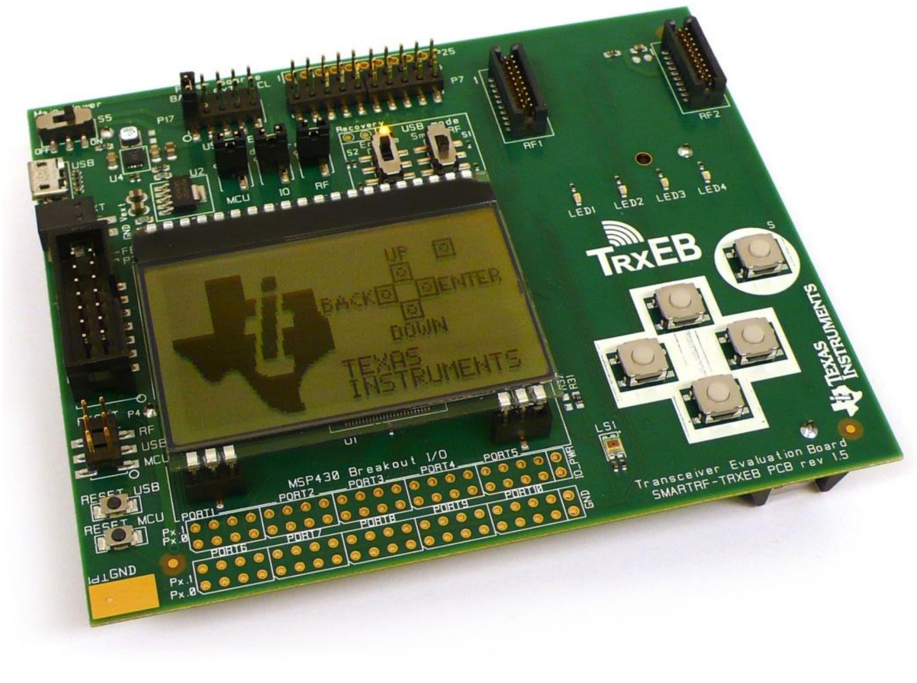
SmartRF Transceiver Evaluation Board "TrxEB"

User's Guide



SWRU294A

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1 Introduction

The SmartRF Transceiver Evaluation Board (SmartRF TrxEB or simply EB) is the motherboard in a number of development kits for Low Power RF transceiver devices from Texas Instruments. The board has a wide range of features, listed in Table 1 below.

Component	Description
MSP430 MCU	The Ultra-low Power MSP430 serves as a platform for software development, testing and debugging.
Full-speed USB 2.0 interface	Easy plug and play access to full transceiver control using SmartRF™ Studio PC software. Integrated serial port over USB enables communication between onboard MSP430 and PC.
64x128 pixels serial LCD	Big LCD display for demo use and user interface development.
LEDs	Four general purpose LEDs for demo use or debugging.
Serial Flash	External flash for extra storage, over-the-air upgrades and more.
Buttons	Five push-buttons for demo use and user interfacing.
Accelerometer	Three-axis highly configurable digital accelerometer for application development and demo use.
Light Sensor	Ambient Light Sensor for application development and demo use.
Breakout pins	Easy access to GPIO pins for quick and easy debugging.

Table 1 – Available features on the SmartRF TrxEB

2 About this manual

This manual contains reference information about the SmartRF TrxEB.

Chapter 4 will give a quick introduction on how to get started with the SmartRF TrxEB. It describes how to install SmartRF Studio and to get the required USB drivers for the evaluation board. Chapter 5 briefly explains how the EB can be used throughout a project's development cycle. Chapter 6 gives an overview of the various features and functionality provided by the board.

Chapter 8, 9 and 10 provide additional details about the different versions of SmartRF TrxEB, revision 1.3.0, 1.5.0 and 1.7.0, respectively. Chapter 11 gives details on how to update the EB firmware, while a troubleshooting guide is found in chapter 12.

Appendices A, B and C contain the schematics for the different versions of SmartRF TrxEB.

The PC tools SmartRF Studio and SmartRF Flash Programmer have their own user manual.

See chapter 13 for references to relevant documents and web pages.

3 Acronyms and Abbreviations

ACM	Abstract Control Model
ALS	Ambient Light Sensor
CEBAL	CC Evaluation Board Abstraction Layer
CDC	Communication Device Class
CTS	Clear to Send
CW	Continuous Wave
DK	Development Kit
DUT	Device Under Test
EB	Evaluation Board
EM	Evaluation Module
IC	Integrated Circuit
I/O	Input/Output
KB	Kibi Byte (1024 byte)
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LPRF	Low Power RF
MCU	Micro Controller
MISO	Master In, Slave Out (SPI signal)
MOSI	Master Out, Slave In (SPI signal)
NA	Not Applicable / Not Available
NC	Not Connected
PER	Packet Error Rate
RF	Radio Frequency
RX	Receive
RTS	Request to Send
SoC	System on Chip
SPI	Serial Peripheral Interface
TI	Texas Instruments
TrxEB	Transceiver Evaluation Board
TX	Transmit
TRX	Transmit / Receive
UART	Universal Asynchronous Receive Transmit
USB	Universal Serial Bus

4 Getting Started

Before connecting the SmartRF TrxEB to the PC via the USB connector, it is highly recommended to install the USB drivers needed for proper communication between the TrxEB and applicable PC tools. The drivers are bundled and installed together with SmartRF™ Studio.

4.1 SmartRF Studio

SmartRF Studio is a PC application developed for evaluation of the low power RF IC products from Texas Instruments. The application is designed for use with SmartRF Evaluation Boards, such as SmartRF TrxEB, and runs on Microsoft Windows operating systems.

SmartRF Studio gives the user full overview of and access to the devices' registers for configuration of the radio parameters and behavior. It also provides a control interface for performing operations like sending and receiving packets and setting up a continuous wave signal. In addition, it offers a flexible system for exporting radio register values to a user defined format for easy integration in software.

The latest version of SmartRF Studio can be downloaded from the Texas Instruments website [1].

4.2 Installing SmartRF Studio and USB drivers

Before your PC can communicate with the SmartRF TrxEB over USB, you will need to install the USB drivers for the EB. The latest SmartRF Studio installer [1] includes the required USB drivers both for Windows x86 and Windows x64 platforms.

After you have downloaded SmartRF Studio from the web, extract the zip-file, run the installer and follow the instructions. Select the complete installation to include the SmartRF Studio program, the SmartRF Studio documentation and the USB drivers. There are two drivers needed for TrxEB: Cebal and a virtual COM port driver.

4.2.1 Cebal USB driver

NOTE: The SmartRF TrxEB must be in "SmartRF Mode" in order to be recognized by the PC as a Cebal device. The EB is in SmartRF Mode when hardware switches S1 and S2 are in positions "SmartRF" and "Enable", respectively. See section 6.1 for more information about the SmartRF TrxEB operating modes.

SmartRF PC software such as SmartRF Studio uses a proprietary USB driver, Cebal, to communicate with evaluation boards. Connect your SmartRF TrxEB to the computer with a USB cable, set the mode switches to "SmartRF" and "Enable", and turn it on. If you did a complete install of SmartRF Studio, Windows will recognize the device automatically and the SmartRF TrxEB is ready for use!

For more information regarding the USB drivers, please consult the SmartRF Studio documentation, the USB driver installation guide [2] or chapter 11.

4.2.2 Virtual COM port USB driver

NOTE: The SmartRF TrxEB must be in "UART Mode" in order to be recognized as a virtual COM port. The EB is in UART Mode when hardware switches S1 and S2 are in positions "UART" and "Enable", respectively. See section 6.1 for more information about the SmartRF TrxEB operating modes.

If you are using SmartRF TrxEB in UART Mode (see section 6.1.2), a standard driver for a virtual COM port over USB is used (USB CDC-ACM). If you did a complete install of SmartRF Studio, Windows will recognize the device automatically. If prompted with the Windows Hardware Wizard, select "Install the software automatically (recommended)" and click next to finish the installation. The SmartRF TrxEB is now ready for use!

If the SmartRF TrxEB CDC-ACM driver is not found by the Hardware Wizard, make sure you have installed the latest version of SmartRF Studio [1]. In the Windows Hardware Wizard, select "Install from a list or specific location (Advanced)". You will see below window.

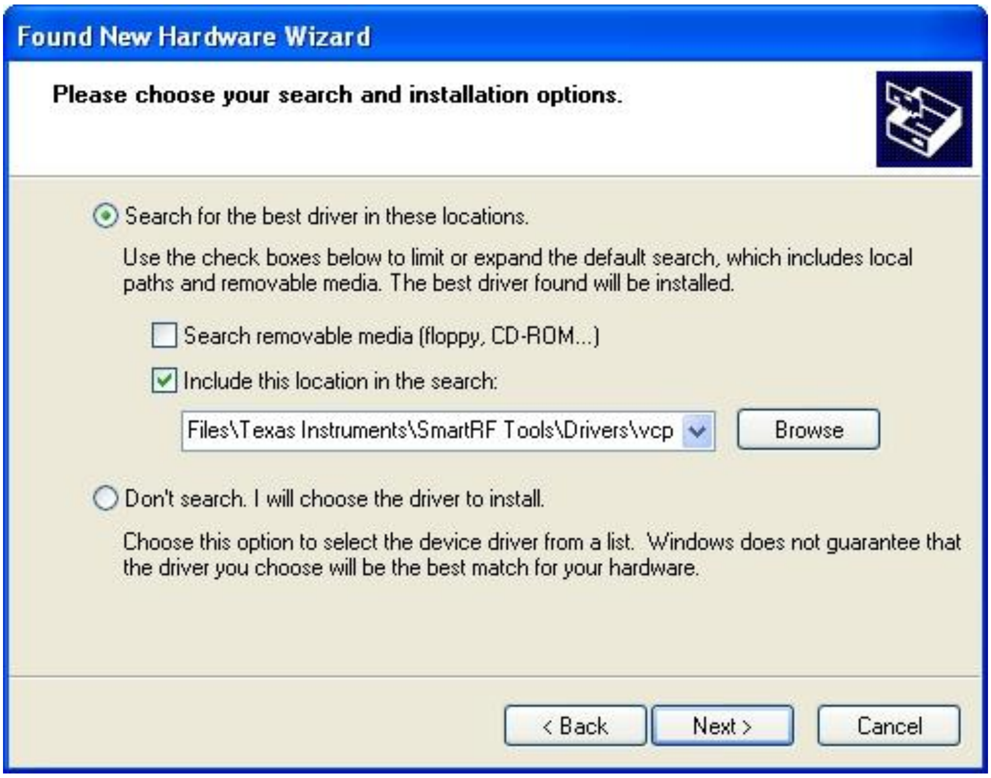


Figure 1 – Install virtual COM port USB driver using the Windows Hardware Wizard

The driver for the Virtual COM Port (VCP) is typically located in the directory *C:\Program Files\Texas Instruments\SmartRF Tools\Drivers\vcp*, where *C:\Program Files\Texas Instruments\SmartRF Tools* is the root installation directory for SmartRF Tools such as SmartRF Studio. The path may be different if you have chosen a different installation directory for SmartRF Studio.

If the above fails, select "Don't Search. I will choose the driver to install." A new window will open, asking for a location of where the drivers can be found. Locate the *trxeb_cdc_uart.inf* file and select that driver for installation.

5 Using the SmartRF Transceiver Evaluation Board

The SmartRF TrxEB is a flexible test and development platform that works together with RF Evaluation Modules from Texas Instruments.

An Evaluation Module is a small RF module with RF chip, balun, matching filter, antenna, and I/O connectors. The modules can be plugged into the SmartRF TrxEB which lets the PC take direct control of the RF device on the EM over the USB interface.

Currently, SmartRF TrxEB supports:

- CC1120EM
- CC1121EM
- CC1175EM
- CC1101EM
- CC1100EM
- CC1100EEM
- CC110LEM
- CC113LEM
- CC115LEM
- CC2520EM

SmartRF TrxEB is included in e.g. the CC1120 development kit. Some of the above EMs comes in variants combined with a RF front-end such as CC1190, CC2590, or CC2591. Such variants are called combo EMs and are also supported by the SmartRF TrxEB[1].

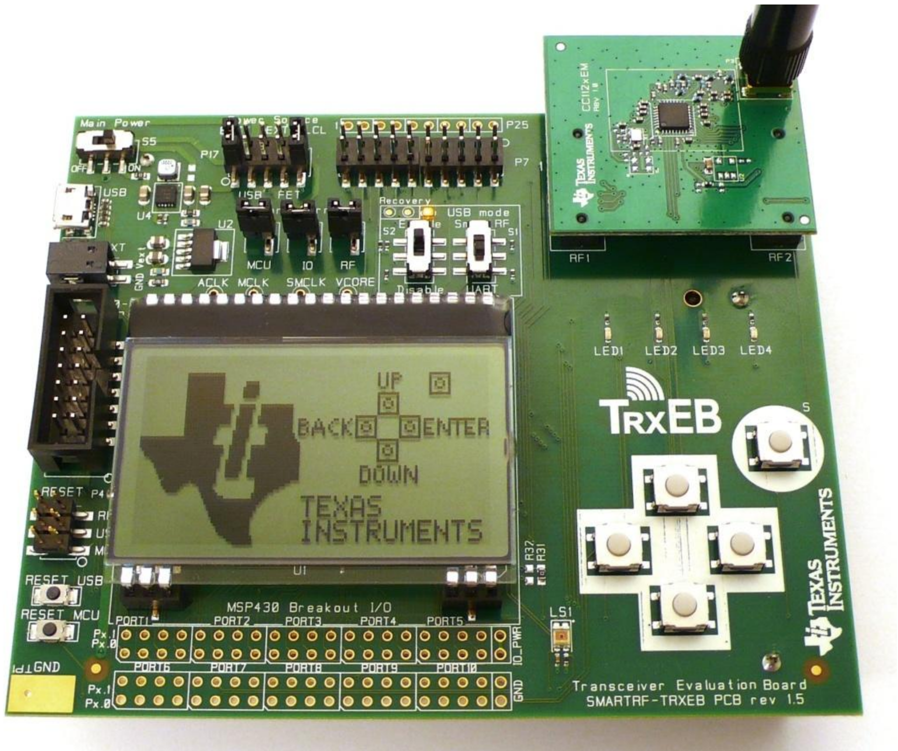


Figure 2 – SmartRF TrxEB (rev. 1.5.0) with EM connected

1 Some limitations exist for boards prior to version 1.7.0.

The PC software that controls the SmartRF TrxEB + EM is SmartRF Studio. Studio can be used to perform several RF tests and measurements, e.g. to set up a CW signal and send and receive packets.

The EB+EM can be of great help during the whole development cycle for a new RF product.

- Perform comparative studies. Compare results obtained with EB+EM with results from your own system.
- Perform basic functional tests of your own hardware by connecting the radio on your board to SmartRF TrxEB. SmartRF Studio can be used to exercise the radio.
- Verify your own software with known good RF hardware, by simply connecting your own microcontroller to an EM via the EB. Test the send function by transmitting packets from your SW and receive with another board using SmartRF Studio. Then transmit using SmartRF Studio and receive with your own software.
- Develop code for the MSP430 MCU.
- Use the SmartRF TrxEB as a debugger interface to the low power RF 8051-based SoCs with IAR Embedded Workbench.

5.1 Absolute maximum ratings

The minimum and maximum operating supply voltages and absolute maximum ratings for the active components onboard the SmartRF TrxEB are summarized in Table 2. Table 3 lists the recommended operating temperature and storage temperature ratings. Please refer to the respective component's datasheet for further details.

Component	Operating voltage		Absolute max. rating	
	Min. [V]	Max. [V]	Min. [V]	Max. [V]
USB MCU [3]	+3.0	+3.6	-0.3	+3.9
MSP430 MCU [6]	+1.8	+3.6	-0.3	+4.1
LCD [7]	+3.0	+3.3	-0.3	+3.6
Accelerometer [8]	+1.7	+3.6	-0.3	+3.6
Ambient light sensor [9]	+2.3	+5.5	NA	+6
Serial Flash [10]	+2.7	+3.6	-0.4	+4.0

Table 2 – Supply voltage: Recommended operating conditions and absolute max. ratings

Component	Operating temperature		Storage temperature	
	Min. [˚C]	Max. [˚C]	Min. [˚C]	Max. [˚C]
USB MCU [3]	0	+85	-50	+150
MSP430 MCU [6]	-40	+85	-55	+105
LCD [7]	-20	+70	-30	+80
Accelerometer [8]	-40	+85	-40	+125
Ambient light sensor [9]	-40	+85	-40	+85
Serial Flash [10]	-40	+85	-65	+150

Table 3 – Temperature: Recommended operating conditions and storage temperatures

6 SmartRF Transceiver Evaluation Board Overview

SmartRF TrxEB acts as the motherboard in several development kits for low power RF ICs from Texas Instruments. The board has several user interfaces and connections to external interfaces, allowing fast prototyping and testing of both software and hardware.

This chapter will give an overview of the general architecture of the board and describe the available I/O. The following sub-sections will explain the I/O in more detail. Pin connections between the evaluation board I/O and EM can be found in section 6.10.

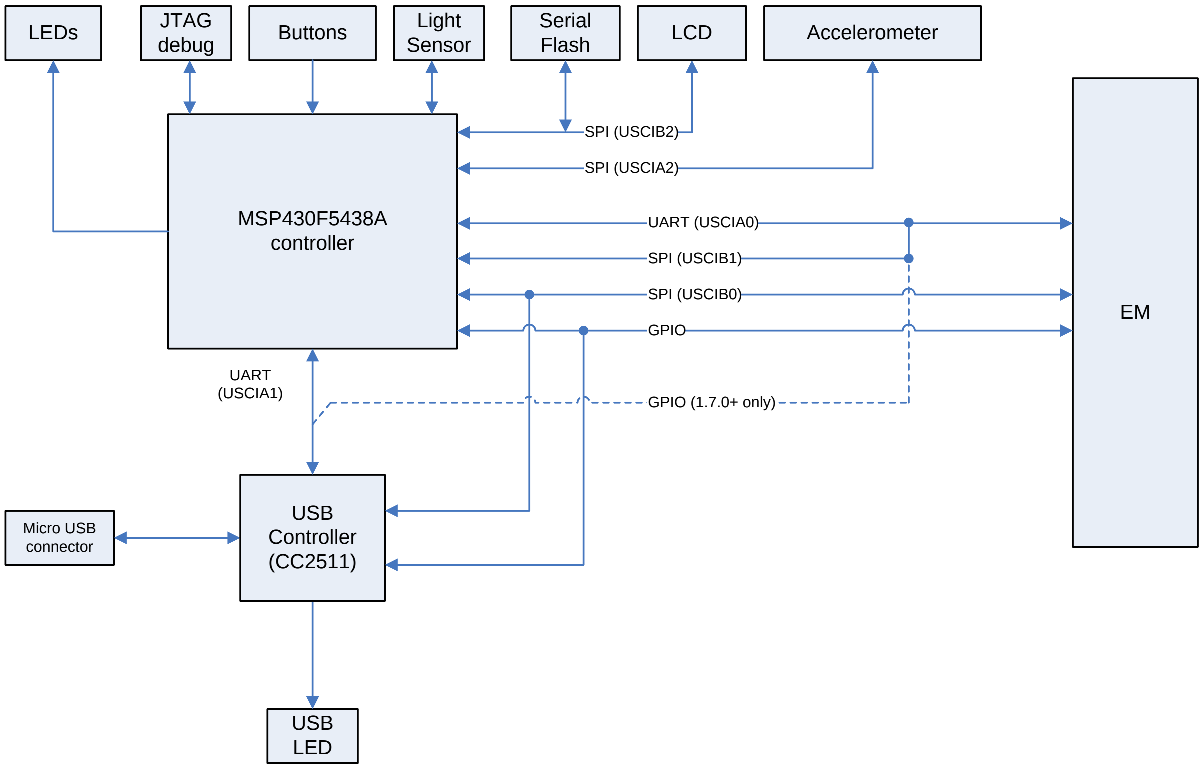


Figure 3 – SmartRF TrxEB architecture

> **NOTE:** Signal names used in this user's guide and in the SmartRF TrxEB schematics, are named "as seen" from the onboard MSP430 MCU. E.g. signal name "P1_3" refers to the signal connected to MSP430 port 1, pin 3.

6.1 USB MCU

The USB MCU is the CC2511F32 from Texas Instruments. Please see the CC2511 product page [3] on the TI web for detailed information about this controller. The recommended operating condition for the CC2511 is a supply voltage between 3.0 V and 3.6 V. The min (max) operating temperature is 0 (+85) ˚C.

The USB controller is programmed with a bootloader and the standard SmartRF TrxEB firmware when it is shipped from the factory. A flow chart over the USB MCU bootloader and standard firmware is shown in Figure 4.

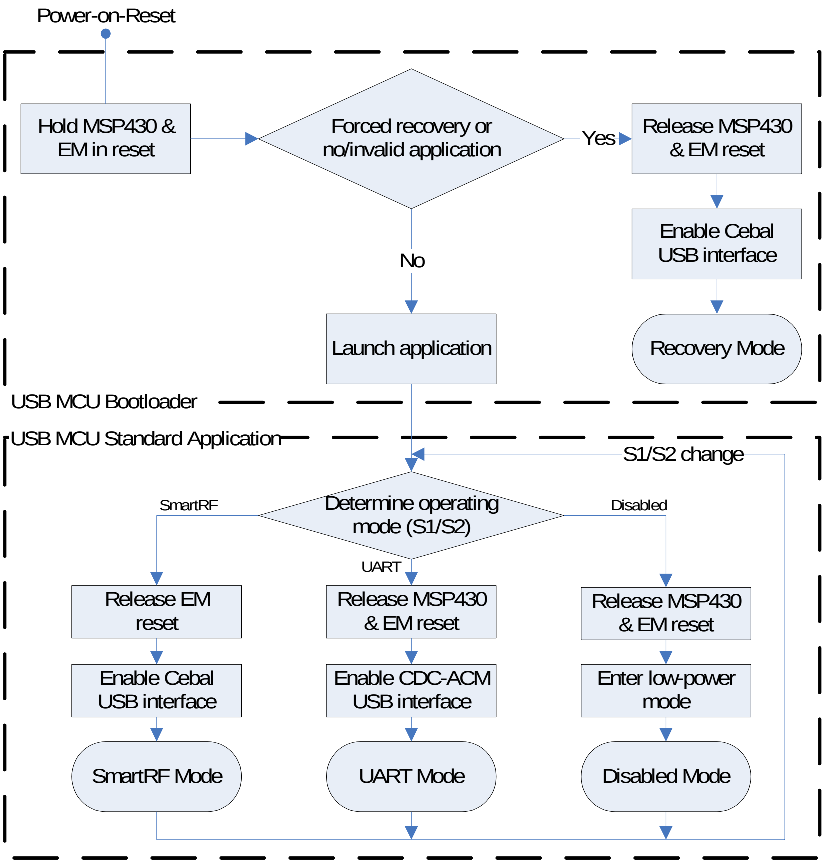


Figure 4 – Flow chart of the USB MCU bootloader and standard firmware

When the bootloader starts running, it will check for a valid application in the CC2511 flash memory. If detection is successful, the application is started and the board can be operated normally. If no application is detected (e.g. blank flash or firmware upgrade failed) the USB LED (D6) will start blinking rapidly – indicating failure. See section 6.9.2 for more details on USB LED states.

The USB MCU bootloader will allow programming/upgrading of the USB MCU firmware over the USB interface. No additional hardware or programmers are needed. Both SmartRF Studio and SmartRF Flash Programmer [4] can be used for this purpose. Please refer to chapter 11 for details.

The standard firmware application has three operating modes, controlled by hardware switches S1 and S2. The three modes are named “SmartRF Mode”, “UART Mode” and “Disabled Mode”. Table 4 shows which S1 and S2 positions that give the different operation modes. The following sections will discuss the different operating modes in more detail.

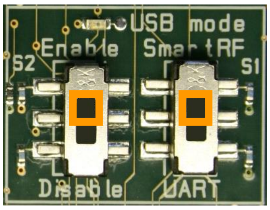
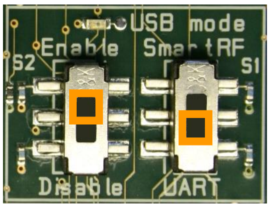
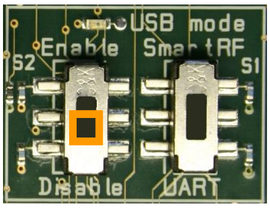
	S2	S1	Operating Mode	Key features
	Enable	SmartRF	SmartRF Mode	- Cebal USB interface - MSP430 disabled - Control RF-IC using SmartRF PC software
	Enable	UART	UART Mode	- CDC-ACM USB interface - MSP430 enabled - UART bridge between PC and MSP430 - Control RF-IC using MSP430 or external MCU
	Disable	x	Disabled Mode	- USB interface disabled - MSP430 enabled - Control RF-IC using MSP430 or external MCU

Table 4 – SmartRF TrxEB operating modes

6.1.1 SmartRF Mode

SmartRF Mode is the standard operating mode and is obtained by setting hardware switches S1 and S2 on the EB to “SmartRF” and “Enable”, respectively (see Table 4).

In SmartRF mode the EB is recognized over USB as a Cebal device, enabling PC software like SmartRF Studio to configure and control the RF-IC connected to the EB’s EM connectors.

The onboard MSP430 microcontroller is in this operating mode held in reset by the USB MCU.

6.1.2 UART Mode

UART Mode is obtained by setting hardware switches S1 and S2 on the EB to “UART” and “Enable”, respectively (see Table 4).

In UART mode, the EB is recognized over USB as a virtual serial port (CDC-ACM). The USB MCU works as a UART bridge between the onboard MSP430 and the PC. The hardware connection between the USB MCU and the MSP430 is shown in Figure 5. The supported data rates are listed in Table 5.

It is not possible to use SmartRF Studio or other PC software to communicate with a connected RF-IC when operating in UART Mode. To communicate with a connected RF-IC, the onboard MSP430 or an external MCU must be programmed with custom firmware. Please refer to the MSP430 User’s Guide [5] for more information about the MSP430 MCU.

Data rate [baud]
9 600
38 400
56 700
115 200

Table 5 – Data rates supported by the USB MCU in UART Mode

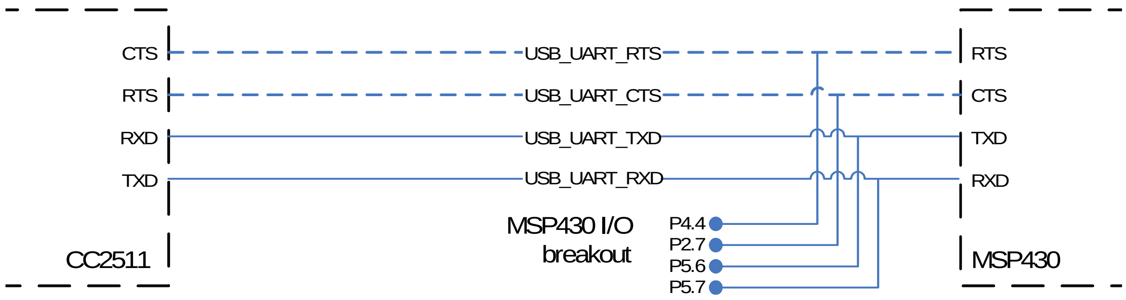


Figure 5 – UART lines connected between the USB MCU and the onboard MSP430 MCU. CTS and RTS lines are dotted to indicate that the USB MCU standard firmware only implements a two-line UART interface to the MSP430 MCU.

> **NOTE:** Figure 5 shows the four hardware connected UART lines between the USB MCU and the MSP430 MCU. The MSP430 does not support hardware flow control (RTS and CTS lines). Such support must be manually implemented in the MSP430 software. To ease MSP430 application development, the standard USB MCU firmware uses a two-line UART interface to the MSP430, i.e. hardware flow control is not implemented.

6.1.3 Disabled Mode

Disabled Mode is obtained by setting hardware switch S2 on the EB to “Disable” position (see Table 4). The position of S1 is disregarded by the USB MCU when S2 is in the “Disable” position.

In Disabled Mode, the USB MCU is in power-down mode and no USB communication is possible between a PC and the EB. It is however still possible to power the EB via the USB cable, see section 6.3.2.

6.2 MSP430 MCU

The SmartRF TrxEB is equipped with an MSP430F5438A micro controller from Texas Instruments. Please see the MSP430F5438A product page [6] on the TI website for detailed information about this controller.

All of the EB's user interface peripherals are available to the MSP430 (Figure 3 on page 11). Excluding the EM, the list of available peripherals consists of

- LCD
- 5x Buttons
- 4x LEDs
- Ambient Light Sensor
- Accelerometer
- SPI Flash.

The recommended operating condition for the MSP430 is a supply voltage (V_{CC}) between 1.8 V and 3.6 V. The min (max) operating temperature is -40 (+85) ˚C.

NOTE: The onboard MSP430 MCU is held in reset by the USB MCU in SmartRF Mode. In order to use the MSP430, make sure the USB MCU is set to Disabled Mode or UART Mode. See section 6.1 for details.

6.3 Power Sources

There are four possible solutions for applying power to the SmartRF TrxEB; batteries, USB bus, external power supply and MSP-FET. The power source can be selected using the power source selection jumpers on header P17 (Figure 6). The main power supply switch (S5) turns off all power sources.

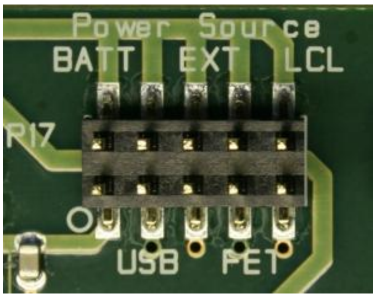


Figure 6 – Main power selection header (P17) and power switch (P5)

WARNING! Do not use multiple power sources to power the SmartRF TrxEB at the same time. Doing so may lead to excessive currents, causing onboard components to break.

WARNING! When using the SmartRF TrxEB with a MSP430 debugger (e.g. MSP-FET430UIF), while powering the EB with a different power source (batteries, USB or external power supply), a jumper should short circuit pin 9-10 of header P17 ("LCL"). This will prevent the MSP-FET from supplying power to the EB.

6.3.1 Battery Power

The SmartRF TrxEB includes a battery holder for two 1.5 V AA batteries on the reverse side of the PCB. Normal AA batteries can be used and the onboard regulator supplies 3.3 V to the board. The power source selection jumpers should short circuit pin 1-2 ("BATT") and 9-10 ("LCL") of header P17, see Figure 7.

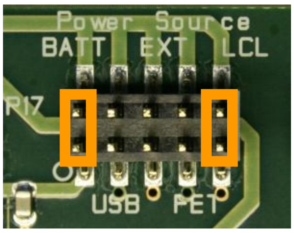


Figure 7 – P17 jumper settings to power TrxEB using batteries

The maximum current consumption is limited by the regulator to 800 mA.

6.3.2 USB Power

When the SmartRF TrxEB is connected to a PC via a USB cable, it can draw power from the USB bus. The onboard voltage regulator supplies approximately 3.3 V to the board. The power source selection jumpers should short circuit pin 3-4 ("USB") and 9-10 ("LCL") of header P17 (Figure 8).

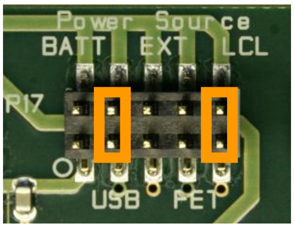


Figure 8 – P17 jumper settings to power TrxEB via the USB cable

The maximum current consumption is limited by the regulator to 1500 mA[2].

[2] Note that most USB power sources are limited to 500 mA.

6.3.3 External Power Supply

The SmartRF TrxEB has a connector for powering the board using an external power supply. The power source selection jumpers should short circuit pin 5-6 (“EXT”) and 9-10 (“LCL”) of header P16 as shown in Figure 9.

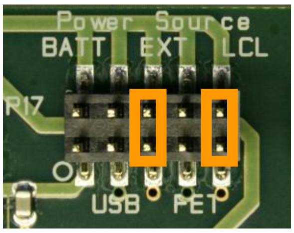


Figure 9 – P17 jumper settings to power TrxEB using external power supply

> **WARNING!** When using an external power source, all onboard voltage regulators are bypassed. There is a risk of damaging the onboard components if the applied voltage on the external power connector/header is lower than -0.3 V or higher than 3.6 V (combined absolute maximum ratings for onboard components. See section 5.1 for further information.

6.3.3.1 SmartRF TrxEB revision ≤1.5.0

The external supply’s ground should be connected to pin 2 of P201. Apply a voltage in the range from 3.0 V to 3.3 V to pin 1 (see Figure 10). Pin 1 and pin 2 of P201 are marked “Vext” and “GND”, respectively, on SmartRF TrxEB revision 1.5.0.

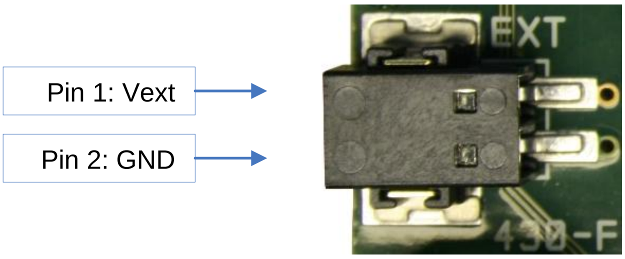


Figure 10 – Powering TrxEB rev. ≤1.5.0 via the external power supply connector (P201)

6.3.3.2 SmartRF TrxEB revision 1.7.0

The external supply’s ground should be connected to the TrxEB ground, e.g. to the ground pad in the bottom left corner of the EB. Connect the positive supply connector to either of the two pins on the external power header P1 (Figure 11). The applied voltage must be in the range from 3.0 V to 3.3 V.

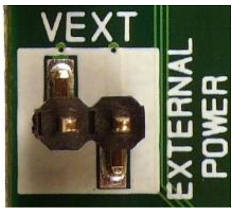


Figure 11 – TrxEB rev. 1.7.0 external power supply header (P1)

6.3.4 MSP-FET Power

The SmartRF TrxEB can be powered via an MSP430 debugger such as MSP-FET430UIF. The power source selection jumpers should in that case short circuit pin 7-8 of header P17 (Figure 12). Note that the MSP-FET will not power the EB if pin 9-10 of header P17 ("LCL") is short circuited.

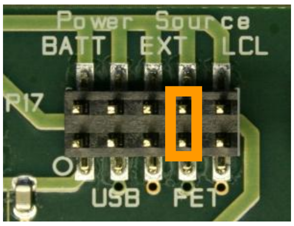


Figure 12 – P17 jumper settings to power EB using a MSP-FET

6.4 LCD

The SmartRF TrxEB comes with a 128x64 pixels display from Electronic Assembly (DOGM128E-6) [7]. The LCD display is available to the onboard MSP430 via an SPI interface, enabling software development of user interfaces and demo use. The LCD display shares SPI interface with the serial flash device (section 6.7).

The recommended operating condition for the LCD display is a supply voltage between 3.0 V and 3.3 V. The min (max) operating temperature is -20 (+70) ˚C.

6.5 Accelerometer

The SmartRF TrxEB is equipped with a digital accelerometer from VTI Technologies (CMA3000-D01) [8]. The accelerometer is available to the onboard MSP430 MCU via an SPI interface and has a dedicated interrupt line to the MCU. The onboard accelerometer is suitable for application development, prototyping and demo use. See sections 8.2.2 and 9.2.2 for details on accelerometer axis orientation for EB revision 1.3.0 and ≥1.5.0, respectively.

The recommended operating condition for the accelerometer is a supply voltage between 1.7 V and 3.6 V. The min (max) operating temperature is -40 (+85) ˚C.

6.6 Ambient Light Sensor

The SmartRF TrxEB has an analog SFH 5711 ambient light sensor from Osram [9] that is available to the onboard MSP430, enabling quick application development for demo use and prototyping. The light sensor is placed outside the bottom right corner of the LCD display.

The recommended operating condition for the ambient light sensor is a supply voltage between 2.3 V and 5.5 V. The min (max) operating temperature is -40 (+85) ˚C.

6.7 Serial Flash

SmartRF TrxEB has a M25PE20 flash device – a paged 256 KB serial flash memory from Micron [10]. The device gives the MSP430 access to extra flash, enabling over-the-air upgrades and more. The serial device shares SPI bus with the LCD display (section 6.4).

The recommended operating condition for the serial flash device is a supply voltage between 2.7 V and 3.6 V. The min (max) operating temperature is -40 (+85) ˚C.

6.8 Buttons

There are 7 buttons on the SmartRF TrxEB. Status of BTN_LEFT, BTN_RIGHT, BTN_UP, BTN_DOWN and BTN_SELECT can be read by the onboard MSP430. These buttons are intended for user interfacing and development of demo applications.

The RESET MCU button resets the MSP430 MCU by pulling its reset line low (MCU_RESET_N). The RESET USB button similarly resets the USB controller (pulling USB_RESET_N low). Note that the standard firmware on the USB controller will reset the EM and MSP430 during startup, so pushing the RESET USB button also resets the controller on the EM board and the MSP430.

6.9 LEDs

6.9.1 General Purpose LEDs

The four LEDs D3, D4, D5, D7 can be controlled from the onboard MSP430 and are suitable for demo use and debugging. The LEDs are active low.

6.9.2 USB LED

LED D6 (USB LED) is controlled by the USB controller and is used to indicate the status of the EB. The USB LED has several states, listed in Table 6.

USB LED state	Description
OFF	Power is turned off, the USB controller is in Disabled Mode or the software on the USB controller is corrupt.
ON	**SmartRF Mode:** The standard firmware is running and a RF-IC has been detected. **UART Mode:** The standard firmware is running. The USB LED is quickly toggled OFF/ON when UART traffic. This is typically seen as slight variations in emitted intensity.
BLINKING (100 ms ON – 900 ms OFF)	**SmartRF Mode:** No RF-IC is detected.
BLINKING (1 Hz)	The USB MCU has entered the boot recovery mode. See chapter 11 for further details.
BLINKING (10 Hz)	The bootloader on the USB MCU could not find a valid application to boot. Basic USB services are available and both SmartRF Studio and SmartRF Flash Programmer can be used to program an application to the USB controller's flash. See chapter 11 for further details.

Table 6 – USB LED state descriptions

6.10 EM Connectors

The EM connectors (TFM-110-02-S-D-A from Samtec), shown in Figure 13, are used for connecting an EM board to the SmartRF TrxEB. The connectors RF1 and RF2 are the main interface and are designed to avoid incorrect mounting of the EM board.

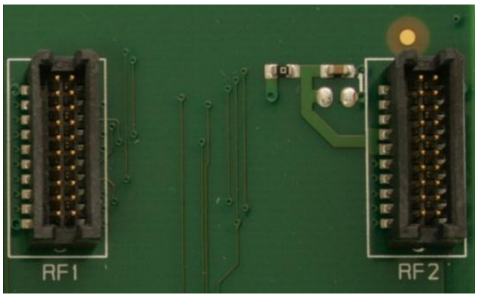


Figure 13 – SmartRF TrxEB EM connectors RF1 and RF2

The signals from the EM are primarily connected to the MSP430 on the TrxEB. Some of the signals are also connected to the USB controller in order to allow control of the RF device from the PC with SmartRF Studio. The figure below (Figure 14) illustrates how the signals are connected to the MSP430 and which serial peripheral modules on the MSP430 that can potentially be used for communication with the EM.

The main serial interface to the EM (transceiver) is over SPI using USCIB0. To support some of the network processors and other EMs with alternative pin-out, some of the signals from the EM are connected to **both** USCIB1 (for SPI) and USCIA0 (for UART). If the serial peripheral modules are not needed, the same pins on the MSP430 can be used as general purpose IOs.

Also note that most of the general purpose control signals from the EM (i.e. the signals not used for serial communication) are connected to interrupt capable pins on the MSP430 (port 1 and 2).

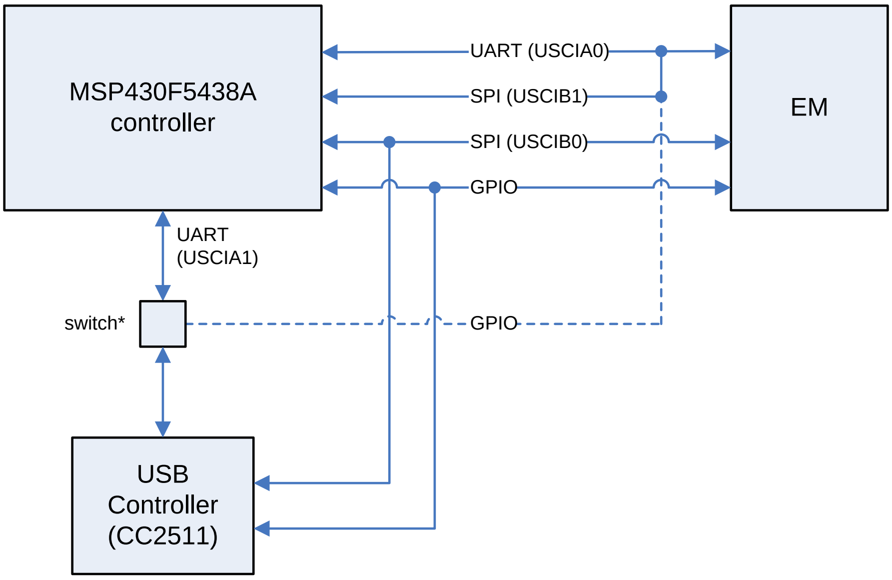


Figure 14 – EM interface

(*) Note that the switch is only present on rev 1.7.0 and newer of the TrxEB (see 10.2.1)

The pin-out of the EM connectors is given in Table 7 and Table 8 below. The signals from the EM connectors are all accessible from either the EM I/O breakout headers (see section 6.11.1) and/or the MSP430 I/O breakout (section 6.11.2).

EM pin	Signal name	Description	Breakout header	MSP430
RF1.1	GND	Ground		
RF1.2	NC	Not connected		
RF1.3	P1_4 / RF_SPI1_CS_N	GPIO signal to EM board / Alt. SPI	P7.5	P1.4
RF1.4	P1_1	GPIO signal to EM board	P7.2	P1.1
RF1.5	P8_2	GPIO signal to EM board	P7.13	P8.2
RF1.6	P1_5	GPIO signal to EM board	P7.6	P1.5
RF1.7	RF_UART_TXD / RF_SPI1_MISO	2-line UART to EM board / Alt. SPI	P7.9	P3.4 / P5.4
RF1.8	(breakout)	GPIO signal	P25A.1	
RF1.9	RF_UART_RXD / RF_SPI1_MOSI	2-line UART to EM board / Alt. SPI	P7.7	P3.5 / P3.7
RF1.10	P1_7	GPIO signal to EM board	P7.8	P1.7
RF1.11	P8_3	GPIO signal to EM board	P7.15	P8.3
RF1.12	P1_3	GPIO signal to EM board	P7.4	P1.3
RF1.13	(breakout)	GPIO signal	P25A.2	
RF1.14	RF_SPI0_CS_N	EM SPI Chip Select	P7.14	P3.0
RF1.15	P8_4	GPIO signal to EM board	P7.17	P8.4
RF1.16	RF_SPI0_SCLK	EM SPI Clock	P7.12	P3.3
RF1.17	P8_5	GPIO signal to EM board	P7.19	P8.5
RF1.18	RF_SPI0_MOSI	EM SPI MOSI	P7.16	P3.1
RF1.19	GND	Ground	P7.20	
RF1.20	RF_SPI0_MISO	EM_SPI_MISO	P7.18	P3.2

Table 7 – EM connector RF1 pin-out

EM pin	Signal name	Description	Breakout header	MSP430
RF2.1	NC	Not connected		
RF2.2	GND	Ground		
RF2.3	NC	Not connected		
RF2.4	NC	Not connected		
RF2.5	NC	Not connected		
RF2.6	(breakout)	GPIO signal	P25C.1	
RF2.7	RF_PWR	EM power		
RF2.8	(breakout)	GPIO signal	P25C.2	
RF2.9	RF_PWR	EM power		
RF2.10	(breakout)	GPIO signal	P25D.1	
RF2.11	(breakout)	GPIO signal	P25B.1	
RF2.12	(breakout)	GPIO signal	P25D.2	
RF2.13	(breakout)	GPIO signal	P25B.2	
RF2.14	(breakout)	GPIO signal	P25E.1	
RF2.15	RF_RESET_N	Signal used to reset EM board	P7.10	P8.0
RF2.16	NC	Not connected		
RF2.17	P8_1	GPIO signal to EM board	P7.11	P8.1
RF2.18	P1_2 / RF_SPI1_SCLK	GPIO signal to EM board / Alt. SPI	P7.3	P1.2 / P5.5
RF2.19	P1_0	GPIO signal to EM board	P7.1	P1.0
RF2.20	GND (NC on rev < 1.7.0)	Ground		

Table 8 – EM connector RF2 pin-out

6.11 Breakout Headers and Jumpers

Header P7 and P25A-E give access to main EM connector pins, while P11, P14, P16 and P18-P24 give access to the MSP430 I/O (section 6.11.2). Some signals can be accessed from both the EM I/O breakout headers and the MSP430 I/O breakout as indicated by Figure 15.

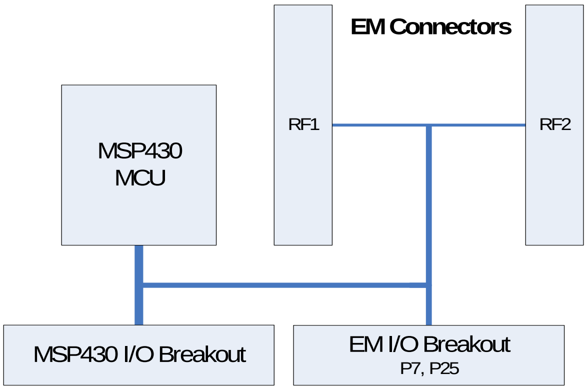


Figure 15 – SmartRF TrxEB I/O breakout overview

6.11.1 EM I/O breakout headers

The EM I/O breakout headers on SmartRF TrxEB consist of header P7 and I/O connector P25. P25 is made out of five 2-pin connectors (P25A-E). The layout of these connectors is shown in Figure 16. Table 7 and Table 8 in section 6.10 shows how the EM I/O connector headers are mapped to EM connector RF1 and RF2, respectively.

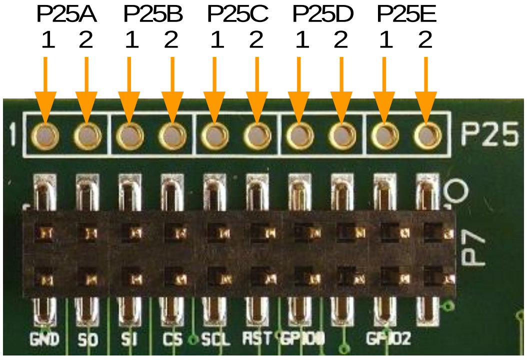


Figure 16 – I/O connector P25A-E PCB layout

6.11.2 MSP430 I/O breakout

MSP430 ports 1-10 are on SmartRF TrxEB available through the MSP430 I/O breakout shown in Figure 17. Table 9 lists I/O breakout for ports 1-5, while Table 10 covers ports 6-10. Both tables indicate if the given MSP430 pin is connected to an EM connector pin. For additional info on the MSP430 pin-out on SmartRF TrxEB, please refer to section 8.4.

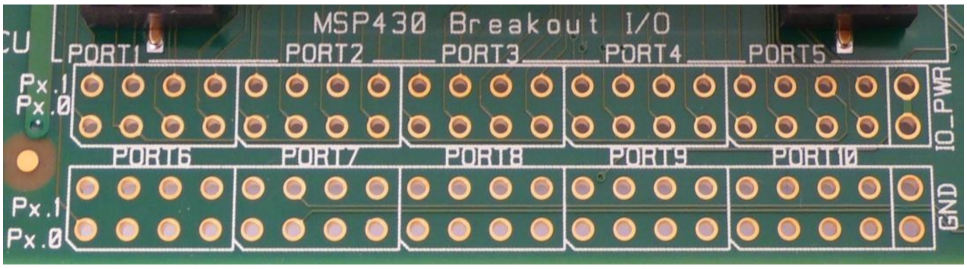


Figure 17 – MSP430 I/O breakout on SmartRF TrxEB

MSP430	Signal Name	Description	EM pin
P1.0	P1_0	Unused GPIO	RF2.19
P1.1	P1_1	GPIO signal to EM board	RF1.4
P1.2	P1_2 / RF_SPI1_SCLK	Alternative EM SPI Clock	RF2.18
P1.3	P1_3	GPIO signal to EM board	RF1.12
P1.4	P1_4 / RF_SPI1_CS_N	Alternative EM SPI Chip Select	RF1.3
P1.5	P1_5	GPIO signal to EM board	RF1.6
P1.6	P1_6	Unused GPIO	
P1.7	P1_7	GPIO signal to EM board	RF1.10
P2.0	ACC_INT	Accelerometer interrupt line	
P2.1	BTN_LEFT	Left button input line	
P2.2	BTN_RIGHT	Right button input line	
P2.3	BTN_SELECT	Select button input line	
P2.4	BTN_UP	Up button input line	
P2.5	BTN_DOWN	Down button input line	
P2.6	P2_6	Unused GPIO	
P2.7	USB_UART_CTS	CTS line to USB MCU	
P3.0	RF_SPI0_CS_N	EM SPI Chip Select	RF1.14
P3.1	RF_SPI0_MOSI	EM SPI MOSI	RF1.18
P3.2	RF_SPI0_MISO	EM SPI MISO	RF1.20
P3.3	RF_SPI0_SCLK	EM SPI Clock	RF1.16
P3.4	RF_UART_TXD / RF_SPI1_MISO	2-line UART to EM board	RF1.7
P3.5	RF_UART_RXD / RF_SPI1_MOSI	2-line UART to EM board	RF1.9
P3.6	LCD_BL	LCD backlight module enable line [3]	
P3.7	RF_UART_RXD / RF_SPI1_MOSI	Alternative EM SPI MOSI	RF1.9
P4.0	LED_1	General purpose LED 1 line	
P4.1	LED_2	General purpose LED 2 line	
P4.2	LED_3	General purpose LED 3 line	
P4.3	LED_4	General purpose LED 4 line	
P4.4	USB_UART_RTS	RTS line to USB MCU	
P4.5	P4_5	Unused GPIO	
P4.6	P4_6	Unused GPIO	
P4.7	P4_7	Unused GPIO	
P5.0	P5_0	GPIO or VREF+	
P5.1	P5_1	GPIO or VREF-	
P5.2	P5_2 / XT2IN	Unused GPIO / External crystal oscillator line	
P5.3	P5_3 / XT2OUT	Unused GPIO / External crystal oscillator line	
P5.4	RF_UART_TXD / RF_SPI1_MISO	Alternative EM SPI MISO	RF1.7
P5.5	P1_2 / RF_SPI1_SCLK	Alternative EM SPI Clock	RF2.18
P5.6	USB_UART_TXD	TXD line to USB MCU	
P5.7	USB_UART_RXD	RXD line to USB MCU	

Table 9 – MSP430 Port 1-5 pin-out

[3] LCD backlight module is not included. Additional components needed to use backlight module.

MSP430	Signal Name	Description	EM pin
P6.0	ACC_PWR	Accelerometer power, enable high	
P6.1	ALS_PWR	Ambient light sensor power, enable high	
P6.2	ALS_OUT	Ambient light sensor output line	
P6.3	P6_3	Unused GPIO	
P6.4	P6_4	Unused GPIO	
P6.5	P6_5	Unused GPIO	
P6.6	P6_6	Unused GPIO	
P6.7	P6_7	Unused GPIO	
P7.0	P7_0 / XIN	External crystal oscillator line	
P7.1	P7_1 / XOUT	External crystal oscillator line	
P7.2	FLASH_RESET_N	Serial flash reset line, active low	
P7.3	LCD_RESET_N	LCD reset line, active low	
P7.4	P7_4	Unused GPIO	
P7.5	P7_5	Unused GPIO	
P7.6	FLASH_PWR	Serial flash power, enable high	
P7.7	LCD_PWR	LCD power, enable high	
P8.0	RF_RESET_N	Signal used to reset EM board	RF2.15
P8.1	P8_1	GPIO signal to EM board	RF2.17
P8.2	P8_2	GPIO signal to EM board	RF1.5
P8.3	P8_3	GPIO signal to EM board	RF1.11
P8.4	P8_4	GPIO signal to EM board	RF1.15
P8.5	P8_5	GPIO signal to EM board	RF1.17
P8.6	FLASH_CS_N	SPI Chip Select for serial flash, active low	
P8.7	ACC_CS_N	SPI Chip Select for accelerometer, active low	
P9.0	IO_SPI1_SCLK	SPI Clock (interface used by accelerometer)	
P9.1	IO_SPI0_MOSI	SPI MOSI (interface shared by LCD, serial flash)	
P9.2	IO_SPI0_MISO	SPI MISO (interface shared by LCD, serial flash)	
P9.3	IO_SPI0_SCLK	SPI SCLK (interface shared by LCD, serial flash)	
P9.4	IO_SPI1_MOSI	SPI MOSI (interface used by accelerometer)	
P9.5	IO_SPI1_MISO	SPI MISO (interface used by accelerometer)	
P9.6	LCD_CS_N	SPI Chip Select for LCD, active low	
P9.7	LCD_MODE	LCD mode select signal [7]	
P10.0	P10_0	Unused GPIO	
P10.1	P10_1	Unused GPIO	
P10.2	P10_2	Unused GPIO	
P10.3	P10_3	Unused GPIO	
P10.4	P10_4	Unused GPIO	
P10.5	P10_5	Unused GPIO	
P10.6	P10_6	Unused GPIO	
P10.7	P10_7	Unused GPIO	

Table 10 – MSP430 Port 6-10 pin-out

6.12 Current Measurement Jumpers

SmartRF TrxEB has three current measurement jumpers, MCU_PWR, IO_PWR and RF_PWR, as shown in Figure 18. By removing one of the jumpers, an ammeter can easily be connected to the board and perform current consumption measurements on the different segments of the EB. Similarly, a separate, regulated power supply for the EM can be connected. Table 11 shows an overview of what onboard components are connected to which power segment.

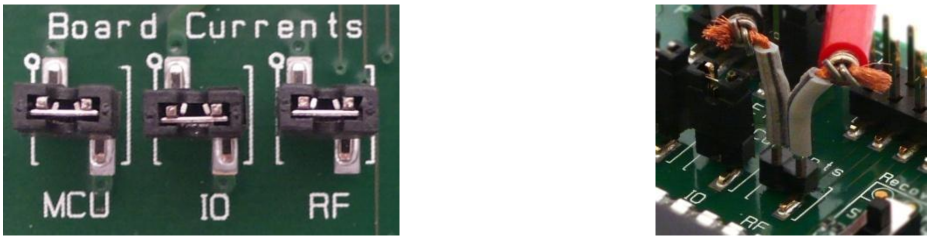


Figure 18 – Current measurement jumpers

If the EM is powered by a different source than the rest of the board, the same voltage should be used on the EM as on the EB. The digital signals between the EB and the EM are not isolated from each other, and different voltage levels can cause excessive current consumption or erroneous interaction between the EB and the EM.

> **NOTE:** On SmartRF TrxEB revision 1.3.0, the “IO” and “RF” labels in the silk print are switched around. For all revisions, IO and RF current should be measured on the jumpers indicated by the silk print in Figure 18. See chapter 8 for details about EB revision 1.3.0.

Figure 19 – Current measurement setup

Component	Default power	Alternative power
Evaluation Module	RF_PWR	NA
MSP430 MCU	MCU_PWR	NA
USB MCU	IO_PWR	NA
General Purpose LEDs	IO_PWR	NA
USB LED	IO_PWR	NA
Accelerometer	MCU_PWR (MSP430 P6.0)	NA
Ambient Light Sensor	MCU_PWR (MSP430 P6.1)	NA
SPI Flash	MCU_PWR (MSP430 P7.6)	IO_PWR (swap R17/R18)
LCD	MCU_PWR (MSP430 P7.7)	IO_PWR (swap R29/R30)

Table 11 – Component/Power segment overview

7 Connecting an external MCU to SmartRF TrxEB

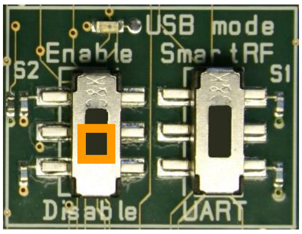
You can easily connect an external MCU to a SmartRF TrxEB and use it to control the EM board mounted on the TrxEB. This chapter gives a quick overview over the signals that must be connected to enable your external MCU to control the EM.

7.1 Disable MCUs onboard SmartRF TrxEB

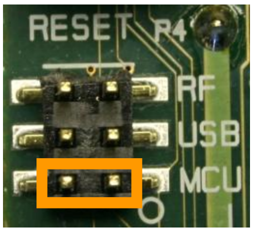
To avoid any signal conflicts between the MCUs onboard the SmartRF TrxEB (MSP430 and USB MCU) and the external MCU, both onboard MCUs should be disabled.

Disable the USB MCU by setting mode selection switch S2 to “Disable” position (Figure 20a).

To hold the onboard MSP430 MCU in reset state, short circuit pins 1-2 on header P4 as shown in Figure 20b. An alternative, more power efficient option is to program the onboard MSP430 with you own, custom software which configures the MSP430 pins to minimize current consumption and makes the MSP430 enter a low-power mode [5].



a) Disable USB MCU



b) Hold MSP430 in reset

Figure 20 – Switch and jumper settings to disable both SmartRF TrxEB MCUs

7.2 Select power source

When connecting an external MCU board to the SmartRF TrxEB, there are typically two options for powering the boards, both consisting of sharing a power source. The first is to let the external MCU board draw power from the SmartRF TrxEB; the second is to power the SmartRF TrxEB from an external power source. It is in both cases important that the voltage levels on shared signals are the same.

7.2.1 Power external MCU from SmartRF TrxEB

Power the external MCU board by connecting it to IO_PWR (P9) and GND (P6) on SmartRF TrxEB, shown in Figure 21.

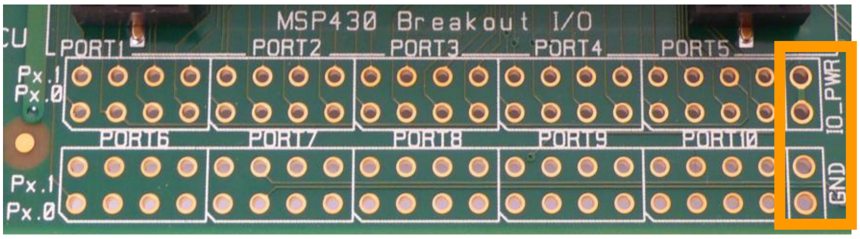


Figure 21 – Power external MCU board by connecting it to IO_PWR and GND

7.2.2 Power SmartRF TrxEB from external power source

Connect the power from the external power source to the external power source connector on SmartRF TrxEB and set the power source selection jumpers accordingly. Please see section 6.3.3 for a detailed description on how to power the SmartRF TrxEB from an external power source.

> **NOTE:** When powering the SmartRF TrxEB from an external power source, the TrxEB main power switch must be in on position for the EB to be powered up.

7.3 Connect signals

7.3.1 Common signals

Table 12 shows the common signals needed to communicate with transceivers on a mounted EM board. Figure 22 shows where the signals listed Table 12 and Table 13 can be found on the P7 EM I/O breakout header on SmartRF TrxEB.

TrxEB Signal Name	TrxEB breakout pin	Description
RF_RESET_N	P7.10	Signal used to reset EM board
RF_SPI0_SCLK	P7.12	EM SPI interface clock signal
RF_SPI0_CS_N	P7.14	EM SPI interface chip select signal, active low
RF_SPI0_MOSI	P7.16	EM SPI interface MOSI signal
RF_SPI0_MISO	P7.18	EM SPI interface MISO signal
GND	P7.20	Common ground for EB and external MCU board

Table 12 – Strapping overview to connect common signals to an external MCU

7.3.2 Transceiver GPIO signals

The CC1120 GPIO pins available through the EM connectors on the SmartRF TrxEB are listed in Table 13. Figure 22 shows where the signals listed Table 12 and Table 13 can be found on the P7 EM I/O breakout header on SmartRF TrxEB. On SmartRF TrxEB rev. 1.7.0, silk print indicates where the most important EM I/O signals on header P7 are located.

NOTE: Transceiver EM boards from Texas Instruments share much of the same GPIO routing to the EM connectors. However, the number of GPIO signals available depends on the transceiver. Please refer to the schematics of your EM board for further details on the available GPIO.

TrxEB Signal Name	TrxEB Breakout Pin	Description
P1_7	P7.8	Transceiver GPIO0
RF_SPI0_MISO	P7.18	Transceiver GPIO1 (Shared with EM SPI MISO)
P1_3	P7.4	Transceiver GPIO2
P1_2 / RF_SPI1_SCLK	P7.3	Transceiver GPIO3

Table 13 – Strapping overview to strap CC1120 GPIO to an external MCU

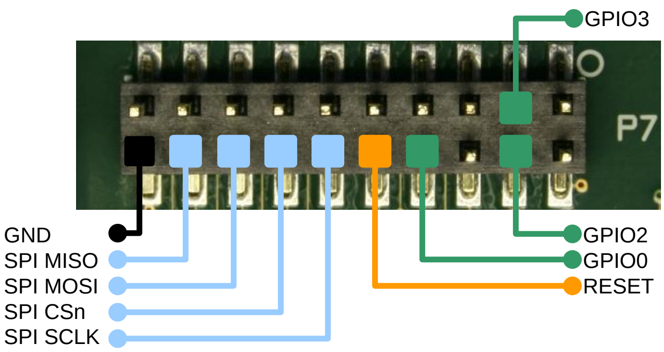


Figure 22 – P7 with strapping to connect external MCU to SmartRF TrxEB

8 SmartRF TrxEB rev. 1.3.0

8.1 Board Overview

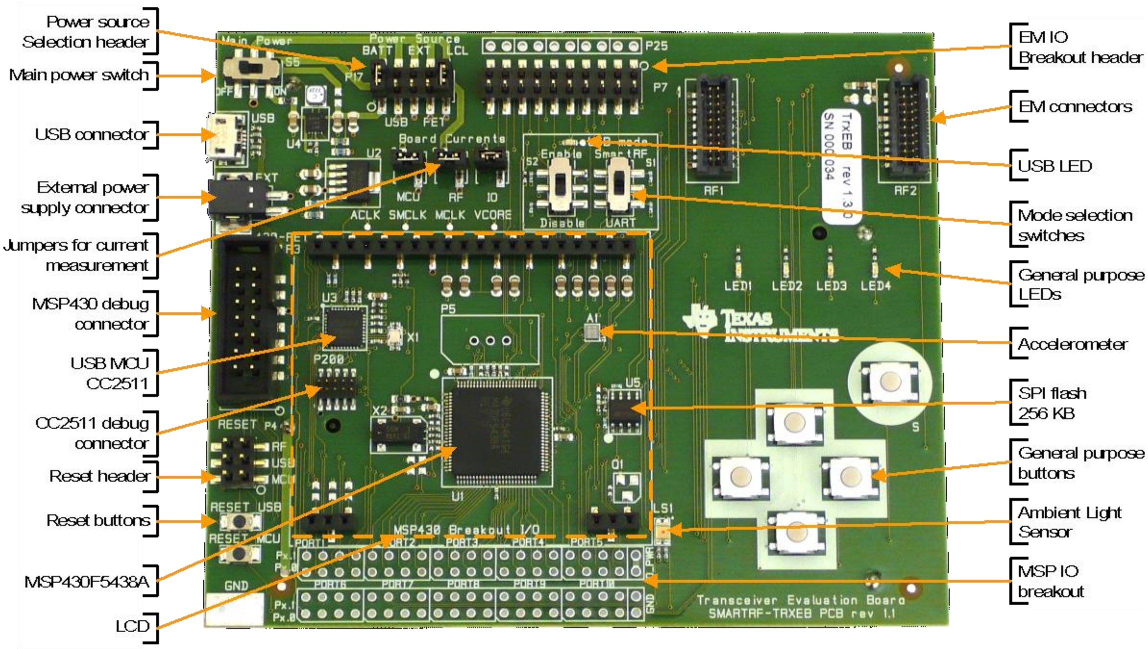


Figure 23 – SmartRF TrxEB revision 1.3.0 overview

8.2 Software Considerations

8.2.1 Virtual COM port over USB

The onboard MSP430 MCU can communicate with a PC over a virtual serial port when the USB MCU is in UART Mode (described in section 6.1.2). When developing MSP430 code to communicate via the USB MCU, keep in mind that the standard USB MCU firmware only supports a two-line UART interface (see section 6.1.2 for further details).

8.2.2 Accelerometer

The onboard MSP430 MCU has access to accelerometer A1. On SmartRF TrxEB revision 1.3.0, the accelerometer axes are as shown in Figure 24.

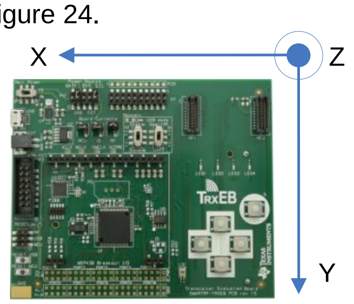


Figure 24 – Accelerometer axes on SmartRF TrxEB rev. 1.3.0

8.3 USB MCU pin-out

Table 14 shows how the USB MCU's pins are connected to the different functionalities on EB revision 1.3.0.

CC2511	Signal name	Description	EM pin
P0.0	MCU_RESET_N	Signal used to reset MSP430 MCU	
P0.1	RF_RESET_N	Signal used to reset EM board	RF2.15
P0.2	RF_SPI0_CS_N	EM SPI Chip Select	RF1.14
P0.3	RF_SPI0_SCLK	EM SPI Clock	RF1.16
P0.4	RF_SPI0_MOSI	EM SPI MOSI	RF1.18
P0.5	RF_SPI0_MISO	EM SPI MISO	RF1.20
P1.0	USB_PULLUP	Enable USB Interface pull-up resistor	
P1.1	P1_3	CC Debug Clock	RF1.12
P1.2	USB_UART_RTS	MSP430 UART (CC2511 CTS)	
P1.3	USB_UART_CTS	MSP430 UART (CC2511 RTS)	
P1.4	USB_UART_TXD	MSP430 UART (CC2511 RXD)	
P1.5	USB_UART_RXD	MSP430 UART (CC2511 TXD)	
P1.6	USB_ENABLE	Switch S2 input	
P1.7	P1_7	CC Debug Data	RF1.10
P2.0	RF_UART_RXD / RF_SPI1_MOSI	GPIO signal to EM board	RF1.9
P2.1	USB_DBG_DD	CC2511 CC Debug Interface Data	
P2.2	USB_DBG_DC	CC2511 CC Debug Interface Clock	
P2.3	USB_MODE	Switch S1 input	
P2.4	USB_LED	USB LED and Forced Recovery signal	

Table 14 – USB MCU pin-out on SmartRF TrxEB rev. 1.3.0

8.4 MSP430 MCU pin-out

For details on the pin-out for MSP430 port 1-10, please refer to Table 9 and Table 10 in section 6.11.2. Table 15 below shows the MSP430 pin-out not listed in section 6.11.2.

MSP430	Signal Name	Description
P11.0	ACLK	MSP430 ACLK output to test point TP5
P11.1	MCLK	MSP430 MCLK output to test point TP6
P11.2	SMCLK	MSP430 SMCLK output to test point TP7
VCORE	VCORE	MSP430 VCORE output to test point TP8
PJ.0	TDO	JTAG Test Data Out
PJ.1	TDI	JTAG Test Data In
PJ.2	TMS	JTAG Test Mode Select
PJ.3	TCK	JTAG Test Clock

Table 15 – MSP430 miscellaneous signal pin-out

9 SmartRF TrxEB rev. 1.5.0

9.1 Board Overview

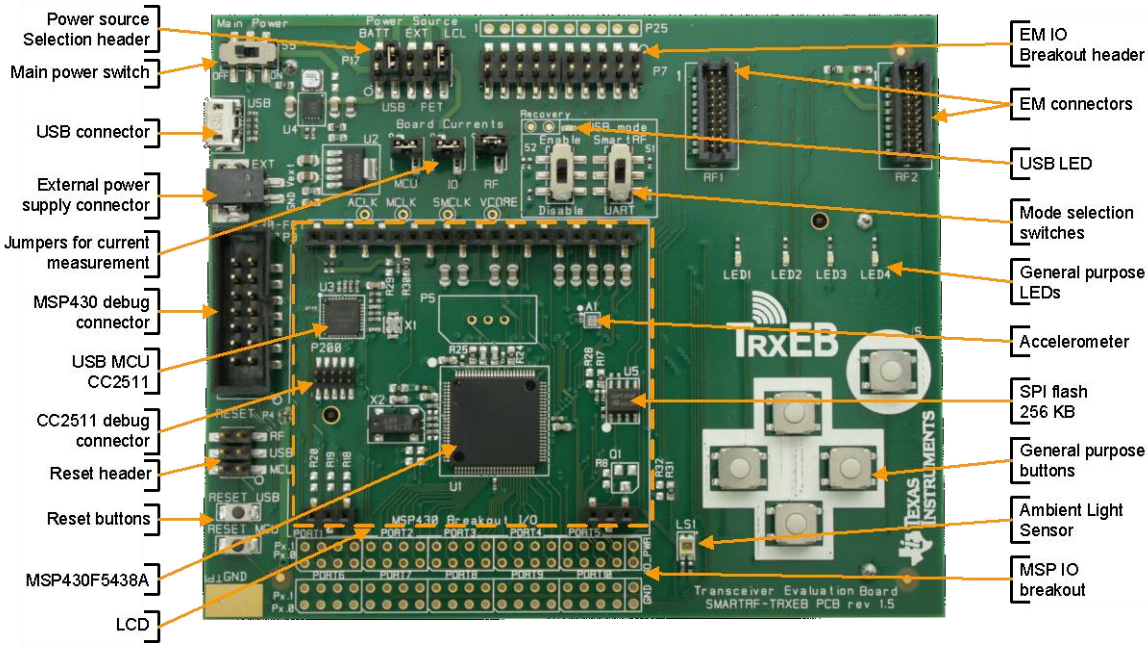


Figure 25 – SmartRF TrxEB revision 1.5.0 overview

9.2 Changes from rev. 1.3.0

9.2.1 RC filter on USB MCU reset line

The pull-up resistor R22 on the USB MCU's reset line (USB_RESET_N) has been removed. It is replaced by a RC filter (R22 and C50) to remove ripple during reset line state transitions. See the schematics for EB revision 1.5.0 for more details.

9.2.2 Accelerometer

The onboard accelerometer (A1) has been rotated 180 degrees compared to EB revision 1.3.0. The accelerometer axes are given in Figure 26. Silk print has been added on the EB backside indicating the accelerometer axes.

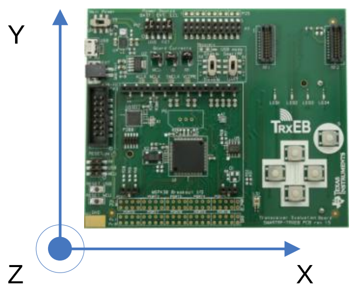


Figure 26 – Accelerometer axes on SmartRF TrxEB rev. ≥1.5.0

9.2.3 Silk print

Silk print text “IO” and “RF” near board current measurement jumpers P10 and P15 were on EB revision 1.3.0 placed next to the wrong jumper. This has been corrected as seen in Figure 27.

Silk print text “MCLK” and “SMCLK” near test points TP6 and TP7 were on EB revision 1.3.0 swapped, and placed next to the wrong test point. This has been corrected as seen in Figure 27.

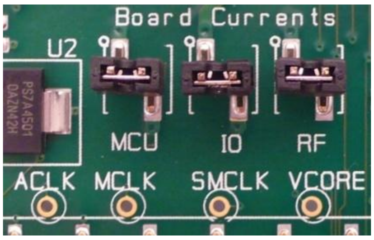


Figure 27 – Correct silk print for MCLK and SMCLK test points

Silk print has been added to the backside for EB revision 1.5.0. The silk print indicates the orientation of the accelerometer axes (see section 9.2.1) and power source jumper configurations (see section 6.3).

9.3 USB MCU pin-out

Same as revision 1.3.0, see section 8.3.

9.4 MSP430 MCU pin-out

Same as revision 1.3.0, see section 8.4.

10 SmartRF TrxEB rev. 1.7.0

10.1 Board Overview

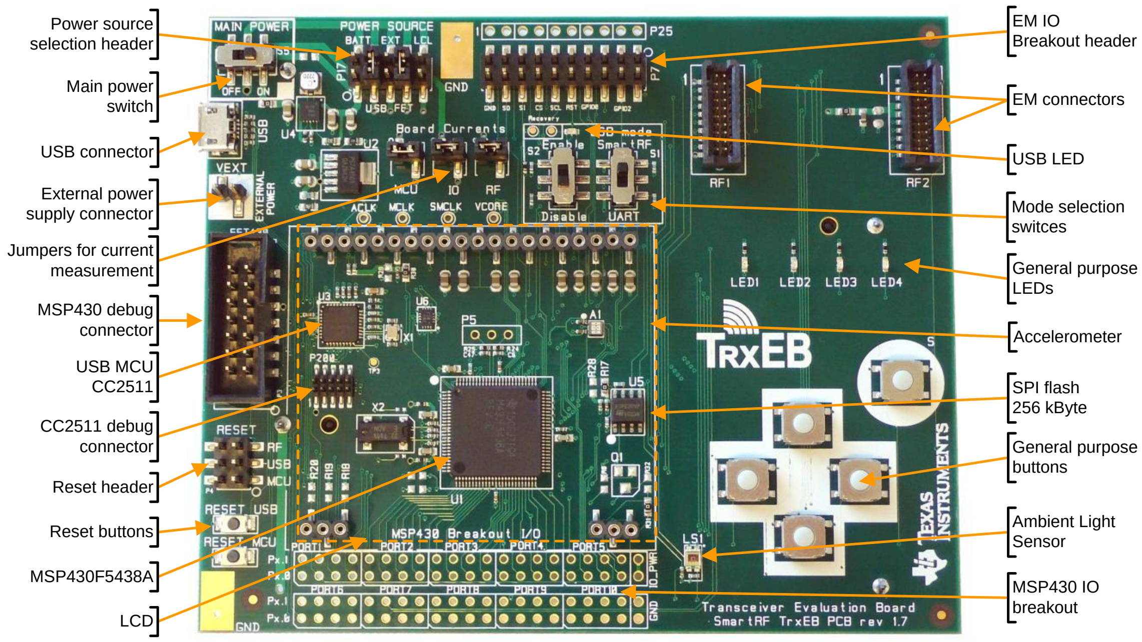


Figure 28 – SmartRF TrxEB revision 1.7.0 overview

10.2 Changes from rev. 1.5.0

10.2.1 Switch added to enable combo EM support

In order to support all combo EMs (e.g. CC1101-CC1190), a switch (TS3A44159) has been added in EB revision 1.7.0. The switch is placed between the four UART lines between the USB MCU and the MSP430 as shown in Figure 29. Hardware switch S1 controls the switch as given in Table 16.

With the USB MCU in UART Mode (see section 6.1.2), the switch connects COMx lines to NCx lines resulting in the same behavior as for older revisions of SmartRF TrxEB. In SmartRF Mode (see section 6.1.1), COMx lines are connected to NOx giving the USB MCU extra access to the EM interface, enabling support of combo EMs in SmartRF Studio.

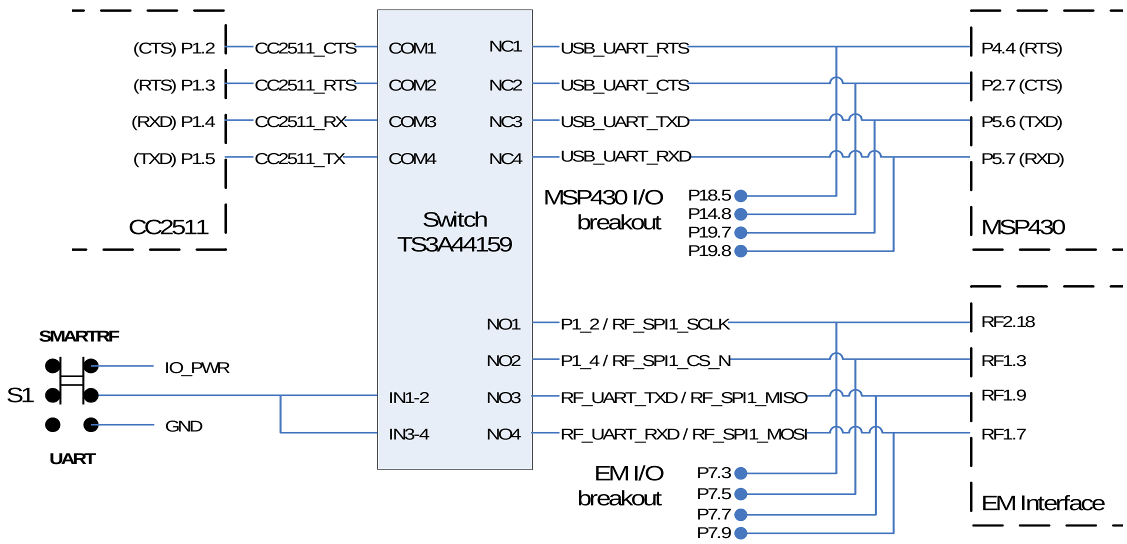


Figure 29 – Signal overview for switch TS3A44159 added for SmartRF TrxEB rev. 1.7.0

S1 position	Switch TS3A44159 connection
UART	COMx ↔ NCx
SMARTRF	COMx ↔ NOx

Table 16 – S1 control over TS3A44159 switch for SmartRF TrxEB rev. 1.7.0

10.2.2 Connector type for external power sources

On SmartRF TrxEB rev. 1.7.0, the external power source connector has been switched to a two-pin header (P1). See section 6.3.3.2 for more details on how to power SmartRF TrxEB rev. 1.7.0 using an external power supply.

10.2.3 Connector type for LCD

SmartRF TrxEB rev. 1.7.0 comes with a different LCD connector type than previous revisions to ensure proper connection to the LCD.

WARNING! The LCD connector on SmartRF TrxEB rev. 1.7.0 is very tight. Be extremely cautious when removing the LCD display to avoid the LCD display from breaking.

10.2.4 Ground pad between P17 and P7

A new ground pad has been added between the power source header (P17) and the EM I/O breakout header (P7) to ease connection of probes with these headers. The new ground pad is shown in Figure 30.

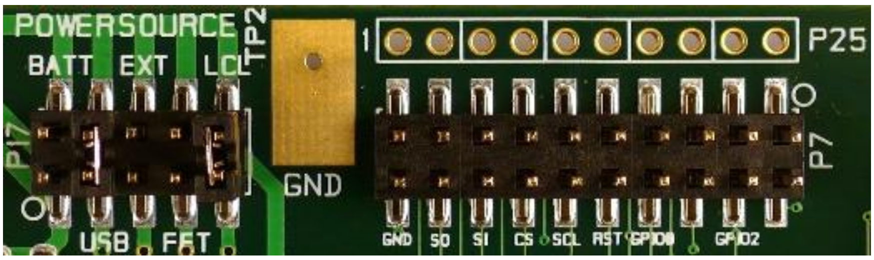


Figure 30 – Added ground pad on SmartRF TrxEB rev. 1.7.0.

10.2.5 Silk print

There has been made several minor additions to the silk print on SmartRF TrxEB 1.7.0, e.g. EM I/O breakout pins on header P7 are now marked (see Figure 30).

10.3 USB MCU pin-out

Table 17 shows how the USB MCU's pins are connected to the different functionalities on EB revision 1.7.0. Changes from previous EB revision are in bold.

CC2511	Signal name	Description	EM pin
P0.0	MCU_RESET_N	Signal used to reset MSP430 MCU	
P0.1	RF_RESET_N	Signal used to reset EM board	RF2.15
P0.2	RF_SPI0_CS_N	EM SPI Chip Select	RF1.14
P0.3	RF_SPI0_SCLK	EM SPI Clock	RF1.16
P0.4	RF_SPI0_MOSI	EM SPI MOSI (Master Out, Slave In)	RF1.18
P0.5	RF_SPI0_MISO	EM SPI MISO (Master in, slave out)	RF1.20
P1.0	USB_PULLUP	Enable USB Interface pull-up resistor	
P1.1	P1_3	CC Debug Clock	RF1.12
P1.2	**CC2511_CTS**	MSP430 UART / **GPIO connected to EM board**	**RF2.18** [4]
P1.3	**CC2511_RTS**	MSP430 UART / **GPIO connected to EM board**	**RF1.3** 4
P1.4	**CC2511_RX**	MSP430 UART / **GPIO connected to EM board**	**RF1.9** 4
P1.5	**CC2511_TX**	MSP430 UART / **GPIO connected to EM board**	**RF1.7** 4
P1.6	USB_ENABLE	Switch S2 input	
P1.7	P1_7	CC Debug Data	RF1.10
P2.0	**TP3**	**GPIO connected to test point TP3**	**NC**
P2.1	USB_DBG_DD	CC2511 CC Debug Interface Data	
P2.2	USB_DBG_DC	CC2511 CC Debug Interface Clock	
P2.3	USB_MODE	Switch S1 input	
P2.4	USB_LED	USB LED and Forced Recovery signal	

Table 17 – USB MCU pin-out on SmartRF TrxEB rev. 1.7.0

10.4 MSP430 MCU pin-out

Same as revision 1.3.0, see section 8.4.

[4] USB MCU pin is GPIO connected to the EM board in SmartRF Mode (section 6.1.1).

11 Updating the firmware

> **NOTE:** This chapter only describes how to program the firmware on the USB controller on the TrxEB. To program the MSP430, use the MSP-FET430UIF tool and connect it to the FET430 connector on the EB. Programming can be done using IAR EW430, CCS or SmartRF Flash Programmer.

Updating the EB firmware is done automatically by SmartRF Studio and SmartRF Flash Programmer if an old or incompatible firmware version is found on the USB MCU. SmartRF Flash Programmer also allows manual programming of the EB firmware. Please refer to the respective user's guides for detailed instructions. A simple step-by-step guide for updating the USB MCU firmware using SmartRF Studio is provided below.

1. Turn off the evaluation board (EB).
2. Disconnect any connected evaluation module (EM).
3. Plug in the USB cable and turn the power switch on.
4. The SmartRF TrxEB device should appear in the SmartRF Studio main window as seen in Figure 31a.
5. Double click the TrxEB device. SmartRF Studio will prompt if you wish to update the EB firmware (Figure 31b).
6. Confirm that you wish to update the EB firmware and wait for the upgrade process to complete (Figure 31c). This may take several seconds.
7. The EB will re-appear as a connected device in the SmartRF Studio window when the update is completed.

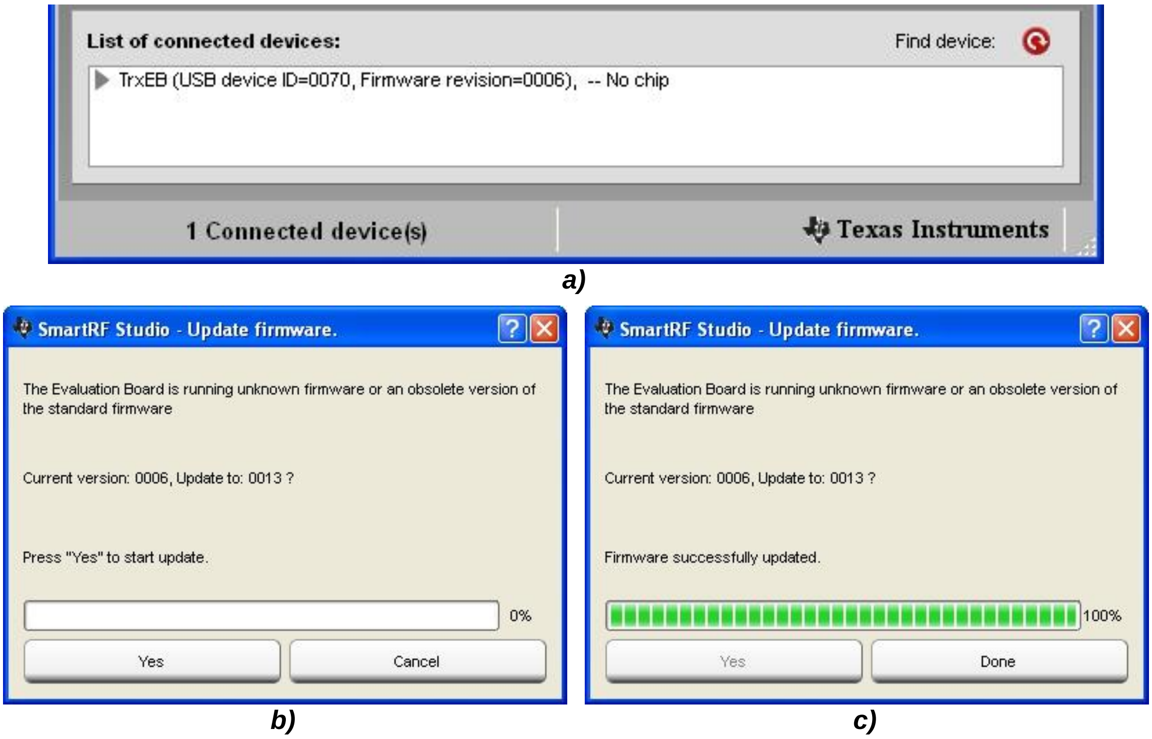


Figure 31 – Firmware upgrade steps in SmartRF Studio

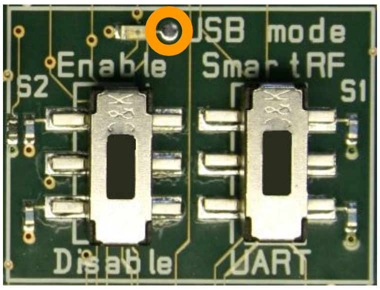
11.1 Forced Boot Recovery Mode

If the firmware update fails and the evaluation board appears to be dead, there is a way to force the board to only run the bootloader and stop all further execution. No attempts will be made to start the EB firmware.

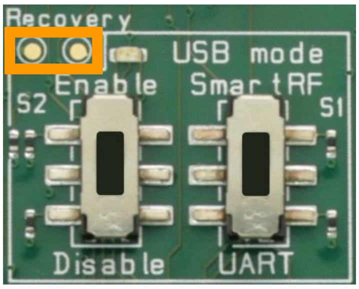
1. Turn the EB power off.
2. Rev. 1.3.0: Ground the USB LED test point shown in Figure 32a.
   Rev. ≥1.5.0: Ground the USB LED test point with the GND test point in Figure 32b.
3. While doing as explained in the second step, turn the EB power on.

When the board is powered up, the bootloader will not attempt to start the firmware and it will remain in control of the board. LED D6 (USB LED) will be blinking with a 1 second interval, indicating that the bootloader is running. You can use the USB LED state as an indicator to whether you have a working bootloader or not.

When the bootloader is running, the only functionality that is offered from SmartRF Studio and SmartRF Flash Programmer is to load a new version of the standard firmware.



a) Revision 1.3.0



b) Revision ≥1.5.0

Figure 32 – Enter forced boot recovery mode

11.2 Board Resurrection

If the forced boot recovery method above also fails, the board might be faulty or the flash on the CC2511 device has been inadvertently deleted. If the latter has happened, you can try to reprogram the boot loader on the CC2511. This will require that you have a CC Debugger [11].

First, you will have to remove the LCD from the TrxEB to get access to the debug connector for the CC2511 (P200). The LCD might be difficult to remove and can easily break if you use excessive force. Once the LCD is removed, connect the CC Debugger to P200 with the small flat-cable and adapter board included with the debugger.

Next, apply power to the TrxEB board from a suitable power source (e.g. USB). Then connect the CC Debugger to the PC via a USB cable and press the reset button on the debugger. The GREEN LED on the debugger should now be turned on to indicate that it has detected the CC2511 device on the TrxEB. If the RED LED is turned on, verify that the voltage level on the TrxEB is 3.3V and that the debugger is connected correctly (note the orientation of pin 1 on the debugger cable).

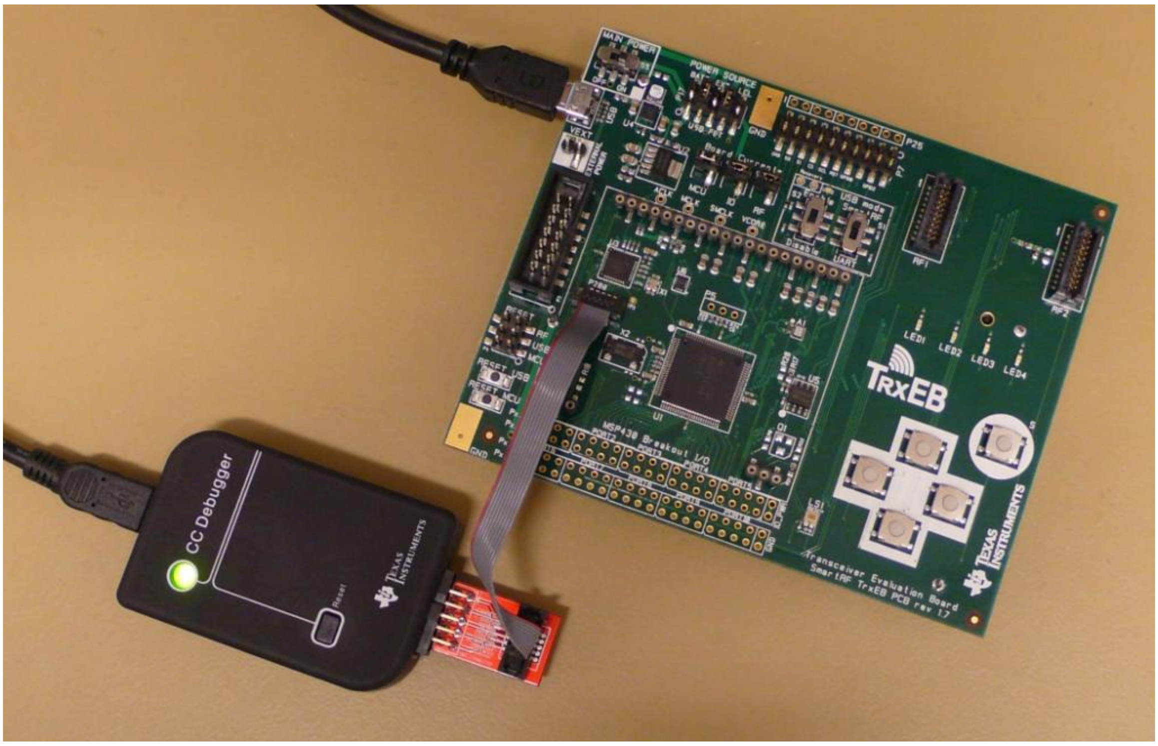
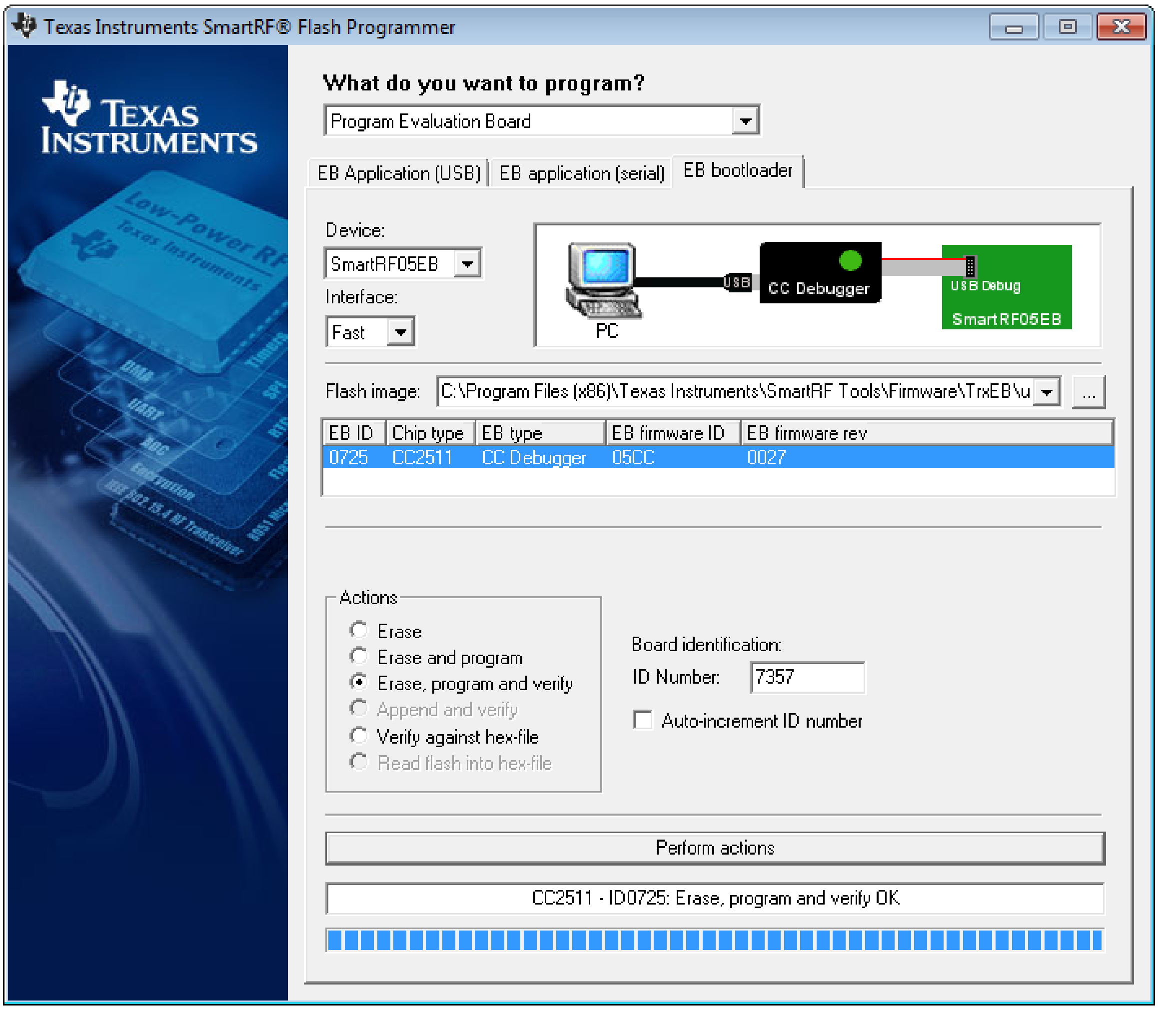


Figure 33 – Proper connection for board resurrection.

If the RED LED on the debugger remains on, the TrxEB is most likely broken. Please contact your TI representative for a possible replacement.

If the GREEN LED on the debugger is on, you can proceed with programming the boot loader from SmartRF Flash Programmer.

In SmartRF Flash Programmer, first select “Program Evaluation Board” and then go to the “EB bootloader” tab. The screenshot below shows the settings you will need to use.



- In the Device drop down list, select SmartRF05EB.
- The interface speed can be set to Fast.
- The flash image to program is C:\Program Files (x86)\Texas Instruments\SmartRF Tools\Firmware\TrxEB\usb_bootloader_trxeb.hex
- In the list of connected devices, you should see the CC Debugger connected to the CC2511.
- Select “Erase, program and verify” from the list of actions.
- Give the board a unique ID number.

When all of the above is set, press the “Perform actions” button.

If everything went well, the yellow USB Led on the TrxEB should start blinking rapidly. This means that the boot loader is running and that it is waiting for the firmware to be programmed. Follow the steps in the first section of this chapter to program the firmware.

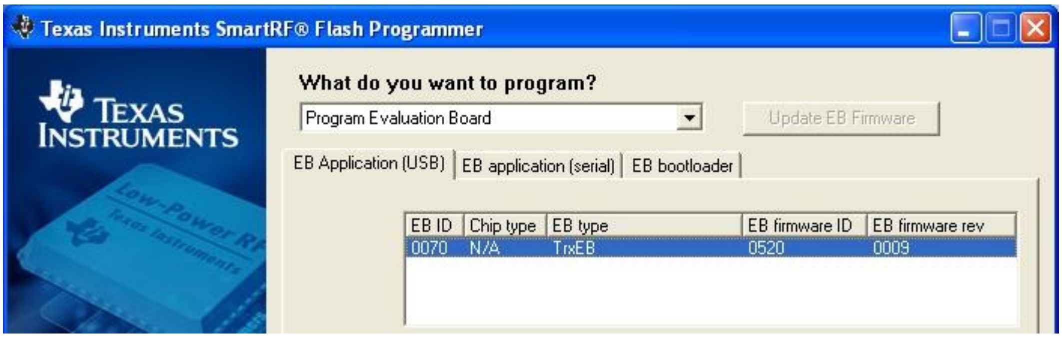
12 Frequently Asked Questions

Q1 I have a SmartRF TrxEB that says revision 1.1 on the PCB, but rev. 1.1 is not mentioned in the User's Guide. Why?

A1 Your SmartRF TrxEB is what this document calls revision 1.3.0. This user's guide refers to the assembly revision of the EB. On SmartRF TrxEB (assembly) revision 1.3.0, the PCB revision is 1.1. For EB revisions 1.5.0 and 1.7.0, PCB revisions are synchronized with the assembly revision, being 1.5 and 1.7, respectively.

Q2 How do I check the firmware revision on the evaluation board?

A2 You can use both SmartRF Studio and SmartRF Flash Programmer to check the firmware revision. Connect the EB to a PC via USB and launch e.g. the SmartRF Flash Programmer. Select the "EB application (USB)" tab. The SmartRF board should be listed with relevant information about the firmware running on the board. In the below example, the EB firmware revision is 0009.



Q3 Installation of USB drivers for the evaluation board fails. Help!

A3 Please refer to design note DN304 [2] on the TI web for help regarding installation of the Cxxxx Development Tools USB driver (Cebal).

Q4 Nothing happens when I power up the evaluation board. Why?

A4 Make sure the power selection jumpers on header P17 are set according to your power source (see section 6.3). Check that the Mode Selection switches (section 6.1) are not set to disable the USB MCU. Also, make sure the board current jumpers (P10, P13 and P15) are all short circuited.

Q5 When powering up the evaluation board, LED D6 starts blinking. Why?

A5 LED D6 (aka. USB LED) indicates the state of the TrxEB. If the observed behavior is short blinks with long pauses (0.1 s ON, 0.9 s OFF), the EB firmware does not detect any connected chip. If an EM is connected, the firmware does not support the connected EM. Try updating the EB firmware using SmartRF Studio or SmartRF Flash Programmer (see chapter 11).

If the blink frequency is about 1 Hz (0.5 s ON, 0.5 s OFF), the USB MCU bootloader has entered a forced boot recovery mode (set during programming of the device). Power off the system and turn it back on to start the application.

If the blinking is more rapid (10 times per second) the bootloader could not find a valid application in flash. Use SmartRF Studio or SmartRF Flash Programmer to program a new firmware on the board.

See section 6.9.2 for more details on LED D6 states.

Q6 I already have a SmartRF TrxEB revision 1.3.0/1.5.0 and I have written a lot of software for the MSP430 MCU on that board. Now, I get revision 1.7.0 in new development kits. Do I need to rewrite all of my software?

A6 No, you do not need to rewrite your software. The hardware connection between the onboard MSP430 and the EM remains the same in revision 1.7.0. The difference is that in revision 1.7.0, an extra switch has been added between the USB MCU and the MSP430/EM. This switch gives the USB MCU access to extra EM I/O in SmartRF Mode, allowing support for combo EMs (e.g. CC1101-CC1190). See section 10.2 for further details on hardware changes in EB revision 1.7.0 and chapter.

Q7 **I have a CC1101-CC1190EM combo board. Will it work with SmartRF TrxEB and SmartRF Studio?**

A7 Yes and no. Yes, you can connect the CC1101-CC1190EM to the TrxEB and control the combo board from the MSP430. However, this assembly is not yet fully supported by SmartRF Studio. Studio does support the CC1101-CC1190 combo, but the automatic control of the signals to the CC1190 device is currently only supported on SmartRF04EB.

You can of course still use TrxEB + CC1101-CC1190EM in SmartRF Studio, as all the relevant RF registers will be correct, but you need to “help” the system to set the CC1190 device in the right mode. Use the jumpers on the EM to control the LNA/PA/HGM signals. For all RX tests, the LNA signal should be high (PA low) and for all TX tests, the PA signal should be high (LNA low).

13 References

[1] **SmartRF Studio Product Page**
www.ti.com/smartrfstudio

[2] **DN304 – CCxxxx Development Tools USB Driver Installation Guide**
www.ti.com/lit/swra366

[3] **CC2511F32 Product Page**
www.ti.com/product/cc2511f32

[4] **SmartRF Flash Programmer Product Page**
www.ti.com/tool/flash-programmer

[5] MSP430x5xx/MSP430x6xx Family User's Guide
www.ti.com/lit/slau208

[6] MSP430F5438A Product Page
www.ti.com/product/msp430f5438a

[7] Electronic Assembly DOGM128-6 Datasheet
http://www.lcd-module.com/eng/pdf/grafik/dogm128e.pdf

[8] VTI CMA3000-D01
http://www.vti.fi/en/products/accelerometers/consumer_electronics/cma3000_series/

[9] Osram SFH 5711
http://www.osram-os.com/

[10] **Micron M25PE Datasheet**
http://www.micron.com/~/media/Documents/Products/Data%20Sheet/NOR%20Flash/5965M25PE20_10.ashx

[11] **CC Debugger**
www.ti.com/tool/cc-debugger

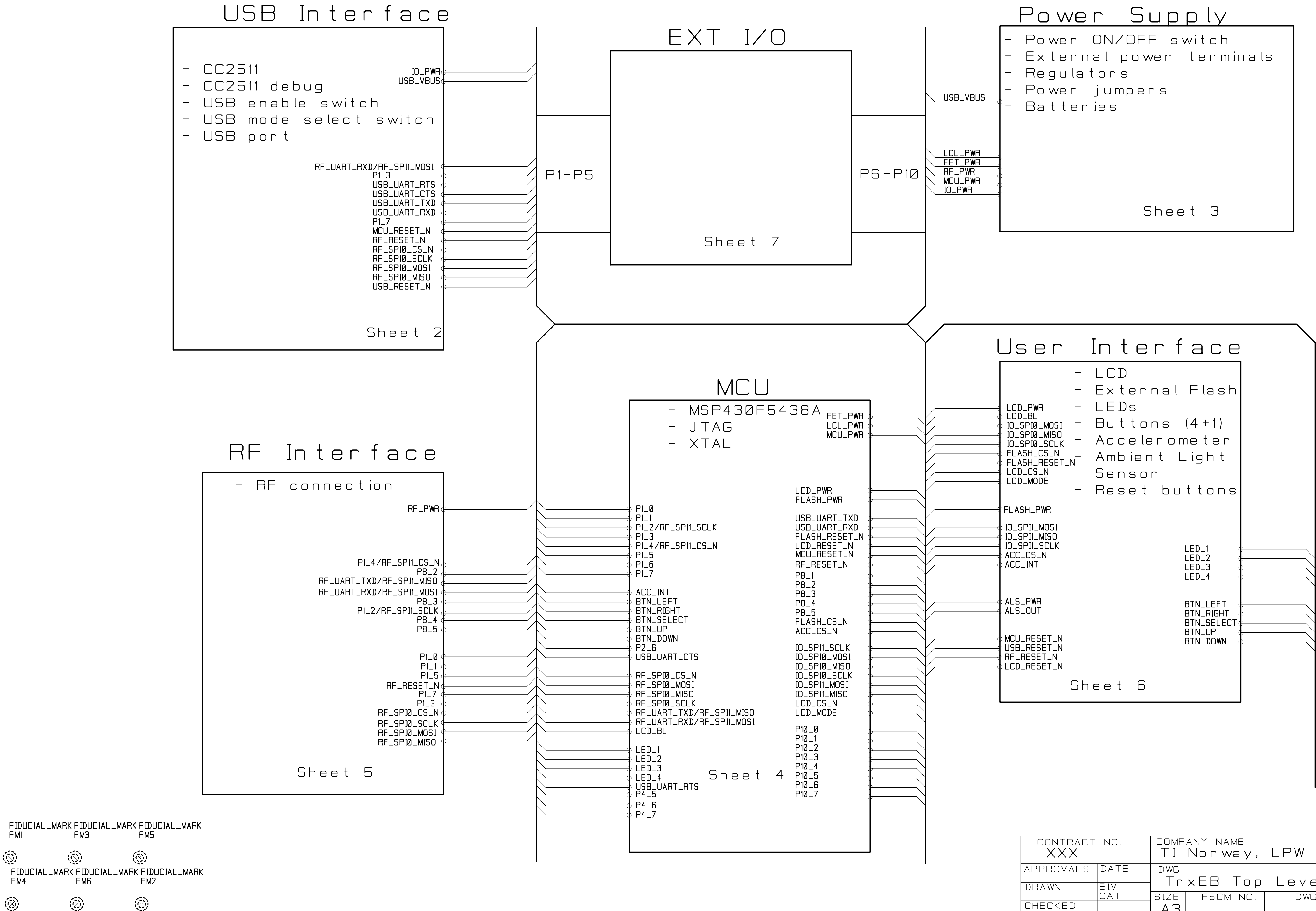
14 Document History

Revision	Date	Description/Changes
SWRU294A	2012-02-10	Updated with information about revision 1.7.0. Corrected information about use of CC1101-CC1190EM on TrxEB. Added information about board resurrection. Added some more information about the EM connector/interface.
SWRU294	2011-06-30	Initial release.

Appendix A

Schematics

SmartRF TrxEB 1.3.0



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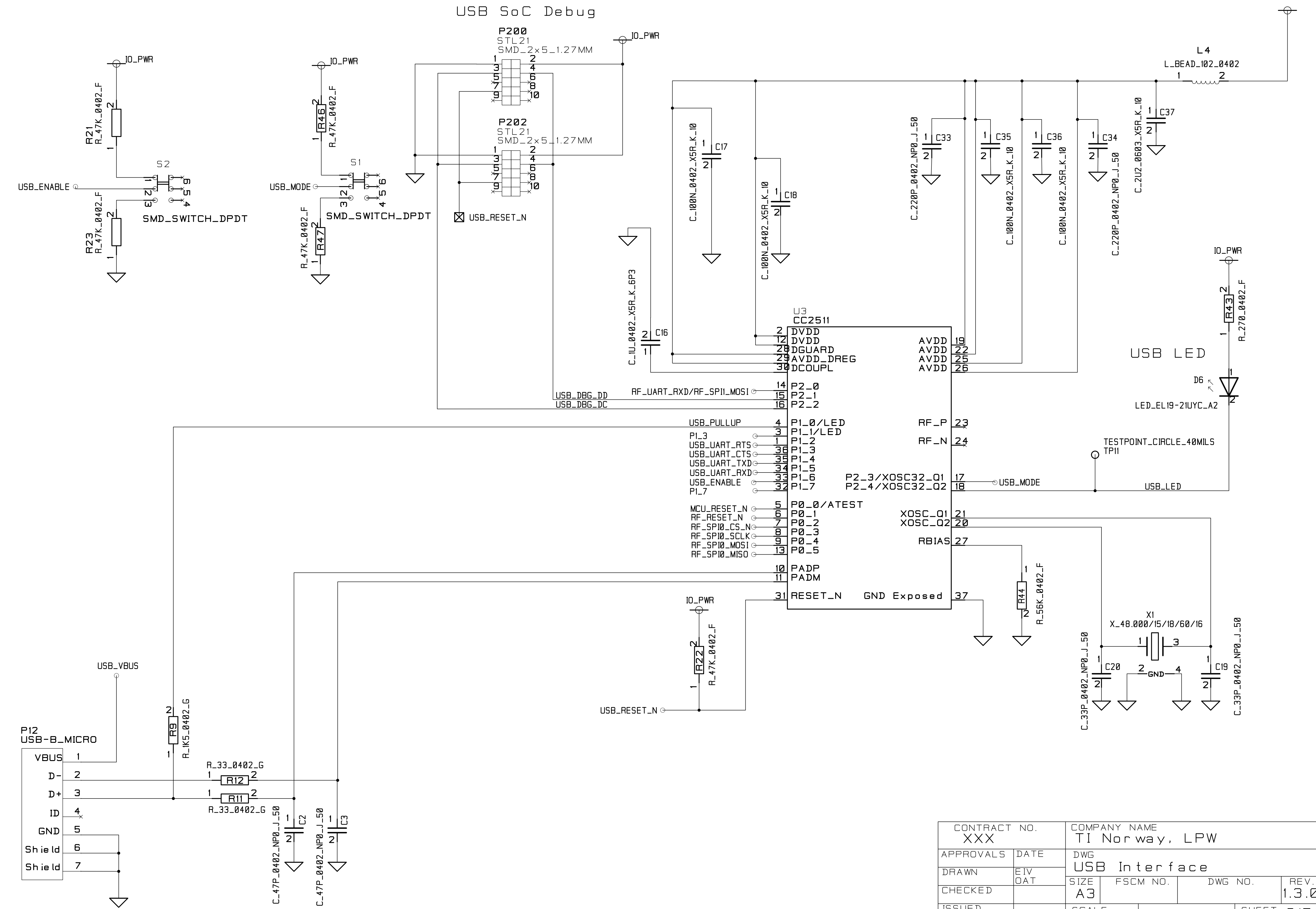
ISSUED		SCALE		SHEET 1(7)	



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APPROVALS / DATE	DWG USB Interface			
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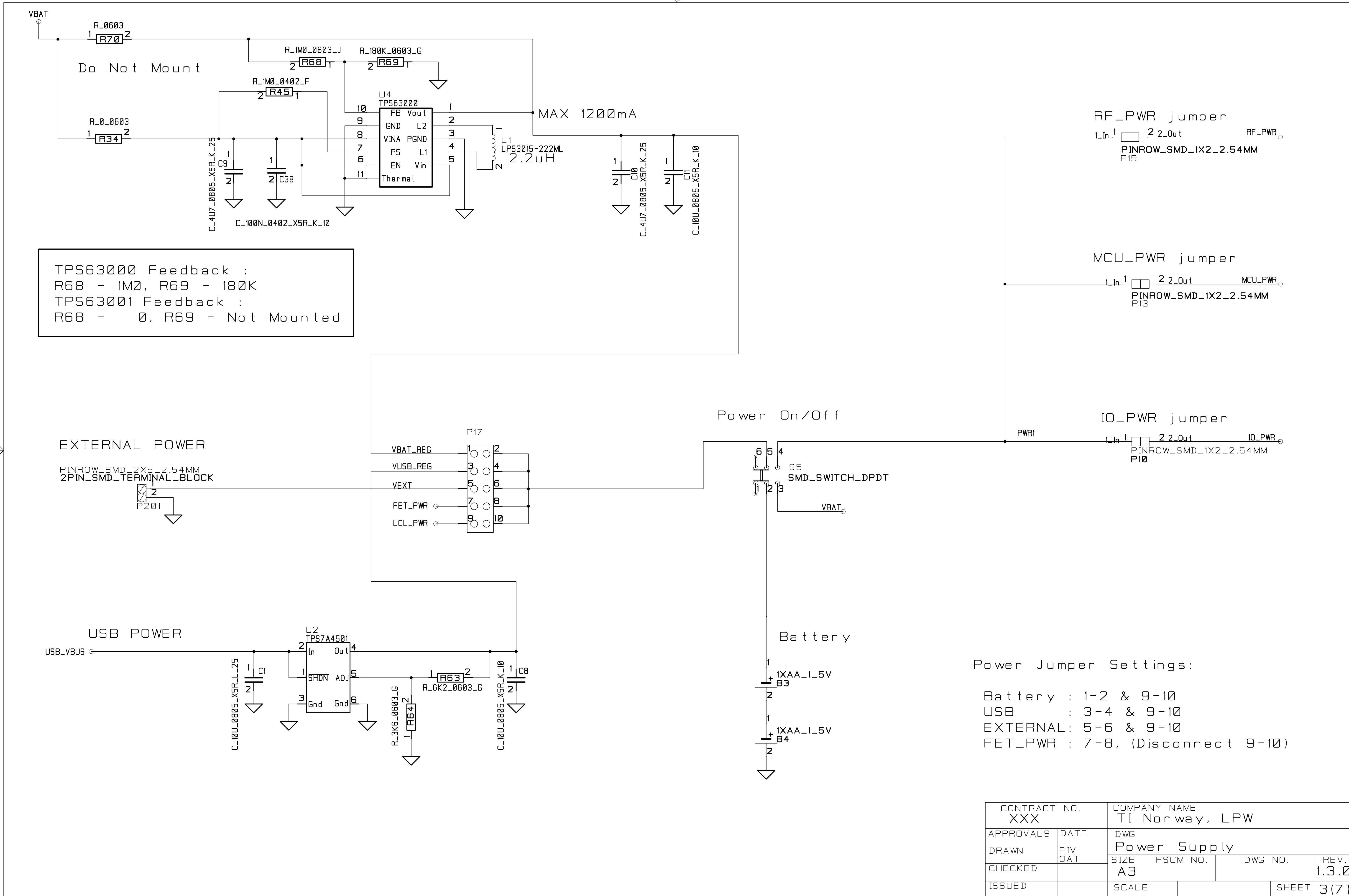
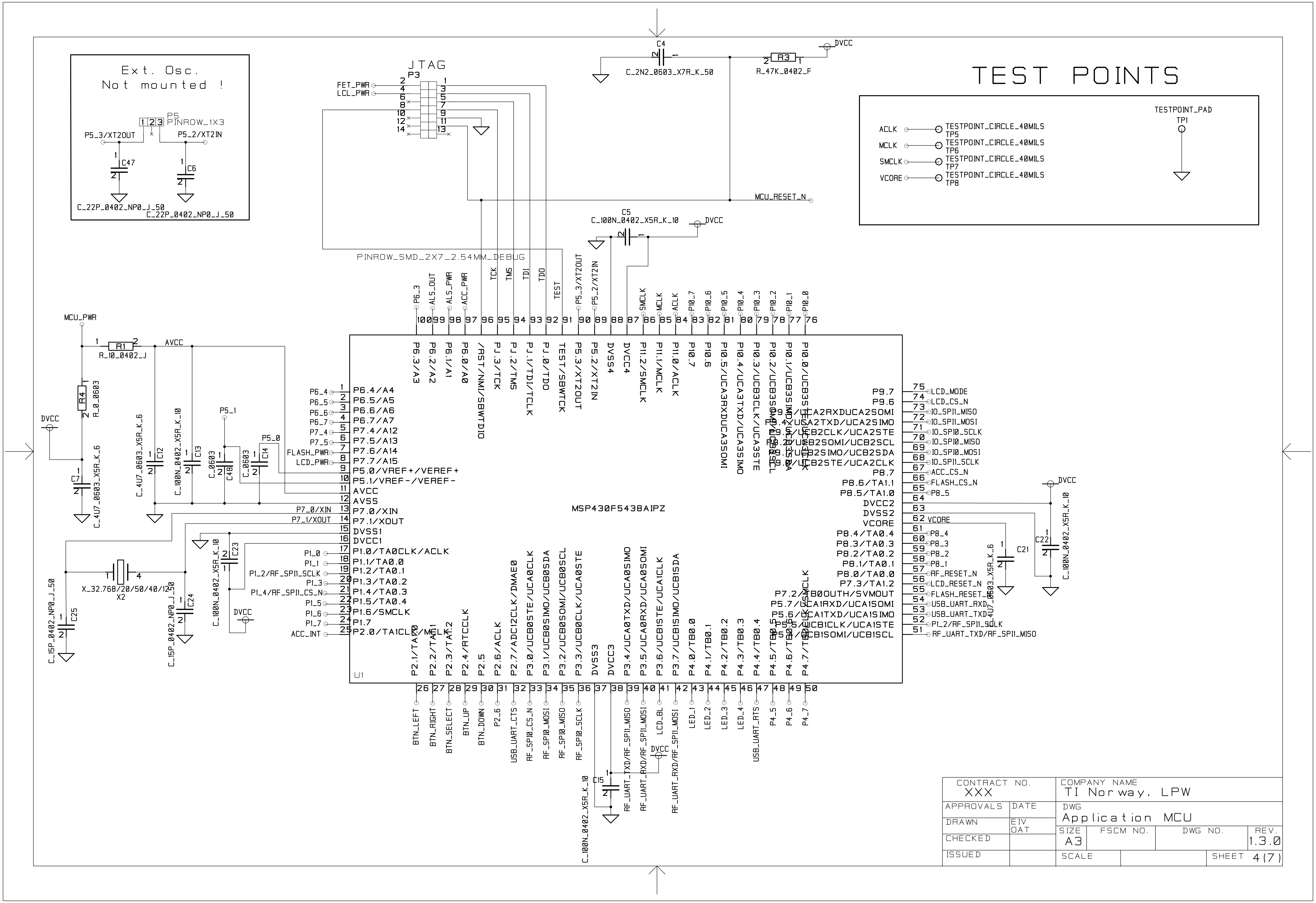
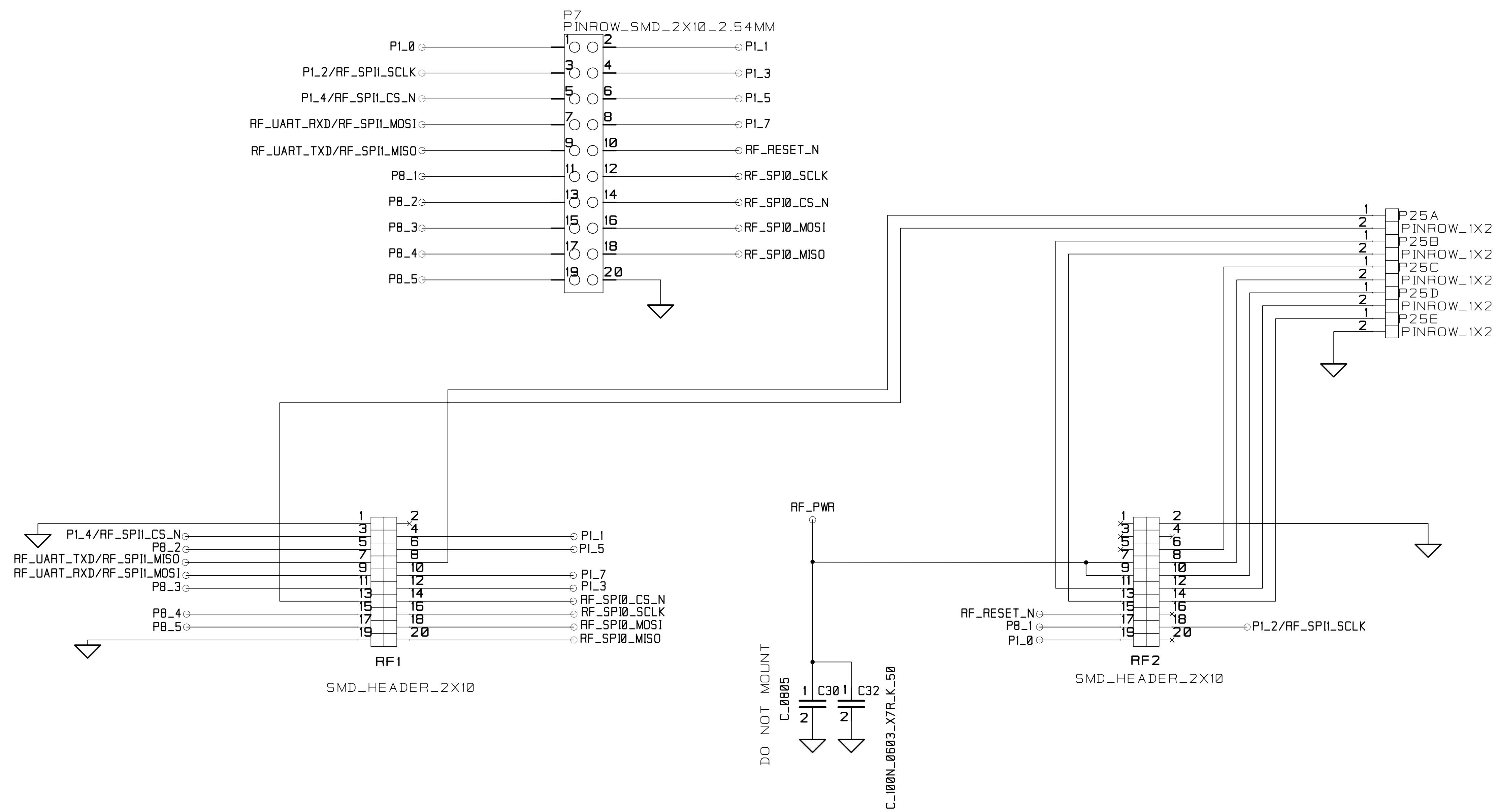
ISSUED	SCALE		SHEET 2(7)	


VBAT
R_0603
R70
Do Not Mount
R_1M0_0603_J
R68
R_180K_0603_G
R69
R_1M0_0402_F
R45
U4
TPS63000
FB Vout
GND L2
VINA PGND
PS L1
EN Vin
Thermal
MAX 1200mA
L1
LPS3015-222ML
2.2uH
R_0_0603
R34
C9
C38
C_4U7_0805_X5R_K_25
C_100N_0402_X5R_K_10
C10
C_4U7_0805_X5R_K_25
C11
C_10U_0805_X5R_K_10
TPS63000 Feedback :
R68 - 1M0, R69 - 180K
TPS63001 Feedback :
R68 - 0, R69 - Not Mounted
RF_PWR jumper
I_In
2_Out
RF_PWR
PINROW_SMD_1X2_2.54MM
P15
MCU_PWR jumper
MCU_PWR
PINROW_SMD_1X2_2.54MM
P13
IO_PWR jumper
PWR1
IO_PWR
PINROW_SMD_1X2_2.54MM
P10
Power On/Off
S5
SMD_SWITCH_DPDT
VBAT
EXTERNAL POWER
PINROW_SMD_2X5_2.54MM
2PIN_SMD_TERMINAL_BLOCK
P201
P17
VBAT_REG
VUSB_REG
VEXT
FET_PWR
LCL_PWR
USB POWER
USB_VBUS
U2
TPS7A4501
In Out
SHDN ADJ
Gnd Gnd
C1
C_10U_0805_X5R_L_25
R63
R_6K2_0603_G
R64
R_3K6_0603_G
C8
C_10U_0805_X5R_K_10
Battery
1XAA_1_5V
B3
1XAA_1_5V
B4
Power Jumper Settings:
Battery : 1-2 & 9-10
USB : 3-4 & 9-10
EXTERNAL: 5-6 & 9-10
FET_PWR : 7-8, (Disconnect 9-10)
CONTRACT NO.
XXX
COMPANY NAME
TI Norway, LPW
APPROVALS DATE
DWG
Power Supply
DRAWN
EIV
OAT
CHECKED
SIZE
A3
FSCM NO.
DWG NO.
REV.
1.3.0
ISSUED
SCALE
SHEET 3(7)



TEST POINTS
Ext. Osc.
Not mounted !
P5
PINROW_1X3
P5_3/XT2OUT
P5_2/XT2IN
C47
C6
C_22P_0402_NP0_J_50
C_22P_0402_NP0_J_50
JTAG
P3
FET_PWR
LCL_PWR
PINROW_SMD_2X7_2.54MM_DEBUG
C4
C_2N2_0603_X7R_K_50
R3
R_47K_0402_F
DVCC
MCU_RESET_N
C5
C_100N_0402_X5R_K_10
ACLK
MCLK
SMCLK
VCORE
TESTPOINT_CIRCLE_40MILS
TP5
TP6
TP7
TP8
TESTPOINT_PAD
TP1
MCU_PWR
R1
R_10_0402_J
AVCC
R4
R_0_0603
C7
C_4U7_0603_X5R_K_6
C12
C13
C_100N_0402_X5R_K_10
C48
C14
C_0603
P5_1
P5_0
FLASH_PWR
LCD_PWR
P7_0/XIN
P7_1/XOUT
X_32.768/20/50/40/12
X2
C25
C24
C_15P_0402_NP0_J_50
C23
P1_2/RF_SPI1_SCLK
P1_4/RF_SPI1_CS_N
ACC_INT
MSP430F5438AIPZ
U1
BTN_LEFT
BTN_RIGHT
BTN_SELECT
BTN_UP
BTN_DOWN
USB_UART_CTS
RF_SPI0_CS_N
RF_SPI0_MOSI
RF_SPI0_MISO
RF_SPI0_SCLK
C15
RF_UART_TXD/RF_SPI1_MISO
RF_UART_RXD/RF_SPI1_MOSI
LCD_BL
LED_1
LED_2
LED_3
LED_4
USB_UART_RTS
LCD_MODE
LCD_CS_N
IO_SPI1_MISO
IO_SPI1_MOSI
IO_SPI0_SCLK
IO_SPI0_MISO
IO_SPI0_MOSI
IO_SPI1_SCLK
ACC_CS_N
FLASH_CS_N
RF_RESET_N
LCD_RESET_N
FLASH_RESET_N
USB_UART_RXD
USB_UART_TXD
RF_UART_TXD/RF_SPI1_MISO
C21
C22
CONTRACT NO.
XXX
COMPANY NAME
TI Norway, LPW
APPROVALS
DATE
DWG
Application MCU
DRAWN
EIV OAT
CHECKED
ISSUED
SIZE
A3
FSCM NO.
DWG NO.
REV.
1.3.0
SCALE
SHEET
4(7)



Connectors RF1 and RF2 are SMD,
2x10 pin row headers with 0.05 spacing.
P/N TFM-110-02-SM-D-A-K, produced by Samtec.

The matching connector used on RF
evaluation modules are SFM-110-02-SM-D-A-K.

The distance between RF1 and RF2 is 1200 mils
(center to center).

CONTRACT NO. XXX		COMPANY NAME TI Norway, LPW			
APPROVALS	DATE	DWG EM Interface			
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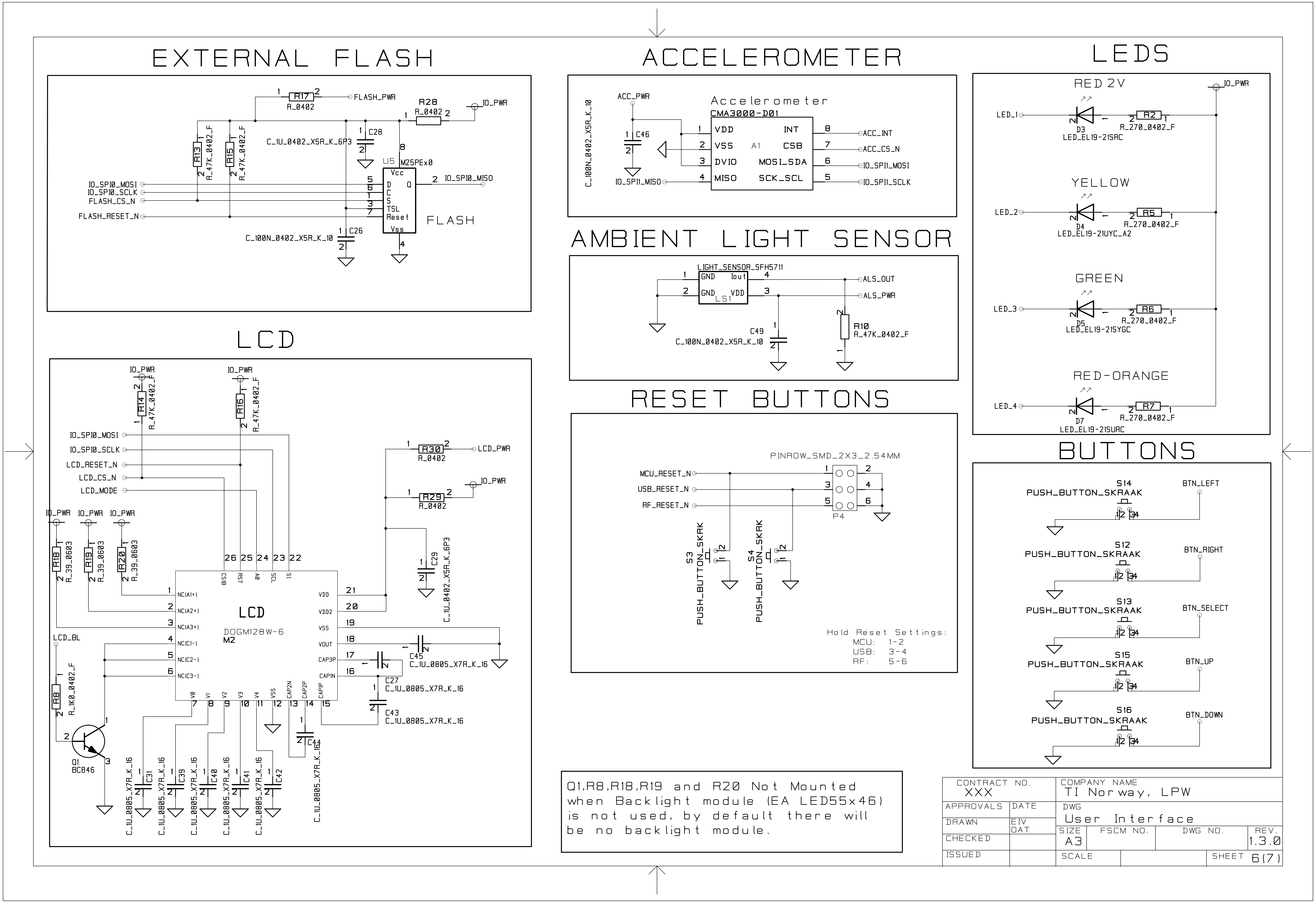
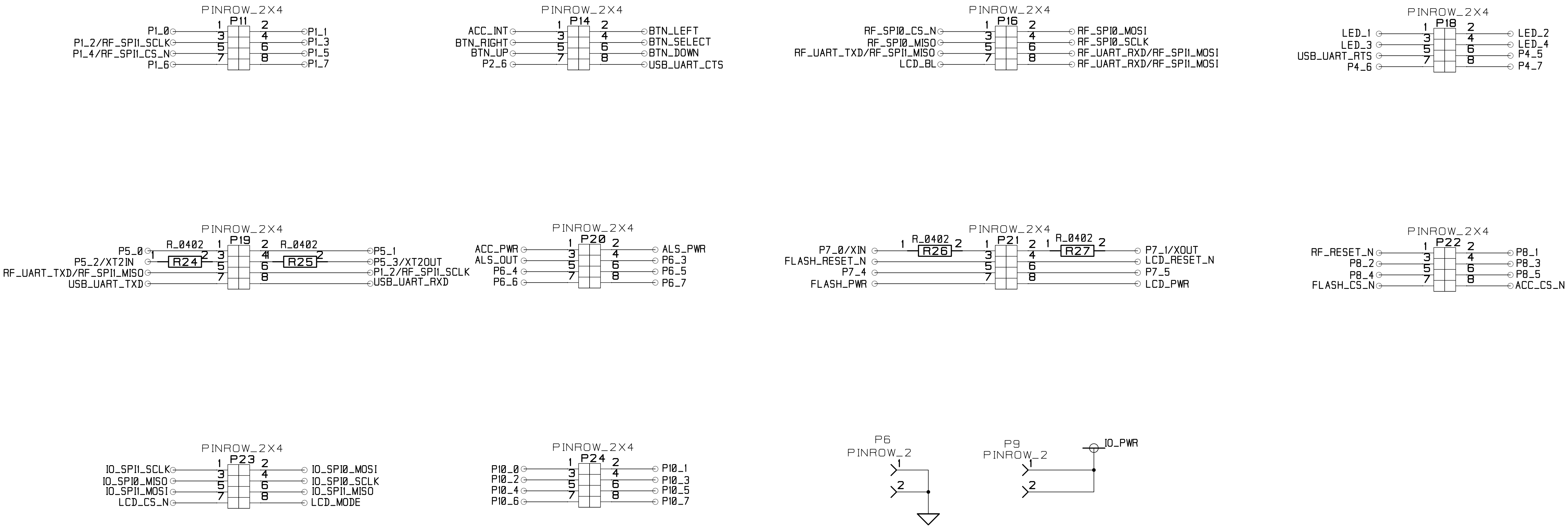
CHECKED		SIZE A3	FSCM NO.	DWG NO.	REV. 1.3.0
ISSUED		SCALE		SHEET 5(7)	


EXTERNAL FLASH
R17
R_0402
FLASH_PWR
R28
R_0402
IO_PWR
C28
C_1U_0402_X5R_K_6P3
R13
R_47K_0402_F
R15
R_47K_0402_F
U5
M25PEx0
Vcc
D
C
S
TSL
Reset
Vss
Q
IO_SPI0_MISO
IO_SPI0_MOSI
IO_SPI0_SCLK
FLASH_CS_N
FLASH_RESET_N
FLASH
C26
C_100N_0402_X5R_K_10
ACCELEROMETER
ACC_PWR
C46
C_100N_0402_X5R_K_10
Accelerometer
CMA3000-D01
VDD
VSS
DVIO
MISO
INT
CSB
MOSI_SDA
SCK_SCL
A1
IO_SPI1_MISO
ACC_INT
ACC_CS_N
IO_SPI1_MOSI
IO_SPI1_SCLK
AMBIENT LIGHT SENSOR
LIGHT_SENSOR_SFH5711
GND
GND
Iout
VDD
LS1
ALS_OUT
ALS_PWR
C49
C_100N_0402_X5R_K_10
R10
R_47K_0402_F
LEDS
RED 2V
IO_PWR
LED_1
D3
LED_EL19-21SRC
R2
R_270_0402_F
YELLOW
LED_2
D4
LED_EL19-21UYC_A2
R5
R_270_0402_F
GREEN
LED_3
D5
LED_EL19-21SYGC
R6
R_270_0402_F
RED-ORANGE
LED_4
D7
LED_EL19-21SURC
R7
R_270_0402_F
LCD
IO_PWR
R14
R_47K_0402_F
R16
R_47K_0402_F
IO_SPI0_MOSI
IO_SPI0_SCLK
LCD_RESET_N
LCD_CS_N
LCD_MODE
R30
R_0402
LCD_PWR
R29
R_0402
IO_PWR
C29
C_1U_0402_X5R_K_6P3
R18
R_39_0603
R19
R_39_0603
R20
R_39_0603
LCD
DOGM128W-6
M2
NC(A1+)
NC(A2+)
NC(A3+)
NC(C1-)
NC(C2-)
NC(C3-)
VDD
VDD2
VSS
VOUT
CAP3P
CAPIN
V0
V1
V2
V3
V4
VSS
CAP2N
CAP2P
CAP1P
CS0
RST
A0
SCL
SI
C45
C_1U_0805_X7R_K_16
C27
C_1U_0805_X7R_K_16
C43
C_1U_0805_X7R_K_16
C44
C_1U_0805_X7R_K_16
LCD_BL
R8
R_1K0_0402_F
Q1
BC846
C31
C39
C40
C41
C42
C_1U_0805_X7R_K_16
RESET BUTTONS
PINROW_SMD_2X3_2.54MM
MCU_RESET_N
USB_RESET_N
RF_RESET_N
P4
S3
PUSH_BUTTON_SKRK
S4
PUSH_BUTTON_SKRK
Hold Reset Settings:
MCU: 1-2
USB: 3-4
RF: 5-6
BUTTONS
S14
PUSH_BUTTON_SKRAAK
BTN_LEFT
S12
PUSH_BUTTON_SKRAAK
BTN_RIGHT
S13
PUSH_BUTTON_SKRAAK
BTN_SELECT
S15
PUSH_BUTTON_SKRAAK
BTN_UP
S16
PUSH_BUTTON_SKRAAK
BTN_DOWN
Q1,R8,R18,R19 and R20 Not Mounted when Backlight module (EA LED55x46) is not used, by default there will be no backlight module.
CONTRACT NO.
XXX
COMPANY NAME
TI Norway, LPW
APPROVALS
DATE
DWG
User Interface
DRAWN
EIV
OAT
CHECKED
SIZE
A3
FSCM NO.
DWG NO.
REV.
1.3.0
ISSUED
SCALE
SHEET
6(7)

EXTERNAL I/O

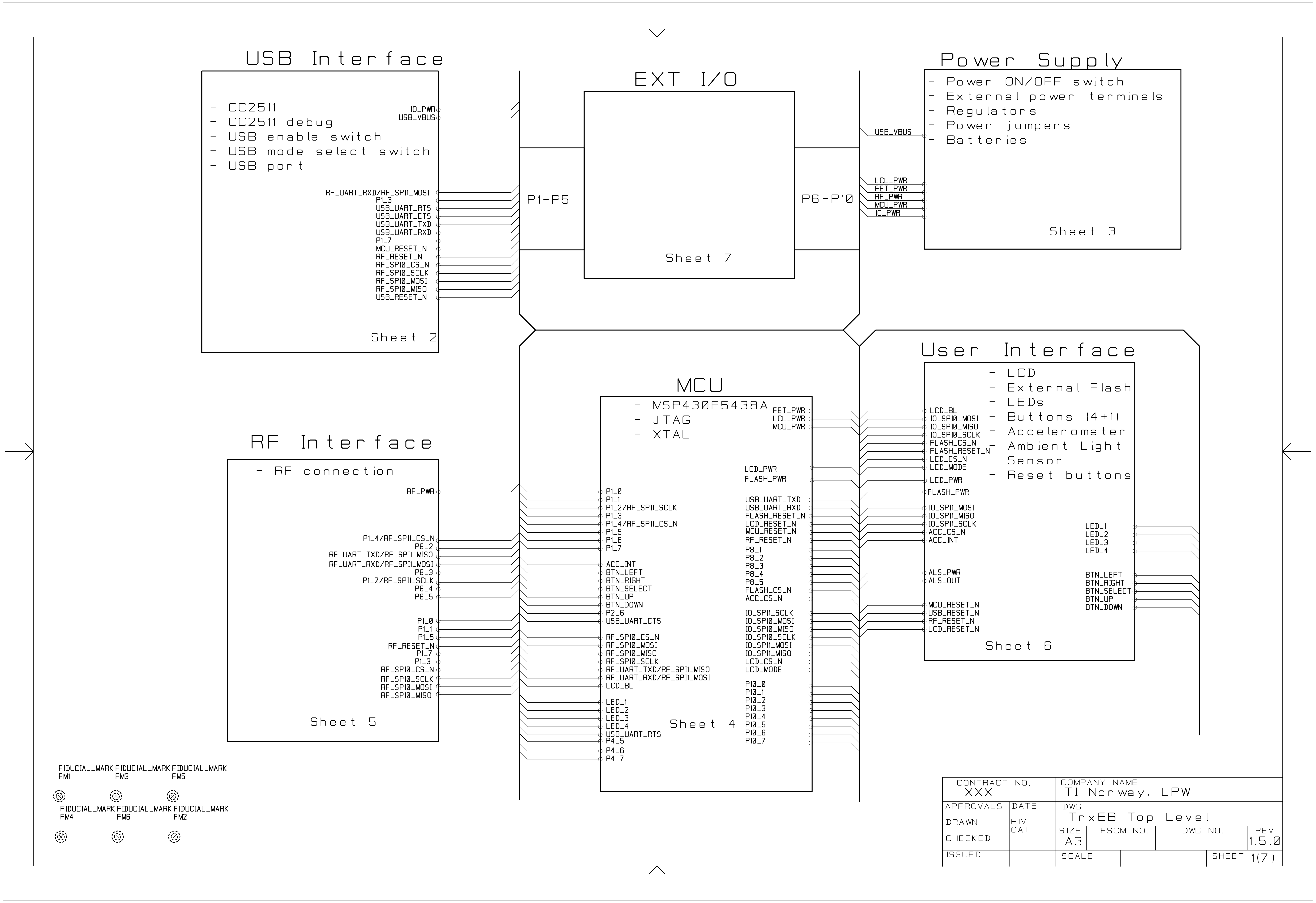


CONTRACT NO. XXX		COMPANY NAME TI Norway, LPW			
APPROVALS	DATE	DWG			
DRAWN	EIV OAT				
CHECKED		SIZE A3	FSCM NO.	DWG NO.	REV. 1.3.0
ISSUED		SCALE			SHEET 7(7)

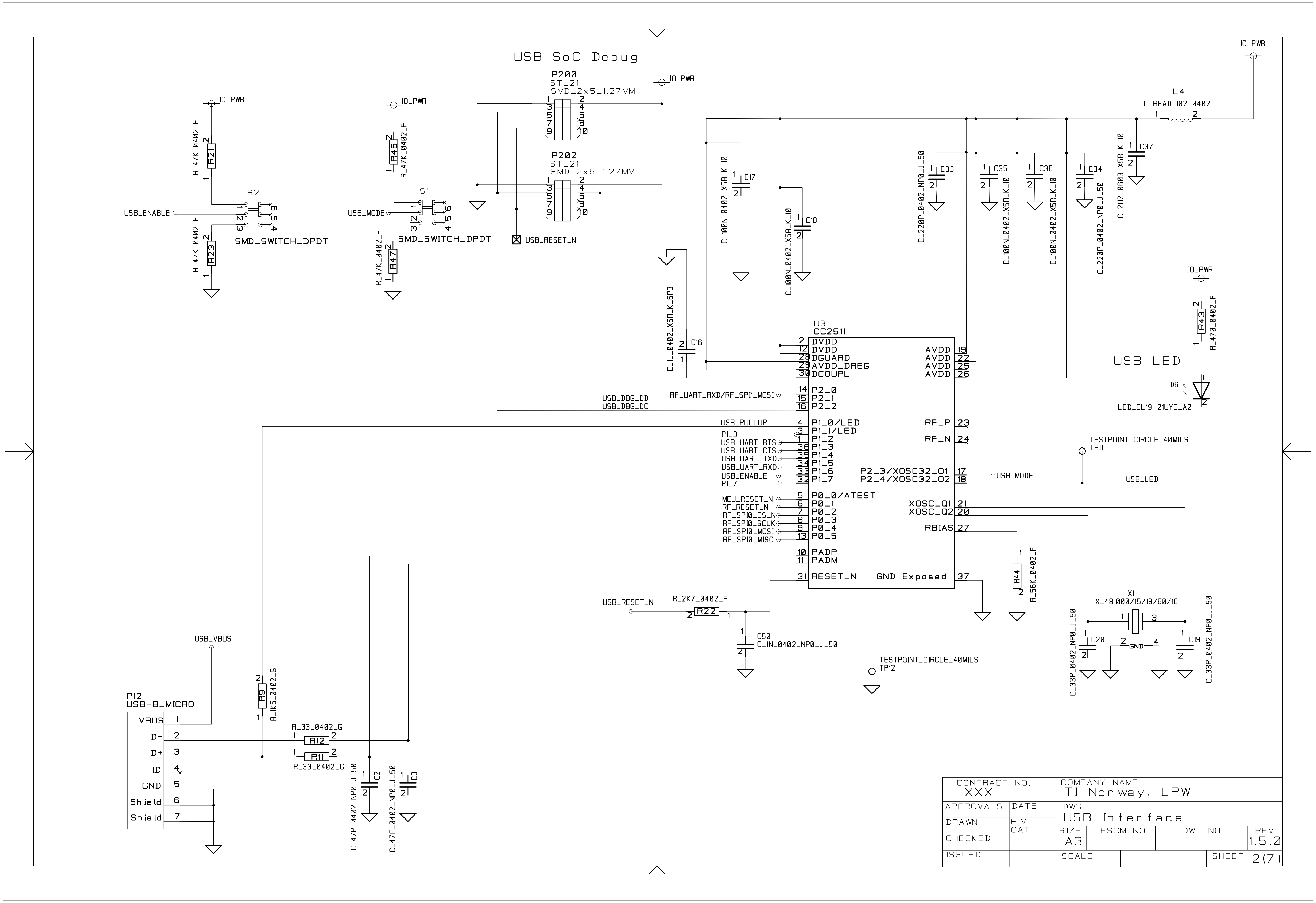
Appendix B

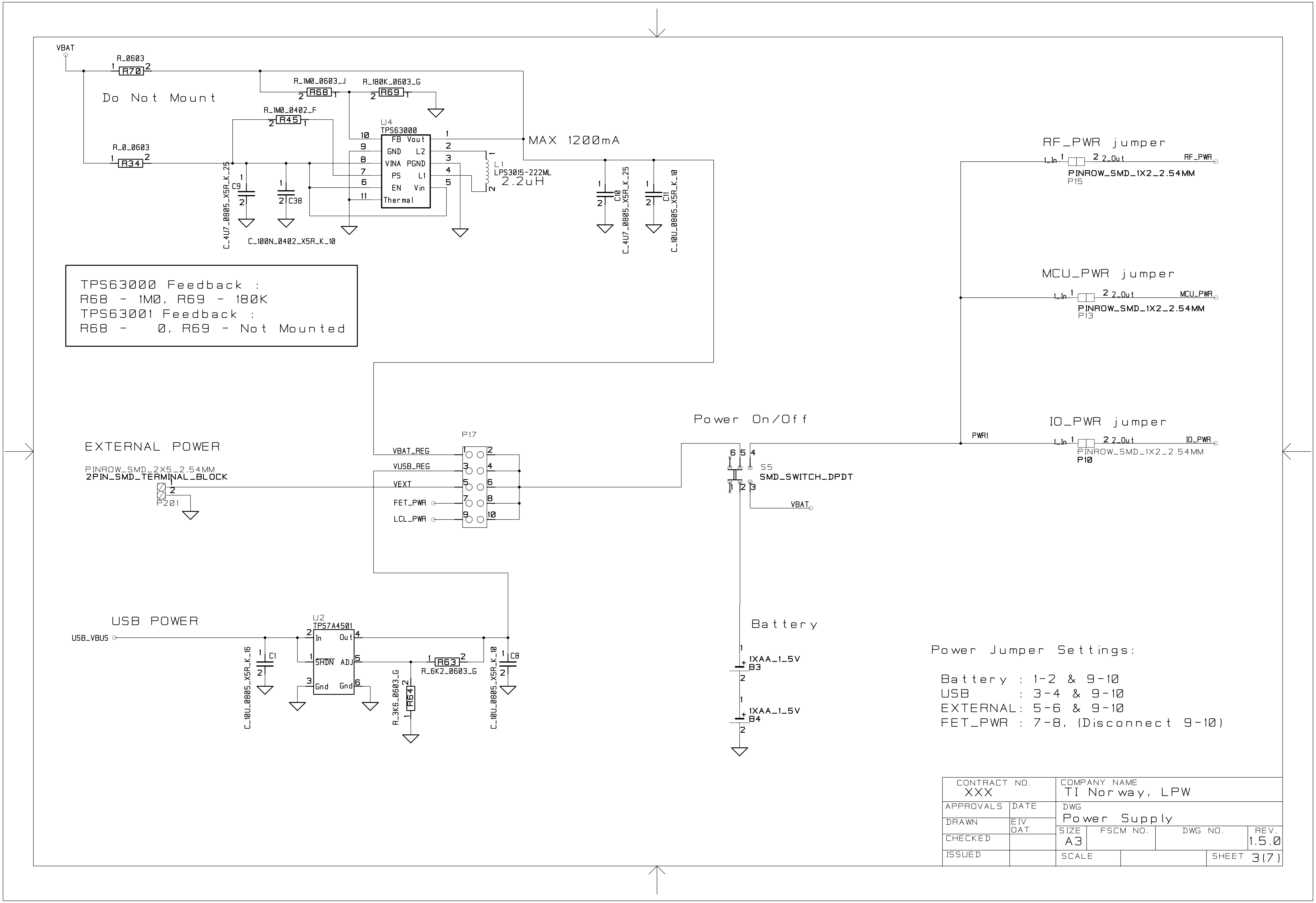
Schematics

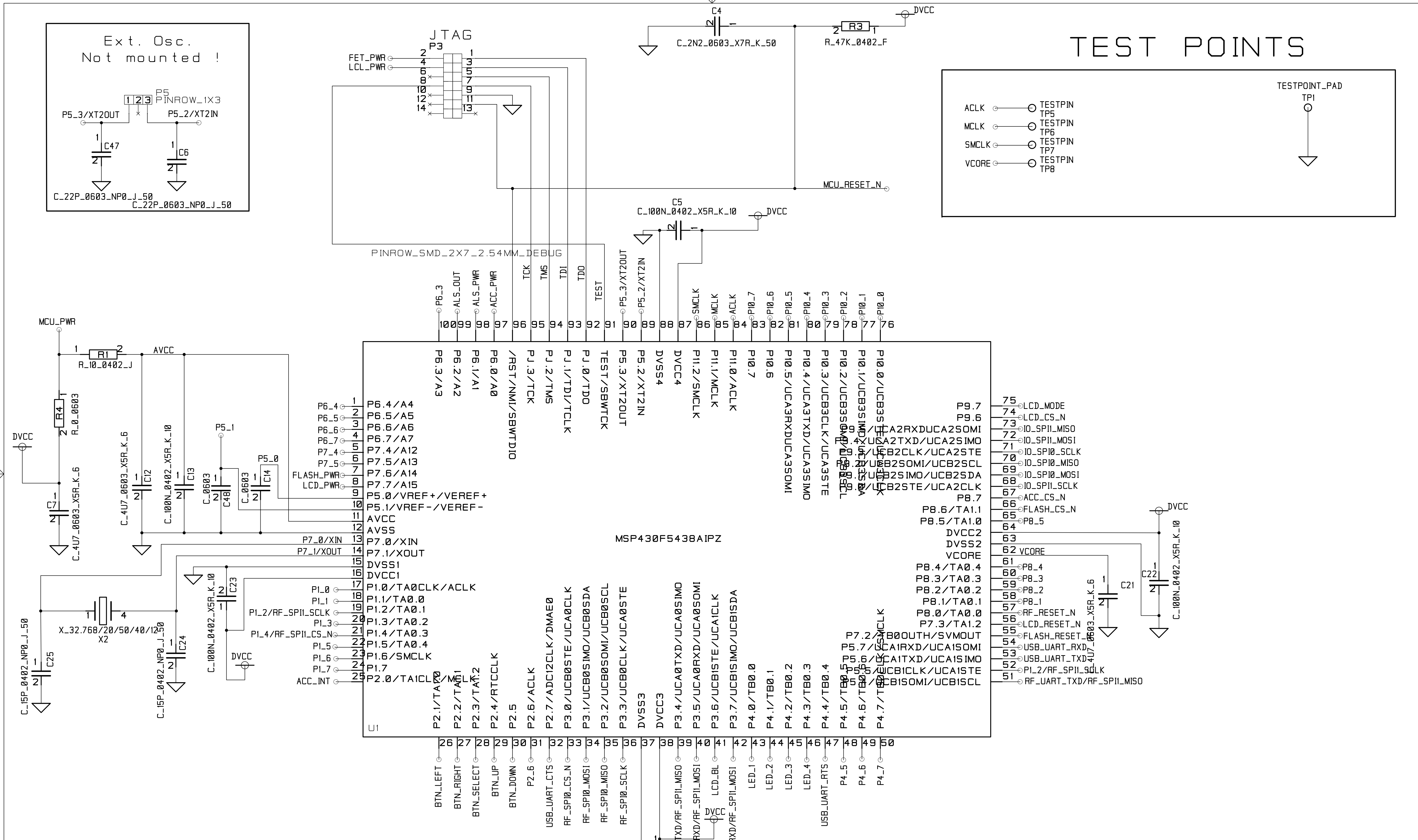
SmartRF TrxEB 1.5.0



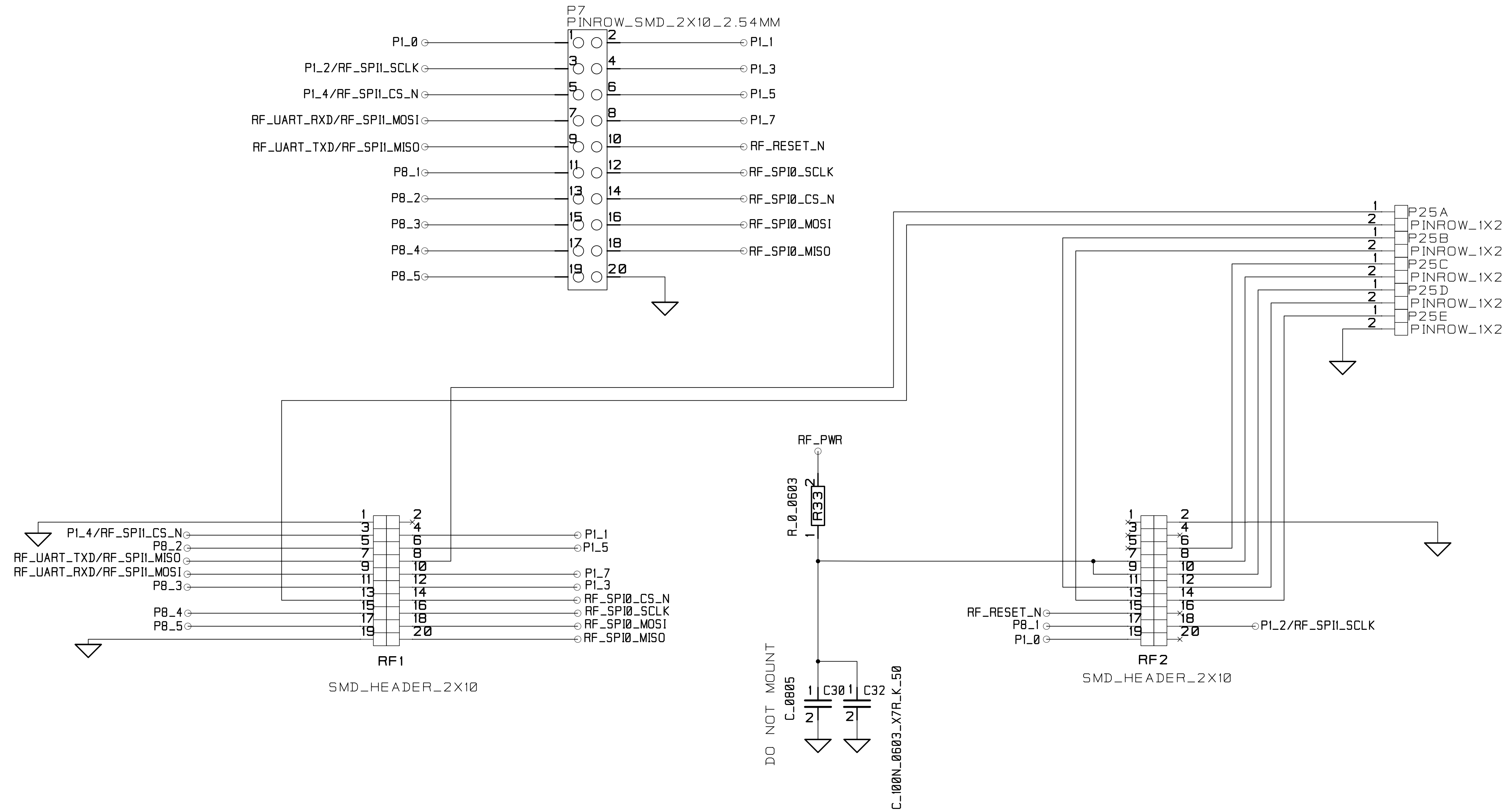
USB Interface
- CC2511
- CC2511 debug
- USB enable switch
- USB mode select switch
- USB port
IO_PWR
USB_VBUS
RF_UART_RXD/RF_SPI1_MOSI
P1_3
USB_UART_RTS
USB_UART_CTS
USB_UART_TXD
USB_UART_RXD
P1_7
MCU_RESET_N
RF_RESET_N
RF_SPI0_CS_N
RF_SPI0_SCLK
RF_SPI0_MOSI
RF_SPI0_MISO
USB_RESET_N
Sheet 2
EXT I/O
P1-P5
P6-P10
Sheet 7
Power Supply
- Power ON/OFF switch
- External power terminals
- Regulators
- Power jumpers
- Batteries
USB_VBUS
LCL_PWR
FET_PWR
RF_PWR
MCU_PWR
IO_PWR
Sheet 3
RF Interface
- RF connection
RF_PWR
P1_4/RF_SPI1_CS_N
P8_2
RF_UART_TXD/RF_SPI1_MISO
RF_UART_RXD/RF_SPI1_MOSI
P8_3
P1_2/RF_SPI1_SCLK
P8_4
P8_5
P1_0
P1_1
P1_5
RF_RESET_N
P1_7
P1_3
RF_SPI0_CS_N
RF_SPI0_SCLK
RF_SPI0_MOSI
RF_SPI0_MISO
Sheet 5
MCU
- MSP430F5438A
- JTAG
- XTAL
FET_PWR
LCL_PWR
MCU_PWR
LCD_PWR
FLASH_PWR
P1_0
P1_1
P1_2/RF_SPI1_SCLK
P1_3
P1_4/RF_SPI1_CS_N
P1_5
P1_6
P1_7
ACC_INT
BTN_LEFT
BTN_RIGHT
BTN_SELECT
BTN_UP
BTN_DOWN
P2_6
USB_UART_CTS
RF_SPI0_CS_N
RF_SPI0_MOSI
RF_SPI0_MISO
RF_SPI0_SCLK
RF_UART_TXD/RF_SPI1_MISO
RF_UART_RXD/RF_SPI1_MOSI
LCD_BL
LED_1
LED_2
LED_3
LED_4
USB_UART_RTS
P4_5
P4_6
P4_7
USB_UART_TXD
USB_UART_RXD
FLASH_RESET_N
LCD_RESET_N
MCU_RESET_N
RF_RESET_N
P8_1
P8_2
P8_3
P8_4
P8_5
FLASH_CS_N
ACC_CS_N
IO_SPI1_SCLK
IO_SPI0_MOSI
IO_SPI0_MISO
IO_SPI0_SCLK
IO_SPI1_MOSI
IO_SPI1_MISO
LCD_CS_N
LCD_MODE
P10_0
P10_1
P10_2
P10_3
P10_4
P10_5
P10_6
P10_7
Sheet 4
User Interface
- LCD
- External Flash
- LEDs
- Buttons (4+1)
- Accelerometer
- Ambient Light Sensor
- Reset buttons
LCD_BL
IO_SPI0_MOSI
IO_SPI0_MISO
IO_SPI0_SCLK
FLASH_CS_N
FLASH_RESET_N
LCD_CS_N
LCD_MODE
LCD_PWR
FLASH_PWR
IO_SPI1_MOSI
IO_SPI1_MISO
IO_SPI1_SCLK
ACC_CS_N
ACC_INT
ALS_PWR
ALS_OUT
MCU_RESET_N
USB_RESET_N
RF_RESET_N
LCD_RESET_N
LED_1
LED_2
LED_3
LED_4
BTN_LEFT
BTN_RIGHT
BTN_SELECT
BTN_UP
BTN_DOWN
Sheet 6
FIDUCIAL_MARK FM1
FIDUCIAL_MARK FM3
FIDUCIAL_MARK FM5
FIDUCIAL_MARK FM4
FIDUCIAL_MARK FM6
FIDUCIAL_MARK FM2
CONTRACT NO.
XXX
COMPANY NAME
TI Norway, LPW
APPROVALS
DATE
DWG
TrxEB Top Level
DRAWN
EIV
OAT
CHECKED
SIZE
A3
FSCM NO.
DWG NO.
REV.
1.5.0
ISSUED
SCALE
SHEET 1(7)


USB SoC Debug
P200
STL21
SMD_2x5_1.27MM
P202
STL21
SMD_2x5_1.27MM
IO_PWR
USB_RESET_N
R_47K_0402_F
R21
R23
R46
R47
S2
S1
USB_ENABLE
USB_MODE
SMD_SWITCH_DPDT
L4
L_BEAD_102_0402
C37
C_2U2_0603_X5R_K_10
C17
C_100N_0402_X5R_K_10
C18
C33
C_220P_0402_NP0_J_50
C35
C36
C34
C16
C_1U_0402_X5R_K_6P3
U3
CC2511
DVDD
DGUARD
AVDD_DREG
DCOUPL
AVDD
P2_0
P2_1
P2_2
RF_UART_RXD/RF_SPI1_MOSI
USB_DBG_DD
USB_DBG_DC
USB_PULLUP
P1_0/LED
P1_1/LED
P1_2
P1_3
P1_4
P1_5
P1_6
P1_7
USB_UART_RTS
USB_UART_CTS
USB_UART_TXD
USB_UART_RXD
RF_P
RF_N
P2_3/XOSC32_Q1
P2_4/XOSC32_Q2
P0_0/ATEST
P0_1
P0_2
P0_3
P0_4
P0_5
MCU_RESET_N
RF_RESET_N
RF_SPI0_CS_N
RF_SPI0_SCLK
RF_SPI0_MOSI
RF_SPI0_MISO
XOSC_Q1
XOSC_Q2
RBIAS
PADP
PADM
RESET_N
GND Exposed
USB LED
R43
R_470_0402_F
D6
LED_EL19-21UYC_A2
TESTPOINT_CIRCLE_40MILS
TP11
TP12
USB_LED
R44
R_56K_0402_F
X1
X_48.000/15/18/60/16
GND
C20
C19
C_33P_0402_NP0_J_50
R22
R_2K7_0402_F
C50
C_1N_0402_NP0_J_50
USB_VBUS
R9
R_1K5_0402_G
P12
USB-B_MICRO
VBUS
D-
D+
ID
GND
Shield
Shield
R_33_0402_G
R12
R11
C2
C3
C_47P_0402_NP0_J_50
CONTRACT NO.
XXX
COMPANY NAME
TI Norway, LPW
APPROVALS
DATE
DWG
USB Interface
DRAWN
EIV
OAT
CHECKED
SIZE
A3
FSCM NO.
DWG NO.
REV.
1.5.0
ISSUED
SCALE
SHEET
2(7)


VBAT
R_0603
R70
Do Not Mount
R_1M0_0603_J
R68
R_180K_0603_G
R69
R_1M0_0402_F
R45
U4
TPS63000
FB Vout
GND L2
VINA PGND
PS L1
EN Vin
Thermal
MAX 1200mA
L1
LPS3015-222ML
2.2uH
R_0_0603
R34
C_4U7_0805_X5R_K_25
C9
C38
C_100N_0402_X5R_K_10
C10
C_4U7_0805_X5R_K_25
C11
C_10U_0805_X5R_K_10
TPS63000 Feedback :
R68 - 1M0, R69 - 180K
TPS63001 Feedback :
R68 - 0, R69 - Not Mounted
RF_PWR jumper
1_In
2_Out
RF_PWR
PINROW_SMD_1X2_2.54MM
P15
MCU_PWR jumper
MCU_PWR
P13
IO_PWR jumper
PWR1
IO_PWR
P10
Power On/Off
S5
SMD_SWITCH_DPDT
VBAT
EXTERNAL POWER
PINROW_SMD_2X5_2.54MM
2PIN_SMD_TERMINAL_BLOCK
P201
P17
VBAT_REG
VUSB_REG
VEXT
FET_PWR
LCL_PWR
USB POWER
USB_VBUS
U2
TPS7A4501
In Out
SHDN ADJ
Gnd Gnd
C1
C_10U_0805_X5R_K_16
R63
R_6K2_0603_G
R64
R_3K6_0603_G
C8
C_10U_0805_X5R_K_10
Battery
1XAA_1_5V
B3
B4
Power Jumper Settings:
Battery : 1-2 & 9-10
USB : 3-4 & 9-10
EXTERNAL: 5-6 & 9-10
FET_PWR : 7-8, (Disconnect 9-10)
CONTRACT NO.
XXX
COMPANY NAME
TI Norway, LPW
APPROVALS
DATE
DWG
Power Supply
DRAWN
EIV
OAT
CHECKED
SIZE
A3
FSCM NO.
DWG NO.
REV.
1.5.0
ISSUED
SCALE
SHEET
3(7)



CONTRACT NO. XXX		COMPANY NAME TI Norway, LPW		
APPROVALS	DATE	DWG Application MCU		
DRAWN	EIV OAT			
CHECKED		SIZE A3	FSCM NO.	DWG NO. / REV. 1.5.0
ISSUED		SCALE		SHEET 4(7)

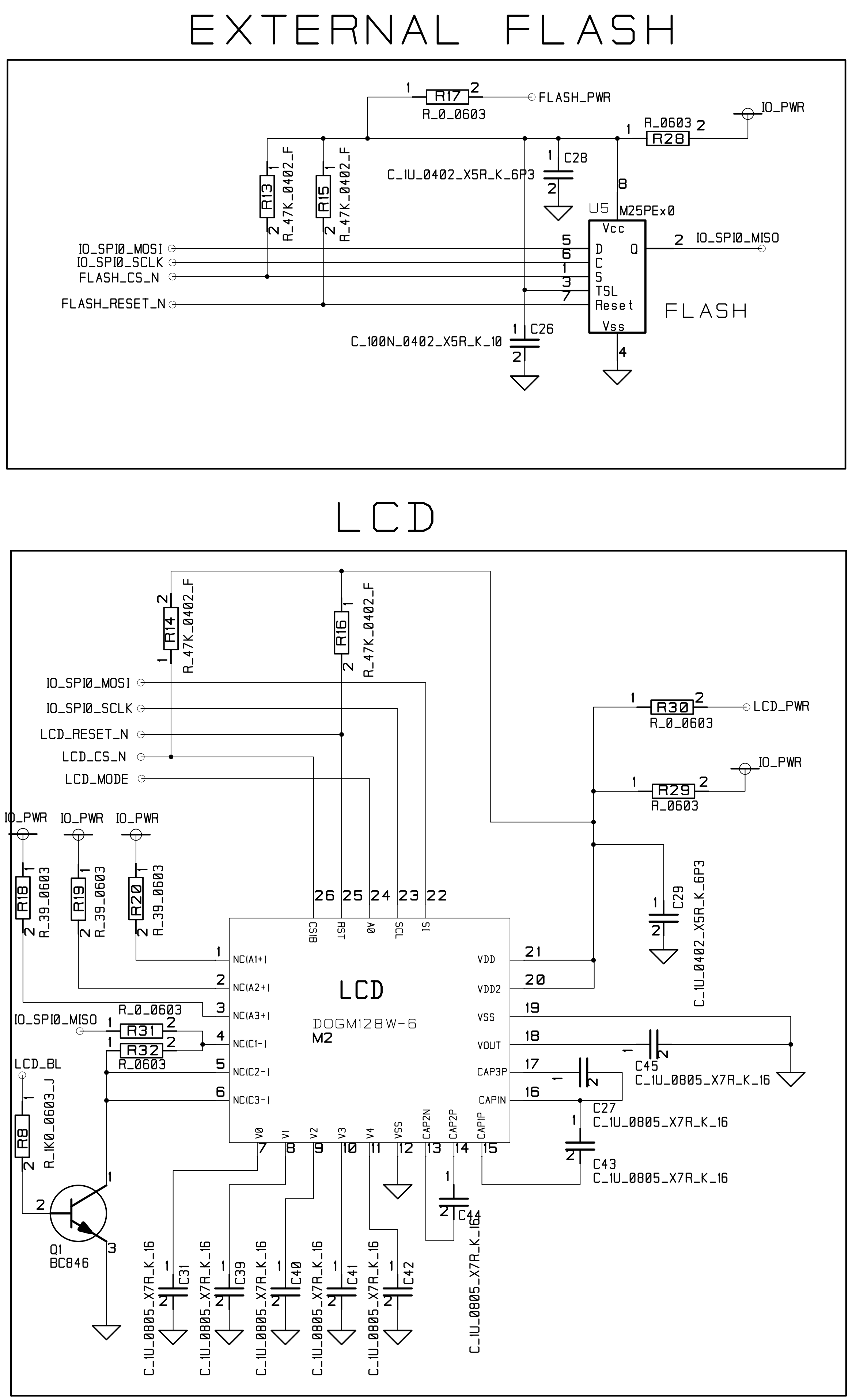


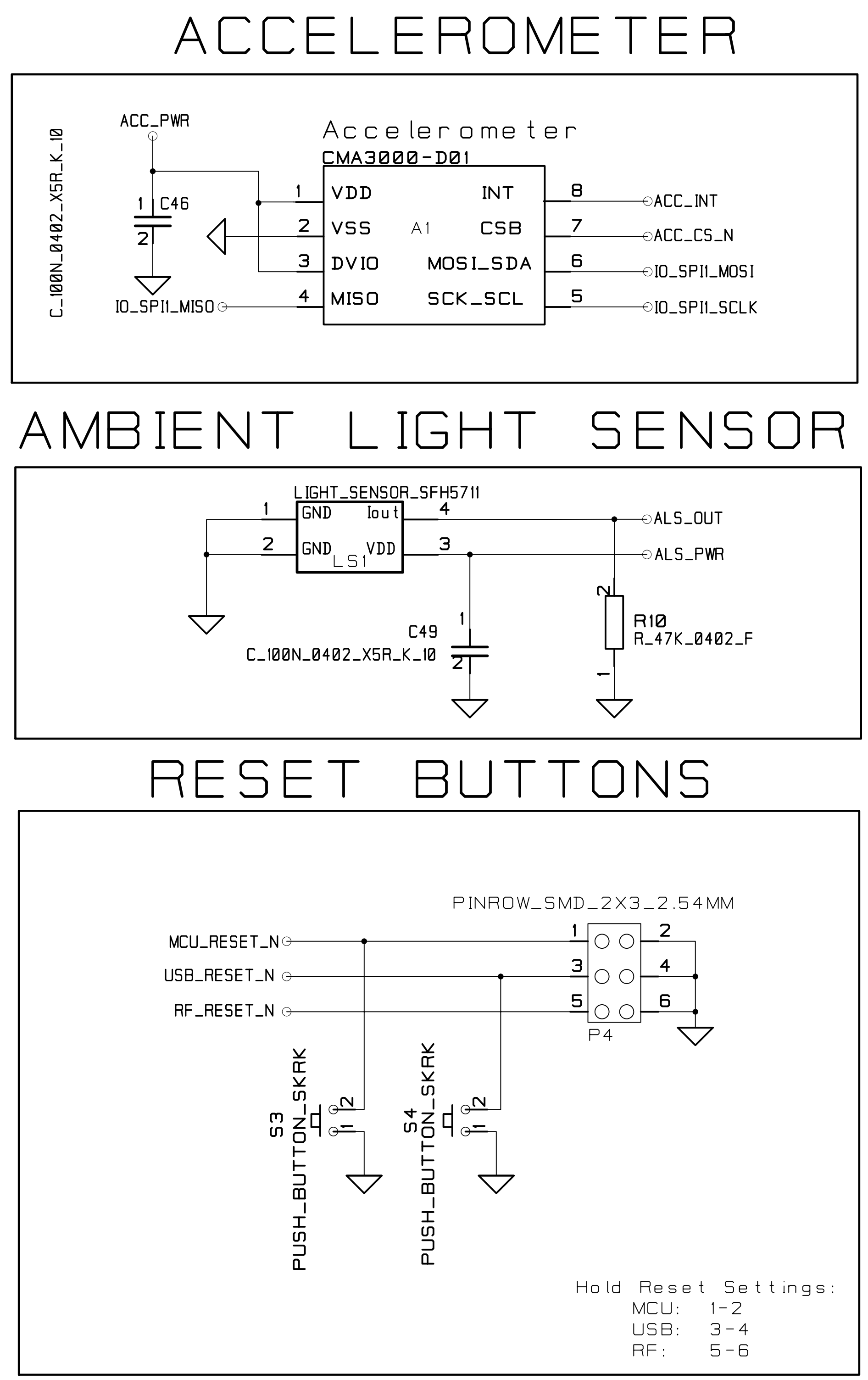
Connectors RF1 and RF2 are SMD,
2x10 pin row headers with 0.05 spacing.
P/N TFM-110-02-SM-D-A-K, produced by Samtec.

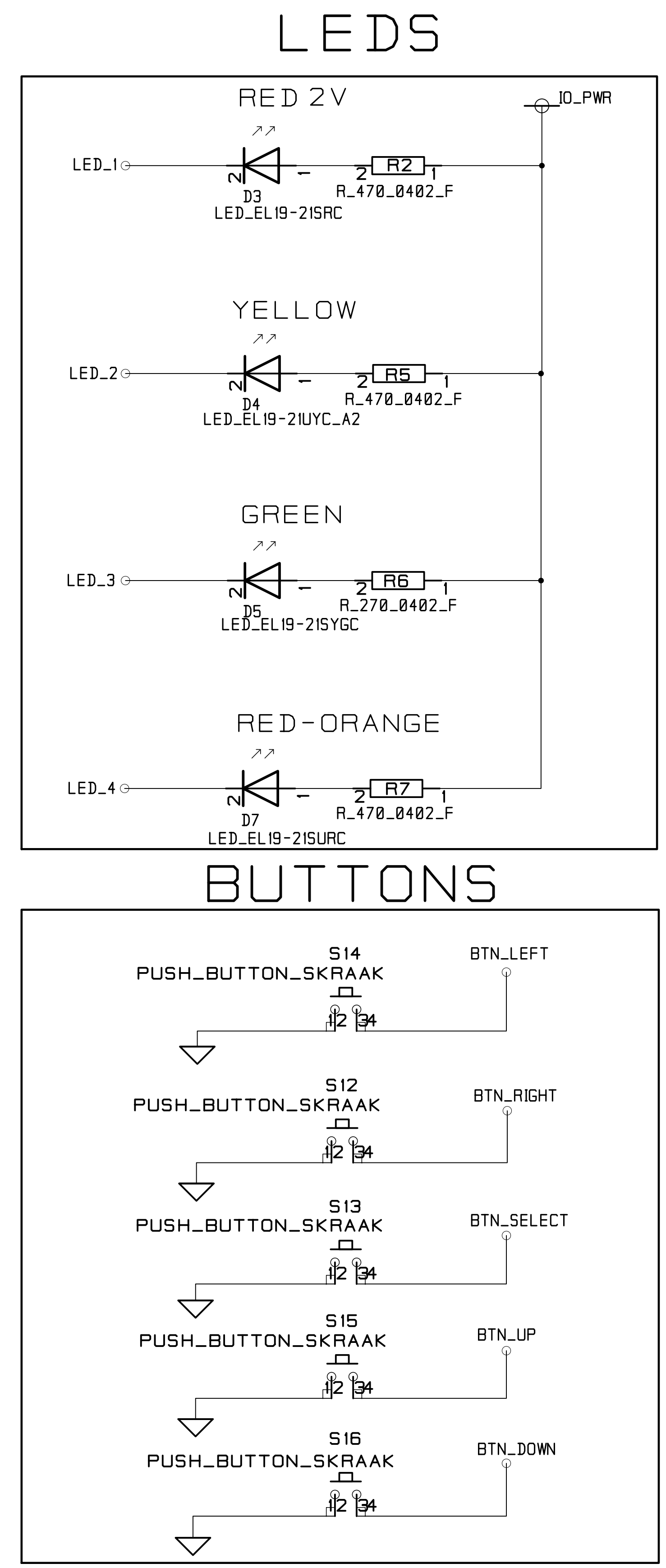
The matching connector used on RF
evaluation modules are SFM-110-02-SM-D-A-K.

The distance between RF1 and RF2 is 1200 mils
(center to center).

CONTRACT NO. XXX		COMPANY NAME TI Norway, LPW			
APPROVALS	DATE	DWG EM Interface			
DRAWN	EIV OAT				
CHECKED		SIZE A3	FSCM NO.	DWG NO.	REV. 1.5.0
ISSUED		SCALE			SHEET 5(7)



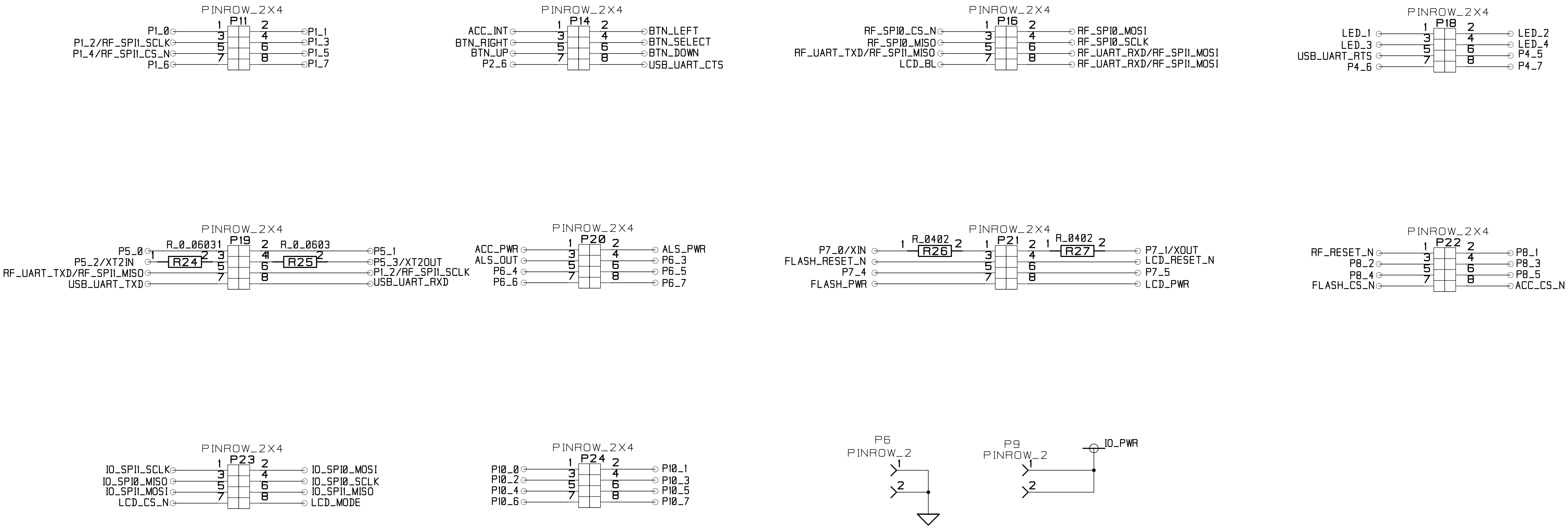




Q1,R8,R18,R19 and R20 Not Mounted when Backlight module (EA LED55x46) is not used, by default there will be no backlight module.

CONTRACT NO. XXX		COMPANY NAME TI Norway, LPW			
APPROVALS	DATE	DWG User Interface			
DRAWN	EIV OAT				
CHECKED		SIZE A3	FSCM NO.	DWG NO.	REV. 1.5.0
ISSUED		SCALE		SHEET 6(7)	

EXTERNAL I/O

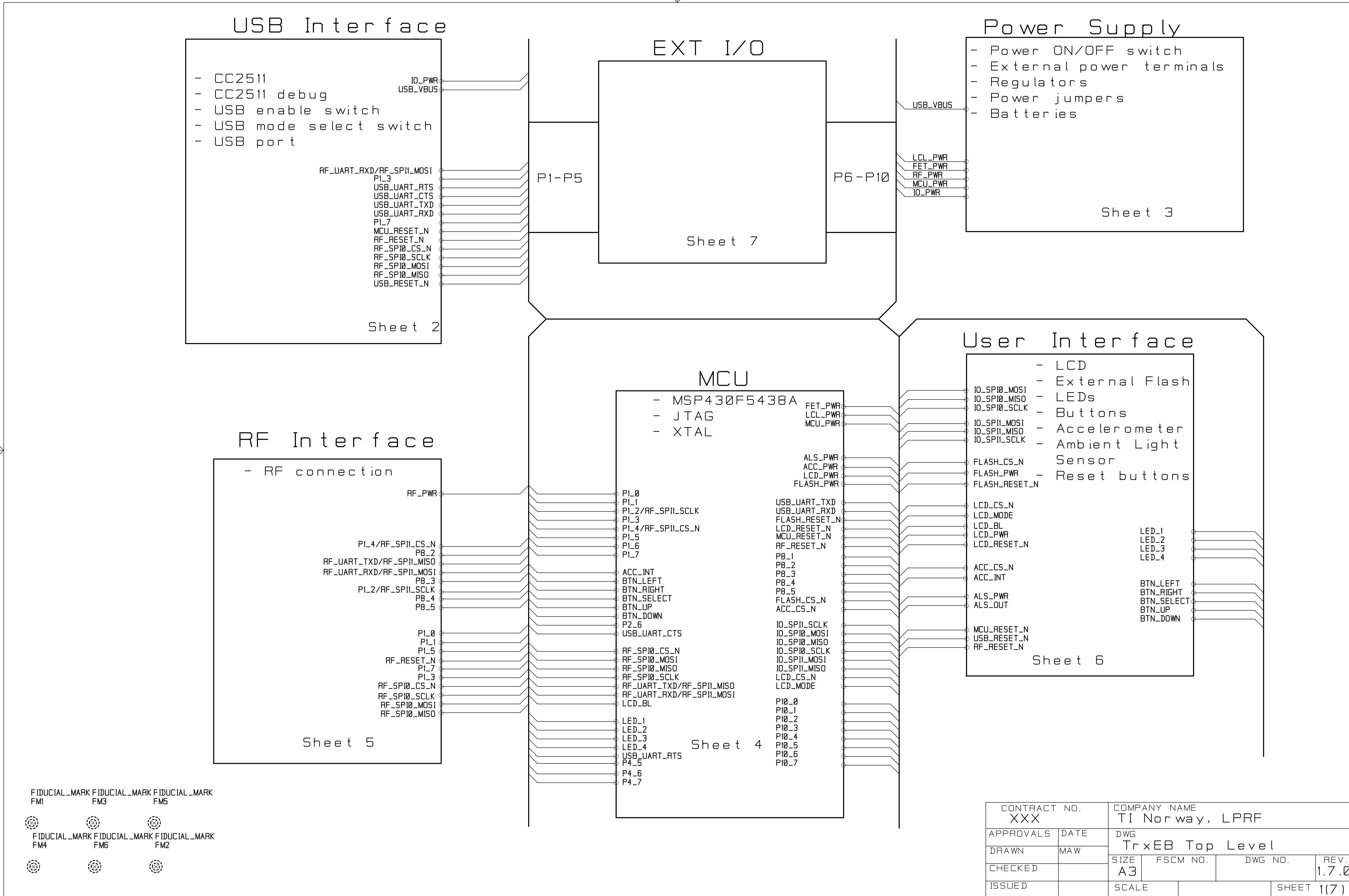


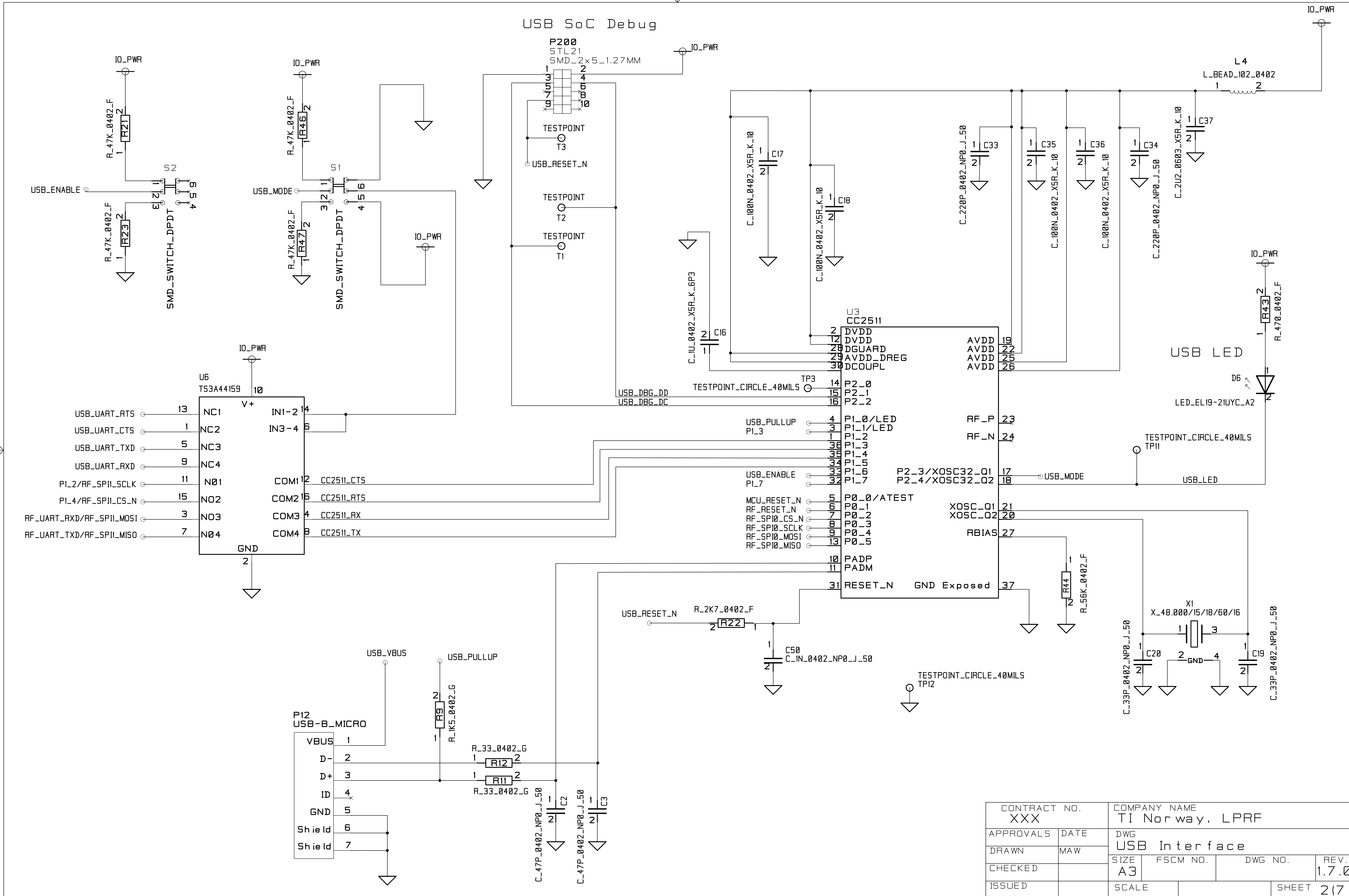
CONTRACT NO. XXX		COMPANY NAME TI Norway, LPW			
APPROVALS	DATE	DWG			
DRAWN	EIV OAT	SIZE A3	FSCM NO.	DWG NO.	REV. 1.5.0
CHECKED					
ISSUED		SCALE			SHEET 7(7)

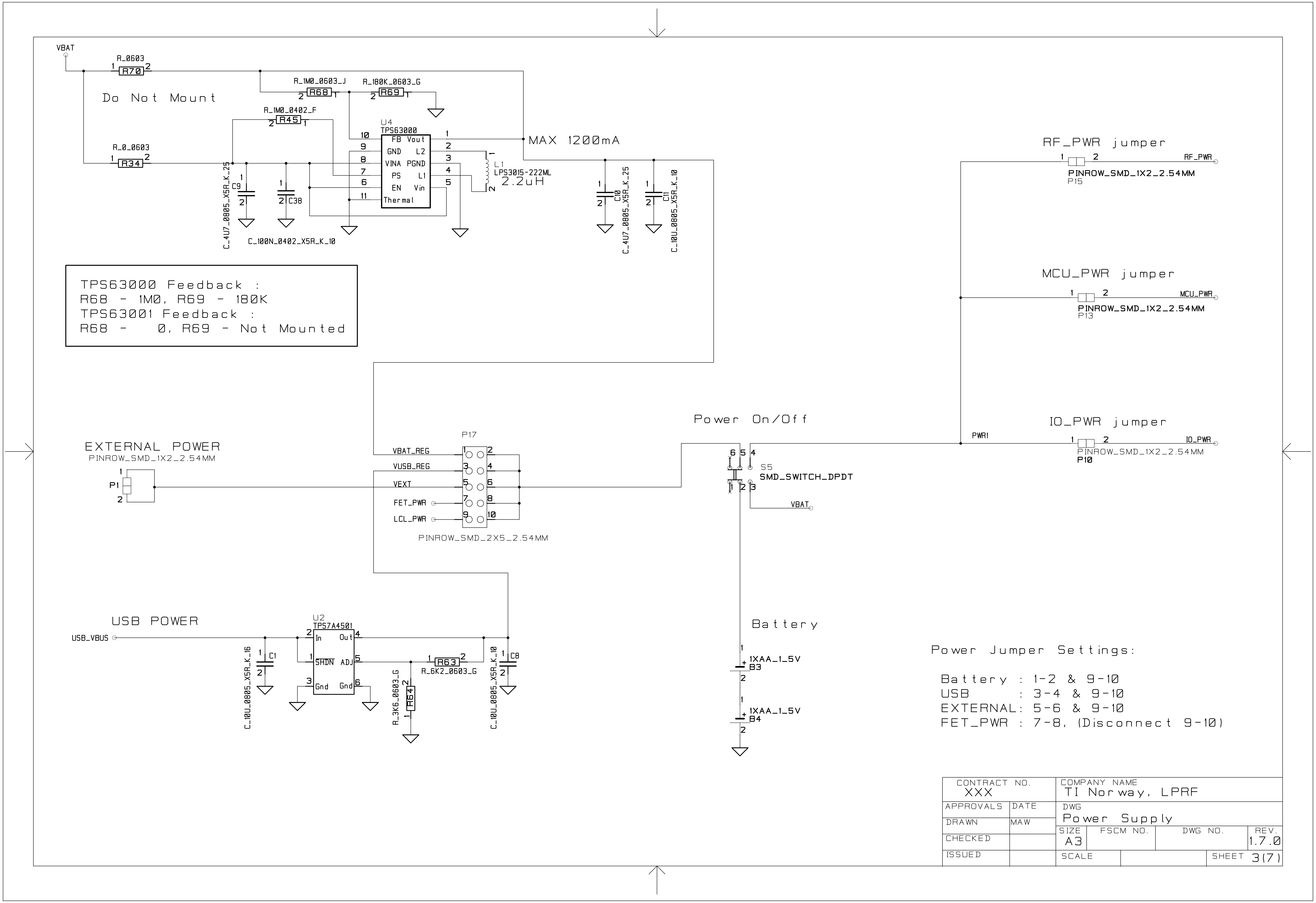
Appendix C

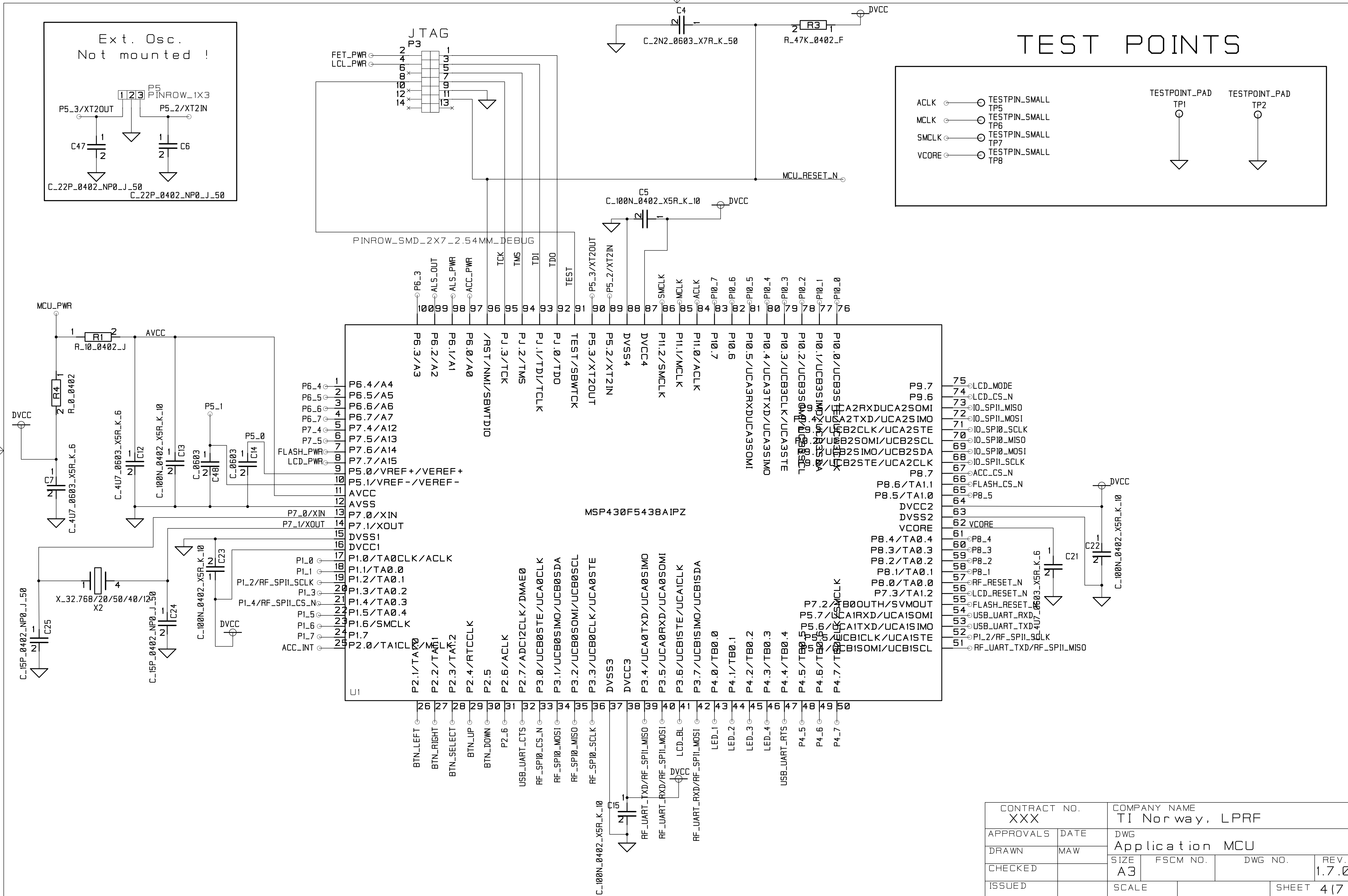
Schematics

SmartRF TrxEB 1.7.0

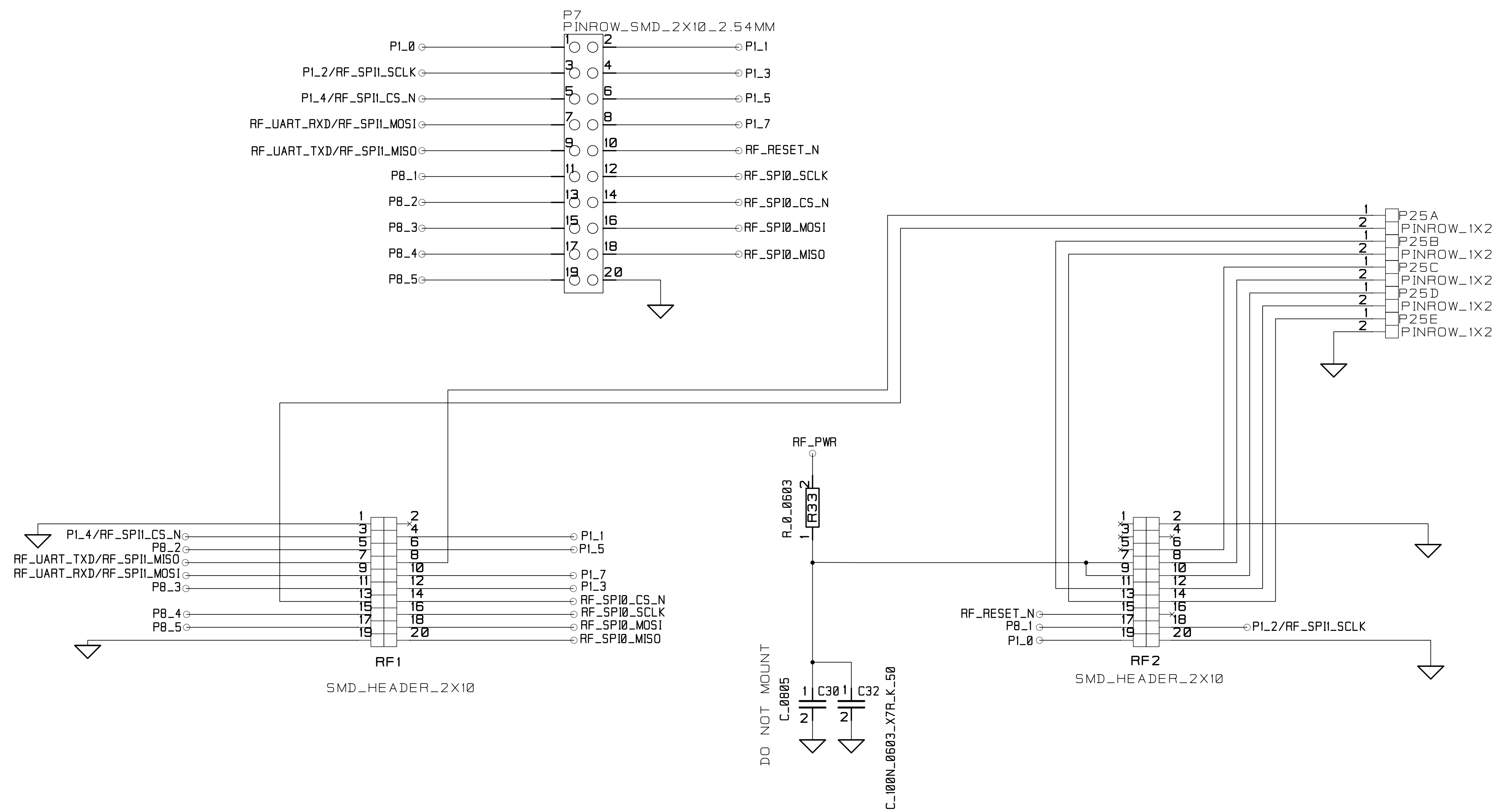

USB Interface
- CC2511
- CC2511 debug
- USB enable switch
- USB mode select switch
- USB port
IO_PWR
USB_VBUS
RF_UART_RXD/RF_SPI1_MOSI
P1_3
USB_UART_RTS
USB_UART_CTS
USB_UART_TXD
USB_UART_RXD
P1_7
MCU_RESET_N
RF_RESET_N
RF_SPI0_CS_N
RF_SPI0_SCLK
RF_SPI0_MOSI
RF_SPI0_MISO
USB_RESET_N
Sheet 2
EXT I/O
P1-P5
P6-P10
Sheet 7
Power Supply
- Power ON/OFF switch
- External power terminals
- Regulators
- Power jumpers
- Batteries
USB_VBUS
LCL_PWR
FET_PWR
RF_PWR
MCU_PWR
IO_PWR
Sheet 3
RF Interface
- RF connection
RF_PWR
P1_4/RF_SPI1_CS_N
P8_2
RF_UART_TXD/RF_SPI1_MISO
RF_UART_RXD/RF_SPI1_MOSI
P8_3
P1_2/RF_SPI1_SCLK
P8_4
P8_5
P1_0
P1_1
P1_5
RF_RESET_N
P1_7
P1_3
RF_SPI0_CS_N
RF_SPI0_SCLK
RF_SPI0_MOSI
RF_SPI0_MISO
Sheet 5
MCU
- MSP430F5438A
- JTAG
- XTAL
P1_0
P1_1
P1_2/RF_SPI1_SCLK
P1_3
P1_4/RF_SPI1_CS_N
P1_5
P1_6
P1_7
ACC_INT
BTN_LEFT
BTN_RIGHT
BTN_SELECT
BTN_UP
BTN_DOWN
P2_6
USB_UART_CTS
RF_SPI0_CS_N
RF_SPI0_MOSI
RF_SPI0_MISO
RF_SPI0_SCLK
RF_UART_TXD/RF_SPI1_MISO
RF_UART_RXD/RF_SPI1_MOSI
LCD_BL
LED_1
LED_2
LED_3
LED_4
USB_UART_RTS
P4_5
P4_6
P4_7
FET_PWR
LCL_PWR
MCU_PWR
ALS_PWR
ACC_PWR
LCD_PWR
FLASH_PWR
USB_UART_TXD
USB_UART_RXD
FLASH_RESET_N
LCD_RESET_N
MCU_RESET_N
RF_RESET_N
P8_1
P8_2
P8_3
P8_4
P8_5
FLASH_CS_N
ACC_CS_N
IO_SPI1_SCLK
IO_SPI0_MOSI
IO_SPI0_MISO
IO_SPI0_SCLK
IO_SPI1_MOSI
IO_SPI1_MISO
LCD_CS_N
LCD_MODE
P10_0
P10_1
P10_2
P10_3
P10_4
P10_5
P10_6
P10_7
Sheet 4
User Interface
- LCD
- External Flash
- LEDs
- Buttons
- Accelerometer
- Ambient Light Sensor
- Reset buttons
IO_SPI0_MOSI
IO_SPI0_MISO
IO_SPI0_SCLK
IO_SPI1_MOSI
IO_SPI1_MISO
IO_SPI1_SCLK
FLASH_CS_N
FLASH_PWR
FLASH_RESET_N
LCD_CS_N
LCD_MODE
LCD_BL
LCD_PWR
LCD_RESET_N
ACC_CS_N
ACC_INT
ALS_PWR
ALS_OUT
MCU_RESET_N
USB_RESET_N
RF_RESET_N
LED_1
LED_2
LED_3
LED_4
BTN_LEFT
BTN_RIGHT
BTN_SELECT
BTN_UP
BTN_DOWN
Sheet 6
FIDUCIAL_MARK FM1
FIDUCIAL_MARK FM3
FIDUCIAL_MARK FM5
FIDUCIAL_MARK FM4
FIDUCIAL_MARK FM6
FIDUCIAL_MARK FM2
CONTRACT NO. XXX
COMPANY NAME TI Norway, LPRF
APPROVALS DATE
DRAWN MAW
CHECKED
ISSUED
DWG TrxEB Top Level
SIZE A3
FSCM NO.
DWG NO.
REV. 1.7.0
SCALE
SHEET 1(7)


USB SoC Debug
P200
STL21
SMD_2x5_1.27MM
IO_PWR
TESTPOINT
T3
USB_RESET_N
TESTPOINT
T2
TESTPOINT
T1
R21
R_47K_0402_F
R23
R_47K_0402_F
S2
SMD_SWITCH_DPDT
USB_ENABLE
R46
R_47K_0402_F
R47
R_47K_0402_F
S1
SMD_SWITCH_DPDT
USB_MODE
L4
L_BEAD_102_0402
C37
C_2U2_0603_X5R_K_10
C17
C_100N_0402_X5R_K_10
C18
C_100N_0402_X5R_K_10
C33
C_220P_0402_NP0_J_50
C35
C_100N_0402_X5R_K_10
C36
C_100N_0402_X5R_K_10
C34
C_220P_0402_NP0_J_50
C16
C_1U_0402_X5R_K_6P3
U3
CC2511
DVDD
DVDD
DGUARD
AVDD_DREG
DCOUPL
AVDD
AVDD
AVDD
AVDD
P2_0
P2_1
P2_2
P1_0/LED
P1_1/LED
P1_2
P1_3
P1_4
P1_5
P1_6
P1_7
P0_0/ATEST
P0_1
P0_2
P0_3
P0_4
P0_5
PADP
PADM
RESET_N
GND Exposed
RF_P
RF_N
P2_3/XOSC32_Q1
P2_4/XOSC32_Q2
XOSC_Q1
XOSC_Q2
RBIAS
TESTPOINT_CIRCLE_40MILS
TP3
USB_DBG_DD
USB_DBG_DC
USB_PULLUP
P1_3
USB_ENABLE
P1_7
MCU_RESET_N
RF_RESET_N
RF_SPI0_CS_N
RF_SPI0_SCLK
RF_SPI0_MOSI
RF_SPI0_MISO
USB LED
IO_PWR
R43
R_470_0402_F
D6
LED_EL19-21UYC_A2
TESTPOINT_CIRCLE_40MILS
TP11
USB_MODE
USB_LED
R44
R_56K_0402_F
X1
X_48.000/15/10/60/16
GND
C20
C_33P_0402_NP0_J_50
C19
C_33P_0402_NP0_J_50
U6
TS3A44159
V+
NC1
NC2
NC3
NC4
NO1
NO2
NO3
NO4
IN1-2
IN3-4
COM1
COM2
COM3
COM4
GND
USB_UART_RTS
USB_UART_CTS
USB_UART_TXD
USB_UART_RXD
P1_2/RF_SPI1_SCLK
P1_4/RF_SPI1_CS_N
RF_UART_RXD/RF_SPI1_MOSI
RF_UART_TXD/RF_SPI1_MISO
CC2511_CTS
CC2511_RTS
CC2511_RX
CC2511_TX
USB_RESET_N
R_2K7_0402_F
R22
C50
C_1N_0402_NP0_J_50
TESTPOINT_CIRCLE_40MILS
TP12
USB_VBUS
USB_PULLUP
R9
R_1K5_0402_G
P12
USB-B_MICRO
VBUS
D-
D+
ID
GND
Shield
Shield
R_33_0402_G
R12
R11
R_33_0402_G
C2
C_47P_0402_NP0_J_50
C3
C_47P_0402_NP0_J_50
CONTRACT NO.
XXX
COMPANY NAME
TI Norway, LPRF
APPROVALS
DATE
DWG
USB Interface
DRAWN
MAW
CHECKED
SIZE
A3
FSCM NO.
DWG NO.
REV.
1.7.0
ISSUED
SCALE
SHEET
2(7)


VBAT
R_0603
R70
Do Not Mount
R_1M0_0603_J
R68
R_180K_0603_G
R69
R_1M0_0402_F
R45
U4
TPS63000
FB Vout
GND L2
VINA PGND
PS L1
EN Vin
Thermal
MAX 1200mA
L1
LPS3015-222ML
2.2uH
R_0_0603
R34
C9
C38
C_4U7_0805_X5R_K_25
C_100N_0402_X5R_K_10
C10
C11
C_4U7_0805_X5R_K_25
C_10U_0805_X5R_K_10
TPS63000 Feedback :
R68 - 1M0, R69 - 180K
TPS63001 Feedback :
R68 - 0, R69 - Not Mounted
RF_PWR jumper
RF_PWR
PINROW_SMD_1X2_2.54MM
P15
MCU_PWR jumper
MCU_PWR
PINROW_SMD_1X2_2.54MM
P13
IO_PWR jumper
PWR1
IO_PWR
PINROW_SMD_1X2_2.54MM
P10
Power On/Off
S5
SMD_SWITCH_DPDT
VBAT
EXTERNAL POWER
PINROW_SMD_1X2_2.54MM
P1
P17
VBAT_REG
VUSB_REG
VEXT
FET_PWR
LCL_PWR
PINROW_SMD_2X5_2.54MM
USB POWER
USB_VBUS
U2
TPS7A4501
In Out
SHDN ADJ
Gnd Gnd
C1
C_10U_0805_X5R_K_16
R63
R_6K2_0603_G
R64
R_3K6_0603_G
C8
C_10U_0805_X5R_K_10
Battery
1XAA_1_5V
B3
1XAA_1_5V
B4
Power Jumper Settings:
Battery : 1-2 & 9-10
USB : 3-4 & 9-10
EXTERNAL: 5-6 & 9-10
FET_PWR : 7-8, (Disconnect 9-10)
CONTRACT NO.
XXX
COMPANY NAME
TI Norway, LPRF
APPROVALS DATE
DWG
DRAWN MAW
Power Supply
CHECKED
SIZE A3
FSCM NO.
DWG NO.
REV. 1.7.0
ISSUED
SCALE
SHEET 3(7)



Ext. Osc.
Not mounted !
P5
PINROW_1X3
P5_3/XT2OUT
P5_2/XT2IN
C47
C6
C_22P_0402_NP0_J_50
C_22P_0402_NP0_J_50
JTAG
P3
FET_PWR
LCL_PWR
PINROW_SMD_2X7_2.54MM_DEBUG
C4
C_2N2_0603_X7R_K_50
R3
R_47K_0402_F
DVCC
MCU_RESET_N
C5
C_100N_0402_X5R_K_10
TEST POINTS
ACLK
MCLK
SMCLK
VCORE
TESTPIN_SMALL
TP5
TP6
TP7
TP8
TESTPOINT_PAD
TP1
TP2
MCU_PWR
R1
R_10_0402_J
AVCC
R4
R_0_0402
C7
C_4U7_0603_X5R_K_6
C12
C13
C_100N_0402_X5R_K_10
P5_1
P5_0
C48
C14
C_0603
FLASH_PWR
LCD_PWR
P7_0/XIN
P7_1/XOUT
X2
X_32.768/20/50/40/12
C25
C24
C_15P_0402_NP0_J_50
C23
ACC_INT
MSP430F5438AIPZ
U1
C15
C21
C22
C_4U7_0603_X5R_K_6
C_100N_0402_X5R_K_10
CONTRACT NO.
XXX
COMPANY NAME
TI Norway, LPRF
APPROVALS
DATE
DWG
Application MCU
DRAWN
MAW
CHECKED
SIZE
A3
FSCM NO.
DWG NO.
REV.
1.7.0
ISSUED
SCALE
SHEET
4(7)



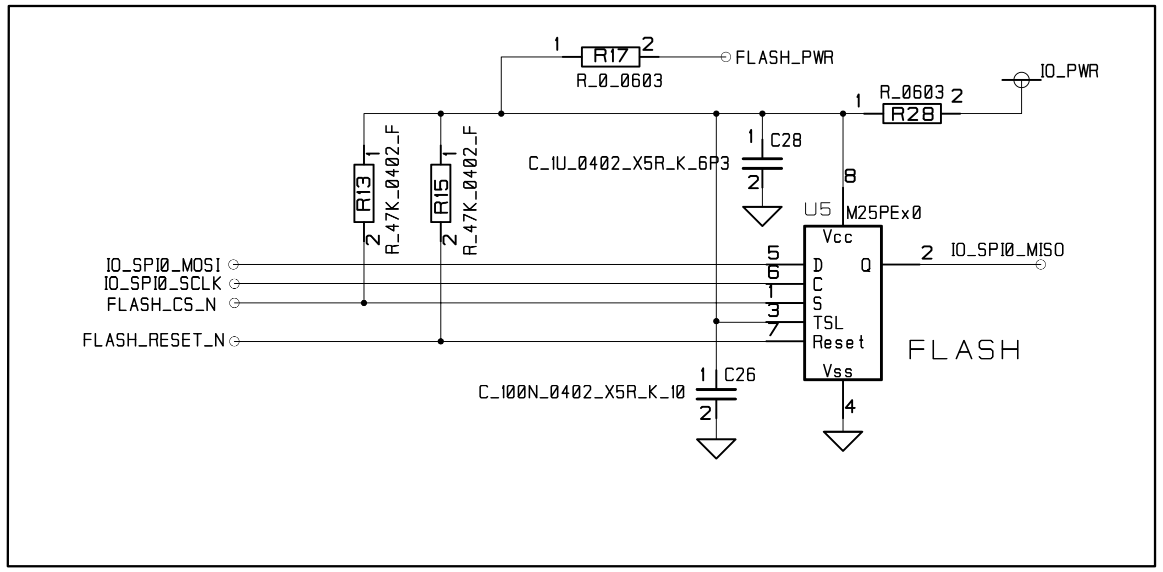
Connectors RF1 and RF2 are SMD,
2x10 pin row headers with 0.05 spacing.
P/N TFM-110-02-SM-D-A-K, produced by Samtec.

The matching connector used on RF
evaluation modules are SFM-110-02-SM-D-A-K.

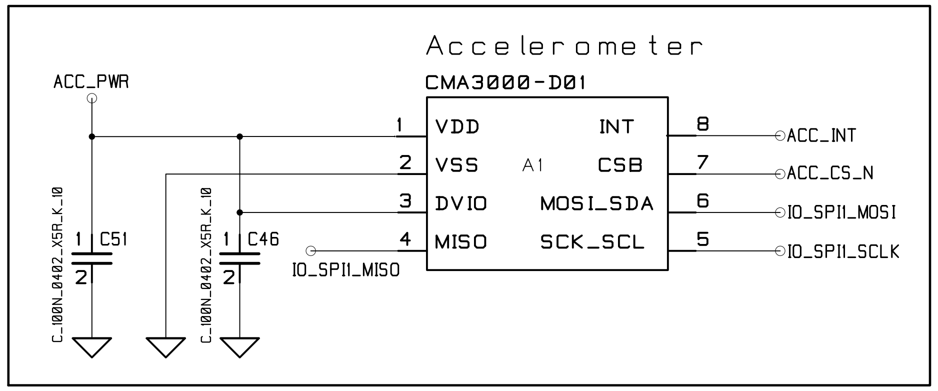
The distance between RF1 and RF2 is 1200 mils
(center to center).

CONTRACT NO. XXX		COMPANY NAME TI Norway, LPRF			
APPROVALS	DATE	DWG EM Interface			
DRAWN	MAW				
CHECKED		SIZE A3	FSCM NO.	DWG NO.	REV. 1.7.0
ISSUED		SCALE		SHEET	5(7)

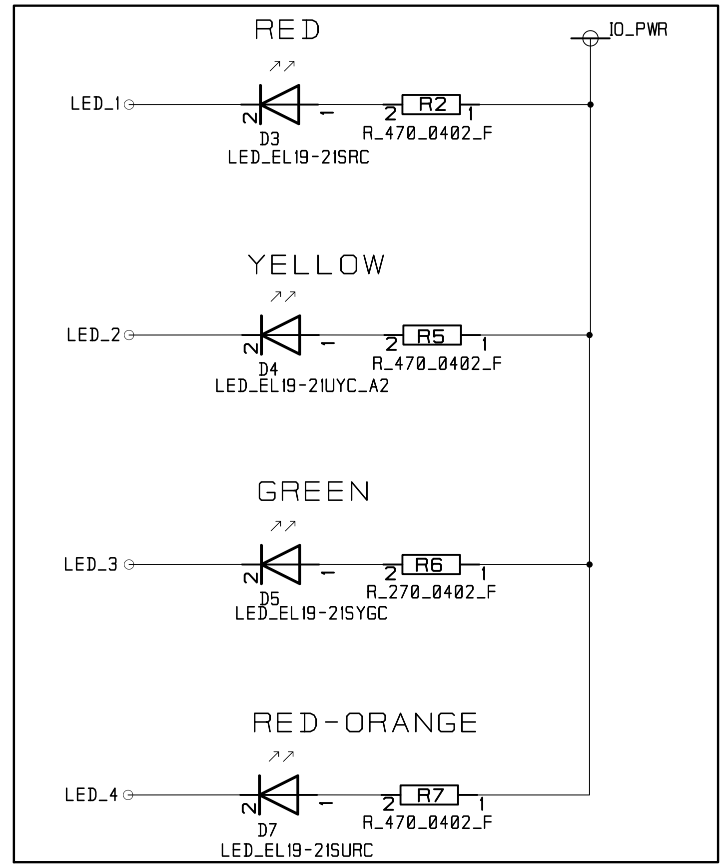
EXTERNAL FLASH



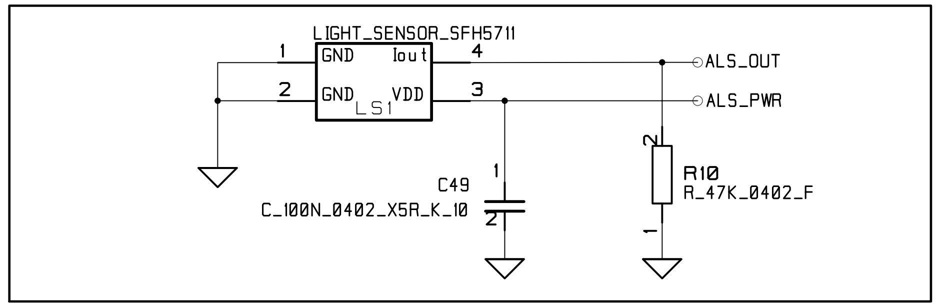
ACCELEROMETER



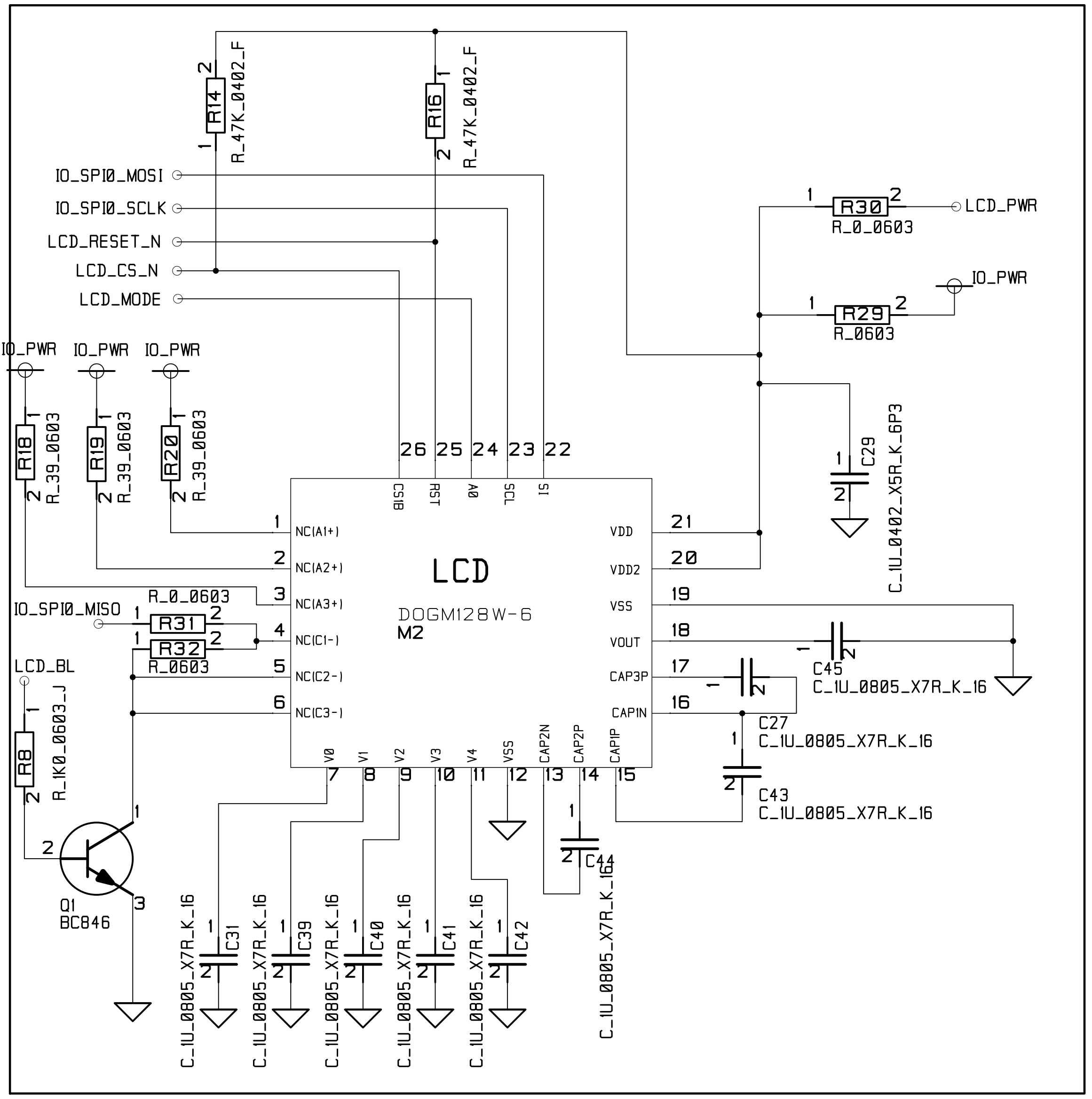
LEDS



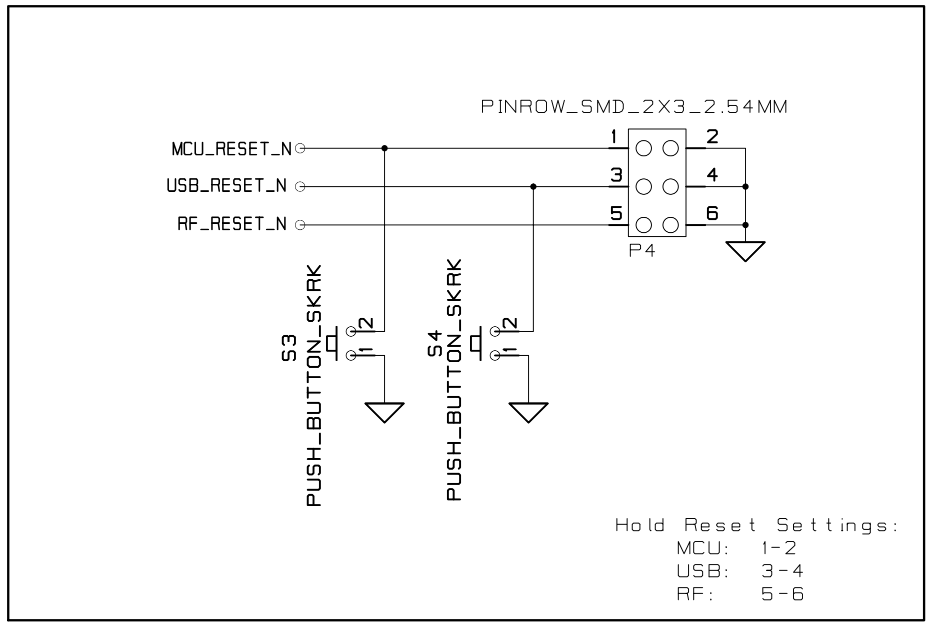
AMBIENT LIGHT SENSOR



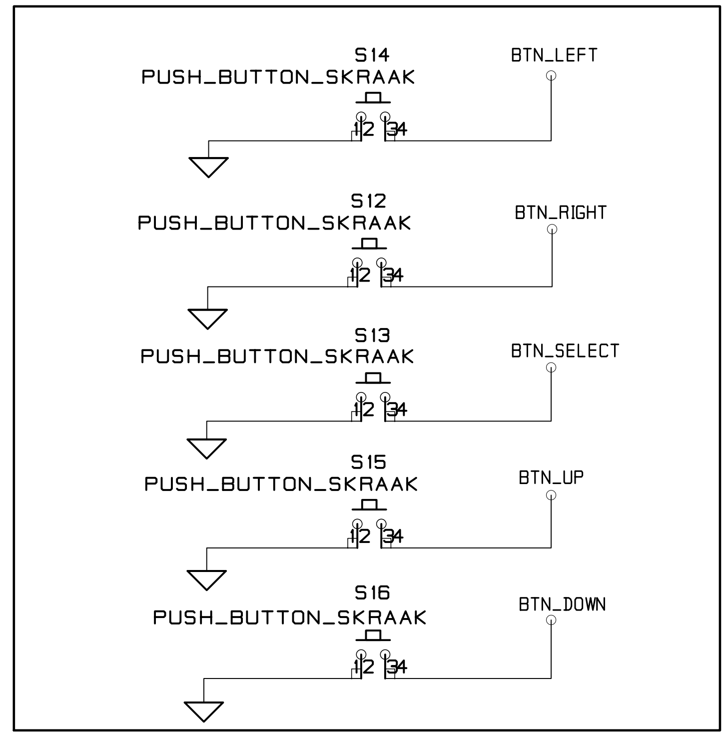
LCD



RESET BUTTONS



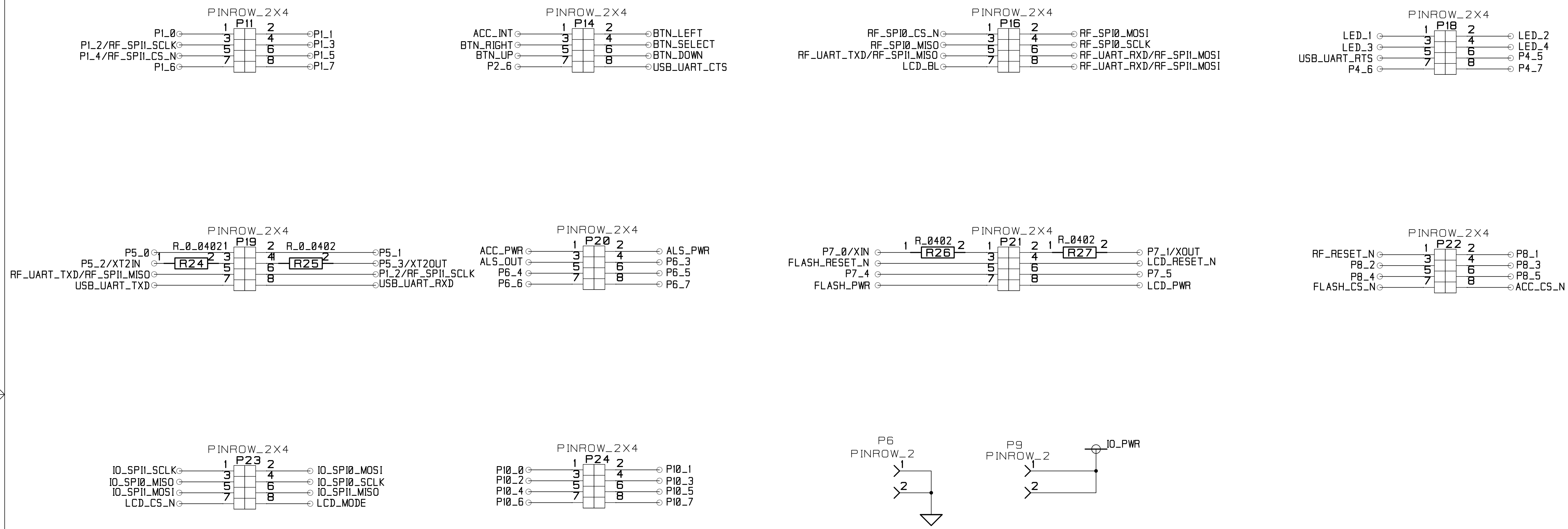
BUTTONS



Q1,R8,R18,R19 and R20 Not Mounted when Backlight module (EA LED55x46) is not used, by default there will be no backlight module.

CONTRACT NO. XXX		COMPANY NAME TI Norway, LPRF			
APPROVALS	DATE	DWG User Interface			
DRAWN	MAW	SIZE A3	FSCM NO.	DWG NO.	REV. 1.7.0
CHECKED					
ISSUED		SCALE		SHEET 6(7)	

EXTERNAL I/O



CONTRACT NO. XXX	COMPANY NAME TI Norway, LPRF			
APPROVALS / DATE	DWG			
DRAWN / MAW				
CHECKED	SIZE A3	FSCM NO.	DWG NO.	REV. 1.7.0
ISSUED	SCALE		SHEET 7(7)	

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OMAP Mobile Processors	www.ti.com/omap		
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