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## ZigBee® USB dongle demonstration kit (STEVAL-IFS013V2)

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### **1 Introduction**

This document describes the hardware and software of the STMicroelectronics™ ZigBee® USB dongle demonstration kit working under the Microsoft® Windows® 98/2000/XP operating systems.

The purpose of this design is to demonstrate the key features of STMicroelectronics ZigBee PRO compliant wireless networking solutions. ZigBee PRO, the leading wireless control and sensory network solution, stands apart from other RF solutions as the only standards-based technology that:

- Addresses the unique needs of remote monitoring and control, and sensory network applications
- Enables broad-based deployment of wireless mesh networks with low-cost, low-power solutions
- Provides the ability to run for years on inexpensive primary batteries for a typical monitoring application.

This particular demonstration kit primarily offers USB interface operating either under USB communication device class (CDC) for virtual COM port connectivity or under device firmware upgrade (DFU) class for reprogramming an application through USB. All design source data are coming together with the kit and are ready to be reused in next development. Target applications are: ZigBee network analysis and control through your PC, universal PC based ZigBee “sink” node, low cost PC based node for rapid start of ZigBee technology evaluation.

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## 2 Description

The ZigBee USB dongle demonstration kit tool is designed to demonstrate several STMicroelectronics products:

- SPZB260-PRO is a low power consumption ZigBee module optimized for embedded applications. It enables OEMs to easily add wireless capability to electronic devices. The module is based on SN260 ZigBee network processor which integrates 2.4 GHz, IEEE 802.15.4-compliant transceiver as well as IEEE 802.15.4 PHY and MAC. 24 MHz high stability Xtal is available aboard the module to perform the timing requirements as per ZigBee specifications. A single supply voltage is requested to power the module. An integrated 2.5 GHz specific Murata antenna is aboard. The voltage supply also determines the I/O ports level allowing an easy interface with the host system. The module is controlled by means of a standard serial interface (SPI) allowing the connections to a variety of host microcontrollers.
- The medium density devices STM32F103xx performance line family incorporates the high-performance ARM<sup>®</sup> Cortex<sup>™</sup>-M3 32-bit RISC core operating at a 72 MHz frequency, high-speed embedded memories (Flash memory up to 128 Kbytes and SRAM up to 20 Kbytes), and an extensive range of enhanced I/Os and peripherals connected to two APB buses. All devices offer two 12-bit ADCs, three general purpose 16-bit timers plus one PWM timer, as well as standard and advanced communication interfaces: up to two I<sup>2</sup>Cs and SPIs, three USARTs, an USB and a CAN. The STM32F103xx performance line family operates from 2.0 to 3.6 V power supply. It is available in both the –40 to +85 °C temperature range and the –40 to +105 °C extended temperature range. A comprehensive set of power-saving mode allows designing low-power applications. The complete STM32F103xx performance line family includes devices in 5 different package types: from 36 pins to 100 pins.

## 3 Getting started

### 3.1 System requirements

In order to use the USB to ZigBee dongle evaluation kit with the Windows operating system, a recent version of Windows, such as Windows XP, Windows 98, Windows Millennium or Windows 2000 must be installed on the PC.

The version of the Windows OS installed on your PC may be determined by clicking on the “system” icon in the control panel.

### 3.2 Package contents

The low-speed USB to ZigBee dongle evaluation kit includes the following items:

#### 3.2.1 Hardware content

- One evaluation board with USB connector and ZigBee module
- One soldered STM32F103CBT6 ARM-based 32-bit microcontroller device (TQFP48 package). This is a Flash device allowing up to 10 thousands reprogramming cycles. The STM32F103CBT6 is delivered already programmed with the evaluation firmware.

#### 3.2.2 Software content

- STM32™ design firmware update (DFU) firmware
- STM32 DFU application for ZigBee sink node that collects data from a sensor network
- STM32 DFU application for ZigBee sensor node that simulates sensing node

#### 3.2.3 Documentation

- STM32F103xx and SPZB260-PRO datasheets
- PCB production data
- STM32F103 and ZigBee flyers
- This user manual UM0602.

*Note:* Software content and documentation are on enclosed CD.

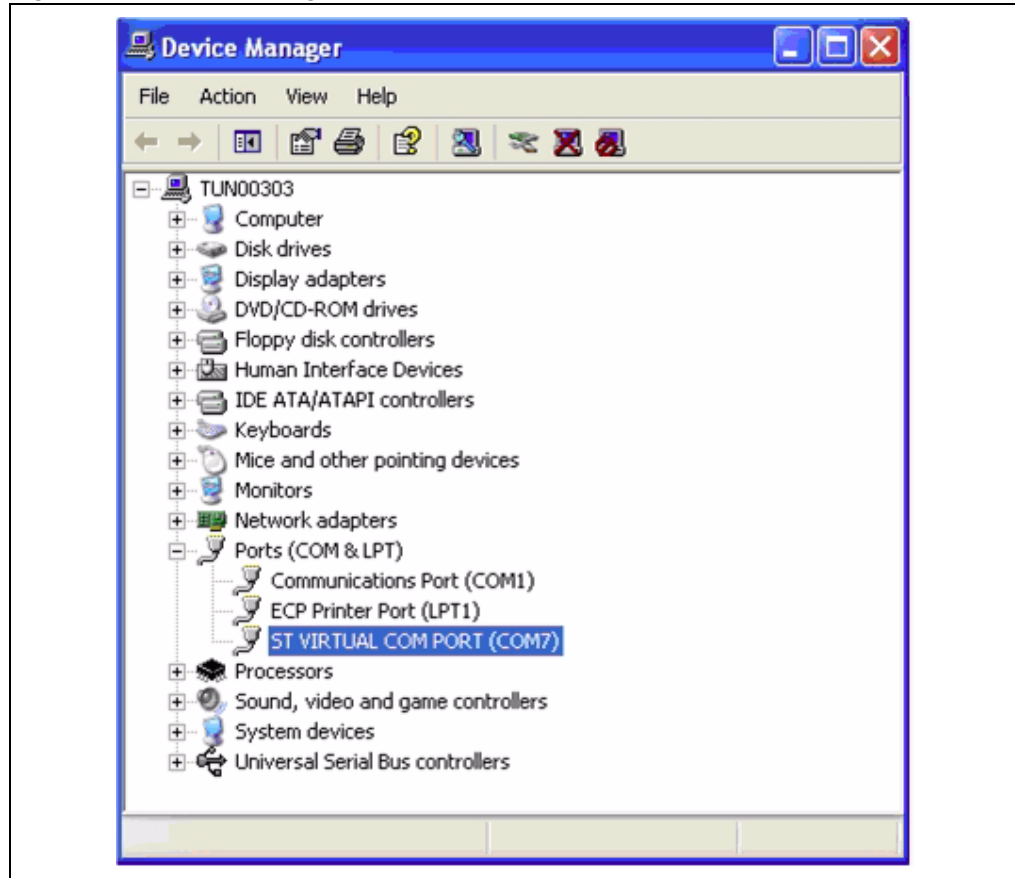
### 3.3 Software driver installation

To install the software driver of the virtual COM port, follow the following steps:

- Connect the ZigBee USB dongle to your PC/laptop USB port and let the Windows recognize the CDC class device
- Indicate to the PC the location of the stmcdc.inf file (already provided in the kit)

At the end of the installation a new COM port appears in the device manager window as shown in [Figure 1](#).

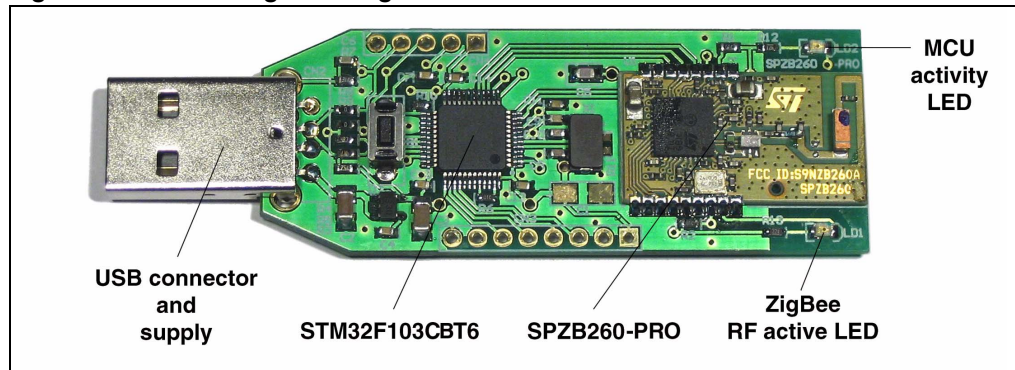
Figure 1. Device manager window



### 3.4 Hardware installation

Figure 2 shows the location of the main components of the evaluation board. The schematic drawing is given in Figure 5 and Figure 6.

Figure 2. USB to ZigBee dongle based on STM32 and SPZB260-PRO



### 3.4.1 Power supply

The USB to ZigBee dongle evaluation board is directly supplied by the USB connector (bus-powered) and therefore does not require an external voltage supply.

### 3.4.2 STM32 JTAG interface

The 8-pin connector CN3 must be connected to a programming tool in order to program or erase the microcontroller Flash memory.

For further information, please refer to both the Reference manual RM0008 - “Low-, medium- and high-density STM32F101xx, STM32F102xx and STM32F103xx advanced ARM-based 32-bit MCUs” and the Programming manual PM0042 - “STM32F10xxx Flash programming”, available online from [www.st.com/mcu](http://www.st.com/mcu).

*Note:* The USB cable must be plugged in to supply the board with voltage.

### 3.4.3 SPZB260-PRO debug and programming interface (SIF)

In order to program the integrated Flash and debug the software application within the SPZB260-PRO, a synchronous serial interface, known as SIF, connects either Ember's™ InSight™ Adapter (ISA) or Ember's USB link programmer directly to the XAP2b core and integrated memory bus. The SIF is a synchronous port which operates in a similar command/response manner as JTAG. It uses four, dedicated pins (SIF\_CLK, SIF\_MISO, SIF\_MOSI and nSIF\_LOAD) from the SPZB260-PRO. This interface is available through optional connector CN1.



## 4 Software equipment of the evaluation kit

This part of the document presents key software techniques that are used and ready for testing in the USB to ZigBee dongle evaluation kit.

### 4.1 Design firmware update

This paragraph describes the implementation of a device firmware upgrade (DFU) capability in the STM32F103xx microcontroller. It follows the DFU class specification defined by the USB Implementers Forum for reprogramming an application through USB. The DFU principle is particularly well suited to USB applications that need to be reprogrammed in the field: The same USB connector can be used for both the standard operating mode and the reprogramming process.

This operation is made possible by the IAP capability featured by most of the STMicroelectronics USB Flash microcontrollers, which allows a Flash MCU to be reprogrammed by any communication channel.

The DFU process, like any other IAP process, is based on the execution of firmware located in one small part of the Flash memory and that manages the erase and program operations of the others Flash memory modules depending on the device capabilities: it could be the main program/code Flash, data Flash/EEPROM or any other memory connected to the microcontroller even a serial Flash (through SPI or I<sup>2</sup>C etc.). In case of the USB to ZigBee dongle evaluation kit is DFU used to program the internal Flash memory.

Refer to the UM0412, DfuSe USB device firmware upgrade STMicroelectronics extension, for more details on the driver installation and PC user interface.

### 4.2 Virtual COM port

In modern PCs, USB is the standard communication port for almost all peripherals. The virtual COM port feature used in the standard firmware delivery provides a simple solution to bypass need of dedicated PC software equipment or drivers for our evaluation board control. It uses the USB as a COM port by affecting the legacy PC application designed for COM port communication.

The target of virtual COM port feature in our evaluation design is to bridge ZigBee node serial control port located on STM32 to USB and to provide communication between a laptop (without RS-232 port) and our evaluation board. The PC application used in the communication is Windows HyperTerminal.

### 4.3 Sensor - sink ZigBee application

An example of a complete application that implements a distributed sensor network with 1 or more data collection points (called "sensors") and 1 or more data storage points (called "sinks") is partially included in your standard evaluation kit delivery. A sink node sends out advertisements (SINK\_ADVERTISE) at regular intervals using a multicast (after making a many-to-one route request). When a sensor without a sink hears this multicast, it sends a message (SENSOR\_SELECT\_SINK) requesting to use this sink (after setting its address table entry to the sink). If the sink has a free address table entry it responds with a sink

ready message (SINK\_READY) and, at that point, the sensor is free to send data (DATA) to the sink at fixed intervals (as set by SEND\_DATA\_RATE).

*Note:* The sink, sensor applications require the user interaction through the serial communication channels (virtual COM through USB). Press the “?” key on the hyper terminal for printing the user help menu. See the [Section 4.3.3: Serial commands supported on sensor and sink](#) for a description of the available serial commands.

### 4.3.1 Sensor

A device that takes data readings from some input source and passes these readings to a particular collection point. Many sensors report to a single sink. When the sensor application joins the network, led LD2 on the board will blink (visual signal that the node is active and joined to a network).

### 4.3.2 Sink

Sink is a device that serves as a collection point for 1 or more sensor devices. In this example, the sink is set up to be the ZigBee coordinator device, and it forms the network automatically on first startup and retains these settings across reboots. Once the sink application starts running, led LD2 on your evaluation STEVAL-IFS013V2 board will blink (visual signal that the node is active).

### 4.3.3 Serial commands supported on sensor and sink

**Table 1. Serial commands supported on sensor and sink**

Command	Response / description
<b>l</b>	Tells the node to send a multicast hello packet
<b>!</b>	Leave the ZigBee network so on node reset the sink can form a new network
<b>i</b>	Prints info about this node including channel and power
<b>?</b>	Prints the help menu
<b>5</b>	Simulate button B1 press - turns permit join, allowing other nodes to join to this node
<b>6</b>	Leave the ZigBee network
<b>a</b>	Prints the address table
<b>m</b>	Prints the multicast table
<b>c</b>	Print child table
<b>k</b>	Print the security keys

**Table 2. Serial commands supported on sink only**

Command	Response / description
<b>f</b>	Force the sink to advertise
<b>*</b>	Switch the network key: send the key followed by a switch key command 30 s later
<b>&amp;</b>	Send a switch key command. This is needed only if the device sent a new key and then reset before it was able to send the switch key command

#### 4.3.4 Notes and limitations

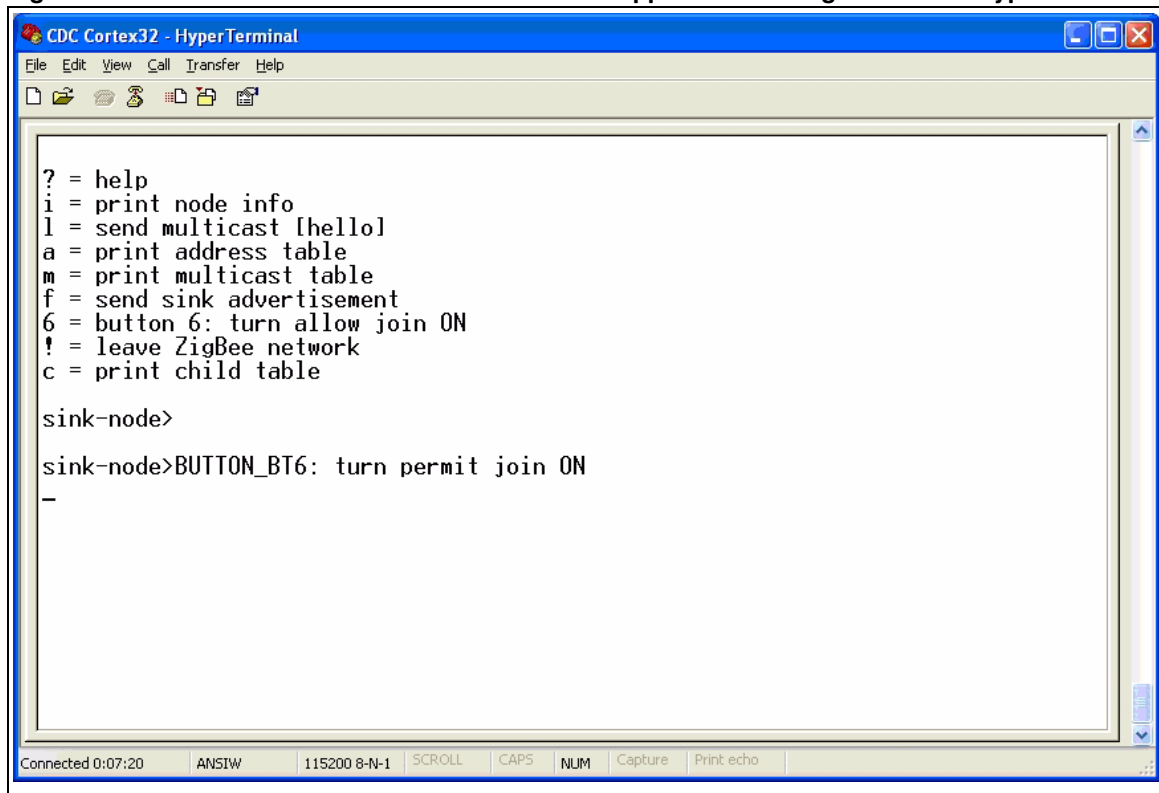
- This application defaults to using a fixed set of network parameters, with a default channel setting of 26.  
(Remove the #define USE\_HARDCODED\_NETWORK\_SETTINGS line in the common.h header file to allow the application to dynamically select its network parameters.)
- Although the example portrays a single sink node that acts as a ZigBee coordinator, the application could be easily adapted to allow a variant of the sink node that joins the network as an ordinary ZigBee router so that multiple sinks can be supported.
- This application uses a “push” style of communication, where the sensor sends reports to the sink without needing to be asked for this data. This is more efficient than a “pull” model, where a device only transmits data when asked to do so by another device, because it cuts the amount of traffic in half, thereby reducing the number of collisions and routing burden in the network.
- The data reports used in this example are fixed size packets (of a size defined by SEND\_DATA\_SIZE). The data contents are simply a 16-bit actual temperature value, measured at the sensor side.
- The application uses a constant called MISS\_PACKET\_TOLERANCE as a threshold for fault tolerance. On the sensor, this controls how many message timeouts can be permitted between the sensor and sink before the sensor decides to attach itself to a different sink. For a sink, this controls how many data reports can be missed from a sensor before the sink “forgets” about the sensor (stops maintaining a record of its attachment). Although bindings are kept on the sink node to track the attached sensors, these could easily be made temporary (used only for the SINK\_READY message) to allow the sink application to support more nodes without enlarging the binding table, assuming that the sink application does not care which sensors and how many sensors are attached to it.
- The sensor advertisement is a broadcast. The behavior of such a broadcast in the network depends on the network topology and density. ZigBee limits the number of broadcasts that can be active in a network to 10 to minimize the network disruption and loss of bandwidth. As this network increases in size or density, the rate of the sensor advertisement should be reduced in frequency.

## 5 Running the USB to ZigBee dongle evaluation kit

First, connect the evaluation board to the PC via the USB cable. As a result, the evaluation board is enumerated as a STM™ virtual COM port device as shown in [Figure 1](#), and is ready to use.

To access the ZigBee serial control interface of pre-flashed “sink application” demonstration you need to start Windows HyperTerminal ([Figure 3](#)) and setup port settings according to the screenshot here below ([Figure 4](#)). UART communication speed 115200 kbps, 8 data bits with no parity and 1 stop bit. Refer to [Section 4.3: Sensor - sink ZigBee application](#) for more details about sink node behavior and control.

**Figure 3. Control of sensor - sink demonstration application through Windows HyperTerminal**

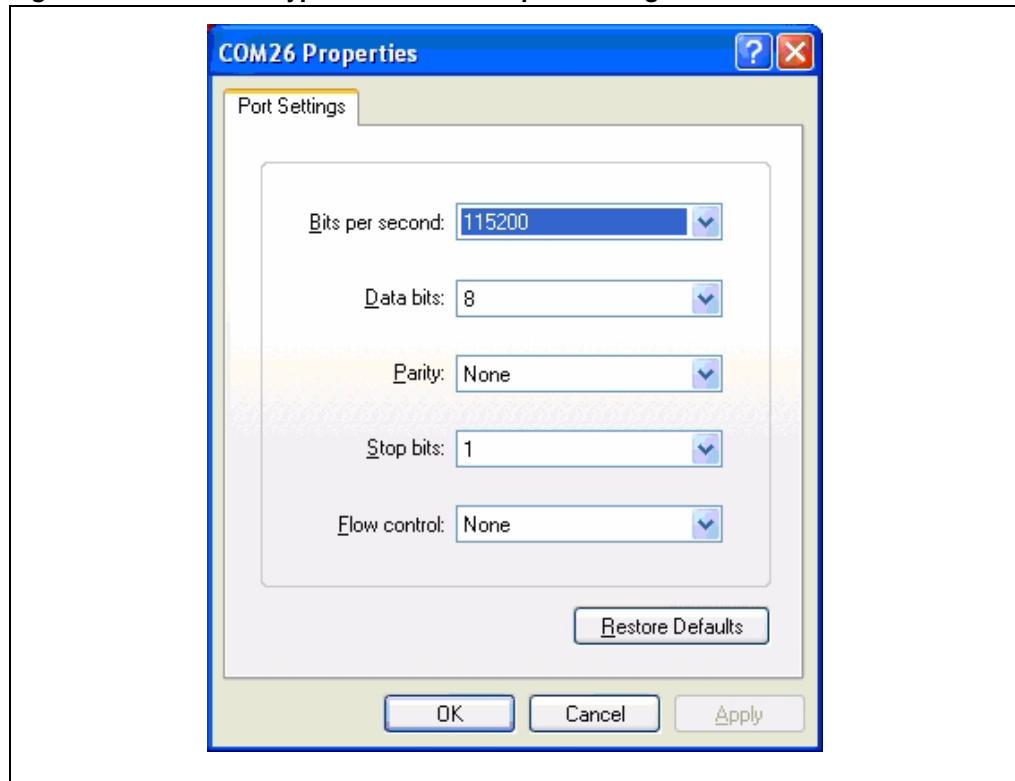


```
CDC Cortex32 - HyperTerminal
File Edit View Call Transfer Help
? = help
i = print node info
l = send multicast [hello]
a = print address table
m = print multicast table
f = send sink advertisement
6 = button 6: turn allow join ON
! = leave ZigBee network
c = print child table

sink-node>
sink-node>BUTTON_BT6: turn permit join ON
-
```

Connected 0:07:20 ANSIW 115200 8-N-1 SCROLL CAPS NUM Capture Print echo

Figure 4. Windows HyperTerminal serial port settings



## 6 Updating demonstration application in the evaluation kit

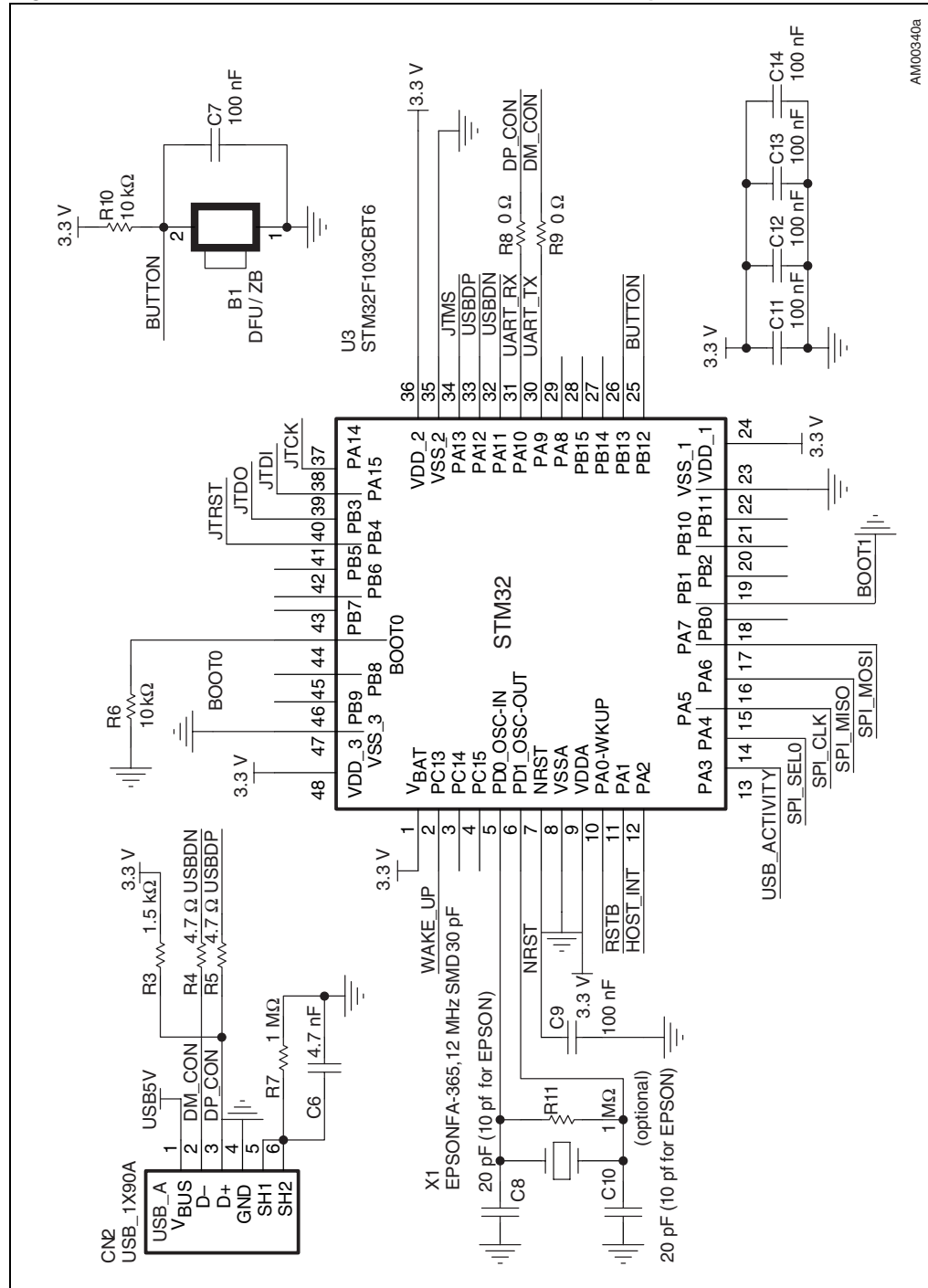
For the STM32 the DFU mode is entered after an MCU reset if:

- The DFU mode is forced by the user: the user presses the key push-button during a reset (while he is attaching the evaluation dongle to the USB).
- There is no correct code available in the applicative area: before jumping to the applicative code, the DFU code tests if there is a correct top of stack address in the first address in the applicative area of the internal Flash memory (for the STM32F103xx the first applicative address is 0x0800 3000). This is done by reading the value of the first applicative address and verifying if the MSB half-word is equal to 0x2000 (base address of the RAM area in the STM32F103xx).

Once is the device in the DFU mode, you can simply update main application with support of tools coming from STM in DfuSe package. For further information, please refer to user manual UM0412 - Getting started with DfuSe USB device firmware upgrade STMicronics extension, available online from [www.st.com/mcu](http://www.st.com/mcu).

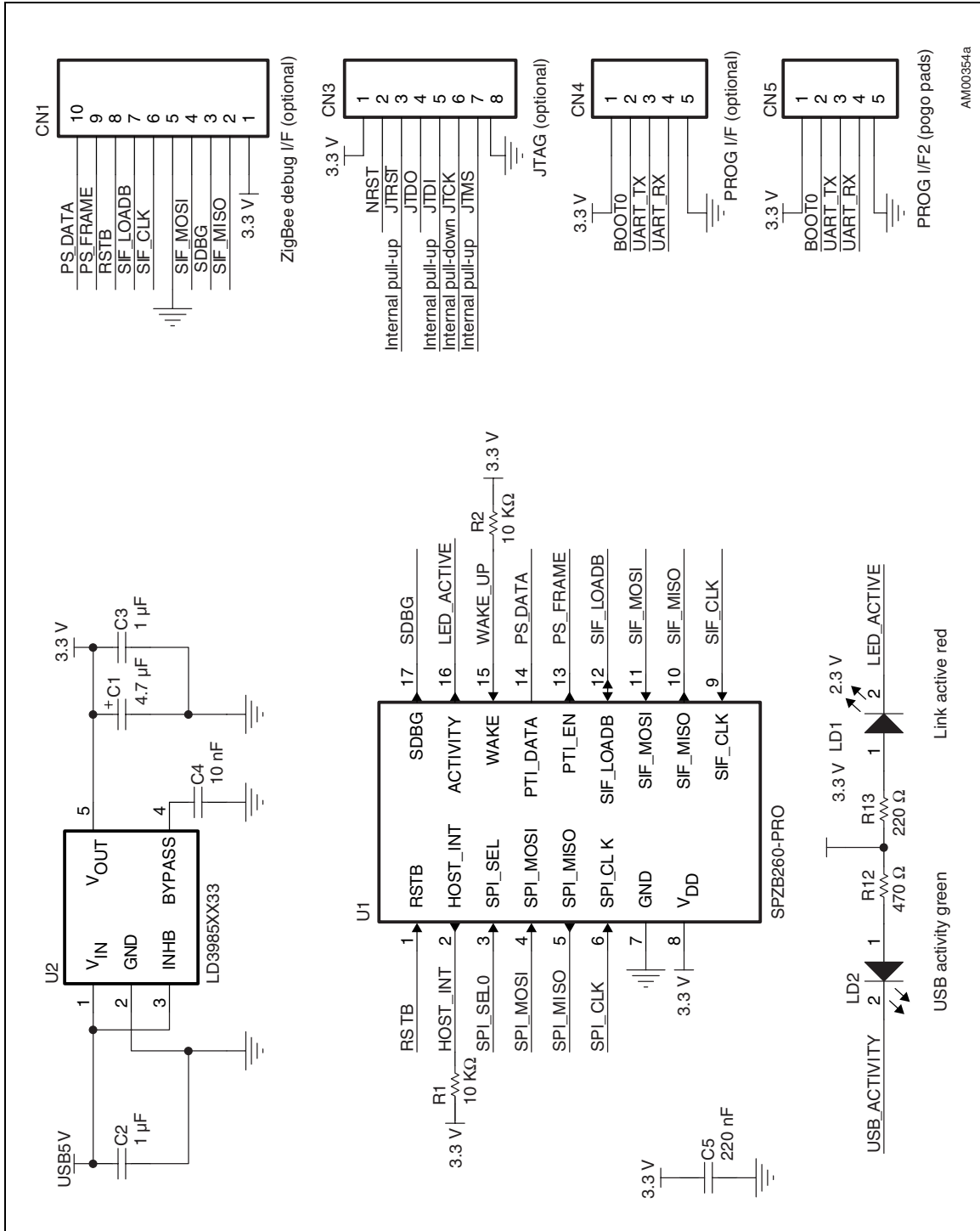
# 7 Appendix

Figure 5. Evaluation board schematics - microcontroller part



AM00340a

Figure 6. Evaluation board schematics - ZigBee and interface connectors part





## 8 Revision history

Table 3. Document revision history

Date	Revision	Changes
13-Nov-2008	1	Initial release.
26-Aug-2009	2	Document reformatted, replaced devices: STEVAL-IFS013V1 by STEVAL-IFS013V2, STM32F103C6T6 by STM32F103CBT6 and SPZB260 by SPZB260-PRO, SN260 debug interface by SPZB260-PRO debug interface, removed STEVAL-IFS009V1, updated <a href="#">Section 3.2.2</a> , <a href="#">Section 4.3.1</a> , <a href="#">Section 4.3.3</a> , <a href="#">Figure 2</a> , <a href="#">Figure 5</a> , <a href="#">Figure 6</a> and <a href="#">Table 1</a> , added <a href="#">Table 2</a> .

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