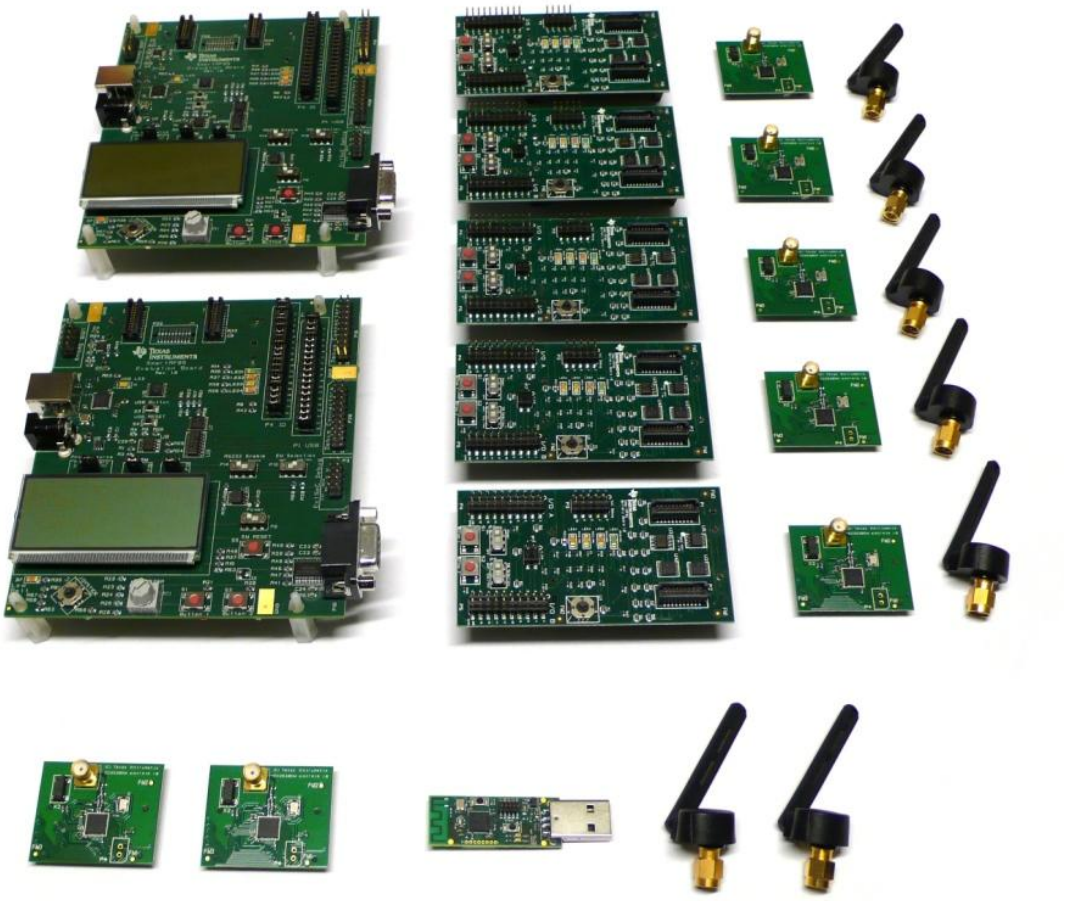
CC2530 ZigBee Development Kit User's Guide



swru209b

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1 Introduction

Thank you for purchasing the CC2530 ZigBee Development Kit.

The CC2530 is Texas Instrument's second generation ZigBee/IEEE 802.15.4 compliant System-on-Chip with an optimized 8051 MCU core and radio for the 2.4 GHz unlicensed ISM/SRD band. This device 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 CC2530 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.

Z-Stack™ is TI's ZigBee compliant protocol stack for a growing portfolio of IEEE 802.15.4 products and platforms. Z-Stack support the CC2530 and is compliant with both the ZigBee® 2007 (ZigBee and ZigBee PRO) and ZigBee® 2006 specification.

The CC2530 ZigBee Development Kit is well suited for demonstration, evaluation and software development targeting IEEE 802.15.4 and ZigBee compliant applications with the CC2530.

The CC2530 product folder on the web [1] has more information, with datasheets, user guides and application notes. For more information about TI's ZigBee software implementation, refer to the Z-Stack product folder on the web [7]. This web site also has links for download of Z-stack.

2 About this manual

This manual describes all the hardware included in the CC2530 ZigBee Development Kit (CC2530ZDK) and points to other useful information resources.

Chapter 4 briefly describes the contents of the development kit and chapter 5 gives 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 lists 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 the hardware in the kit and where to find more information about how to use it. A troubleshooting guide can be found in chapter 11.

The CC2530ZDK Quick Start Guide [9] has a short tutorial on how to get started with this kit.

More information and user manuals for the PC tools SmartRF Studio and SmartRF Flash Programmer can be found on their respective product sites on the web [2] [3].

Please visit the CC2530 ZigBee Development Kit [11] web page and CC2530 product page [1] for additional information. Further information can be found on the TI LPRF Online Community [16].

Refer also to the document CC2530DK User's Guide [13] which gives a detailed description of how to set up the software development environment for the CC2530. This document also lists other available software solutions for CC2530.

See chapter 12 for a list of relevant documents and links.

3 Acronyms

ACM	Abstract Control Model
BB	Battery Board
CDC	Communications Device Class
DK	Development Kit
EB	Evaluation Board
EM	Evaluation Module
HID	Human Interface Device
IC	Integrated Circuit
ISM	Industrial, Scientific and Medical
KB	Kilo Byte (1024 byte)
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LPRF	Low Power RF
MCU	Micro Controller
NC	Not connected
PER	Packet Error Rate
RF	Radio Frequency
RX	Receive
SoC	System on Chip
SPI	Serial Peripheral Interface
SRD	Short Range Device
TI	Texas Instruments
TX	Transmit
UART	Universal Asynchronous Receive Transmit
USB	Universal Serial Bus
ZDK	ZigBee Development Kit
Z-Stack	TI's ZigBee software implementation

4 ZigBee Development Kit contents

The CC2530 ZigBee Development Kit (CC2530ZDK) includes hardware and software that allows quick testing of the CC2530 RF performance and offers a complete platform for development of advanced prototype RF systems and ZigBee applications.

- Evaluate the CC2530 and ZigBee right out of the box. The kit can be used to demonstrate a small sensor network application using ZigBee and the CC2530.
- Use the CC2530ZDK to do software development of your own ZigBee applications using Z-Stack™ for CC2530.
- 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 pins from the CC2530 are available on pin connectors on the SmartRF05EB, allowing easy interconnection to peripherals on the EB board or other external sensors and devices.

The CC2530ZDK contains the following components

- 2 x SmartRF05EB (the two large boards)
- 5 x SmartRF05 Battery Boards
- 7 x CC2530 Evaluation Modules (with the CC2530 and antenna connector)
    - 2 of these CC2530EM's are pre-programmed with the SensorDemo Collector application[1]
    - 5 of the CC2530EM's are pre-programmed with the SensorDemo Sensor application
- 7 x Antennas
- 1 x CC2531 USB Dongle
- Cables
- Batteries
- Documents

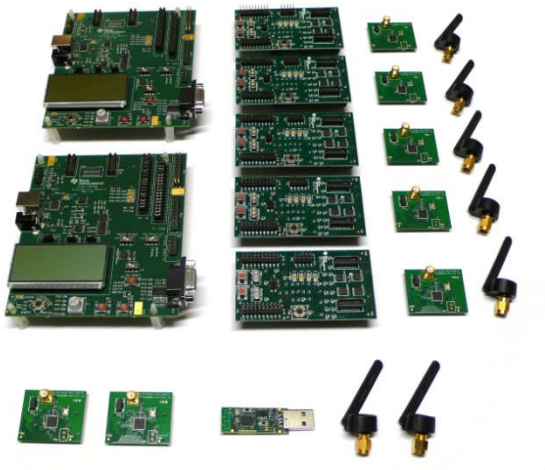


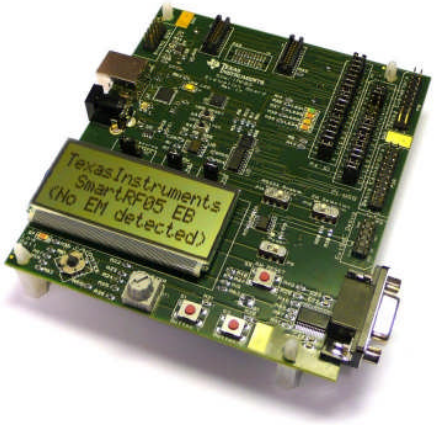
Figure 1 - CC2530 ZigBee Development Kit Contents

[1] Consult the CC2530ZDK Quick Start Guide [9] and the CC2530ZDK Sensor Demo User's Guide [10] for a description of the software programmed on the CC2530EM's.

SmartRF05EB

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

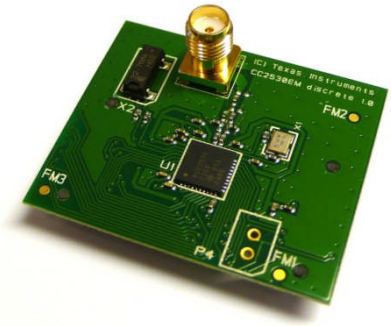
- 3x16 character serial LCD
- Full speed USB 2.0 interface
- UART
- LEDs
- Serial Flash
- Potentiometer
- Joystick
- Buttons



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

CC2530EM

The CC2530EM (evaluation module) contains 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. **Use the EM as reference design for RF layout.** The schematics are included at the end of this document and the layout files can be found on the web [1].



CC2531 USB Dongle

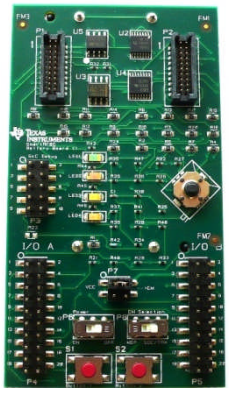
The CC2531 USB Dongle is a fully operational USB device that can be plugged into a PC. The dongle has 2 LEDs, two small push-buttons and connector holes that allow connection of external sensors or devices. The dongle also has a connector for programming and debugging of the CC2531 USB controller.



The dongle comes preprogrammed with firmware such that it can be used as a packet sniffer device.

SmartRF05BB

The SmartRF05 Battery Board can be used as an alternative to the EB, providing a standalone node when the CC2530EM is connected. It is powered with 2 AA batteries in the sockets underneath the board. The board peripherals include 4 LED's, 2 push buttons and a joystick. The BB also has a SoC debug connector for connection to an external debug/programming tool e.g. the SmartRF05EB.



5 Getting started

5.1 Setting up the hardware

After opening the kit, make sure you have all components. Please contact your TI Sales Representative or TI Support [17] if anything is missing.

Start by connecting the antennas to the SMA connector on the RF evaluation boards. Tighten the antenna's screw firmly on to the SMA connector. If not properly connected, you might see reduced RF performance. It is also possible to connect the EM board to RF instruments via coax cables. The EM is designed to match a 50 Ohm load at the SMA connector.

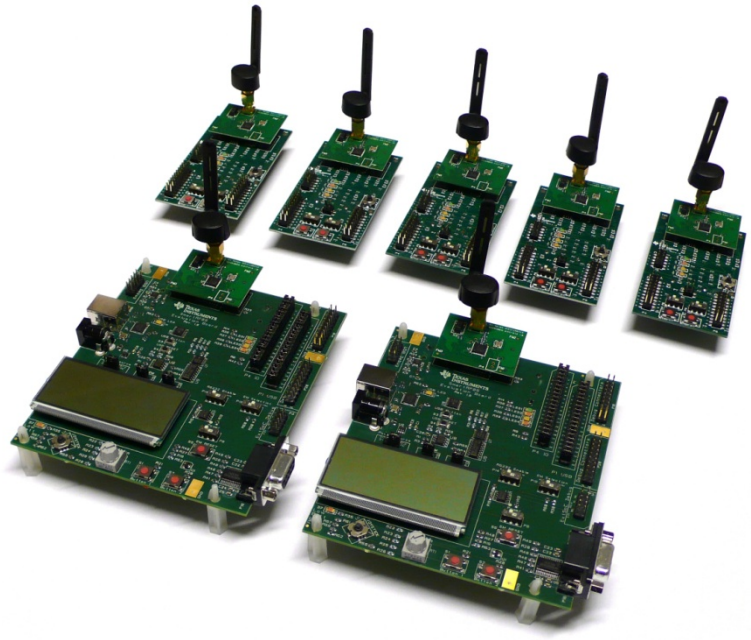


Figure 2 CC2530ZDK assembled hardware

Next, the evaluation modules should be plugged in to the SmartRF05EB's and to the SmartRF05BB's. A ZigBee sensor demo application is preprogrammed on the CC2530EM's included in this kit. The application consists of two different device types; collectors and sensors. 5 of the CC2530EM's are programmed as the sensor device type. When running the out of the box demonstration the sensor EM's shall be connected to the BB's. The two EM's programmed as collector device shall be connected to the EB's.

When not using the out of the box demonstration (i.e. the preprogrammed application) e.g, for RF evaluation or software development, all of the 7 EM's can be used equally.

The purpose of the SmartRF05EB is to serve as a general I/O board for testing of the various peripherals of the CC2530 microcontroller. The SmartRF05EB is also used for programming and debugging of the CC2530, and has several useful peripheral devices like LCD, LED's, I/O connectors, push buttons and joystick etc.

The evaluation board can be powered from several different sources:

- 2 x 1.5V AA batteries (included in this kit)
- USB (via the USB connector)
- DC power (4 to 10 Volt) (not included in this kit)

- External regulated power source (not included in this kit)

The power source can be selected using jumper P11 on the SmartRF05EB. The SmartRF05EB User's Guide [6] provides more details.

The SmartRF05 Battery Boards (BB) can be used as a standalone device when equipped with a CC2530EM. This board is powered by AA batteries. See section 10 in this document for more information about the SmartRF05BB.

After assembling the hardware, you now have several options for working with the CC2530:

- **Run the Sensor Demo ZigBee application that is preprogrammed on the CC2530's.** The CC2530ZDK Quick Start Guide document [9] included in this kit describes the necessary steps to run the demonstration.
- **Running the packet error rate (PER) test software available for CC2530EM.** Chapter 5.3 describes this application.
- **Evaluate and explore the RF capabilities of the CC2530 using SmartRF Studio.** Chapter 5.4 provides the details how to do so.
- **Develop your own software for the CC2530.** Install IAR Embedded Workbench for 8051 and set up your first software project. Section 5.5 explains how.
- **Develop your own hardware with the CC2530.** See chapter 5.6.

5.2 Running the Preprogrammed ZigBee Sensor Demo

The CC2530EM's are pre-programmed with a Sensor Demo application used to demonstrate a temperature monitoring application in a small ZigBee network. The CC2530ZDK Quick Start Guide document [9] included in this kit describes the necessary steps to run the demonstration.

A software package with the source code for the Sensor Demo, and Intel HEX files ready to be programmed on the devices, is available on the CC2530ZDK web site [11]. A detailed description about the Sensor Demo application is found in the document CC2530ZDK Sensor Demo User's Guide [10].

5.3 CC2530 PER test

A Packet Error Rate (PER) test application is also available for the CC2530. This application can be used to evaluate the RF performance of CC2530 using either the hardware included in the kit or other boards with a CC2530.

More information about the PER test application can be found in the documents CC2530DK Quick Start Guide [12] and CC2530 Software Examples User's Guide [13].

A software package with the source code for the PER test application, and Intel HEX files ready to be programmed on the devices, is available on the CC2530DK web site [14].

5.4 Evaluate the CC2530 Radio using 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 CC2530. The application communicates with the CC2530 via the USB controller on the SmartRF05EB board. The USB controller uses the debug interface of the CC2530 to execute commands and to read and write registers.

SmartRF Studio lets you explore the radio on the CC2530, as it gives you full overview and access to the radio registers. The tool has a control interface for running basic radio performance tests from the

PC. SmartRF Studio also offers a flexible code export function of radio register settings for software developers.

Before proceeding, please download and install the latest version of SmartRF Studio from the web [2]. By installing Studio, the USB drivers needed for proper interaction between the PC and the hardware of the CC2530DK will also be installed.

In order to use the SmartRF Studio with CC2530, connect the CC2530EM to the SmartRF05EB. Next, connect the SmartRF05EB board to the PC via one of the USB cables included in the kit. If you have installed SmartRF Studio, select automatic installation of driver in the device wizard that appears. The device wizard will only pop up when you turn on the SmartRF05EB and only once for each board. Allow Windows to complete the driver installation before proceeding.

With the board connected to the PC, you can start SmartRF Studio. The following window should appear:

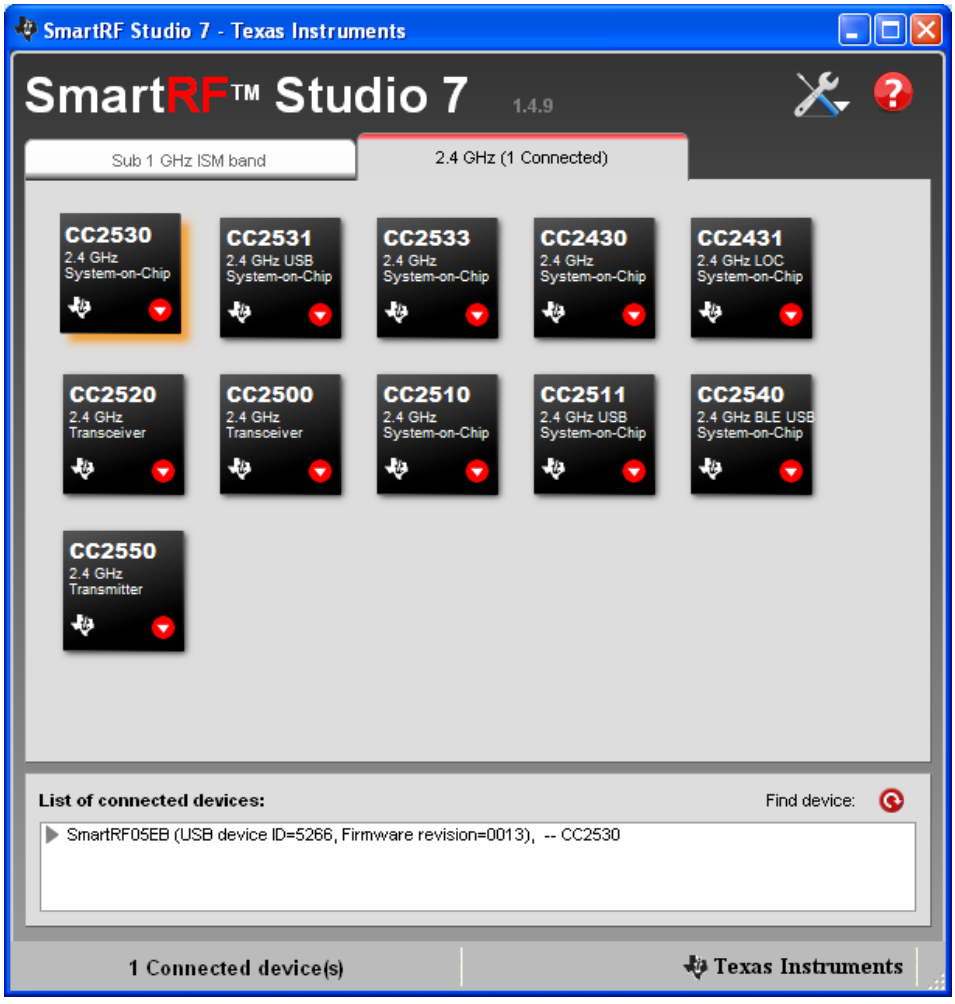


Figure 3 - CC2530 and SmartRF Studio

Make sure you select the tab called “2.4 GHz”. The tab will indicate if there is a board/device connected, and you should see the CC2530 icon highlighted as in the screenshot above. Double click on the CC2530 icon, and a new window will appear.

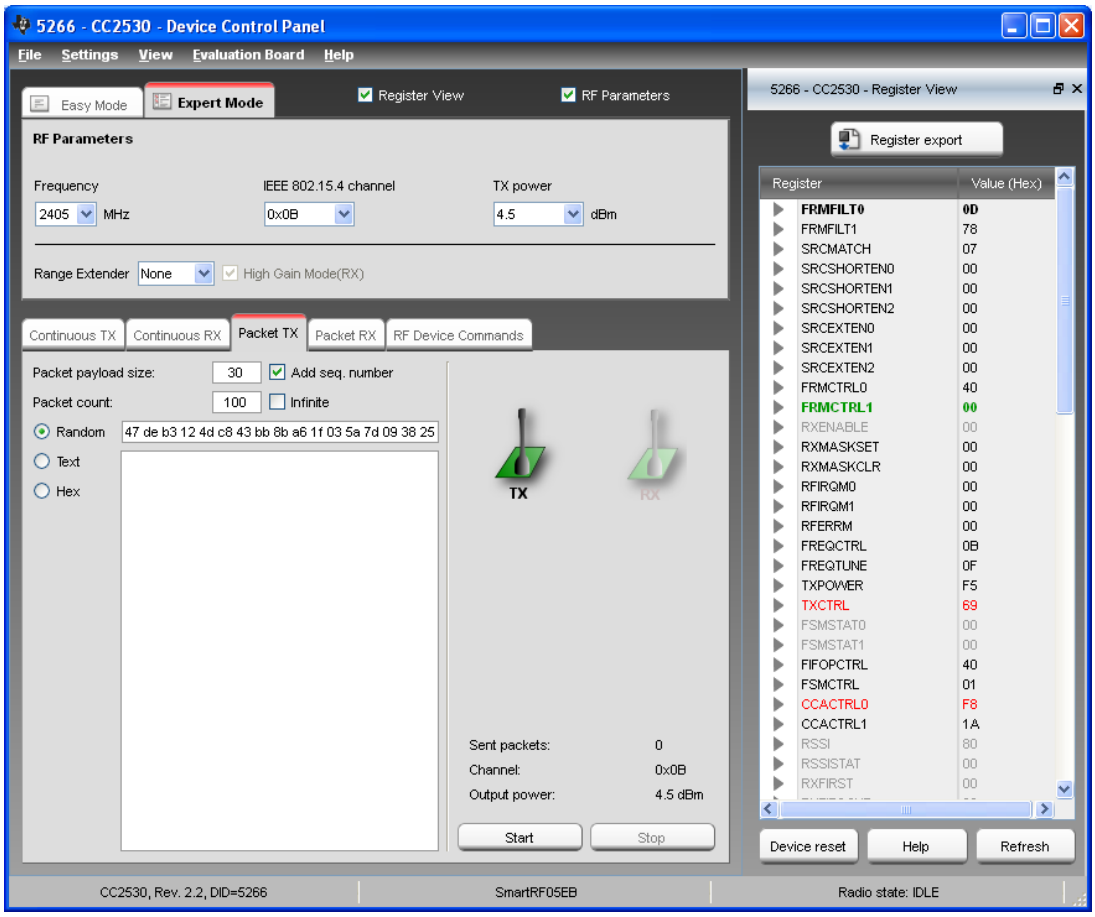


Figure 4 - CC2530 control panel in SmartRF Studio

Figure 4 shows the main control panel for the CC2530. It lets you perform a number of operations:

- Run TX Test modes for testing of RF output power and spectrum; e.g. by connecting a spectrum analyser or a power meter to the CC2530EM SMA connector to perform RF measurements.
- Run Packet TX and RX tests. For this test, you should have two EBs with CC2530EMs connected to the PC.
    - Double click on both of the devices in the device list in SmartRF Studio (Figure 3), opening two windows, giving control of the two radios at the same time.
    - Select one device to be the transmitter, by selecting the “Packet TX” tab shown in the lower middle of Figure 4.
    - On the other device (the receiver), select the “Packet RX” tab.
    - Set up basic test parameters and press the “Start” button for the receiver.
    - Now you can start transmission by pressing the “Start” button for the transmitter.
    - The window will show the number of packets sent on the transmitter side and the number of received packets and signal strength of the last received packet on the receiver side.
- Read and/or modify registers and common settings, such as RF frequency (or channel) and output power.
- Export RF register values in a user modifiable format by selecting “File → Register Export”.

SmartRF Studio offers a lot of possibilities for testing and evaluating the hardware. Download the tool and try it for yourself.

5.5 Developing your own software with the CC2530

To develop software and debug an application on the CC2530, it is recommended to use IAR Embedded Workbench. It supports debugging of CC2530 through the SmartRF05EB, so no additional hardware is required.

IAR EW8051 is bundled with all the required files for CC2530 to start development:

- Register definition header file
- Linker command file
- Driver and device description file needed for debugging and programming

Note that other compilers and linkers can be used, but these tools may have limited debugging capabilities.

An evaluation version of IAR Embedded Workbench is included in the ZigBee Development Kit. To install the software, insert the CD and follow the instructions. You will be asked to register on IAR's web site to get a license key for the product. As the owner of a CC2530 Development Kit, you are entitled to a 60 day evaluation period. The evaluation version in the kit automatically gives you 30 days. Please contact your local IAR sales representative for the additional 30-days evaluation period. For a list of sales offices and distributors in your country, please see this site: http://www.iar.com/contact.

Refer also to the CC2530DK User's Guide [13] which will guide you through the steps of setting up your own IAR project from scratch.

The CC2530DK User's Guide [13] also gives a brief overview of complete software solutions for CC2530 from Texas Instruments.

TI's ZigBee compliant protocol stack Z-Stack™ can be downloaded from the product folder [7]. This software is needed in order to develop ZigBee application for the CC2530. The product folder include downloads of Z-Stack™ for the various TI platforms. Make sure the version for CC2530 is selected. After installation refer to the Z-stack User's Guide document found in the installation folders of Z-Stack™. The default root installation path for Z-Stack is C:\Texas Instruments\.

A software package with the source code for the Sensor Demo, and Intel HEX files ready to be programmed on the devices, is available on the CC2530ZDK web site [11]. This package also includes the CC2530ZDK Sensor Demo User's Guide giving information about how to set up the software example in the IAR development environment.

5.6 Developing your own hardware with the CC2530

It is recommended to use the CC2530EM as a reference design when designing new hardware using the CC2530. The CC2530EM reference design files can be downloaded from the CC2530 product folder on the web [1].

6 RF Testing

NB! When running RF performance tests, it is recommended to disable all other peripherals on the SmartRF05EB in order to avoid unwanted noise on the on-board voltage. In particular, make sure the RS232 level converter/line driver is disabled.

RF testing can be performed by using SmartRF Studio together with the Development Kit. The basic set-up is described in section 5.4. As described in that chapter, SmartRF Studio can be used to set up basic tests and tune RF registers accordingly.

Since the CC2530 evaluation board is equipped with an SMA connector, both radiated (via antenna) and conducted (via cable) tests can be performed, and it is easy to hook the EM up to RF measurement equipment. The RF equipment may be connected in two different ways.

- To measure radiated performance, connect an appropriate antenna to the spectrum analyzer or power meter and an antenna on the EM board.
- To measure conducted performance, connect a 50 Ohm coaxial cable directly from the EM to the RF equipment.

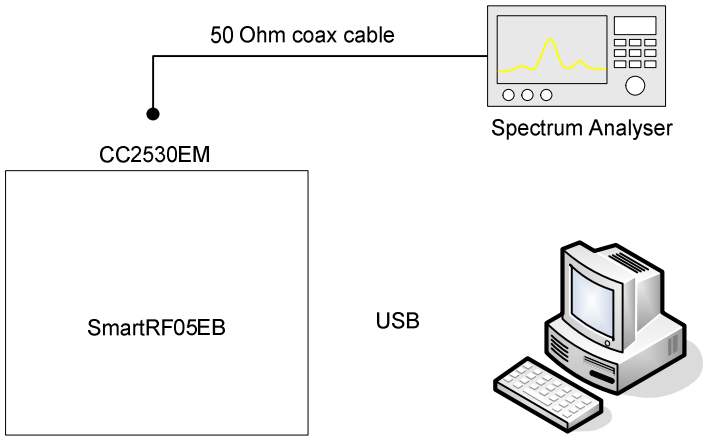


Figure 5 - RF Test Set-Up with a Spectrum analyzer

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

6.1 TX Parameter Testing Basics

To investigate the TX performance of the CC2530, you can either use a Spectrum Analyzer or an RF Power Meter. Use the “Simple TX” test mode in SmartRF Studio to set up the device to transmit a signal at the desired frequency. Both a modulated or unmodulated carrier signal can be generated.

Use the RF Power Meter to observe the output power or the spectrum analyzer to observe the spectrum and to measure the error vector magnitude (EVM).

6.2 RX Parameter Testing Basics

To investigate the RX performance of the CC2530, you can use a signal generator or “Packet TX” in SmartRF Studio (with another EB+EM) to generate the packets to receive. The receiver can be configured by using the “Packet RX” test feature in SmartRF Studio.

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 PER test application, that was described in section 5.3, can be used for simple sensitivity measurements with the CC2530EM 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 regarding sensitivity measurements, refer to “Design Note 2 – Practical Sensitivity Testing” [15].

7 CC2530EM

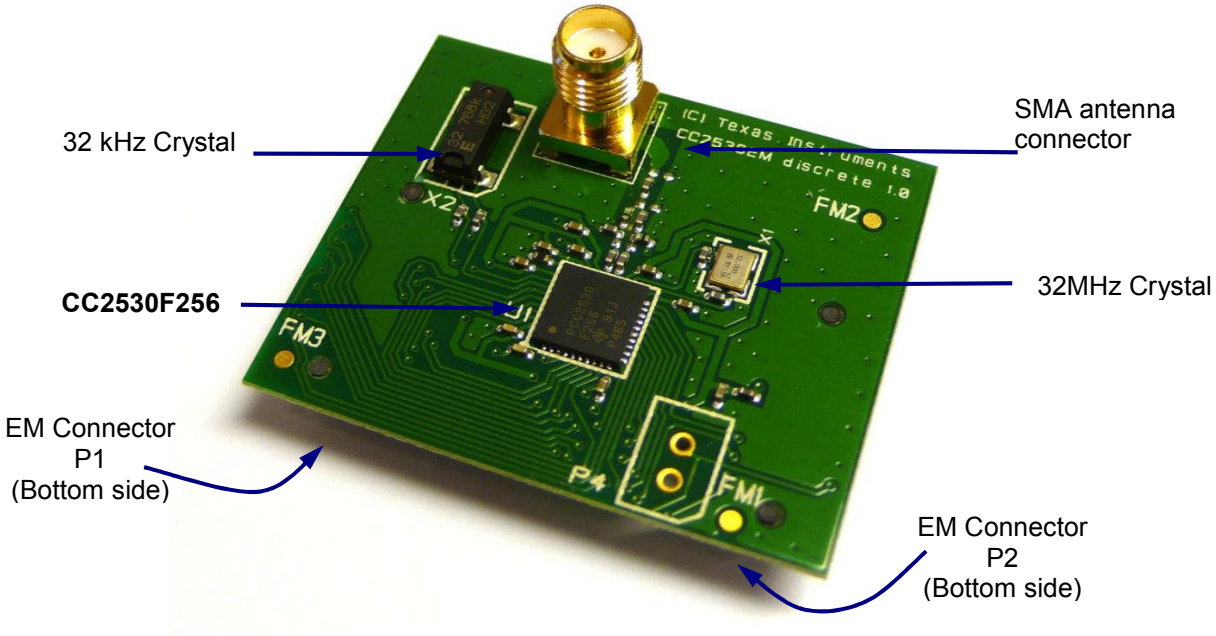


Figure 6 - CC2530 Evaluation Module

The CC2530EM is a complete RF module based on one of the recommended reference designs for the CC2530 radio. The module is equipped with a 32 MHz crystal, a 32.768 kHz crystal, external passive components for the balun and antenna match filter, an SMA connector for the antenna or any other RF instrument connection and general IO headers/connectors.

The table below shows the pin-out from the CC2530 to the two connectors on the backside of the evaluation module.

CC2530 Signal	P1	P1	CC2530 Signal
GND	1	2	-
P0.4	3	4	P1.3
P0.1	5	6	P1.0
P0.2	7	8	-
P0.3	9	10	P2.1
P0.0	11	12	P2.2
P1.1	13	14	P1.4
P0.6	15	16	P1.5
P0.7	17	18	P1.6
GND	19	20	P1.7

CC2530 Signal	P2	P2	CC2530 Signal
-	1	2	-
-	3	4	-
-	5	6	-
VDD	7	8	-
VDD	9	10	-
-	11	12	-
-	13	14	-
RESET	15	16	-
P1.2	17	18	P0.5
P2.0	19	20	-

Table 1 - CC2530EM pin-out

The part number of the EM connector is SFM-110-02-SM-D-A-K-TR from Samtec. It mates with the TFM-110-02-SM-D-A-K-TR, also from Samtec.

Please refer to the reference design on the web [1] for further details.

8 CC2531 USB Dongle

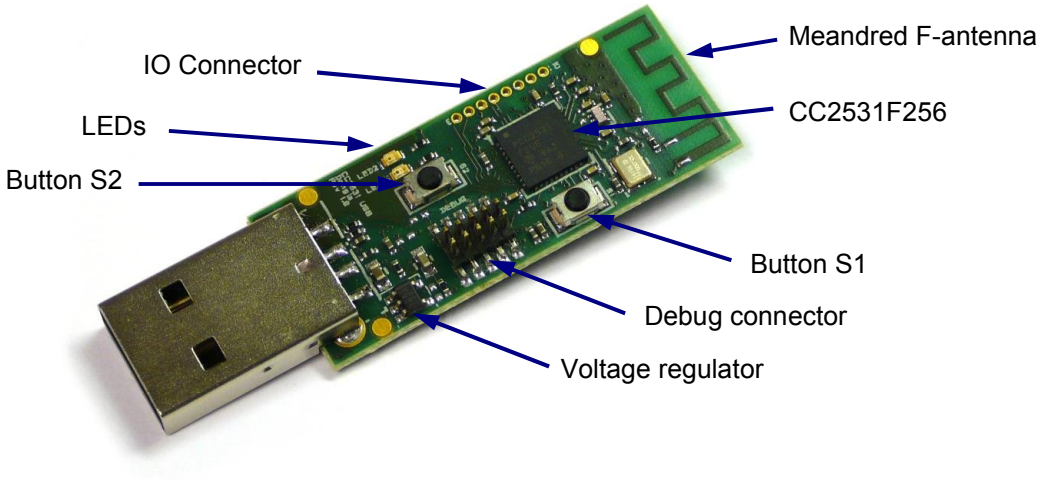


Figure 7 - CC2531 USB Dongle

The USB dongle that is included in the kit comes preprogrammed such that it can be used together with the SmartRF Packet Sniffer [4] to capture packets going over the air. To use the dongle as a sniffer, just install the Packet Sniffer PC application (available on the web [4]), plug in the USB dongle and start capturing packets. The Packet Sniffer User Manual [5] has more information.

The USB dongle can also be used as a general development board for USB and RF software. There is a USB firmware library available from the TI web pages with an implementation of a complete USB framework, including examples showing both HID and CDC ACM. There is a link to this library on the CC2530 DK web pages [14].

Table 2 shows which CC2531 signals are connected to what IO on the dongle.

IO Connector	CC2531
1	P0.2
2	P0.3
3	P0.4
4	P0.5
5	P1.7
6	P1.6
7	P1.5
8	P1.4

Dongle User IO	CC2531
Green LED	P0.0
Red LED	P1.1
Button S1	P1.2
Button S2	P1.3

Table 2 - CC2531 USB Dongle Pinout

In order to debug and program firmware on the CC2531, the CC2531 USB dongle can be connected to the SmartRF05EB as shown in the picture below. The small adapter board and flat cable is included in the development kit.

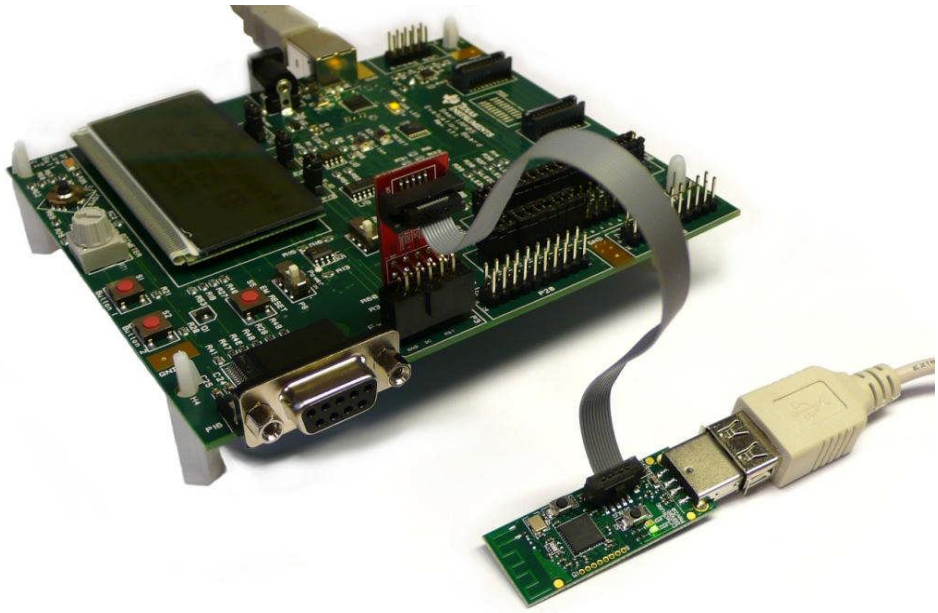


Figure 8 - CC2531 USB Dongle connected to SmartRF05EB

The debug connector on the CC2531 USB Dongle matches the debug connector on the SmartRF05EB (and the CC Debugger). Note that, by default, the CC2531 dongle is not powered through the debug connector, so an external power source must be used while programming. The easiest solution is to connect it to a USB port on the PC. Alternatively, resistor R2 can be mounted. The table below shows the pin out of the debug connector.

Pin #	Connection
1	GND
2	VCC
3	CC2531 P2.2 (DC)
4	CC2531 P2.1 (DD)
5	NC
6	NC
7	CC2531 RESET
8	NC
9	Optional external VCC (R2 must be mounted)
10	NC

Table 3 – CC2531 USB Dongle Debug Connector

Refer to the schematics (in the appendices) for additional details.

9 SmartRF05 Evaluation Board

The SmartRF05 Evaluation Board is thoroughly described in the SmartRF05EB User's Guide [6]. That document will describe the hardware features in detail and provide the schematics for the board.

10 SmartRF05 Battery Board

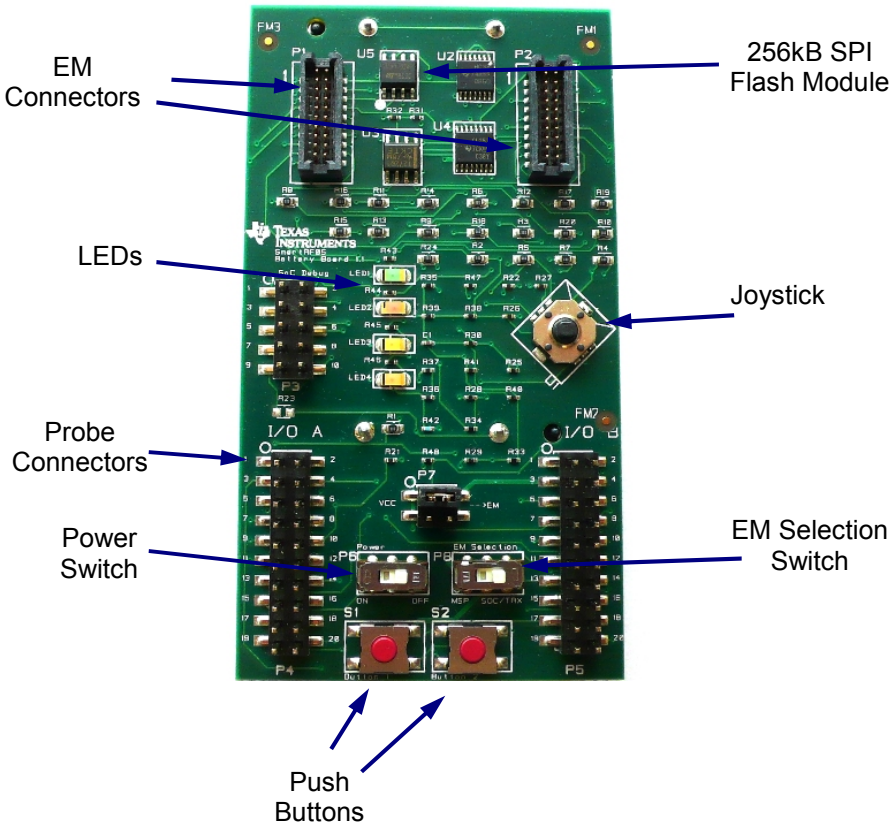


Figure 9 SmartRF05 Battery Board

The SmartRF05 Battery Board is a smaller and simpler board than the SmartRF05EB. The Battery Board can together with an EM be used as a standalone node. Figure 9 shows the SmartRF05 Battery Board. The Battery Board is powered with 2 AA batteries placed in the battery connectors underneath the board.

The peripherals that are available include 2 push buttons, a joystick with 5 directions and 4 LED's of different colours that can be controlled via the EM.

There are 2 switches on the SmartRF05 Battery Board:

- The *Power* switch P6 used to switch the board's power supply on/off.
- The *EM selection* switch.

NB: The *EM selection switch* shall be placed in position *SoC/TRX* when using a SoC EM such as CC2530EM or a transceiver EM is connected to the Battery Board.

The position MSP is used when the CCMSP-EM430F2618 board (not part of this kit) is connected. More information about the *EM Selection switch* is found in section 10.3.

The following sections give the pin out of the different connectors on the SmartRF05 Battery Board. Refer to the schematics (in the appendices) and layout (available on the web) for additional details.

10.1 Joystick

The joystick detects five positions (centre, up, down, left, right) and one event (pushed). The two aggregated signals, JOY_MOVE and JOY_LEVEL, are used to detect a joystick event when using a SoC (e.g. the CC2530). JOY_MOVE is high whenever the joystick is moved 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. The table below shows these values. Note that the voltage levels are relative to the voltage on the board.

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

Table 4 - Voltage on JOY_LEVEL for different joystick positions (T=25°C, Vdd=3.0V)

When the EM selection switch is in position MSP, there are 5 discrete signals in addition to JOY_MOVE and JOY_LEVEL to be used to distinguish which direction the joystick was pressed. These 5 discrete signals are not used with CC2530 - only with the CCMSP-EM430F2618 board (not part of this kit). The discrete signals are routed to the EM connectors. See section 10.2 for details.

10.2 EM connectors

The EM connectors P1 and P2 are used to connect an EM to the Battery Board. The pin out for these connectors is shown below. Table 1 in section 7 gives information about how the signals of the EM connectors are connected to the CC2530 on the EM board.

Note that some of the signals are shared, e.g. IO_LED4_SOC/IO_BUTTON1. This means that the signal is shared between IO's on the board; in this case both LED 4 when in SoC mode and Button 1. Pressing Button 1 will affect the state of LED 4. Similarly, if a SoC is toggling LED 4, it cannot read from Button 1 at the same time.

Function on BB	Pin	Pin	Function on BB
GND	1	2	GND
Not in use on BB	3	4	FLASH_CS
IO_LED4_SOC/IO_BUTTON1	5	6	IO_LED1
Not in use on BB	7	8	JOYSTICK_RT
Not in use on BB	9	10	SoC Debug P3.4
Not in use on BB	11	12	SoC Debug P3.3
IO_LED2_SOC	13	14	CS & SoC Debug P3.5
JOY_LEVEL	15	16	SCLK & SoC Debug P3.6
Not in use on BB	17	18	MOSI & SoC Debug P3.8
GND	19	20	MISO & SoC Debug P3.10

Table 5 - EM connector P1 pin-out

Function on BB	Pin	Pin	Function on BB
JOYSTICK_PUSH	1	2	GND
NC	3	4	IO_LED2_MSP
Not in use on BB	5	6	IO_LED3_MSP
VCC_EM	7	8	IO_LED4_MSP
VCC_EM	9	10	NC
JOYSTICK_UP	11	12	Not in use on BB
JOYSTICK_LEFT	13	14	Not in use on BB
SoC Debug P3.7 & Flash Reset	15	16	IO_BUTTON2
Not in use on BB	17	18	Not in use on BB
JOY_MOVE	19	20	Not in use on BB

Table 6 EM connector P2 pin out

10.3 EM Selection Switch

The EM selection switch on SmartRF05BB controls a multiplexer on the board that allows either a connected RF SoC EM or an MSP430 add-on board to access all four LEDs on the evaluation board. The limitation was caused by the particular pin-out on the RF evaluation modules that needed to be backwards compatible with other boards and test equipment.

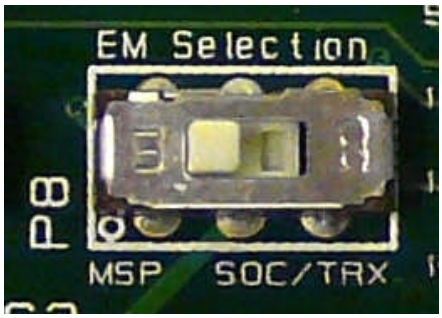


Figure 10 - EM Selection Switch (P8)

The switch will both affect the operation of the LEDs and Button 1.

NB: The *EM Selection* switch shall be placed in position SoC/TRX when the CC2530EM is used with SmartRF05BB.

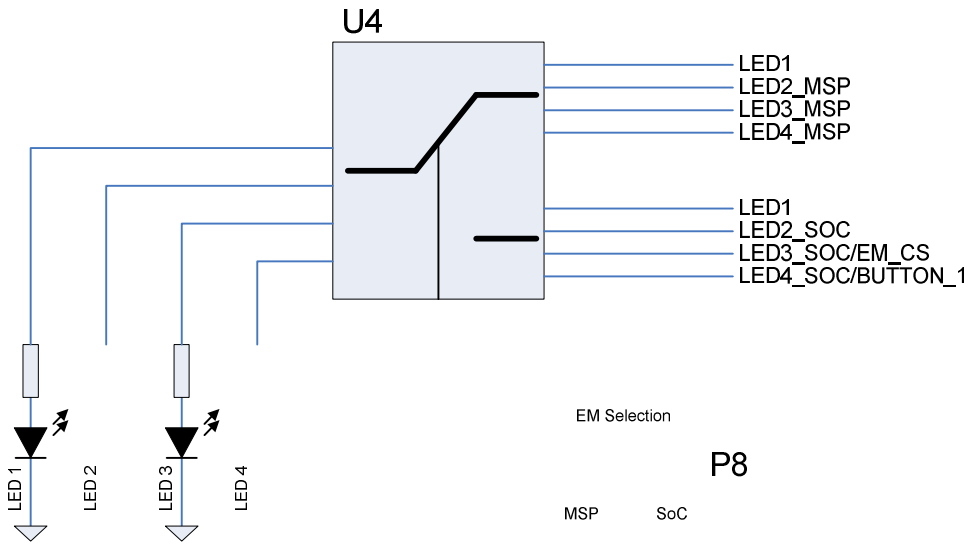


Figure 11 - Switch P8 effect on LED 1-4

Due to lack of pins, some of the signals are shared.

The chip select signal to the EM will also be affected when LED3 is used by the SoC (e.g. CC2530). In most cases, this will not be a problem, since the SoC does not, by default, implement a SPI slave.

When LED4 is used by the SoC, the signal from Button 1 might interfere. In short, Button 1 and LED 4 can not be used simultaneously by the SoC.

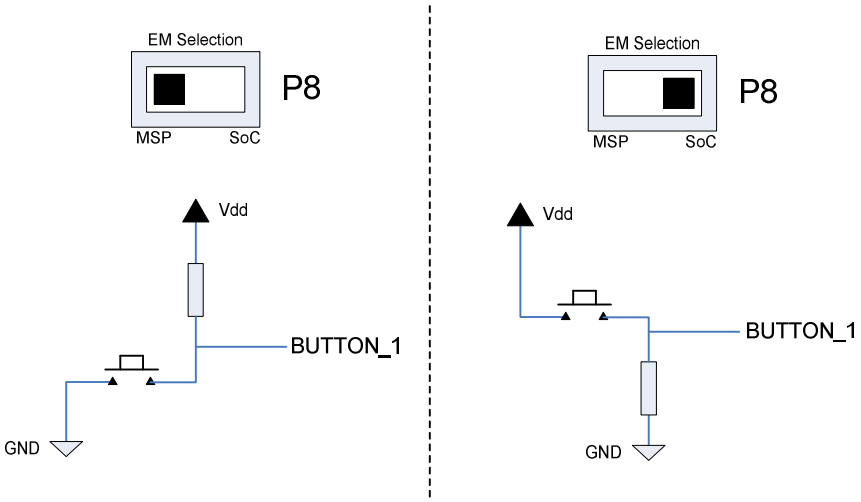


Figure 12 - Switch P8 effect on Button 1

The EM Selection switch will change the polarity of button number 1.

In the MSP position, the button is active low, i.e. low voltage when the button is pressed. In the inactive position, the level is high (signal is pulled up by a 10k Ohm resistor).

In the SoC position, the button is active high, i.e. high voltage when the button is pressed. In the inactive position, the level is low (signal is pulled down by a 10k Ohm resistor).

Note that it is possible to use this feature to determine the position of switch P8 (assuming the button is not pressed).

10.4 Probe connectors

The probe connectors P4 and P5 bring out all the signals from the EM connectors for probing purposes. The connectors allow easy access to I/O signals and to connect prototyping boards. The pin-out of these connectors are shown below.

Function on BB	Signal name	Pin	Pin	Signal name	Function on BB
NC	NC	1	2	NC	NC
Not in use on BB	EM_P2_14	3	4	EM_P1_04	FLASH_CS
Not in use on BB	EM_P2_12	5	6	EM_P1_13	IO_LED2_SOC
IO_LED4_SOC/IO_BUTTON1	EM_P1_05	7	8	EM_P1_10	SoC Debug P3.4
Not in use on BB	EM_P1_07	9	10	EM_P1_12	SoC Debug P3.3
Not in use on BB	EM_P1_09	11	12	EM_P1_20	MISO & SoC Debug P3.10
Not in use on BB	EM_P1_03	13	14	EM_P1_14	IO_LED3_SOC & SoC Debug P3.5
Not in use on BB	EM_P2_18	15	16	EM_P1_16	SCLK & SoC Debug P3.6
Not in use on BB	EM_P1_17	17	18	EM_P1_18	MOSI & SoC Debug P3.8
Not in use on BB	EM_P2_20	19	20	GND	GND

Table 7 I/O connector P4 pin out

Function on BB	Signal name	Pin	Pin	Signal name	Function on BB
NC	NC	1	2	NC	NC
VCC_EM	VCC_EM	3	4	EM_P1_06	IO_LED1
Not in use on BB	EM_P2_05	5	6	EM_P2_04	IO_LED2_MSP
JOYSTICK_RT	EM_P1_08	7	8	EM_P2_06	IO_LED3_MSP
JOYSTICK_DN	EM_P1_02	9	10	EM_P2_08	IO_LED4_MSP
JOYSTICK_UP	EM_P2_11	11	12	EM_P1_11	Not in use on BB
JOYSTICK_LEFT	EM_P2_13	13	14	EM_P2_15	SoC Debug P3.7 & Flash Reset
JOYSTICK_PUSH	EM_P2_01	15	16	EM_P2_16	IO_BUTTON2
JOY_LEVEL	EM_P1_15	17	18	EM_P2_17	Not in use on BB
JOY_MOVE	EM_P2_19	19	20	GND	GND

Table 8 I/O connector P5 pin out

10.5 SoC Debug connector

The SoC debug connector P3 is used to program and debug the SoC on the connected EM with an external programmer/debug tool. The SmartRF05EB can be used for this purpose by connecting a cable to P3 on the Battery Board as shown in Figure 13 below.

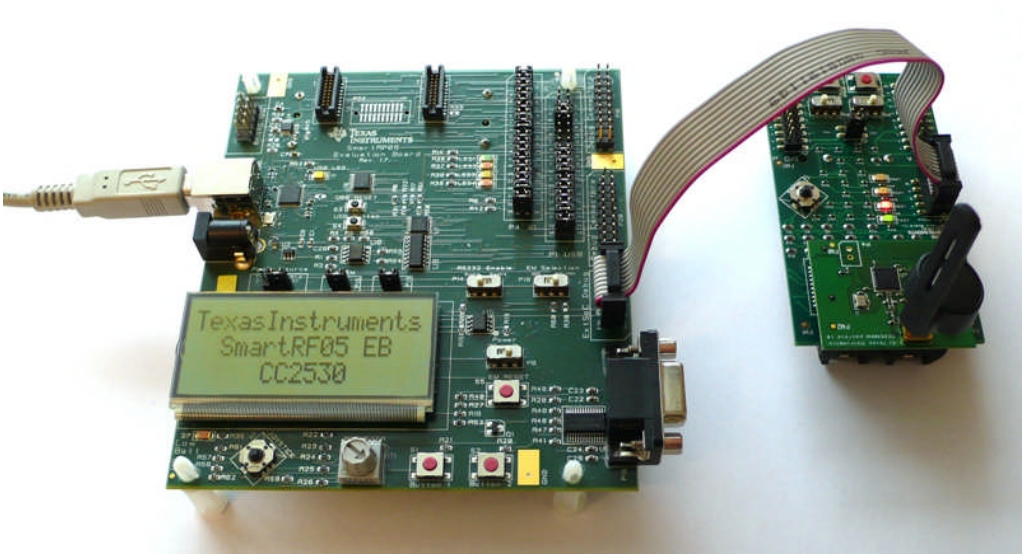


Figure 13 Program/debug with SmartRF05EB

The pin out of this connector is depicted below. For debugging and programming of the SoC the following signals are used; SoC RESET_N, DD and DC. In addition GND and +3.3V shall be connected.

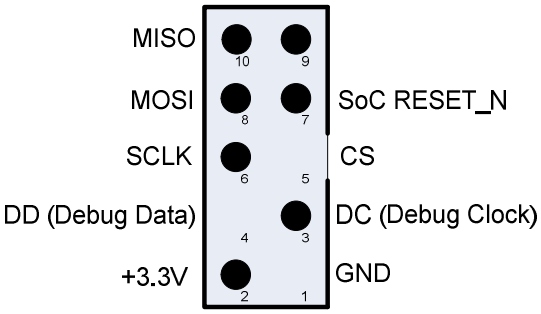


Figure 14 SmartRF05BB SoC Debug Connector

As seen on Figure 14 also the SPI signals CS, MISO, MOSI and SCLK can be found on this connector.

10.6 Current Measurement Jumper

Jumper P7, also called V_EM, has been added to the board to simplify current consumption measurements. By removing the jumper, an Ampere Meter can easily be connected to the board to perform current consumption measurements. Similarly, a separate, regulated power supply for the EM can be connected. Refer to the schematics (in the appendices) for further details.

11 Frequently Asked Questions

Q1 When connecting the SmartRF05EB to my PC via USB, the dialog window below appears. Why? What should I do?



A1 The SmartRF05EB will be recognized as a USB device by the operating system, and it will ask the user to provide information about which USB driver that should be associated with the device.

If you have installed SmartRF Studio, just follow the instructions and select “Automatic installation”. Windows should find the required driver (cebal2.sys), as specified in an .inf file. Both files (.inf and .sys) are included in the SmartRF installation.

If you have not installed SmartRF Studio, it is recommended that you do so before proceeding. Both the SmartRF Studio User Manual and SmartRF05EB User’s Guide has more details.

Q2 SmartRF05EB with the CC2530EM is not detected by IAR/SmartRF Studio. Why?

A2 Make sure you have installed SmartRF Studio as described in section 5.4. Then verify that the device is associated with the correct driver by opening the Device Manager on your PC. When the EB is connected, the “Cebal controlled devices” list contains “SmartRF05EB”. If the board is listed as an unknown device, please follow the steps outlined in the SmartRF05EB User’s Guide.



Q3 How can I measure the current consumption of the CC2530?

A3 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. The jumper on header P13 should not be removed. Connect the ampere meter between the two terminals on P15. On P10, the jumper for the EM_RESET signal (connector 35-36) should be mounted. On P1, no jumpers are required, but in order to control the SoC from a debugger, mount a jumper between 19-20 (DBG_DD) and 21-22 (DBG_DD). Make sure the RS232 Enable switch is in the “disable” position.

Use SmartRF Studio to set the radio in different modes (RX, TX, etc.), or download an application on the CC2530 setting the device in the preferred state.

Q4 Can I use another compiler than IAR to develop software for CC2530?

A4 Yes, there are several tools available that can be used for CC2530. Any 8051 compiler (e.g. Keil, GCC, and SDCC) can, in theory, be used. Note that these tools may have limited debugging support for CC2530. When working with the TI Z-Stack (and RemoTI) stack for CC253x, you must use IAR Embedded Workbench for 8051.

12 References

[1] CC2530 product web site
http://focus.ti.com/docs/prod/folders/print/cc2530.html

[2] SmartRF Studio product web site
http://focus.ti.com/docs/toolsw/folders/print/smartrftm-studio.html

[3] SmartRF Flash Programmer product web site
http://focus.ti.com/docs/toolsw/folders/print/flash-programmer.html

[4] SmartRF Packet Sniffer
http://focus.ti.com/docs/toolsw/folders/print/packet-sniffer.html

[5] SmartRF Packet Sniffer User Manual
http://www.ti.com/lit/swru187

[6] SmartRF05EB User's Guide
http://www.ti.com/lit/swru210

[7] Z-Stack
http://www.ti.com/z-stack

[8] CC2530 Software Examples User's Guide
http://www.ti.com/lit/swru137

[9] CC2530ZDK Quick Start Guide
http://www.ti.com/lit/swra274

[10] CC2530ZDK Sensor Demo User's Guide
http://www.ti.com/lit/swru225

[11] CC2530ZDK web site
http://focus.ti.com/docs/toolsw/folders/print/cc2530zdk.html

[12] CC2530DK Quick Start Guide
http://www.ti.com/lit/swra273

[13] CC2530DK User's Guide
http://www.ti.com/lit/swru208

[14] CC2530DK web site
http://focus.ti.com/docs/toolsw/folders/print/cc2530dk.html

[15] DN002 -- Practical Sensitivity Testing
http://www.ti.com/lit/swra097

[16] Texas Instruments Low Power RF Online Community
http://www.ti.com/lprf-forum

[17] Texas Instruments Support
http://support.ti.com

13 Document history

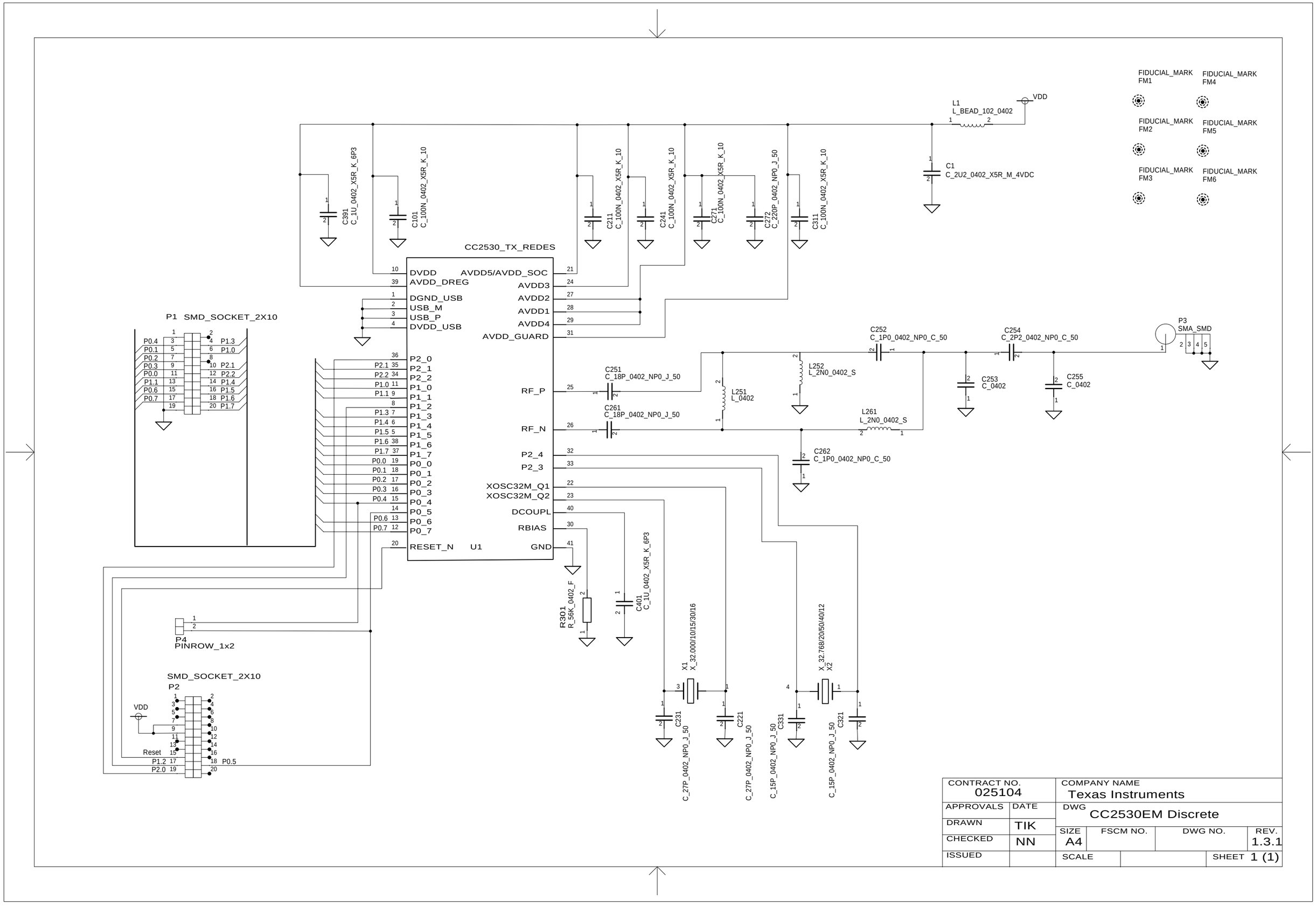
Revision	Date	Description/Changes
B	2011-04-05	Clarified that IAR EW8051 is required when working with the Z-Stack. Updated screenshots of SmartRF Studio. Include updated schematics. Fixed a few typos.
A	2009-08-04	Added SmartRF05 Battery Board schematics
-	2009-06-08	First revision.

Appendix A Schematics

Please refer to the following pages for the schematics for

- CC2530 Evaluation Module
- CC2531 USB Dongle
- SmartRF05 Evaluation Board
- SmartRF05 Battery Board

The reference design for the CC2530 evaluation module can be found on the CC2530 web page [1].



CONTRACT NO. 025104		COMPANY NAME Texas Instruments		
APPROVALS	DATE	DWG CC2530EM Discrete		
DRAWN	TIK			
CHECKED	NN	SIZE A4	FSCM NO.	DWG NO. REV. 1.3.1
ISSUED		SCALE		SHEET 1 (1)

FIDUCIAL_MARK_1mm
FM1

FIDUCIAL_MARK_1mm
FM2

FIDUCIAL_MARK_1mm
FM3

VOLTAGE REGULATOR

Generated voltage:
3.3 V for CC2531

SoC periferials

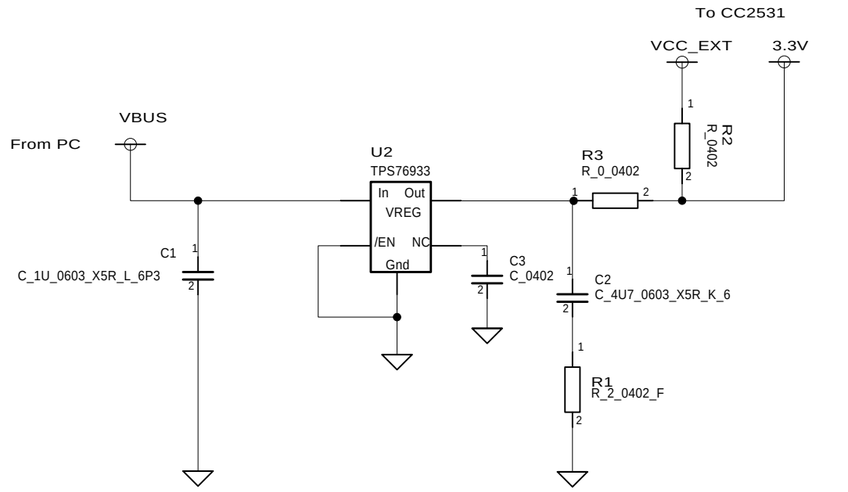
- USB Connector
- Buttons
- LEDs
- SMD sockets

RF-SoC PART

Including PCB antenna

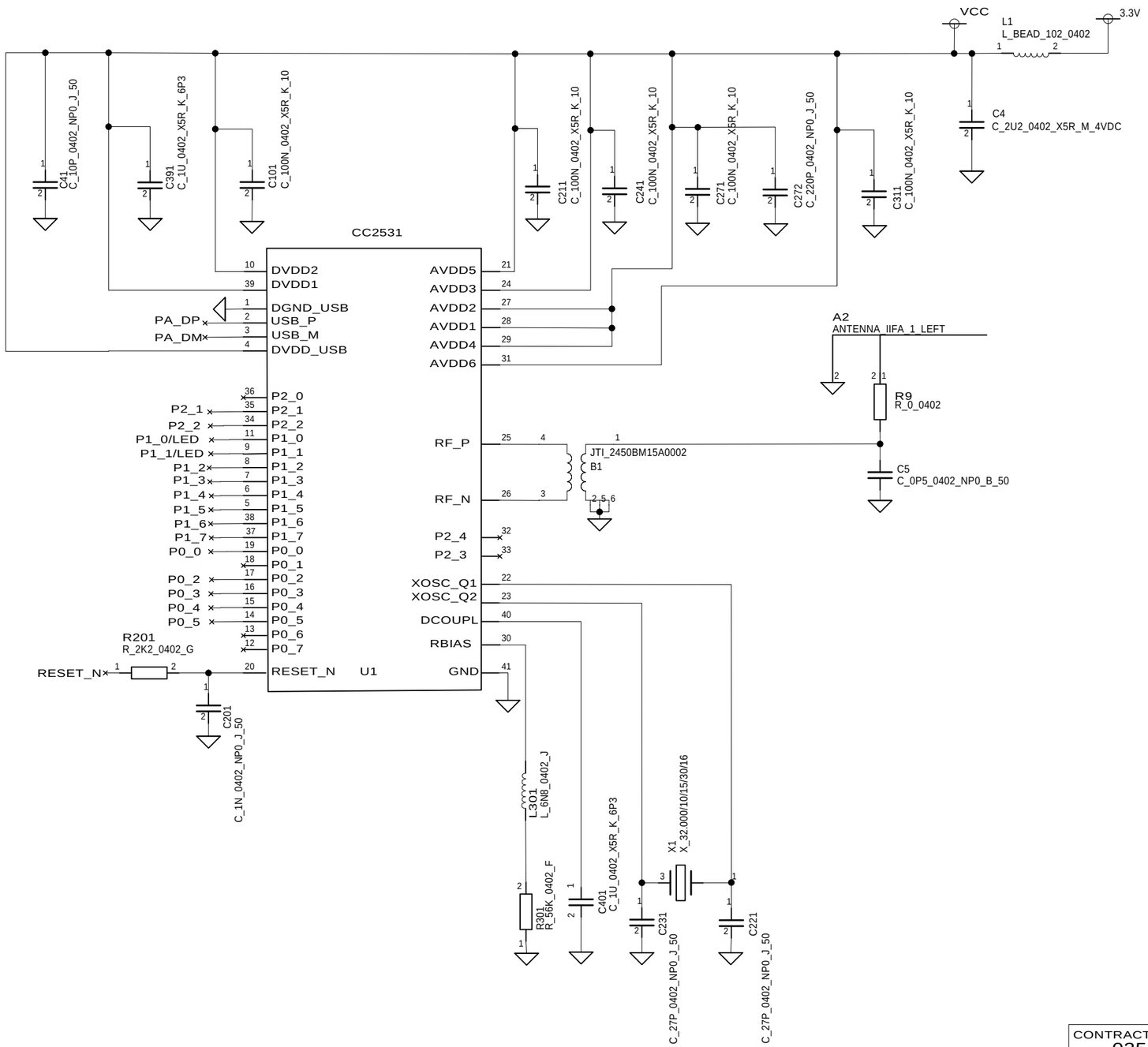
RESET_N	RESET_N
P0_0	P0_0
P0_2	P0_2
P0_3	P0_3
P0_4	P0_4
P0_5	P0_5
P1_0/LED	P1_0/LED
P1_1/LED	P1_1/LED
P1_2	P1_2
P1_3	P1_3
P1_4	P1_4
P1_5	P1_5
P1_6	P1_6
P1_7	P1_7
P2_1	P2_1
P2_2	P2_2
PA_DM	PA_DM
PA_DP	PA_DP

CONTRACT NO. 025104		COMPANY NAME Texas Instruments		
APPROVALS	DATE	DWG CC2531 USB dongle		
DRAWN	TIK	SIZE A4	FSCM NO.	DWG NO. REV. 2.4
CHECKED	MAP			
ISSUED		SCALE		SHEET 1(4)



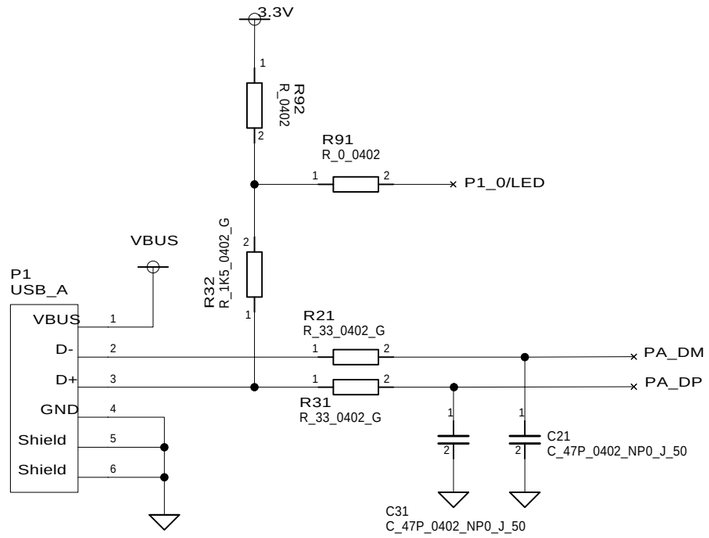
Not mount: C3, R2

CONTRACT NO. 025104		COMPANY NAME Texas Instruments		
APPROVALS	DATE	DWG CC2531 USB DONGLE VOLTAGE REGULATOR		
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ISSUED		SCALE		SHEET 2(4)

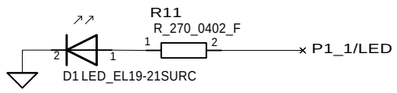


CONTRACT NO. 025104		COMPANY NAME Texas Instruments		
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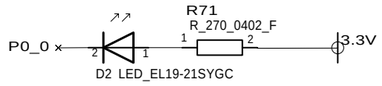
USB Interface



LED_Red



LED_Green



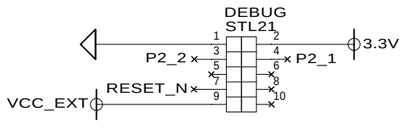
button_P_1_2



button_P_1_3

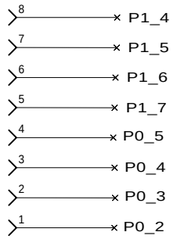


SoC debug/flash



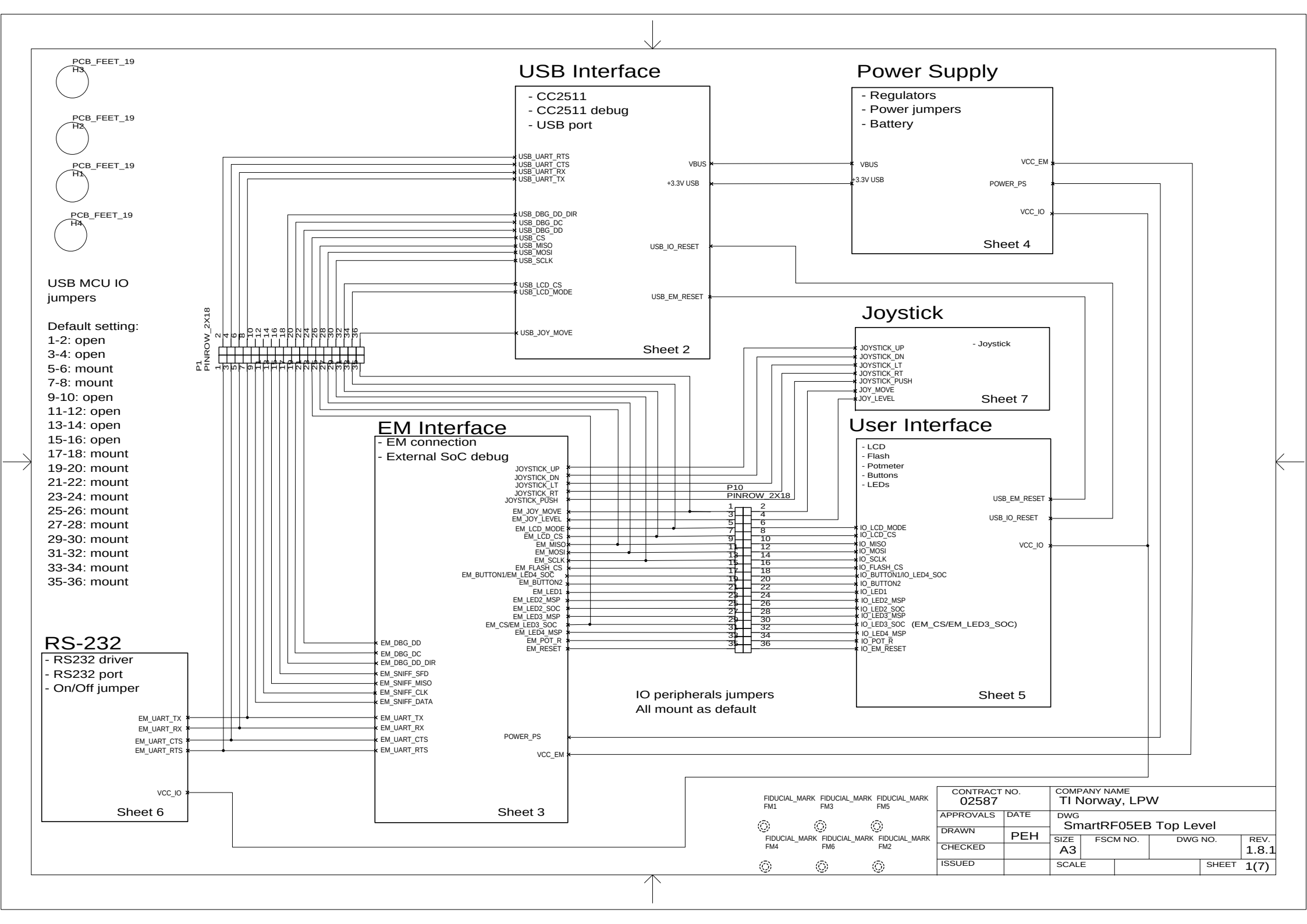
Additional testpins

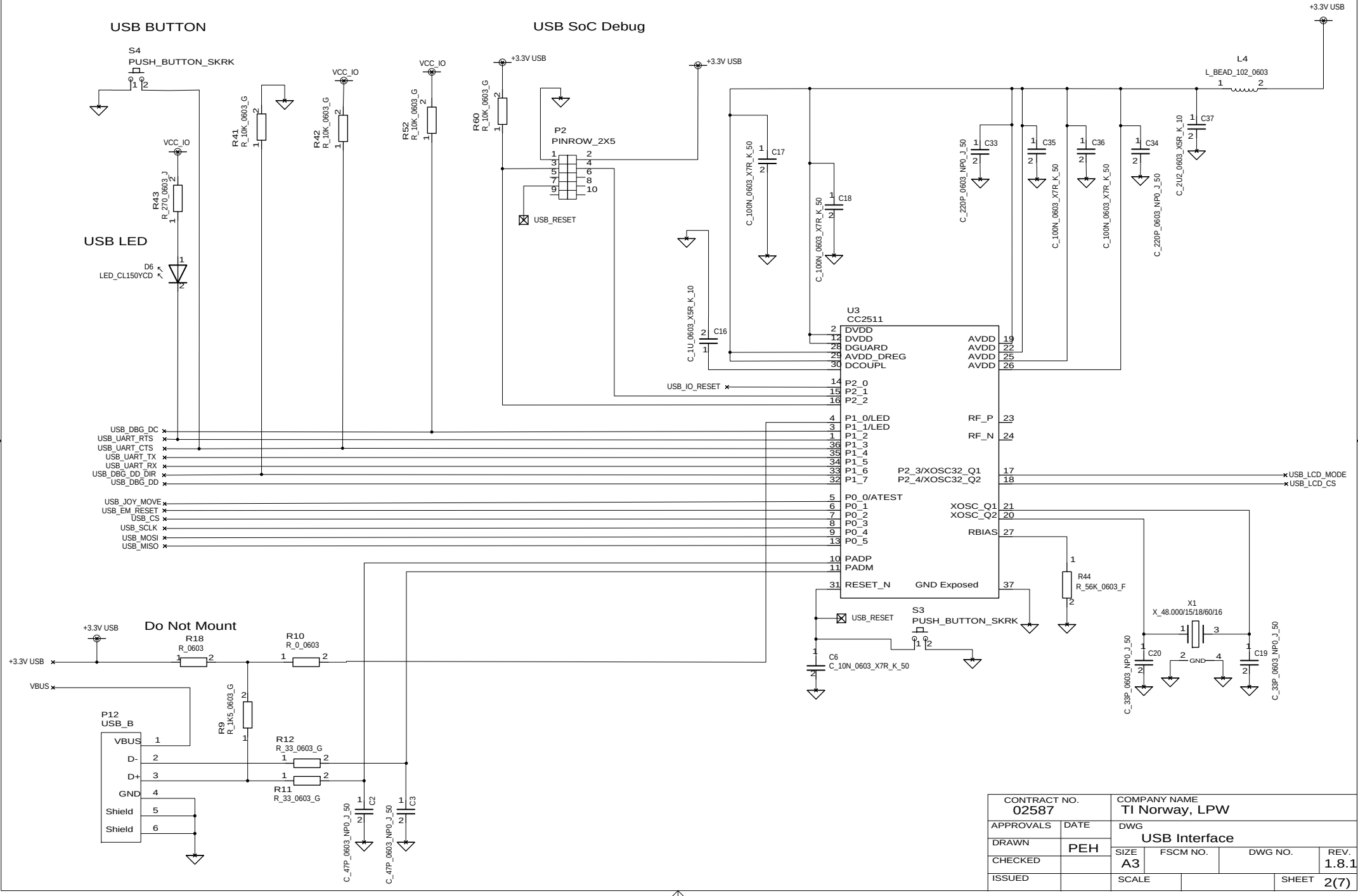
IO
BL_31_008U_NO_SILK



Not mount: R92, IO

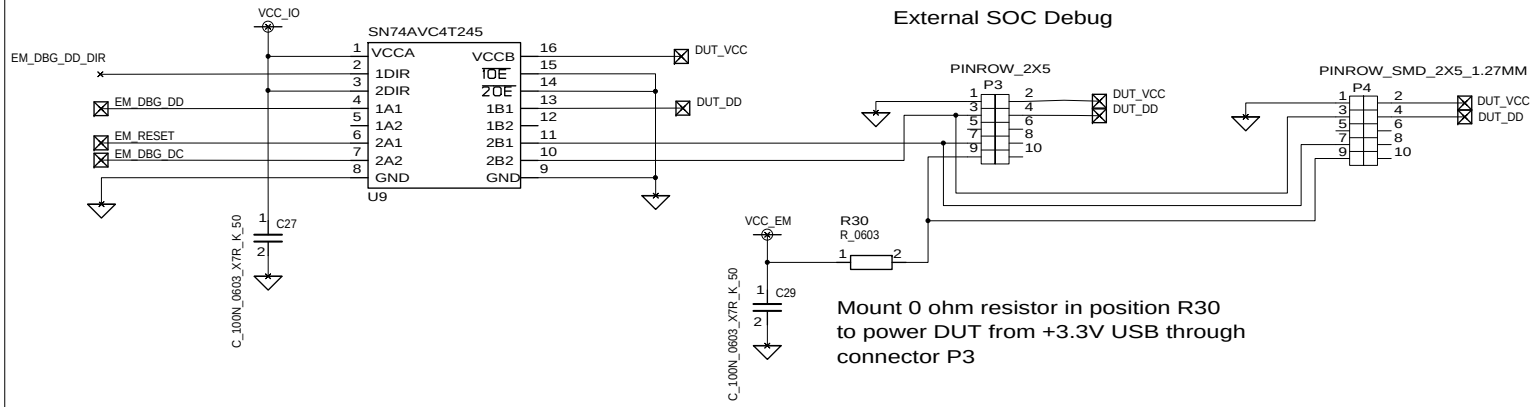
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DRAWN	TIK	SIZE A4	FSCM NO.	DWG NO. / REV. 2.4
CHECKED	MAP			
ISSUED		SCALE		SHEET 4(4)


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
USB Interface
- CC2511
- CC2511 debug
- USB port
USB_UART_RTS
USB_UART_CTS
USB_UART_RX
USB_UART_TX
USB_DBG_DD_DIR
USB_DBG_DC
USB_DBG_DD
USB_CS
USB_MISO
USB_MOSI
USB_SCLK
USB_LCD_CS
USB_LCD_MODE
USB_JOY_MOVE
VBUS
+3.3V USB
USB_IO_RESET
USB_EM_RESET
Sheet 2
Power Supply
- Regulators
- Power jumpers
- Battery
VBUS
+3.3V USB
VCC_EM
POWER_PS
VCC_IO
Sheet 4
P1
PINROW_2X18
Joystick
- Joystick
JOYSTICK_UP
JOYSTICK_DN
JOYSTICK_LT
JOYSTICK_RT
JOYSTICK_PUSH
JOY_MOVE
JOY_LEVEL
Sheet 7
EM Interface
- EM connection
- External SoC debug
JOYSTICK_UP
JOYSTICK_DN
JOYSTICK_LT
JOYSTICK_RT
JOYSTICK_PUSH
EM_JOY_MOVE
EM_JOY_LEVEL
EM_LCD_MODE
EM_LCD_CS
EM_MISO
EM_MOSI
EM_SCLK
EM_FLASH_CS
EM_BUTTON1/EM_LED4_SOC
EM_BUTTON2
EM_LED1
EM_LED2_MSP
EM_LED2_SOC
EM_LED3_MSP
EM_CS/EM_LED3_SOC
EM_LED4_MSP
EM_POT_R
EM_RESET
EM_DBG_DD
EM_DBG_DC
EM_DBG_DD_DIR
EM_SNIFF_SFD
EM_SNIFF_MISO
EM_SNIFF_CLK
EM_SNIFF_DATA
EM_UART_TX
EM_UART_RX
EM_UART_CTS
EM_UART_RTS
POWER_PS
VCC_EM
Sheet 3
P10
PINROW_2X18
User Interface
- LCD
- Flash
- Potmeter
- Buttons
- LEDs
USB_EM_RESET
USB_IO_RESET
VCC_IO
IO_LCD_MODE
IO_LCD_CS
IO_MISO
IO_MOSI
IO_SCLK
IO_FLASH_CS
IO_BUTTON1/IO_LED4_SOC
IO_BUTTON2
IO_LED1
IO_LED2_MSP
IO_LED2_SOC
IO_LED3_MSP
IO_LED3_SOC (EM_CS/EM_LED3_SOC)
IO_LED4_MSP
IO_POT_R
IO_EM_RESET
Sheet 5
IO peripherals 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
COMPANY NAME TI Norway, LPW
APPROVALS
DATE
DRAWN PEH
CHECKED
ISSUED
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SIZE A3
FSCM NO.
DWG NO.
REV. 1.8.1
SCALE
SHEET 1(7)

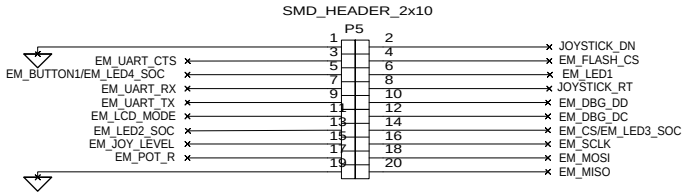


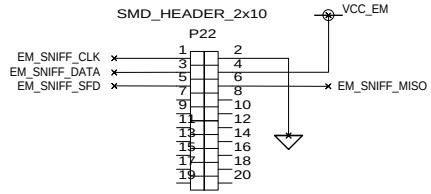
CONTRACT NO. 02587		COMPANY NAME TI Norway, LPW			
APPROVALS	DATE	DWG USB Interface			
DRAWN	PEH				
CHECKED		SIZE A3	FSCM NO.	DWG NO.	REV. 1.8.1
ISSUED		SCALE			SHEET 2(7)

External SOC Debug



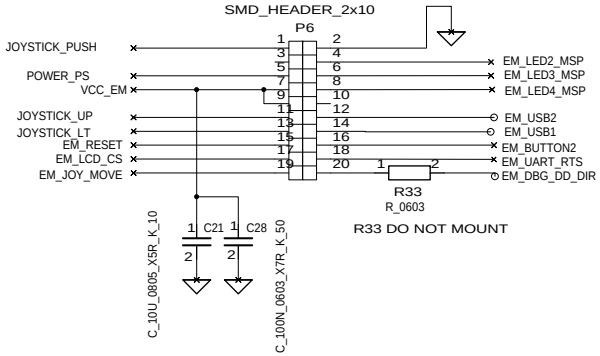
Mount 0 ohm resistor in position R30 to power DUT from +3.3V USB through connector P3





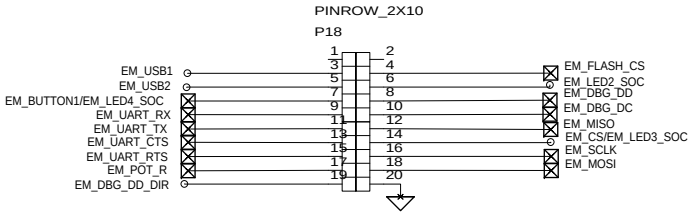
DO NOT MOUNT

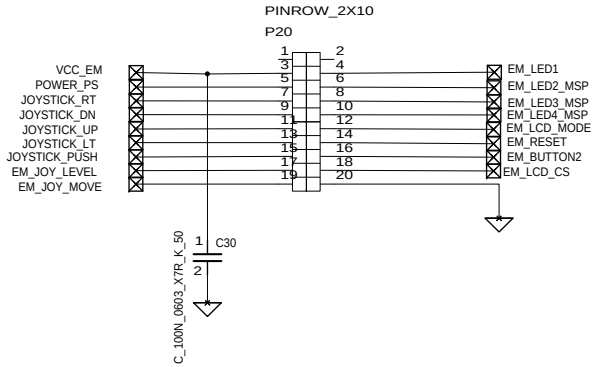
EM Connectors



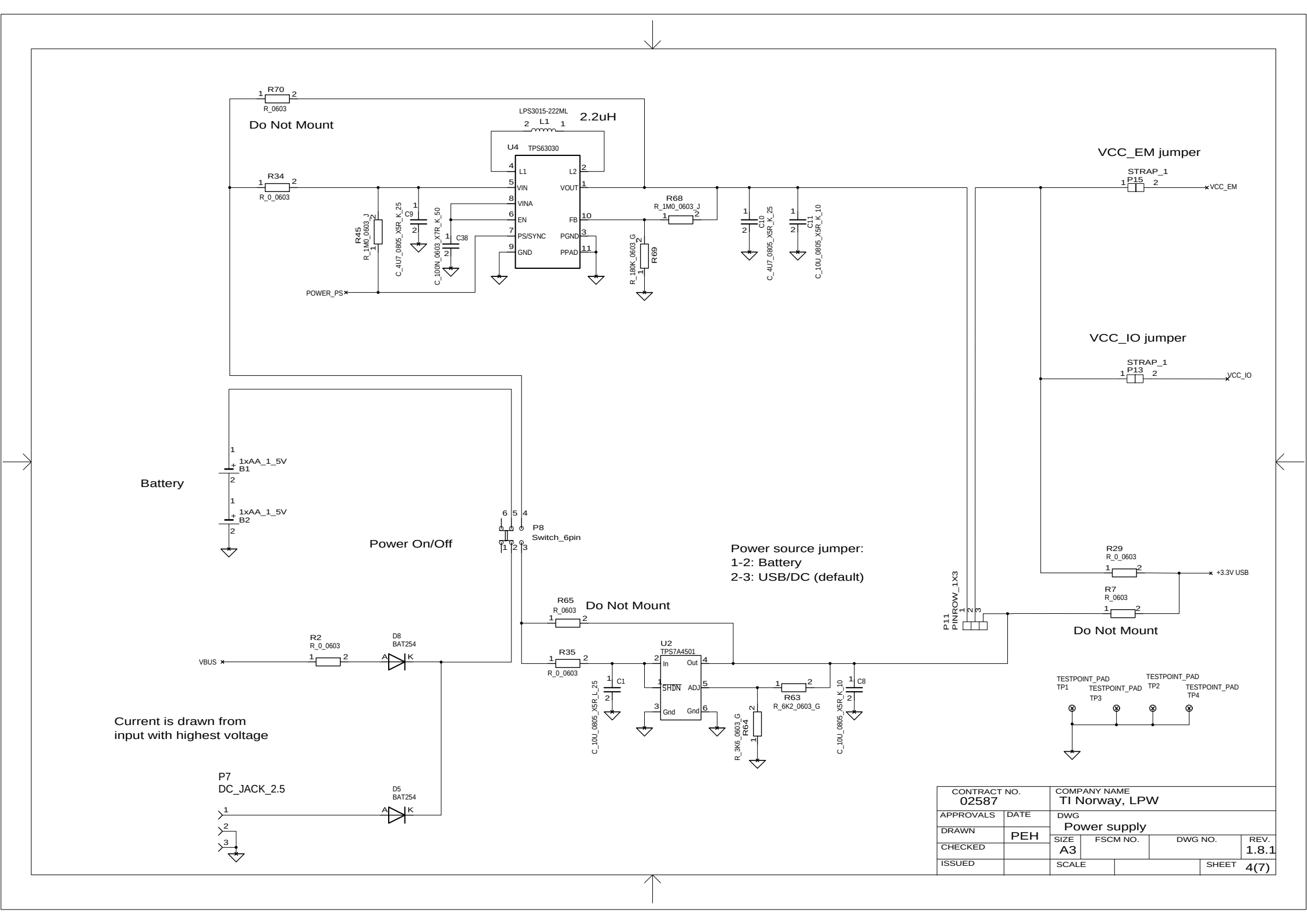
R33 DO NOT MOUNT

Debug Connectors

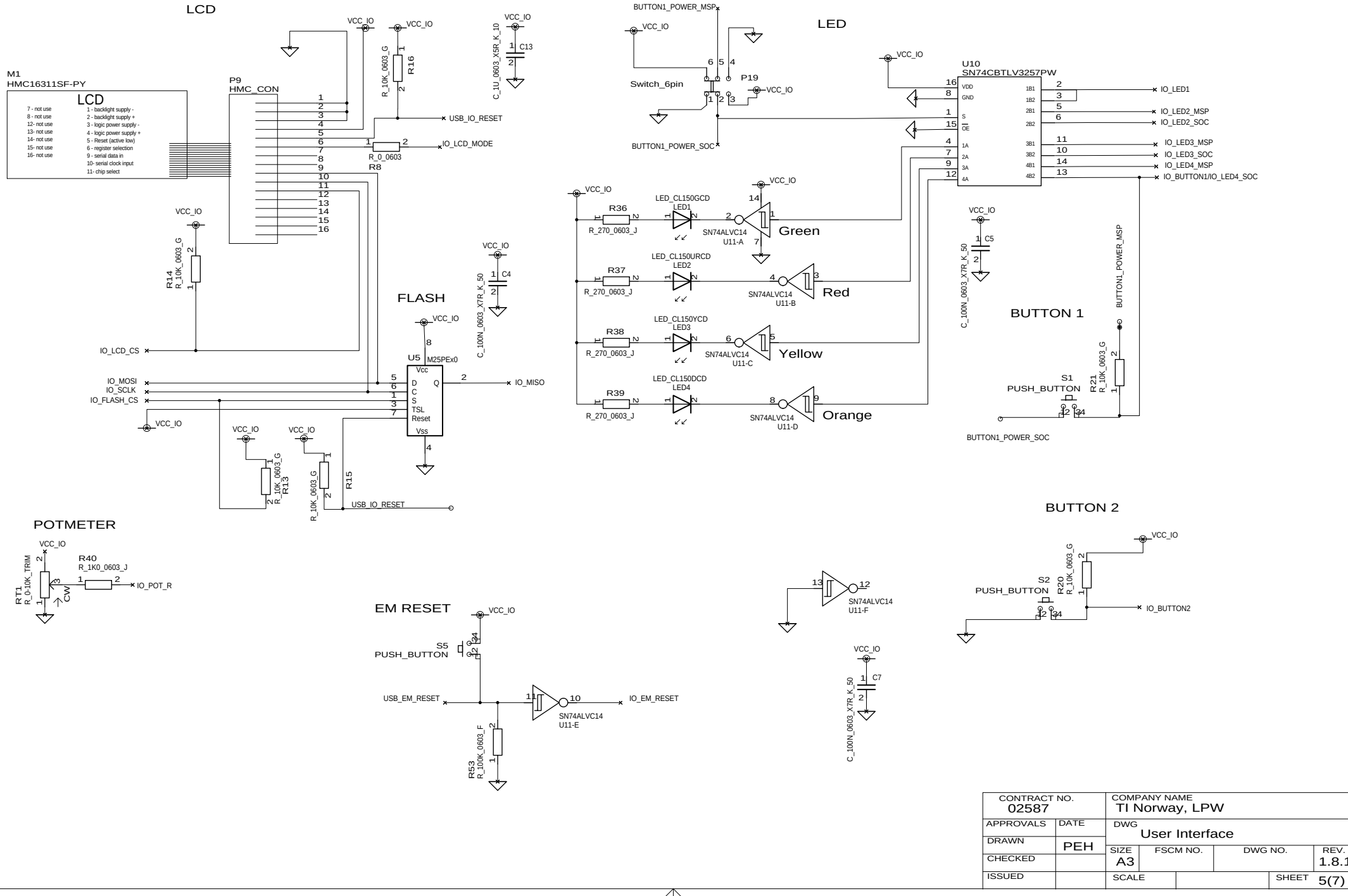




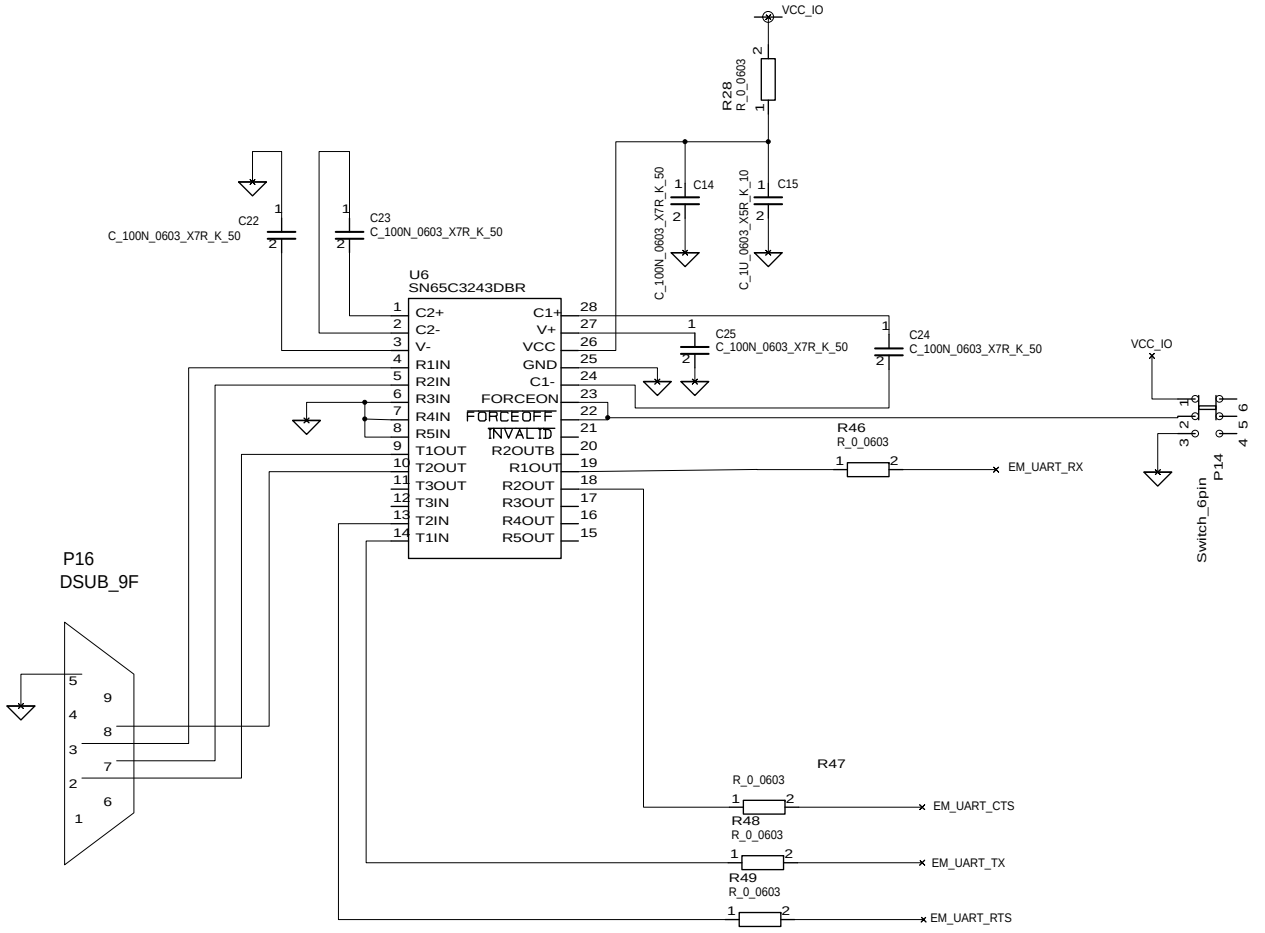
CONTRACT NO. 02587		COMPANY NAME TI Norway, LPW	
APPROVALS	DATE	DWG EM Interface	
DRAWN	PEH	SIZE A3 / FSCM NO. / DWG NO.	REV. 1.8.1
CHECKED			
ISSUED		SCALE	SHEET 3(7)



CONTRACT NO. 02587		COMPANY NAME TI Norway, LPW			
APPROVALS	DATE	DWG Power supply			
DRAWN	PEH	SIZE A3	FSCM NO.	DWG NO.	REV. 1.8.1
CHECKED					
ISSUED		SCALE			SHEET 4(7)

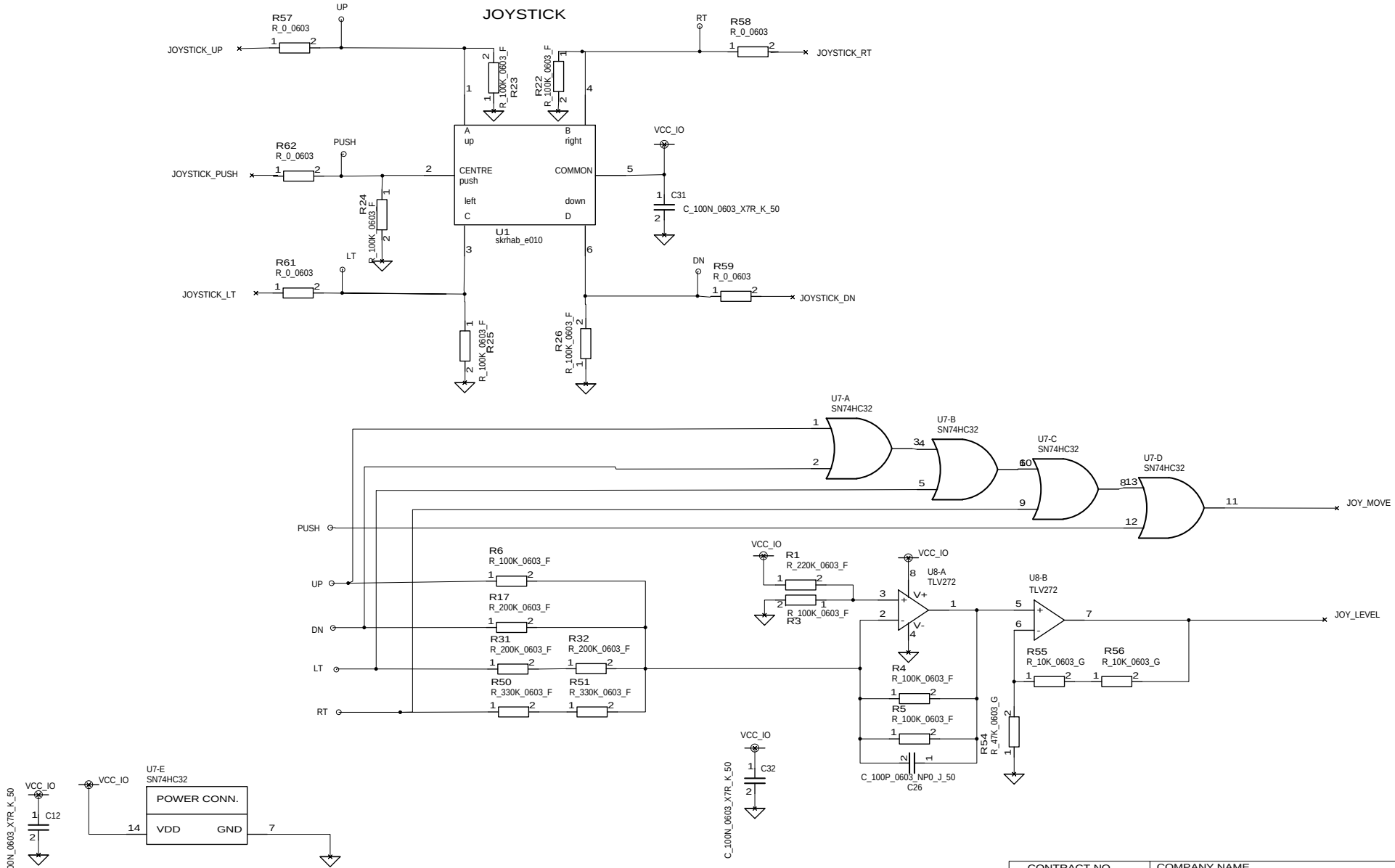


CONTRACT NO. 02587		COMPANY NAME TI Norway, LPW			
APPROVALS	DATE	DWG User Interface			
DRAWN	PEH	SIZE A3	FSCM NO.	DWG NO.	REV. 1.8.1
CHECKED					
ISSUED		SCALE			SHEET 5(7)

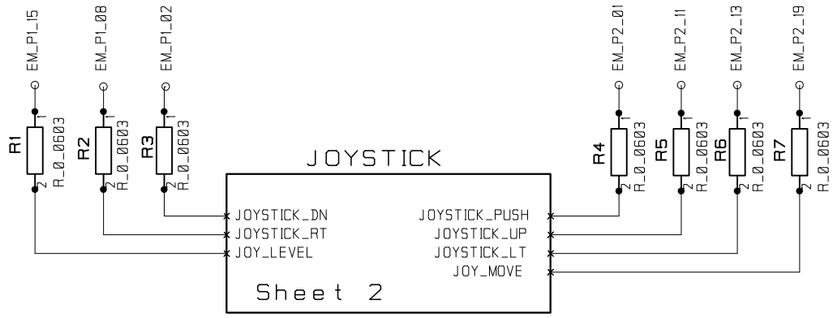


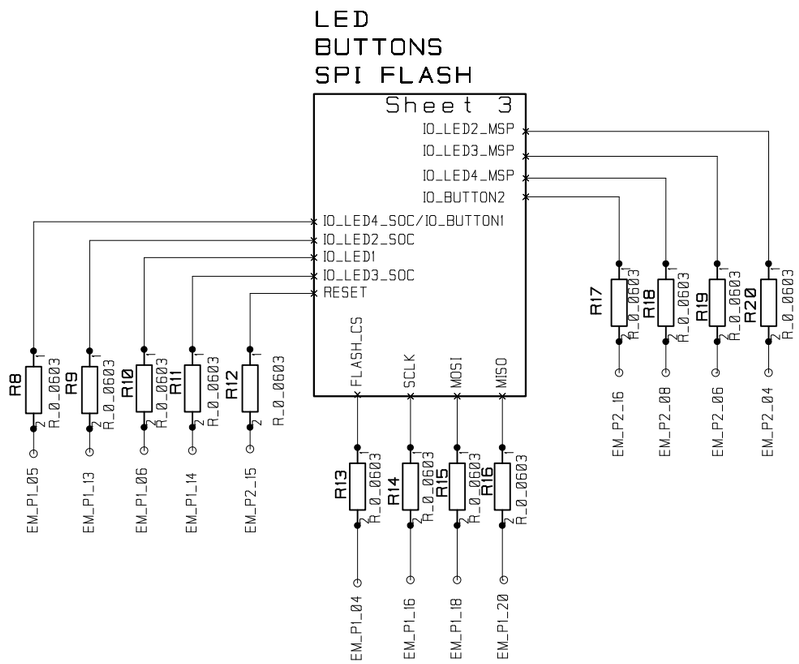
PC RS232-port
2-RXD
3-TXD
5-GND
7-RTS
8-CTS

CONTRACT NO. 02587		COMPANY NAME TI Norway, LPW		
APPROVALS	DATE	DWG RS-232 Interface		
DRAWN	PEH			
CHECKED		SIZE A3	FSCM NO.	DWG NO. / REV. 1.8.1
ISSUED		SCALE		SHEET 6(7)



CONTRACT NO. 02587		COMPANY NAME TI Norway, LPW		
APPROVALS	DATE	DWG Joystick		
DRAWN	PEH	SIZE A3	FSCM NO.	DWG NO. / REV. 1.8.1
CHECKED				
ISSUED		SCALE		SHEET 7(7)



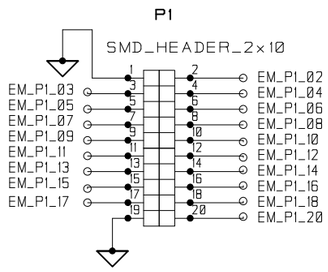


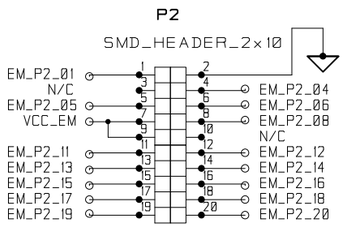
SoC	EM conn
P0.0	EM_P1_11
P0.1	EM_P1_05
P0.2	EM_P1_07
P0.3	EM_P1_09
P0.4	EM_P1_03
P0.5	EM_P2_18
P0.6	EM_P1_15
P0.7	EM_P1_17

SoC	EM conn
P1.0	EM_P1_06
P1.1	EM_P1_13
P1.2	EM_P2.17
P1.3	EM_P1_04
P1.4	EM_P1_14
P1.5	EM_P1.16
P1.6	EM_P1_18
P1.7	EM_P1_20

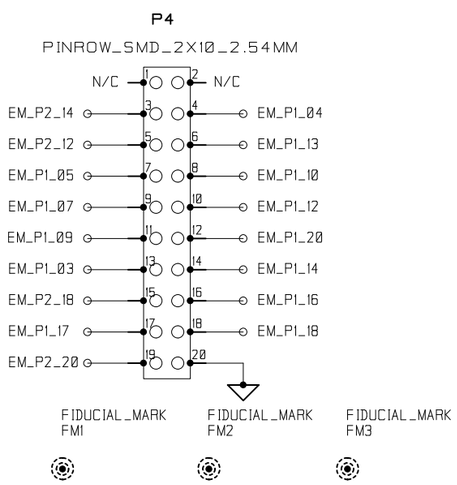
SoC	EM conn
P2.0	EM_P2_19
P2.1	EM_P1_10
P2.2	EM_P1_12

EM CONNECTORS

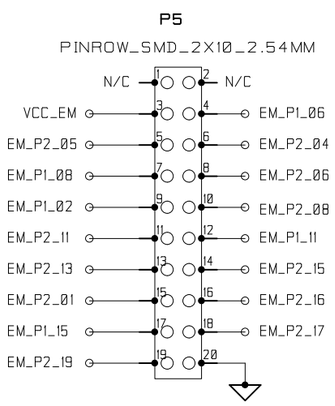




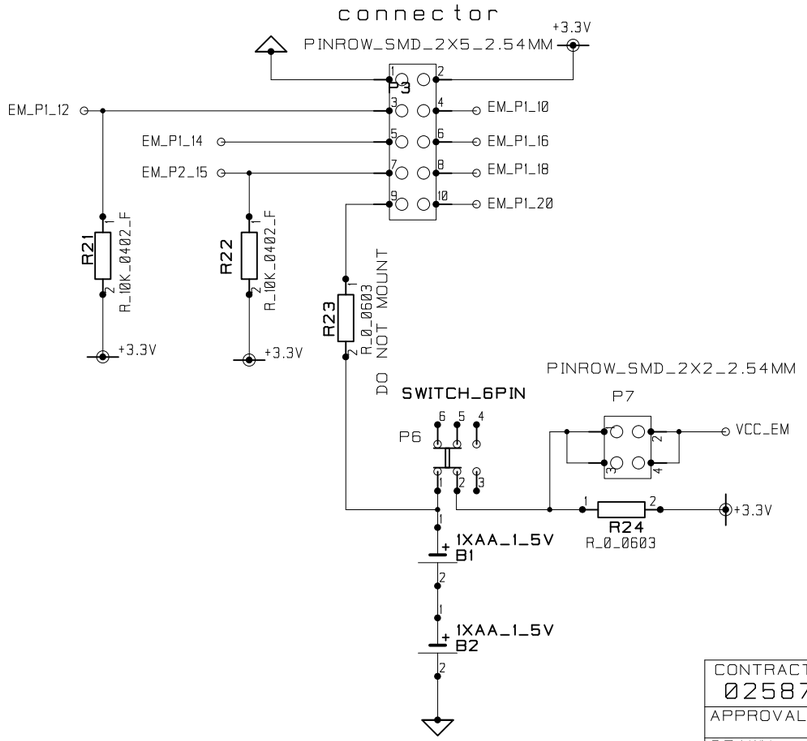
I/O HEADER A



I/O HEADER B

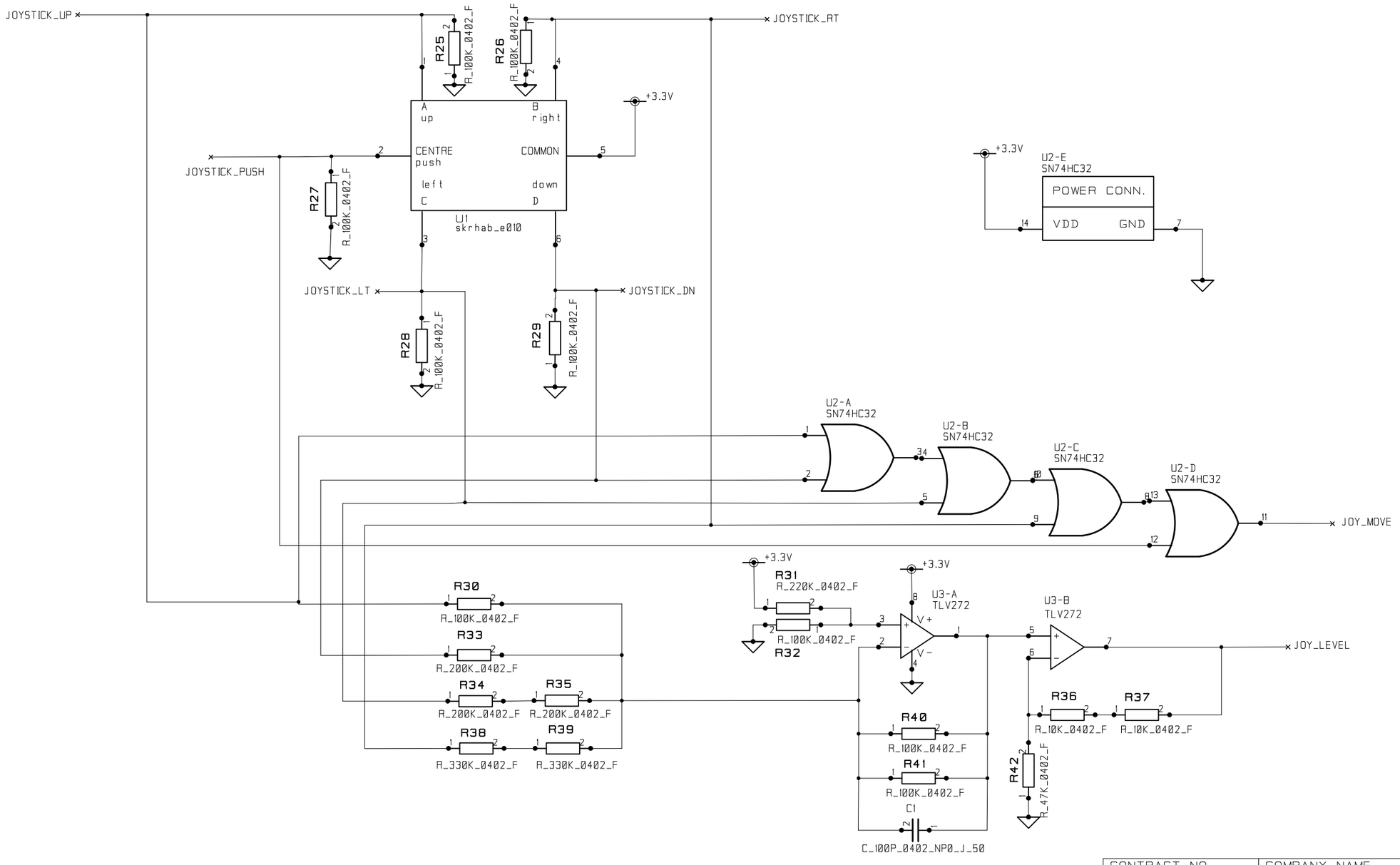


SoC debug connector

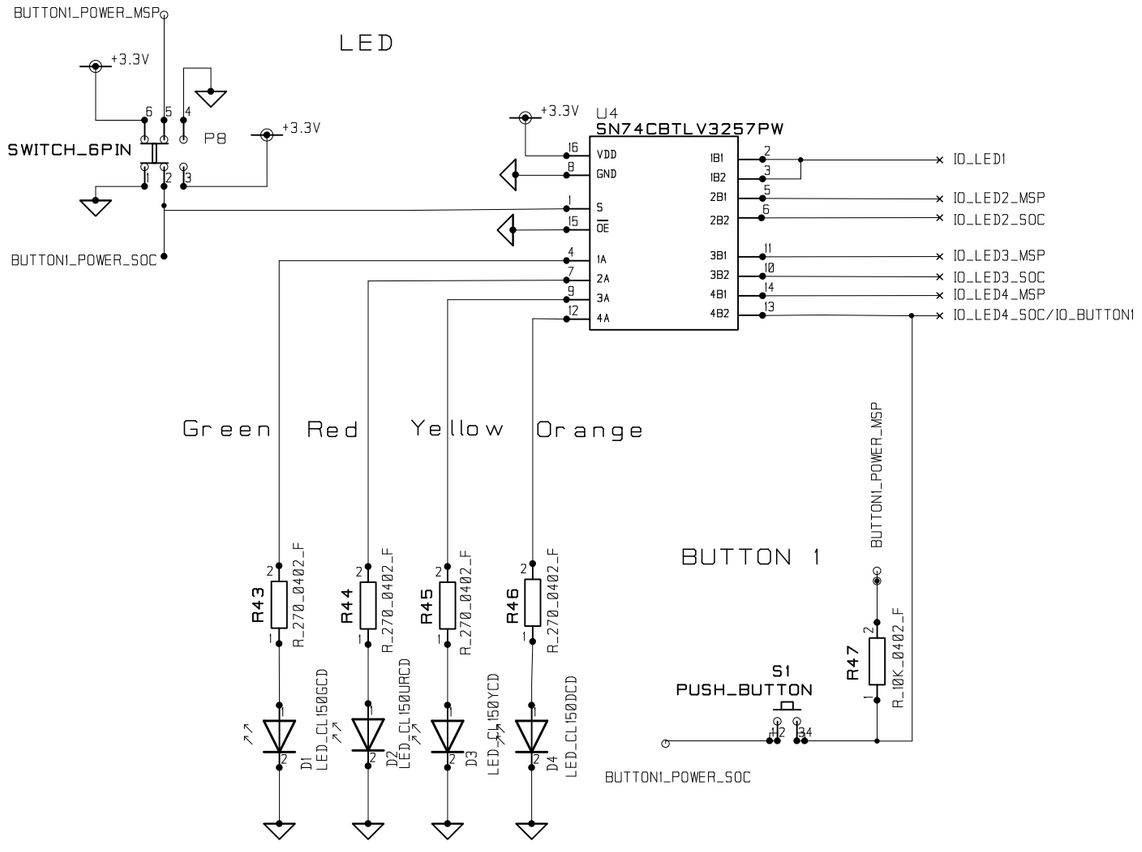


CONTRACT NO. 02587		COMPANY NAME TI Norway AS	
APPROVALS	DATE	DWG Battery Board	
DRAWN	ESS	SIZE A3 / FSCM NO. / DWG NO.	REV. 1.1
CHECKED			
ISSUED DATE	DWG	SCALE	SHEET 1 (3)

JOYSTICK



CONTRACT NO. 02587		COMPANY NAME TI Norway AS	
APPROVALS	DATE	DWG Battery Board	
DRAWN	ESS	SIZE A3 / FSCM NO. / DWG NO. / REV. 1.1	
CHECKED			
ISSUED DATE	DWG	SCALE	SHEET 2 (3)



CONTRACT NO. 02587		COMPANY NAME TI Norway AS	
APPROVALS	DATE	DWG Battery Board	
DRAWN	ESS		
CHECKED		SIZE A3	FSCM NO. / DWG NO. / REV. 1.1
ISSUED DATE	DWG	SCALE	SHEET 3 (3)

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