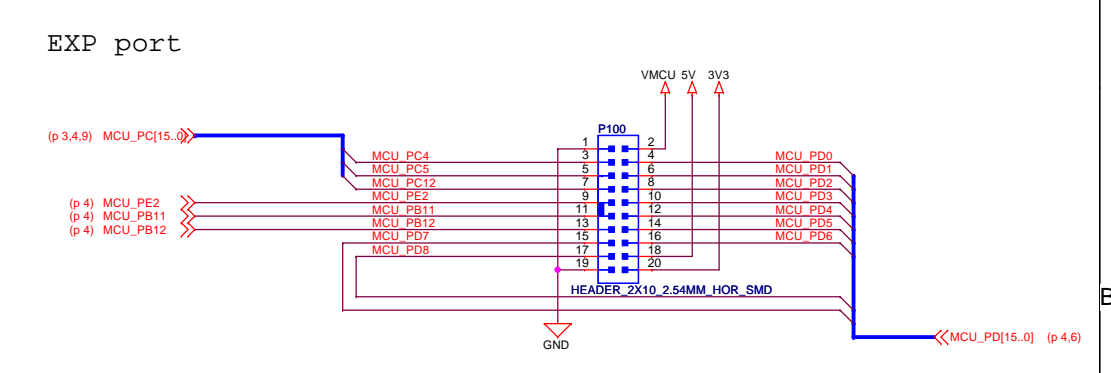
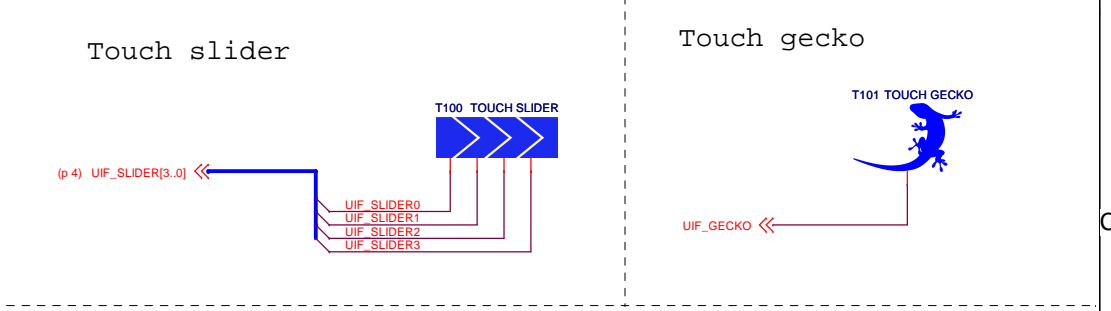
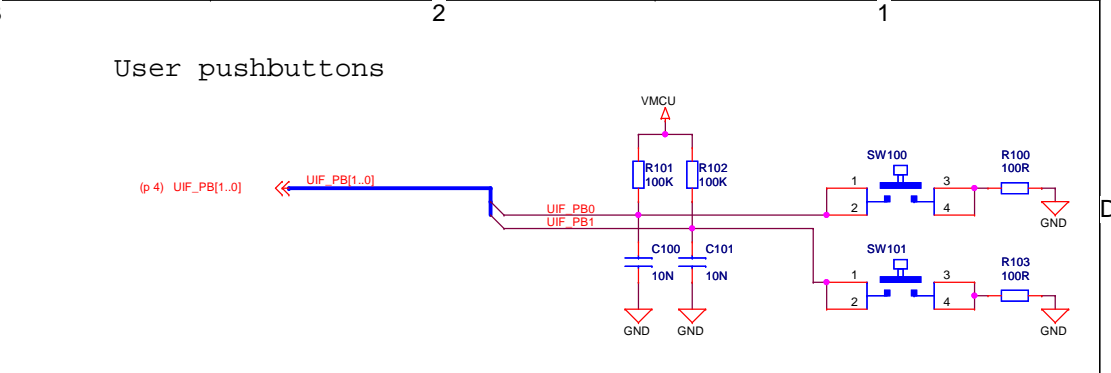
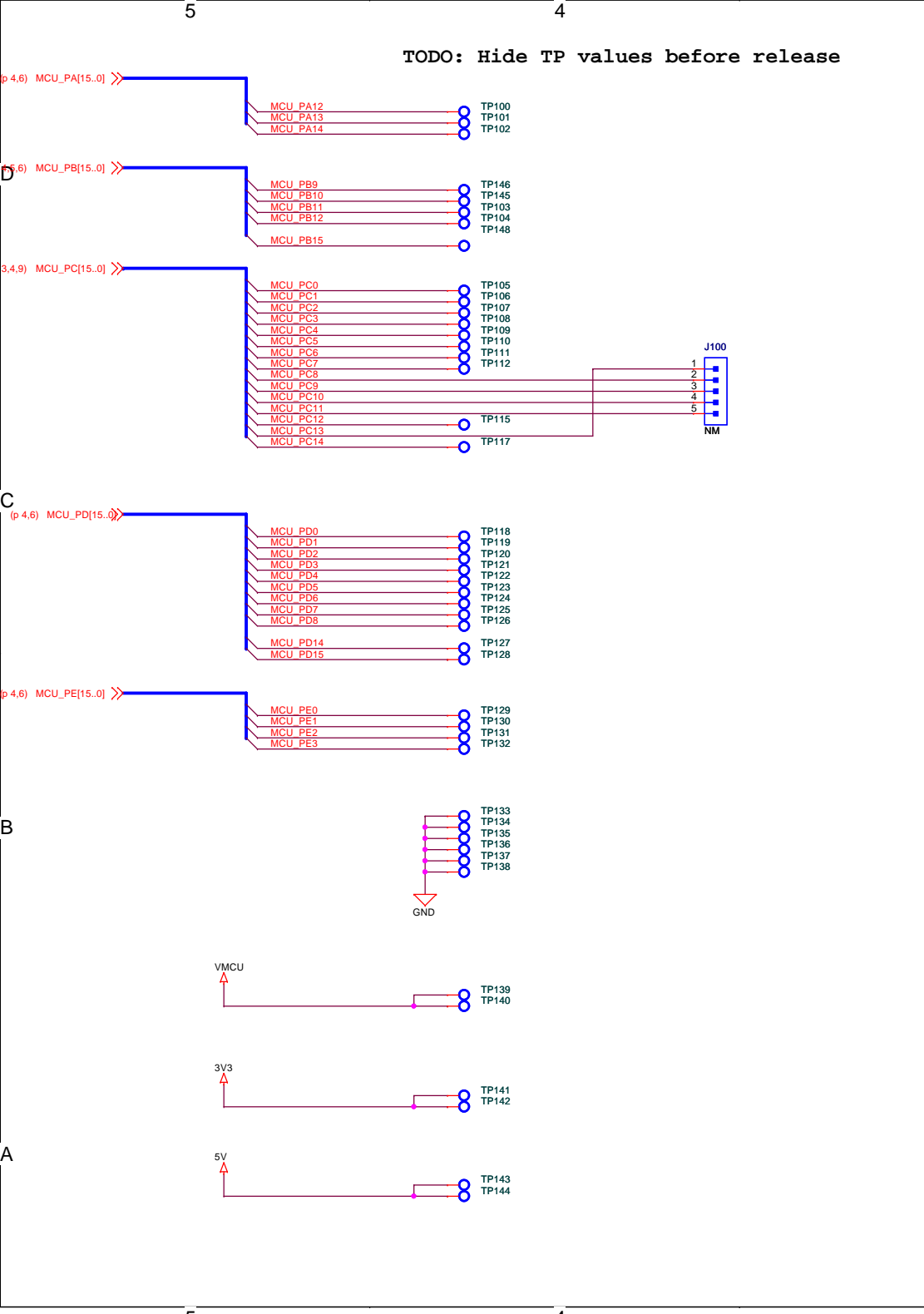
Board Function	Page
Top Level Schematic	1
	2
	3
	4
	5

## Revision History

Rev.	Description
A	A lot of bug fixes and improvements.
A1	Added #RST to the debug header and added a separate header (J100) for the touch segment pins.
A2	Fixed renaming of 3V3 to PCB_REV0
A3	Swapped two pins on D600 to simplify routing.

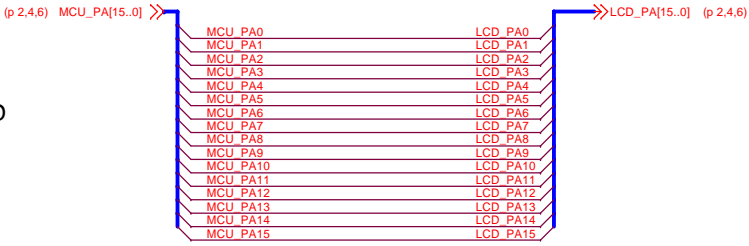
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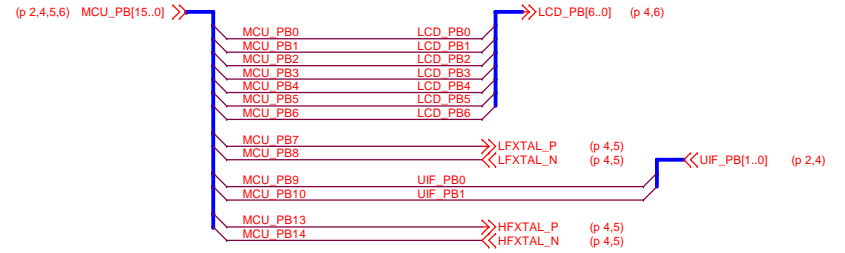


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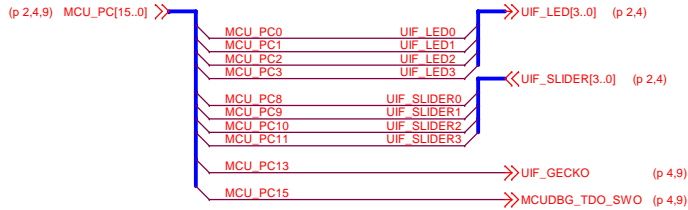
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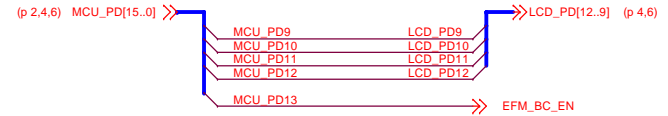
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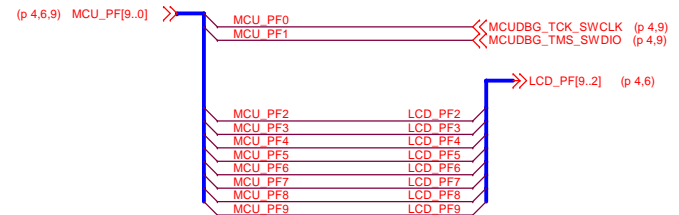
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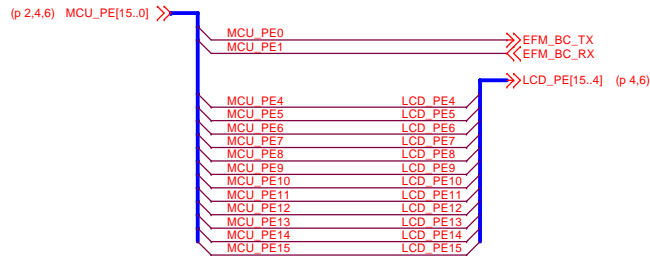
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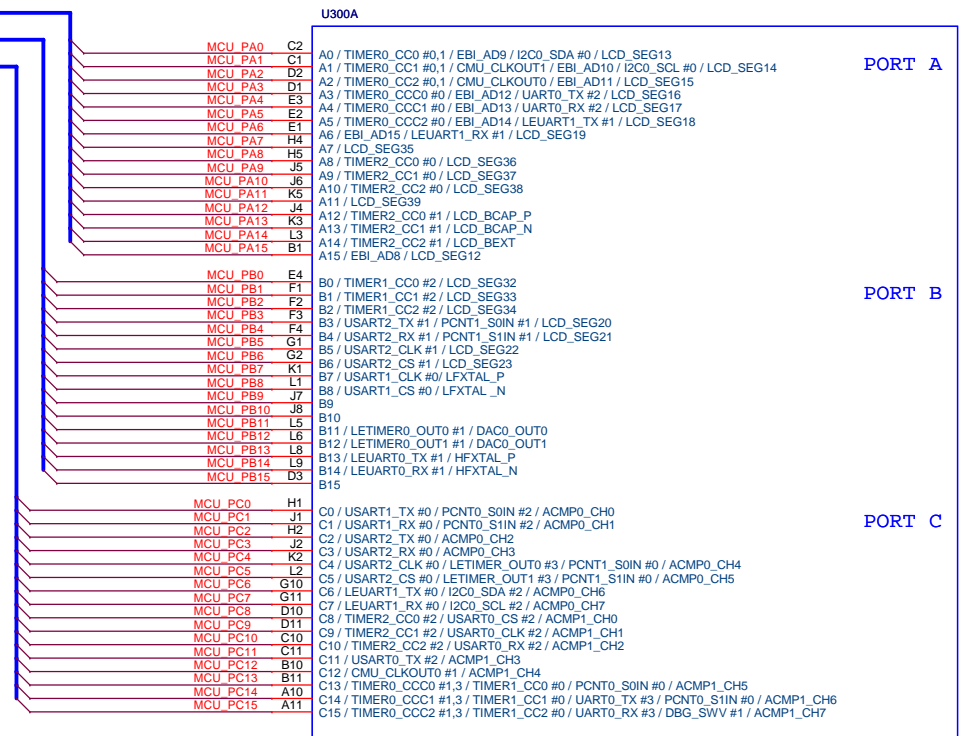
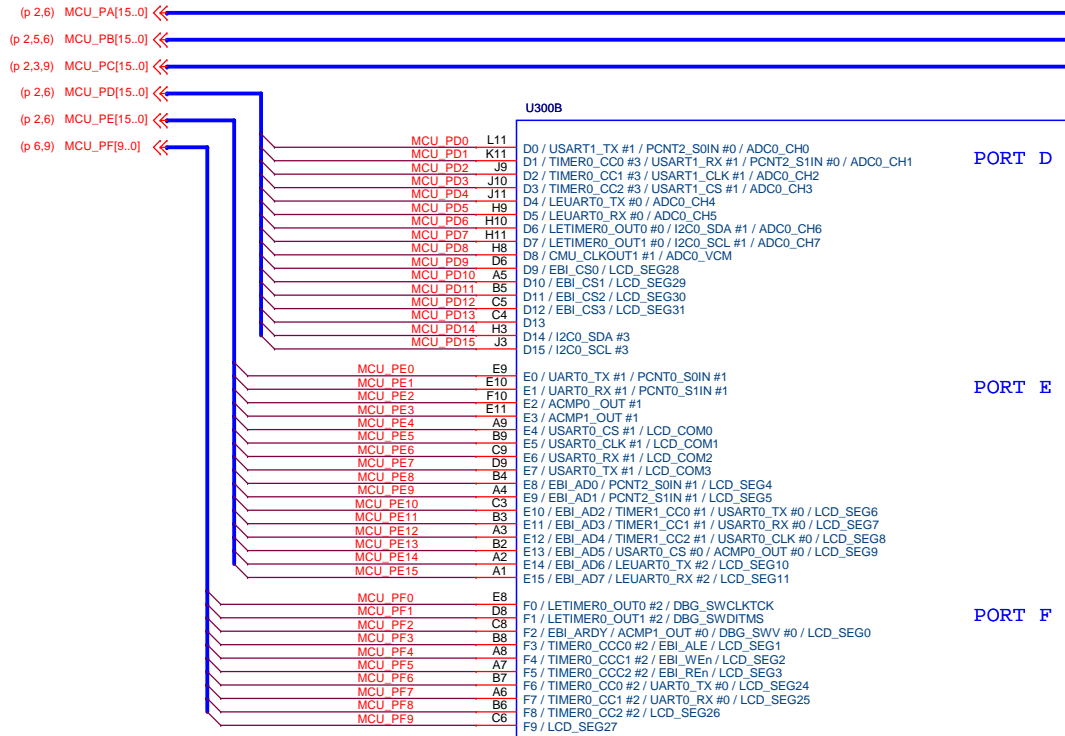


PE Connections



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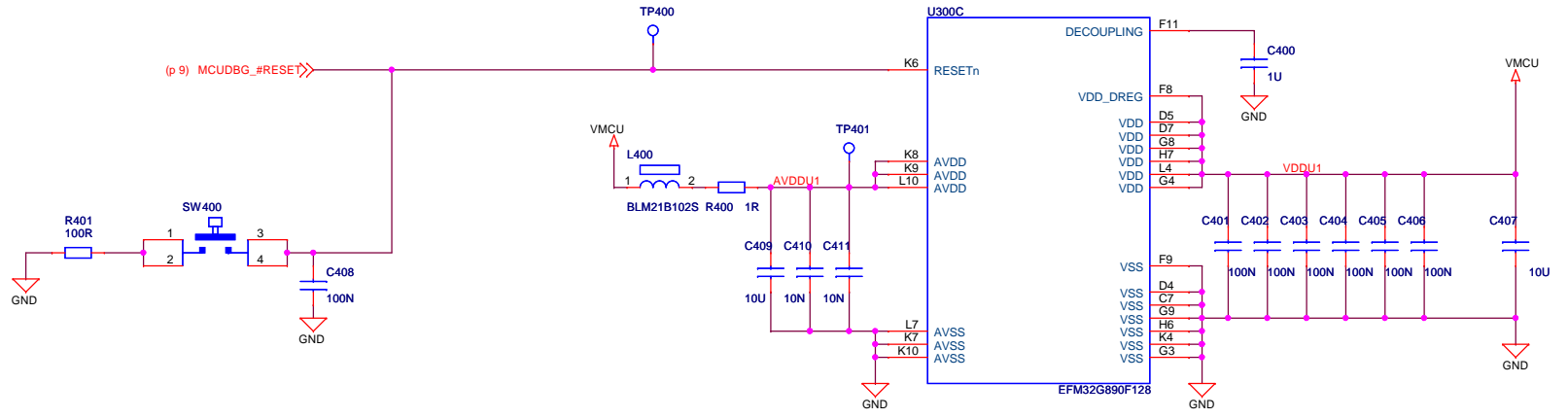
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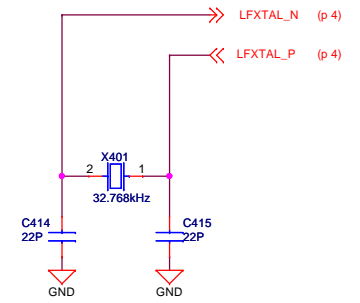
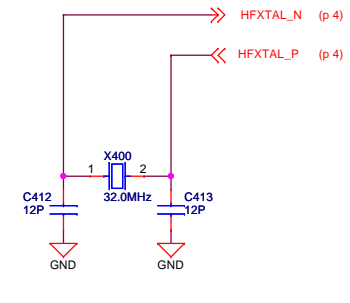
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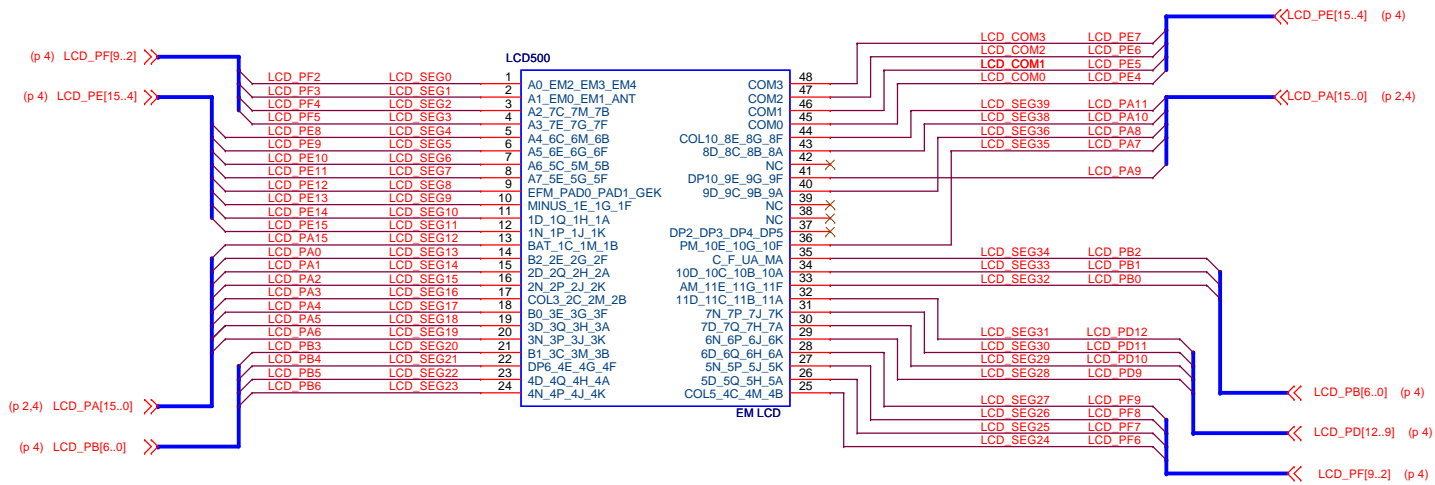


Low Frequency Clock

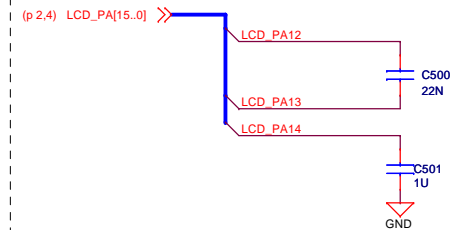


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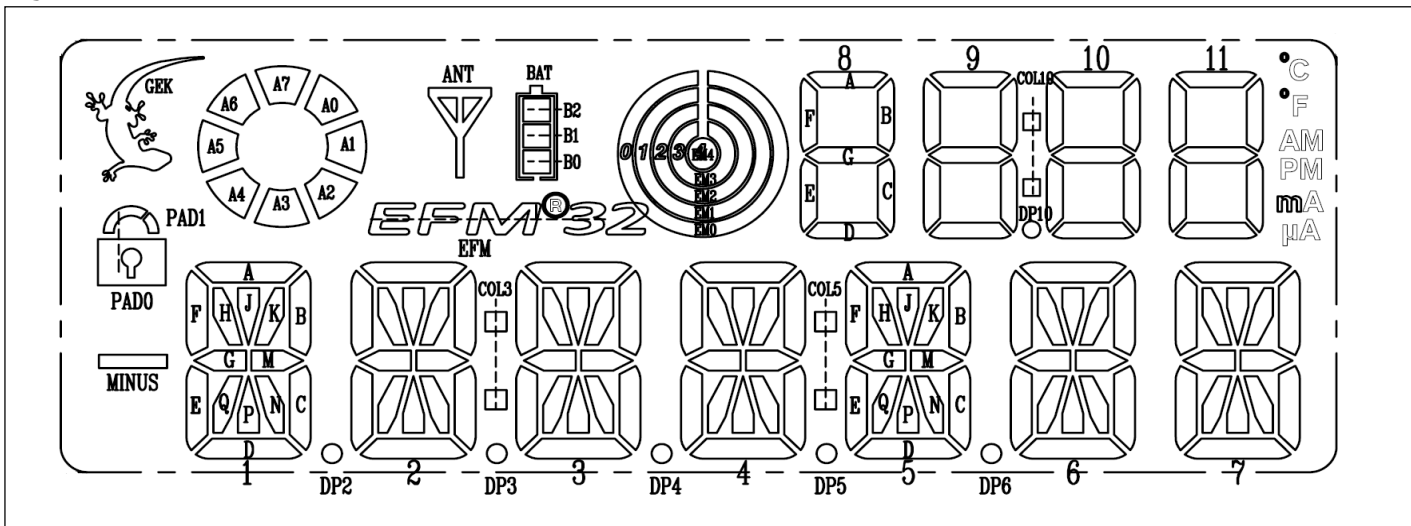
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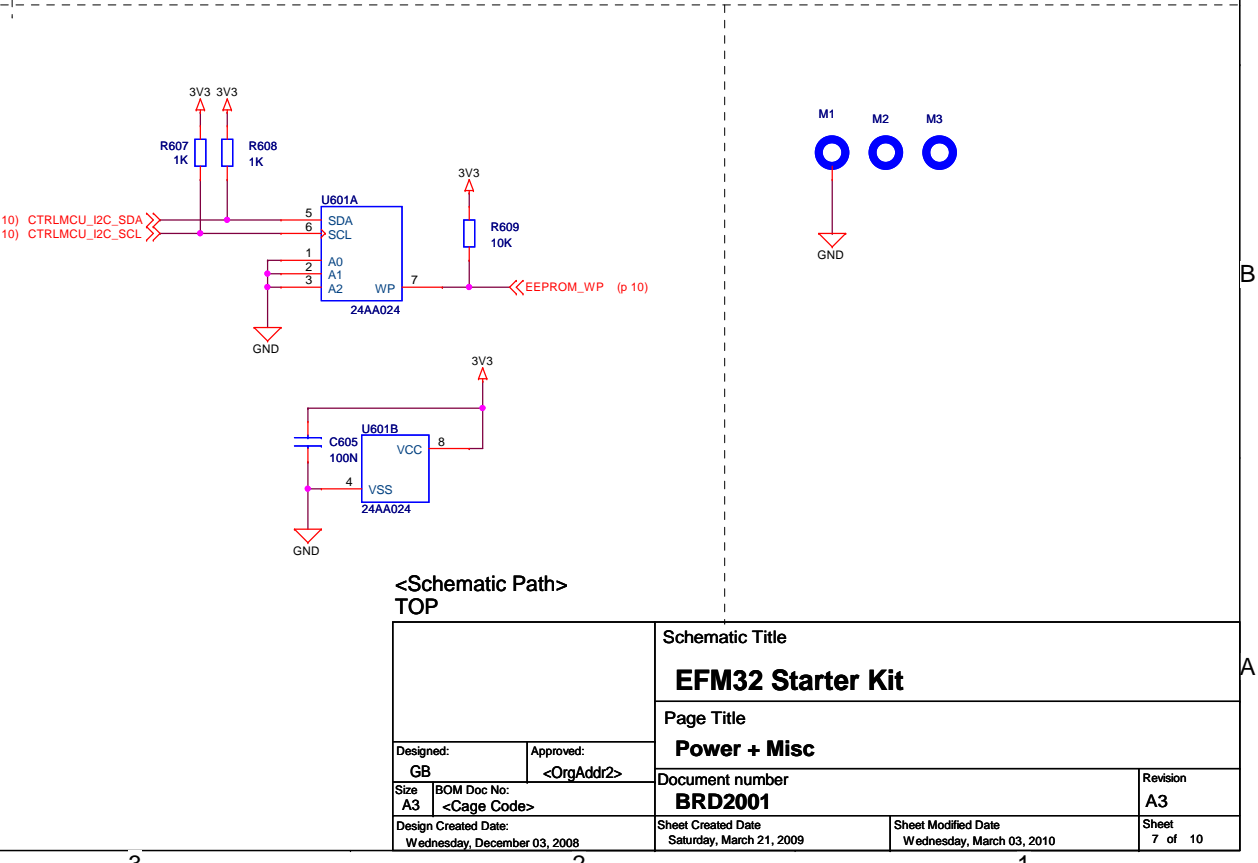
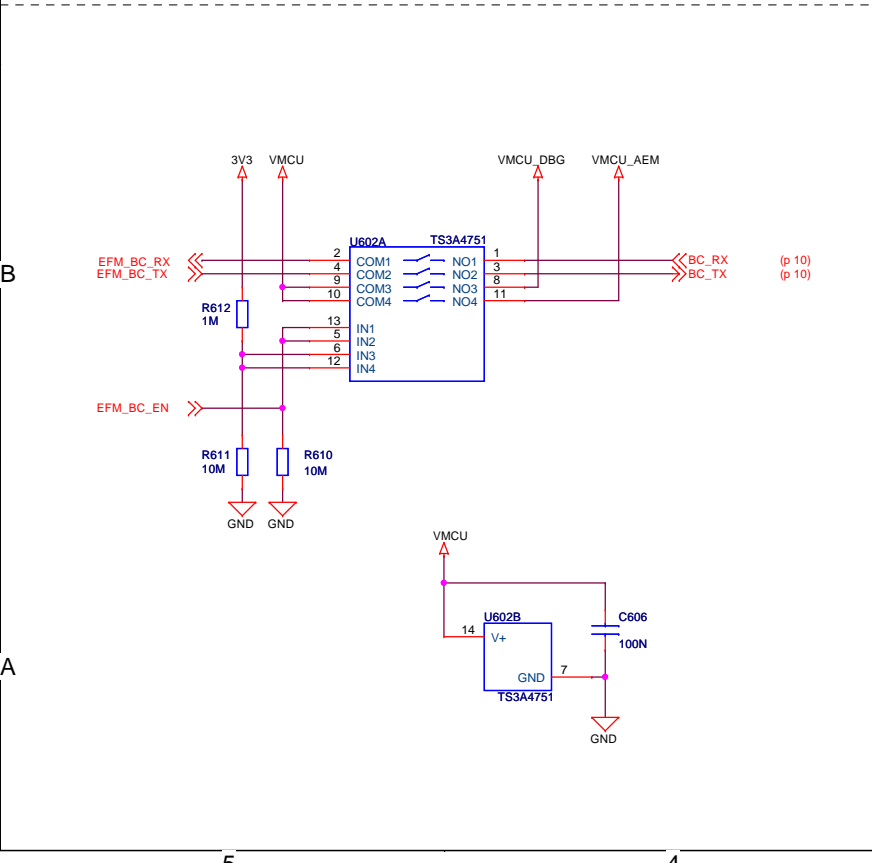
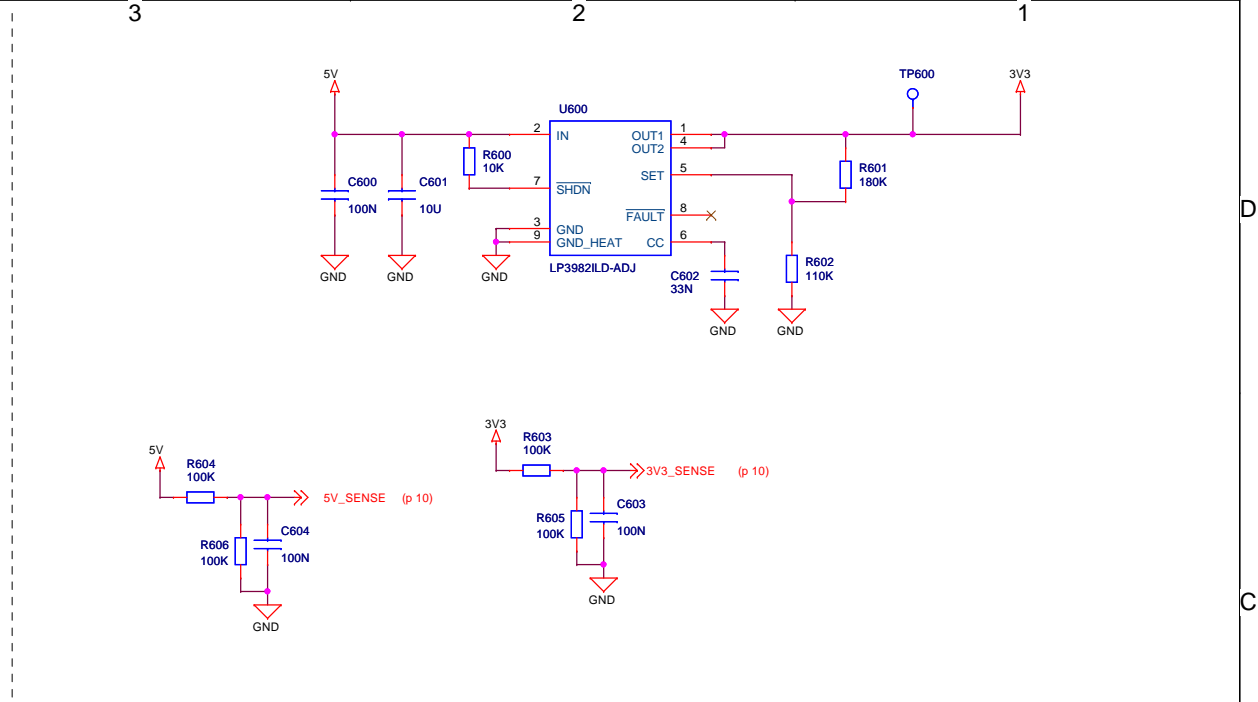
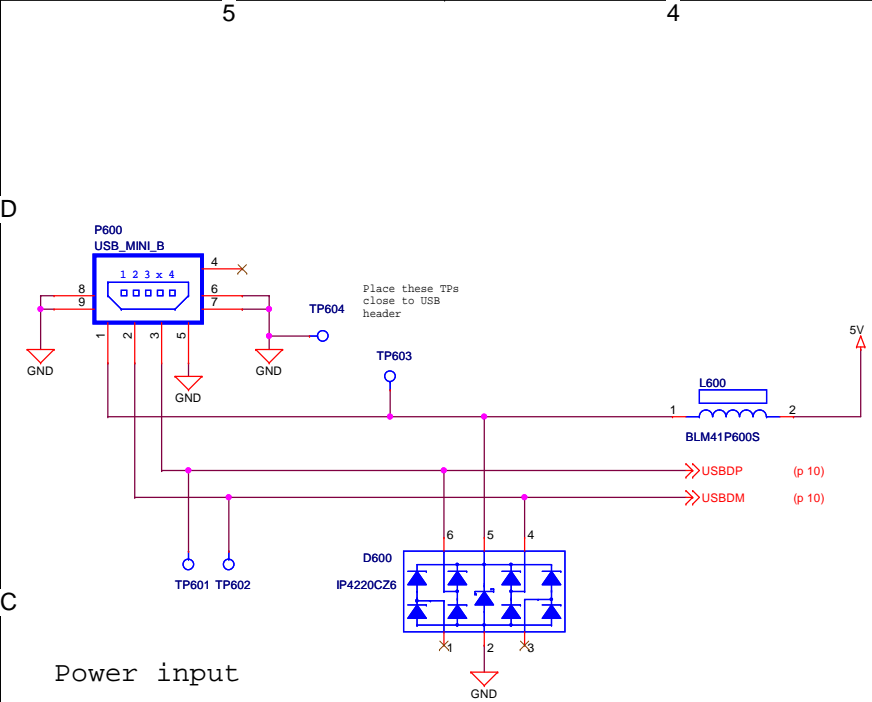


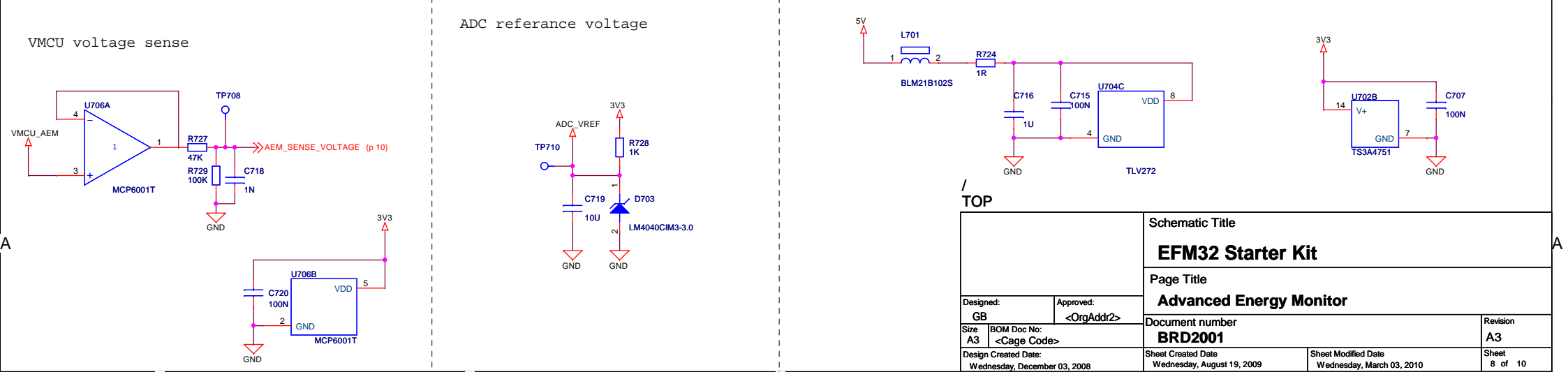
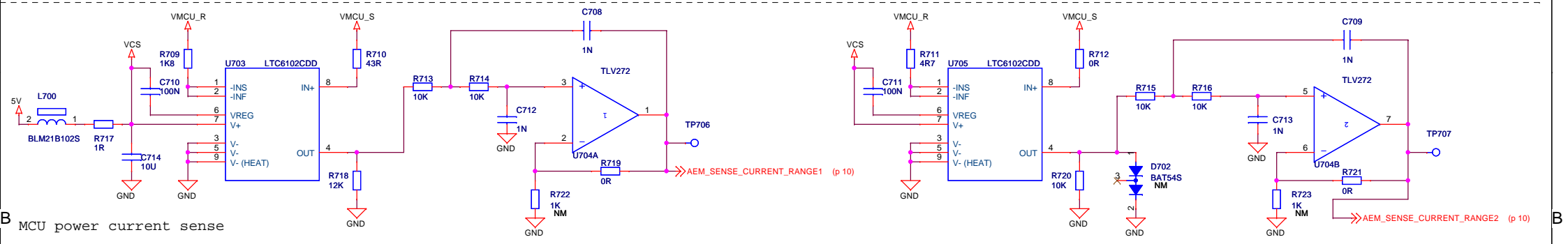
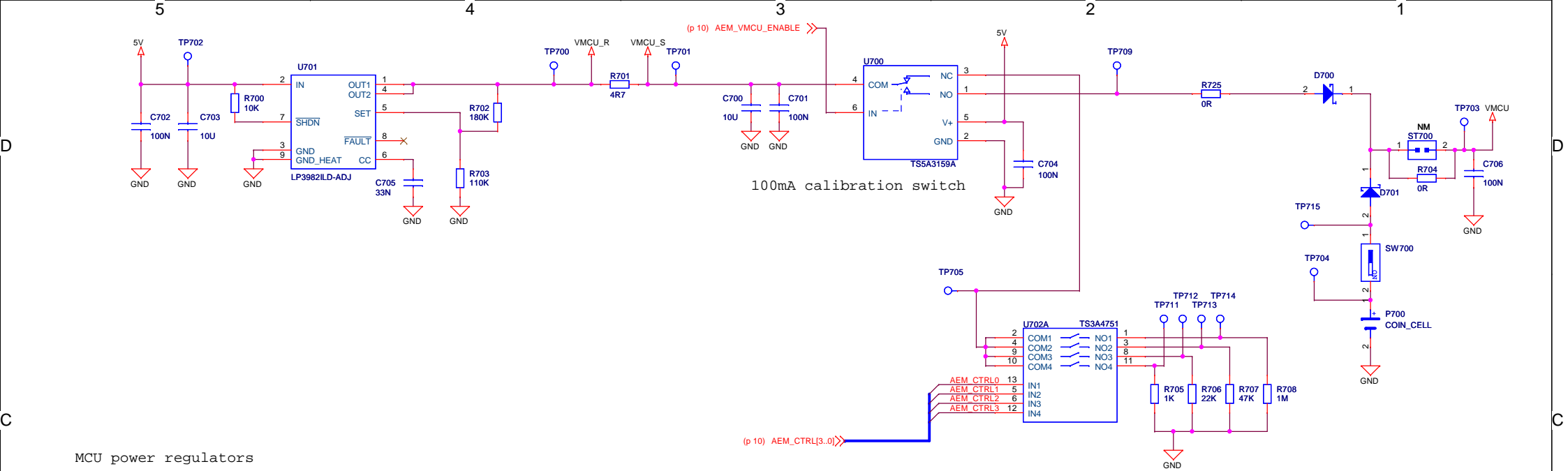
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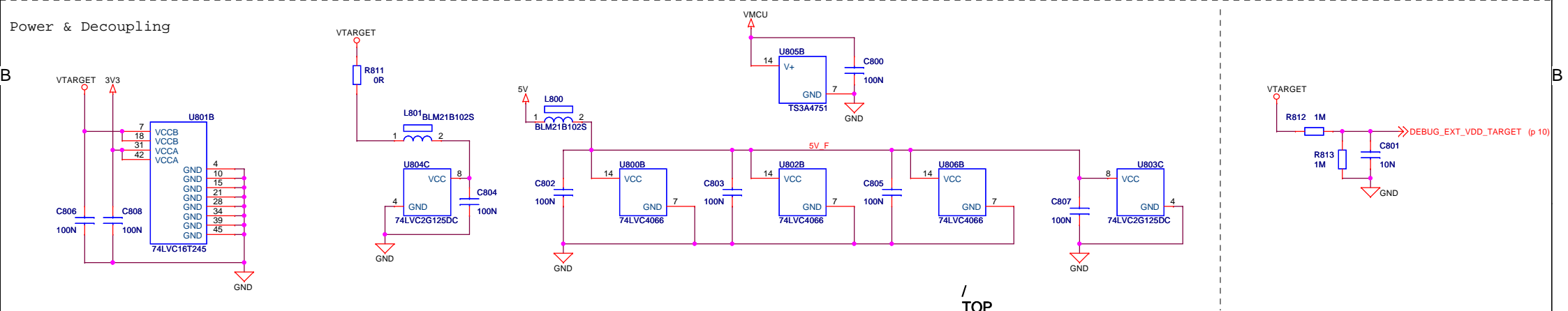
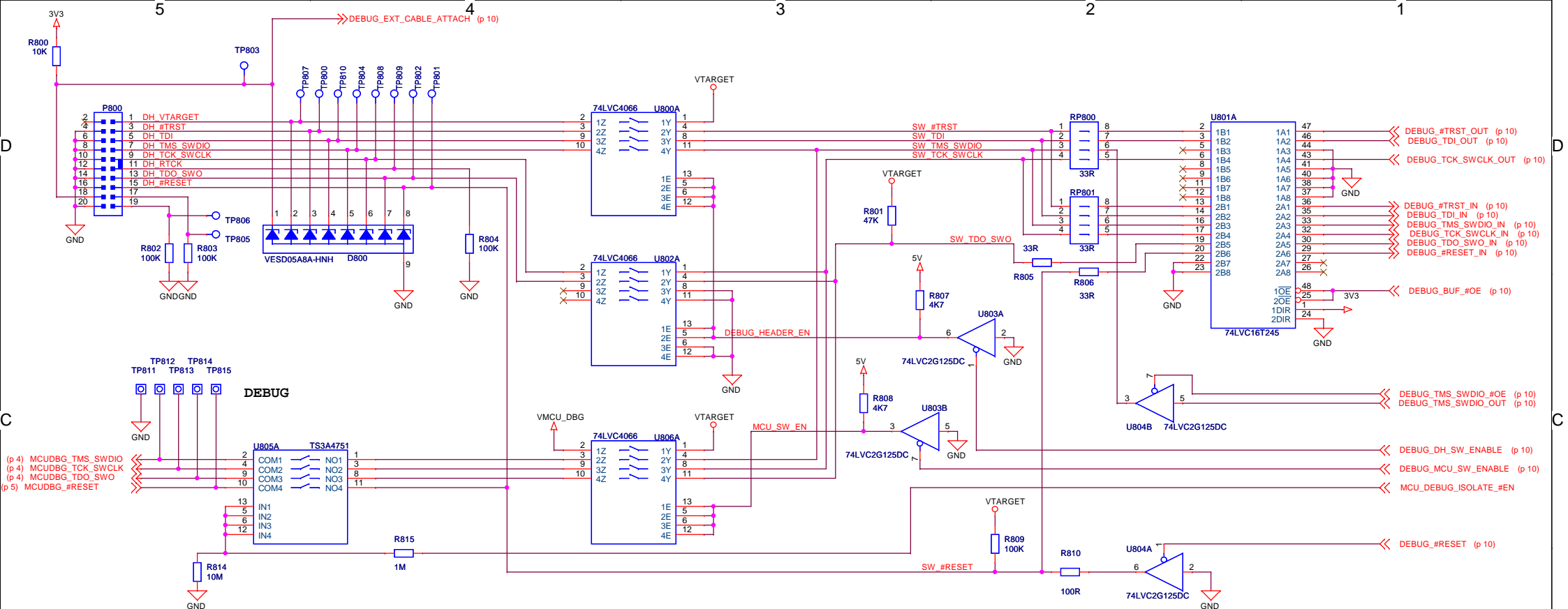
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**TOP**

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Page Title		<b>Advanced Energy Monitor</b>	
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Mode	DEBUG_MCU_SW_ENABLE	DEBUG_DH_SW_ENABLE	DEBUG_BUF_#OE	DH_VTARGET	VTARGET
Debug Out	0	1	0	External voltage	External voltage
MCU Debug	1	0	0	Disconnected	VMCU
Debug In	1	1	1	VMCU	VMCU

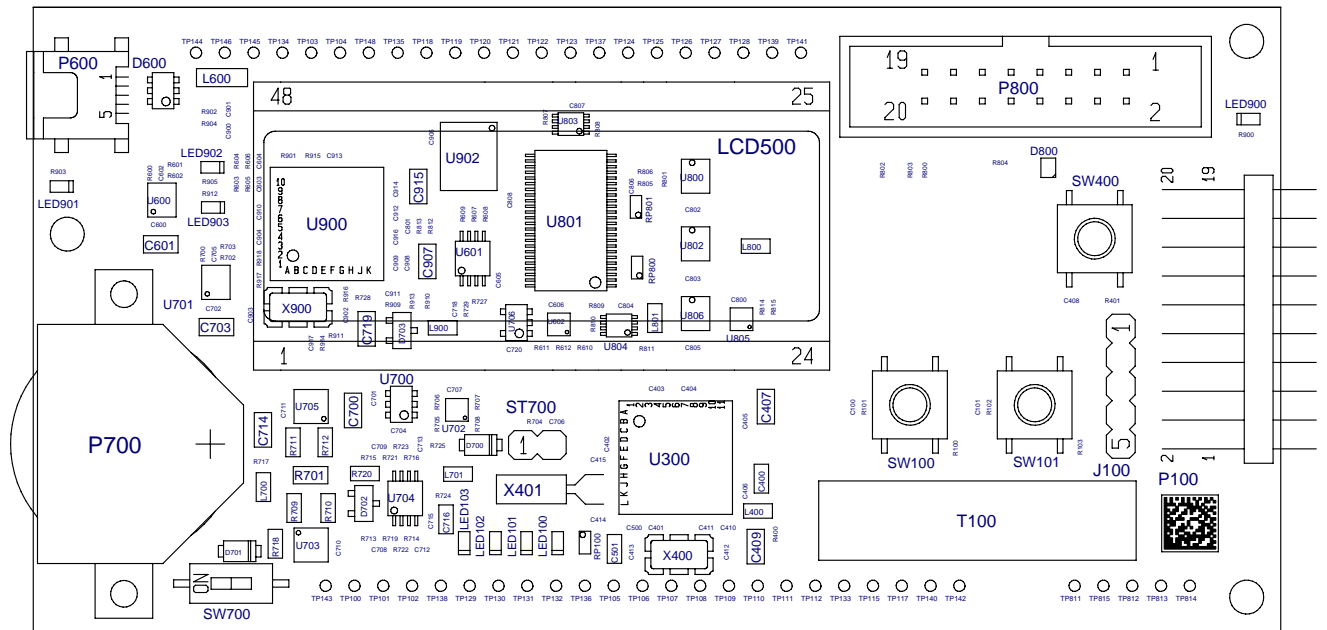
  

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Schematic Title  
**EFM32 Starter Kit**

Page Title  
**Debug Interface**





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PRINTED BOARD ASSEMBLY

Dokumentnr - Document No.

Side - Sheet

( Scale 1.5 : 1 )

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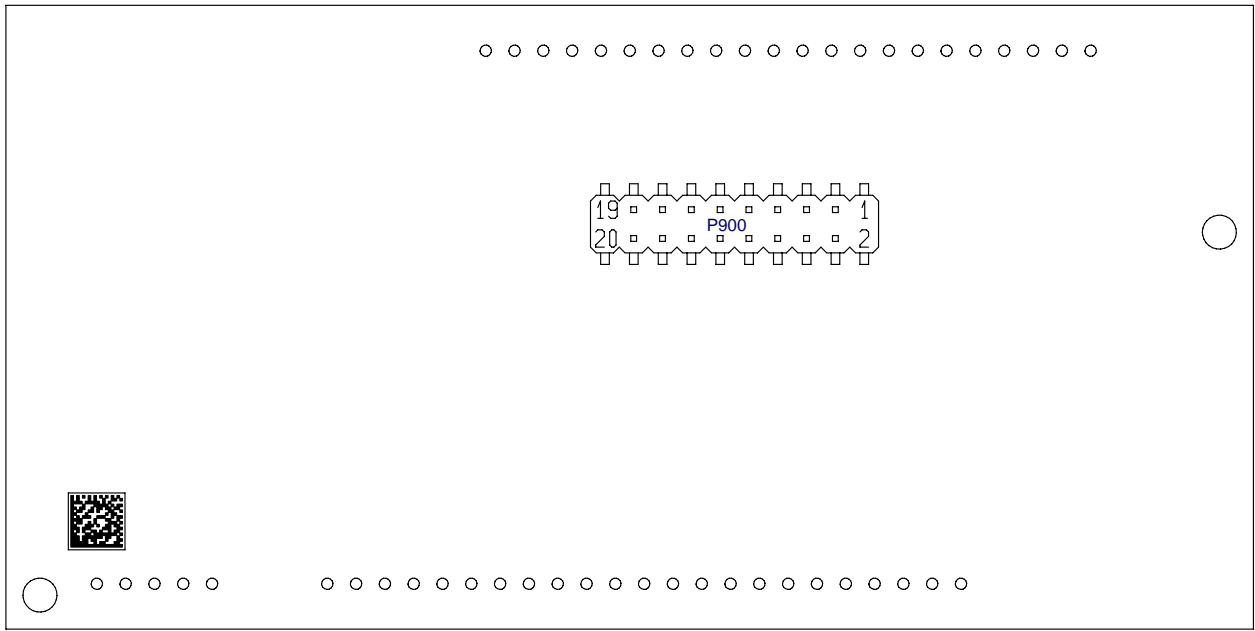
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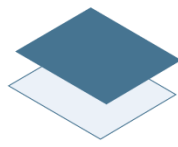
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