UM1892
User manual

Getting started with the X-CUBE-SUBG1 for WM-Bus communications based on Sub-1 GHz RF expansion board

Introduction

X-CUBE-SUBG1 provides a middleware example and demo application for the STM32 to build applications using the SPSGRF-868 module based on the SPIRIT1 low data rate, low power sub-1 GHz transceiver device. It is easily portable across different MCU families thanks to STM32Cube.

This manual describes how to get started with the X-CUBE-SUBG1 software for a wireless meter bus (WM-Bus) application.

The software provides implementation examples for STM32 Nucleo platforms equipped with the X-NUCLEO-IDS01A4 expansion board using SPSGRF-868 module

The following demo examples are available for testing with the expansion board:

- WM-Bus: wireless metering bus demo
- Point-to-point communication protocol demo

This document explains the wireless metering bus demo.

Contents

1 What is STM32Cube?

1.1 STM32Cube overview

STMCube™ represents an original initiative by STMicroelectronics to ease developers' life by reducing development effort, time and cost. STM32Cube covers the STM32 portfolio. Version 1.x of STM32Cube includes:

STM32Cube Version 1.x includes:

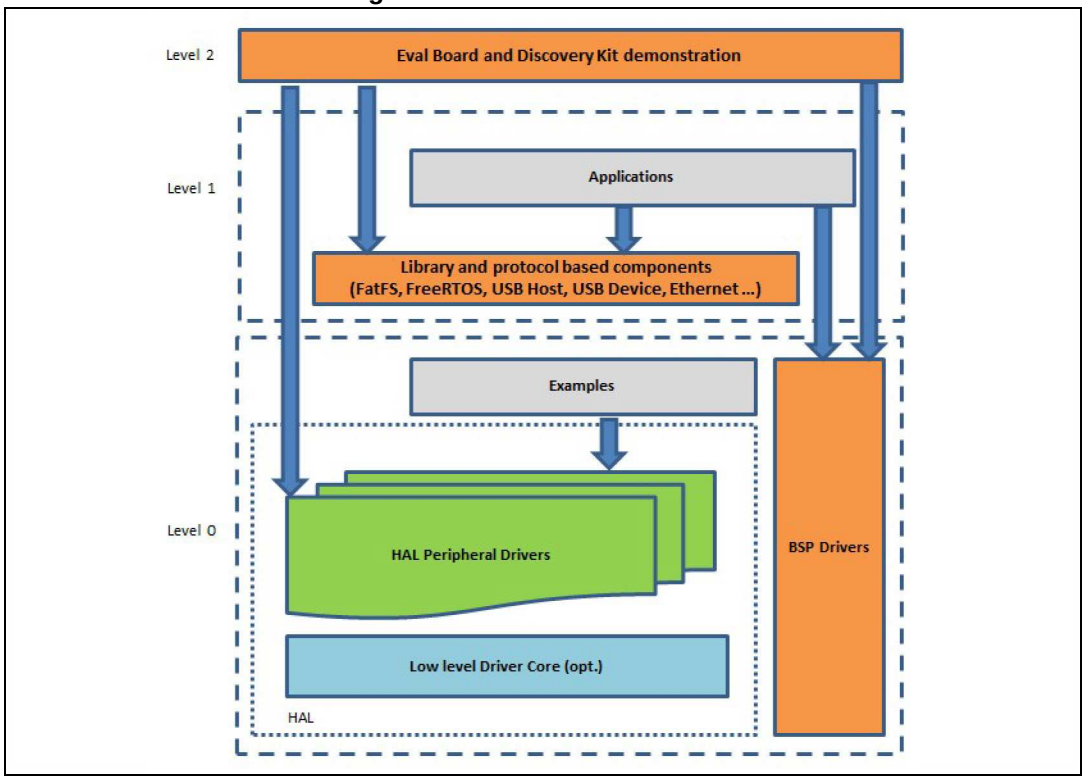
- STM32CubeMX, a graphical software configuration tool that allows the generation of C initialization code using graphical wizards.
- A comprehensive embedded software platform, delivered per series (such as STM32CubeF4 for STM32F4 series).
  - The STM32Cube HAL, an STM32 abstraction layer embedded software, ensuring maximized portability across STM32 portfolio
  - A consistent set of middleware components such as RTOS, USB, TCP/IP, graphics
  - All embedded software utilities, including a full set of examples.

Information about STM32Cube is available on st.com at: http://www.st.com/stm32cube.

1.2 STM32Cube architecture

The STM32Cube firmware solution is built around three independent levels that can easily interact with each other, as illustrated in the figure below:

Figure 1. Firmware architecture



Level 0: This level is divided into three sub-layers:

- Board support package (BSP): this layer offers a set of APIs relative to the hardware components in the hardware boards (audio codec, IO expander, touchscreen, SRAM driver, LCD drivers, etc.) and composed of two parts:
  - Component: the driver relative to the external device on the board and not related to the STM32. The component driver provides specific APIs to the BSP driver external components and could be portable to any other board.
  - BSP driver: permits the linking of the component driver to a specific board and provides a set of user friendly APIs. The API naming rule is BSP_FUNCT_Action(): ex. BSP_LED_Init(),BSP_LED_On()

It is based on a modular architecture allowing it to be easily ported to any hardware by implementing the low level routines.

- Hardware abstraction layer (HAL): this layer provides the low level drivers and the hardware interfacing methods to interact with the upper layers (application, libraries and stacks). It provides generic, multi instance and functionality-oriented APIs which permit offloading of the user application implementation by providing a ready-to-use process. As an example, for the communication peripherals (I^2S, UART, etc.) it provides APIs allowing initialization and configuration of the peripheral, management of data transfer based on polling, interrupt or DMA process, and management of communication errors that may arise during communication. The HAL driver APIs are split into two categories, generic APIs which provide common and generic functions to all the STM32 series, and extension APIs which provide specific and customized functions for a specific family or a specific part number.
- Basic peripheral usage examples: this layer encloses the examples build over the STM32 peripheral using only the HAL and BSP resources.

Level 1: This level is divided into two sub-layers:

- Middleware components: set of libraries covering USB host and device libraries, STemWin, FreeRTOS, FatFS, LwIP, and PolarSSL. Horizontal interaction between the components of this layer is done directly by calling the feature APIs, while the vertical interaction with the low level drivers is done through specific callbacks and static macros implemented in the library system call interface. For example, the FatFs implements the disk I/O driver to access microSD drive or the USB mass storage class.
- Examples based on the middleware components: each middleware component comes with one or more examples (also called applications) describing how to use it. Integration examples that use several middleware components are provided as well.

Level 2: This level is composed of a single layer which is a global real-time and graphical demonstration based on the middleware service layer, the low level abstraction layer and the basic peripheral usage applications for board-based functionalities.

2 X-CUBE-SUBG1 software expansion for STM32Cube

2.1 Overview

X-CUBE-SUBG1 is a software package that expands the functionality provided by STM32Cube.

The key features of the package are:

- Demo example of Point-to-point (P2P) communication to transfer data from one node to another
- Middleware to build applications for WM-Bus (wireless metering bus)
- Easy portability across different MCU families thanks to STM32Cube
- Free user-friendly license terms
- Example implementation available on board X-NUCLEO-IDS01A4 (868 MHz) plugged on top of one NUCLEO-L053R8 or NUCLEO-F401RE

Using the software details explained in this document, the following applications can also be developed:

- Automatic meter reading
- Gas meter reading
- Water meter reading
- Electricity meter reading
- Heat meter reading

2.2 Introduction to WM-Bus

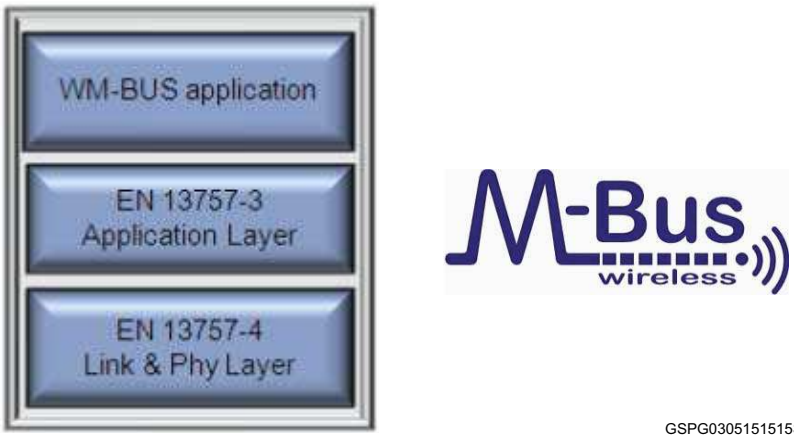
The M-Bus (meter bus) is a common standard used for AMR implementation, for remote energy meter reading, and is based on European standards EN 13757-2 physical and link layer, and EN 13757-3 application layer. The M-Bus interface is made for communication on two wires, twisted cable, making it very cost effective. In the M-Bus, it is possible use any kind of network topology (linear, star, etc.), except ring network, capable of achieving long distance communication. When interrogated, the meters send the data to a concentrator that can render them available locally or remotely. A radio variant of M-Bus, wireless M-Bus, is also specified in EN 13757-4.

The wireless meter bus is an open standard for automatic meter reading at RF sub 1-GHz level. The relevant standards documents are:

- European standard prEN13757-4:2011 Wireless meter readout
- European standard EN13757-3:2004 Dedicated application layer (in common with M-Bus)
- ETSI EN 300 220 v2.3.1

The wireless M-Bus firmware stack is based on EN 13757-4:2011.10 (communication systems for meters and remote reading of meters - Part 4: Wireless meter readout (Radio meter reading for operation in SRD bands)). This European standard specifies the requirements for parameters for the physical and the link layer for systems using radio to read remote meters. The primary focus is to use the short range device (SRD) unlicensed telemetry bands. The standard encompasses systems for walk-by, drive-by and fixed installations:

Figure 2. Basic wireless M-Bus architecture



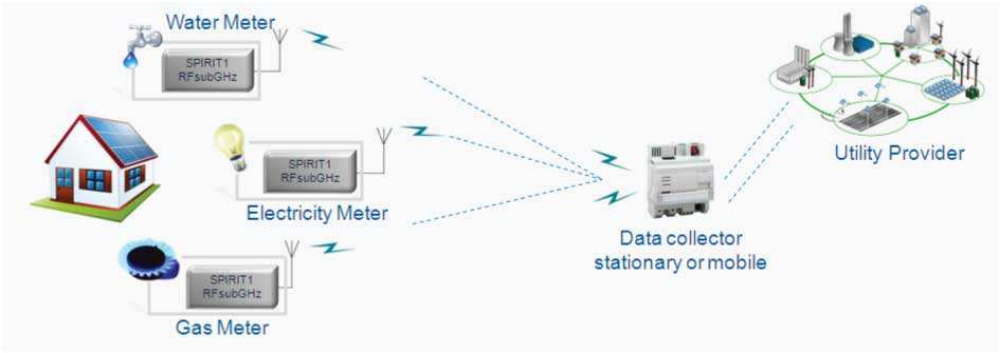
The wireless M-Bus standard is defined by the European standard EN 13757-4 for physical and data link layers. The application layer is defined by EN 13757-3 standard.

There are different types of devices:

1. Meter
2. Concentrator/ read-out device
3. Router

The standard defines the communication between remote meters and mobile readout devices, stationary receivers, data collectors, etc. The typical application scenario is shown below:

Figure 3. Final application scenario



STMicroelectronics has developed a wireless M-Bus firmware stack implementation, based on ST's dual chip platform, SPIRIT1 RF sub-1 GHz transceiver and the STM32 NUCLEO-L053R8 (ARM Cortex-M0+) / STM32L15 ultra low power (ARM Cortex-M3) microcontroller.

SPIRIT1:

The SPIRIT1 is a very low-power and high performance RF transceiver, addressing RF wireless applications in the sub-1 GHz band. It is designed to operate at 169, 315, 433, 868, and 915 MHz. It supports the following modulation: 2-FSK, GFSK, MSK, OOK, and ASK. The air data rate is programmable from 1 to 500 kbps, depending on the selected modulation. It has an integrated SMPS which allows very low power consumption: 9 mA in Rx and 21 mA in Tx mode at +11 dBm. It uses a very small number of discrete external

components and integrates a configurable baseband modem, which supports data management, modulation, and demodulation. The data management handles the data in the proprietary fully programmable packet format also allows the M-Bus standard compliance format (all performance classes). The SPIRIT1 is native HW supporting the low level of WM-Bus PHY protocol.

Ultra low power 32-bit MCU ARM-based Cortex-M0+, STM32L053x6/8

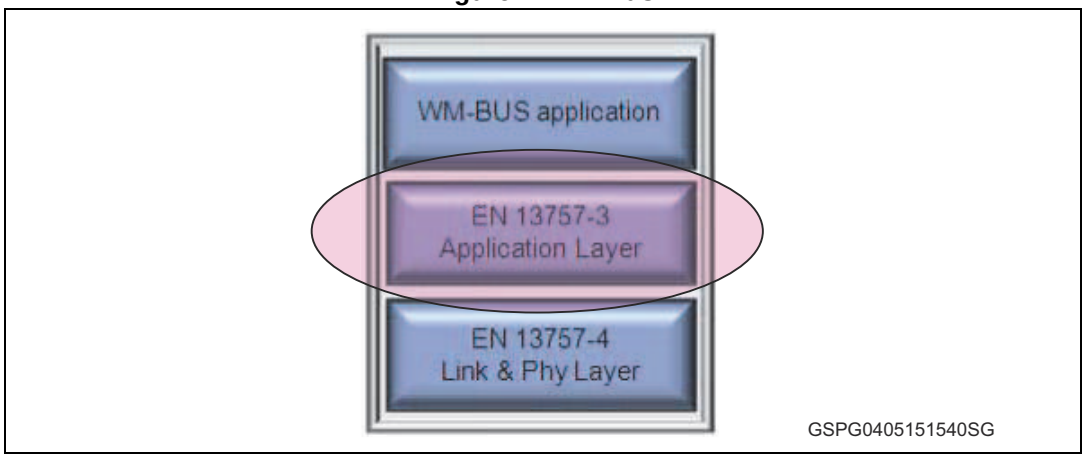
The ultra low power STM32L053x6/8 incorporates the connectivity power of the universal serial bus (USB 2.0 crystal-less) with the high-performance ARM Cortex™-M0+ 32-bit RISC core operating at a 32 MHz frequency, a memory protection unit (MPU), high-speed embedded memories (up to 64 Kbytes of Flash program memory, 2 Kbytes of data EEPROM and 8 Kbytes of RAM) plus an extensive range of enhanced I/Os and peripherals. The STM32L053x6/8 devices provides high power efficiency for a wide range of performance. It is achieved with a large choice of internal and external clock sources, an internal voltage adaptation and several low power modes.

The STM32L053x6/8 devices offer several analog features, one 12-bit ADC, one DAC, two ultra low power comparators, several timers, one low-power timer (LPTIM), three general-purpose 16-bit timers and one basic timer, one RTC and one SysTick which can be used as time bases. They also feature two watchdogs, one watchdog with independent clock and window capability and one window watchdog based on bus clock.

Moreover, the STM32L053x6/8 devices embed standard and advanced communication interfaces: up to two I²Cs, two SPIs, two I^2S, three USARTs and a crystal-less USB. The devices offer up to 24 capacitive sensing channels to easily add touch sensing functionality to any application.

In this user manual, STMicroelectronics' WM-Bus application layer is explained:

Figure 4. WM-Bus



The WM-Bus protocol stack is developed on ST's dual chip platform. The SPIRIT1 implements just a part of the WM-Bus physical layer, the PHY and LINK firmware stack layers are implemented in STM32Lxx.

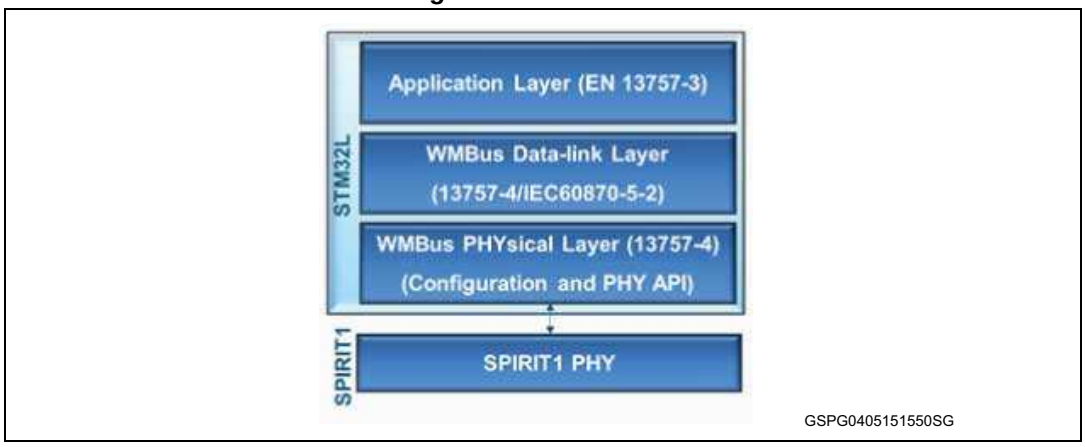
The firmware partitioning between STM32 available on Nucleo boards and SPIRIT1 device is explained below.

STM32 MCU:

- WM-Bus application layer
  - Wireless M-Bus application layer partially implements the EN13757-3.

- WM-Bus link layer
  - MAC packet and CRC handling
  - Encryption/ decryption initiate/read.
- WM-Bus PHY
  - Init PHY for WM-Bus
  - Interrupt services

Figure 5. SPIRIT1 role



SPIRIT1 role:

- WM-Bus modes
- Header, sync and trailer fields
- Manchester/3-out-of-6-encoding
- Sync detection
- Tx and RX FIFO

Note: STM32 NUCLEO-L053R8 supports WM-Bus METER implementation only

2.3 Architecture

This software is an expansion for STM32Cube, and as such it fully complies with the architecture of STM32Cube and expands it in order to enable development of applications using X-NUCLEO-IDS01A4 boards hosting the SPIRIT1 device module. Please see the previous chapter for an introduction to the STM32Cube architecture.

The software is based on the STM32CubeHAL, the hardware abstraction layer for the STM32 microcontroller. The package extends STM32Cube by providing a board support package (BSP) for the SPIRIT1 expansion board and some example firmware for P2P communication and middleware example of WM-Bus.

The software layers used by the application software to access and use the SPIRIT1 expansion board are as follows:

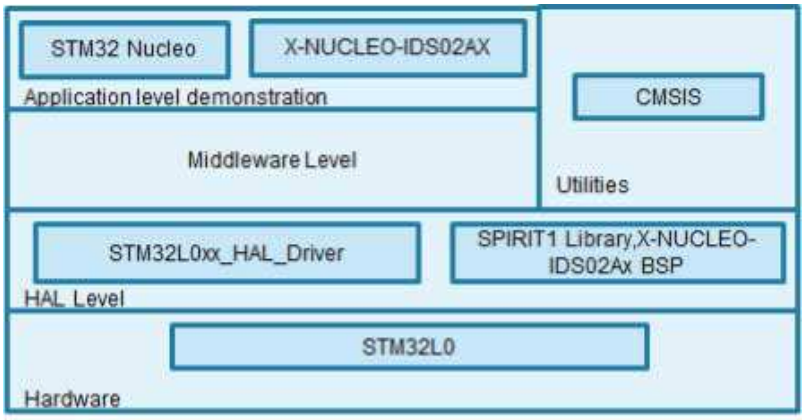
- STM32Cube HAL layer: The HAL driver layer provides a generic multi instance simple set of APIs (application programming interfaces) to interact with the upper layers (application, libraries and stacks). It is composed of generic and extension APIs. It is directly built around a generic architecture and allows the layers that are built upon, such as the middleware layer, to implement their functionalities without dependencies on the specific

hardware configuration for a given microcontroller unit (MCU). This structure improves library code reusability and guarantees easy portability to other devices.

- Board support package (BSP) layer: The software package needs to support the peripherals on the STM32 Nucleo board apart from the MCU. This software is included in the board support package (BSP). This is a limited set of APIs which provides a programming interface for certain board specific peripherals, e.g. the LED, the user button, etc. The BSP firmware layer of the X-NUCLEO-IDS01A4 board contains set of APIs related to the hardware components. This is composed of two parts:
  a) Component: As defined in STM32Cube this is the driver related to the external device on the board and not related to the STM32. The SPIRIT1 BSP driver is called as the firmware component.
     The SPIRIT1 component driver provides specific APIs and can be ported and used on any board.
  b) BSP driver: Enables the component driver to be linked to a specific board and provides a set of user-friendly APIs.
- Middleware: This layer includes the libraries for WM-Bus, USB, touch sensing, etc. This document explains the WM-Bus middleware for X-NUCLEO-IDS01A4
- Application layer:
  This layer provides example of Point-to-point communication. This example is discussed in a separate document.

The following figure outlines the software architecture of the package:

Figure 6. X-CUBE-SUBG1 software architecture

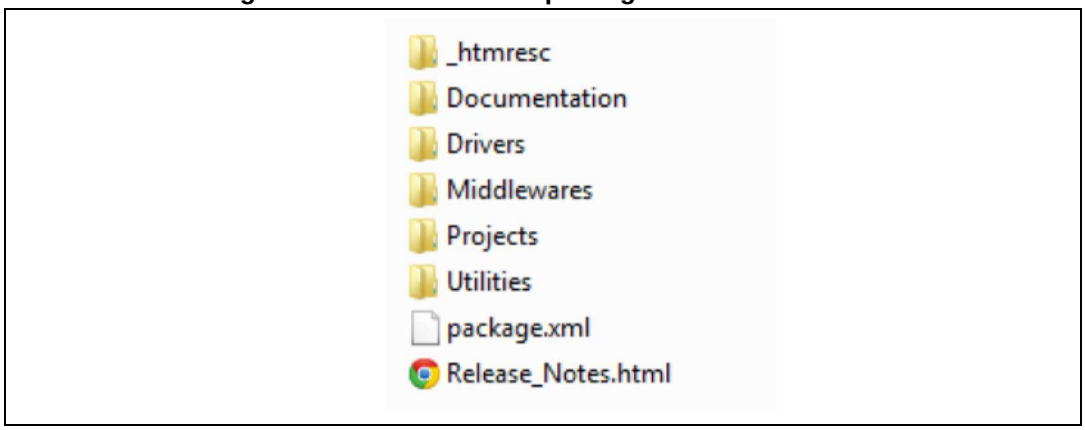


2.4 Folder structure

This section provides an overview of the package folder structure.

Figure 7 outlines the architecture of the package.

Figure 7. X-CUBE-SUBG1 package folders structure



The following folders are included in the software package:

- **Documentation**: this folder contains a compiled HTML file generated from the source code and documenting in detail the software components and APIs.
- **Drivers**: this folder contains the HAL drivers, the board specific drivers for each supported board or hardware platform, including the on-board component ones and the CMSIS layer which is a vendor-independent hardware abstraction layer for the Cortex-M processor series.
- **Middlewares**: this folder contains libraries for WM-Bus.
- **Projects**: this folder contains a sample application used for WM-Bus and P2P firmware examples for the NUCLEO-L053R8 and NUCLEO-F401RE platforms with three development environments (IAR Embedded Workbench for ARM, RealView Microcontroller Development Kit (MDK-ARM), Atollic TrueSTUDIO® for ARM).
- **Utilities**: this folder contains a folder called “PC_software” in which a Windows PC utility is provided. The utility is for WM-Bus usage and testing.

2.5 APIs

Detailed technical information about the APIs is available in a compiled HTML file located inside the “Documentation” folder of the software package, where all the functions and parameters are fully described.

3 WM-Bus demo firmware

The following section explains how the demo firmware is implemented, the user settings and configurations available and how to modify the firmware for other application usage.

3.1 WM-Bus application workspace

X-NUCLEO-IDS01V4 can be programmed only as a WM-Bus meter. The dedicated workspace is:

…\Projects\[Board Name]\Applications\WMBusStandalone

For example, for STM32L053R8-Nucleo boards, the location of the workspace is:

...\Projects\Multi\Applications\WMBusStandalone

STEVAL-IKR00xVx/STEVAL-IDS001Vx boards are used as a concentrator device for the WM-Bus application demo.

3.2 Running the demo board (X-NUCLEO-IDS01V4)

The following are the steps required to run the basic demo of the WM-Bus application.

3.2.1 Programming the Nucleo board with firmware

The steps to program the Nucleo board with WM-Bus firmware are:

1. Ensure the use of the appropriate toolchain IDE
2. The workspace is provided for the WM-Bus meter application at 868 MHz frequency band
3. Connect Nucleo board to a PC using a USB-Mini B-type cable
4. Flash the Nucleo Board with WMBusStandalone workspace
5. Make sure that the meter and concentrator devices are programmed with the same configuration, i.e. if the meter is programmed with the 868 MHz configuration, then the same configuration should be used at the concentrator side also

Table 1. WM-Bus modes summary and support

Mode	Communication	Frequency band to choose	Mode supported
S1	Unidirectional	868 MHz	Yes
S1-m	Unidirectional	868 MHz	Yes
S2	Bidirectional	868 MHz	Yes
T1	Unidirectional	868 MHz	Yes
T2	Bidirectional	868 MHz	Yes
R2	Bidirectional	868 MHz	Yes
N1	Unidirectional	169 MHz	No
N2	Bidirectional	169 MHz	No

6. Connect the concentrator to WM-Bus PC GUI. Follow the steps described to use the GUI.
7. Different meter types are supported in WM-Bus. For example:
   a) Electricity meter=0x02
   b) Gas meter=0x03
   c) Heat meter=0x04 and so on.

The user can set the meter type by changing the following in file “radio_hal.c”, as shown in *Figure 8* below:

Figure 8. User settings in firmware

```
94
95  /* Private macro -------------------------------------------------------------*/
96
97  #if defined  (DEVICE_BAND_868MHz)
98  #define        DEVICE_WMBUS_MODE S1_MODE    /*S1_MODE/ S1m_MODE/\
99                                               S2_MODE/ T1_MODE/\
100                                              T2_MODE/ R2_MODE*/
101 #define        DEVICE_WMBUS_CHANNEL CHANNEL_1
102 #define        WMBUS_FRAME_FORMAT FRAME_FORMAT_A
103 #else
104 #error         DEVICE_BAND undefined or unsupported
105 #endif
106
107 #define        SW_PRESSED          ((uint8_t)0x01)
108
109 #if defined    (DEVICE_TYPE_OTHER)
110 #define        DEVICE_TYPE         OTHER
111 #define        DEVICE_METER_TYPE   ((uint8_t)0x31)
112 #elif defined  (DEVICE_TYPE_METER)
113 #define        DEVICE_TYPE         METER
114 #define        DEVICE_METER_TYPE   ((uint8_t)0x03)
115 #else
116 #error         DEVICE_TYE undefined or unsupported
117 #endif
118
119
120 /* Private variables ---------------------------------------------------------*/
```

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3.2.2 WM-Bus application demonstration for X-NUCLEO-IDS01A4

The WM-Bus application is demonstrated in two steps:

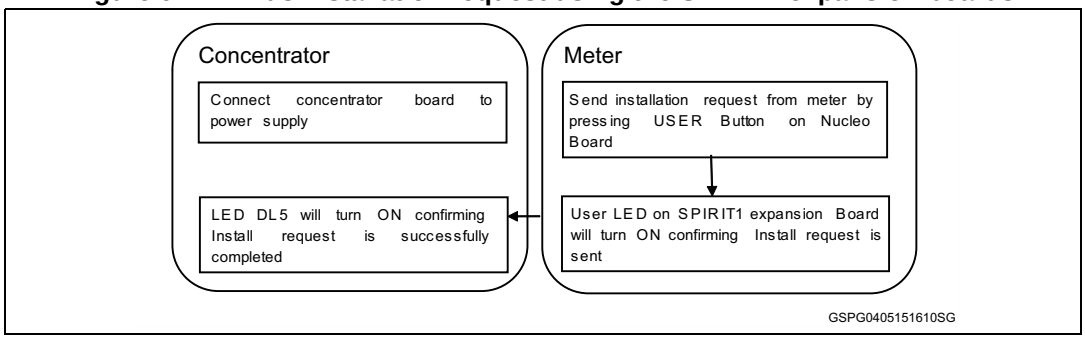
Step 1. Installation sequence

Step 2. Data communication sequence.

3.2.3 Installation sequence for X-NUCLEO-IDS01A4

As the first step, the meter must be connected to the concentrator.

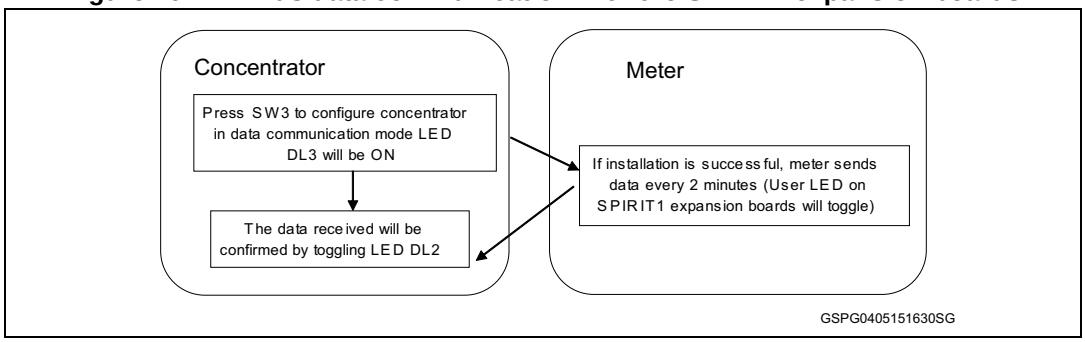
Figure 9. WM-Bus installation request using the SPIRIT1 expansion boards



3.2.4 Data communication sequence for X-NUCLEO-IDS01A4

The meter must be connected to the concentrator prior to this step.

Figure 10. WM-Bus data communication with the SPIRIT1 expansion boards



4 Using the demo board with GUI

The demo board Flashed with concentrator firmware must be connected to PC-GUI through the USB port.

4.1 GUI description

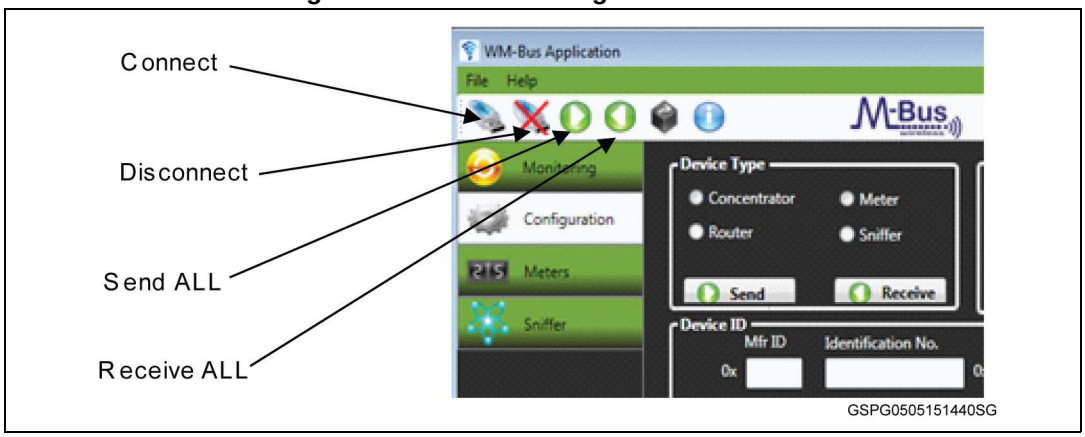
The wireless M-Bus application GUI has following windows:

1. Monitoring window
2. Configuration window
3. Meters window
4. Sniffer window

4.2 Configuration window

The wireless M-Bus devices can be configured using this window. The configurable parameters are: device type, header length, wireless M-bus mode, Manufacturer ID, RF power, time, typical response time, etc. The current configuration can also be retrieved here. Upon pressing the connection button, the board type and WM-Bus mode parameters retrieved.

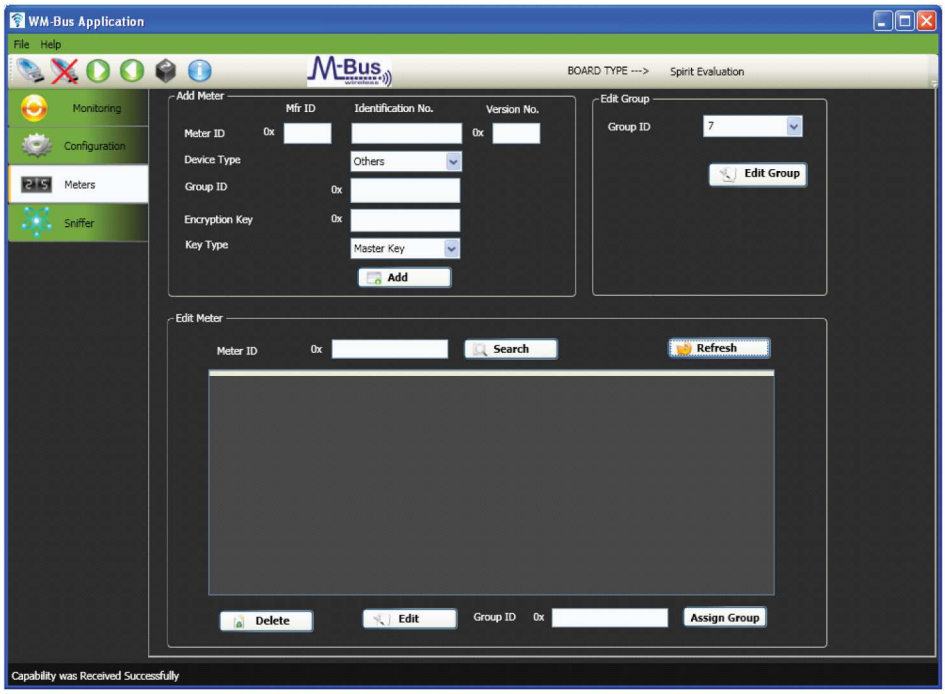
Figure 11. WM-Bus configuration window



4.3 Meter window

The meter window can be used to add meters, update meter attributes and delete meters from the database. This window is available only in case of concentrator.

Figure 12. Meter window

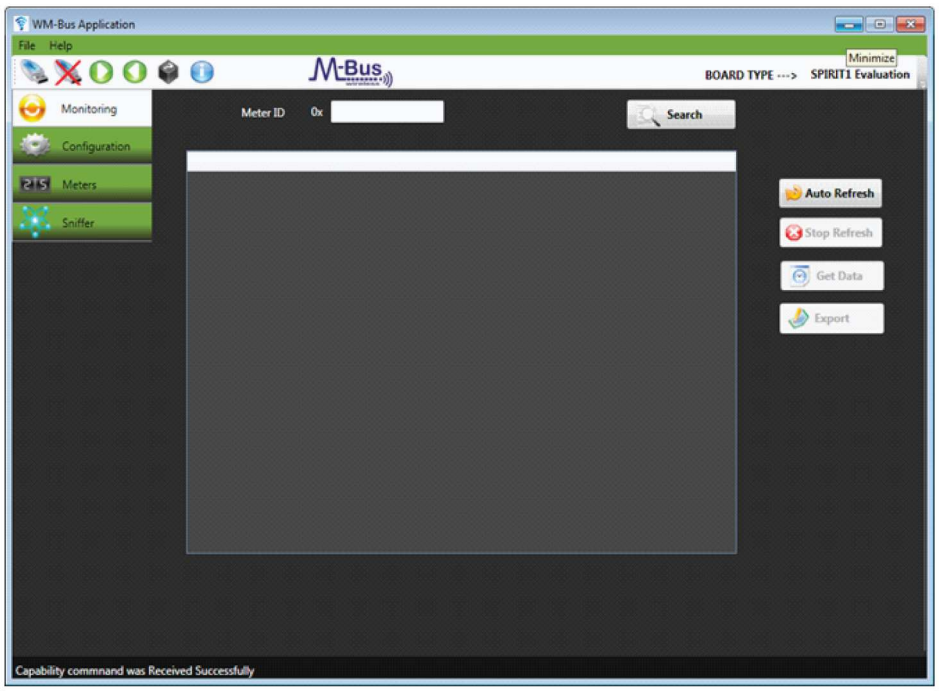


4.4 Monitoring window

The monitoring window offers view of meter reading and also the history of the meters.

There is a provision for exporting the meter reading database to *.csv format.

Figure 13. Monitoring window



4.5 Board configuration with PC GUI

In order to support the GUI, the board must be programmed with the WM-Bus_SDK firmware as explained in *Section 3.2: Running the demo board (X-NUCLEO-IDS01V4)*.

1. After launching the GUI, connect the board to the PC using the top-left icon. The GUI will ask the user to select the serial port for the device. Upon successful connection, the “Connection successful” window will appear.

Figure 14. Select COM port for device

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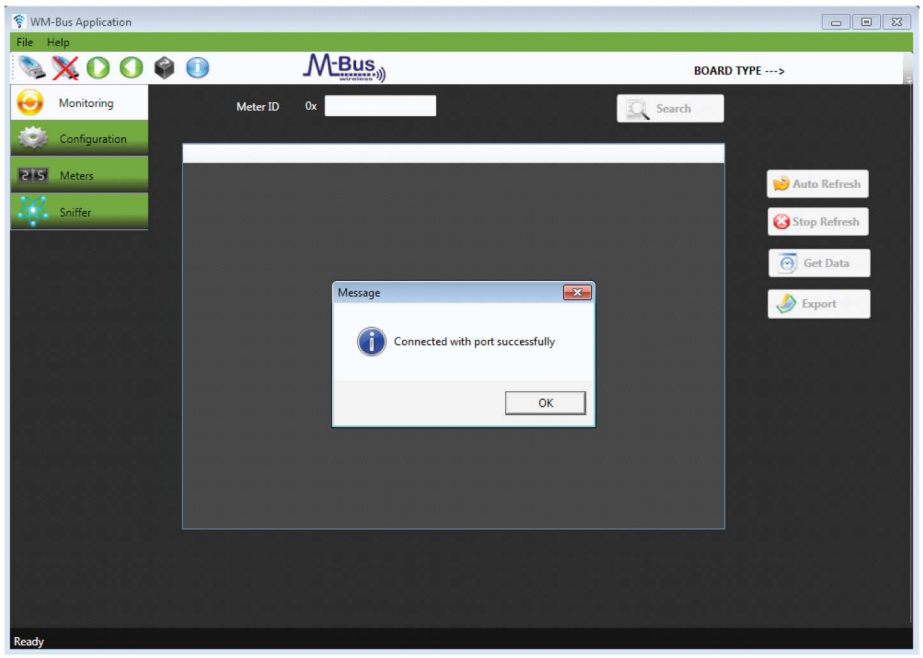
Figure 15. Connection successful



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2. The concentrator configuration can be retrieved using the “Receive all” icon. Go to configuration window, which shows the current configuration of the concentrator board.

Also the entire configuration can be sent to the board with the “Send all” icon. Refer to the screenshot below to identify the different icons on the GUI.

Figure 16. Configuration window

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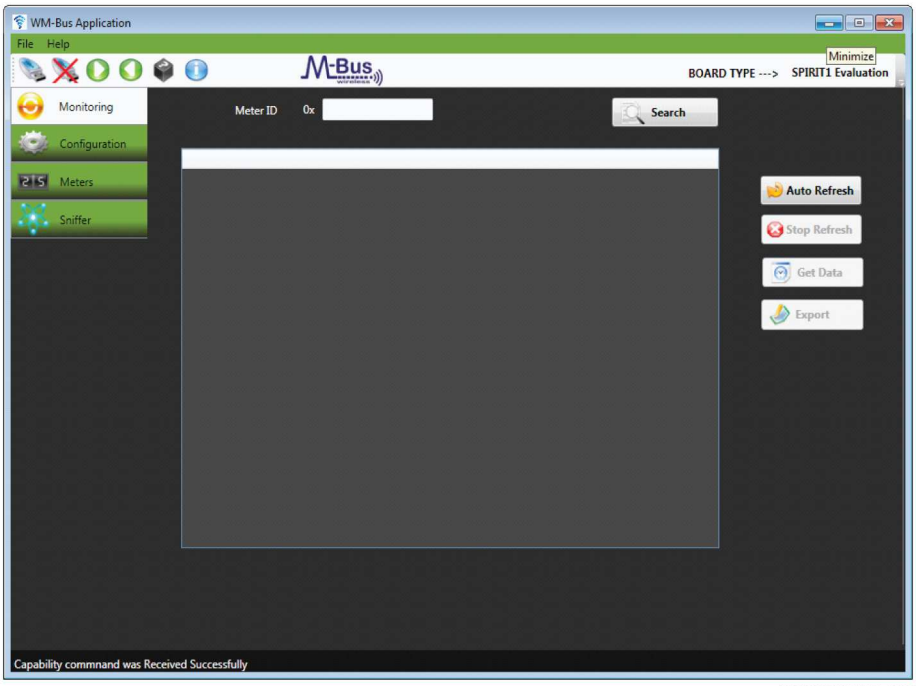
3. User can monitor the meter data received on concentrator side using monitoring window by clicking on “Auto Refresh” button.

Figure 17. GUI monitoring window



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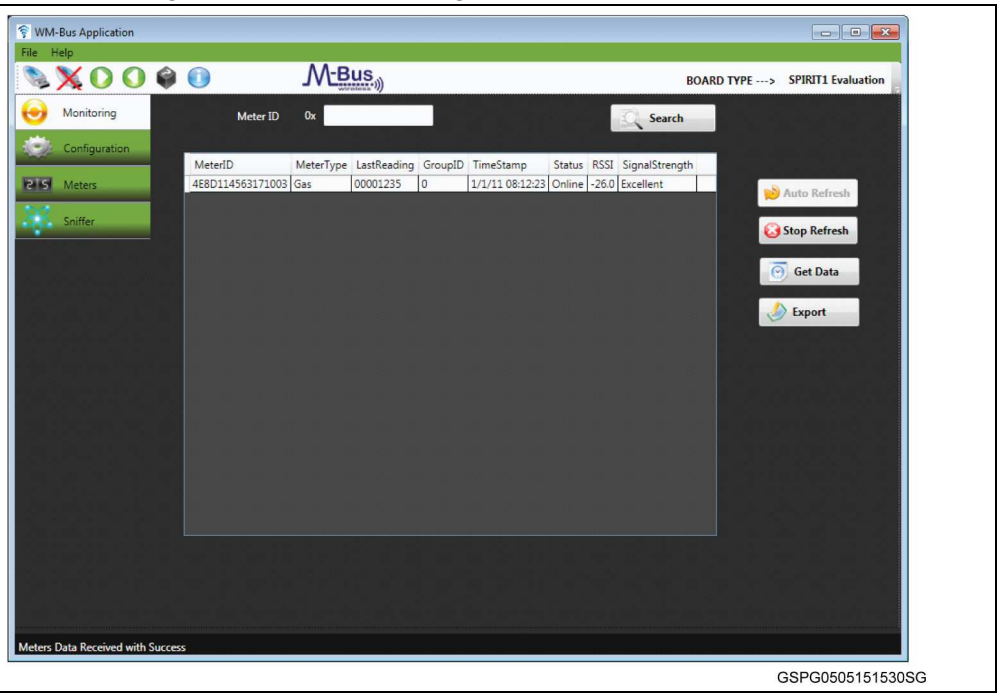
The meter data is displayed in the GUI, as shown below:

Figure 18. GUI monitoring window with meter data



4. A new meter can be added to or deleted from the concentrator database using the “Meter Window”. This window is useful in a cases where encryption is enabled. The window displays the concentrator database in “Edit Meter” section. The concentrator database contains meter IDs and corresponding encryption keys.

Default values (meter ID and encryption key) for three meters are stored in the concentrator database. If encryption is enabled and any of these three meters comes online, the concentrator will talk to them using the encryption key allotted to them. The same encryption keys are also preset in the meter firmware for:

a) DEVICE_METER_TYPE = 0x02 (electricity meter)

b) DEVICE_METER_TYPE = 0x03 (gas meter)

c) DEVICE_METER_TYPE = 0x04 (heat meter)

The concentrator database can contain values (meter ID and encryption key) for ten meters, at most.

The user can add a new meter to the concentrator database through the “Add Meter” section. The user must enter the meter ID, device type, encryption key and entry no. (the entry no. corresponds to sequential EEPROM addresses of the concentrator data base). After entering all details for the meter, press the “Add” button.

Figure 19. A view of the concentrator database

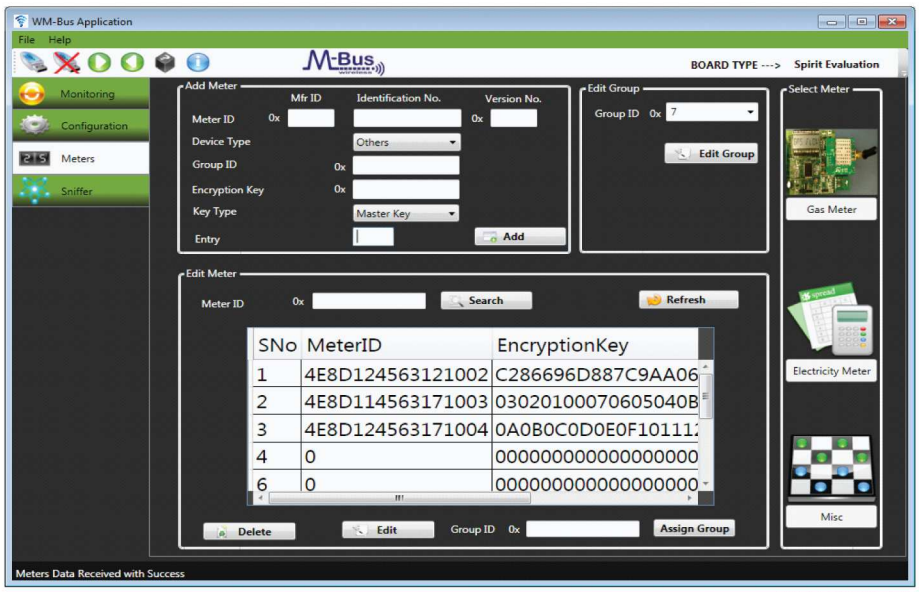


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Figure 20. Adding a new meter to the concentrator database

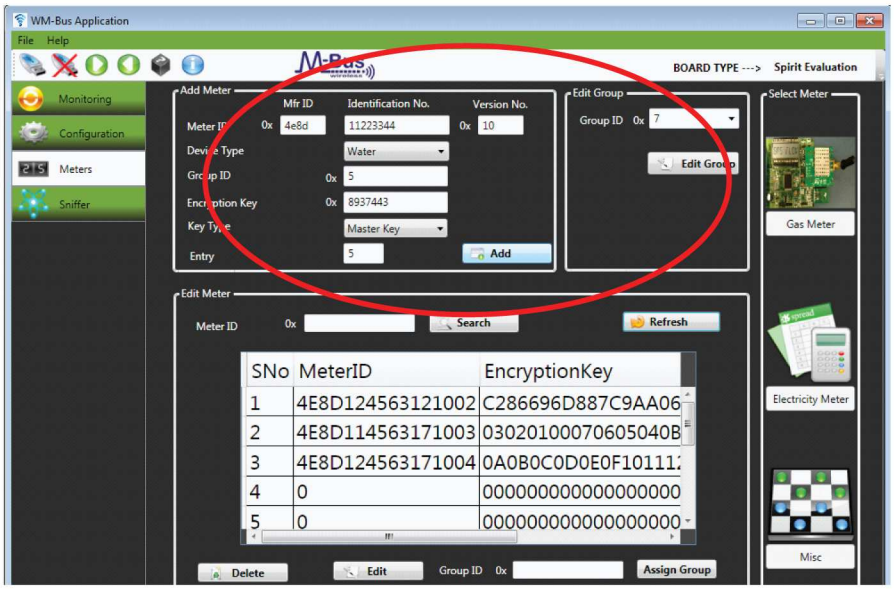

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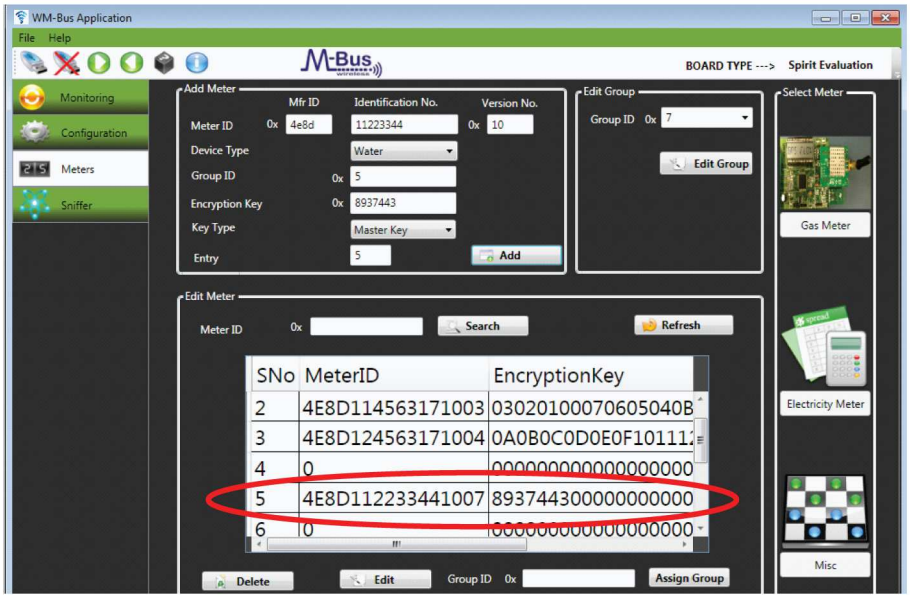
Figure 21. The new meter added to the database



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5. Delete a meter entry by selecting the row corresponding to that meter in the “Edit Meter” section and click the “Delete” button.

5 Hardware description

This section describes the hardware components needed for developing a SPIRIT1-based application.

The following subsections describe the individual components.

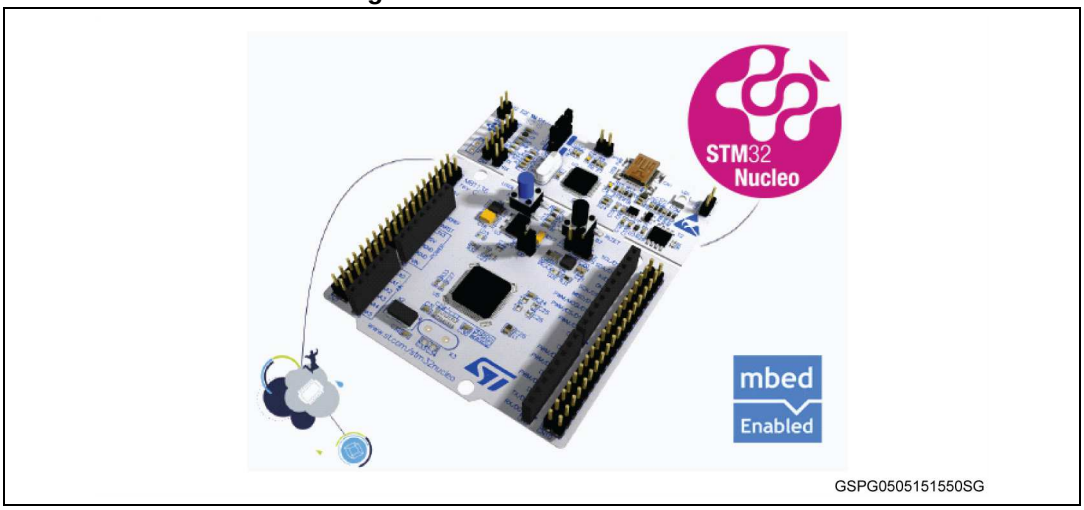
For further details, please refer to ST user manual UM1872 “Getting started with the Sub-1 GHz expansion board based on the SPSGRF-868 and SPSGRF-915 modules for STM32”.

5.1 STM32 Nucleo platform

The STM32 Nucleo boards provide an affordable and flexible way for users to try out new ideas and build prototypes with any of the STM32 microcontroller lines. The Arduino™ connectivity support and ST Morpho headers make it easy to expand the functionality of the STM32 Nucleo open development platform with a wide choice of specialized expansion boards. The STM32 Nucleo board does not require any separate probe as it integrates the ST-LINK/V2-1 debugger/programmer. The STM32 Nucleo board comes with the STM32 comprehensive software HAL library together with various packaged software examples.

Information about the STM32 Nucleo boards is available on www.st.com at http://www.st.com/stm32nucleo

Figure 22. STM32 Nucleo board

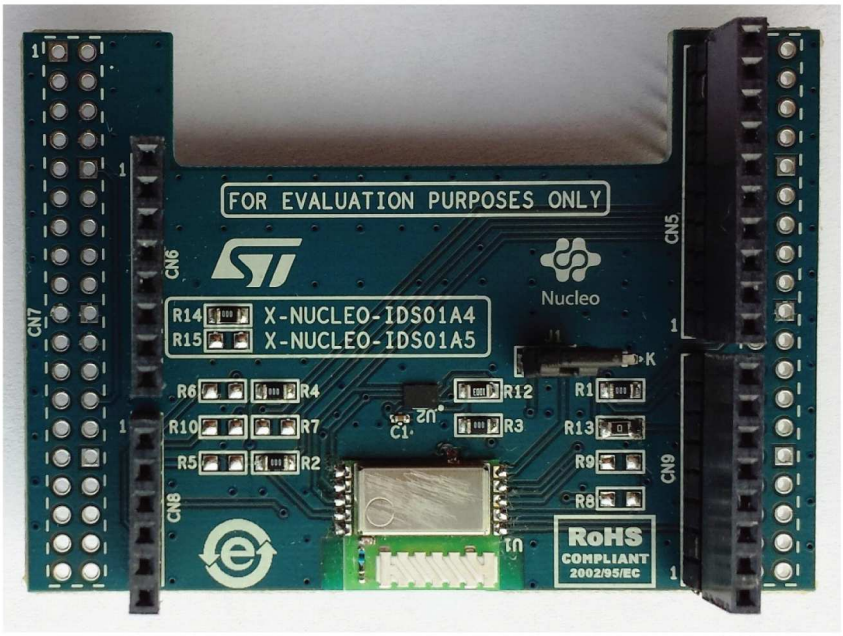


5.2 X-NUCLEO-IDS01A4 expansion board

The X-NUCLEO-IDS01A4 is an evaluation kit that provides a platform for testing the features and capabilities of the SPSGRF module based on the SPIRIT1 low data rate, low power sub-1 GHz transceiver device.

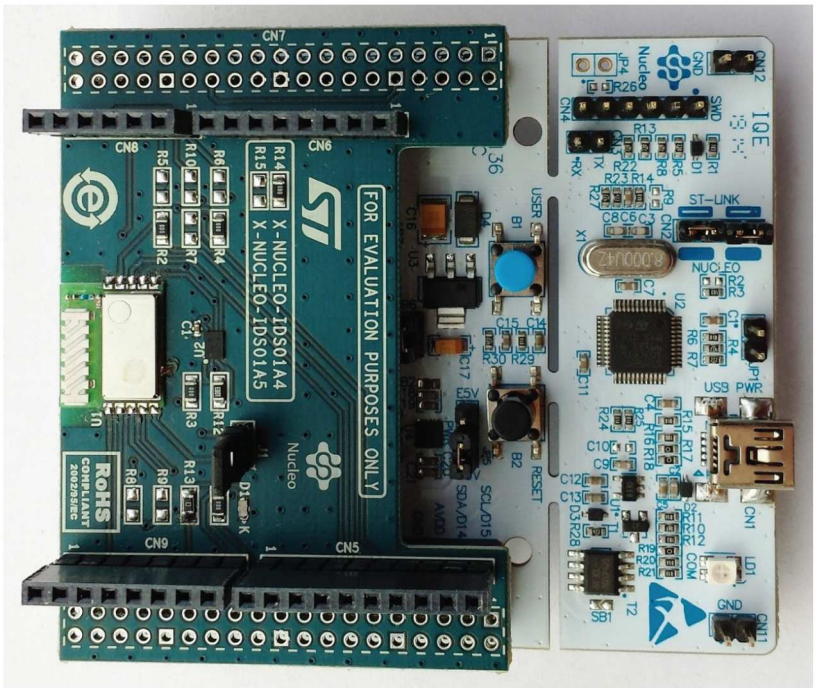
The expansion board features on-board SPI EEPROM to save parameters, and an LED for user interface.

Figure 23. X-NUCLEO-IDS1Ax SPIRIT1 expansion board



Information about the X-NUCLEO-IDS01A4 expansion board is available on www.st.com at http://www.st.com/x-nucleo

Figure 24. SPIRIT1 expansion board connected to STM32 Nucleo board



5.3 Software description

The following software components are needed in order to setup a suitable development environment for creating applications for the STM32 Nucleo equipped with the SPIRIT1 expansion board:

- X-CUBE-SUBG1: an expansion for STM32Cube dedicated to SPIRIT1 application development. The X-CUBE-SUBG1 firmware and related documentation is available on st.com.
- Development tool-chain and compiler: The STM32Cube expansion software supports the following three environments:
  - IAR Embedded Workbench for ARM® (EWARM) toolchain + ST- LINK
  - RealView Microcontroller Development Kit (MDK-ARM) toolchain + ST-LINK
  - System Workbench for STM32 (SW4STM32) + ST-Link

5.4 Hardware setup

This section describes the hardware and software setup procedures. It also describes the system setup needed for the above.

5.4.1 Hardware setup

The following hardware components are needed:

1. One STM32 Nucleo Development platform (suggested order code: either NUCLEO-F401RE or NUCLEO-L053R8)
2. One SPIRIT1 expansion board (order code: X-NUCLEO-IDS01A4 (868 MHz)
3. One USB type A to Mini-B USB cable to connect the STM32 Nucleo to the PC

5.4.2 Setting up the board

Follow these steps to set up the board:

1. Check that the jumper on the J1 connector is connected. This jumper provides the required voltage to the devices on the board
2. Connect the X-NUCLEO-IDS01A4 to the Nucleo board from the top, as shown in *Figure 22*
3. Power the Nucleo board using the Mini-B USB cable
4. Program the firmware in the STM32 on the Nucleo board using the firmware example provided
5. Reset the MCU board using the Reset button available on the Nucleo board
6. The evaluation kit is ready for use

5.4.3 Setting up the WM-Bus concentrator

The WM-Bus firmware demo requires two demo boards to run the basic application example. One board is used as a concentrator device and another is used as a meter device. *Table 2* provides the list of evaluation boards which are used to run the WM-Bus example application:

Table 2. Demo board description

Demo board	WM-Bus device type
STEVAL- IKR002Vx	METER / CONCENTRATOR
STEVAL- IDS001Vx	CONCENTRATOR
STEVAL- IKR001Vx	METER / CONCENTRATOR
X-NUCLEO-IDS02Ax	METER

Take care to use the correct board for the matching RF frequency. For example, for the WM-Bus to work with X-NUCLEO-IDS01A4, use the 868 MHz board.

6 Acronyms and abbreviations

Table 3. Acronyms

Acronym	Description
AMR	Automatic meter reading
BSP	Boot support package. Generally refers to the hardware interface layer
EEPROM	Electrically erasable programmable read only memory
GHz	Giga Hertz
GUI	Graphical user interface
HAL	Hardware abstraction layer
LED	Light emitting diode
MCU	Microcontroller unit
P2P	Point-to-point communication
PC	Personal computer
RF	Radio frequency communication
SPI	Serial peripheral interface
USB	Universal serial bus
WM-Bus	Wireless metering bus
WSN	Wireless sensors network

7 References

[1] SPIRIT1 device datasheet

[2] SPSGRF module datasheet

[3] STM32 and Nucleo boards datasheets/data briefs

[4] UM1872 Getting started with the Sub-1 GHz expansion board based on the SPSGRF-868 and SPSGRF-915 modules for STM32

7.1 Document conventions

- SPIRIT1 expansion boards: All references to these boards refer to the X-NUCLEO-IDS01A4 (868 MHz) in this document. The WM-Bus standard specifies 868 MHz as the communication frequency
- STM32 Nucleo board: This term is used for the reference of NUCLEO-L053R8 boards and NUCLEO-F401RE, unless otherwise specified
- The firmware described in this document is developed and tested using the NUCLEO-L053R8 and X-NUCLEO-IDS01A4 boards. The demo firmware can easily be ported to other NUCLEO or SPIRIT1 boards by making changes to the BSP layer
- Node: This term is used for the combination of STM32 Nucleo board and SPIRIT1 expansion board when used in a connected network

8 Revision history

Table 4. Document revision history

Date	Revision	Changes
29-May-2015	1	Initial release.