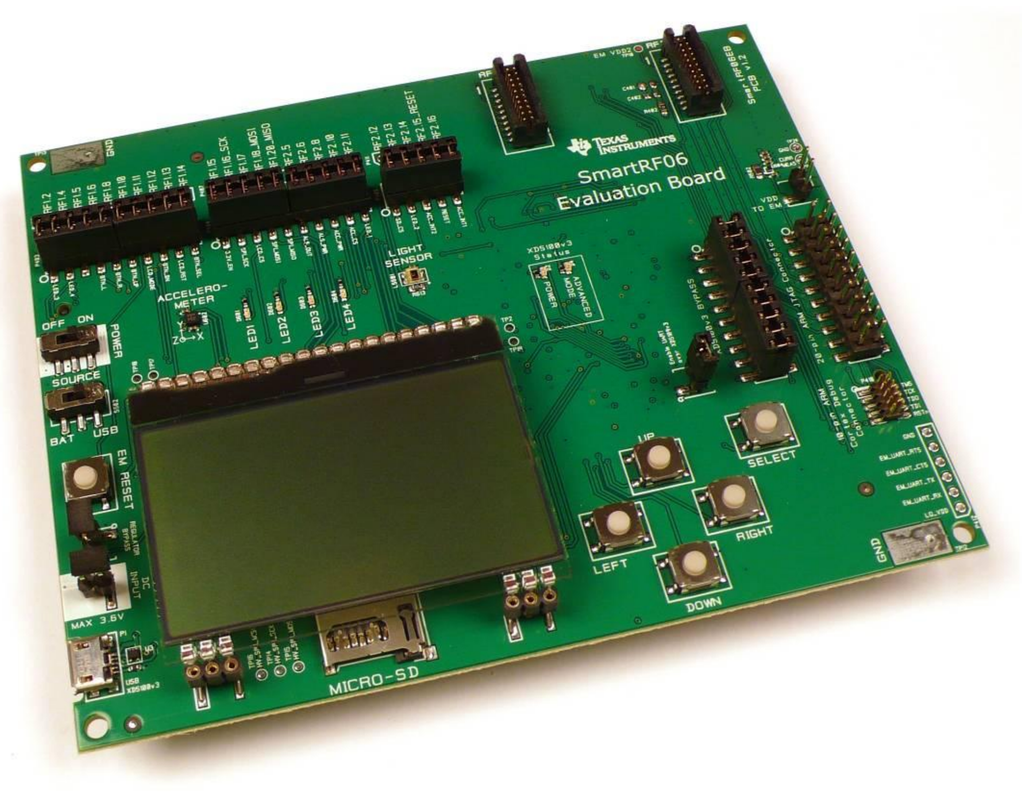
SmartRF06 Evaluation Board

User's Guide



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1 Introduction

The SmartRF06 Evaluation Board (SmartRF06EB or simply EB) is the motherboard in development kits for Low Power RF ARM Cortex®-M based System on Chips from Texas Instruments. The board has a wide range of features, listed in Table 1 below.

Component	Description
TI XDS100v3 Emulator	cJTAG and JTAG emulator for easy programming and debugging of SoCs on Evaluation Modules or external targets.
High-speed USB 2.0 interface	Easy plug and play access to full SoC control using SmartRF™ Studio PC software. Integrated serial port over USB enables communication between the SoC via the UART back channel.
64x128 pixels serial LCD	Big LCD display for demo use and user interface development.
LEDs	Four general purpose LEDs for demo use or debugging.
Micro SD card slot	External flash for extra storage, over-the-air upgrades and more.
Buttons	Five push-buttons for demo use and user interfacing.
Accelerometer	Three-axis highly configurable digital accelerometer for application development and demo use.
Light Sensor	Ambient Light Sensor for application development and demo use.
Current measurement	Current sense amplifier for high side current measurements.
Breakout pins	Easy access to SoC GPIO pins for quick and easy debugging.

Table 1 – SmartRF06EB features

2 About this manual

This manual contains reference information about the SmartRF06EB.

Chapter 4 will give a quick introduction on how to get started with the SmartRF06EB. It describes how to install SmartRF™ Studio to get the required USB drivers for the evaluation board. Chapter 5 briefly explains how the EB can be used throughout a project's development cycle. Chapter 6 gives an overview of the various features and functionality provided by the board.

A troubleshooting guide is found in chapter 8 and Appendix A contains the schematics for SmartRF06EB revision 1.2.1.

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

See chapter 9 for references to relevant documents and web pages.

3 Acronyms and Abbreviations

ALS	Ambient Light Sensor
cJTAG	Compact JTAG (IEEE 1149.7)
CW	Continuous Wave
DK	Development Kit
EB	Evaluation Board
EM	Evaluation Module
FPGA	Field-Programmable Gate Array
I/O	Input/Output
JTAG	Joint Test Action Group (IEEE 1149.1)
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LPRF	Low Power RF
MCU	Micro Controller
MISO	Master In, Slave Out (SPI signal)
MOSI	Master Out, Slave In (SPI signal)
NA	Not Applicable / Not Available
NC	Not Connected
RF	Radio Frequency
RTS	Request to Send
RX	Receive
SoC	System on Chip
SPI	Serial Peripheral Interface
TI	Texas Instruments
TP	Test Point
TX	Transmit
UART	Universal Asynchronous Receive Transmit
USB	Universal Serial Bus
VCP	Virtual COM Port

4 Getting Started

Before connecting the SmartRF06EB to the PC via the USB cable, it is highly recommended to perform the steps described below.

4.1 Installing SmartRF Studio and USB drivers

Before your PC can communicate with the SmartRF06EB over USB, you will need to install the USB drivers for the EB. The latest SmartRF Studio installer [1] includes USB drivers both for Windows x86 and Windows x64 platforms.

After you have downloaded SmartRF Studio from the web, extract the zip-file, run the installer and follow the instructions. Select the complete installation to include the SmartRF Studio program, the SmartRF Studio documentation and the necessary drivers needed to communicate with the SmartRF06EB.

4.1.1 SmartRF Studio

SmartRF Studio is a PC application developed for configuration and evaluation of many RF-IC products from Texas Instruments. The application is designed for use with SmartRF Evaluation Boards, such as SmartRF06EB, and runs on Microsoft Windows operating systems.

SmartRF Studio lets you explore and experiment with the RF-ICs as it gives full overview and access to the devices' registers to configure the radio and has a control interface for simple radio operation from the 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 [1], where you will also find a complete user manual.

4.1.2 FTDI USB driver

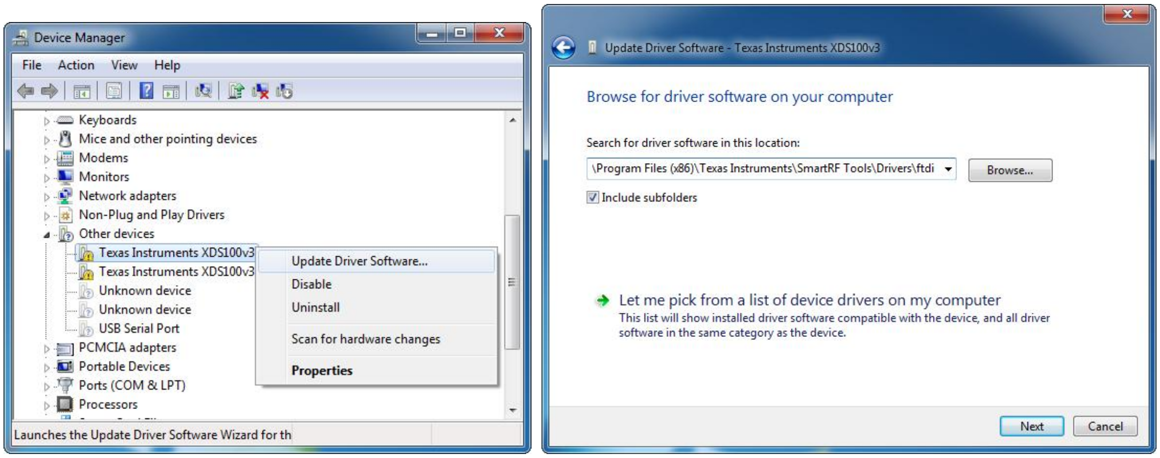
SmartRF PC software such as SmartRF Studio uses a proprietary USB driver from FTDI [2] to communicate with SmartRF06 evaluation boards. Connect your SmartRF06EB to the computer with a USB cable and turn it on. If you did a complete install of SmartRF Studio, Windows will recognize the device automatically and the SmartRF06EB is ready for use!

4.1.2.1 Install FTDI USB driver manually in Windows

If the SmartRF06EB was not properly recognized after plugging it into your PC, try the following steps to install the necessary USB drivers. The steps described are for Microsoft Windows 7, but are very similar to those in Windows XP and Windows Vista. It is assumed that you have already downloaded and installed the latest version of SmartRF Studio 7 [1].

Open the Windows Device Manager and right click on the first "Texas Instruments XDS100v3" found under "Other devices" as shown in Figure 1a.

Select "Update Driver Software…" and, in the appearing dialog, browse to *<Studio install dir>\Drivers\ftdi* as shown in Figure 1b.



a) b)

Figure 1 – Driver install: a) Update driver, b) Specify path to FTDI drivers

Press Next and wait for the driver to be installed. The selected device should now appear in the Device Manager as "TI XDS100v3 Channel x" (x = A or B) as seen in Figure 2b. Repeat the above steps for the second "Texas Instruments XDS100v3" listed under "Other devices".

4.1.2.1.1 Enable XDS100v3 UART back channel on Windows

If you have both "TI XDS100v3 Channel A" and "TI XDS100v3 Channel B" listed under Universal Serial Bus Controllers, you can proceed. Right click on "TI XDS100v3 Channel B" and select Properties. Under the Advanced tab, make sure "Load VCP" is checked as shown in Figure 2a.

A "USB Serial Port" may be listed under "Other devices", as seen in Figure 1a. Follow the same steps as for the "Texas Instruments XDS100v3" devices to install the VCP driver. When the drivers from <*Studio install dir*>*\Drivers\ftdi* is properly installed, you should see the USB Serial Port device be listed under "Ports (COM & LPT)" as shown in Figure 2b.

The SmartRF06EB drivers are now installed correctly.

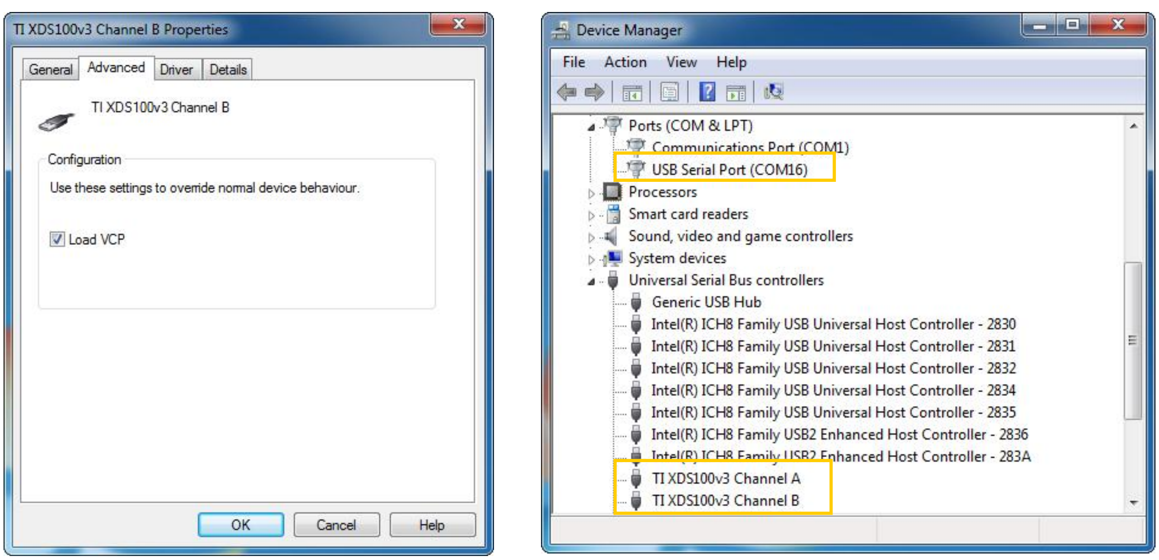


Figure 2 – Driver install: a) VCP loaded and b) drivers successfully installed

4.1.2.2 Install XSD100v3 UART back channel on Linux

The ports on SmartRF06EB will typically be mounted as *ttyUSB0* or *ttyUSB1*. The UART back channel is normally mounted as *ttyUSB1*.

1. Download the Linux drivers from [2].
2. Untar the *ftdi_sio.tar.gz* file on your Linux system.
3. Connect the SmartRF06EB to your system.
4. Install driver
    a. Verify the USB Product ID (PID) and Vendor ID (VID).
       The TI XDS100v3 USB VID is 0x0403 and the PID is 0xA6D1, but if you wish to find the PID using a terminal window/shell, use
       ```
       > lsusb | grep -i future
       ```
    b. Install driver using modprobe
       In a terminal window/shell, navigate to the *ftdi_sio* folder and run
       ```
       > sudo modprobe ftdi_sio vendor=0x403 product=0xA6D1
       ```

SmartRF06EB should now be correctly mounted. The above steps have been tested on Fedora and Ubuntu distributions.

If the above steps failed, try uninstalling 'brltty' prior to step 5 (technical note TN_101, [2]).

```
> sudo apt-get remove brltty
```

5 Using the SmartRF06 Evaluation Board

The SmartRF06EB is a flexible test and development platform that works together with RF Evaluation Modules from Texas Instruments.

An Evaluation Module (EM) is a small RF module with RF chip, balun, matching filter, SMA antenna connector and I/O connectors. The modules can be plugged into the SmartRF06EB which lets the PC take direct control of the RF device on the EM over the USB interface.

SmartRF06EB currently supports:

- CC2538EM

SmartRF06EB is included in e.g. the CC2538 development kit.

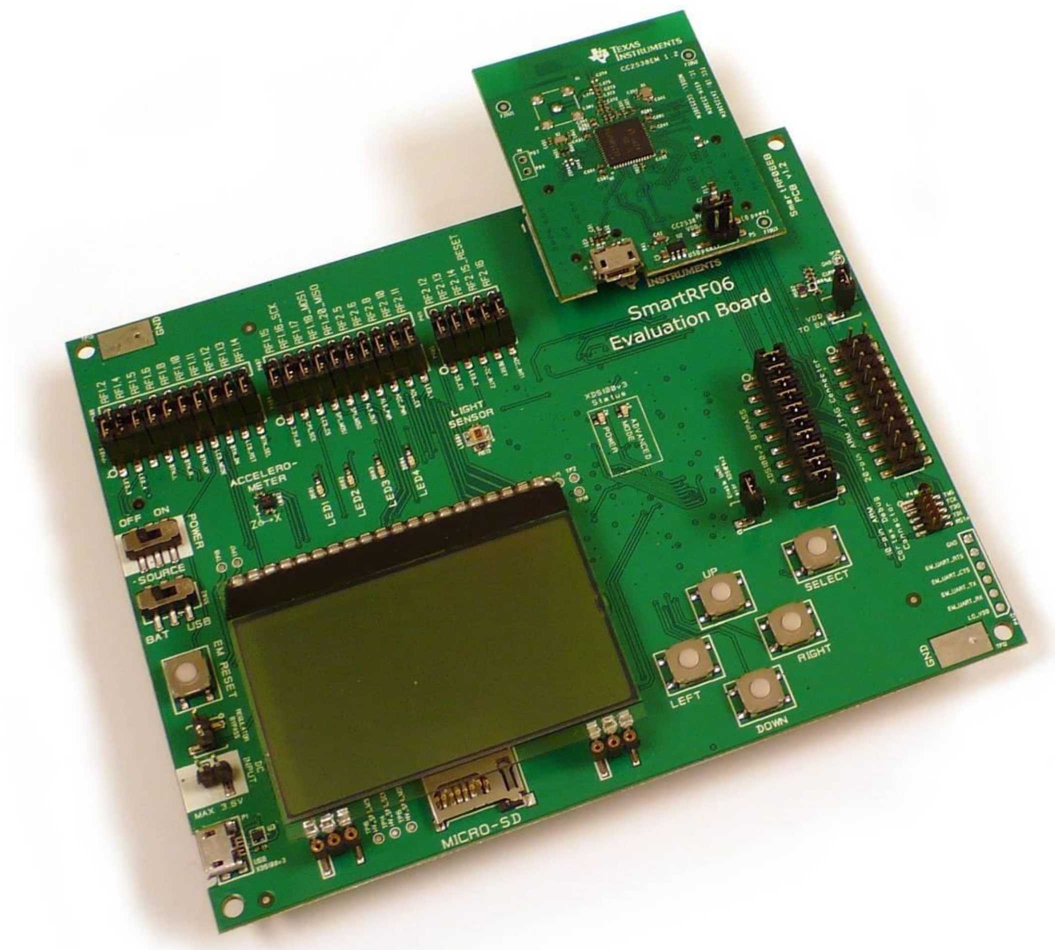


Figure 3 – SmartRF06EB (rev. 1.2.1) with EM connected

The PC software that controls the SmartRF06EB + EM is SmartRF Studio. Studio can be used to perform several RF tests and measurements, e.g. to set up a CW signal and send/receive packets.

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

- Perform comparative studies. Compare results obtained with EB+EM with results from your own system.
- Perform basic functional tests of your own hardware by connecting the radio on your board to SmartRF06EB. SmartRF Studio can be used to exercise the radio.
- Verify your own software with known good RF hardware, by simply connecting your own microcontroller to an EM via the EB. Test the send function by transmitting packets from your SW and receive with another board using SmartRF Studio. Then transmit using SmartRF Studio and receive with your own software.
- Develop code for your SoC and use the SmartRF06EB as a standalone board without PC tools.

The SmartRF06EB can also be used as a debugger interface to the SoCs from IAR Embedded workbench for ARM or Code Composer Studio from Texas Instruments. For details on how to use the SmartRF06EB to debug external targets, see chapter 7.

5.1 Absolute Maximum Ratings

The minimum and maximum operating supply voltages and absolute maximum ratings for the active components onboard the SmartRF06EB are summarized in Table 2. Table 3 lists the recommended operating temperature and storage temperature ratings. Please refer to the respective component's datasheet for further details.

Component	**Operating voltage**		**Absolute max. rating**	
	Min. [V]	**Max. [V]**	**Min. [V]**	**Max. [V]**
XDS100v3 Emulator[1] [4]	+1.8	+3.6	-0.3	+3.75
LCD [5]	+3.0	+3.3	-0.3	+3.6
Accelerometer [6]	+1.62	+3.6	-0.3	+4.25
Ambient light sensor [7]	+2.3[2]	+5.5	NA	+6

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

Component	**Operating temperature**		**Storage temperature**	
	Min. [˚C]	**Max. [˚C]**	**Min. [˚C]**	**Max. [˚C]**
XDS100v3 Emulator [4]	-20	+70	-50	+110
LCD [5]	-20	+70	-30	+80
Accelerometer [6]	-40	+85	-50	+150
Ambient light sensor [7]	-40	+85	-40	+85

Table 3 – Temperature: Recommended operating conditions and storage temperatures

[1] The XDS100v3 Emulator is USB powered. Values refer to the supply and I/O pin voltages of the connected target.
[2] Recommended minimum operating voltage.

6 SmartRF06 Evaluation Board Overview

SmartRF06EB acts as the motherboard in development kits for ARM® Cortex™ based Low Power RF SoCs from Texas Instruments. The board has several user interfaces and connections to external interfaces, allowing fast prototyping and testing of both software and hardware. An overview of the SmartRF06EB architecture is found in Figure 4. The board layout is found in Figure 5 and Figure 6, while the schematics are located in Appendix A.

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

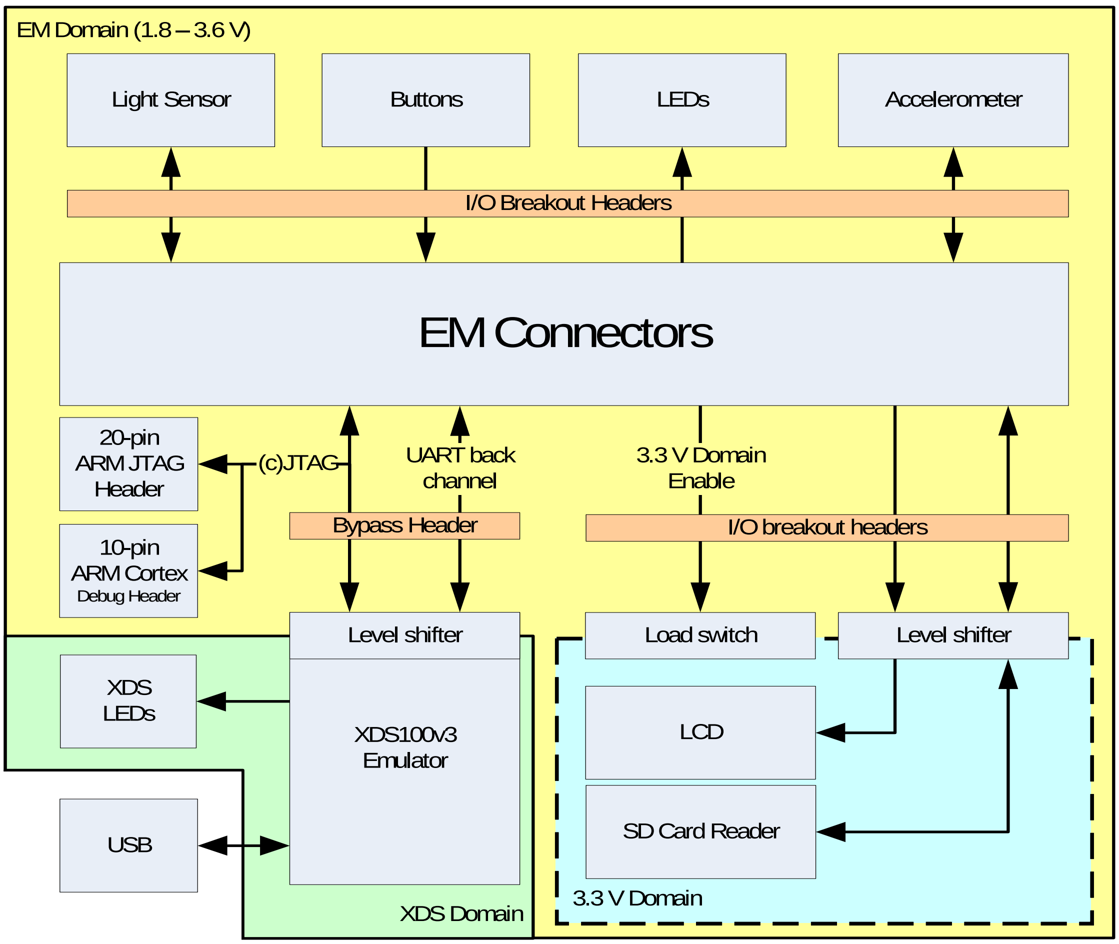


Figure 4 – SmartRF06EB architecture

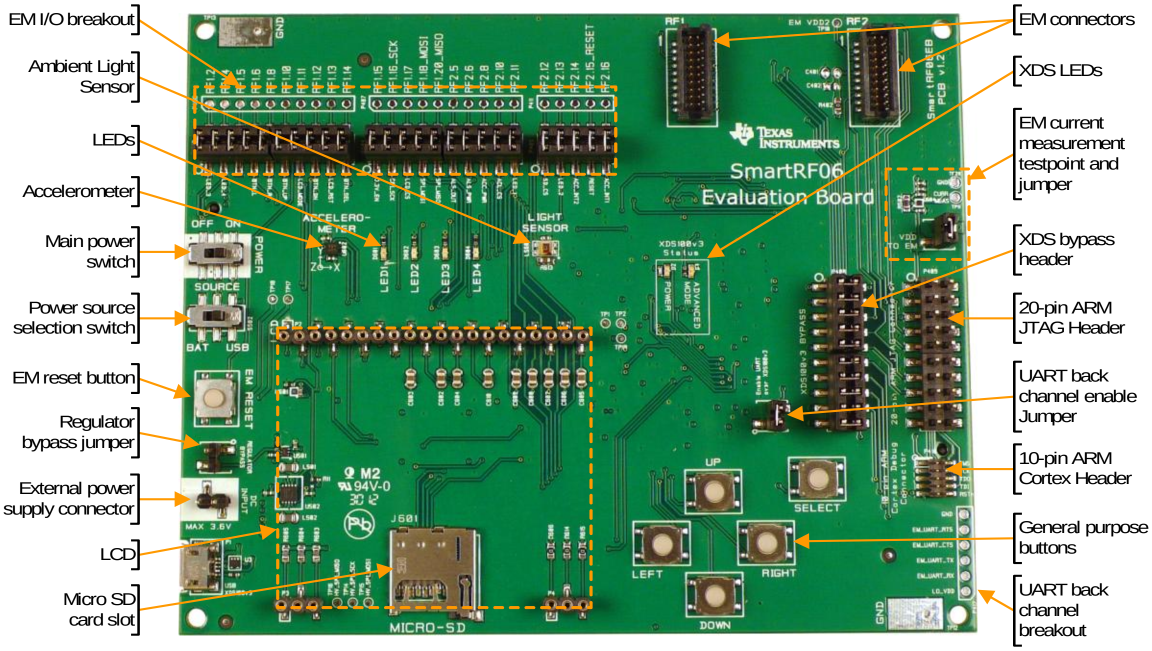


Figure 5 – SmartRF06EB revision 1.2.1 front side

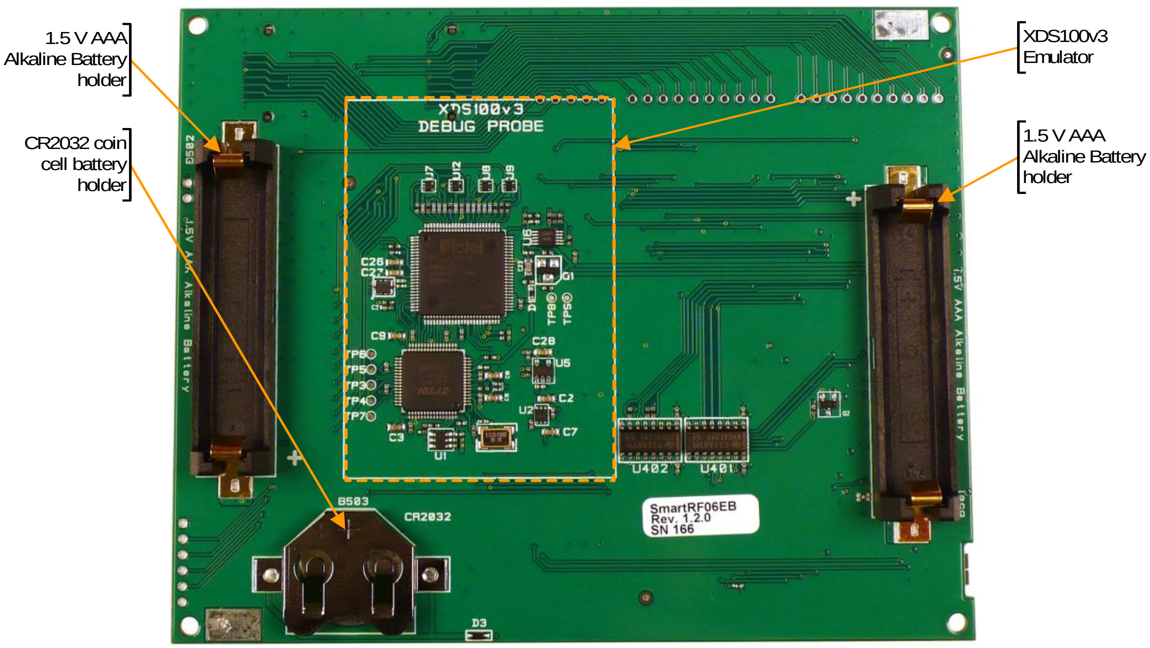


Figure 6 – SmartRF06EB revision 1.2.1 reverse side

6.1 XDS100v3 Emulator

The XDS100v3 Emulator from Texas Instruments has cJTAG and regular JTAG support. cJTAG is a 2-pin extension to regular 4-pin JTAG. The XDS100v3 consists of a USB to JTAG chip from FTDI [2] and an FPGA to convert JTAG instructions to cJTAG format.

In addition to regular debugging capabilities using cJTAG or JTAG, the XDS100v3 Emulator supports a UART backchannel over a USB Virtual COM Port (VCP) to the PC. The UART back channel supports flow control, 8-N-1 format and data rates up to 12Mbaud.

Please see the XDS100v3 emulator product page [4] for detailed information about the emulator. The XDS100v3 Emulator is powered over USB and is switched on as long as the USB cable is connected to the SmartRF06EB and the main power switch (S501) is in the ON position. The XDS100v3 Emulator supports targets with operating voltages between 1.8 V and 3.6. The min (max) operating temperature is -20 (+70) ˚C.

6.1.1 UART back channel

The mounted EM can be connected to the PC via the XDS100v3 Emulator's UART back channel. When connected to a PC, the XDS100v3 is enumerated as a Virtual COM Port (VCP) over USB. The driver used is a royalty free VCP driver from FTDI, available for e.g. Microsoft Windows, Linux and Max OS X. The UART back channel gives the mounted EM access to a four pin UART interface, supporting 8-N-1 format at data rates up to 12 Mbaud.

To enable the SmartRF06EB UART back channel the "Enable UART over XDS100v3" jumper (J5), located on the lower right side of the EB, must be mounted (Figure 7). Table 4 shows an overview of the I/O signals related to UART Back Channel.

Figure 7 – Jumper mounted on J5 to enable the UART back channel

Signal name	Description	Probe header	EM pin
RF1.7_UART_RX	UART Receive (EM data in)	EM_UART_RX (P412.2)	RF1.7
RF1.9_UART_TX	UART Transmit (EM data out)	EM_UART_TX (P412.3)	RF1.9
RF1.3_UART_CTS	UART Clear To Send signal	EM_UART_CTS (P412.4)	RF1.3
RF2.18_UART_RTS	UART Request To Send signal	EM_UART_RTS (P412.5)	RF2.18

Table 4 – UART Back channel signal connections

6.2 Power Sources

There are three ways to power the SmartRF06EB; batteries, USB bus and external power supply. The power source can be selected using the power source selection switch (S502) seen in Figure 8. The XDS100v3 Emulator can only be powered over USB. The main power supply switch (S501) cuts power to the SmartRF06EB.

> Never connect batteries and an external power source to the SmartRF06EB at the same time! Doing so may lead to excessive currents that may damage the batteries or cause onboard components to break. The CR2032 coin cell battery is in particular very sensitive to reverse currents (charging) and must never be combined with other power sources (AAA batteries or an external power source).

Figure 8 – Main power switch (P501) and source selection switch (P502)

6.2.1 USB Power

When the SmartRF06EB is connected to a PC via a USB cable, it can draw power from the USB bus. The onboard voltage regulator supplies approximately 3.3 V to the mounted EM and the EB peripherals. To power the mounted EM and the EB peripherals from the USB bus, the power source selection switch (S502) should be in "USB" position (Figure 9).

The maximum current consumption is limited by the regulator to 1500 mA[3].

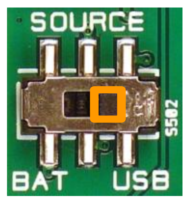


Figure 9 – SmartRF06EB power selection switch (P502) in "USB" position

6.2.2 Battery Power

The SmartRF06EB can be powered using two 1.5 V AAA alkaline batteries or a 3 V CR2032 coin cell battery. The battery holders for the AAA batteries and the CR2032 coin cell battery are located on the reverse side of the PCB. To power the mounted EM and the EB peripherals using batteries, the power source selection switch (S502) should be in "BAT" position (Figure 10).

When battery powered, the EM power domain is by default regulated to 2.1 V. The voltage regulator may be bypassed by mounting a jumper on J502. See section 6.3.2 for more details.

> Do not power the SmartRF06EB using two 1.5 V AAA batteries and a 3 V CR2032 coin cell battery at the same time. Doing so may lead to excessive currents that may damage the batteries or cause onboard components to break.

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

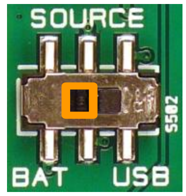


Figure 10 – SmartRF06EB power source selection switch (P502) in "BAT" position

6.2.3 External Power Supply

The SmartRF06EB can be powered using an external power supply. To power the mounted EM and the EB peripherals using an external power supply, the power source selection switch (S502) should be in "BAT" position (Figure 10 in section 6.2.2).

The external supply's ground should be connected to the SmartRF06EB ground, e.g. to the ground pad in the top left corner of the EB. Connect the positive supply connector to the external power header J501 (Figure 11). The applied voltage must be in the range from 2.1 V to 3.6 V and limited to max 1.5 A.

When powered by an external power supply, the EM power domain is by default regulated to 2.1 V. The voltage regulator may be bypassed by mounting a jumper on J502. See section 6.3.2 for more details.

⚠	There is a risk of damaging the onboard components if the applied voltage on the external power connector/header is lower than -0.3 V or higher than 3.6 V (combined absolute maximum ratings for onboard components). See section 5.1 for further information.

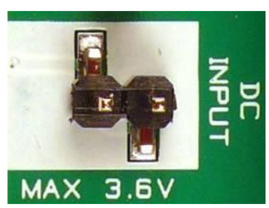


Figure 11 – SmartRF06EB external power supply header (J501)

6.3 Power Domains

The SmartRF06EB is divided into three power domains, described in detail in the following sections. The SmartRF06EB components, and what power domain they belong to, is shown in Figure 12 and Table 5 below.

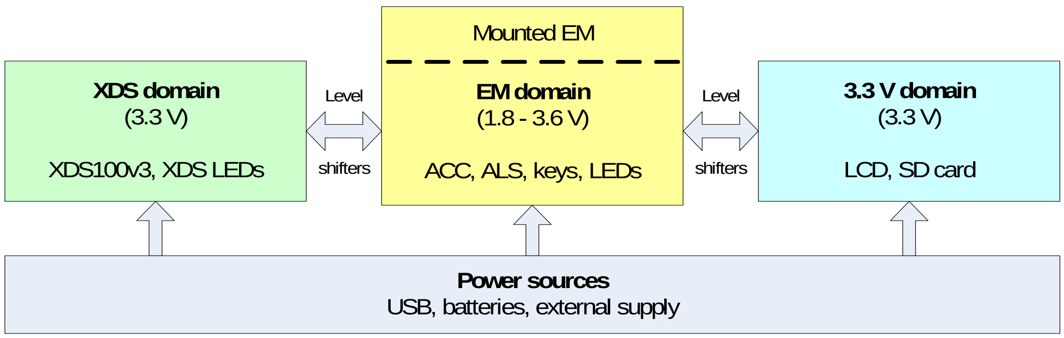


Figure 12 – Power domain overview of SmartRF06EB

Component	Power domain	Power source
Evaluation Module	EM domain (LO_VDD)	USB, battery, external
General Purpose LEDs	EM domain (LO_VDD)	USB, battery, external
Accelerometer	EM domain (LO_VDD)	USB, battery, external
Ambient Light Sensor	EM domain (LO_VDD)	USB, battery, external
Current measurement MSP MCU	EM domain (LO_VDD)	USB, battery, external
LEDs	EM domain (LO_VDD)	USB, battery, external
XDS100v3 Emulator	XDS domain	USB
XDS100v3 LEDs	XDS domain	USB
SD Card Slot	3.3 V domain (HI_VDD)	Same as EM domain
LCD	3.3 V domain (HI_VDD)	Same as EM domain

Table 5 – Power domain overview of SmartRF06EB

6.3.1 XDS Domain

The XDS100v3 Emulator (see section 6.1) onboard the SmartRF06EB is in the XDS domain. The XDS domain is powered over USB. The USB voltage supply (+5 V) is down-converted to +3.3 V and +1.5 V for the different components of the XDS100v3 Emulator.

The SmartRF06EB must be connected to e.g. a PC over USB for the XDS domain to be powered up. The domain is turned on/off by the SmartRF06EB main power switch.

6.3.2 EM Domain

The mounted EM board and most of the SmartRF06EB peripherals are powered in the EM domain and signals in this domain (accessible by the EM), are prefixed “LV_” in the schematics. Table 5 lists the EB peripherals that are powered in the EM domain. The domain is turned on/off by the SmartRF06EB power switch.

The EM domain may be powered using various power sources; USB powered (regulated to 3.3 V), battery powered (regulated to 2.1 V or unregulated) and using an external power supply (regulated to 2.1 V or unregulated).

When battery powered or powered by an external source, the EM power domain is by default regulated to 2.1 V using a step down converter. The step down converter may be bypassed by mounting a jumper on J502 (Figure 13), powering the EM domain directly from the source. When J502 is not mounted, the EM power domain is regulated to 2.1 V. The maximum current consumption of the EM power domain is then limited by the regulator to 410 mA.

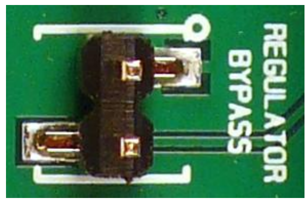


Figure 13 – Mount a jumper on J502 to bypass EM domain voltage regulator

NOTE: Mounting a jumper on J502 will not have any effect if the SmartRF06EB is powered over USB (when the power source selection switch, S502, is in “USB” position).

6.3.3 3.3 V Domain

The 3.3 V domain is a sub domain of the EM domain. The 3.3 V domain is regulated to 3.3 V using a buck-boost converter, irrespective of the source powering the EM domain. Signals in the 3.3V domain (controlled by the EM) are prefixed “HV_” for High Voltage in the schematics.

Two EB peripherals are in the 3.3 V domain, the LCD and the SD card slot, as listed in Table 5. These peripherals are connected to the EM domain via level shifters U401 and U402.

The 3.3 V domain may be switched on (off) completely by the mounted EM board by pulling signal LV_3.3V_EN to a logical 1 (0). See Table 14 in section 6.11.1 for details about the mapping between the EM and signals onboard the SmartRF06EB.

6.4 LCD

The SmartRF06EB comes with a 128x64 pixels display from Electronic Assembly (DOGM128E-6) [4]. The LCD display is available to mounted EM via a SPI interface, enabling software development of user interfaces and demo use. Table 6 shows an overview of the I/O signals related to the LCD.

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

The LCD connector on SmartRF06EB is very tight to ensure proper contact between the EM and the LCD. Be extremely cautious when removing the LCD to avoid the display from breaking.

Signal name	Description	Probe header	EM pin
LV_3.3V_EN	3.3 V domain enable signal[4]	RF1.15 (P407.1)	RF1.15
LV_LCD_MODE	LCD mode signal	RF1.11 (P406.7)	RF1.11
LV_LCD_RESET	LCD reset signal (active low)	RF1.13 (P406.9)	RF1.13
LV_LCD_CS	LCD Chip Select (active low)	RF1.17 (P407.3)	RF1.17
LV_SPI_SCK	SPI Clock	RF1.16_SCK (P407.2)	RF1.16
LV_SPI_MOSI	SPI MOSI (LCD input)	RF1.18_MOSI (P407.4)	RF1.18

Table 6 – LCD signal connections

6.5 Micro SD Card Slot

The SmartRF06EB has a micro SD card slot for connecting external SD/MMC flash devices (flash device not included). A connected flash device is available to the mounted EM via a SPI interface, giving it access to extra flash, enabling over-the-air upgrades and more. Table 8 shows an overview of I/O signals related to the micro SD card slot.

The micro SD card is powered from the 3.3 V power domain (HI_VDD).

Signal name	Description	Probe header	EM pin
LV_3.3V_EN	3.3 V domain enable signal[4]	RF1.15 (P407.1)	RF1.15
LV_SDCARD_CS	SD card Chip Select (active low)	RF2.12 (P411.1)	RF2.12
LV_SPI_SCK	SPI Clock	RF1.16_SCK (P407.2)	RF1.16
LV_SPI_MOSI	SPI MOSI (SD card input)	RF1.18_MOSI (P407.4)	RF1.18
LV_SPI_MISO	SPI MISO (SD card output)	RF1.20_MISO (P407.5)	RF1.20

Table 7 – Micro SD Card signal connections

6.6 Accelerometer

The SmartRF06EB is equipped with a BMA250 digital accelerometer from Bosch Sensortech [6]. The accelerometer is available to the mounted EM via an SPI interface and has two dedicated interrupt lines. The accelerometer is suitable for application development, prototyping and demo use. Table 8 shows an overview of I/O signals related to the accelerometer.

The recommended operating condition for the accelerometer is a supply voltage between 1.62 V and 3.6 V. The min (max) operating temperature is -40 (+85) ˚C.

Signal name	Description	Probe header	EM pin
LV_ACC_PWR	Acc. power enable signal	RF2.8 (P407.8)	RF2.8
LV_ACC_INT1	Acc. interrupt signal	RF2.16 (P411.5)	RF2.16
LV_ACC_INT2	Acc. interrupt signal	RF2.14 (P411.3)	RF2.14
LV_ACC_CS	Acc. Chip Select (active low)	RF2.10 (P407.9)	RF2.10
LV_SPI_SCK	SPI Clock	RF1.16_SCK (P407.2)	RF1.16
LV_SPI_MOSI	SPI MOSI (acc. input)	RF1.18_MOSI (P407.4)	RF1.18

[4] The LCD and SD card are both powered in the 3.3 V domain and cannot be powered on/off individually.

LV_SPI_MISO	SPI MISO (acc. output)	RF1.20_MISO (P407.5)	RF1.20

Table 8 – Accelerometer signal connections

6.7 Ambient Light Sensor

The SmartRF06EB has an analog SFH 5711 ambient light sensor (ALS) from Osram [7] that is available for the mounted EM via the EM connectors, enabling quick application development for demo use and prototyping. Figure 14 and Table 9 shows an overview of I/O signals related to the ambient light sensor.

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

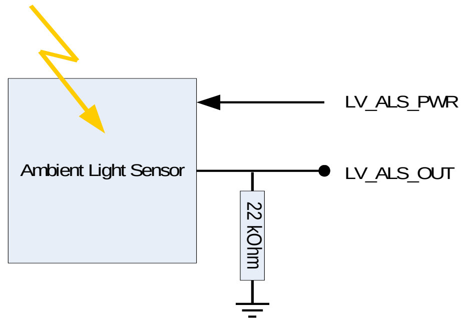


Figure 14 – Simplified schematic of Ambient Light Sensor setup

Signal name	Description	Probe header	EM pin
LV_ALS_PWR	ALS power enable signal	RF2.6 (P407.7)	RF2.6
LV_ALS_OUT	ALS output signal (analog)	RF2.5 (P411.6)	RF2.5

Table 9 – Ambient Light Sensor signal connections

6.8 Buttons

There are 6 buttons on the SmartRF06EB. Status of the LEFT, RIGHT, UP, DOWN and SELECT buttons are available to the mounted EM. These buttons are intended for user interfacing and development of demo applications.

The EM RESET button resets the mounted EM by pulling its reset line low ($\overline{\text{RF2.15\_RESET}}$). Table 10 shows an overview of I/O signals related to the buttons.

Signal name	Description	Probe header	EM pin
LV_BTN_LEFT	Left button (active low)	RF1.6 (P406.4)	RF1.6
LV_BTN_RIGHT	Right button (active low)	RF1.8 (P406.5)	RF1.8
LV_BTN_UP	Up button (active low)	RF1.10 (P406.6)	RF1.10
LV_BTN_DOWN	Down button (active low)	RF1.12 (P406.8)	RF1.12
LV_BTN_SELECT	Select button (active low)	RF1.14 (P406.10)	RF1.14
$\overline{\text{LV\_BTN\_RESET}}$	EM reset button (active low)	$\overline{\text{RF2.15\_RESET}}$ (P411.4)	RF2.15

Table 10 – Button signal connections

6.9 LEDs

6.9.1 General Purpose LEDs

The four LEDs D601, D602, D603, D604 can be controlled from the mounted EM and are suitable for demo use and debugging. The LEDs are active high. Table 11 shows an overview of I/O signals related to the LEDs.

Signal name	Description	Probe header	EM pin
LV_LED_1	LED 1 (red)	RF2.11 (P407.10)	RF2.11
LV_LED_2	LED 2 (yellow)	RF2.13 (P411.2)	RF2.13
LV_LED_3	LED 3 (green)	RF1.2 (P406.1)	RF1.2
LV_LED_4	LED 4 (red-orange)	RF1.4 (P406.2)	RF1.4

Table 11 – General purpose LED signal connections

6.9.2 XDS100v3 Emulator LEDs

The XDS100v3 emulator has two LEDs to indicate its status, D2 and D4. The LEDs are located on the top side of the SmartRF06EB. LED D2 is lit whenever the XDS100v3 Emulator is powered, while LED D4 (ADVANCED MODE) is lit when the XDS100v3 is in an active cJTAG debug state.

6.10 EM Connectors

The EM connectors, shown in Figure 15, are used for connecting an EM board to the SmartRF06EB. The connectors RF1 and RF2 are the main interface and are designed to inhibit incorrect mounting of the EM board. The pin-out of the EM connectors is given in Table 12 and Table 13.

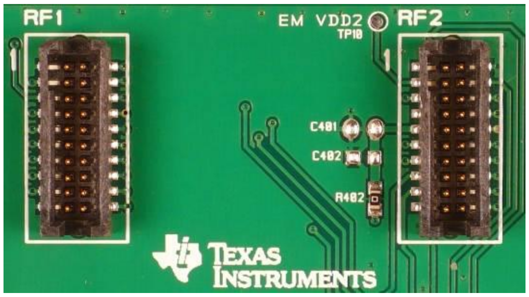


Figure 15 – SmartRF06EB EM connectors RF1 and RF2

EM pin	Signal name	Description	Probe header	Breakout header
RF1.1	GND	Ground		
RF1.2	RF1.2	GPIO signal to EM board	P406.1	P403.1-2
RF1.3	RF1.3_UART_CTS	UART back channel / GPIO	P412.4	P408.15-16
RF1.4	RF1.4	GPIO signal to EM board	P406.2	P403.3-4
RF1.5	RF1.5	GPIO signal to EM board	P406.3	P403.5-6
RF1.6	RF1.6	GPIO signal to EM board	P406.4	P403.7-8
RF1.7	RF1.7_UART_RX	UART back channel (EM RX)	P412.2	P408.11-12
RF1.8	RF1.8	GPIO signal to EM board	P406.5	P403.9-10
RF1.9	RF1.9_UART_TX	UART back channel (EM TX)	P412.3	P408.13-14
RF1.10	RF1.10	GPIO signal to EM board	P406.6	P403.11-12
RF1.11	RF1.11	GPIO signal to EM board	P406.7	P403.13-14
RF1.12	RF1.12	GPIO signal to EM board	P406.8	P403.15-16
RF1.13	RF1.13	GPIO signal to EM board	P406.9	P403.17-18
RF1.14	RF1.14	GPIO signal to EM board	P406.10	P403.19-20
RF1.15	RF1.15	GPIO signal to EM board	P407.1	P404.1-2
RF1.16	RF1.16_SPI_SCK	EM SPI Clock	P407.2	P404.3-4
RF1.17	RF1.17	GPIO signal to EM board	P407.3	P404.5-6
RF1.18	RF1.18_SPI_MOSI	EM SPI MOSI	P407.4	P404.7-8
RF1.19	GND	Ground		
RF1.20	RF1.20_SPI_MISO	EM SPI MISO	P407.5	P404.9-10

Table 12 – EM connector RF1 pin-out

EM pin	Signal name	Description	Probe header	Breakout header
RF2.1	RF2.1_JTAG_TCK	JTAG Test Clock	P409.9	P408.1-2
RF2.2	GND	Ground		
RF2.3	RF_VDD2	EM power	TP10	J503.1-2
RF2.4	RF2.4_JTAG_TMS	JTAG Test Mode Select	P409.7	P408.3-4
RF2.5	RF2.5	GPIO signal to EM board	P407.6	P404.11-12
RF2.6	RF2.6	GPIO signal to EM board	P407.7	P404.13-14
RF2.7	RF_VDD1	EM power	TP10	J503.1-2
RF2.8	RF2.8	GPIO signal to EM board	P407.8	P404.15-16
RF2.9	RF_VDD1	EM power	TP10	J503.1-2
RF2.10	RF2.10	GPIO signal to EM board	P407.9	P404.17-18
RF2.11	RF2.11	GPIO signal to EM board	P407.10	P404.19-20
RF2.12	RF2.12	GPIO signal to EM board	P411.1	P405.1-2
RF2.13	RF2.13	GPIO signal to EM board	P411.2	P405.3-4
RF2.14	RF2.14	GPIO signal to EM board	P411.3	P405.5-6
RF2.15	$\overline{\text{RF2.15\_RESET}}$	EM reset signal (active low)	P411.4	P405.7-8
RF2.16	RF2.16	GPIO signal to EM board	P411.5	P405.9-10
RF2.17	RF2.17_JTAG_TDI	GPIO / JTAG Test Data In	P409.5	P408.5-6
RF2.18	RF2.18_UART_RTS	GPIO / UART Back Channel	P412.5	P408.17-18
RF2.19	RF2.19_JTAG_TDO	GPIO / JTAG Test Data Out	P409.13	P408.7-8
RF2.20	GND	Ground		

Table 13 – EM connector RF2 pin-out

6.11 Breakout Headers and Jumpers

The SmartRF06EB has several breakout headers, giving access to all EM connector pins. An overview of the SmartRF06EB I/O breakout headers is given in Figure 16. Probe headers P406, P407, P411 and P412 give access to the I/O signals of the mounted EM. Breakout headers P403, P404 and P405 allow the user to map any EM I/O signal to any peripheral on the SmartRF06EB.

The XDS bypass header (P408) makes it possible to disconnect the XDS100v3 Emulator onboard the EB from the EM. Using the 20-pin ARM JTAG header (P409) or the 10-pin ARM Cortex Debug Header (P410), it is possible to debug external targets using the onboard emulator.

> **NOTE:** By default, all jumpers are mounted on P403, P404, P405 and P408. The default configuration is assumed in this user's guide unless otherwise stated.

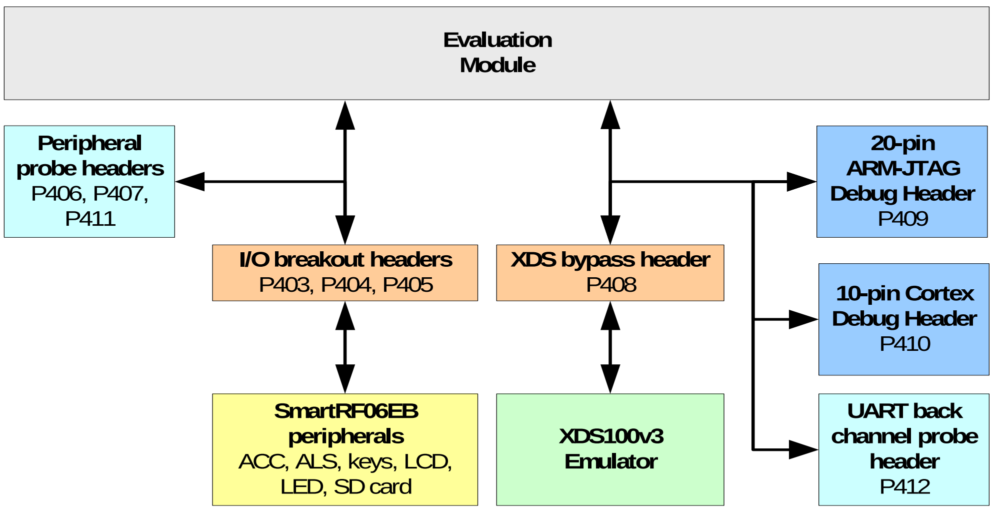


Figure 16 – SmartRF06EB I/O breakout overview

6.11.1 I/O Breakout Headers

The I/O breakout headers on SmartRF06EB consist of pin connectors P406, P407, P411 and P412. P406, P407 and P411 are located at the top left side of SmartRF06EB. All EM signals available on these probe headers can be connected to or disconnected from SmartRF06EB peripherals using jumpers on headers P403, P404, P405.

Probe header P412 is located near the bottom right corner of the SmartRF06EB. The signals available on P412 are connected to the XDS100v3 Emulator's UART back channel using jumpers on header P408.

The I/O breakout mapping between the SmartRF06EB and the mounted EM is given in Table 14. The leftmost column in the below table refers to the silk print seen on the SmartRF06EB. The rightmost column shows the corresponding CC2538 I/O pad on CC2538EM.

Probe header	Silk print	EB signal name	EM connector	CC2538EM I/O
P406	RF1.2	LV_LED_3	RF1.2	PC2
	RF1.4	LV_LED_4	RF1.4	PC3
	RF1.5	NC	RF1.5	PB1
	RF1.6	LV_BTN_LEFT	RF1.6	PC4
	RF1.8	LV_BTN_RIGHT	RF1.8	PC5
	RF1.10	LV_BTN_UP	RF1.10	PC6
	RF1.11	LV_LCD_MODE	RF1.11	PB2
	RF1.12	LV_BTN_DOWN	RF1.12	PC7
	RF1.13	$\overline{\text{LV\_LCD\_RESET}}$	RF1.13	PB3
	RF1.14	LV_BTN_SELECT	RF1.14	PA3
P407	RF1.15	LV_3.3V_EN	RF1.15	PB4
	RF1.16_SCK	LV_SPI_SCK	RF1.16	PA2
	RF1.17	$\overline{\text{LV\_LCD\_CS}}$	RF1.17	PB5
	RF1.18_MOSI	LV_SPI_MOSI	RF1.18	PA4
	RF1.20_MISO	LV_SPI_MISO	RF1.20	PA5
	RF2.5	LV_ALS_OUT	RF2.5	PA6
	RF2.6	LV_ALS_PWR	RF2.6	PA7
	RF2.8	LV_ACC_PWR	RF2.8	PD4
	RF2.10	$\overline{\text{LV\_ACC\_CS}}$	RF2.10	PD5
	RF2.11	LV_LED_1	RF2.11	PC0
P411	RF2.12	$\overline{\text{LV\_SDCARD\_CS}}$	RF2.12	PD0
	RF2.13	LV_LED_2	RF2.13	PC1
	RF2.14	LV_ACC_INT2	RF2.14	PD1
	RF2.15_RESET	$\overline{\text{LV\_BTN\_RESET}}$	RF2.15	nRESET
	RF2.16	LV_ACC_INT1	RF2.16	PD2
P412	EM_UART_RX	RF1.7_UART_RX	RF1.7	PA0
	EM_UART_TX	RF1.9_UART_TX	RF1.9	PA1
	EM_UART_CTS	RF1.3_UART_CTS	RF1.3	PB0
	EM_UART_RTS	RF2.18_UART_RTS	RF2.18	PD3

Table 14 – SmartRF06EB I/O breakout overview

6.11.2 XDS100v3 Emulator Bypass Headers

The XDS100v3 Emulator bypass header, P408, is by default mounted with jumpers (Figure 17), connecting the XDS100v3 Emulator to a mounted EM or external target. By removing the jumpers on P408, the XDS100v3 Emulator may be disconnected from the target.

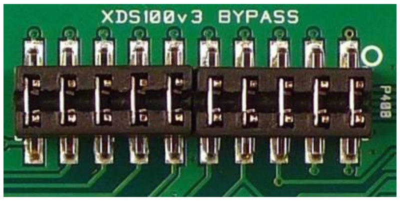


Figure 17 – XDS100v3 Emulator Bypass Header (P408)

6.11.3 20-pin ARM JTAG Header

The SmartRF06EB comes with a standard 20-pin ARM JTAG header [8] (Figure 18), enabling the user to debug an external target using the XDS100v3 Emulator. The pin-out of the ARM JTAG header is given in Table 15. Chapter 7 has more information on how to debug an external target using the XDS100v3 Emulator onboard the SmartRF06EB.

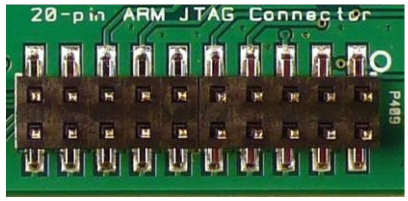


Figure 18 – 20-pin ARM JTAG header (P409)

Pin	Signal	Description	EB signal name	XDS bypass header
P409.1	VTRef	Voltage reference	VDD_SENSE	P408.19-20
P409.2	VSupply	Voltage supply	NC	
P409.3	nTRST	Test Reset	NC	
P409.4	GND	Ground	GND	
P409.5	TDI	Test Data In	RF2.17_JTAG_TDI	P408.5-6
P409.6	GND	Ground	GND	
P409.7	TMS	Test Mode Select	RF2.4_JTAG_TMS	P408.3-4
P409.8	GND	Ground	GND	
P409.9	TCK	Test Clock	RF2.1_JTAG_TCK	P408.1-2
P409.10	GND	Ground	GND	
P409.11	RTCK	Return Clock	NC	
P409.12	GND	Ground	GND	
P409.13	TDO	Test Data Out	RF2.19_JTAG_TDO	P408.7-8
P409.14	GND	Ground	GND	
P409.15	nSRST	System Reset	RF2.15_RESET	P408.9-10
P409.16	GND	Ground	GND	
P409.17	DBGRQ	Debug Request	NC	
P409.18	GND	Ground	GND	
P409.19	DBGACK	Debug Acknowledge	NC	
P409.20	GND	Ground	GND	

Table 15 – 20-pin ARM JTAG header pin-out (P409)

6.11.4 10-pin ARM Cortex Debug Header

The SmartRF06EB comes with a standard 10-pin ARM Cortex debug header [8] (Figure 19), enabling the user to debug an external target using the XDS100v3 Emulator. The ARM Cortex debug header is located near the right hand edge of the EB. The header pin-out is given in Table 16. Chapter 7 has more information on how to debug an external target using the XDS100v3 Emulator onboard the SmartRF06EB.

Figure 19 – 10-pin ARM Cortex Debug header (P410)

Pin	Signal	Description	EB signal name	XDS bypass header
P410.1	VCC	Voltage reference	VDD_SENSE	P408.19-20
P410.2	TMS	Test Mode Select	RF2.4_JTAG_TMS	P408.3-4
P410.3	GND	Ground	GND	
P410.4	TCK	Test Clock	RF2.1_JTAG_TCK	P408.1-2
P410.5	GND	Ground	GND	
P410.6	TDO	Test Data Out	RF2.19_JTAG_TDO	P408.7-8
P410.7	KEY	Key	NC	
P410.8	TDI	Test Data In	RF2.17_JTAG_TDI	P408.5-6
P410.9	GNDDetect	Ground detect	GND	
P410.10	nRESET	System Reset	$\overline{\text{RF2.15\_RESET}}$	P408.9-10

Table 16 – 10-pin ARM Cortex Debug header pin-out (P410)

6.12 Current Measurement

The SmartRF06EB provides two options for easy measurements of the current consumption of a mounted EM. The following sections describe these two options in detail.

6.12.1 High-side current sensing

The SmartRF06EB comes with a current sensing unit for measuring the current consumption of the mounted EM (Figure 20). The current sensing setup is "high-side", that is, it measures the current going to the mounted EM. The current is converted to a voltage, available at the CURMEAS_OUTPUT test point (TP11), located near the right edge of the SmartRF06EB. Using the SmartRF06EB together with for example an oscilloscope makes it easy to measure the EM current consumption as a function of time.

The relationship between the voltage measured at CURMEAS_OUTPUT, $V_{CURMEAS}$, and the EM current consumption, I_{EM}, is given by Equation 1 below.

$$I_{EM} = \frac{V_{CURMEAS}}{15} \quad (1)$$

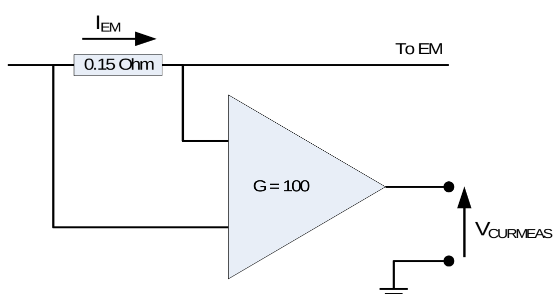


Figure 20 – Simplified schematic of high-side current sensing setup

6.12.2 Current Measurement Jumper

SmartRF06EB has a current measurement header, J503, for easy measurement of EM current consumption. Header J503 is located on the upper right hand side of the EB. By replacing the jumper with an ammeter, as shown in Figure 21, the current consumption of the mounted EM can be measured.

Figure 21 – Measuring current consumption using jumper J503

7 Debugging an external target using SmartRF06EB

You can easily use XDS100v3 Emulator onboard the SmartRF06EB to debug an external target. It is in this chapter assumed that the target is self-powered.

When debugging an external, self-powered target using SmartRF06EB, make sure to remove the jumper from the current measurement header (J503) as shown in the second scenario of Figure 22. In this scenario, the onboard XDS100v3 senses the target voltage of the external target. In the left side scenario of the same figure, the XDS100v3 senses the target voltage of the EB's EM domain.

⚠	Having a jumper mounted on header J503 when debugging an external target will cause a conflict between the EB's EM domain supply voltage and the target's supply voltage. This may result in excess currents, damaging the onboard components of the SmartRF06EB or the target board.

In Figure 22, the right hand side scenario shows how it is possible to debug an EM mounted on the SmartRF06EB using an external debugger. In this scenario, all the jumpers must be removed from the SmartRF06EB header P408 to avoid signaling conflicts between the onboard XDS100v3 Emulator and the external debugger.

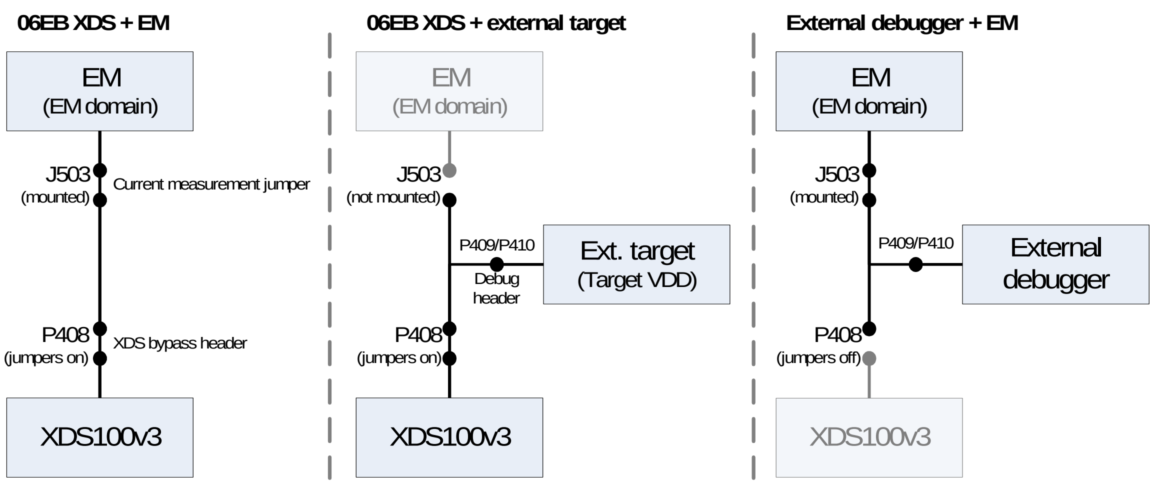


Figure 22 – Simplified connection diagram for different debugging scenarios

7.1 20-pin ARM JTAG Header

The SmartRF06EB has a standard 20-pin ARM JTAG header mounted on the right hand side (P409). Make sure all the jumpers on the XDS bypass header (P408) are mounted and that the jumper is removed from header J503.

Connect the external board to the 20-pin ARM JTAG header (P409) using a 20-pin flat cable as seen in Figure 23. Make sure pin 1 on P409 matches pin 1 on the external target. See sections 6.11.3 and 6.11.2 for more info about the 20-pin ARM JTAG header and the XDS bypass header, respectively.

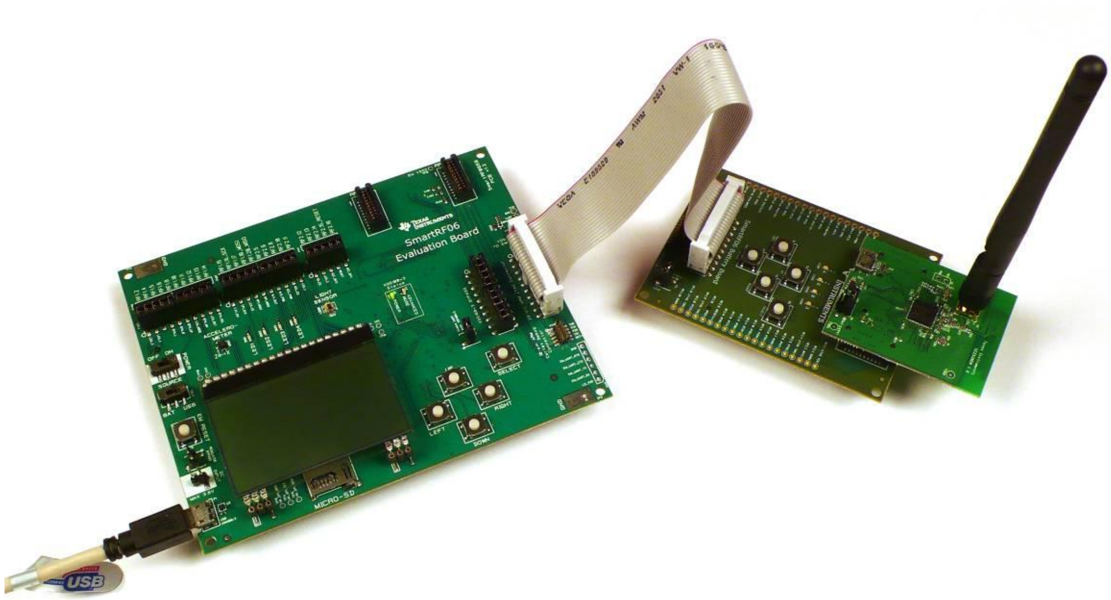


Figure 23 – Debugging external target using SmartRF06EB

7.2 10-pin ARM Cortex Debug Header

The SmartRF06EB has a standard 10-pin ARM Cortex Debug header mounted on the right hand side (P410). Make sure all the jumpers on the XDS bypass header (P408) are mounted and that the jumper is removed from header J503.

Connect the external board to the 10-pin ARM JTAG header using a 10-pin flat cable. Make sure pin 1 on P410 matches pin 1 on the external target See sections 6.11.4 and 6.11.2 for more info about the 10-pin ARM Cortex Debug header and the XDS bypass header, respectively.

7.3 Custom Strapping

If the external board does not have a 20-pin ARM JTAG connector nor a 10-pin ARM Cortex connector, the needed signals may be strapped from the onboard XDS100v3 Emulator to the external target board.

Make sure all the jumpers on the XDS bypass header (P408) are mounted and that the jumper is removed from header J503. Table 17 shows the signals that must be strapped between the SmartRF06EB and the target board. Table 18 shows additional signals that are optional or needed for debugging using 4-pin JTAG. Figure 24 shows where the signals listed in Table 17 and Table 18 can be found on the 20-pin ARM JTAG header.

EB Signal Name	EB Breakout	Description
VDD_SENSE	P409.1	Target voltage supply
GND	P409.4	Common ground for EB and external board
RF2.1_JTAG_TCK	P409.9	Test Clock
RF2.4_JTAG_TMS	P409.7	Test Mode Select

Table 17 – Debugging external target: Minimum strapping (cJTAG support)

EB Signal Name	EB Breakout	Description
RF2.17_JTAG_TDI	P409.5	Test Data In (optional for cJTAG)
RF2.19_JTAG_TDO	P409.13	Test Data Out (optional for cJTAG)
RF2.15_RESET	P409.15	Target reset signal (optional)

Table 18 – Debugging external target: Optional strapping

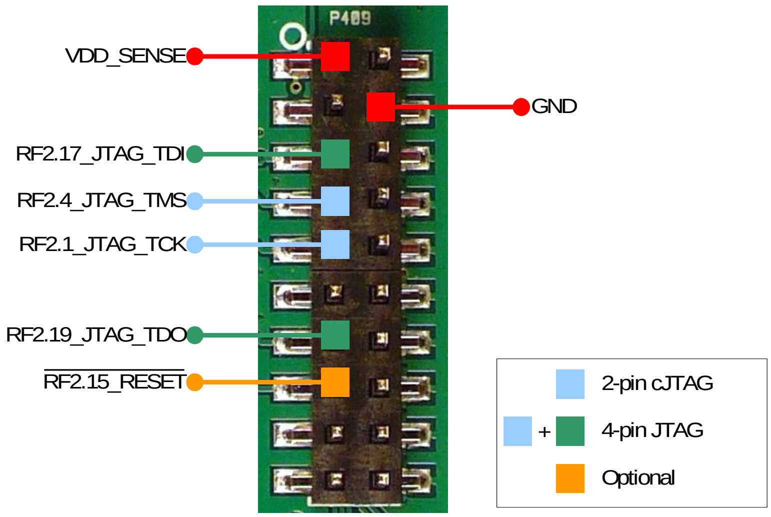


Figure 24 – ARM JTAG header (P409) with strapping to debug external target

8 Frequently Asked Questions

Q1 Nothing happens when I power up the evaluation board. Why?

A1 Make sure you have a power source connected to the EB. Verify that the power source selection switch (S502) is set correctly according to your power source. When powering the EB from either batteries or an external power source, S502 should be in "BAT" position. When powering the EB over USB, the switch should be in "USB" position. Also, make sure the EM current measurement jumper (J503) is short circuited.

Q2 Why are there two JTAG connectors on the SmartRF06EB, which one should I use?

A2 The SmartRF06EB comes with two different standard debug connectors, the 20-pin ARM JTAG connector (P409) and the compact 10-pin ARM Cortex debug connector (P410). These debug connectors are there to more easily debug external targets without the need of customized strapping. For more details on how to debug external targets using the SmartRF06EB, see chapter 7.

Q3 Can I use the SmartRF06EB to debug an 8051 SoC such as CC2530?

A3 No, you cannot debug an 8051 SoC using the SmartRF06EB.

Q4 When connecting my SmartRF06EB to my PC, no serial port appears. Why?

A4 It may be that the virtual COM port on the SmartRF06EB's XDS100 channel B hasn't been enabled. Section 4.1.2.1.1 describes how to enable the Vritual COM Port in the USB driver.

9 References

[1] **SmartRF Studio Product Page**
http://www.ti.com/tool/smartrftm-studio

[2] **FTDI USB Driver Page**
http://www.ftdichip.com

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

[4] **XDS100 Emulator Product Page**
http://processors.wiki.ti.com/index.php/XDS100

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

[6] **Bosch Sensortec BMA250 Datasheet**
http://ae-bst.resource.bosch.com/media/products/dokumente/bma250/bst-bma250-ds002-05.pdf

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

[8] **Cortex-M Debug Connectors**
http://infocenter.arm.com/help/topic/com.arm.doc.faqs/attached/13634/cortex_debug_connectors.pdf

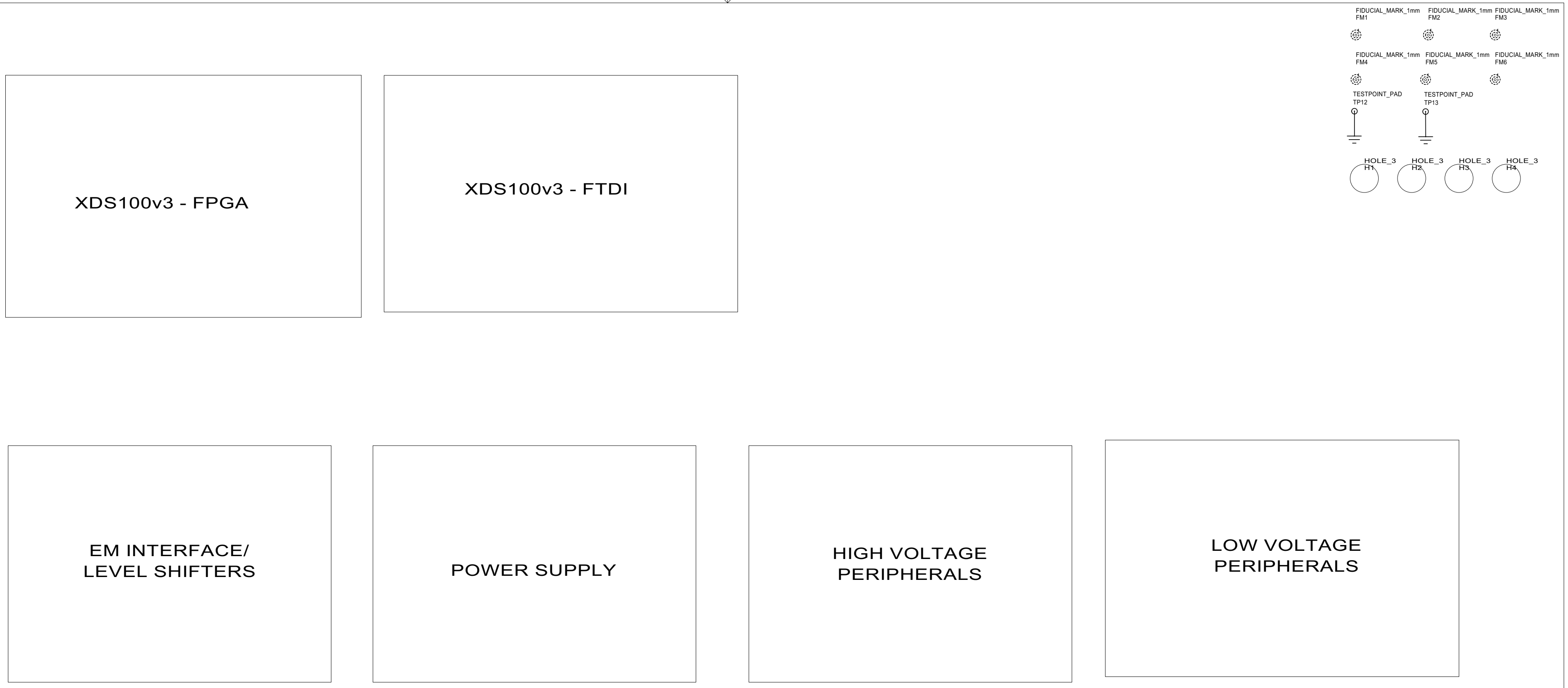
10 Document History

Revision	Date	Description/Changes
SWRU321A	2013-05-21	Minor fixes to Figure 4. Fixed incorrect EM mapping in Table 11. Added steps for installing SmartRF06EB on Linux.
SWRU321	2012-09-07	Initial version.

Appendix A

Schematics

SmartRF06EB 1.2.1



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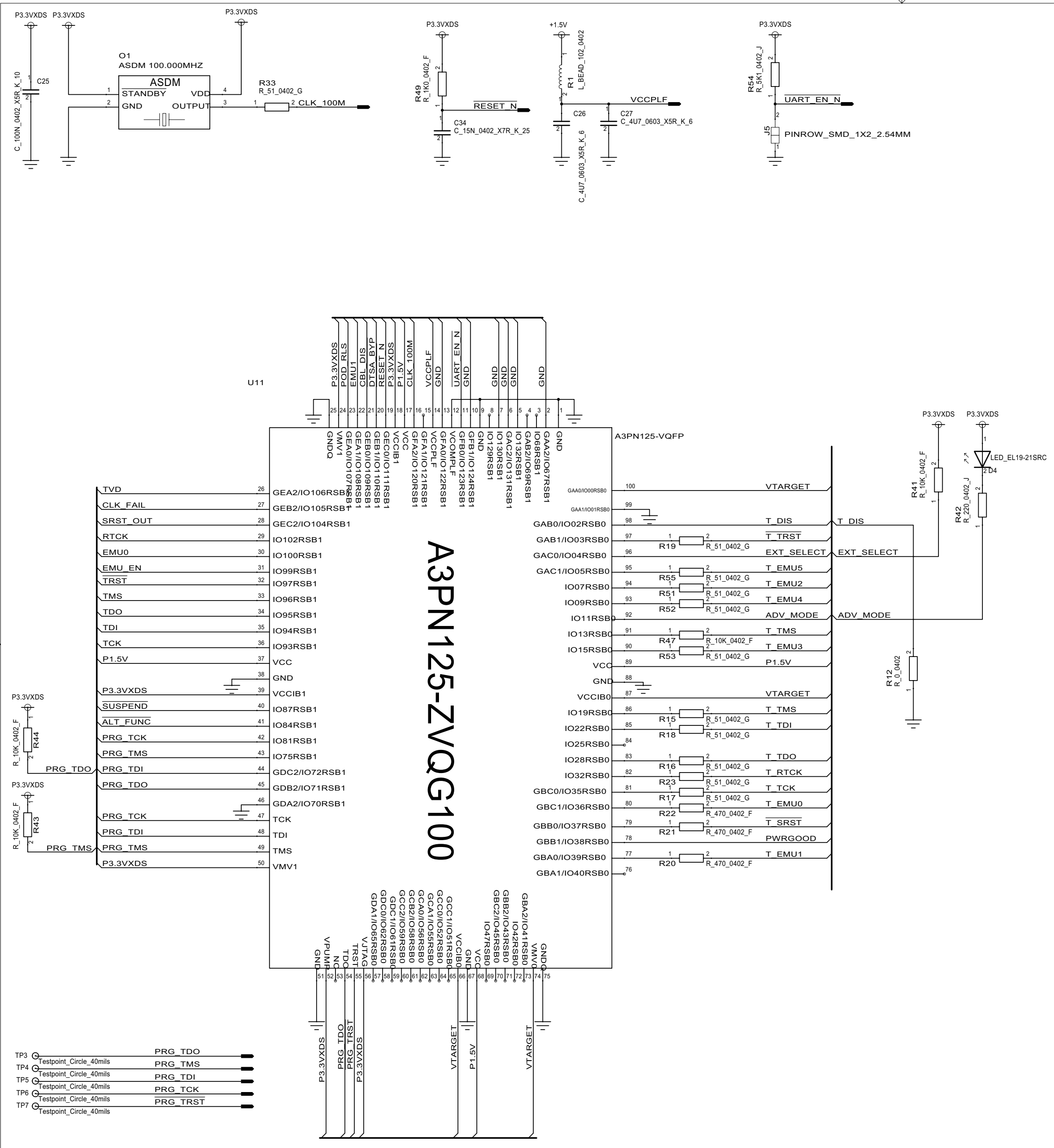
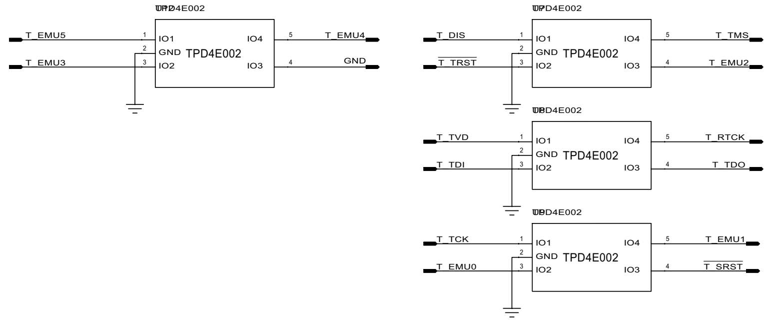
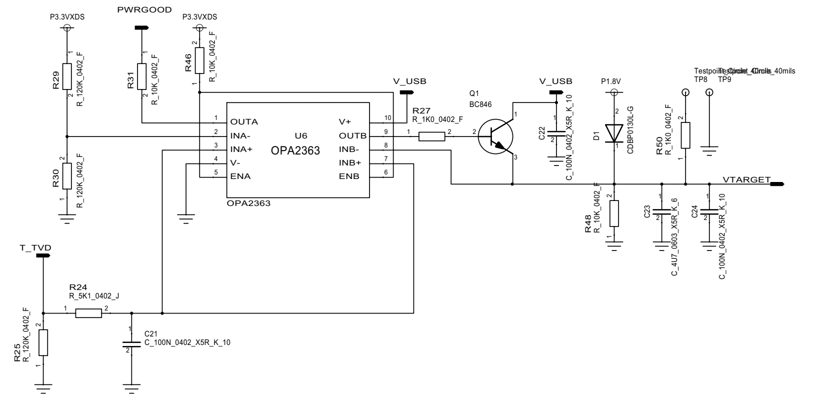
ISSUED	13/07/12	SCALE		SHEET 1(7)	





The XDS100 is connected to the EM through connector P408. See the EM interface page for details.



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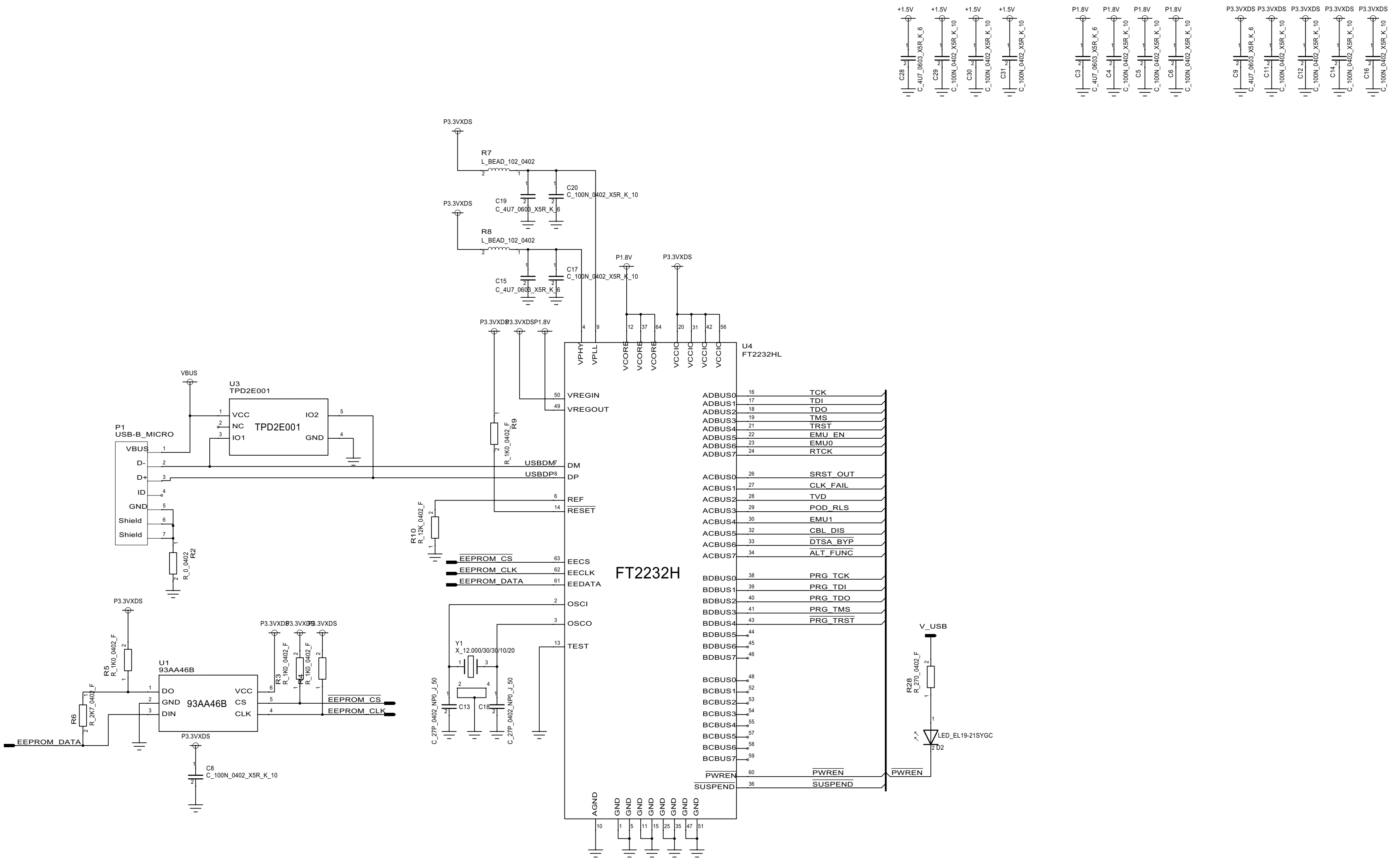

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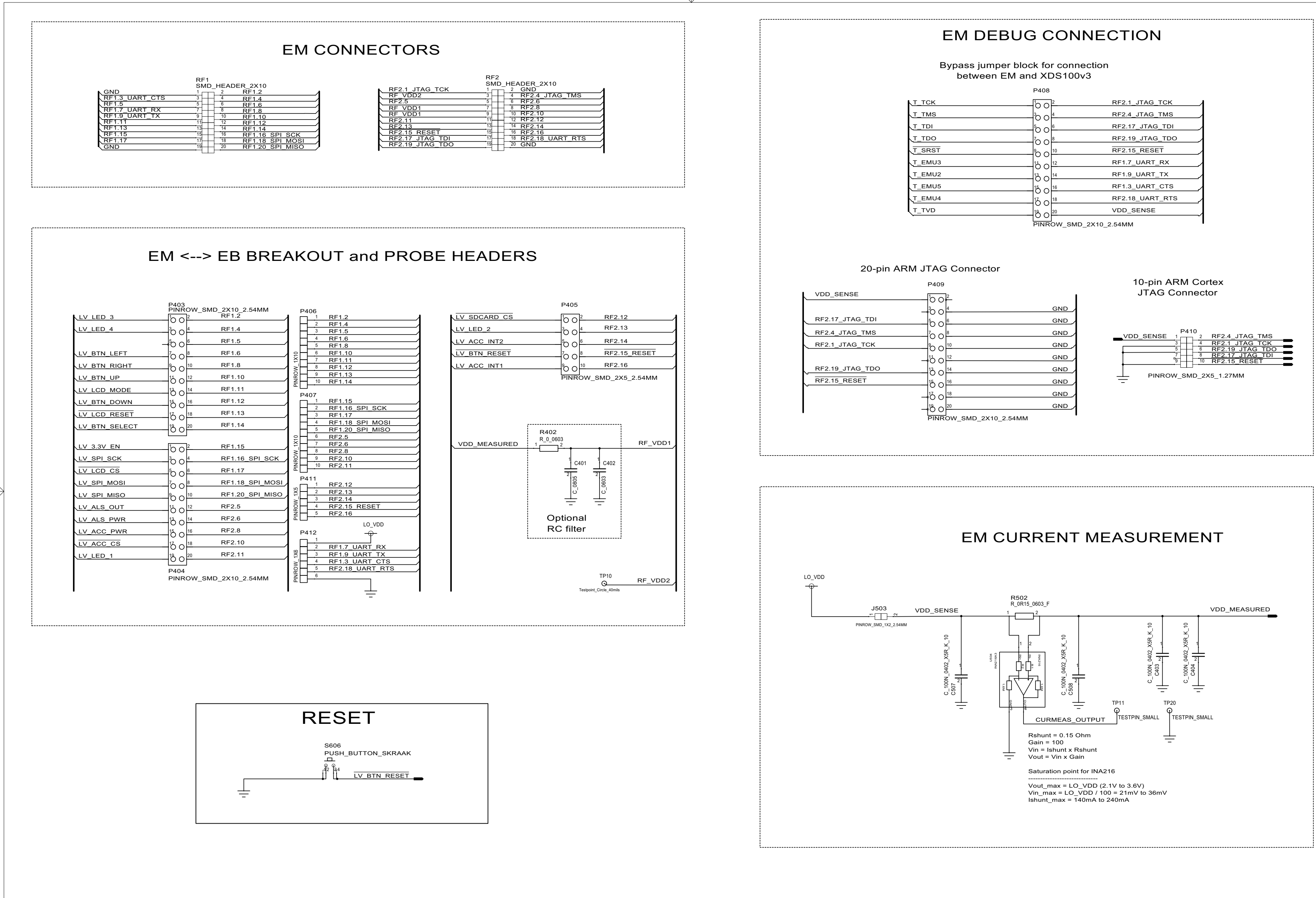
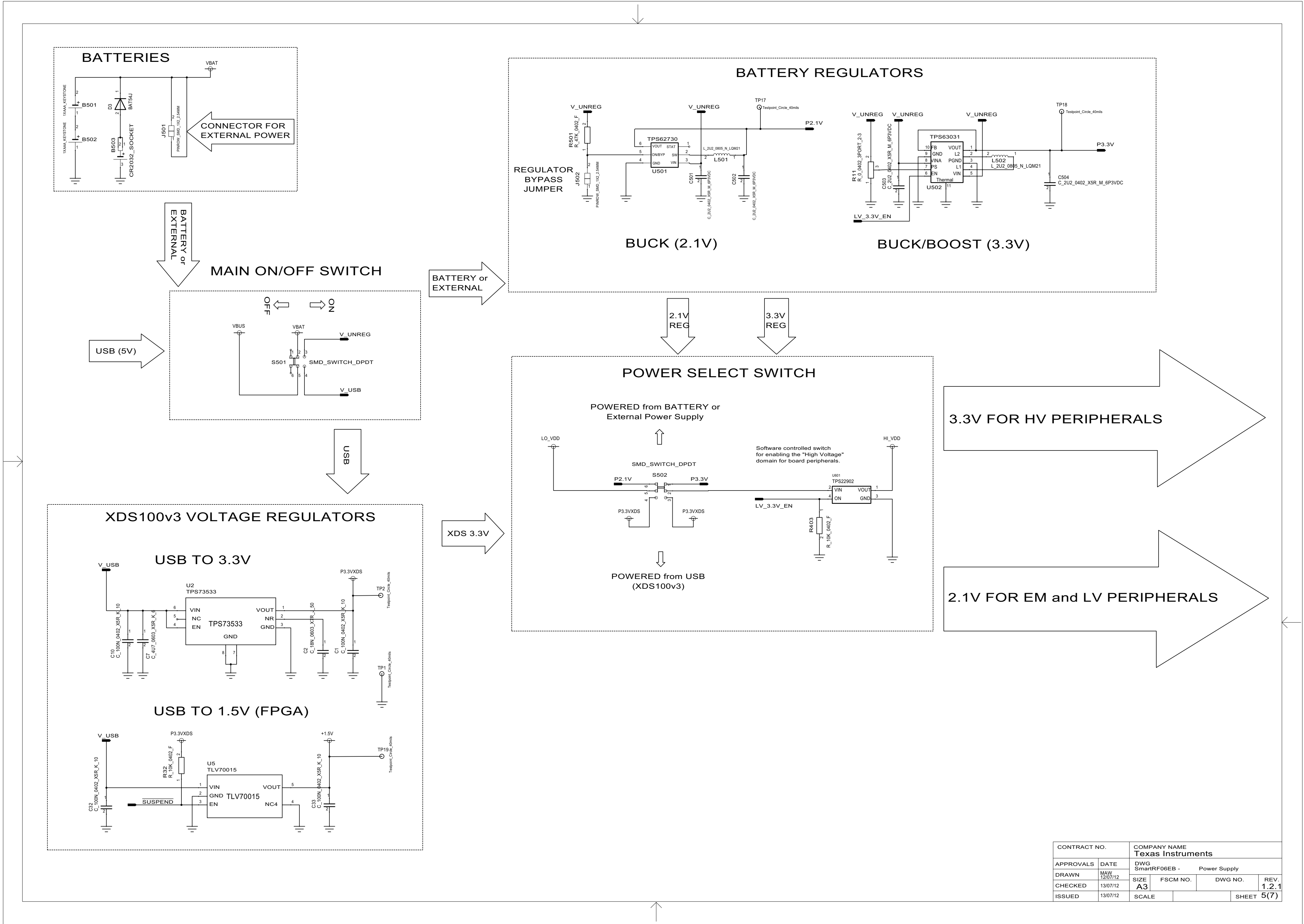
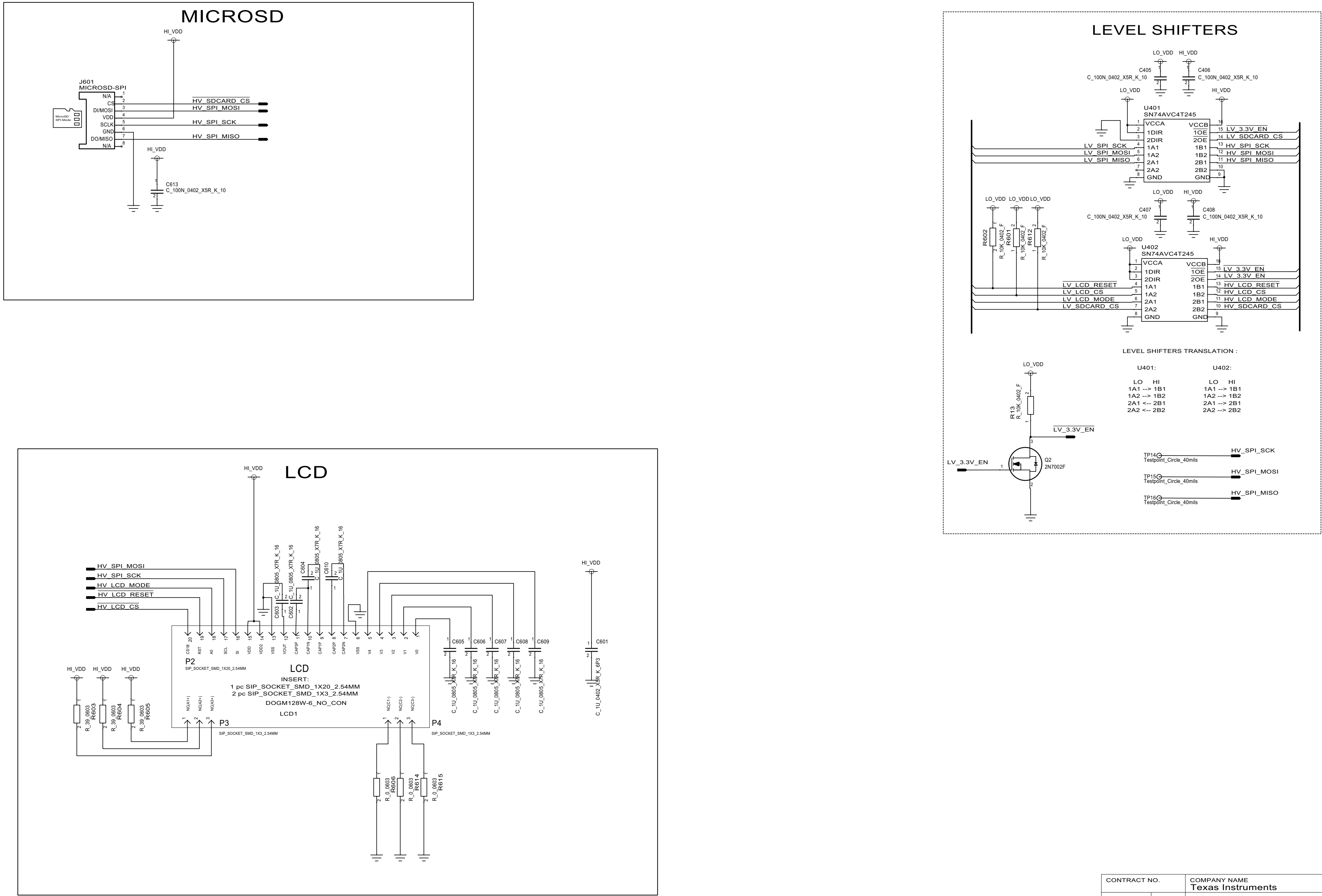
ISSUED	13/07/12	SCALE		SHEET	3(7)

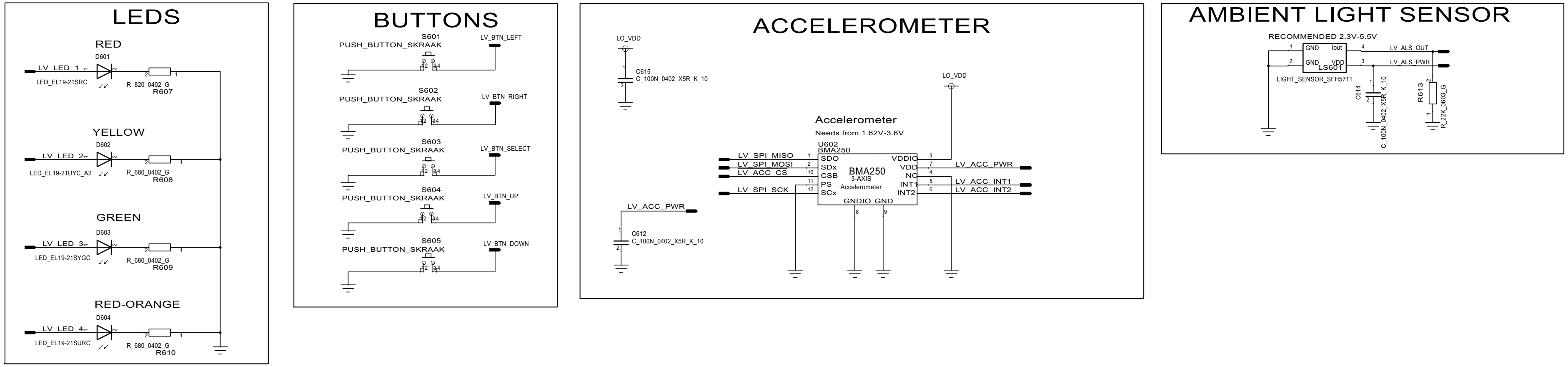


CONTRACT NO.		COMPANY NAME Texas Instruments			
APPROVALS	DATE	DWG SmartRF06EB -	EM Interface / Level Shifters		
DRAWN	MAW 12/07/12	SIZE A3	FSCM NO.	DWG NO.	REV. 1.2.1
CHECKED	13/07/12				
ISSUED	13/07/12	SCALE			SHEET 4(7)


BATTERIES
VBAT
B501
B502
1XAAA_KEYSTONE
D3
BAT54J
B503
CR2032_SOCKET
J501
PINROW_SMD_1X2_2.54MM
CONNECTOR FOR EXTERNAL POWER
BATTERY or EXTERNAL
MAIN ON/OFF SWITCH
OFF
ON
VBUS
VBAT
V_UNREG
S501
SMD_SWITCH_DPDT
V_USB
USB (5V)
USB
BATTERY or EXTERNAL
BATTERY REGULATORS
V_UNREG
R501
R_47K_0402_F
TPS62730
VOUT
STAT
ON/BYP
SW
GND
VIN
U501
L_2U2_0805_N_LQM21
L501
TP17
Testpoint_Circle_40mils
P2.1V
REGULATOR BYPASS JUMPER
J502
PINROW_SMD_1X2_2.54MM
C501
C_2U2_0402_X5R_M_6P3VDC
C502
BUCK (2.1V)
TP18
TPS63031
FB
VOUT
GND
L2
VINA
PGND
PS
L1
EN
VIN
Thermal
U502
L502
L_2U2_0805_N_LQM21
P3.3V
R11
R_0_0402_3PORT_2-3
C503
C_2U2_0402_X5R_M_6P3VDC
C504
C_2U2_0402_X5R_M_6P3VDC
LV_3.3V_EN
BUCK/BOOST (3.3V)
2.1V REG
3.3V REG
POWER SELECT SWITCH
POWERED from BATTERY or External Power Supply
LO_VDD
HI_VDD
Software controlled switch for enabling the "High Voltage" domain for board peripherals.
SMD_SWITCH_DPDT
S502
P2.1V
P3.3V
P3.3VXDS
U601
TPS22902
VIN
VOUT
ON
GND
LV_3.3V_EN
R403
R_10K_0402_F
POWERED from USB (XDS100v3)
3.3V FOR HV PERIPHERALS
2.1V FOR EM and LV PERIPHERALS
XDS 3.3V
XDS100v3 VOLTAGE REGULATORS
USB TO 3.3V
V_USB
U2
TPS73533
VIN
NC
EN
VOUT
NR
GND
P3.3VXDS
TP2
C10
C_100N_0402_X5R_K_10
C7
C_4U7_0603_X5R_K_6
C2
C_18N_0603_X7R_J_50
C1
C_100N_0402_X5R_K_10
TP1
USB TO 1.5V (FPGA)
V_USB
P3.3VXDS
R32
R_10K_0402_F
U5
TLV70015
VIN
GND
EN
VOUT
NC4
SUSPEND
+1.5V
TP19
C32
C_100N_0402_X5R_K_10
C33
C_100N_0402_X5R_K_10
CONTRACT NO.
COMPANY NAME
Texas Instruments
APPROVALS
DATE
DWG
SmartRF06EB - Power Supply
DRAWN
MAW
12/07/12
CHECKED
13/07/12
ISSUED
13/07/12
SIZE
A3
FSCM NO.
DWG NO.
REV.
1.2.1
SCALE
SHEET
5(7)



CONTRACT NO.		COMPANY NAME Texas Instruments			
APPROVALS	DATE	DWG SmartRF06EB -	High Voltage Peripherals		
DRAWN	MAW 12/07/12	SIZE A3	FSCM NO.	DWG NO.	REV. 1.2.1
CHECKED	13/07/12				
ISSUED	13/07/12	SCALE		SHEET	6(7)



CONTRACT NO.		COMPANY NAME Texas Instruments			
APPROVALS	DATE	DWG SmartRF06EB -	Low Voltage Peripherals		
DRAWN	MAW 12/07/12				
CHECKED	13/07/12	SIZE A3	FSCM NO.	DWG NO.	REV. 1.2.1
ISSUED	13/07/12	SCALE		SHEET 7(7)	

EVALUATION BOARD/KIT/MODULE (EVM) ADDITIONAL TERMS

Texas Instruments (TI) provides the enclosed Evaluation Board/Kit/Module (EVM) under the following conditions:

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies TI from all claims arising from the handling or use of the goods.

Should this evaluation board/kit not meet the specifications indicated in the User's Guide, the board/kit may be returned within 30 days from the date of delivery for a full refund. THE FOREGOING LIMITED WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. EXCEPT TO THE EXTENT OF THE INDEMNITY SET FORTH ABOVE, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

Please read the User's Guide and, specifically, the Warnings and Restrictions notice in the User's Guide prior to handling the product. This notice contains important safety information about temperatures and voltages. For additional information on TI's environmental and/or safety programs, please visit www.ti.com/esh or contact TI.

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REGULATORY COMPLIANCE INFORMATION

As noted in the EVM User's Guide and/or EVM itself, this EVM and/or accompanying hardware may or may not be subject to the Federal Communications Commission (FCC) and Industry Canada (IC) rules.

For EVMs **not** subject to the above rules, this evaluation board/kit/module is intended for use for ENGINEERING DEVELOPMENT, DEMONSTRATION OR EVALUATION PURPOSES ONLY and is not considered by TI to be a finished end product fit for general consumer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC or ICES-003 rules, which are designed to provide reasonable protection against radio frequency interference. Operation of the equipment may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

General Statement for EVMs including a radio

User Power/Frequency Use Obligations: This radio is intended for development/professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability of this EVM and its development application(s) must comply with local laws governing radio spectrum allocation and power limits for this evaluation module. It is the user's sole responsibility to only operate this radio in legally acceptable frequency space and within legally mandated power limitations. Any exceptions to this are strictly prohibited and unauthorized by Texas Instruments unless user has obtained appropriate experimental/development licenses from local regulatory authorities, which is responsibility of user including its acceptable authorization.

For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant

Caution

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

For EVMs annotated as IC – INDUSTRY CANADA Compliant

This Class A or B digital apparatus complies with Canadian ICES-003.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Concerning EVMs including radio transmitters

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concerning EVMs including detachable antennas

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada.

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

Concernant les EVMs avec appareils radio

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

【Important Notice for Users of this Product in Japan】

This development kit is NOT certified as Confirming to Technical Regulations of Radio Law of Japan

If you use this product in Japan, you are required by Radio Law of Japan to follow the instructions below with respect to this product:

1. Use this product in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or
3. Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product. Also, please do not transfer this product, unless you give the same notice above to the transferee. Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

Texas Instruments Japan Limited
(address) 24-1, Nishi-Shinjuku 6 chome, Shinjuku-ku, Tokyo, Japan

http://www.tij.co.jp

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東京都新宿区西新宿６丁目２４番１号
西新宿三井ビル
http://www.tij.co.jp

EVALUATION BOARD/KIT/MODULE (EVM) WARNINGS, RESTRICTIONS AND DISCLAIMERS

For Feasibility Evaluation Only, in Laboratory/Development Environments. Unless otherwise indicated, this EVM is not a finished electrical equipment and not intended for consumer use. It is intended solely for use for preliminary feasibility evaluation in laboratory/development environments by technically qualified electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems and subsystems. It should not be used as all or part of a finished end product.

Your Sole Responsibility and Risk. You acknowledge, represent and agree that:

1. You have unique knowledge concerning Federal, State and local regulatory requirements (including but not limited to Food and Drug Administration regulations, if applicable) which relate to your products and which relate to your use (and/or that of your employees, affiliates, contractors or designees) of the EVM for evaluation, testing and other purposes.
2. You have full and exclusive responsibility to assure the safety and compliance of your products with all such laws and other applicable regulatory requirements, and also to assure the safety of any activities to be conducted by you and/or your employees, affiliates, contractors or designees, using the EVM. Further, you are responsible to assure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard.
3. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.
4. You will take care of proper disposal and recycling of the EVM's electronic components and packing materials.

Certain Instructions. It is important to operate this EVM within TI's recommended specifications and environmental considerations per the user guidelines. Exceeding the specified EVM ratings (including but not limited to input and output voltage, current, power, and environmental ranges) may cause property damage, personal injury or death. If there are questions concerning these ratings please contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, some circuit components may have case temperatures greater than 60°C as long as the input and output are maintained at a normal ambient operating temperature. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors which can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during normal operation, please be aware that these devices may be very warm to the touch. As with all electronic evaluation tools, only qualified personnel knowledgeable in electronic measurement and diagnostics normally found in development environments should use these EVMs.

Agreement to Defend, Indemnify and Hold Harmless. You agree to defend, indemnify and hold TI, its licensors and their representatives harmless from and against any and all claims, damages, losses, expenses, costs and liabilities (collectively, "Claims") arising out of or in connection with any use of the EVM that is not in accordance with the terms of the agreement. This obligation shall apply whether Claims arise under law of tort or contract or any other legal theory, and even if the EVM fails to perform as described or expected.

Safety-Critical or Life-Critical Applications. If you intend to evaluate the components for possible use in safety critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, such as devices which are classified as FDA Class III or similar classification, then you must specifically notify TI of such intent and enter into a separate Assurance and Indemnity Agreement.

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Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have ***not*** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

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