



THE DATASHEET OF SMARTRF06EBK



SmartRF06 Evaluation Board (EVM)

User's Guide



Literature Number: SWRU321B
May 2012–Revised March 2017

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SmartRF06 Evaluation Board (EVM)

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, shown in [Table 1](#).

Table 1. SmartRF06EB Features

Component	Description
TI XDS100v3 emulator	cJTAG and JTAG emulator for easy programming and debugging of SoCs on Evaluation Modules (EVM) 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.
Breakout pins	Easy access to SoC GPIO pins for quick and easy debugging.

2 About This Manual

This manual contains reference information about the SmartRF06EB.

[Section 3](#) will give a quick introduction on how to get started with the SmartRF06EB. It describes how to install the SmartRF Studio software to get the required USB drivers for the evaluation board. [Section 4](#) briefly explains how the EB can be used throughout a project's development cycle. [Section 5](#) gives an overview of the various features and functionality provided by the board.

A troubleshooting guide is found in [Section 7](#) 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.

For references to relevant documents and web pages, see [Section 8](#).

2.1 Acronyms

Table 2. Acronyms

Acronym	Description
ALS	Ambient Light Sensor
cJTAG	Compact JTAG (IEEE 1149.7)
CW	Continuous Wave
DK	Development Kit
EB	Evaluation Board
EVM	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	Microcontroller
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

3 Getting Started

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

3.1 Installing SmartRF Studio and USB Drivers

Before your PC can communicate with the SmartRF06EB over USB, the USB drivers for the EB needs to be installed. 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.

3.1.1 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 the 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 a complete user manual can be found.

3.1.2 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, the device is automatically recognized by Windows and the SmartRF06EB is ready for use!

3.1.2.1 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 1.

Select "Update Driver Software..." and, in the appearing dialog, browse to <Studio install dir>\Drivers\ftdi as shown in Figure 2.

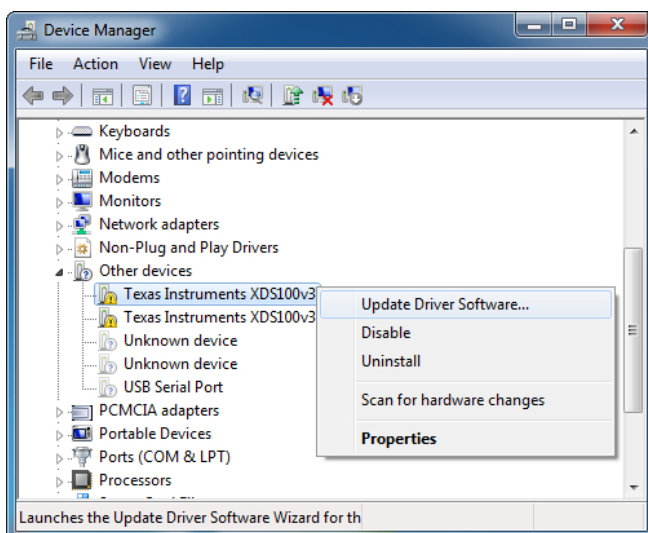


Figure 1. Driver Install: Update Driver

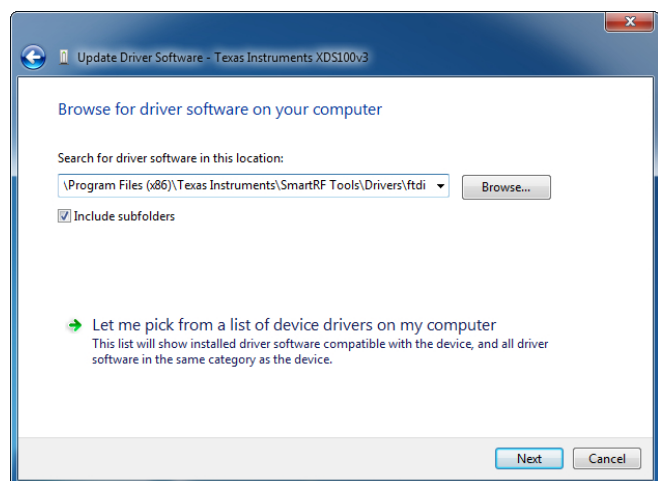


Figure 2. Driver Install: Specify Path to FTDI Drivers

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 4. Repeat the above steps for the second "Texas Instruments XDS100v3" listed under "Other devices".

3.1.2.1.1 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 3](#).

A “USB Serial Port” may be listed under “Other devices”, as seen in [Figure 1](#). 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 4](#).

The SmartRF06EB drivers are now installed correctly.

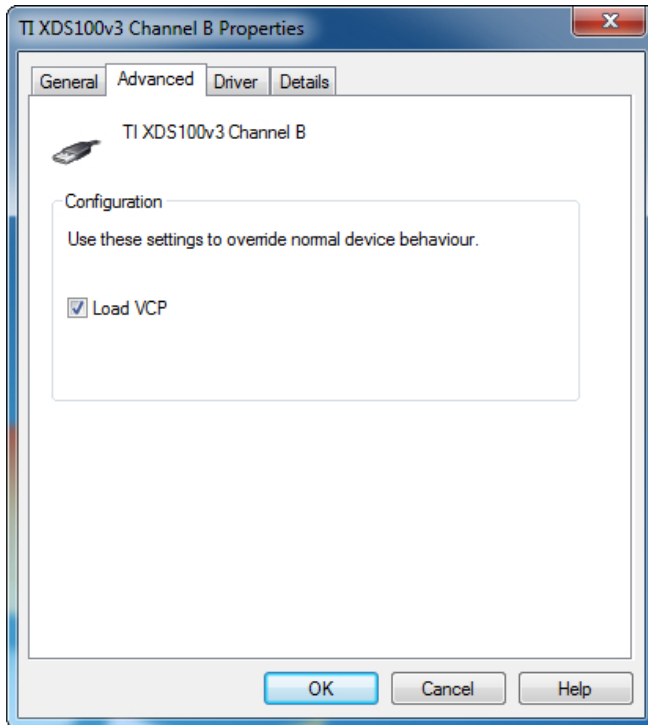


Figure 3. Driver Install: VCP Loaded

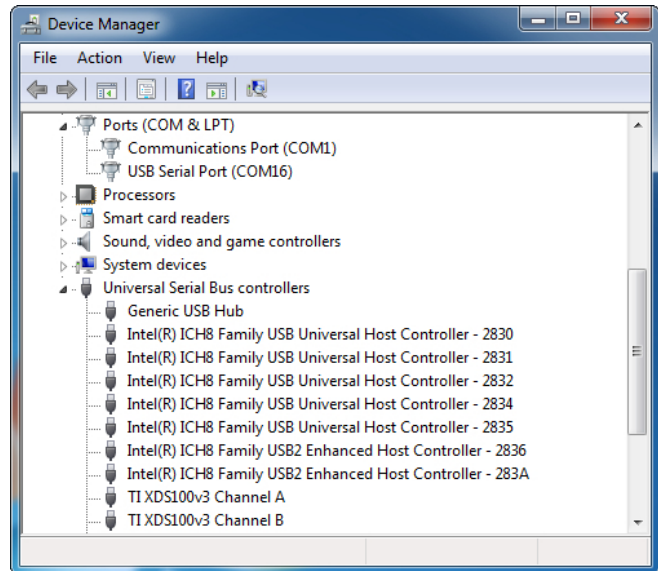


Figure 4. Driver Install: Drivers Successfully Installed

3.1.2.2 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 4 (technical note TN_101, [\[2\]](#)):

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

4 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 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 EVM over the USB interface.

SmartRF06EB currently supports: CC2538EM

SmartRF06EB is included in the CC2538 development kit.

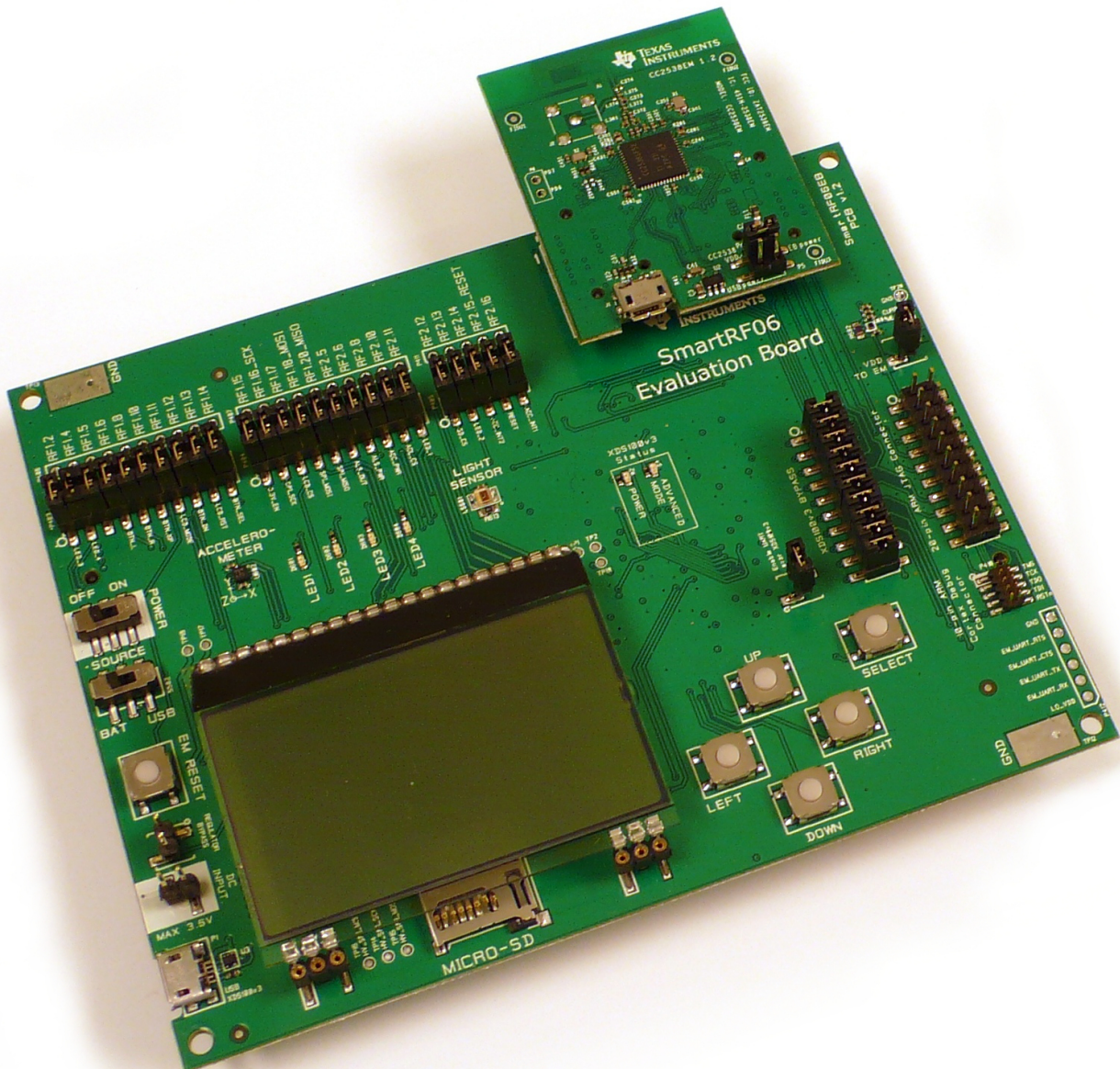


Figure 5. SmartRF06EB (rev. 1.2.1) With EVM Connected

The PC software that controls the SmartRF06EB + EVM is SmartRF Studio. Studio can be used to perform several RF tests and measurements, for example, to set up a CW signal and send or receive packets.

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

- Perform comparative studies. Compare results obtained with EB+EVM 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 EVM via the EB. Test the send function by transmitting packets from your software 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 [Section 6](#).

4.1 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 3](#). [Table 3](#) lists the recommended operating temperature and storage temperature ratings. For more details, see the device-specific data sheet.

Table 3. Supply Voltage: Recommended Operating Conditions and Absolute Maximum Ratings

Component	Operating Voltage		Absolute Maximum 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

⁽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.

Table 4. Temperature: Recommended Operating Conditions and Storage Temperatures

Component	Operating Voltage		Absolute Maximum Rating	
	Min [V]	Max [V]	Min [V]	Max [V]
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

5 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 6](#). The board layout is found in [Figure 7](#) and [Figure 8](#), while the schematics are located in Appendix A.

This section provides an overview of the general architecture of the board and describes the available I/O. The following subsections explain the I/O in more detail. Pin connections between the EVM and the evaluation board I/O can be found in [Section 5.10](#).

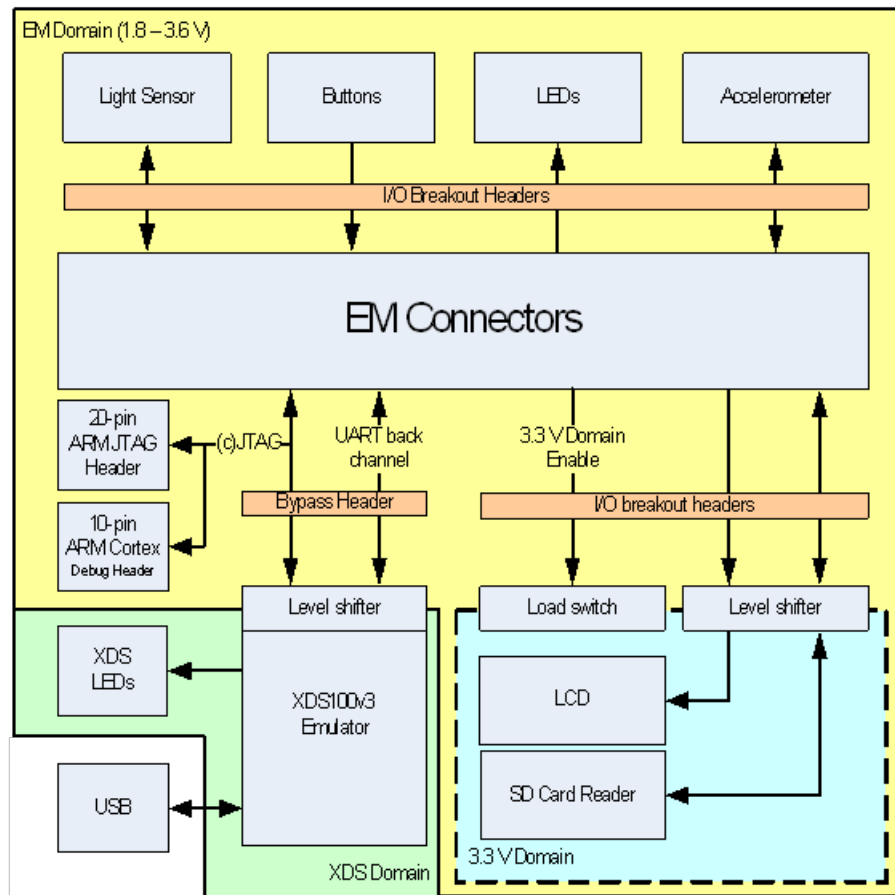


Figure 6. SmartRF06EB Architecture

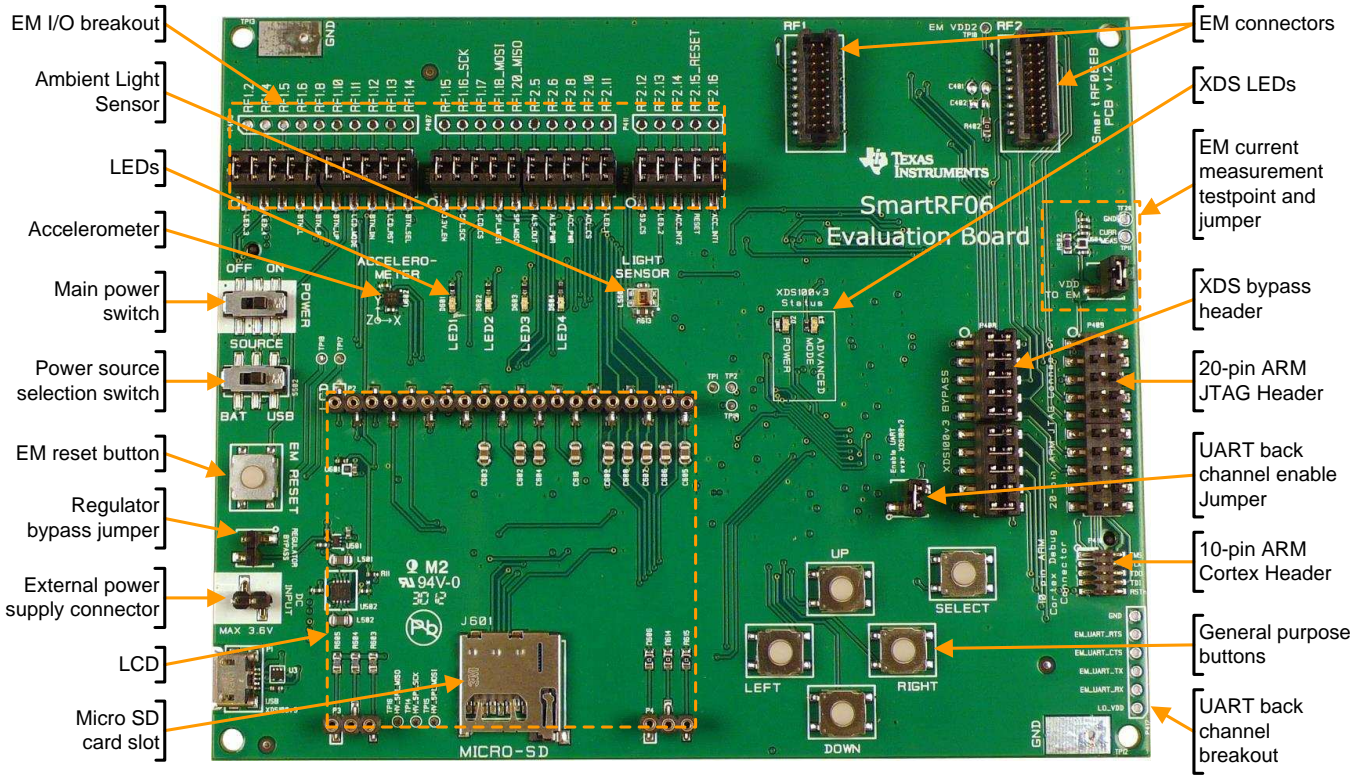


Figure 7. SmartRF06EB Revision 1.2.1 Front Side

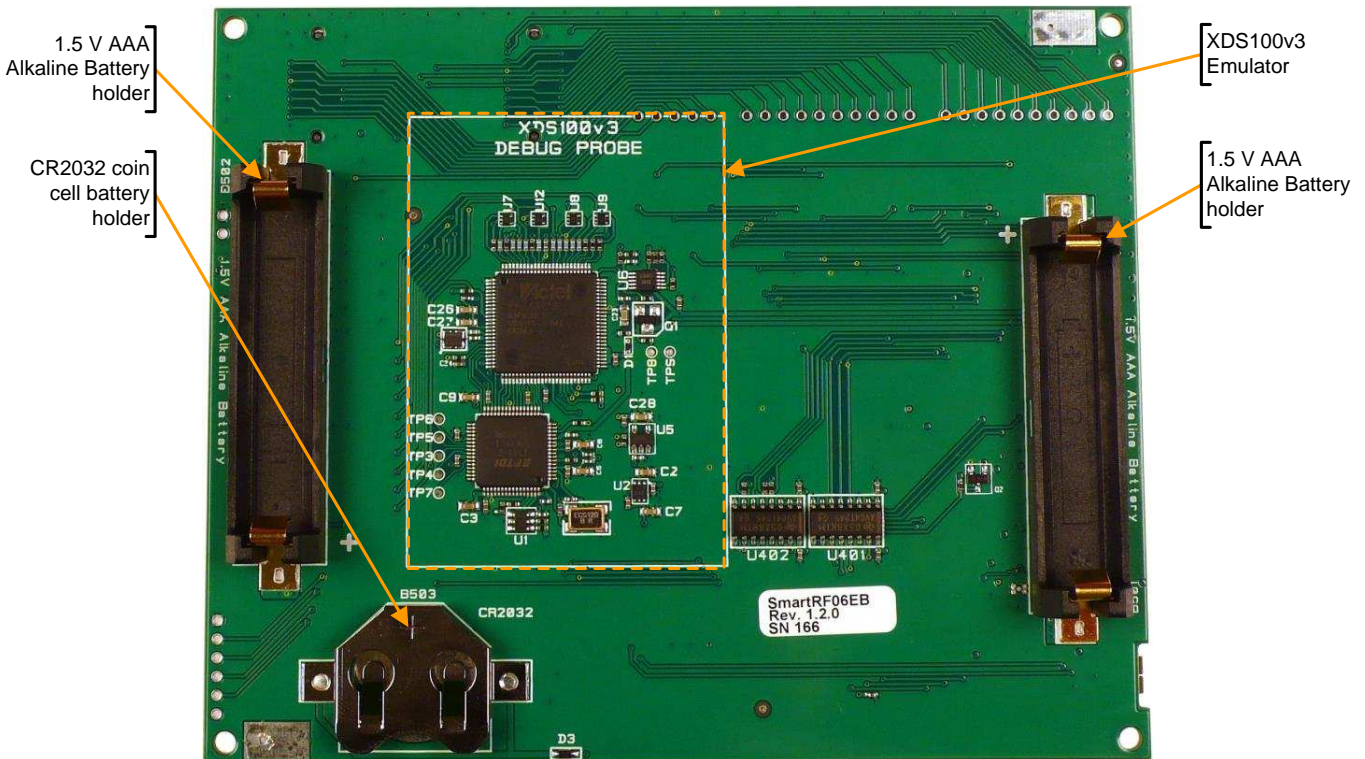


Figure 8. SmartRF06EB Revision 1.2.1 Reverse Side

5.1 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.

For detailed information about the emulator, see the XDS100v3 emulator product page [4]. 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 V. The min (max) operating temperature is -20 (+70) °C.

5.1.1 UART Back Channel

The mounted EVM 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 example, on Microsoft Windows, Linux and Max OS X. The UART back channel gives the mounted EVM 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 (see Figure 9). Table 5 shows an overview of the I/O signals related to UART Back Channel.



Figure 9. Jumper Mounted on J5 to Enable the UART Back Channel

Table 5. UART Back Channel Signal Connections

Signal Name	Description	Probe Header	EVM Pin
RF1.7_UART_RX	UART receive (EVM data in)	EM_UART_RX (P412.2)	RF1.7
RF1.9_UART_TX	UART transmit (EVM 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

5.2 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 10. The XDS100v3 Emulator can only be powered over USB. The main power supply switch (S501) cuts power to the SmartRF06EB.

CAUTION

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).

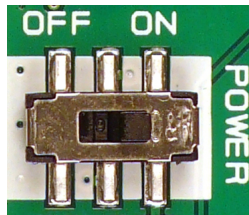


Figure 10. Main Power Switch (P501)

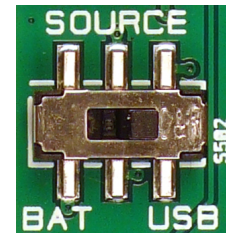


Figure 11. Source Selection Switch (P502)

5.2.1 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 EVM and the EB peripherals. To power the mounted EVM and the EB peripherals from the USB bus, the power source selection switch (S502) should be in “USB” position (see [Figure 12](#)).

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

NOTE: Most USB power sources are limited to 500 mA.

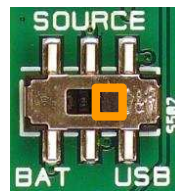


Figure 12. SmartRF06EB Power Selection Switch (P502) in “USB” Position

5.2.2 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 EVM and the EB peripherals using batteries, the power source selection switch (S502) should be in “BAT” position (see [Figure 13](#)).

When battery powered, the EVM power domain is by default regulated to 2.1 V. The voltage regulator may be bypassed by mounting a jumper on J502. For more details, see [Section 5.3.2](#).

CAUTION

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

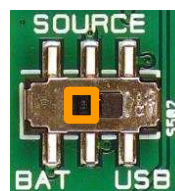


Figure 13. SmartRF06EB Power Source Selection Switch (P502) in “BAT” Position

5.2.3 External Power Supply

The SmartRF06EB can be powered using an external power supply. To power the mounted EVM and the EB peripherals using an external power supply, the power source selection switch (S502) should be in “BAT” position (see [Figure 13](#)).

The external supply’s ground should be connected to the SmartRF06EB ground, for example, to the ground pad in the top left corner of the EB. Connect the positive supply connector to the external power header J501 (see [Figure 14](#)). 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 EVM power domain is by default regulated to 2.1 V. The voltage regulator may be bypassed by mounting a jumper on J502. For more details, see [Section 5.3.2](#).

CAUTION

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). For more information, see [Section 4.1](#).

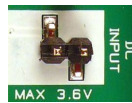


Figure 14. SmartRF06EB External Power Supply Header (J501)

5.3 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 15](#) and [Table 6](#).

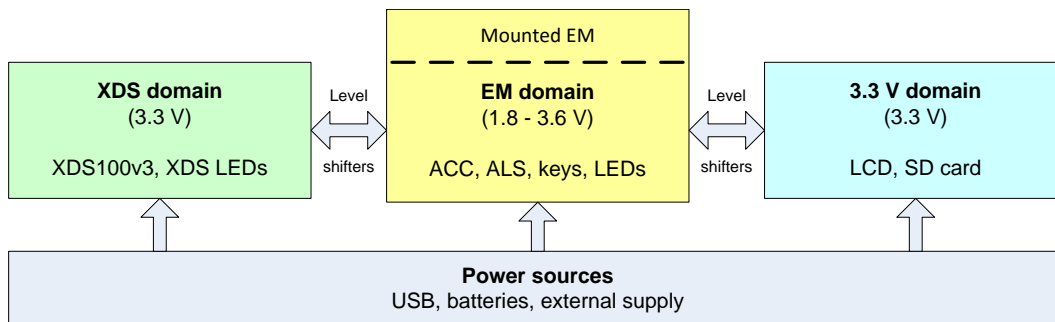


Figure 15. Power Domain Overview of SmartRF06EB

Table 6. Power Domain Overview of SmartRF06EB

Component	Power Domain	Power Source
Evaluation Module	EVM domain (LO_VDD)	USB, battery, external
General Purpose LEDs	EVM domain (LO_VDD)	USB, battery, external
Accelerometer	EVM domain (LO_VDD)	USB, battery, external
Ambient Light Sensor	EVM domain (LO_VDD)	USB, battery, external
Current Measurement MSP MCU	EVM domain (LO_VDD)	USB, battery, external
LEDs	EVM 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 EVM domain
LCD	3.3 V domain (HI_VDD)	Same as EVM domain

5.3.1 XDS Domain

The XDS100v3 Emulator (see [Section 5.1](#)) 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 a PC over USB for the XDS domain to be powered up. The domain is turned on or off by the SmartRF06EB main power switch.

5.3.2 EVM Domain

The mounted EVM board and most of the SmartRF06EB peripherals are powered in the EVM domain and signals in this domain (accessible by the EVM), are prefixed “LV_” in the schematics. [Table 6](#) lists the EB peripherals that are powered in the EVM domain. The domain is turned on or off by the SmartRF06EB power switch.

The EVM 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 EVM 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 (see [Figure 16](#)), powering the EVM domain directly from the source. When J502 is not mounted, the EVM power domain is regulated to 2.1 V. The maximum current consumption of the EVM power domain is then limited by the regulator to 410 mA.

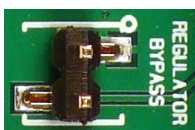


Figure 16. Mount a Jumper on J502 to Bypass EVM Domain Voltage Regulator

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).

5.3.3 3.3 V Domain

The 3.3 V domain is a sub domain of the EVM domain. The 3.3 V domain is regulated to 3.3 V using a buck-boost converter, irrespective of the source powering the EVM domain. Signals in the 3.3 V domain (controlled by the EVM) 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 6](#). These peripherals are connected to the EVM domain via level shifters U401 and U402.

The 3.3 V domain may be switched on (off) completely by the mounted EVM board by pulling signal LV_3.3V_EN to a logical 1 (0). For details about the mapping between the EVM and signals onboard the SmartRF06EB, see [Table 15](#).

5.4 LCD

The SmartRF06EB comes with a 128x64 pixels display from Electronic Assembly (DOG128E-6) [\[4\]](#). The LCD display is available to mounted EVM via a SPI interface, enabling software development of user interfaces and demo use. [Table 7](#) 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.

CAUTION

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

Table 7. LCD Signal Connections

Signal Name	Description	Probe Header	EVM Pin
LV_3.3V_EN	3.3 V domain enable signal	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

5.5 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 EVM via a SPI interface, giving it access to extra flash, enabling over-the-air upgrades and more. [Table 9](#) 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).

Table 8. Micro SD Card Signal Connections

Signal Name	Description	Probe Header	EVM Pin
LV_3.3V_EN	3.3 V domain enable signal ⁽¹⁾	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

⁽¹⁾ The LCD and SD card are both powered in the 3.3 V domain and cannot be powered on or off individually.

5.6 Accelerometer

The SmartRF06EB is equipped with a BMA250E digital accelerometer from Bosch Sensortech [6]. The accelerometer is available to the mounted EVM via an SPI interface and has two dedicated interrupt lines. The accelerometer is suitable for application development, prototyping and demo use. Table 9 shows an overview of I/O signals related to the accelerometer.

Note that some versions of the SmartRF06EB (1.2.2 and earlier – see the sticker on bottom side of PCB) used the original BMA250 IC, while later versions (1.2.3 and later) use BMA250E. The primary difference is that the BMA250E uses a different device ID. For more information, see the Bosch Sensortech data sheet [6].

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

Table 9. Accelerometer Signal Connections

Signal Name	Description	Probe Header	EVM 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_SPL_SCK	SPI clock	RF1.16_SCK (P407.2)	RF1.16
LV_SPL_MOSI	SPI MOSI (acc. input)	RF1.18_MOSI (P407.4)	RF1.18
LV_SPL_MISO	SPI MISO (acc. output)	RF1.20_MISO (P407.5)	RF1.20

5.7 Ambient Light Sensor

The SmartRF06EB has an analog SFH 5711 ambient light sensor (ALS) from Osram [7] that is available for the mounted EVM via the EVM connectors, enabling quick application development for demo use and prototyping. Figure 17 and Table 10 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.

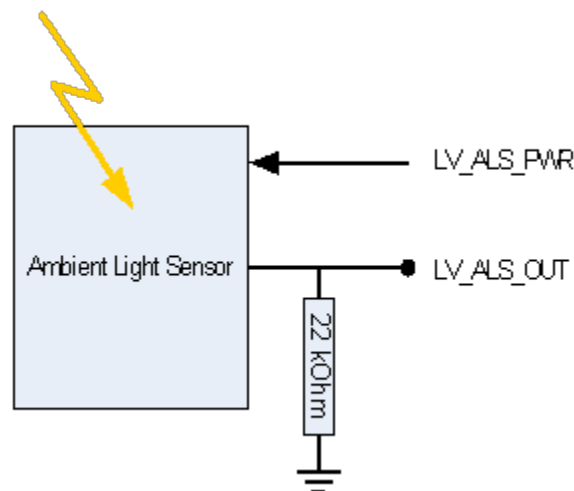


Figure 17. Simplified Schematic of Ambient Light Sensor Setup

Table 10. Ambient Light Sensor Signal Connections

Signal Name	Description	Probe Header	EVM 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

5.8 Buttons

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

The EVM RESET button resets the mounted EVM by pulling its reset line low (RF2.15_RESET); [Table 11](#) shows an overview of I/O signals related to the buttons.

Table 11. Button Signal Connections

Signal Name	Description	Probe Header	EVM 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
:LV_BTN_RESET	EVM reset button (active low)	<u>RF2.15_RESET</u> ; (P411.4)	RF2.15

5.9 LEDs

5.9.1 General Purpose LEDs

The four LEDs D601, D602, D603, D604 can be controlled from the mounted EVM and are suitable for demo use and debugging. The LEDs are active high. [Table 12](#) shows an overview of I/O signals related to the LEDs.

Table 12. General Purpose LED Signal Connections

Signal Name	Description	Probe Header	EVM 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

5.9.2 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.

5.10 EVM Connectors

The EVM connectors, shown in [Figure 18](#), are used for connecting an EVM board to the SmartRF06EB. The connectors RF1 and RF2 are the main interface and are designed to inhibit incorrect mounting of the EVM board. The pin-out of the EVM connectors is given in [Table 13](#) and [Table 14](#).



Figure 18. SmartRF06EB EVM Connectors RF1 and RF2

Table 13. EVM connector RF1 Pin Out

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

Table 14. EVM Connector RF2 Pin Out

EVM 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	EVM 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 EVM board	P407.6	P404.11-12
RF2.6	RF2.6	GPIO signal to EVM board	P407.7	P404.13-14
RF2.7	RF_VDD1	EVM power	TP10	J503.1-2
RF2.8	RF2.8	GPIO signal to EVM board	P407.8	P404.15-16
RF2.9	RF_VDD1	EVM power	TP10	J503.1-2
RF2.10	RF2.10	GPIO signal to EVM board	P407.9	P404.17-18
RF2.11	RF2.11	GPIO signal to EVM board	P407.10	P404.19-20
RF2.12	RF2.12	GPIO signal to EVM board	P411.1	P405.1-2
RF2.13	RF2.13	GPIO signal to EVM board	P411.2	P405.3-4
RF2.14	RF2.14	GPIO signal to EVM board	P411.3	P405.5-6
RF2.15	<u>RF2.15_RESET;</u>	EVM reset signal (active low)	P411.4	P405.7-8
RF2.16	RF2.16	GPIO signal to EVM 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		

5.11 Breakout Headers and Jumpers

The SmartRF06EB has several breakout headers, giving access to all EVM connector pins. An overview of the SmartRF06EB I/O breakout headers is given in Figure 19. Probe headers P406, P407, P411 and P412 give access to the I/O signals of the mounted EVM. Breakout headers P403, P404 and P405 allow the user to map any EVM 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 EVM. 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.

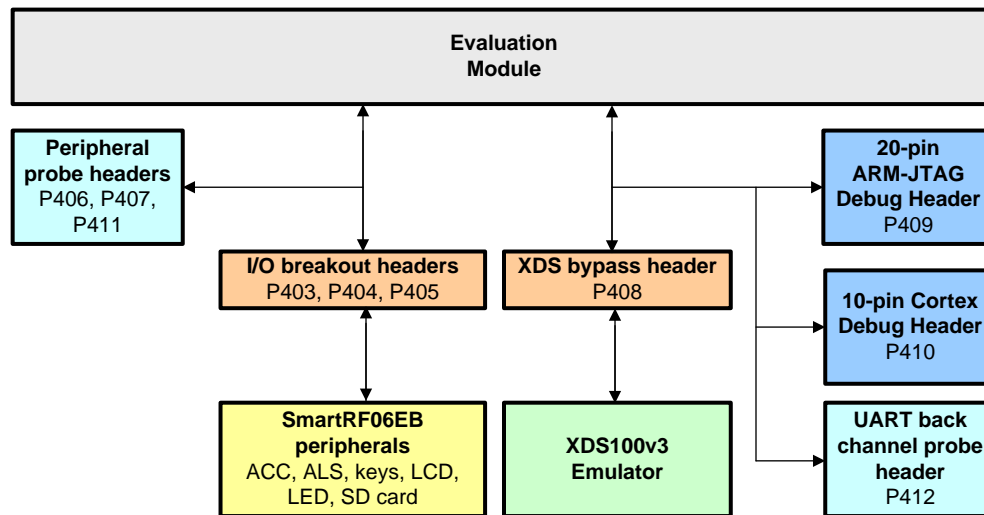


Figure 19. SmartRF06EB I/O Breakout Overview

5.11.1 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 EVM 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 EVM is given in [Table 15](#). The leftmost column in the table refers to the silk print seen on the SmartRF06EB. The rightmost column shows the corresponding CC2538 I/O pad on CC2538EM.

Table 15. SmartRF06EB I/O Breakout Overview

Probe Header	Silk Print	EB Signal Name	EVM 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	;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	;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	;LV_ACC_CS	RF2.10	PD5
	RF2.11	LV_LED_1	RF2.11	PC0
P411	RF2.12	;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	;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

5.11.2 XDS100v3 Emulator Bypass Headers

The XDS100v3 Emulator bypass header, P408, is by default mounted with jumpers (see [Figure 20](#)), connecting the XDS100v3 Emulator to a mounted EVM or external target. By removing the jumpers on P408, the XDS100v3 Emulator can be disconnected from the target.

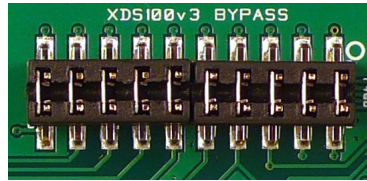


Figure 20. XDS100v3 Emulator Bypass Header (P408)

5.11.3 20-Pin ARM JTAG Header

The SmartRF06EB comes with a standard 20-pin ARM JTAG header [8] (see [Figure 21](#)), enabling the user to debug an external target using the XDS100v3 Emulator. The pin-out of the ARM JTAG header is given in [Table 16. Section 6](#) has more information on how to debug an external target using the XDS100v3 Emulator onboard the SmartRF06EB.

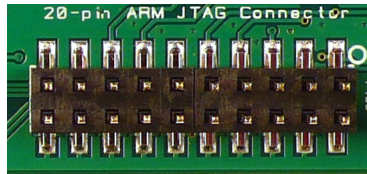


Figure 21. 20-Pin ARM JTAG Header (P409)

Table 16. 20-Pin ARM JTAG Header Pin-Out (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	DBGREQ	Debug request	NC	
P409.18	GND	Ground	GND	
P409.19	DBGACK	Debug acknowledge	NC	
P409.20	GND	Ground	GND	

5.11.4 10-Pin ARM Cortex Debug Header

The SmartRF06EB comes with a standard 10-pin ARM Cortex debug header [8] (see [Figure 22](#)), 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 17](#). [Section 6](#) has more information on how to debug an external target using the XDS100v3 Emulator onboard the SmartRF06EB.

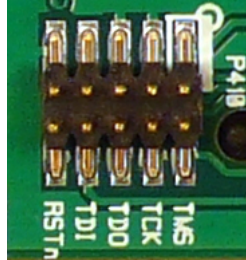


Figure 22. 10-Pin ARM Cortex Debug Header (P410)

Table 17. 10-Pin ARM Cortex Debug Header Pin-Out (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	RF2.15_RESET;	P408.9-10

5.12 Current Measurement

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

5.12.1 Current Measurement Jumper

SmartRF06EB has a current measurement header, J503, for easy measurement of EVM 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 23](#), the current consumption of the mounted EVM can be measured.



Figure 23. Measuring Current Consumption Using Jumper J503

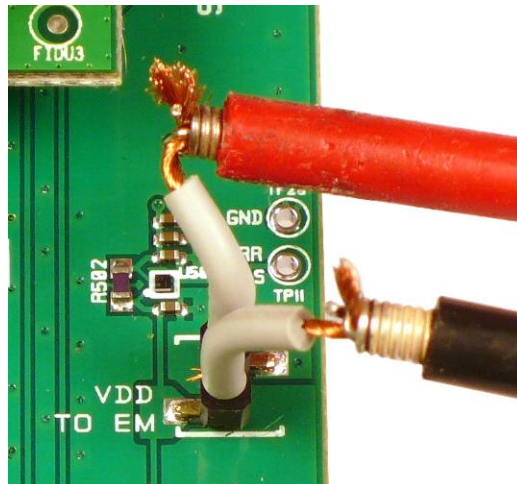


Figure 24. Measuring Current Consumption Using Jumper J503

6 Debugging an External Target Using SmartRF06EB

You can easily use XDS100v3 Emulator onboard the SmartRF06EB to debug an external target. In this section, it is 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 25. 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 EVM domain.

CAUTION

Having a jumper mounted on header J503 when debugging an external target causes a conflict between the EB's EVM 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 25, the right hand side scenario shows how it is possible to debug an EVM 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.

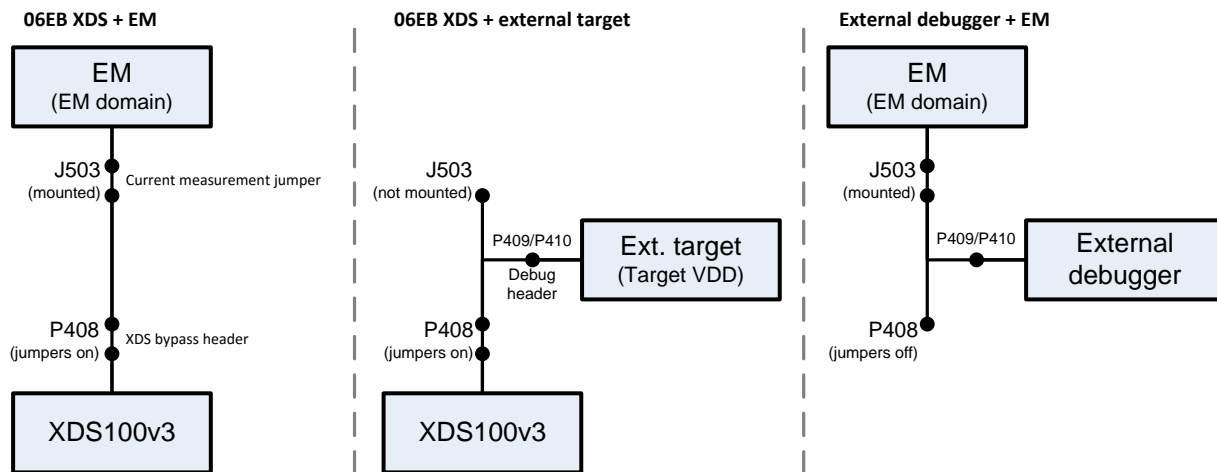


Figure 25. Simplified Connection Diagram for Different Debugging Scenarios

6.1 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 26](#). Make sure pin 1 on P409 matches pin 1 on the external target. For more info about the 20-pin ARM JTAG header and the XDS bypass header, see [Section 5.11.2](#) and [Section 5.11.3](#).

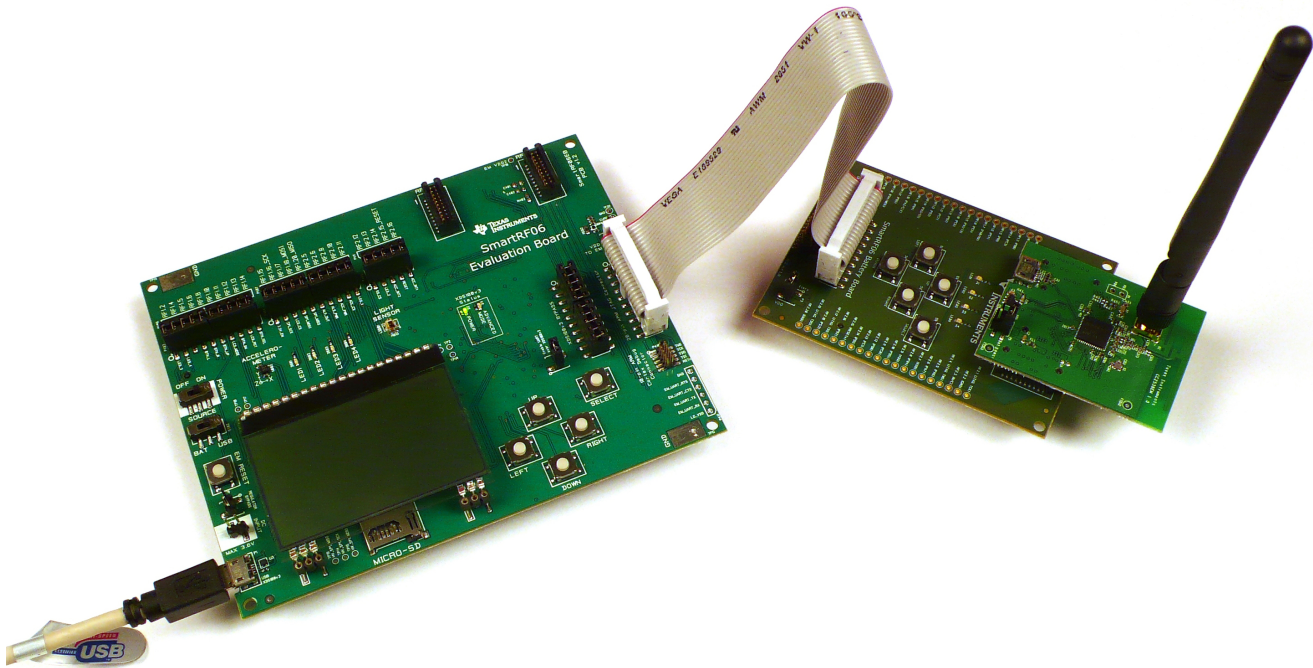


Figure 26. Debugging External Target Using SmartRF06EB

6.2 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. For more info about the 10-pin ARM Cortex Debug header and the XDS bypass header, see [Section 5.11.2](#) and [Section 5.11.4](#).

6.3 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 18](#) shows the signals that must be strapped between the SmartRF06EB and the target board. [Table 19](#) shows additional signals that are optional or needed for debugging using 4-pin JTAG. [Figure 27](#) shows where the signals listed in [Table 18](#) and [Table 19](#) can be found on the 20-pin ARM JTAG header.

Table 18. Debugging External Target: Minimum Strapping (cJTAG support)

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 19. Debugging External Target: Optional Strapping

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)

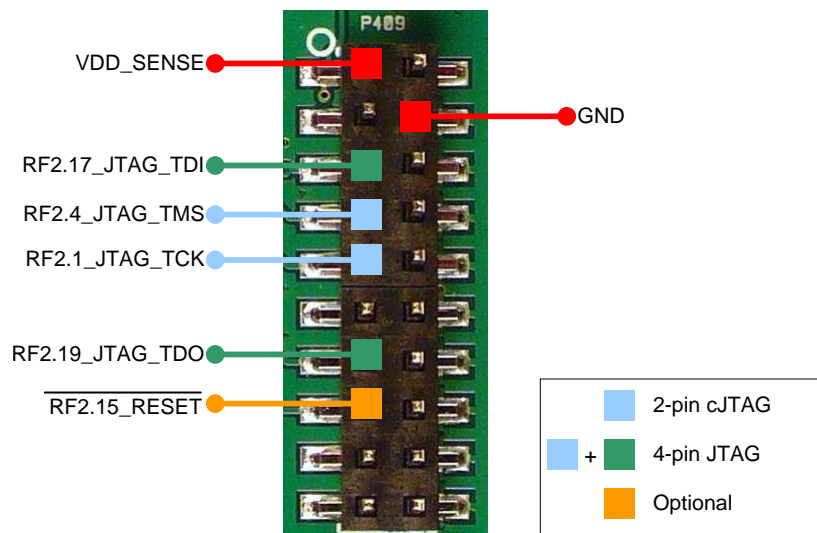


Figure 27. ARM JTAG Header (P409) With Strapping to Debug External Target

7 Frequently Asked Questions

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

Answer: Make sure that a power source is 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 the “BAT” position. When powering the EB over USB, the switch should be in the “USB” position. Also, make sure the EVM current measurement jumper (J503) is short circuited.

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

Answer: 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 [Section 6](#).

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

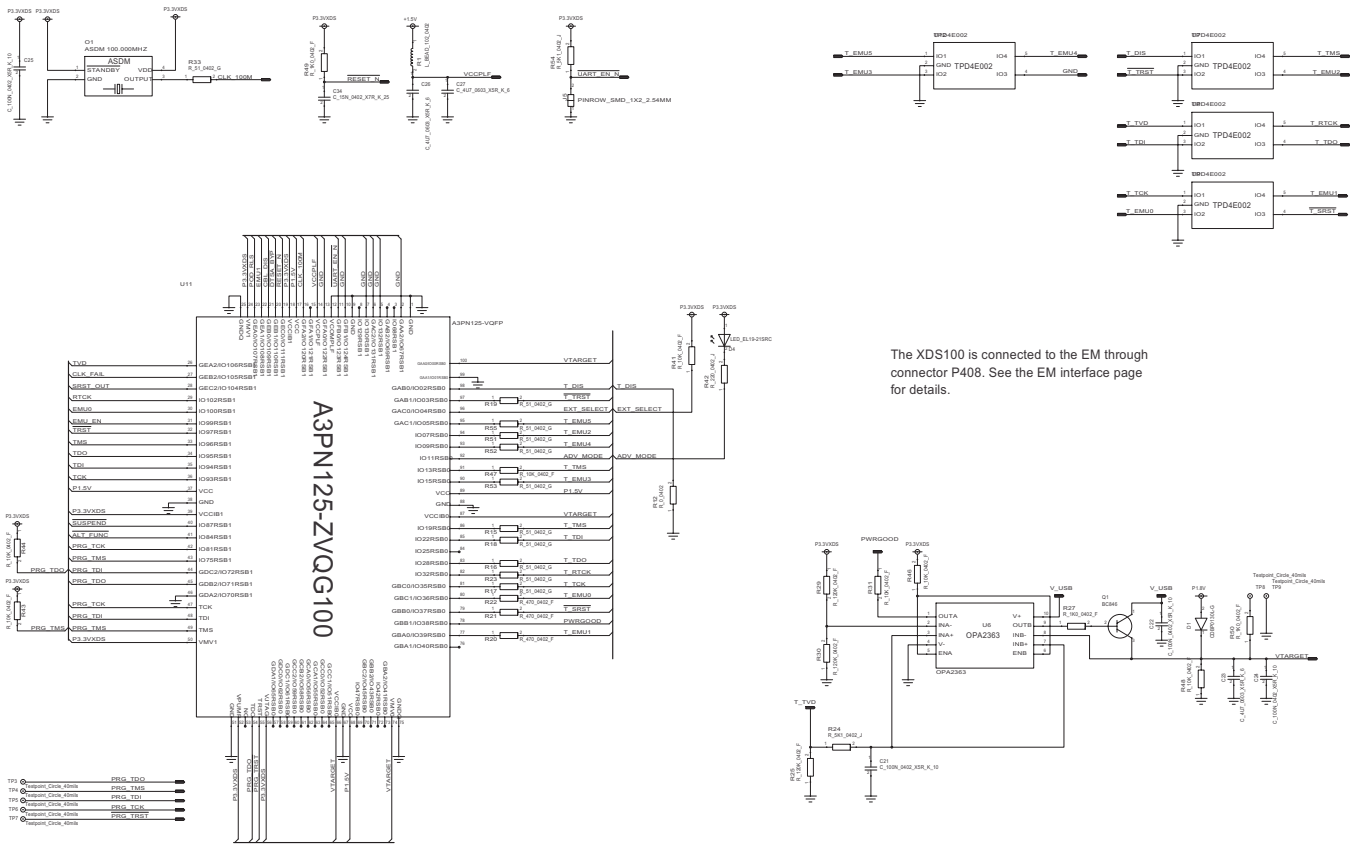
Answer: No, you cannot debug an 8051 SoC using the SmartRF06EB.

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

Answer: It may be that the virtual COM port on the SmartRF06EB’s XDS100 channel B has not been enabled. [Section 3.1.2.1.1](#) describes how to enable the Virtual COM Port in the USB driver.

8 References

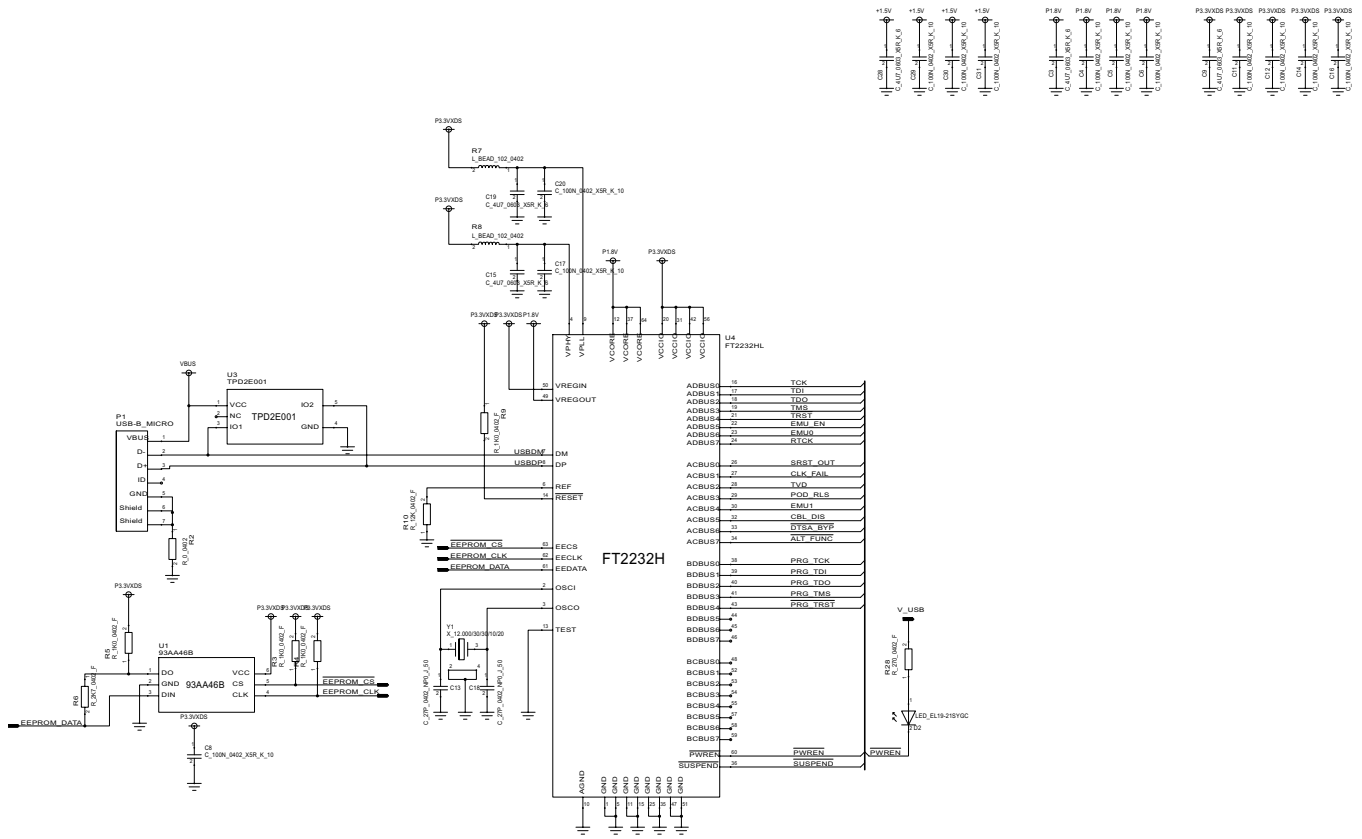
1. [SmartRF Studio Product Page](#)
2. [FTDI USB Driver Page](#)
3. [SmartRF Flash Programmer Product Page](#)
4. [XDS100 Emulator Programmer wiki](#)
5. [Electronic Assembly DOGM128-6 Data Sheet](#)
6. [Bosch Sensortec BMA250 Data Sheet](#)
7. [Osram SFH 5711](#)
8. [Cortex-M Debug Connectors](#)



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

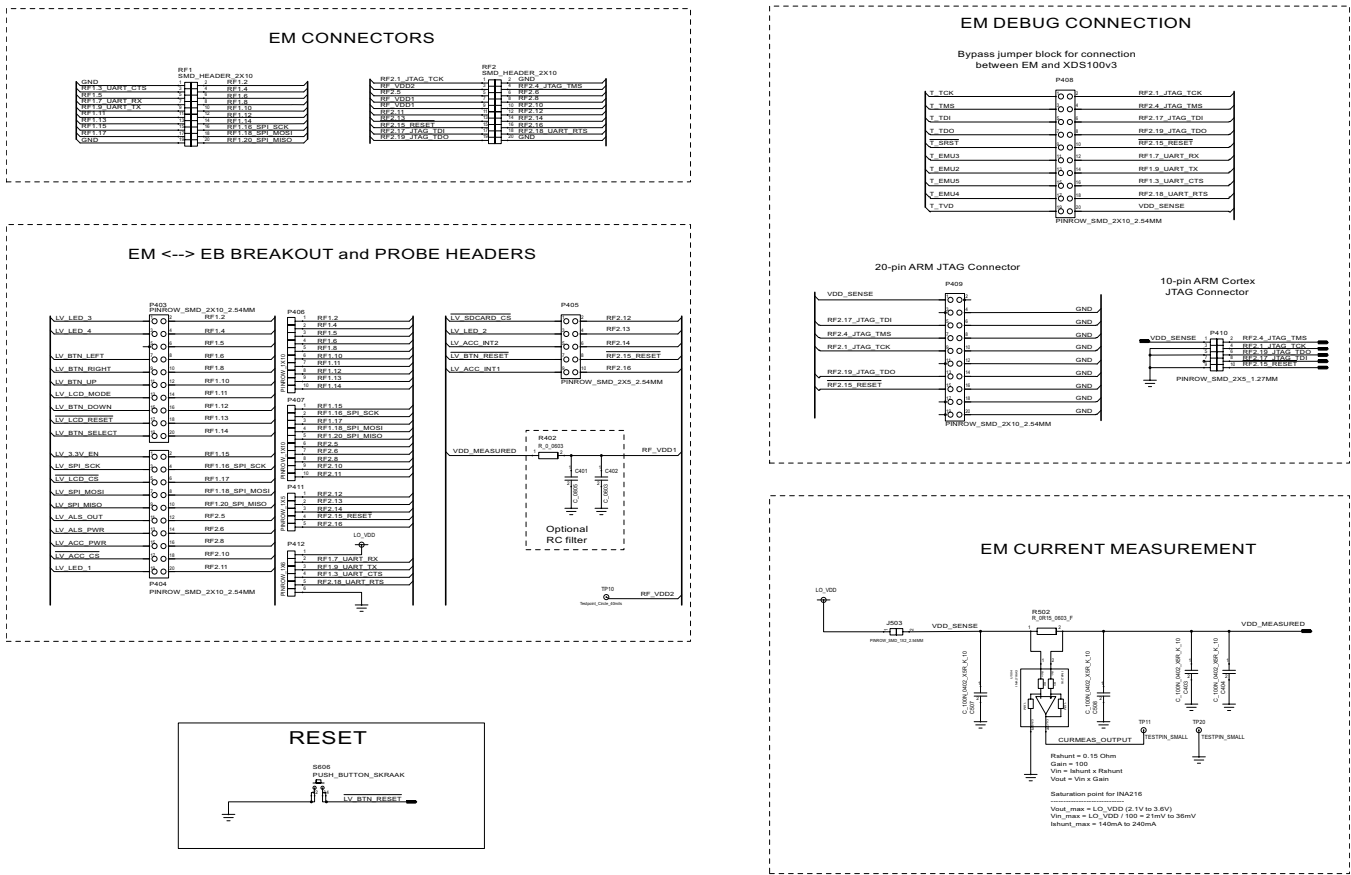
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Figure 29. SmartRF06EB - XDS100v3 - FPGA



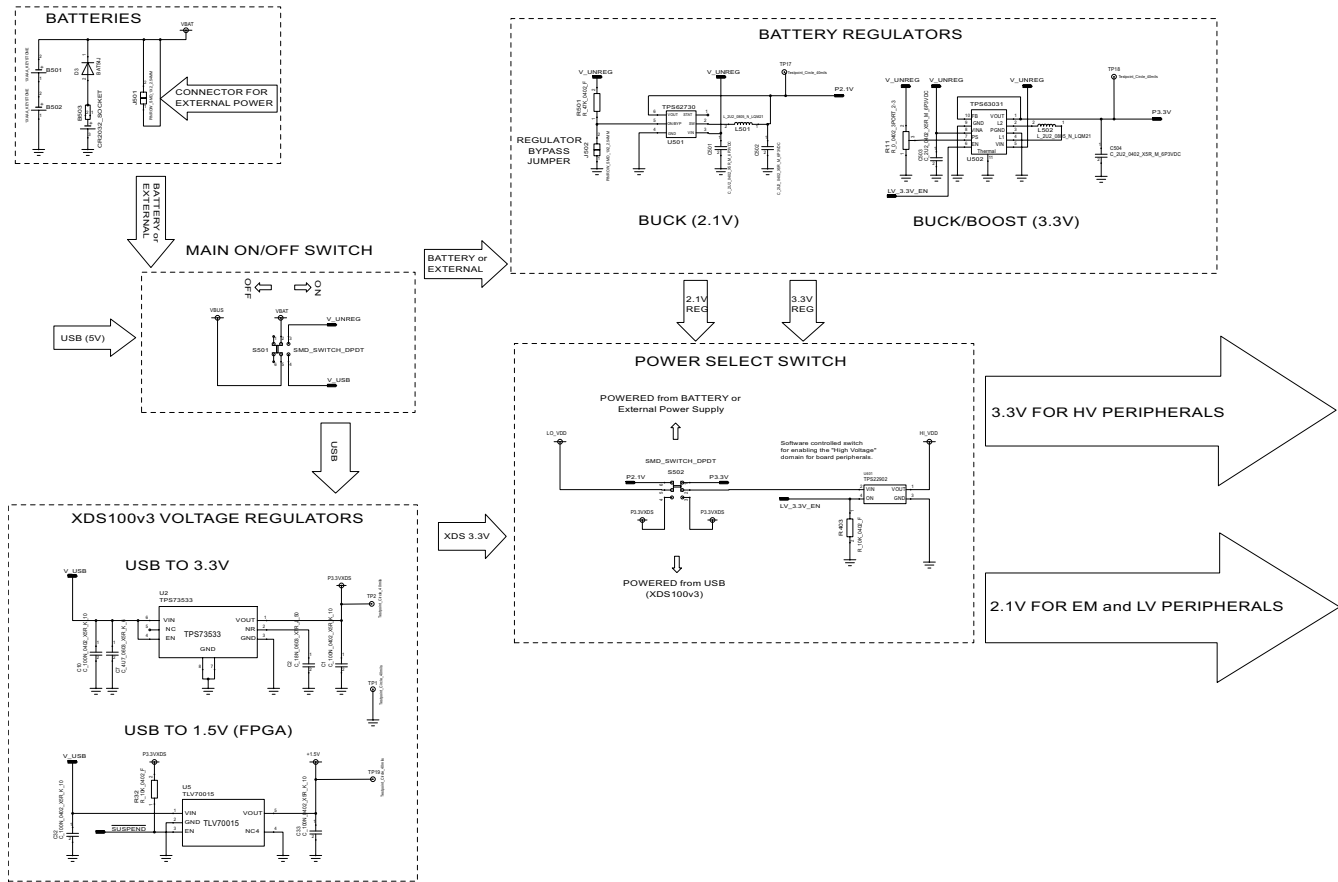
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Figure 30. SmartRF06EB - XDS100v3 - FTDI



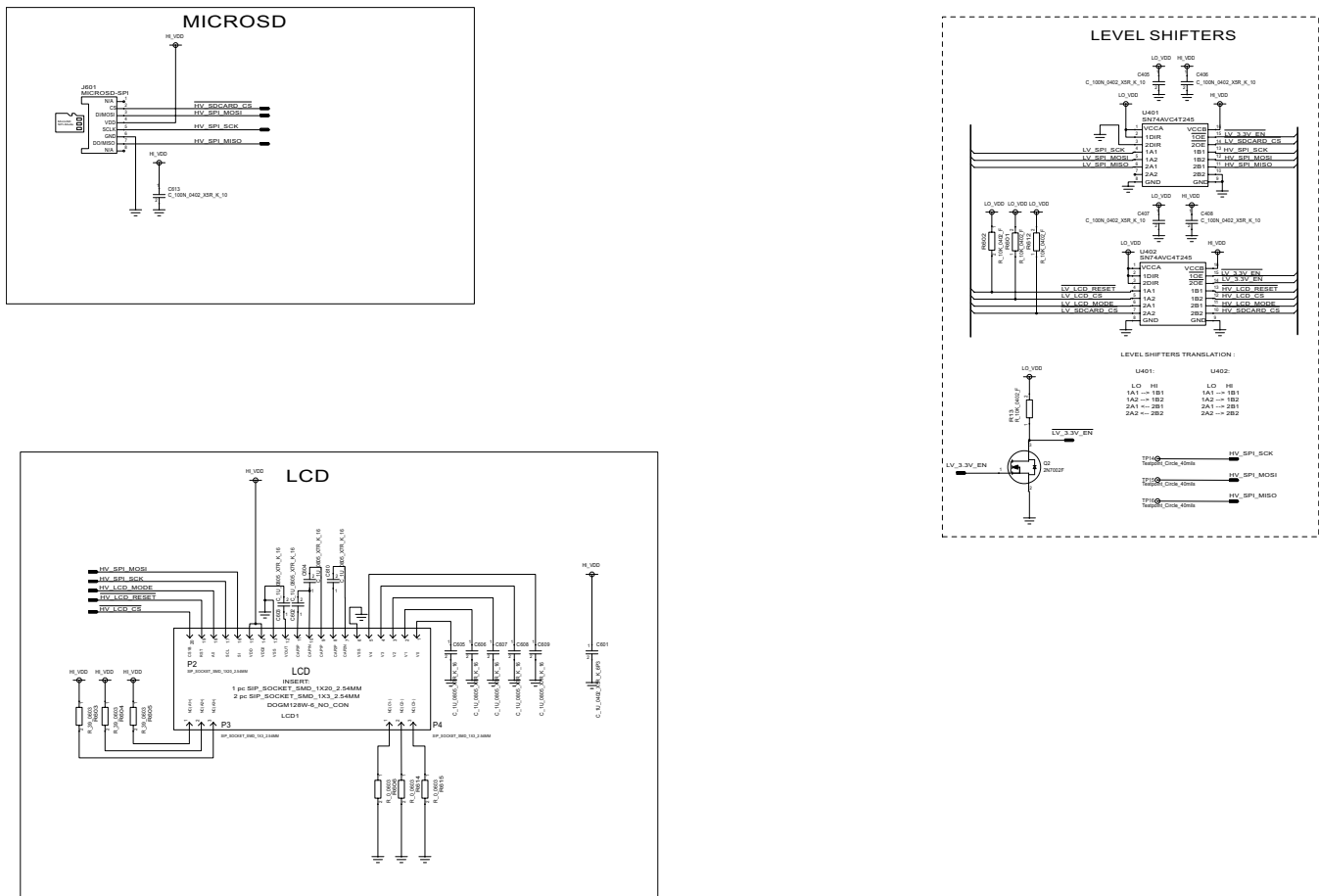
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Figure 31. SmartRF06EB - EVM Interfaces/Level Shifters



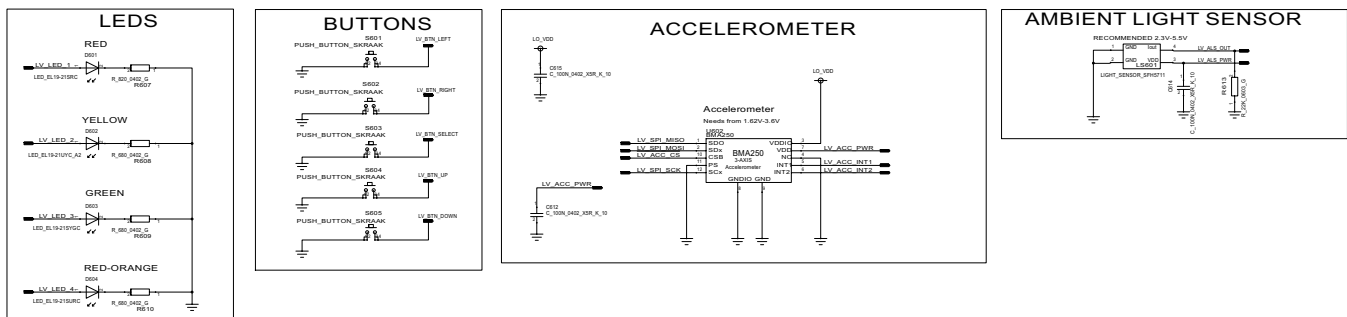
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Figure 32. SmartRF06EB - Power Supply



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Figure 33. SmartRF06EB - High Voltage Peripheral



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Figure 34. SmartRF06EB - Low Voltage Peripherals

Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from A Revision (May 2012) to B Revision	Page
• Added note of change in accelerometer.....	5

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

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FCC Interference Statement for Class B EVM devices

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- 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.

3.2 Canada

3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247

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This device complies with Industry Canada license-exempt RSSs. 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.

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.

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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.

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.

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http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_01.page

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2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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