CC2520 Development Kit

User's Guide

swru138

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1 Introduction

Thank you for purchasing a CC2520 Development Kit.

The CC2520 is Texas Instrument's second generation ZigBee/IEEE 802.15.4 RF transceiver for the 2.4 GHz unlicensed ISM band. This chip enables industrial grade applications by offering state-of-the-art noise immunity, excellent link budget, operation up to 125 degrees and low voltage operation.

In addition, the CC2520 provides extensive hardware support for packet handling, data buffering, burst transmissions, data encryption, data authentication, clear channel assessment, link quality indication and packet timing information. These features reduce the load on the host controller.

The CC2520 Development Kit includes all the necessary hardware in order to properly evaluate, demonstrate, prototype and develop software targeting not only 802.15.4 or ZigBee compliant applications, but also proprietary applications requiring a DSSS radio.

Make sure to subscribe to the Low-Power RF eNewsletter to receive information about updates to documentation, new product releases and more. Sign up on the Texas Instruments Low Power Wireless web site www.ti.com/lpw.

2 About this manual

This manual contains reference information about the hardware components of the CC2520 Development Kit.

Chapter 4 will briefly describe the contents of the development kit and chapter 5 will give a quick introduction to how to get started with the kit. In particular, it describes how to install SmartRF Studio to get the required drivers for the evaluation board, how the hardware can be used and mentions the software that is available for the development kit. Chapter 6 explains some simple methods for performing practical RF testing with the development kit. Chapter 7, 8 and 9 describe in detail the hardware that can be found in the kit. A troubleshooting guide can be found in chapter 10. Appendix A and B contain the schematics for the SmartRF05EB and CCMSP-EM430F2618 respectively.

The CC2520DK Quick Start Guide (www.ti.com/lit/swru139) has a short tutorial on how to get started with the kit. The CC2520 Software User's Guide (www.ti.com/lit/swru137) has details about the software examples and information about other software options for the CC2520.

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

Please visit the kit web page on www.ti.com/cc2520dk for additional information.

See chapter 11 for a list of relevant documents and links.

3 Acronyms

ADC	Analog to Digital Converter
BSL	Bootstrap Loader
DK	Development Kit
EB	Evaluation Board
EM	Evaluation Module
FET	Flash Emulation Tool
IC	Integrated Circuit
JTAG	Joint Test Action Group
kB	Kilo Byte (1024 byte)
LCD	Liquid Crystal Display
LCL	Local
LED	Light Emitting Diode
LPW	Low Power Wireless
MCU	Micro Controller
PER	Packet Error Rate
RF	Radio Frequency
RX	Receive
SoC	System on Chip
SPI	Serial Peripheral Interface
TI	Texas Instruments
TX	Transmit
UART	Universal Asynchronous Receive Transmit
USB	Universal Serial Bus

4 Development Kit contents

The CC2520 Development Kit includes hardware and software that allows quick testing of the CC2520 RF performance and offers a complete platform for development of advanced prototype RF systems.

- Evaluate the CC2520 right out of the box. The kit can be used for range testing using the pre-programmed PER tester running on the MSP430F2618.
- Use SmartRF Studio to perform RF measurements. The radio can be easily configured to measure sensitivity, output power and other RF parameters.
- Prototype development. All I/O from the CC2520 are available on pin connectors on the SmartRF05EB and on the CCMSP-EM, allowing easy interconnection to other devices or controllers.

The development kit contains the following components

- 3 x SmartRF®05EB
- 3 x CC2520EM evaluation modules
- 3 x Antennas
- 2 x CCMSP-EM430F2618
- 1 x MSP-FET430UIF debug interface
- 3 x USB cables
- Documents

Figure 1 - CC2520 Development Kit Contents

SmartRF05EB

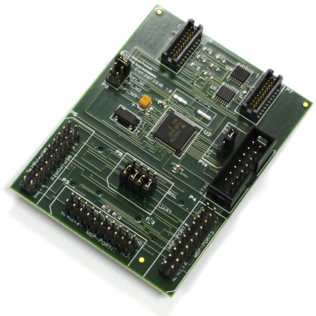
The SmartRF05EB (Evaluation Board) is the main board in the kit with a wide range of user interfaces:

- 3x16 character serial LCD
- Full speed USB 2.0 interface
- UART
- LEDs
- Serial Flash
- Potmeter
- Joystick
- Buttons

The EB is the platform for the evaluation modules (EM) and can be connected to the PC via USB to control the EM.

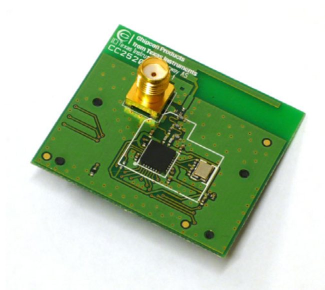
CCMSP-EM430F2618

This is a generic microcontroller board with an MSP430F2618. The MCU Board can be plugged into the SmartRF05EB and it is compatible with most TI LPW RF-IC EMs.



CC2520EM

This is the CC2520 Evaluation Module (EM) with the RF IC and necessary external components and matching filters for getting the most out of the radio. The module can be plugged into the SmartRF05EB directly for control from SmartRF Studio or into the CCMSP-EM430F2618 for control from MSP430. Use the EM as reference design for antenna and RF layout.



MSP-FET430UIF

This is the MSP430 USB Debug Interface for programming and debugging applications running on the MSP430F2618. It connects to the PC via USB and uses JTAG to communicate with the microcontroller.

5 Getting started

Please refer to the CC2520DK Quick Start Guide (www.ti.com/lit/swru139) for a short introduction on how to use the kit.

5.1 SmartRF Studio

SmartRF Studio is a PC application developed for configuration and evaluation of many of the RF-IC products from Texas Instruments, including the CC2520. The application is designed for use with an applicable SmartRF evaluation board, such as the SmartRF05EB, and runs on Microsoft Windows.

SmartRF Studio lets you explore and gain knowledge about the CC2520 as it gives you full overview and access to the RF-IC's registers to configure the radio and has a control interface for simple radio operation from your PC.

This means that SmartRF Studio will help radio system designers to easily evaluate the RF-IC at an early stage in the design process. It also offers a flexible code export function of radio register settings for software developers.

The latest version of SmartRF Studio can be downloaded from the Texas Instruments website (www.ti.com/smartrfstudio), where you will also find a complete user manual.

5.2 Installing SmartRF Studio and Windows drivers

Before your PC can communicate with the SmartRF05EB over USB, you will need to install the driver files for the EB. The latest SmartRF Studio installer includes drivers for Windows.

It is highly recommended to install SmartRF Studio before you connect the SmartRF05EB to the computer.

A brief set of installation instructions for Microsoft Windows XP will be given here, but also Windows 2000, Windows NT and Windows 98 are supported. Please consult the SmartRF Studio User Manual for further details or the troubleshooting section if needed.

After you have downloaded the SmartRF Studio from the web, extract the zip-file, run the installer file and follow the instructions. Pick a complete installation to include the SmartRF Studio program, the SmartRF Studio documentation and the necessary Windows drivers needed to communicate with the SmartRF05EB.

You can now connect your SmartRF05EB to the computer with a USB cable and turn it on. A "Found New Hardware" dialog box will prompt you to locate the missing driver.

Figure 2 - Connecting the SmartRF05EB for the first time (Windows XP)

If you did a complete install of SmartRF Studio, the driver to use is already copied to your hard drive. Select “No, not this time” and continue with “Next”.

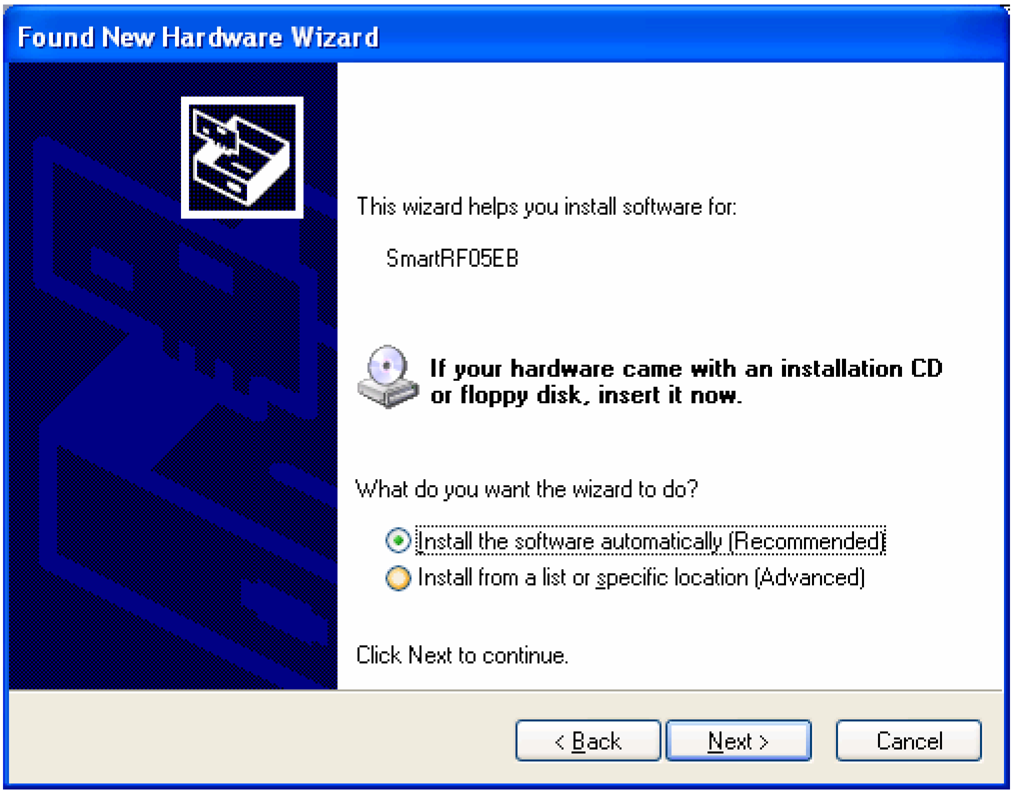


Figure 3 - Select automatic installation of software (Windows XP)

Select “Install the software automatically” to install the driver for the SmartRF05EB. Windows should automatically find the location of the driver to use. If unsuccessful, go back and manually specify to look in specific location and select the directory C:\Program Files\Texas Instruments\Extras\Drivers for the needed *.inf and *.sys driver files.

Figure 4 - The driver installation is completed (Windows XP)

The driver is now installed and the computer should be ready for use with SmartRF Studio. You can verify that the driver is properly installed by opening the Device Manager and see that when the EB is connected the “Cebal controlled devices” list contains “SmartRF05EB” and that it is not labelled with an exclamation mark.

Figure 5 - Properly installed SmartRF05EB software (Windows XP)

When launching SmartRF Studio, the evaluation board should now appear in the SmartRF05 DK tab. Double click on the device, and a new window opens – giving access to all of the registers on the chip as well as making it possible to perform various RF test.

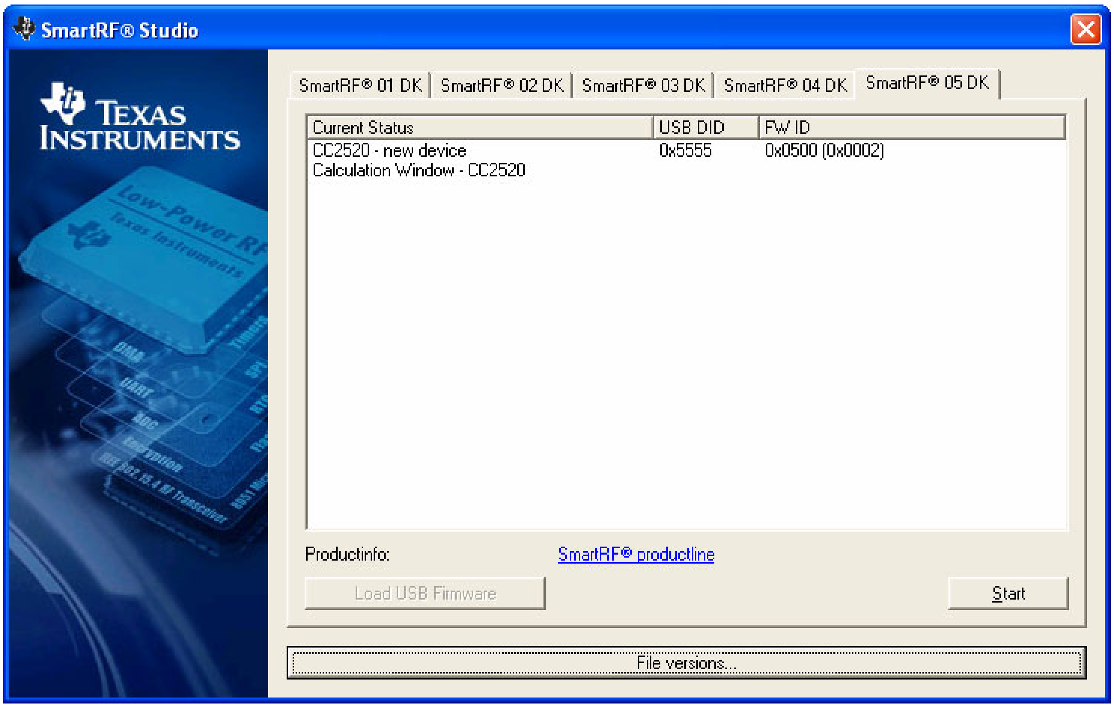


Figure 6 - SmartRF Studio with a CC2520EM connected to a SmartRF05EB

5.3 Using the hardware

The hardware in the kit can be used in two different modes. Either connect the CC2520EM directly to the SmartRF05EB (Figure 7) or connect the EM to the CCMSP-EM and then connect this assembly to the EB (Figure 8).

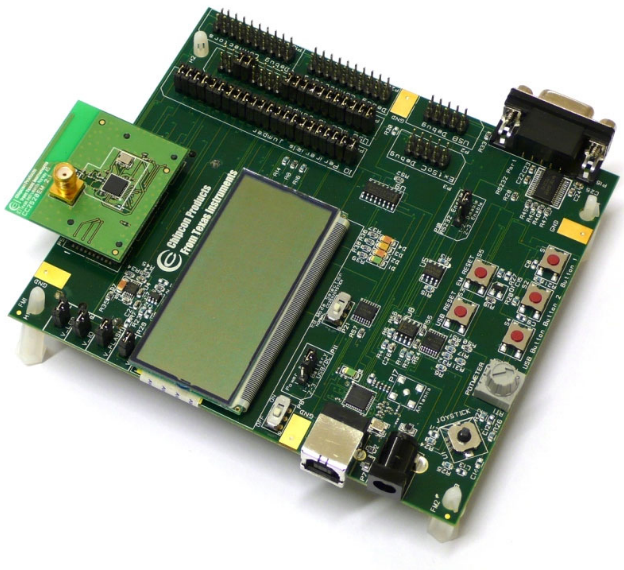


Figure 7 - CC2520EM and SmartRF05EB

The first option (Figure 7) should be used when the RF Module is controlled by SmartRF Studio via the USB controller on SmartRF05EB. It is also possible to implement software running on the microcontroller (CC2511) on SmartRF05EB to control the EM directly.

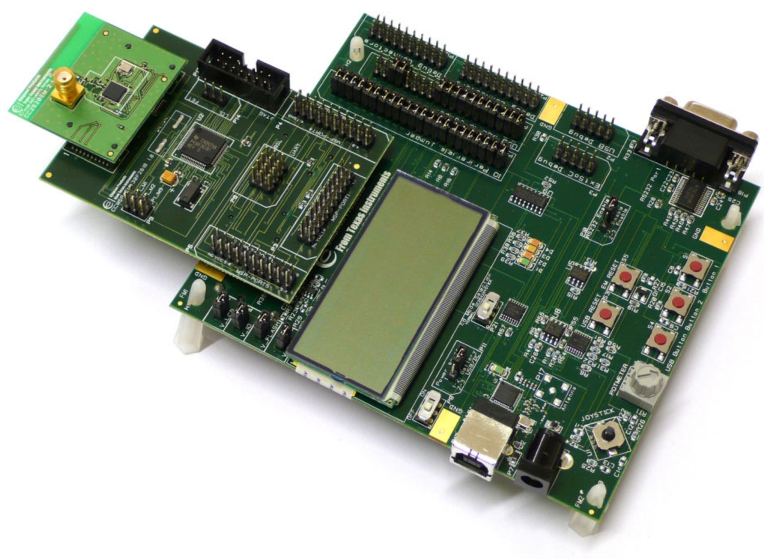


Figure 8 - EB with EM and MCU board

The second case (Figure 8) can be used when the RF module is to be controlled by the MSP430 on the CCMSP-EM430F2618 board.

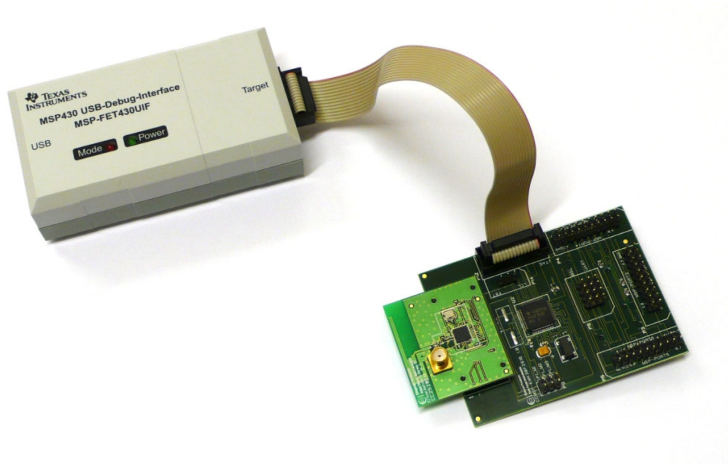


Figure 9 - EM and MCU board operating standalone

Note that it is possible to operate the CC2520EM + CCMSP-EM standalone (i.e. without the EB), but this requires some sort of external power. Figure 9 shows the CC2520EM connected to the MCU board as a standalone unit. The board can be powered through the MSP-FET430UIF by setting the appropriate switch on the board. See chapter 8 for details.

The development kit comes with two CCMSP-EM430F2618 allowing two complete nodes for peer-to-peer link testing and simple protocol testing. The additional hardware (SmartRF05EB + CC2520EM) can be used for debugging purposes, e.g. packet sniffing or capturing and/or inserting packets using SmartRF Studio.

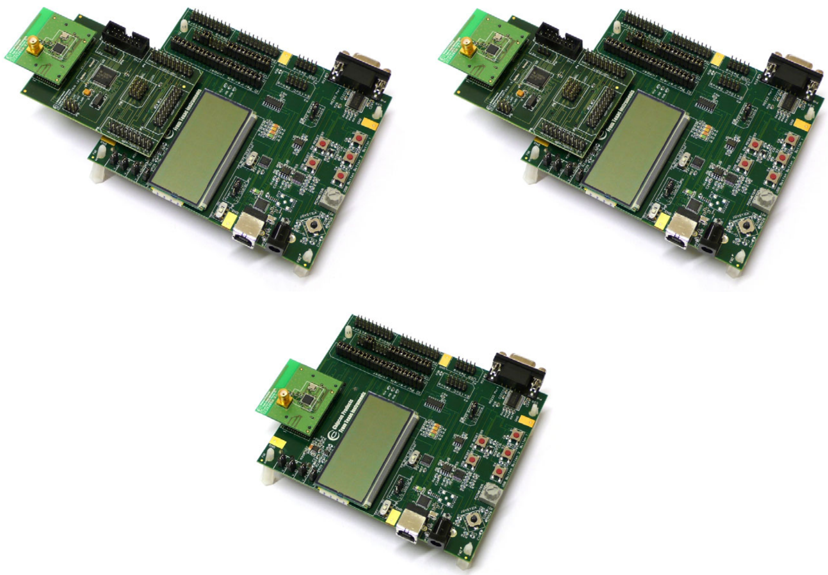


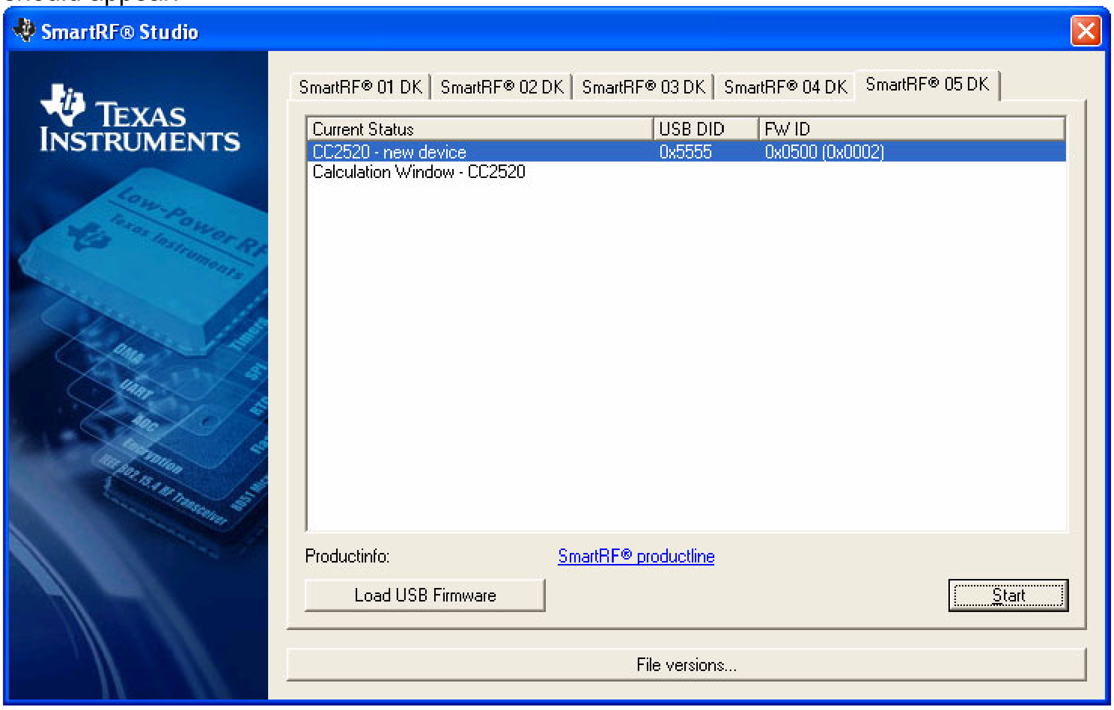
Figure 10 - Complete set up of development kit hardware

5.4 Using SmartRF Studio with SmartRF05EB and CC2520EM

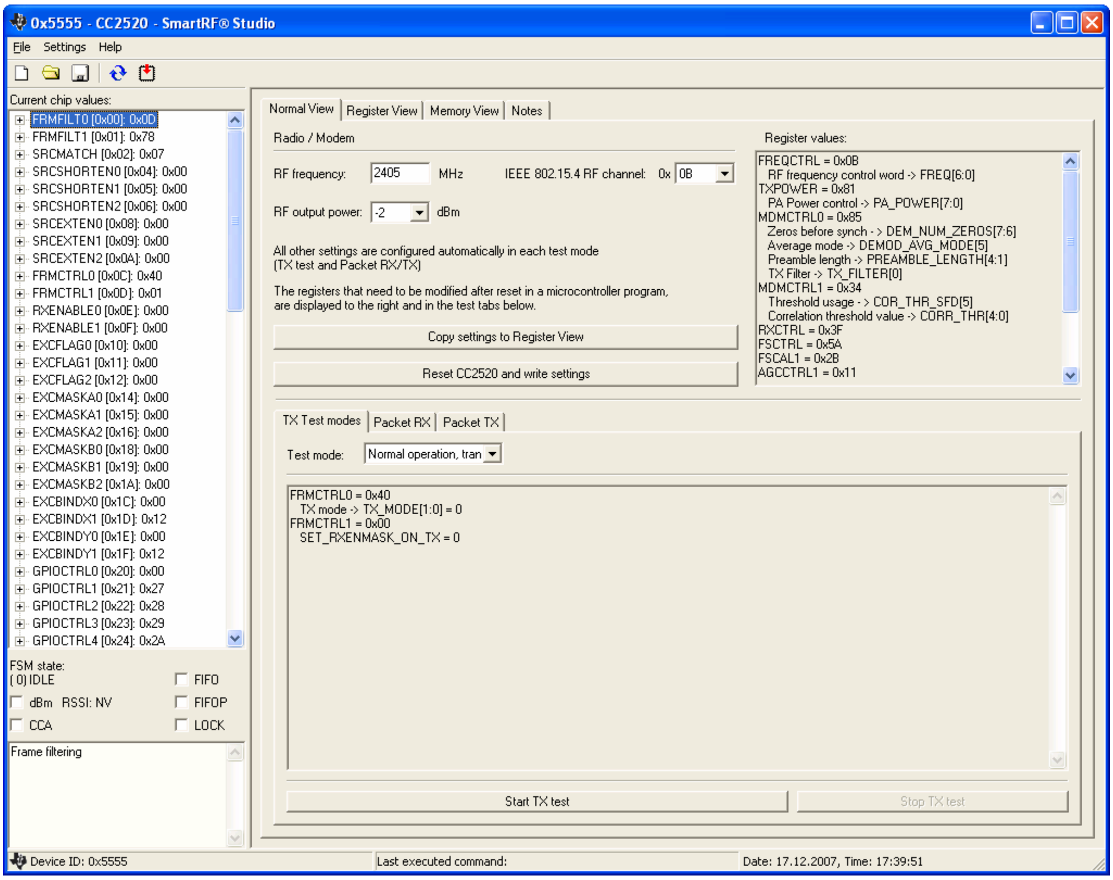
In order to use the SmartRF Studio the CC2520EM is connected directly to the SmartRF05EB, as shown in the picture below.

Figure 11 - CC2520EM connected to SmartRF05EB

After installation of SmartRF Studio and plugging the EB to the PC via USB, the driver can be installed as described in chapter 5.2. When starting SmartRF Studio, the following window should appear:



Make sure you select the tab called SmartRF® 05 DK. The connected evaluation board should be listed, showing that a CC2520 is available. Double click on the item, and a new window will appear.



This is the main control panel for the CC2520 from SmartRF Studio. It lets you perform a number of things:

- Run TX Test modes for testing of RF output power and spectrum. Connect a spectrum analyser or a power meter to the CC2520EM SMA connector to perform RF measurements.
- Run Packet TX and RX tests. For this test, you should have two EBs with CC2520EMs connected to the PC.
    - Double click on both of the devices in the list, opening two windows, giving control of the two radios at the same time.
    - Select one to be the receiver and the other to be the transmitter.
    - On the receiver, select the “Packet RX” tab.
    - Set up basic test parameters and press the “Start packet RX” button.
    - On the transmitter, select the “Packet TX” tab.
    - Start transmission by pressing the “Start packet TX” button.
    - The status window will show the number of packets sent/received and the current signal strength.
- Alternatively, you can have your own application and test your RX routine by receiving a packet sent by a radio controlled by SmartRF Studio – or test your TX routine by using SmartRF Studio to receive packets sent by your application.
- Read and/or modify registers and common settings, such as RF frequency (or channel) and output power.

The SmartRF Studio user manual has more details.

5.5 Running the Software Application Examples

The CCMSP-EM boards come pre-programmed with a Packet Error Rate (PER) test application, making it possible to e.g. perform simple range testing out of the box.

Running the PER test application:

1. Assemble the hardware as described in Figure 8 above. Remember to connect the antennas.
2. Select an appropriate power source. The boards can be powered either via a USB cable, by using a DC power or by using 2xAA batteries. Make sure that the power selection jumper P11 chooses the appropriate power source (right position for batteries, left for USB power or DC power). See details in section 7.3.
3. Power is turned on by switching position of the main power switch from OFF to ON.
4. Follow the instructions on the LCD by using the joystick to select modes and set up one node as transmitter and one as receiver.
5. When the test starts, it displays a PER value and an RSSI value on the LCD on the receiver node.

In order to program the MSP430 MCU on the CCMSP-EM430F2618 board the MSP-FET430UIF (FET) is needed. Connect the FET to the JTAG connector P12 on the CCMSP-EM430F2618 and to a PC with a USB cable. Use IAR Embedded Workbench for MSP430 to download and debug.

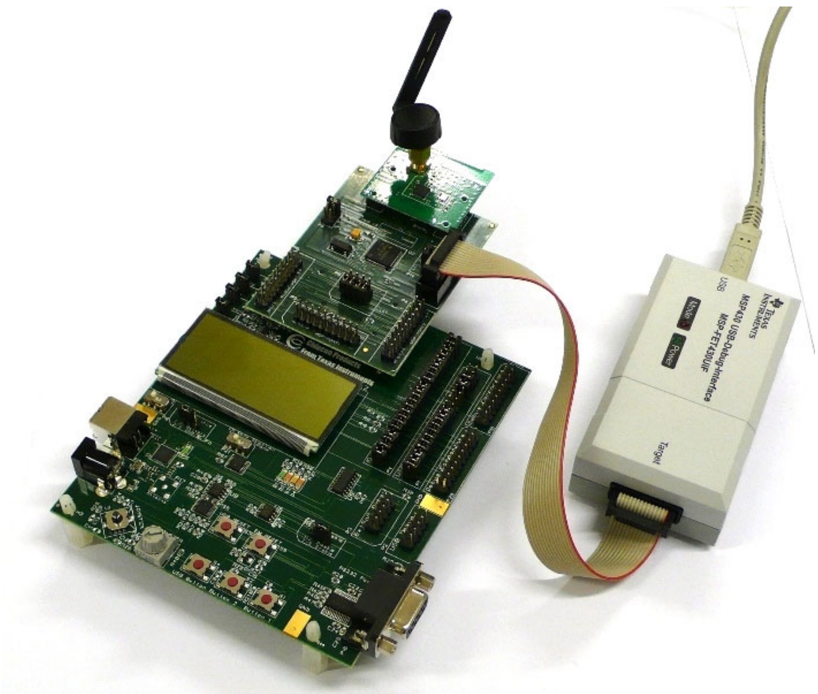


Figure 12 Downloading a new application on the MSP430

The CC2520 Software User's Guide has details about the available software examples.

Full source code for the software examples can be downloaded from the CC2520DK web page (www.ti.com/cc2520dk).

Please also visit the TIMAC web-site (www.ti.com/timac) for a complete 802.15.4 compliant MAC layer for the MSP430F2618 and CC2520 platform.

6 RF testing

RF testing is best performed by using SmartRF Studio together with the Development Kit. Connect the SmartRF05EB to a PC using the USB interface. Start SmartRF Studio and select the SmartRF05DK tab. Select the evaluation board with the CC2520EM (several boards can be connected to a PC at once) - it should be listed as "CC2520 – new device" – and click the start button. In the main SmartRF Studio window settings can be changed, tests performed and registers adjusted. RF measurement equipment may be connected to the SMA connector on the EM.

Please see the SmartRF Studio documentation for more information about how to use the tool.

6.1 Output power testing

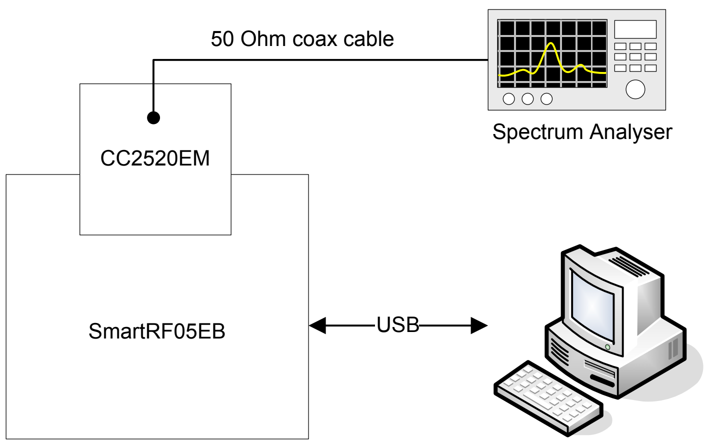


Figure 13 - Output power measurement set up

Instead of connecting an antenna to the SMA connector on the small EM, connect a 50 Ohm coaxial cable directly to a spectrum analyzer. Use the "TX Test Modes" [1] function in SmartRF Studio to set up the chip to emit a signal at the desired frequency.

By using good-quality RF cabling, the loss in the cabling should be negligible. However make sure that the spectrum analyser is calibrated. If possible, check it against a calibrated instrument such as an RF signal generator. Un-calibrated spectrum analysers can display errors of several dBs.

[1] Use either TXFIFO looping or pseudo random data.

6.2 Packet Error Rate (PER) testing

The PER number is the ratio between number of packets being lost and the total number of packets being sent. PER relates to the more traditional Bit Error Rate (BER) through the formula

$$PER = 1 - (1 - BER)^{packet\_length}$$

The sensitivity threshold of the radio is the lowest input signal strength at which the receiver can decode the signal with a reasonable degree of correctness. Usually, a PER of 1% is used as the limit for determining the sensitivity threshold.

It is possible to perform practical range testing with the PER test application which is preprogrammed on the CCMSP-EM430F2618 boards. Place the transmitter at a fixed location and place the receiver at a given distance from the transmitter. Then run the PER test to measure packet errors and possibly the signal strength. Repeat at different distances to get an idea of the range that can be obtained.

By adding a jammer (a third node that generates either noise on the same channel or a strong signal on an adjacent channel) it is also possible to measure co-channel rejection and selectivity/blocking performance.

The same PER test application can be used for simple sensitivity measurements with the CC2520EM and/or with your own prototype hardware. In this case, connect the unit you want to test to a known good transmitter with coaxial cables and attenuators. Add more attenuators until the PER value is 1%. The signal strength at the receiver side is then the sensitivity limit of the system.

For more information about sensitivity testing, please refer to "DN002 – Practical Sensitivity Testing" (www.ti.com/lit/swra097).

7 SmartRF05EB

SmartRF05EB is the motherboard in the system, hosting all of the user interfaces and connections to external interfaces.

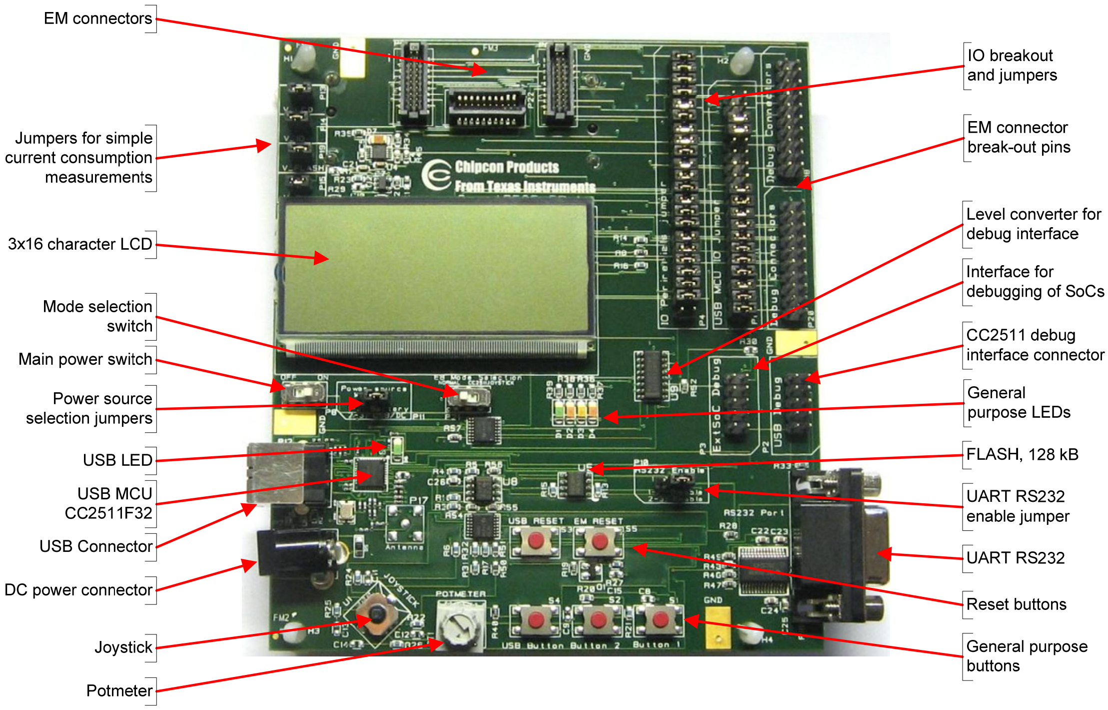


Figure 14 - SmartRF05EB

Figure 15 shows the main components of the board and outlines the main communication buses.

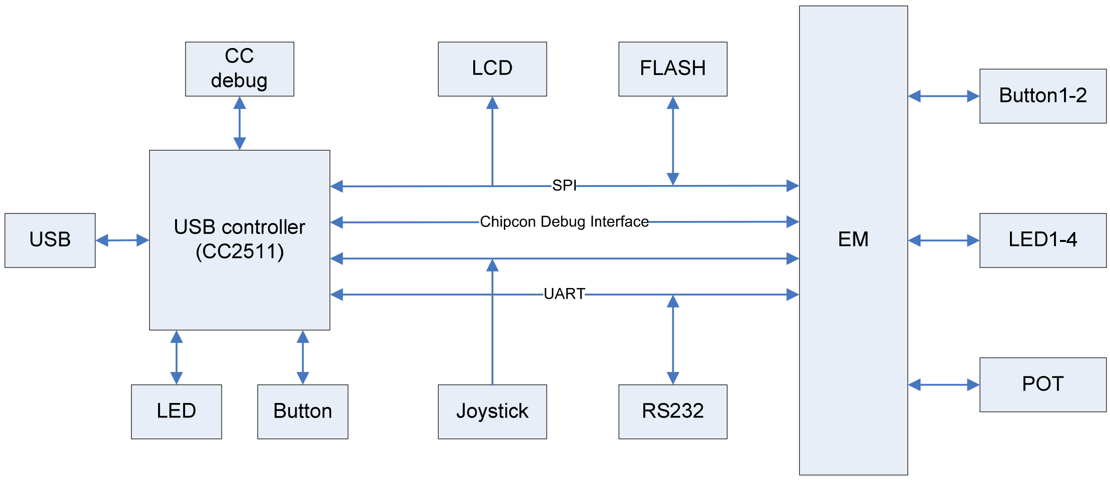


Figure 15 - SmartRF05EB architecture

The main component on the board is the USB controller. It communicates with the PC via USB and translates requests from various PC tools (e.g. SmartRF Studio, SmartRF Flash Programmer) to actions on the board.

The USB controller communicates with the evaluation module using SPI or UART.

Note that not all of the peripherals on the board are accessible from the USB controller. It has access to the UART RS232 interface, LCD, one LED (D6), joystick and one button (USB button). I.e. it does not have access to the serial flash on the board.

The module connected to the EM connector has potentially access to all of the EB peripherals. It has full access to the LCD, serial flash, four LEDs, 2 buttons, joystick and UART RS232 interface.

Since many of the peripherals can be accessed from both the USB controller and the MCU EM, some I/O pins can potentially be driven by two different sources. The standard firmware running on the USB controller handles this by setting all shared I/O in three-state (high impedance) and thus avoids conflict.

7.1 USB MCU

The USB MCU is the CC2511F32 from Texas Instruments. It is actually a Low Power Wireless System-on-chip including a state-of-the-art 2.4 GHz radio, 32 kB in system programmable flash, 4 kB RAM, a 12 bit ADC, timers and a USB controller. Please see www.ti.com/cc2511 for detailed information about this controller.

7.1.1 Boot loader and standard firmware

The USB controller is programmed with a boot loader when it is shipped from the factory. The boot loader allows programming of new code into the USB MCU via the USB cable (i.e. no extra programmer or hardware needed). The boot loader communicates with SmartRF Studio or SmartRF Flash Programmer.

When the USB controller starts running, it will check for a valid version of firmware in flash. If it detects a valid application, the boot loader boots the firmware and cedes control of the controller.

The standard firmware is used to control the RF EM and communicate with applications running on the PC via USB.

Updating of firmware is done automatically by SmartRF Studio if it detects an old and/or incompatible firmware version on the controller. SmartRF Studio and SmartRF Flash Programmer also allow manual programming of the firmware. Please refer to the respective user's guides for detailed instructions.

There should not be any EM boards connected to the 05EB while updating the firmware on the EB.

It is also possible to update the firmware and boot loader on the board by using the debug interface of the USB Controller. As this is a CC2511, use a SmartRF04EB[2] to program the controller. Connect a 10-pin flat cable to the "Ext SoC Debug" plug (P3) on the SmartRF04EB and to the "USB Debug" plug (P2) on the SmartRF05EB. Use SmartRF Flash Programmer to do the actual programming.

Note that there is a way to force the boot loader not to start the firmware. Place the EB Mode Selection switch in the CC2511JOYSTICK position and move the joystick in any direction (other than the centre position). When the board is turned on, the firmware is not started and the boot loader will have control of the board. The LED D6 will be blinking with a 1 second

[2] Not included in this kit

interval, indicating that the boot loader is running. Use this method to check whether you have a working boot loader or not.

If the LED D6 blinks with a faster frequency (10 times per second) the boot loader could not find a valid application to boot.

The same LED will be on when the firmware is running (indicating OK).

When the boot loader 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.

7.1.2 USB MCU pin out

The following table shows the usage of I/O pins on the USB MCU.

Pin	Function	Description
P0.0	SPI_SELECT /JOY_LEVEL	Function depending on switch P21: NORMAL: When SPI_SELECT is set LOW, it enables a special CC2520 sniffer interface (for test and diagnostic purposes. CC2511JOY: Joystick level is an analog value that can be decoded to find the actual position of the joystick (centre, up, left, right or down)
P0.1	USB_EM_RESET	Signal used to reset the EM board
P0.2	USB_CS	SPI Chip select for device on EM board
P0.3	USB_SCLK	SPI Clock
P0.4	USB_MOSI	SPI MOSI (master out, slave in)
P0.5	USB_MISO	SPI MISO (master in, slave out)
P1.0	USB_IFC_CTRL	Enables the USB interface when it is set high. Set either by the boot loader or the firmware.
P1.1	USB_DBG_DC	Debug clock – used when CC2511 communicates with another LPW Soc via the debug interface.
P1.2	USB_UART_RTS/USB_LED	Dual function: UART Ready To Send and output signal for control of LED D6.
P1.3	USB_UART_CTS/USB_BUTTON	Dual function: UART Clear To Send and input signal for USB button event.
P1.4	USB_UART_TX	UART TX
P1.5	USB_UART_RX	UART RX
P1.6	DGB_DD_DIR /JOY_MOVE	Function depending on switch P21: NORMAL: The debug data direction signal controls the signal flow on the level converter for the external debug interface. CC2511JOY: Joystick move signal input. Set high on any joystick event (pushed, moved up, left, right or down)
P1.7	USB_DBG_DD	Debug data – used when CC2511 communicates with another LPW SoC via the debug interface.
P2.0	USB_LCD_FLASH_RESET	Resets both the serial flash and the LCD on the board when it is set low.
P2.1	CC2511 DBG DD	CC2511 debug interface
P2.2	CC2511 DBG DC	CC2511 debug interface
P2.3	LCD_MODE	Selects operating mode of the LCD
P2.4	LCD_CS	SPI Chip select signal for the LCD

Table 1 - USB MCU pin-out

As mentioned in the table, the joystick output is coded as an analogue voltage. This has been done in order to save the number of pins required on the MCU to interface with the joystick.

7.2 Mode selection switch

SmartRF05EB has a mode selection switch (P21) that allows two minor configurations of the evaluation board.

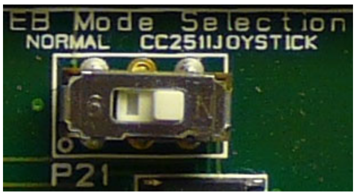


Figure 16 - EB Mode Selection switch

In the NORMAL position, the evaluation board is in a normal operating mode, enabling support in hardware both for debugging of an external SoC and a special packet sniffer interface for the CC2520EM.

The CC2511JOYSTICK position is primarily intended for the special case where a custom application is running on the CC2511 using the joystick (JOY_LEVEL and JOY_MOVE) for user input. In this position, neither the external debug interface nor the hardware support for CC2520 packet sniffer will work. P0.0 is connected to the JOY_MOVE signal and P0.6 is connected to the JOY_LEVEL signal.

The switch is by default placed in the NORMAL position.

7.3 Power Sources

There are four possible solutions for applying power to the SmartRF05EB. The power source can be selected using the power source selection jumper on header P11.

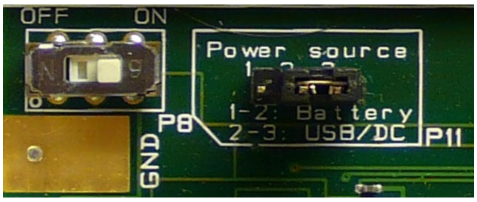


Figure 17 - Main power switch and power selection jumper

The main power supply switch (P8) turns off all power sources, unless an external power supply is connected to the board, overriding the onboard voltage regulators.

7.3.1 Battery power

The evaluation board includes a battery holder for two 1.5V AA batteries on the reverse side of the PCB: Normal AA batteries can be used and the on board regulator supplies 3.25 V to the board. The power source selection jumper should short circuit pin 1 and 2 of header P11. A LOW BATT LED on the board will be lit when the voltage on the board drops beneath 1.56 V. Note that this function is only active when powering the board using batteries.

7.3.2 DC Jack

SmartRF05EB has a connector with standard DC jack power connectors with a 2.5mm centre pin. The centre pin is used for the positive voltage. A 4-10 V DC power supply should be used. The onboard voltage regulator supplies approx 3.05 V to the board. The power source selection jumper should short circuit pin 2 and 3 of header P11.

7.3.3 USB power

When SmartRF05EB is connected to a PC via a USB cable, it can draw power from the USB bus. The onboard voltage regulator supplies approx 3.05 V to the board. The power source selection jumper should short circuit pin 2 and 3 of header P11.

7.3.4 Laboratory power supply

When connecting a lab power supply, ground should be connected to any of the GND pads on the board. Remove the power source selection jumper and apply a voltage in the range from 2.7V to 3.6V to pin 2 on header P11. The main power switch will not have any effect in this case.

WARNING! Note that this will bypass all voltage regulators on the board so there might be a risk of damaging the components on the board if the voltage on pin 2 on header P11 is lower than -0.3V or higher than 3.9V (maximum ratings for CC2511).

7.4 UART RS232 interface

The UART interface can be used by custom applications for communication with other devices. The interface uses a voltage translation device so that the port is compatible with RS232 signalling. The RS232 voltage converter can be disabled by shorting pin 1 and 2 on P10 with a jumper.

The figure below gives a detailed overview of the UART signals and how they are connected to the different devices on the EB.

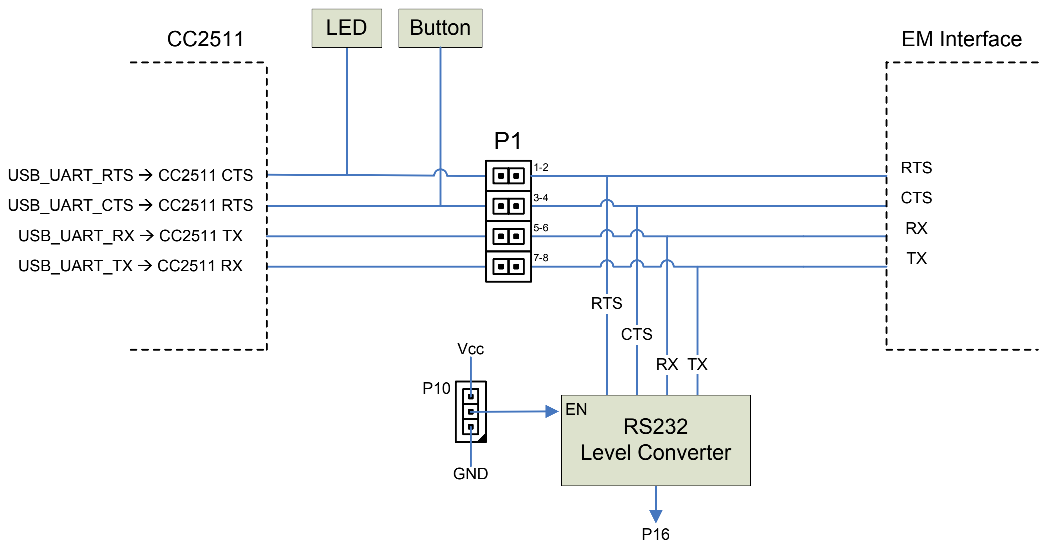


Figure 18 - UART RS232 signals and jumpers

As the figure shows, signals are crossed on the EB between the EM and CC2511 and between the EM and the RS232 level converter/DE9 connector. The implication is that if the board connected to the EM interface communicates with a PC using UART, use a straight serial cable. To communicate with CC2511 from a PC, a null-modem cable (crossed) has to be used. UART communication between CC2511 and the controller on the EM works without crossing any signals (RX connected to TX and vice versa).

Also note that the USB button and USB LED share the RTS and CTS signals going to the CC2511. To avoid any conflicts when the RTS/CTS UART flow control signal are used, disconnect jumpers 1-2 and 3-4 on P1. They are disconnected by default.

7.5 Joystick

The joystick detects five positions (centre, up, down, left, right) and one event (pushed). In case of moving the joystick from its centre position or pushing it, 5 discrete signals can be used to distinguish what happened. The discrete signals are only available to the microcontroller on the EM. In addition, two aggregated signals can be used to detect a joystick event. One signal, JOY_MOVE, is set high in case of any movement away from the centre position, including pushing. The other signal, JOY_LEVEL, is a voltage level signal that gives different values depending on the current position of the joystick.

Joystick position	JOY_LEVEL (Volts)
Up	0.31
Down	1.16
Left	1.62
Right	1.81
Centre	2.12

Table 2 - Voltage on JOY_LEVEL for different joystick positions
Measured at T=25°C, Vdd=3.0V

7.6 LCD

The LCD on SmartRF05EB is a 3x16 character display from Hitech Displays (HMC16311). Use the SPI bus and the additional control signals (LCD CS, LCD Mode and LCD Reset) to control the LCD.

7.7 Buttons

There are five buttons on the evaluation board.

Button 1 and Button 2 are only connected to the EM, while the USB button is connected to the USB Controller. There are no RC filters on the buttons.

The USB Reset button resets the USB controller. Note that the USB controller will in turn reset the EM, so pushing the USB reset button also resets the controller on the EM.

The EM reset button will only result in resetting the controller on the EM (e.g. the MSP430F2618 on the CCMSP EM).

7.8 LEDs

There are 6 LEDs on the board.

The four LEDs D1, D2, D3 and D4 can only be controlled via the EM.

LED D6 can be controlled by the USB controller.

The LOW BATT LED is turned on when the voltage from the batteries drops below approximately 1.56V.

7.9 Serial Flash

SmartRF05EB has a M25PE10 flash device – a 1 Mbit (128 Kb × 8 bit) serial paged flash memory from STMicroelectronics. It can be accessed over the SPI bus from the EM, but not from the USB Controller, as the latter has not access to the flash chip select signal.

7.10 Debug Connectors (P18 and P20)

The debug connectors bring out all the signals from the EM connectors. These connectors are compatible with Agilent logic analyser probes. The connectors allow easy access to I/O signals and to connect prototyping boards.

Signal name	Pin	Pin	Signal name
NC	1	2	NC
NC	3	4	EM_FLASH_CS
EM_BUTTON1	5	6	EM_LED1
EM_UART_RX	7	8	EM_JOYSTICK_RT
EM_UART_TX	9	10	EM_DBG_DD
EM_LCD_MODE	11	12	EM_DBG_DC
EM_LCD_FLASH_RESET	13	14	EM_CS
EM_JOY_LEVEL	15	16	EM_SCLK
EM_POT_R	17	18	EM_MOSI
EM_MISO	19	20	GND

Table 3 - I/O connector P18 pin-out

Signal name	Pin	Pin	Signal name
NC	1	2	NC
NC	3	4	EM_LED2
PS_PWR_SNOOZE	5	6	EM_LED2
EM_VCC	7	8	EM_LED4
NC	9	10	EM_JOYSTICK_PUSH
EM_JOYSTICK_UP	11	12	EM_JOYSTICK_DN
EM_JOYSTICK_LT	13	14	EM_UART_CTS
EM_RESET	15	16	EM_BUTTON2
EM_LCD_CS	17	18	EM_UART_RTS
EM_JOY_MOVE	19	20	GND

Table 4 - I/O connector P20 pin-out

7.11 EM connectors

The EM connectors are used for connecting the EM to the SmartRF®05EB. The connectors P5 and P6 are used as the main interface.

7.12 Break-out headers and jumpers (P1 and P4)

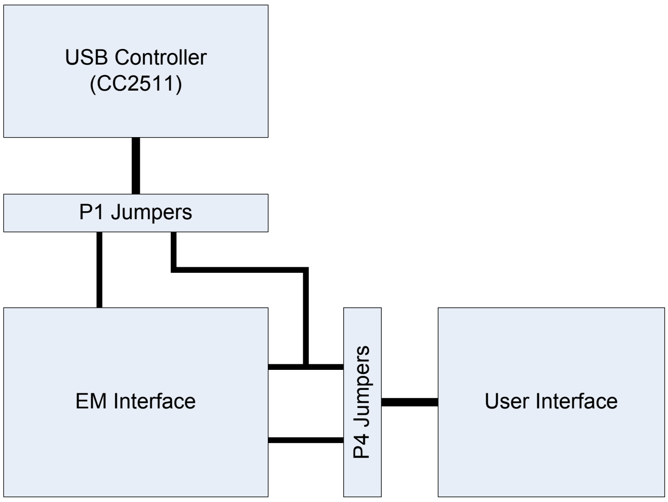


Figure 19 - Basic signal flow on the evaluation board

The signals from the EM connectors are connected to user interfaces or the CC2511 on the EB, but all of the signals are gated through either header P1 or P4. Jumpers on these headers allows for fine tuned control of which signals are routed to what device and allows easy break-out of signals for debugging and development using proprietary peripherals.

All of the peripherals on the board and the USB controller can be isolated entirely from the EM, facilitating accurate power consumption measurements.

Pins	Function	Description	Default mounted
1-2	UART_RTS	Ready to send – for systems supporting hardware flow control	No
3-4	UART_CTS	Clear to send – for systems supporting hardware flow control	No
5-6	UART_RX	Received data- connected to TX on CC2511	Yes
7-8	UART_TX	Transmitted data – connected to RX on CC2511	Yes
9-10	SNIFF_DATA	Sniff interface – bit stream of data from radio	No
11-12	SNIFF_CLK	Sniff interface – clock for data sampling	No
13-14	SNIFF_MISO	Sniff interface – not used	No
15-16	SNIFF_SFD	Sniff interface – start of frame delimiter from	No
17-18	DBG_DC	Debug Clock signal (debug interface for system-on-chips)	Yes
19-20	DBG_DD	Debug Data signal (debug interface for system-on-chips)	Yes
21-22	CS	Chip select for SPI device on EM module	Yes
23-24	SCLK	SPI clock	Yes
25-26	MOSI	SPI data – master output, slave input	Yes
27-28	MISO	SPI data – master input, slave output	Yes
29-30	LCD_CS	Chip select for LCD	Yes
31-32	LCD_MODE	LCD control signal	Yes
33-34	LCD_FLASH_RESET	Common reset signal for serial Flash and LCD	Yes
35-36	JOY_LEVEL	Voltage level from joystick, indicating position	Yes
37-38	JOY_MOVE	There is a positive edge on this signal when the joystick is moved	Yes

Table 5 - Jumpers on P1. Control signals available to the USB controller.

Pins	Function	Description	Default mounted
1-2	JOY_MOVE	See P1, 37-38	Yes
3-4	JOY_LEVEL	See P1, 35-36	Yes
5-6	LCD_FLASH_RESET	See P1, 33-34	Yes
7-8	LCD_MODE	See P1, 31-32	Yes
9-10	LCD_CS	See P1, 29-30	Yes
11-12	MISO	See P1, 27-28. Connected to LCD and serial Flash.	Yes
13-14	MOSI	See P1, 25-26. Connected to LCD and serial Flash.	Yes
15-16	SCLK	See P1, 23-24. Connected to LCD and serial Flash.	Yes
17-18	FLASH_CS	Chip select for serial flash	Yes
19-20	BUTTON1	Button 1. Low when pushed.	Yes
21-22	BUTTON2	Button 2. Low when pushed.	Yes
23-24	LED1	Control signal for LED D1. Set high to turn LED on.	Yes
25-26	LED2	Control signal for LED D2. Set high to turn LED on.	Yes
27-28	LED3	Control signal for LED D3. Set high to turn LED on.	Yes
29-30	LED4	Control signal for LED D4. Set high to turn LED on.	Yes
31-32	JOYSTICK_UP	Signal goes high when joystick is moved up.	Yes
33-34	JOYSTICK_DN	Signal goes high when joystick is moved down.	Yes
35-36	JOYSTICK_LT	Signal goes high when joystick is moved left.	Yes
37-38	JOYSTICK_RT	Signal goes high when joystick is moved right.	Yes
39-40	JOYSTICK_PUSH	Signal goes high when joystick is pushed.	Yes
41-42	POT_R	Voltage level from potentiometer. Value between 0 and VCC.	Yes
43-44	EM_RESET	Reset signal to EM. Set either by the USB controller or as a result of pushing the EM reset button.	Yes

Table 6 - Jumpers on P4. IO signals from all of the peripherals on the evaluation board.

8 CCMSP-EM430F2618

The CCMSP-EM430F2618 is a generic MCU board that can be plugged into a SmartRF05EB, giving access to all of that board's user interfaces. Any TI LPW transceiver EM, or even a system-on-chip EM, can be plugged into the MCU board, enabling a versatile development platform for RF testing and software design.

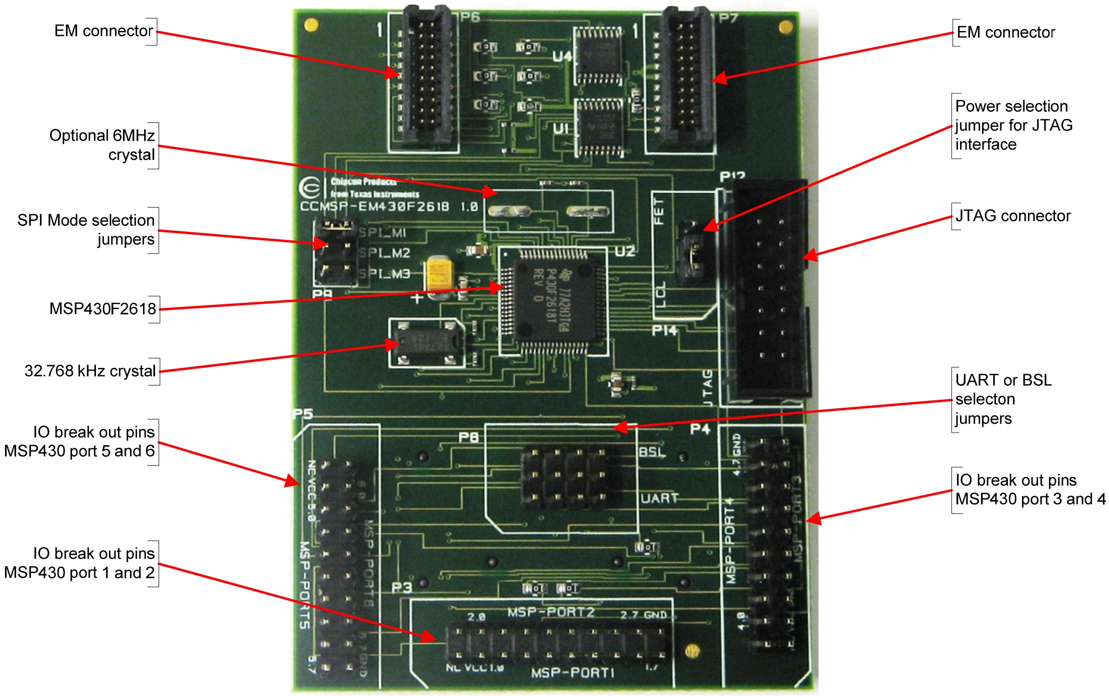


Figure 20 - CCMSP-EM430F2618

8.1 JTAG interface and power source

The JTAG connector, located on the right side of the board, is used for programming and debugging software running on the MSP430F2618. Please refer to the CC2520DK Software User's Guide for further details on how the debugger can be used.

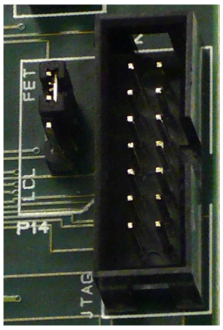


Figure 21 - JTAG and power selection jumper

The power source selection header (P14) allows selection of what power source to use for the MSP430 controller. If the selection jumper is in the FET position (short circuiting pin 2 and 3) the board can be powered from the FET tool. Note that if the board is already powered from a second source (e.g. the SmartRF05EB), you will have two separate power sources. To avoid damage of the board, only use FET power if the board is already powered.

If the jumper is in the LCL position (short circuiting pin 1 and 2), the board is powered from a different source, and the FET uses that as input for correct voltage level conversion of the JTAG signals.

The default jumper setting is LCL.

8.2 BSL or UART connector

The BSL/UART header enables support for accessing and using the Boot Strap Loader features of the MSP430.

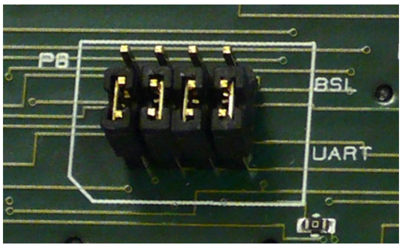


Figure 22 - BSL or UART selection jumpers

Default position is UART, routing UART signal (RX, TX, CTS and RTS) to the UART RS232 connector on the EB.

If BSL is selected, the necessary signals (BSL RX, BSL TX, RST and TST) can be accessed from the CC2511. Custom software can be implemented to use the features. It is also possible to connect an external cable to access the BSL.

Please refer to application reports www.ti.com/lit/slaa089 and www.ti.com/lit/slaa096 for further details.

8.3 SPI Modes

The CCMSP-EM430F2618 board supports two major SPI modes and a third mode that enables a particular “bypass” mode. The SPI mode is selected with jumpers on header P9.

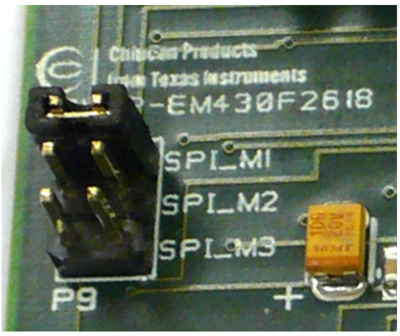


Figure 23 - SPI Mode selection header

8.3.1 SPI Mode 1 (SPI_M1)

This is the default SPI mode and uses two separate SPI busses. One is dedicated for communication with the EM module and the other is dedicated to all the SPI devices on the EB. The MSP430 uses the internal serial interface USCIB1 for the EM and USCIB0 for the EB. Se figure below for details.

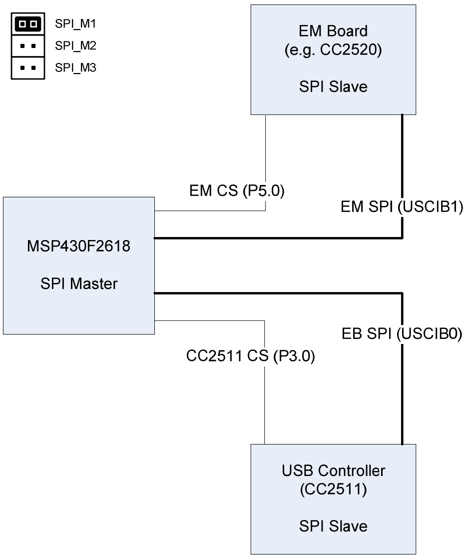


Figure 24 - SPI Mode 1

This mode allows uninterrupted use of the communication bus to the EM while using peripherals on the EB (typically updating the LCD or accessing the serial flash) at the expense of requiring two serial interfaces on the microcontroller.

8.3.2 SPI Mode 2 (SPI_M2)

An alternative mode is to use only one SPI bus for all devices. This is achieved by using SPI mode 2.

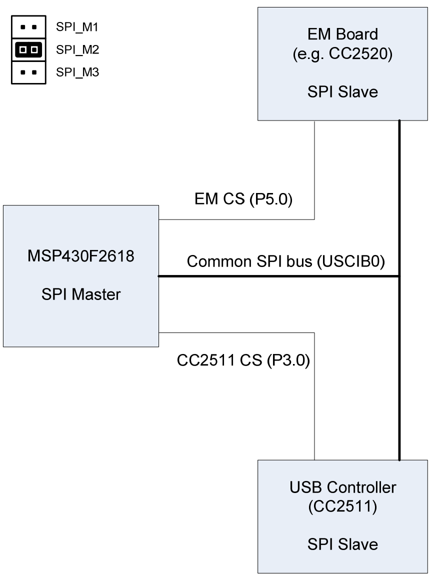


Figure 25 - SPI Mode 2

In this case, USCIB0 is used for accessing both the SPI devices on the EB and the EM. In some cases, this might complicate software, as it needs to make sure ongoing SPI transactions are not interrupted prematurely (e.g. interrupt from radio triggers reading from the transceiver using the SPI bus while the MCU is in the middle of writing to the LCD).

8.3.3 SPI Mode 3 (Bypass mode)

SPI Mode 3 is a particular mode that enables the USB controller on the EB to access the EM, and thus bypassing the MSP430. Note that either SPI_M1 or SPI_M2 has to be selected at the same time in order for the bypass mode to work.

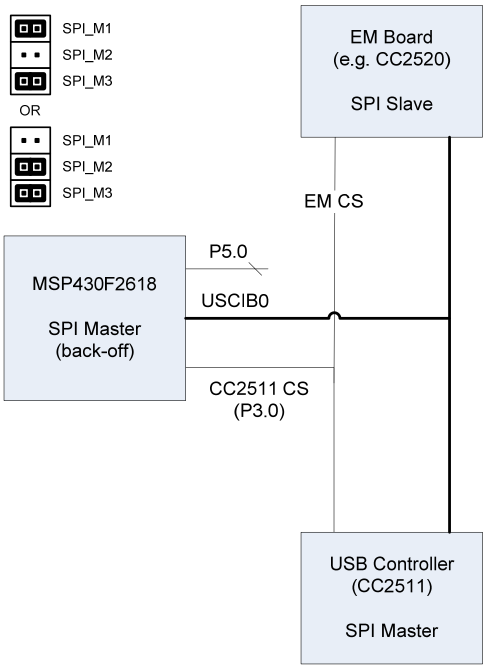


Figure 26 - SPI Mode 3

Also note that in this mode, both MSP430 and CC2511 are operating as SPI masters. The MSP430 has to set up in multi master mode (enable 4 wire SPI interface) in order for the mode to operate properly.

The bypass mode only takes effect when the CC2511 assert the chip select signal. At this instant, the MSP430 will detect that the CS signal goes low, thus releasing the bus, operating as a passive slave. This chip select signal is routed to the EM chip select signal, enabling its SPI interface. The CC2511 can now operate as SPI master and communicate with the EM as if the MSP430 was not present on the bus. The EM chip select signal from the MSP will temporarily be disconnected.

Once CC2511 de-asserts the chip select signal, the MCU board switches back to one of the chosen SPI modes (SPI_M1 or SPI_M2).

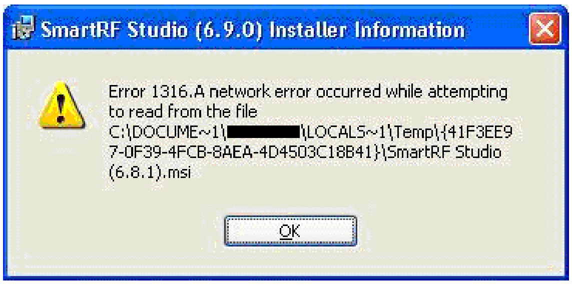
This mode can be particularly handy for debugging purposes. While debugging software on the MSP430 and using the RF EM, it is possible to halt the MSP430 application (e.g. at a breakpoint) and use SmartRF Studio to read out the registers from the radio – without interfering with the application.

9 CC2520EM

Please refer to the reference design on the web and a description of the evaluation module in the CC2520 Datasheet.

10 Frequently Asked Questions

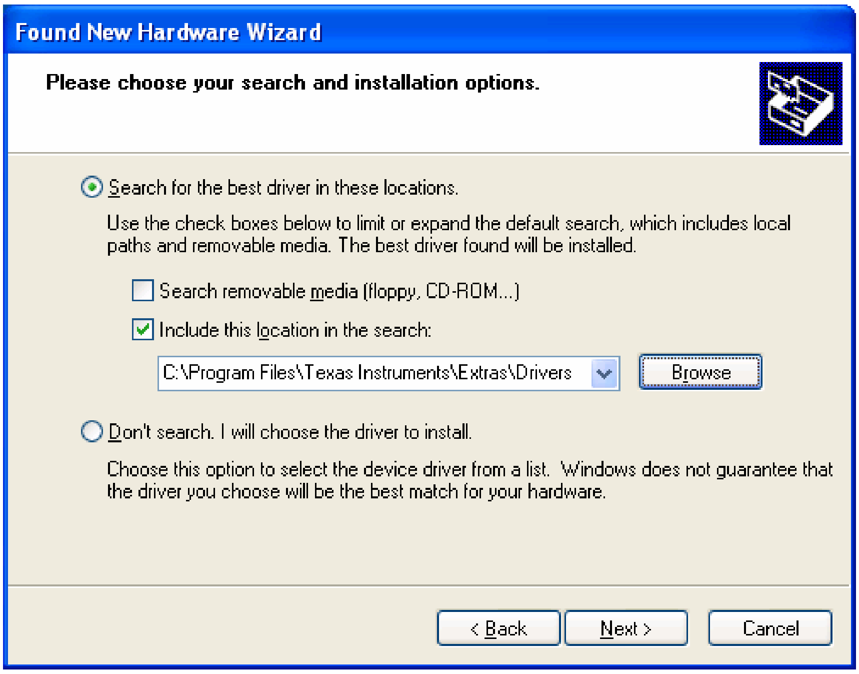
Q1 I get the following error from Windows during installation of SmartRF Studio:



A1 Uninstall previous versions of SmartRF Studio and try again.

Q2 Installation of drivers for the evaluation board fails.

A2 Instead of selecting automatic installation of drivers, select "Install form a list or specific location (Advanced)". You will get the following window.



Select the path as indicated in the figure above. Windows should now be able to find and install the required driver.

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 drivers can be found. Select "C:\Program Files\Texas Instruments\Extras\Drivers\srf05eb.inf".

Q3 Nothing happens when I power up the evaluation board.

A3 Make sure that all jumpers on the IO headers on the evaluation board are set in default position. Please refer to Table 5 and Table 6 for correct jumper setting.

Q4 The MSP-FET430UIF should be able to power the CCMSP-EM and SmartRF05EB when connected to the JTAG connector, but it doesn't seem to work. Why?

A4 Place the jumper on header P14 in position FET (short circuiting pin 2 and 3).

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

A5 If the blink frequency is 1 time per second, the boot loader 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 boot loader could not find a valid application in flash. Use SmartRF Studio or SmartRF Flash Programmer to program a new firmware on the board.

Q6 How can I measure the current consumption of the radio on the EM?

A6 The easiest way to measure current consumption of the chip in various modes is to connect the EM directly to the SmartRF05EB and disconnect everything on the board that consumes power by removing all jumpers on P1 and P4. The only jumpers needed on P1 are the four SPI signals (CS, SCLK, MISO and MOSI) and one for the CC2520 VREG enable signal (DBG_DD). On P4, only the jumper for the EM_RESET signal is required. Set the jumper on header P10 in position 1-2 (disable RS232 level converter) and remove jumpers on P13, P14 and P19. Connect the ampere meter between the two pins on P15 (V_EM).

Use SmartRF Studio to set the radio in different modes (RX, TX, etc.).

The same approach can be used when powering the CCMSP-EM + CC2520EM from the EB. In this case, only the jumper for the EM_RESET signal on P4 is required.

11 References

[1] CC2520DK Quick Start Guide www.ti.com/lit/swru139

[2] CC2520DK website www.ti.com/cc2520dk

[3] CC2520 Software Examples User's Guide www.ti.com/lit/swru137

[4] CC2520 website www.ti.com/cc2520

[5] SmartRF Studio www.ti.com/smartrfstudio

[6] TIMAC www.ti.com/timac

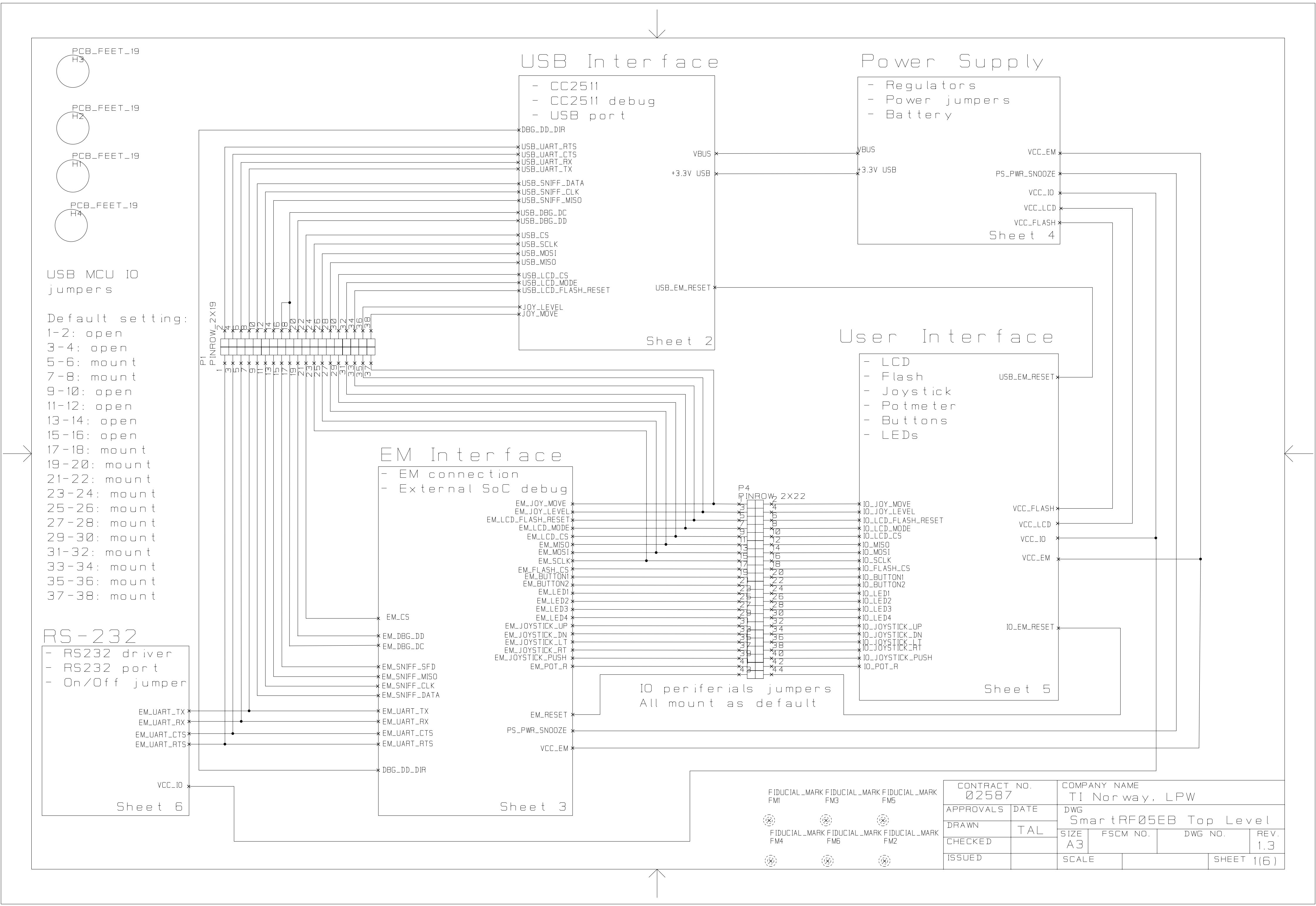
[7] DN002 -- Practical Sensitivity Testing www.ti.com/lit/swra097

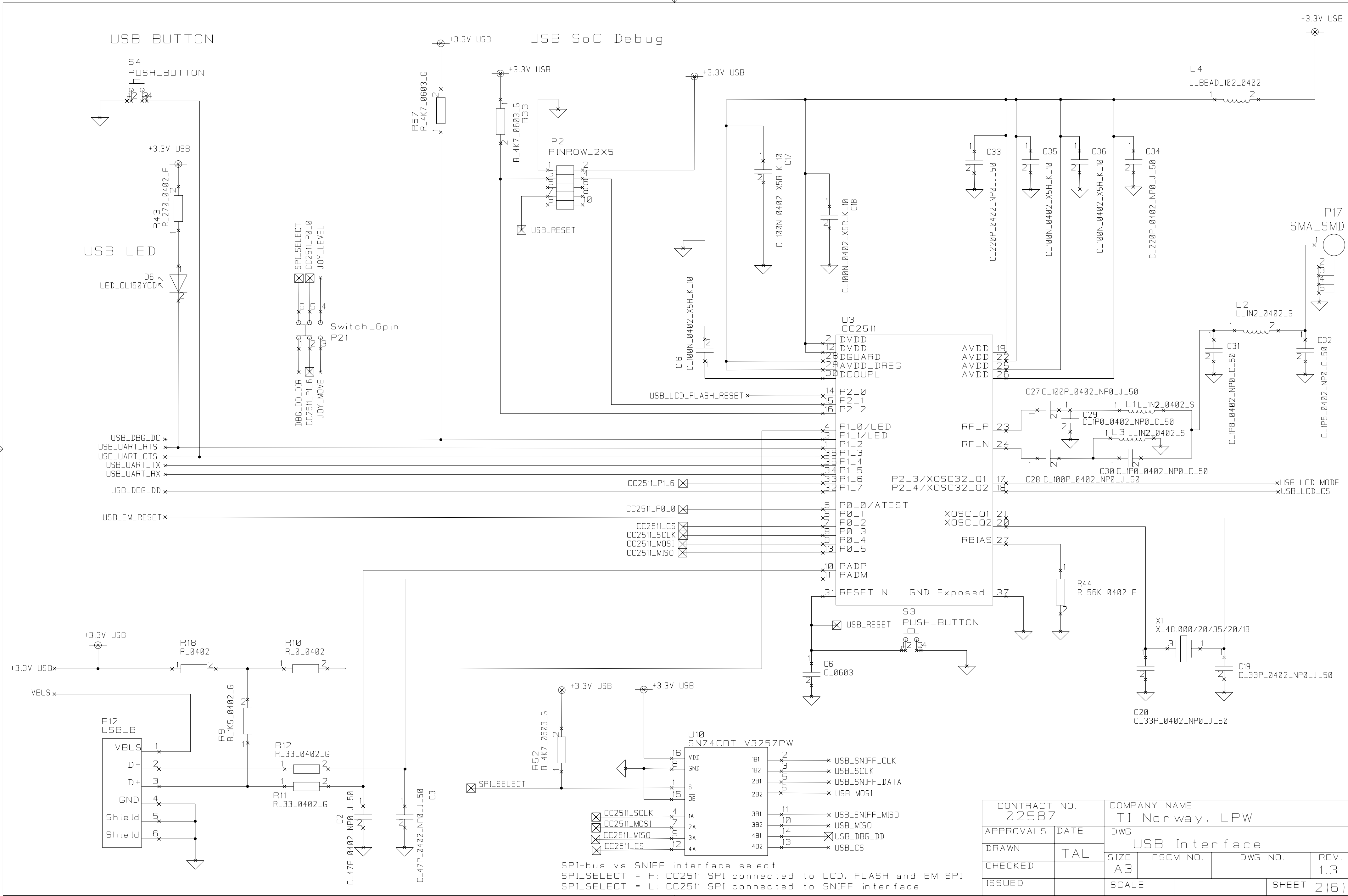
12 Document history

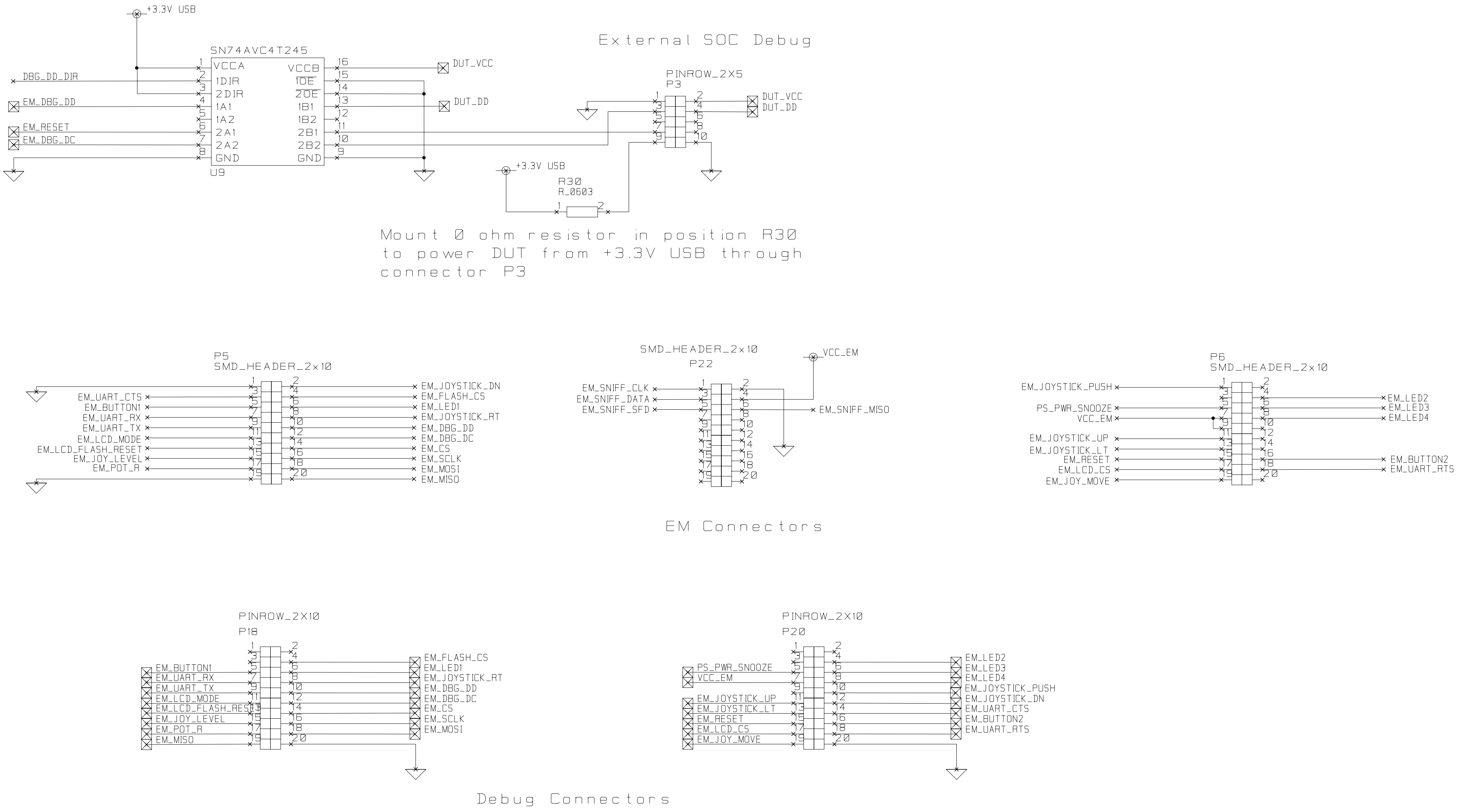
Revision	Date	Description/Changes
-	2007-12-18	First revision.

Appendix A

SmartRF05EB Schematics

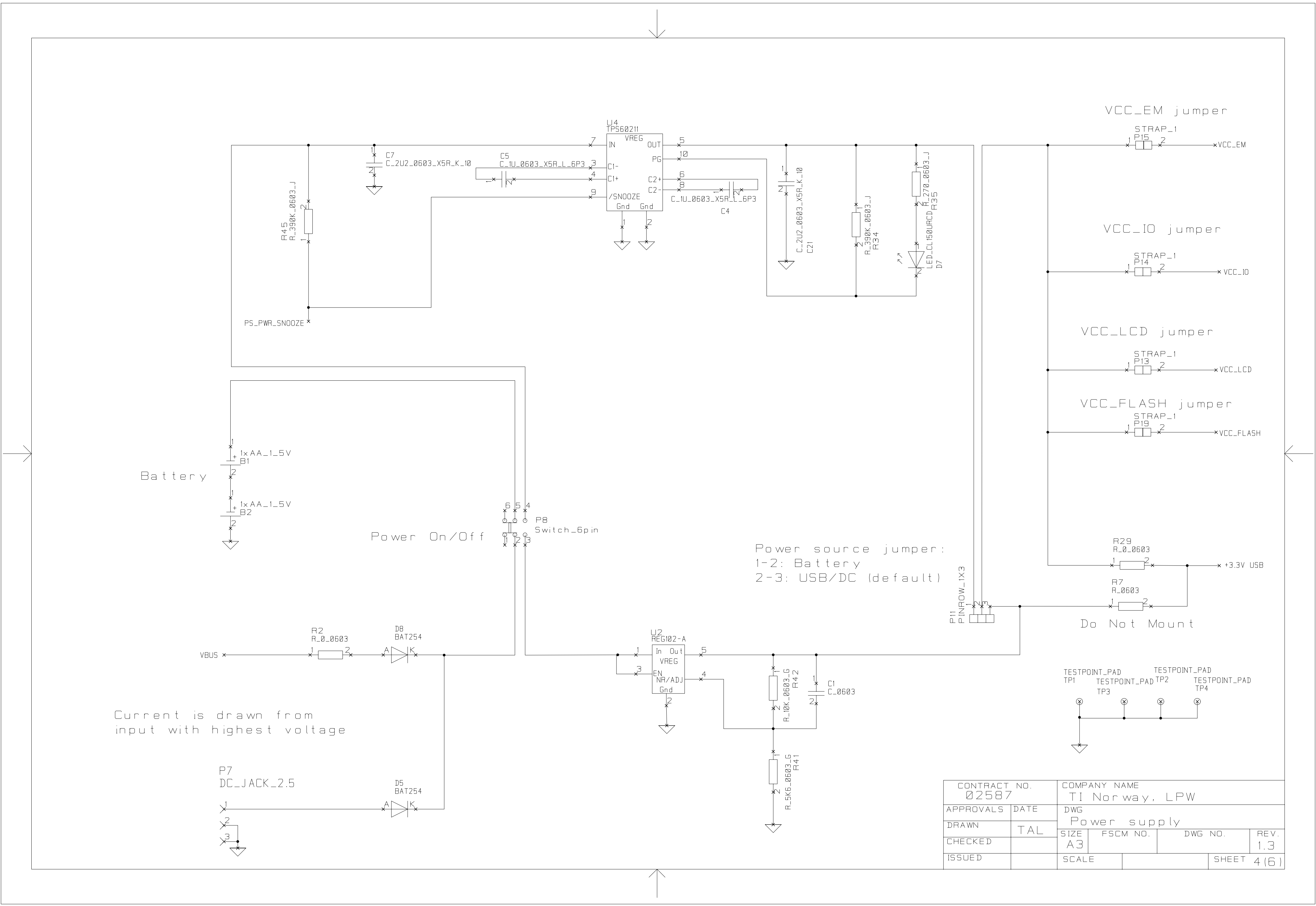

USB Interface
- CC2511
- CC2511 debug
- USB port
DBG_DD_DIR
USB_UART_RTS
USB_UART_CTS
USB_UART_RX
USB_UART_TX
USB_SNIFF_DATA
USB_SNIFF_CLK
USB_SNIFF_MISO
USB_DBG_DC
USB_DBG_DD
USB_CS
USB_SCLK
USB_MOSI
USB_MISO
USB_LCD_CS
USB_LCD_MODE
USB_LCD_FLASH_RESET
JOY_LEVEL
JOY_MOVE
VBUS
+3.3V USB
USB_EM_RESET
Sheet 2
Power Supply
- Regulators
- Power jumpers
- Battery
VBUS
+3.3V USB
VCC_EM
PS_PWR_SNOOZE
VCC_IO
VCC_LCD
VCC_FLASH
Sheet 4
PCB_FEET_19
H3
PCB_FEET_19
H2
PCB_FEET_19
H1
PCB_FEET_19
H4
USB MCU IO
jumpers
Default setting:
1-2: open
3-4: open
5-6: mount
7-8: mount
9-10: open
11-12: open
13-14: open
15-16: open
17-18: mount
19-20: mount
21-22: mount
23-24: mount
25-26: mount
27-28: mount
29-30: mount
31-32: mount
33-34: mount
35-36: mount
37-38: mount
P1
PINROW_2X19
User Interface
- LCD
- Flash
- Joystick
- Potmeter
- Buttons
- LEDs
USB_EM_RESET
IO_JOY_MOVE
IO_JOY_LEVEL
IO_LCD_FLASH_RESET
IO_LCD_MODE
IO_LCD_CS
IO_MISO
IO_MOSI
IO_SCLK
IO_FLASH_CS
IO_BUTTON1
IO_BUTTON2
IO_LED1
IO_LED2
IO_LED3
IO_LED4
IO_JOYSTICK_UP
IO_JOYSTICK_DN
IO_JOYSTICK_LT
IO_JOYSTICK_RT
IO_JOYSTICK_PUSH
IO_POT_R
VCC_FLASH
VCC_LCD
VCC_IO
VCC_EM
IO_EM_RESET
Sheet 5
EM Interface
- EM connection
- External SoC debug
EM_JOY_MOVE
EM_JOY_LEVEL
EM_LCD_FLASH_RESET
EM_LCD_MODE
EM_LCD_CS
EM_MISO
EM_MOSI
EM_SCLK
EM_FLASH_CS
EM_BUTTON1
EM_BUTTON2
EM_LED1
EM_LED2
EM_LED3
EM_LED4
EM_JOYSTICK_UP
EM_JOYSTICK_DN
EM_JOYSTICK_LT
EM_JOYSTICK_RT
EM_JOYSTICK_PUSH
EM_POT_R
EM_CS
EM_DBG_DD
EM_DBG_DC
EM_SNIFF_SFD
EM_SNIFF_MISO
EM_SNIFF_CLK
EM_SNIFF_DATA
EM_UART_TX
EM_UART_RX
EM_UART_CTS
EM_UART_RTS
DBG_DD_DIR
EM_RESET
PS_PWR_SNOOZE
VCC_EM
Sheet 3
P4
PINROW_2X22
IO periferials jumpers
All mount as default
RS-232
- RS232 driver
- RS232 port
- On/Off jumper
EM_UART_TX
EM_UART_RX
EM_UART_CTS
EM_UART_RTS
VCC_IO
Sheet 6
FIDUCIAL_MARK FM1
FIDUCIAL_MARK FM3
FIDUCIAL_MARK FM5
FIDUCIAL_MARK FM4
FIDUCIAL_MARK FM6
FIDUCIAL_MARK FM2
CONTRACT NO.
02587
APPROVALS
DATE
DRAWN
TAL
CHECKED
ISSUED
COMPANY NAME
TI Norway, LPW
DWG
SmartRF05EB Top Level
SIZE
A3
FSCM NO.
DWG NO.
REV.
1.3
SCALE
SHEET 1(6)


USB BUTTON
S4
PUSH_BUTTON
USB LED
R43
R_270_0402_F
D6
LED_CL150YCD
USB SoC Debug
R57
R_4K7_0603_G
R33
R_4K7_0603_G
P2
PINROW_2X5
USB_RESET
+3.3V USB
SPI_SELECT
CC2511_P0_0
JOY_LEVEL
Switch_6pin
P21
DBG_DD_DIR
CC2511_P1_6
JOY_MOVE
L4
L_BEAD_102_0402
C17
C_100N_0402_X5R_K_10
C18
C_100N_0402_X5R_K_10
C16
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
P17
SMA_SMD
L2
L_1N2_0402_S
C31
C_1P8_0402_NP0_C_50
C32
C_1P5_0402_NP0_C_50
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
USB_LCD_FLASH_RESET
USB_DBG_DC
USB_UART_RTS
USB_UART_CTS
USB_UART_TX
USB_UART_RX
USB_DBG_DD
USB_EM_RESET
CC2511_P1_6
CC2511_P0_0
CC2511_CS
CC2511_SCLK
CC2511_MOSI
CC2511_MISO
C27 C_100P_0402_NP0_J_50
L1 L_1N2_0402_S
C29 C_1P0_0402_NP0_C_50
L3 L_1N2_0402_S
C30 C_1P0_0402_NP0_C_50
C28 C_100P_0402_NP0_J_50
USB_LCD_MODE
USB_LCD_CS
R44
R_56K_0402_F
S3
PUSH_BUTTON
USB_RESET
C6
C_0603
X1
X_48.000/20/35/20/18
C19
C_33P_0402_NP0_J_50
C20
C_33P_0402_NP0_J_50
+3.3V USB
R18
R_0402
R10
R_0_0402
VBUS
R9
R_1K5_0402_G
P12
USB_B
VBUS
D-
D+
GND
Shield
Shield
R12
R_33_0402_G
R11
R_33_0402_G
C2
C_47P_0402_NP0_J_50
C3
C_47P_0402_NP0_J_50
R52
R_4K7_0603_G
SPI_SELECT
U10
SN74CBTLV3257PW
VDD
GND
S
OE
1A
2A
3A
4A
1B1
1B2
2B1
2B2
3B1
3B2
4B1
4B2
CC2511_SCLK
CC2511_MOSI
CC2511_MISO
CC2511_CS
USB_SNIFF_CLK
USB_SCLK
USB_SNIFF_DATA
USB_MOSI
USB_SNIFF_MISO
USB_MISO
USB_DBG_DD
USB_CS
SPI-bus vs SNIFF interface select
SPI_SELECT = H: CC2511 SPI connected to LCD, FLASH and EM SPI
SPI_SELECT = L: CC2511 SPI connected to SNIFF interface
CONTRACT NO.
02587
COMPANY NAME
TI Norway, LPW
APPROVALS
DATE
DWG
USB Interface
DRAWN
TAL
CHECKED
SIZE
A3
FSCM NO.
DWG NO.
REV.
1.3
ISSUED
SCALE
SHEET
2(6)

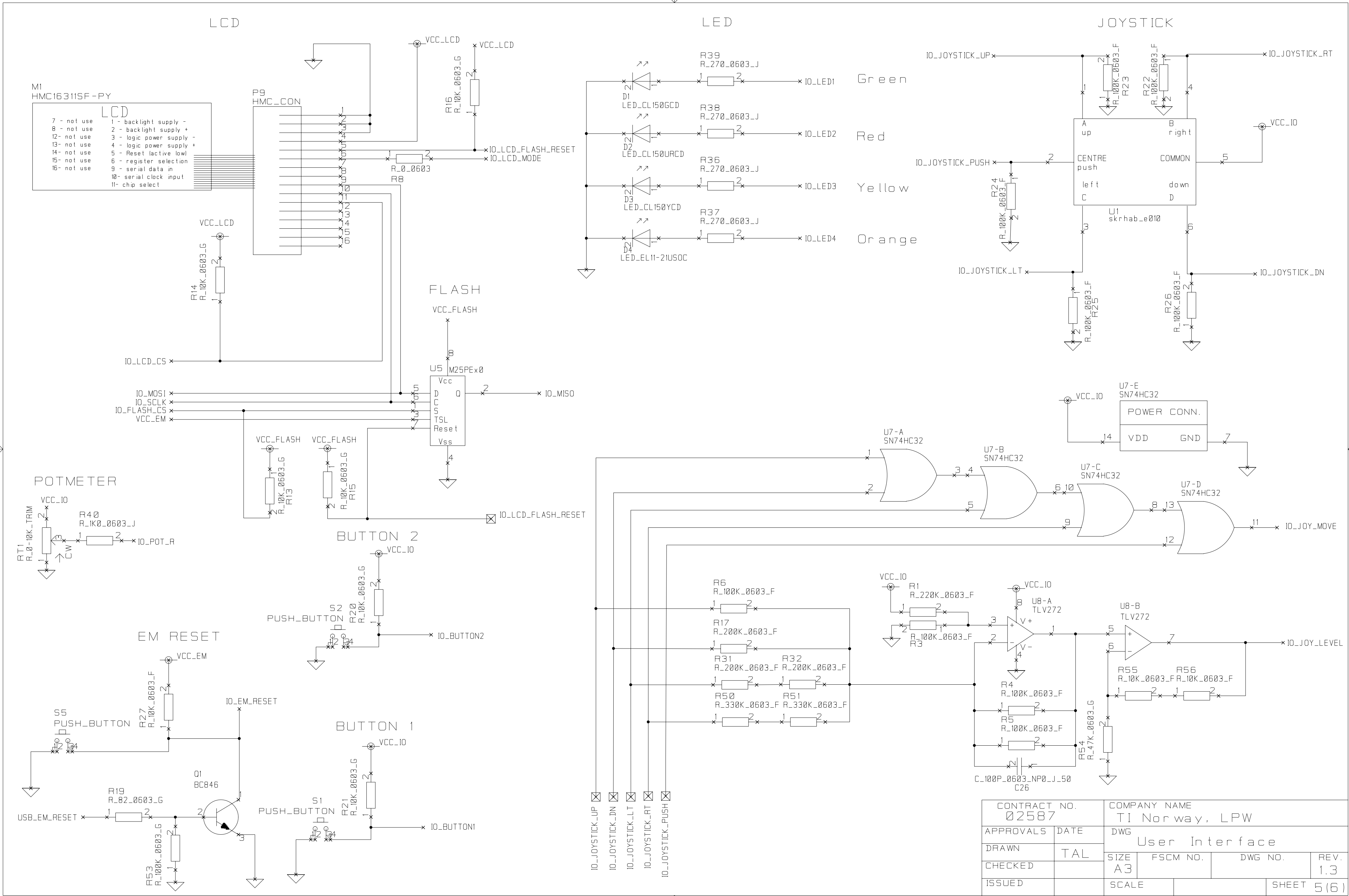


Debug connectors mirror EM connectors with a few exceptions.
Exceptions: Pins 1, 2 and 3 left unconnected. GND connected to pin 20.
Reason for exception is to be able to connect an Agilent logic analyzer probe directly to the debug connector.

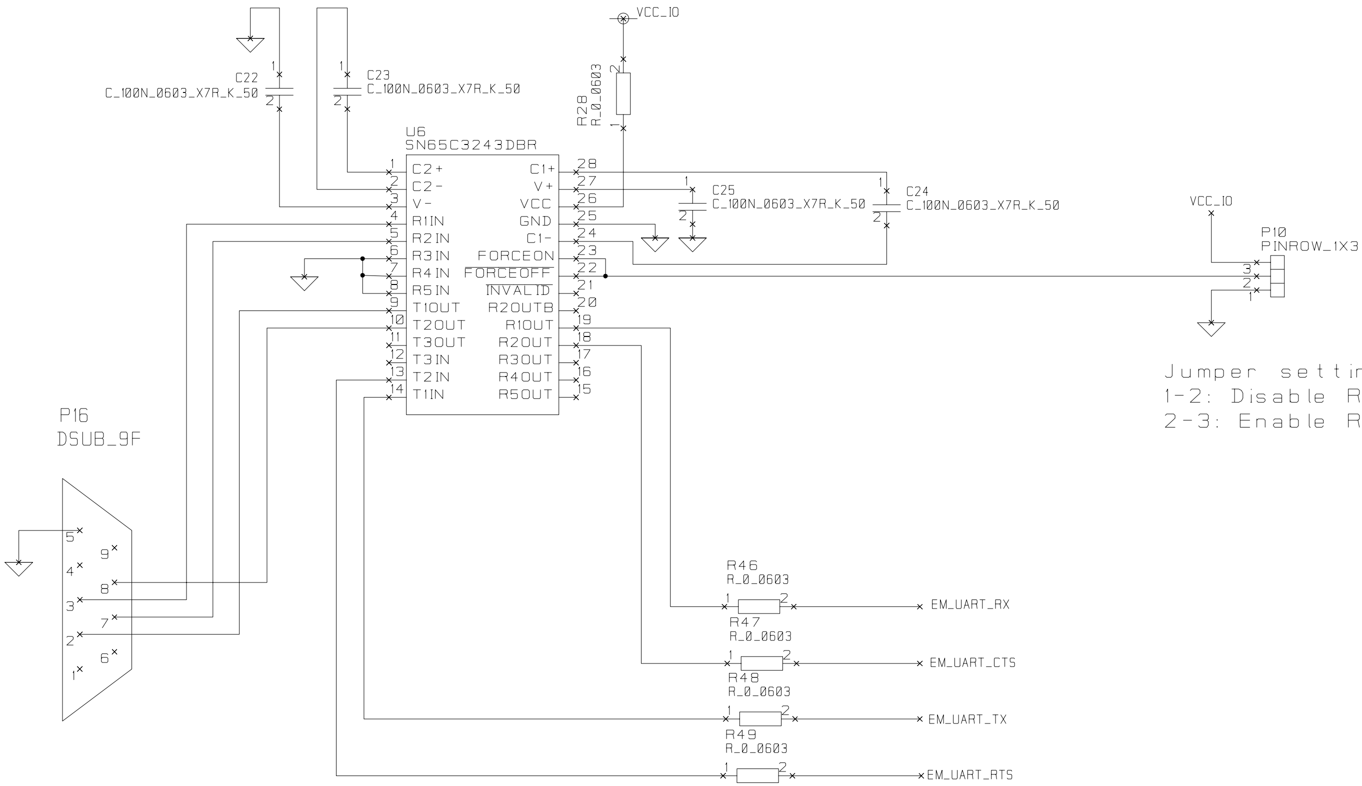
CONTRACT NO. 02587		COMPANY NAME TI Norway, LPW			
APPROVALS	DATE	DWG EM Interface			
DRAWN	TAL	SIZE A3	FSCM NO.	DWG NO.	REV. 1.3
CHECKED					
ISSUED		SCALE		SHEET 3(6)	



VCC_EM jumper
VCC_IO jumper
VCC_LCD jumper
VCC_FLASH jumper
STRAP_1
P15
P14
P13
P19
VCC_EM
VCC_IO
VCC_LCD
VCC_FLASH
U4
TPS60211
VREG
IN
OUT
PG
C1-
C1+
C2+
C2-
/SNOOZE
Gnd
C7
C_2U2_0603_X5R_K_10
C5
C_1U_0603_X5R_L_6P3
C4
C_1U_0603_X5R_L_6P3
C21
C_2U2_0603_X5R_K_10
R34
R_390K_0603_J
R35
R_270_0603_J
D7
LED_CL150URCD
R45
R_390K_0603_J
PS_PWR_SNOOZE
Battery
1xAA_1_5V
B1
B2
Power On/Off
P8
Switch_6pin
Power source jumper:
1-2: Battery
2-3: USB/DC (default)
P11
PINROW_1X3
R29
R_0_0603
+3.3V USB
R7
R_0603
Do Not Mount
VBUS
R2
R_0_0603
D8
BAT254
U2
REG102-A
In
Out
EN
NR/ADJ
R42
R_10K_0603_G
C1
C_0603
R41
R_5K6_0603_G
TESTPOINT_PAD
TP1
TP2
TP3
TP4
Current is drawn from
input with highest voltage
P7
DC_JACK_2.5
D5
BAT254
CONTRACT NO.
02587
COMPANY NAME
TI Norway, LPW
APPROVALS
DATE
DWG
Power supply
DRAWN
TAL
CHECKED
SIZE
A3
FSCM NO.
DWG NO.
REV.
1.3
ISSUED
SCALE
SHEET
4(6)



LCD
LED
JOYSTICK
FLASH
POTMETER
BUTTON 2
BUTTON 1
EM RESET
M1
HMC16311SF-PY
LCD
7 - not use
8 - not use
12- not use
13- not use
14- not use
15- not use
16- not use
1 - backlight supply -
2 - backlight supply +
3 - logic power supply -
4 - logic power supply +
5 - Reset (active low)
6 - register selection
9 - serial data in
10- serial clock input
11- chip select
P9
HMC_CON
VCC_LCD
R16
R_10K_0603_G
IO_LCD_FLASH_RESET
IO_LCD_MODE
R_0_0603
R8
R14
R_10K_0603_G
IO_LCD_CS
R39
R_270_0603_J
IO_LED1
Green
D1
LED_CL150GCD
R38
R_270_0603_J
IO_LED2
Red
D2
LED_CL150URCD
R36
R_270_0603_J
IO_LED3
Yellow
D3
LED_CL150YCD
R37
R_270_0603_J
IO_LED4
Orange
D4
LED_EL11-21USOC
IO_JOYSTICK_UP
IO_JOYSTICK_RT
R23
R_100K_0603_F
R22
R_100K_0603_F
A
up
B
right
CENTRE
push
COMMON
left
C
down
D
U1
skrhab_e010
VCC_IO
IO_JOYSTICK_PUSH
R24
R_100K_0603_F
IO_JOYSTICK_LT
IO_JOYSTICK_DN
R25
R_100K_0603_F
R26
R_100K_0603_F
VCC_FLASH
U5
M25PEx0
Vcc
D
C
S
TSL
Reset
Vss
Q
IO_MISO
IO_MOSI
IO_SCLK
IO_FLASH_CS
VCC_EM
R13
R_10K_0603_G
R15
R_10K_0603_G
IO_LCD_FLASH_RESET
U7-E
SN74HC32
POWER CONN.
VDD
GND
U7-A
SN74HC32
U7-B
SN74HC32
U7-C
SN74HC32
U7-D
SN74HC32
IO_JOY_MOVE
RT1
R_0-10K_TRIM
CW
R40
R_1K0_0603_J
IO_POT_R
S2
PUSH_BUTTON
R20
R_10K_0603_G
IO_BUTTON2
R6
R_100K_0603_F
R17
R_200K_0603_F
R31
R_200K_0603_F
R32
R_200K_0603_F
R50
R_330K_0603_F
R51
R_330K_0603_F
R1
R_220K_0603_F
R3
R_100K_0603_F
U8-A
TLV272
U8-B
TLV272
V+
V-
IO_JOY_LEVEL
R4
R_100K_0603_F
R5
R_100K_0603_F
C_100P_0603_NP0_J_50
C26
R54
R_47K_0603_G
R55
R_10K_0603_F
R56
R_10K_0603_F
S5
PUSH_BUTTON
R27
R_10K_0603_F
IO_EM_RESET
Q1
BC846
R19
R_82_0603_G
USB_EM_RESET
R53
R_100K_0603_G
S1
PUSH_BUTTON
R21
R_10K_0603_G
IO_BUTTON1
IO_JOYSTICK_UP
IO_JOYSTICK_DN
IO_JOYSTICK_LT
IO_JOYSTICK_RT
IO_JOYSTICK_PUSH
CONTRACT NO.
02587
COMPANY NAME
TI Norway, LPW
APPROVALS
DATE
DWG
User Interface
DRAWN
TAL
CHECKED
SIZE
A3
FSCM NO.
DWG NO.
REV.
1.3
ISSUED
SCALE
SHEET
5(6)



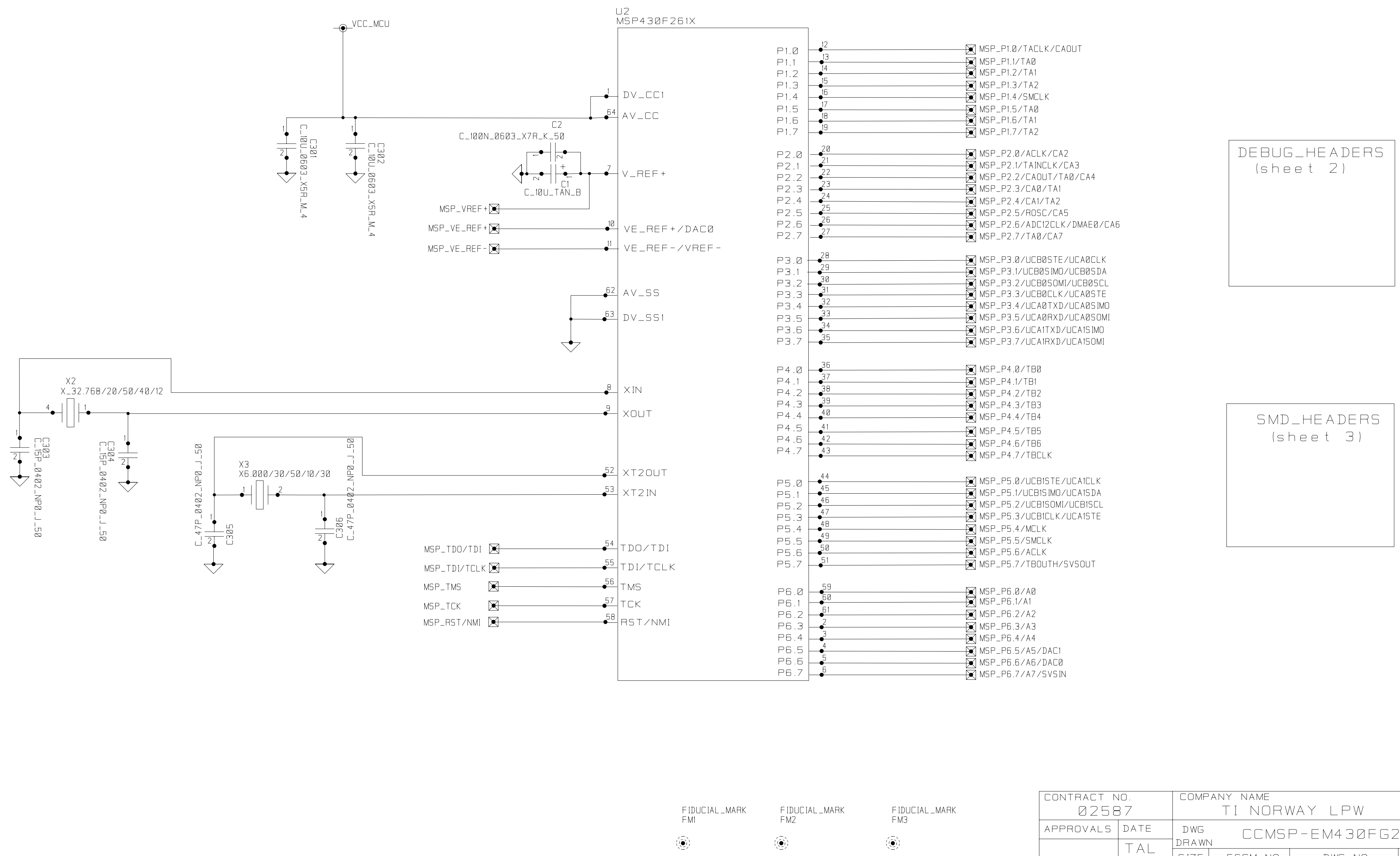
Jumper setting:
1-2: Disable RS232-port
2-3: Enable RS232-port (Default)

PC RS232-port
2-RXD
3-TXD
5-GND
7-RTS
8-CTS

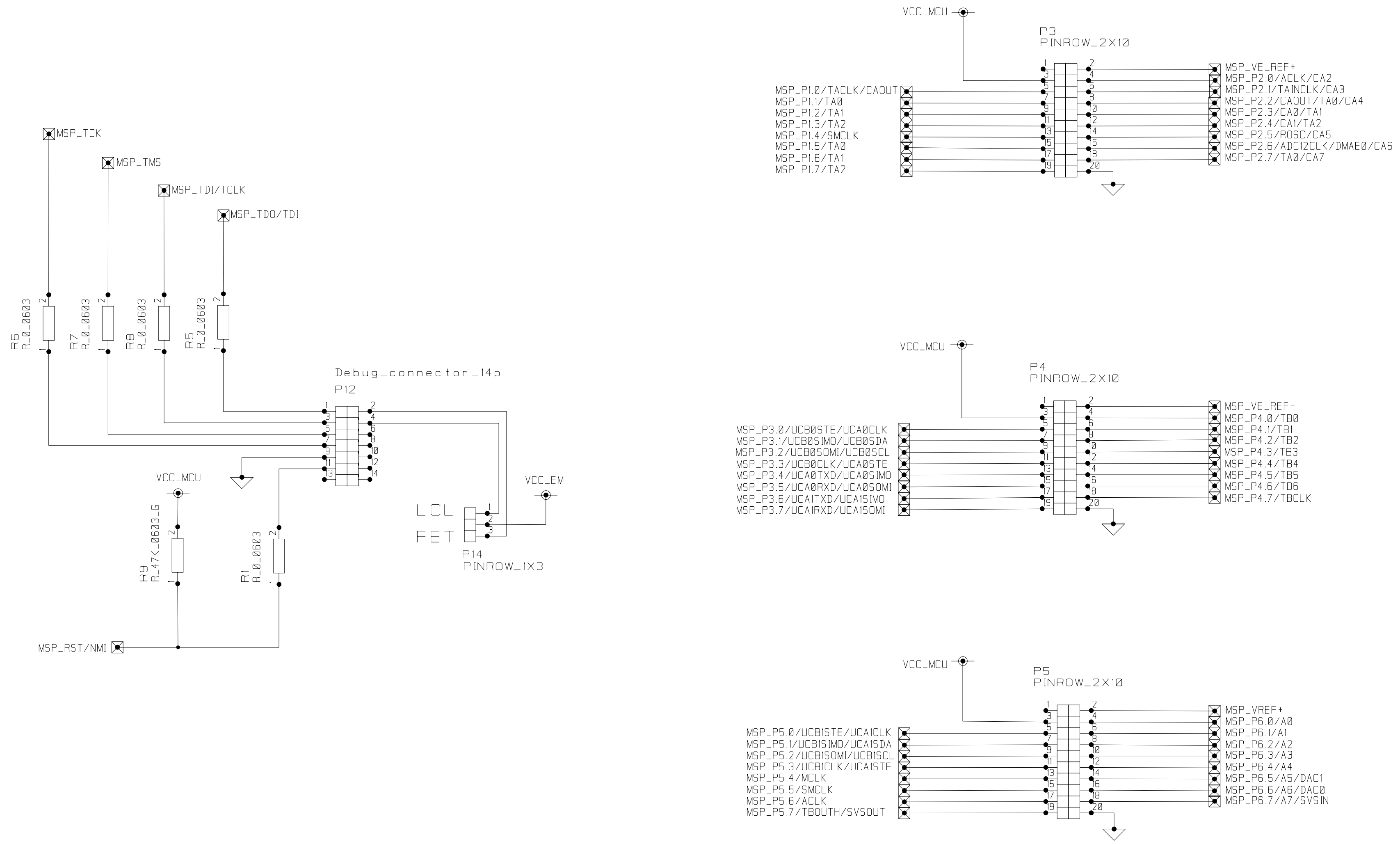
CONTRACT NO. 02587		COMPANY NAME TI Norway, LPW			
APPROVALS	DATE	DWG RS-232 Interface			
DRAWN	TAL				
CHECKED		SIZE A3	FSCM NO.	DWG NO.	REV. 1.3
ISSUED		SCALE		SHEET 6(6)	

Appendix B

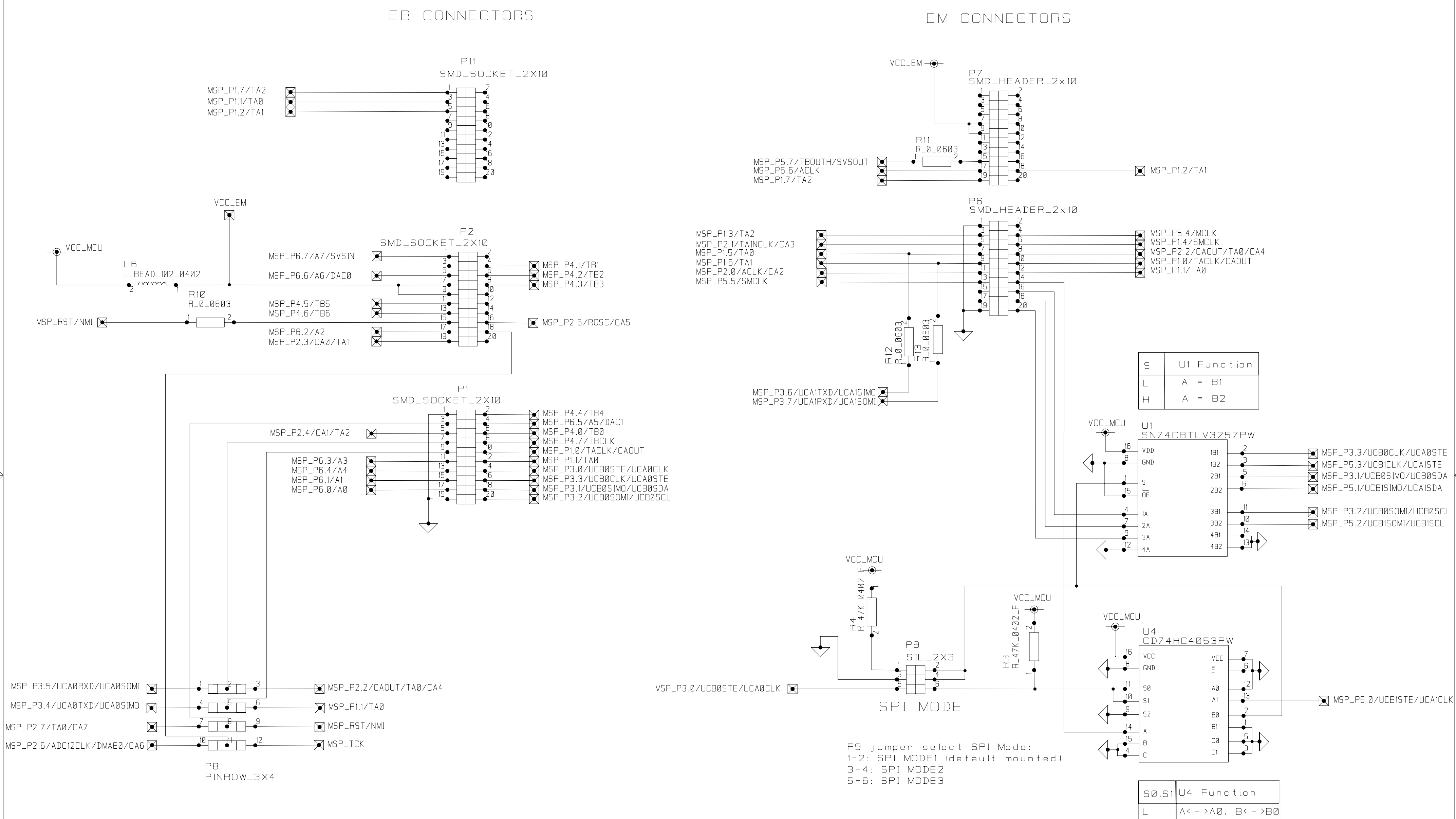
CCMSP-EM430F2618 Schematics



CONTRACT NO. 02587		COMPANY NAME TI NORWAY LPW			
APPROVALS	DATE	DWG DRAWN	CCMSP-EM430FG2618		
	TAL	SIZE A3	FSCM NO.	DWG NO.	REV. 1.0
CHECKED					
ISSUED		SCALE		SHEET 1(3)	



CONTRACT NO. 02587		COMPANY NAME TI NORWAY LPW			
APPROVALS	DATE	DWG DRAWN	DEBUG_HEADERS		
	TAL	SIZE A3	FSCM NO.	DWG NO.	REV. 1.0
CHECKED					
ISSUED		SCALE			SHEET 2(3)



BOOTSTRAP LOADER

P8 jumpers select between normal UART and BSL.
All jumpers left = P1/P2 UART connected to MSP UART (default mounted)
All jumpers right = P1/P2 UART connected to MSP BSL

CONTRACT NO. 02587		COMPANY NAME TI NORWAY LPW			
APPROVALS	DATE	DWG DRAWN SMD_HEADERS			
	TAL				
CHECKED		SIZE A3	FSCM NO.	DWG NO.	REV. 1.0
ISSUED		SCALE		SHEET 3(3)	