WiMOD LR Studio

User Guide Version 1.5

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Revision History

Version	Note
0.1	Created, Initial Version
0.2	Draft Version Created For Review
0.3	Preliminary Version
1.0	First Release
1.1	Radio Configuration updated: Signal Bandwidth 500kHz, Frequency Band 915 MHz, RTC enable/disable option
1.2	Chapter Remote Control added Chapter Radio Settings: LED Button Pressed Indicator + HCI Button Pressed Indication added
1.3	Chapter Disconnect / Remove iM880A added Chapter Sensor Application added
1.4	Updates according to latest Version 1.19.0
1.5	Updates for latest version 1.27.0

Aim of this Document

This document describes the WiMOD LR Studio, a Windows application which can be used in combination with the WiMOD LoRa compatible radio modules (e.g. iM880B, iM282A, …) and its embedded WiMOD LR Base firmware.

Table of Contents

1. Introduction

1.1 Overview

The WiMOD LR Studio is a Windows application which allows to explore the capabilities of the WiMOD **Lo**ng **Ra**nge radio modules. The Windows GUI offers a comfortable way to configure and control the features of the embedded WiMOD LR Base & Base Plus firmware like:

- Radio Settings
- Embedded Radio Link Test
- Data Link / Modem Services
- Packet Sniffer
- Sensor App

The communication between WiMOD LR Studio and the connected WiMOD LR radio modules is implemented by means of so called HCI messages (see [1] or [2]) which are exchanged over a serial interface.

1.2 Installation

The WiMOD LR Studio is delivered as part of the WiMOD LR Starter Kit which contains the radio modules with pre-programmed firmware and a Demo Board which can be equipped with different radio modules. This Demo Board provides a USB Connector for communication and power supply purposes. An USB chip converts the serial interface signals from the radio module into USB signals. For communication over this USB interface a Virtual Com port (VCP) driver must be installed on the Host PC.

1.2.1 USB Driver

The USB driver can be found in (<local folder>\drivers\CDM *version*.exe) on the Starter Kit CD/Memory Stick, but it is recommended to download the recent version from the USB drivers web site.

Run the CDM *version*.exe. A command box appears and the driver will be installed.

Plug in the USB cable to the USB port on the Demo Board. Plug in the other end of the USB cable into the USB port of the Host PC. Now the Windows OS will recognize the Demo Board as a USB serial converter.

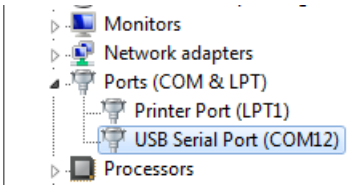

Figure 1-1: USB Driver Installation

To verify that the USB driver installation was successful, open the Windows Device Manager ("Start>Control>Panel>System>Hardware>Device Manager" or hit <WIN>+<PAUSE>).

A new USB – Serial Port (COMxx) entry in section "Ports (COM & LPT)" should appear.

Note: for firmware update purpose of old firmware and other custom firmware it is also necessary to install the D2XX driver of FTDI (see Firmware Update).

1.2.2 WiMOD LR Studio

The WiMOD LR Studio is based on Qt, a cross-platform application and UI framework, compiled with MinGW and delivered as a bunch of files:

- WiMOD_LR_Studio.exe
  the executable Windows application file
- WiMOD_LR_Studio.ini
  an internal configuration file
- WiMOD_LR_RadioMsg.cfg
  includes some example radio link messages
- WiMOD_LR_RadioSettings.cfg
  includes a radio configuration set
- WiMOD_LR_Studio_UserGuide.pdf
  this document
- Several dynamic runtime libraries

Note: It might be necessary to install the Microsoft Visual C++ 2008 Redistributable Package (x86) in case the WiMOD LR Studio doesn't start. Click the download button on the Microsoft web page. Double click the vcredist_x86.exe to install runtime components of Visual C++ libraries on a computer that does not have Visual C++ installed.

1.2.3 Finish Installation

Mount the WiMOD radio module on the Demo Board and connect the board by means of an USB cable to the PC. Start WiMOD_LR_Studio.exe and continue with the following chapter.

2. Getting Started

The WiMOD LR Studio enables the user to evaluate the capabilities of the WiMOD Long Range radios. Several features of the embedded radio firmware can be controlled from different pages which are described in more detail in the following chapters.

2.1 Navigation

The provided software features are presented on several pages. The navigation from one page to another is implemented by means of two navigation bars. The vertical bar on the left side is used to change between the main sections:

- Radio Services
- Configuration
- Extras

Each section provides an individual horizontal bar on top which offers access to several subpages e.g. *Radio Link Test*, *Data Link Service, Packet Sniffer* and so on.

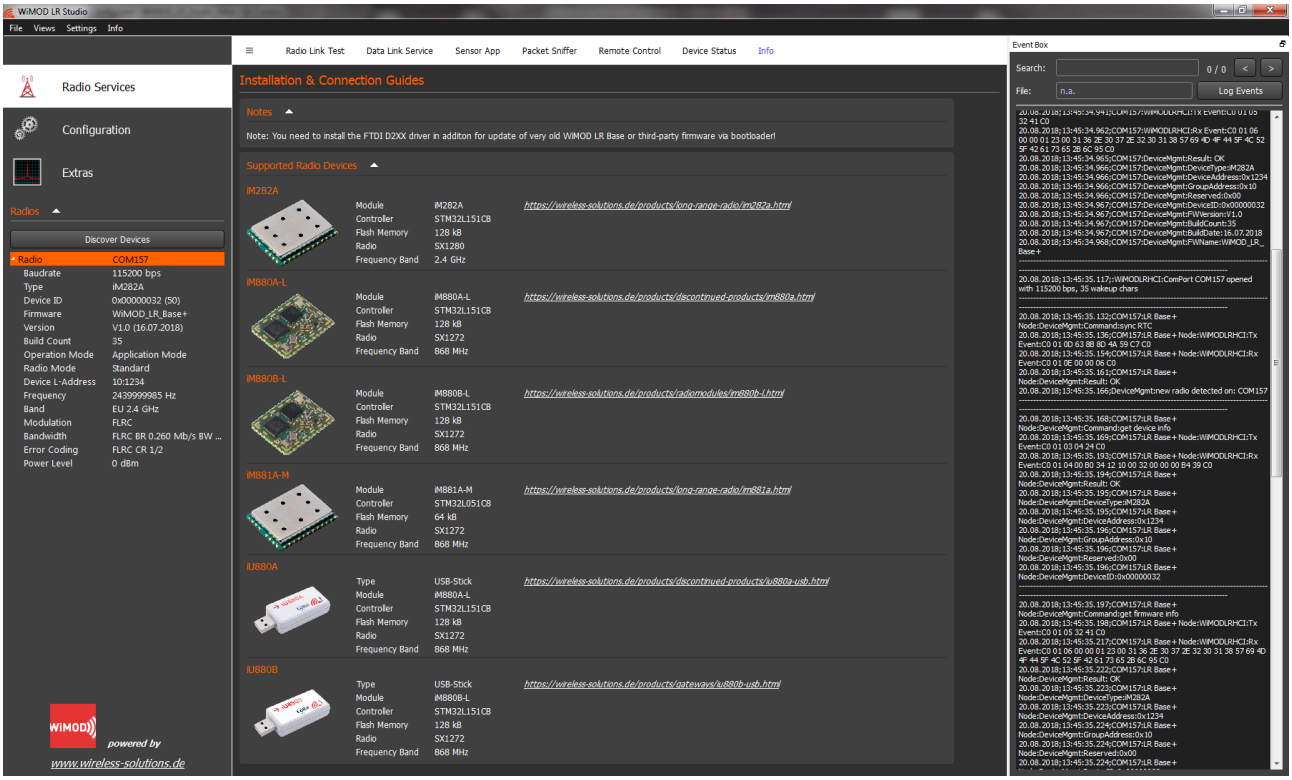

Figure 2-1: Navigation Bars

2.2 Connection to Radio Modules

The WiMOD LR Studio provides an automatic device discovery procedure. A new connected radio module and its serial com port will be displayed in the list box *Radios* (left side) after successful identification. The box provides additional information about the radio configuration and its firmware version. The application allows connecting multiple radio devices at the same time. Note that commands are always sent to the selected device in the list box.

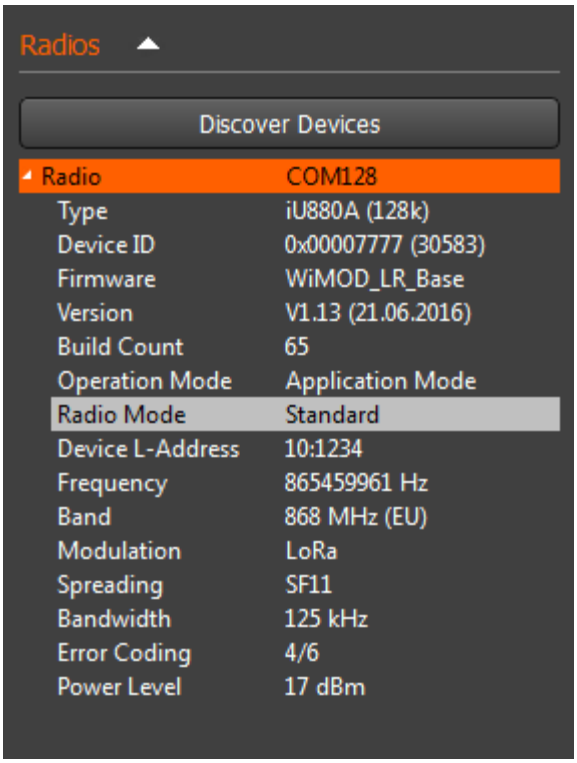

Figure 2-2: Selected radio module on serial com port 128

2.3 Disconnect/Remove Radio Device

If you want to make a device available for second instance of the Studio on the same PC, you can remove it by *right-click* mouse operation. Reconnecting to the same Studio requires to unplug and to plug the module again.

2.4 Event Box

The right area of the main window contains the so called *Event Box* which is used to display events or the result of any issued command. The *Event Box* can be picked by its title bar and moved to any other area on the screen. The content of this box can be cleared from the context menu (*right-click* mouse operation).

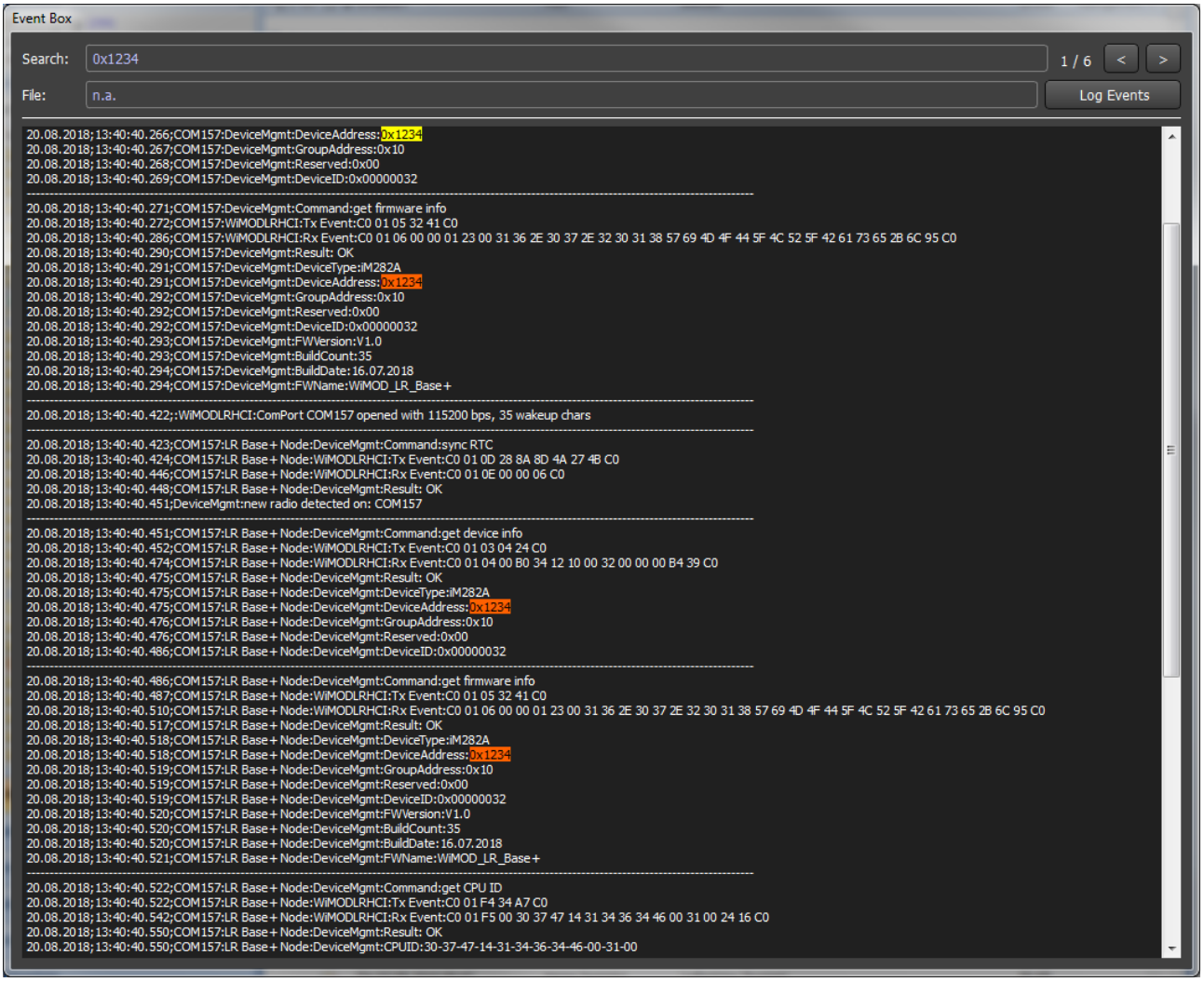

Figure 2-3: Event Box (left side)

The search field enables a simple text search. All results are highlighted and can be found by means of the forward/backward control buttons in the top right corner.
The *Log Events* feature allows to log every line into a human readable ASCII text file. The created text file can be opened with any kind of text editor.

3. Feature Sections

The software features are presented on the following main sections:

- Radio Services
- Configuration
- Extras

3.1 Radio Services

The section Radio Services includes the following pages:

- Radio Link Test
- Data Link Service
- Sensor App
- Packet Sniffer
- Remote Control
- Device Status
- Info

3.1.1 Radio Link Test

The *Radio Link Test* can be used to verify the radio link quality between two radio modules. This test application measures the packet error rate by counting the number of transmitted and received packets on the local connected device and the peer device. The number of test packets and the packet size is configurable.

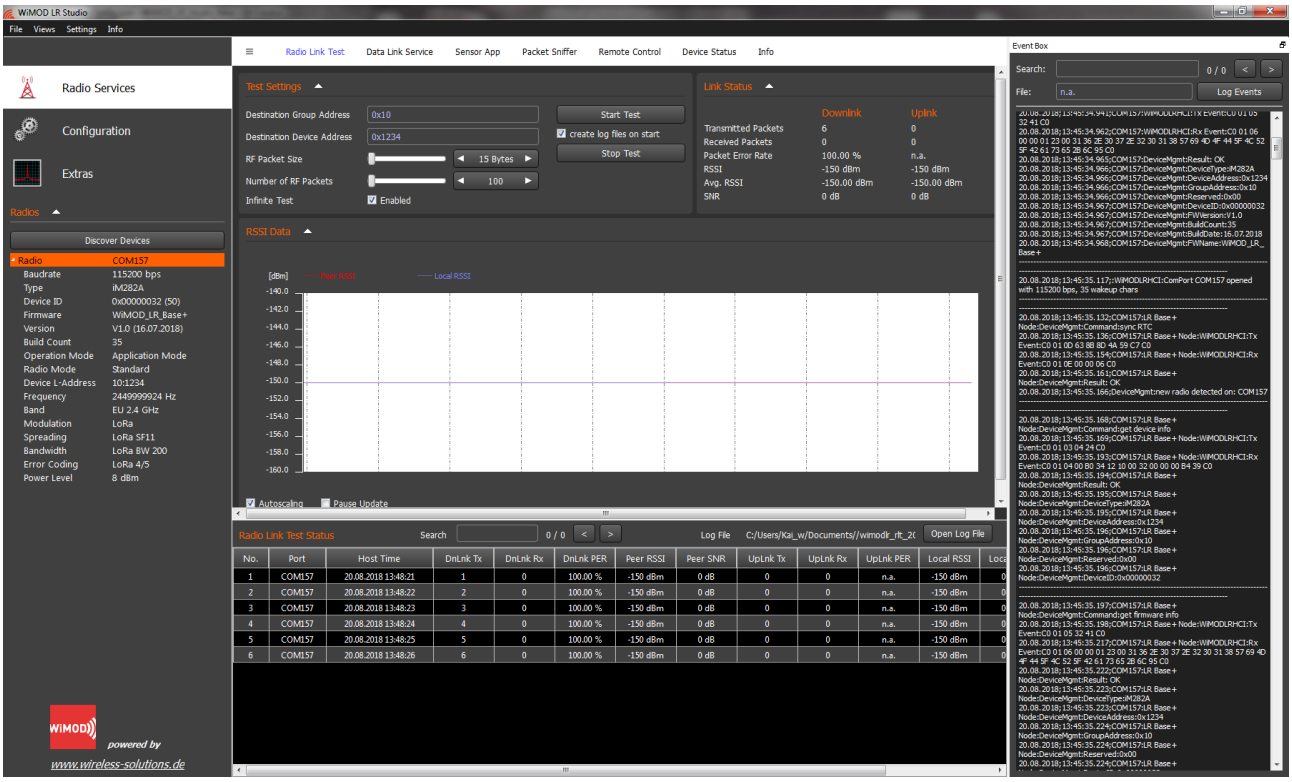

Figure 3-1: Radio Link Test

After test start the local device transmits a set of test packets to the peer device. The direction from local to peer device is called *Downlink*. For every received *Downlink* packet a corresponding *Uplink* packet is expected. The peer device counts the number of received and transmitted packets and returns this status back to the local device within the so called *Uplink* timeslot. Finally the local device sends a status message to the PC which contains the packet counters and further status information about the *Downlink* and *Uplink* channel quality.

Downlink Status

- Transmitted Packets
  number of RF packets transmitted from local device to peer device
- Received Packets
  number of received packets on peer device
- Packet Error Rate
  PER = 100 * (1 – Received Packets/Transmitted Packets)
- Peer RSSI
  received signed strength on peer device
- Peer SNR
  measured SNR on peer device

Uplink Status

- Transmitter Packets
  number of RF packets transmitted from peer device to local device
- Received Packets
  number of received packets on local device
- Packet Error Rate
  PER = 100 * (1 – Received Packets/Transmitted Packets)
- Local RSSI
  received signal strength on local device
- Local SNR
  measured SNR on local device

Configuration

The following parameters are transmitted to the local connected device to perform a radio link test session:

- Destination Group Address
  Radio Group Address of peer device
- Destination Device Address
  Radio Device Address of peer device
- RF Packet Size
  number of bytes in a single test packet
- Number of packets
  number of RF test packets to transmit per test session
- Infinite Test
  determines if the test should be repeated automatically or not

Prepare Test

- Check the radio configuration for both devices (local and peer device).
  The physical settings (Frequency, Spreading and Bandwidth) must be the same!
  Note: both devices must have "Rx always on" configured (see *Configuration*)
- Change the configuration parameter on both devices to the same settings if needed.
- Ensure that no other interfering devices are in range!
- Configure the peer device with a unique group and device address e.g. 0x10, 0x5555 to avoid collisions!
- Enter the destination radio group and device address e.g. 0x10, 0x5555 into the *Test Settings* input fields

Start Test

- Select the local master device from *Devices* box.
- Press *Start* button.
  The test configuration is sent to the local device. The transmission of radio test packets and its timing is now controlled by the firmware itself!
- *Log Test Status*
  This option allows to store the measured link status to a (character separated values) text file which can be imported into standard spreadsheet applications.

Stop Test

- Press *Stop* button.
  A stop command is sent to the local device to finish the test session.

3.1.2 Data Link Service

The Data Link Service can be used to send radio messages from one radio to another in a comfortable way. It is possible to send messages with or without acknowledgement.

Note: broadcast messages (Address = 0xFFFF) can only be transmitted using the unreliable service without acknowledgement.

For the acknowledgement message it is possible to transport some piggybacked data which can be configured for a specific device and group address.

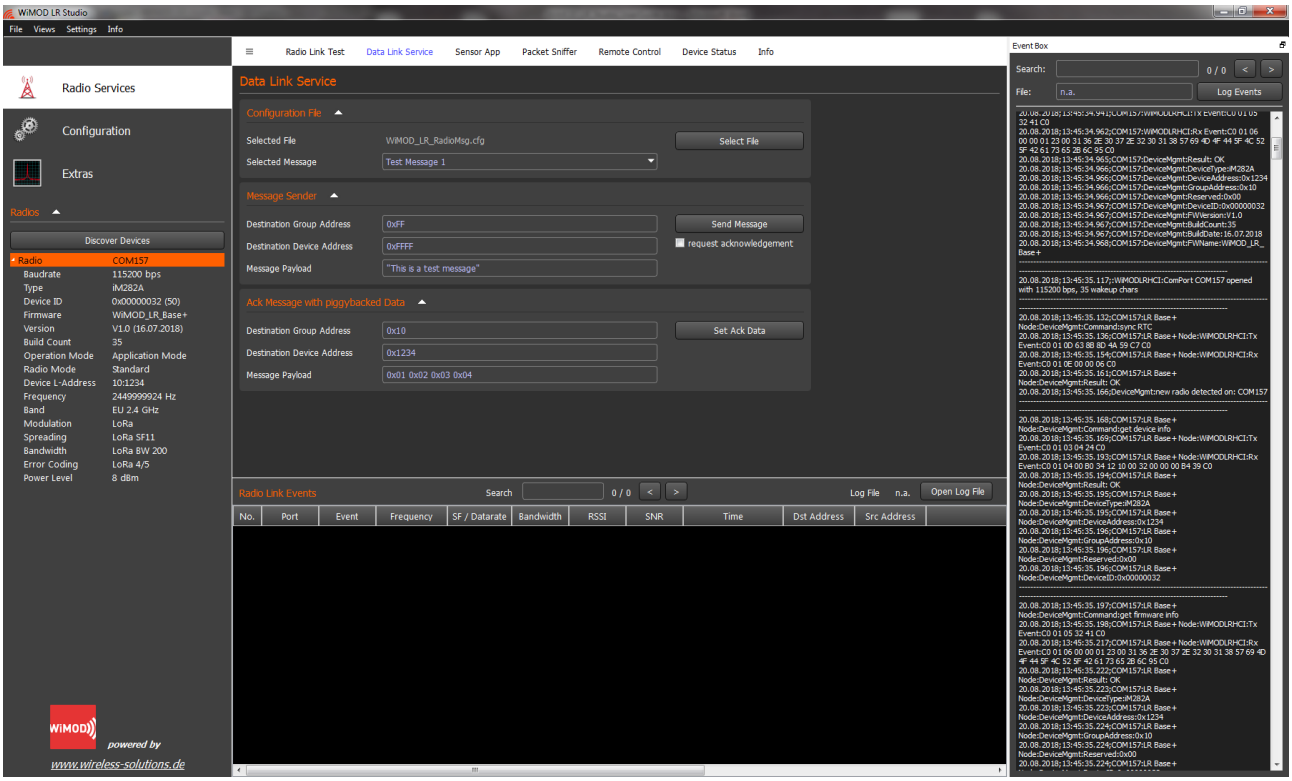

Figure 3-2: Data Link Service

Radio messages can either be selected from a configuration file or they can directly be created by means of the given edit fields. The configuration file(s) uses a standard windows INI file format and can be modified by any text editor. A single radio message consists of a user defined ***Payload***, a ***Destination Group Address*** (8 Bit) and ***Destination Device Address*** (16 Bit). The message transmission can be triggered once via ***Send Message*** button or in a periodically way (enable checkbox ***send periodically***). The ***Transmit Interval*** for periodic transmission can be changed if desired. Furthermore it is possible to iterate over all messages of the selected configuration file (enable checkbox ***auto message iteration***). Please configure the ***Transmit Interval*** accordingly.

Received radio messages from another device will be displayed in the bottom section of this page. The radio messages are displayed row by row together with the serial com port information, device ID, target radio address, source radio address, user defined payload. Furthermore it is possible by configuration to see the RSSI, SNR and Rx Timestamp of a received message. The receiver list box can be cleared from the context menu (***right click*** mouse operation).

3.1.3 Sensor Application

This embedded firmware application can be used to send some example "sensor" values in a periodically way from so called "sensor nodes" to one or more sensor data receivers.

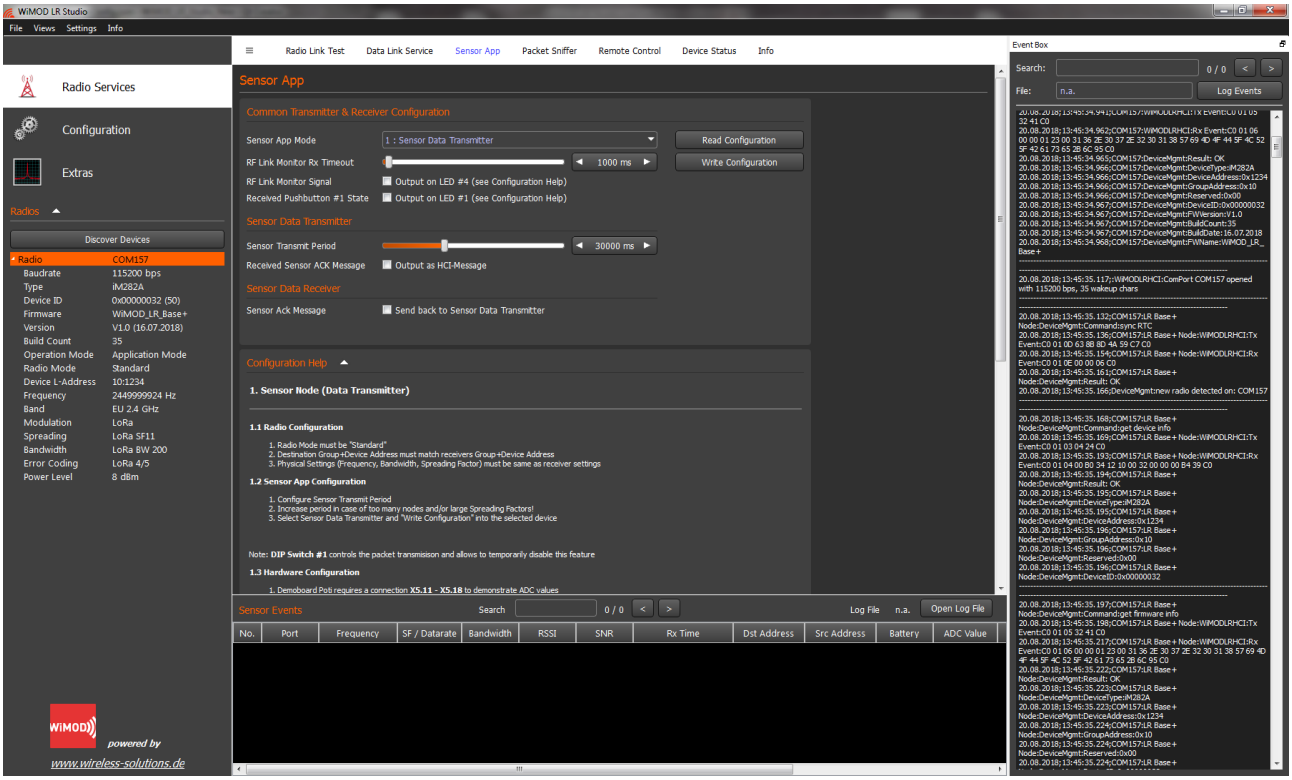

Figure 3-3: Sensor Application

The GUI provides the following configuration items:

- Sensor Application Mode
  Off, Transmitter, Receiver
  Note: DIP Switch #1 on WiMOD Demo Board must be enabled too!
- RF Link Monitor Rx Timeout
  receiver packet timeout to indicate a link loss via LED #4, might be set to 3.5 * sensor transmit period
- RF Link Monitor output option via LED #4
- Received Pushbutton #1 State output option via LED #1
- Sensor Transmit Period
  defines the sensor data packet transmit interval on sensor node side
- Received Sensor ACK Message
  optional event output as HCI message
- Sensor Ack Message
  optional radio message sent back to sensor containing input state of Pushbuttons #1, #2,#3 and DIP Switch #1

This application demonstrates the following sensor data values:

- Battery

the supply voltage of the sensor node

- ADC Value
  an ADC raw value which can be tuned by the onboard potentiometer
- Temperature
  an estimated temperature value of the radio modules internal temperature sensor (not calibrated)
- Digital Input
  the input pin state of DIP Switch #1, Pushbutton #1, #2 and #3
  Note: the pin state is sampled just before a sensor data packet is sent

3.1.4 Packet Sniffer

The WiMOD LR Base radio stack supports a radio sniffer mode which allows to monitor the radio communication between other LoRa radio devices. While in Sniffer mode, the device forwards every received radio message in raw format via wired serial interface to a connected host controller.

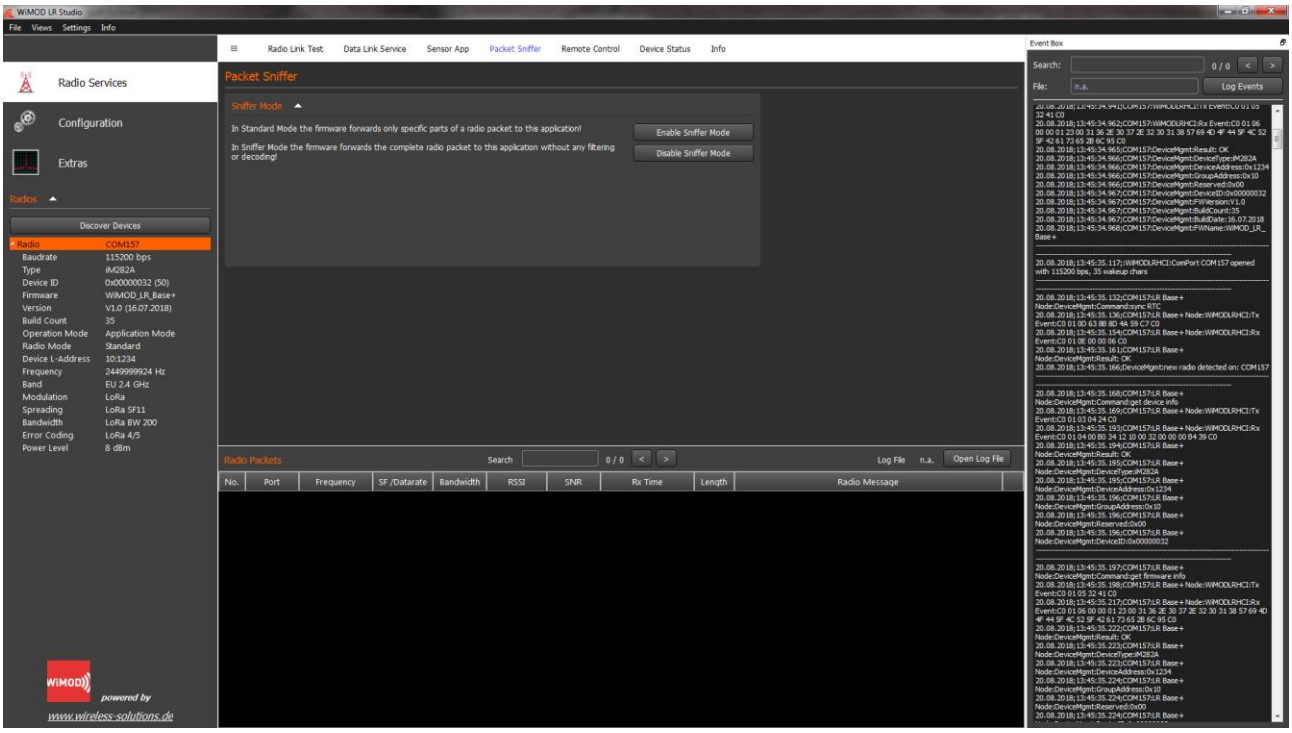

Figure 3-4: Packet Sniffer

The received radio messages are displayed in a list box and can be stored in a text file for further processing purposes if desired (press *Open Log File*).

Similar to the *Data Link Service* it is possible by configuration to get the RSSI, SNR and Rx Timestamp for every received radio message. Note: It is not possible to execute a Radio Link Test or to use the Data Link Service while a module operates in Sniffer mode. Again the content of the Sniffer list box can be cleared from the context menu (*right-click* mouse operation).

3.1.5 Remote Control

The firmware supports a simple remote control feature.

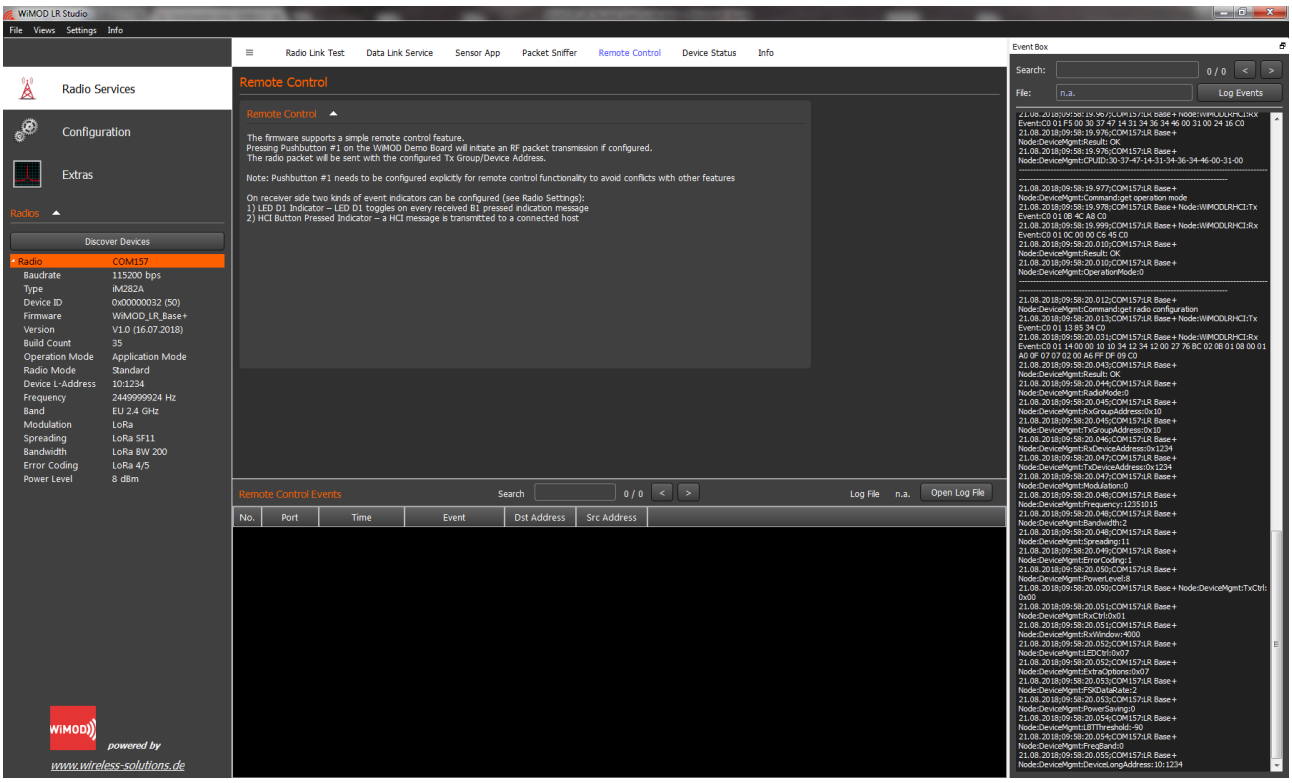

Figure 3-5: Remote Control

Pressing Pushbutton #1 on the WiMOD Demo Board will initiate an RF packet transmission. The radio packet will be sent to the configured Tx Group Address / Tx Device Address.

Note: Pushbutton #1 needs to be configured explicitly for remote control functionality to avoid conflicts with other features.

On receiver side two kinds of event indicators can be configured via page "Radio Configuration":

- LED #1 indicator – LED #1 toggles on every received Pushbutton #1 pressed indication message
- HCI Button Pressed Indicator – a HCI message is transmitted to a connected host

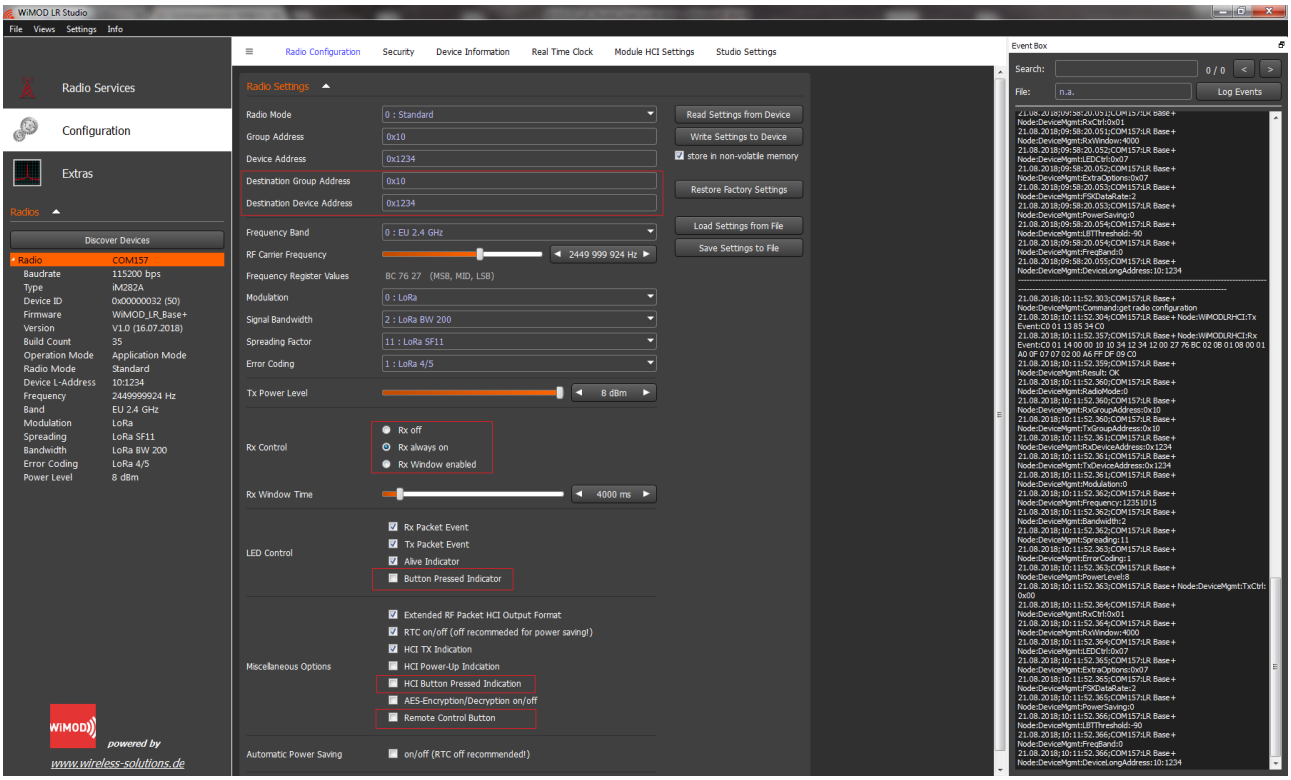

Figure 3-6: Remote Control Configuration

3.1.6 Device Status

This page offers some status information of the radio firmware.

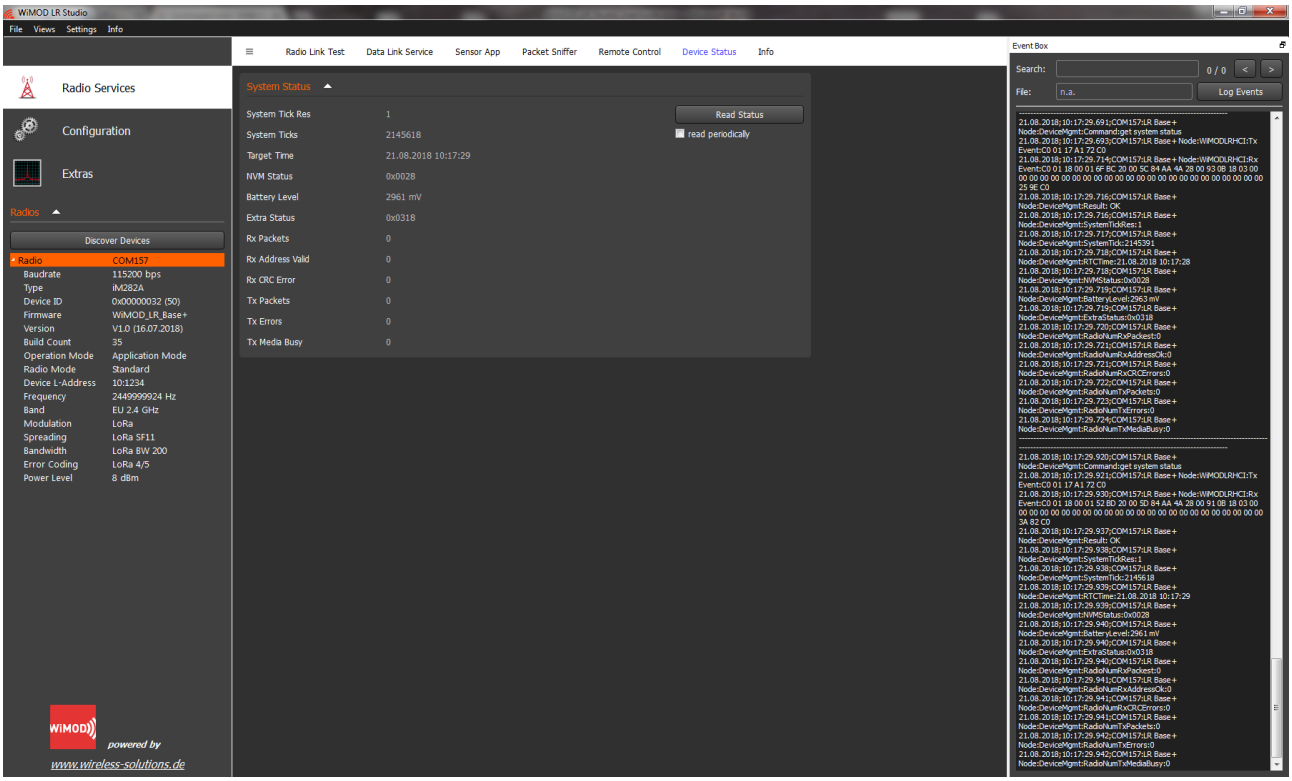

Figure 3-7: Device Status

3.1.6.1 System Status

The System Status contains the following information elements:

- System Tick Resolution
  the firmware system tick resolution in milliseconds
- System Ticks
  number of system ticks since reset / start-up
- Target Time
  the radio time derived from the embedded RTC
- NVM State
  indicates if the internal non-volatile memory which is used for device configuration is ok (0x0000) or not. The stored information is protected by a checksum which is tested during start-up. On success the configuration is loaded from NVM into RAM and propagated to the related firmware and hardware components. In case of a wrong checksum default settings are used.
- Battery Level
  the current supply voltage
- Extra Status
  reserved for future use
- Rx Packets
  number of received radio messages
- Rx Address Valid
  number of received messages with matching target address
- Rx CRC Error
  received radio messages with CRC error
- Tx Packets
  number of transmitted radio messages
- Tx Errors
  number of failed transmissions

  Tx Media Busy
  number of events where the media couldn't be used due to "busy" detection
  (see Listen Before Talk option)

The system status can be read once or in a periodically way (enable checkbox ***read periodically***) if desired.

3.2 Configuration

The section Configuration provides the following pages:

- Radio Configuration
- Security
- Device Information
- Real Time Clock
- Module HCI Settings
- Studio Settings

3.2.1 Radio Configuration

The Radio Settings page provides a comfortable way to change the most important radio parameters.

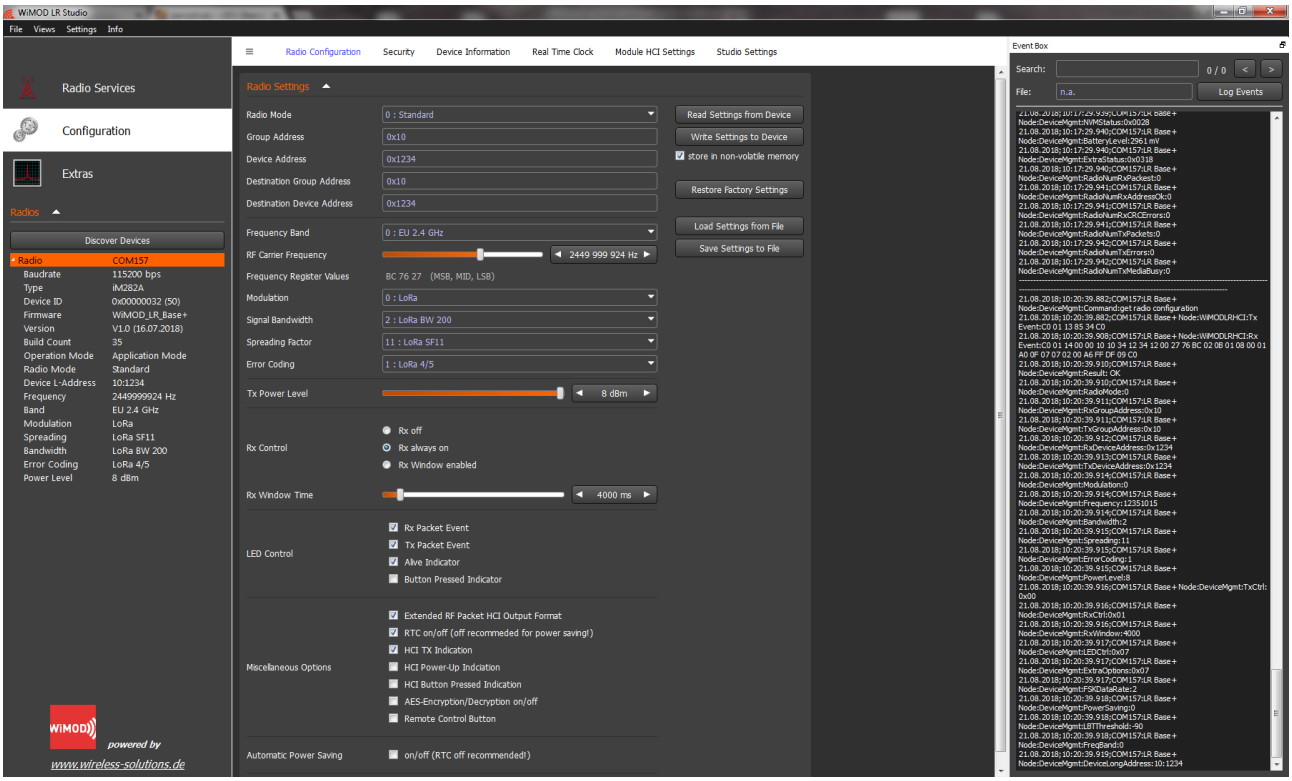

Figure 3-8: Radio Settings

The following radio module depending parameters are configurable:

Note: some parameters might not be available due to modulation settings or missing implementation for the connected radio module.

- Radio Mode
  the radio firmware supports three different radio modes
  0 : Standard mode, address filtering enabled
  2 : Sniffer mode, packet output via HCI without address filtering
- Group Address
  used to separate groups of radios. This value is compared against the Dest. Group Address field of a received radio message to filter radio packets (0xFF = BROADCAST

address).

- Device Address
  used to address a specific radio device. This value is compared against the Dest. Device Address field of a received radio message to filter radio packets (0xFFFF = BROADCAST address).
- Destination Group Address
  used as target address for transmission of local generated events, e.g. "Pushbutton #1 pressed"
- Destination Device Address
  used as target address for transmission of local generated events
- Frequency Band
  defines the used frequency band
- RF Carrier Frequency
  defines the used radio frequency
- Signal Bandwidth
  defines the signal bandwidth
- Spreading Factor
  defines the spreading factor if LoRa modulation is configured
- Error Coding
  defines the radio error coding format
- Transmitter Control
  defines further transmitter control options
- Tx Power Level
  defines the transmit power level
- Listen Before Talk Threshold
  defines the RSSI level for channel busy detection
- Rx Control
  defines further receiver control options
- Rx Window Time
  configurable time for radio receive mode after radio packet transmission (Rx Window option must be set)
- LED Control
  bit field which determines if the firmware should control the Demo Board LEDs via port pin to indicate several internal events
- Miscellaneous Options
  Bit field which configures further radio firmware options
- Automatic Power Saving
  enables/disables the automatic power saving support

The following buttons / commands are provided for configuration purposes:

Read Settings form Device

This command reads the current configuration of the local device.

Write Settings to Device

The displayed settings are transmitted to the local device and stored in RAM or NVM.

Store in non-volatile memory

If this option is set, new settings will be stored in the non-volatile memory of the radio device, thus they are also available after the next module reset.

Restore Factory Settings

This command forces the local device to load the default radio settings.

Load Settings from File

This command allows loading a complete parameter set from a configuration file.

Save Settings to File

The set of displayed parameter can be stored in a configuration file for later usage.

3.2.2 Security

This page offers a simple way to configure the 128-Bit AES Key which is used for encryption and decryption of radio packets sent via Data Link Service. The automatic radio packet encryption must be enabled explicitly via Radio Configuration page.

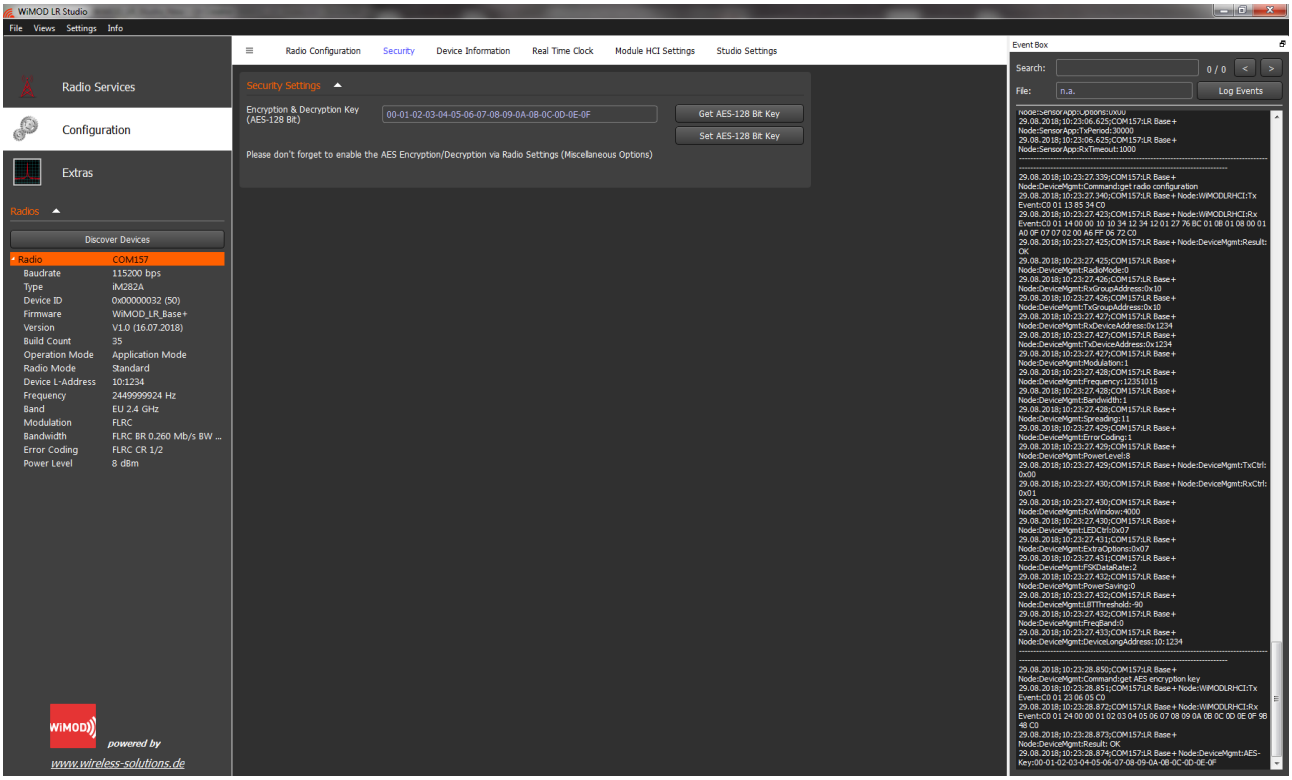

Figure 3-9: AES Key Configuration

3.2.3 Device Information

This page provides some basic information about the connected device and its firmware:

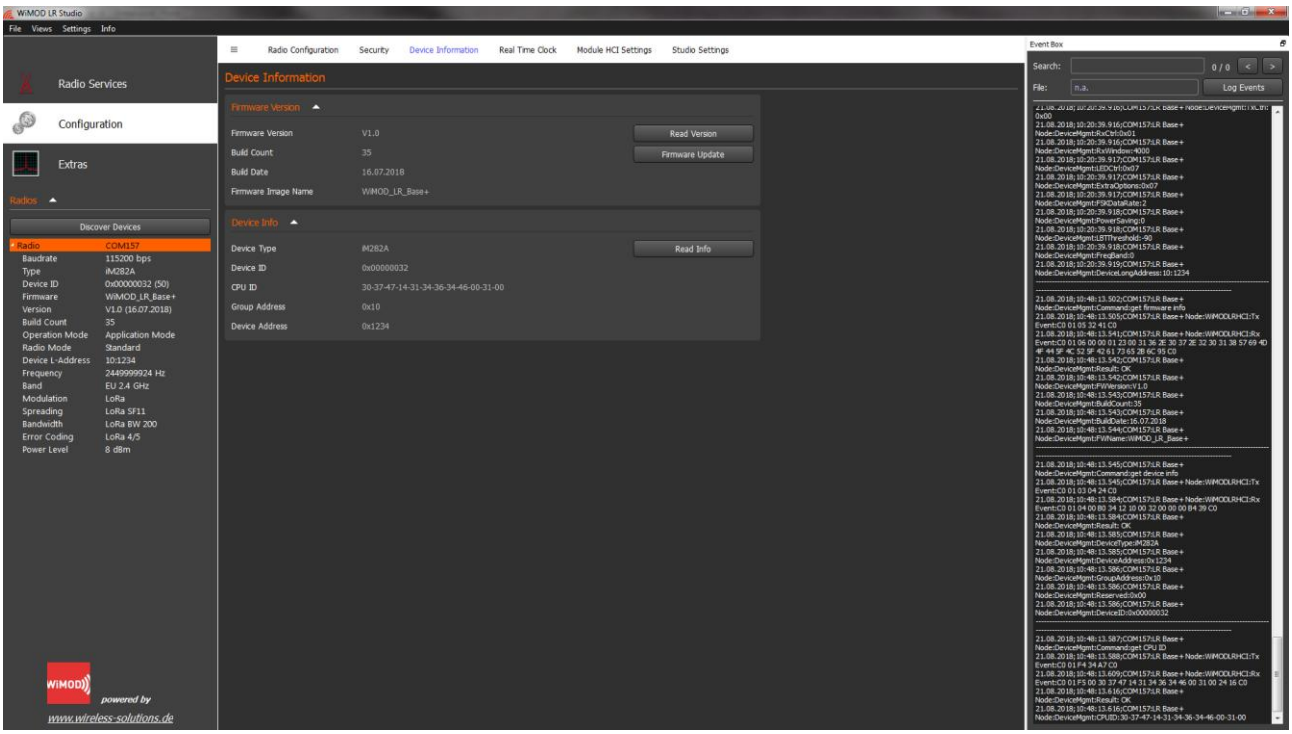

Figure 3-10: Device Information

The following information elements can be read:

- Firmware Version
  a version string identifying the current firmware release
- Build Count
  a firmware build number, generated by the firmware tool chain
- Build Date
  the firmware release date
- Firmware Image Name
  the name of the firmware image
- Device Type
  identifies the specific module/device type e.g.: iM880B
- Device Address
  the configured radio device address
- Group Address
  the configured radio group address
- Device ID
  a unique module identification number (32 Bit)
- Controller ID
  a unique 96 Bit identification number of the embedded STM32 microcontroller

3.2.4 Real Time Clock

This page allows to synchronize the embedded Real Time Clock of the radio module with the PC.

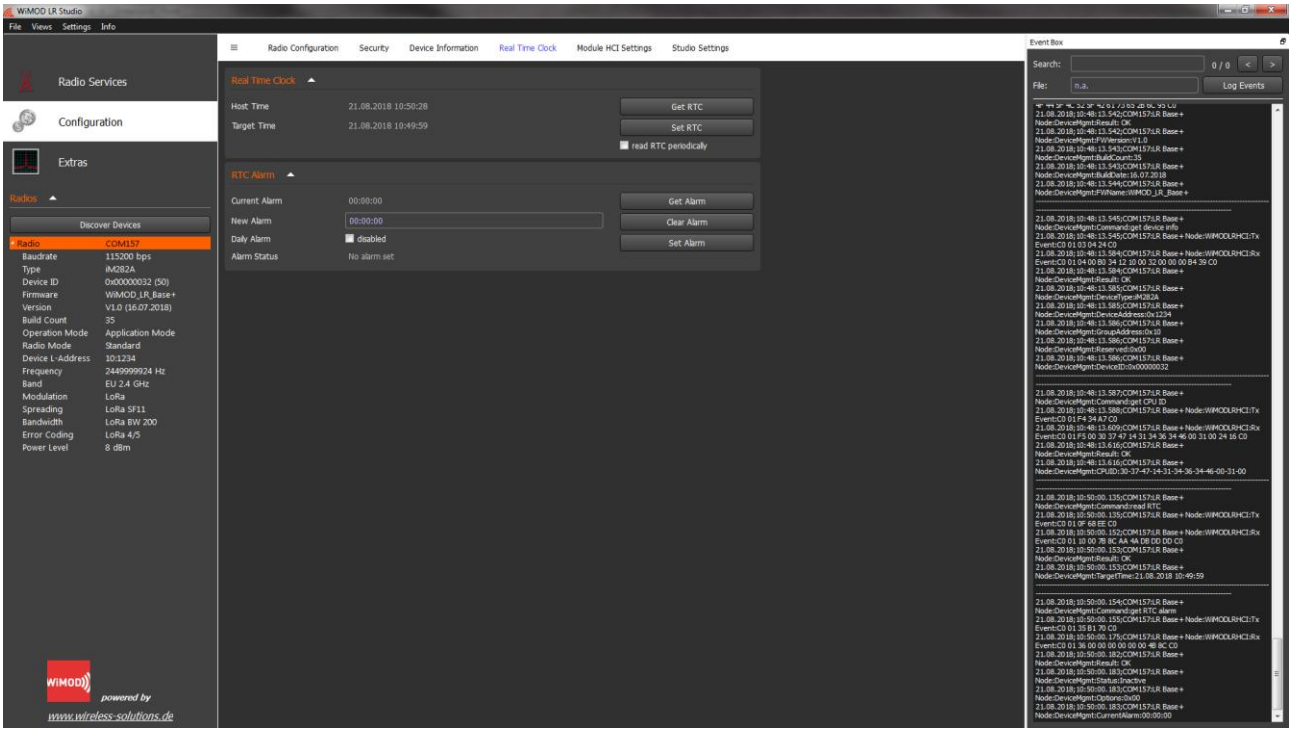

Figure 3-11: Real Time Clock

The Real Time Clock provides timestamps which can be attached to every received radio message.

RTC Alarm

Furthermore it is possible to configure a single or daily **RTC Alarm** which forces the device to wake-up and to send a corresponding wake-up HCI message to the host controller.

3.2.5 Module HCI Settings

This page provides a mean to change UART baudrate which is used by the radio module on the host controller interface. The new setting can be stored in the non volatile section of the module if needed.

The WiMOD LR Studio will automatically adapt to the new baudrate to maintain the communication link.

Note: it might be necessary to enable an additional discovery baudrate on page *Studio Settings*.

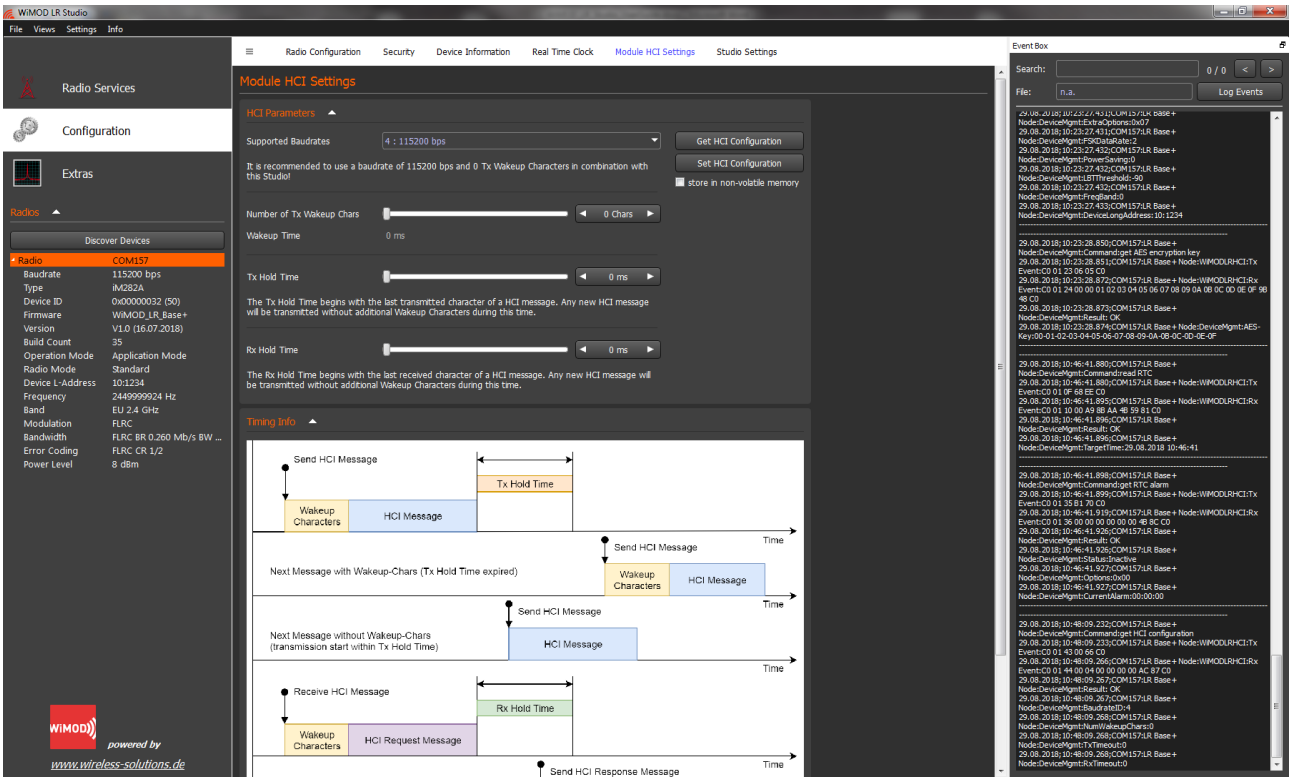

Figure 3-12: Module HCI Settings

Wakeup Chars

The next configurable parameter is the number of additional SLIP ESC wakeup characters the module will transmit ahead of any HCI message to wake a sleeping host controller.

Tx Hold Time

The Tx Hold Time begins with the last transmitted character of a HCI message. Any new HCI message will be transmitted without additional Wakeup Characters during this time.

Rx Hold Time

The Rx Hold Time begins with the last received character of a HCI message. Any new HCI message will be transmitted without additional Wakeup Characters during this time.

3.2.6 Studio Settings

This page allows to configure additional baudrates which are used during the radio module discovery procedure. It is highly recommended to enable only baudrates which are used due to performance issues.

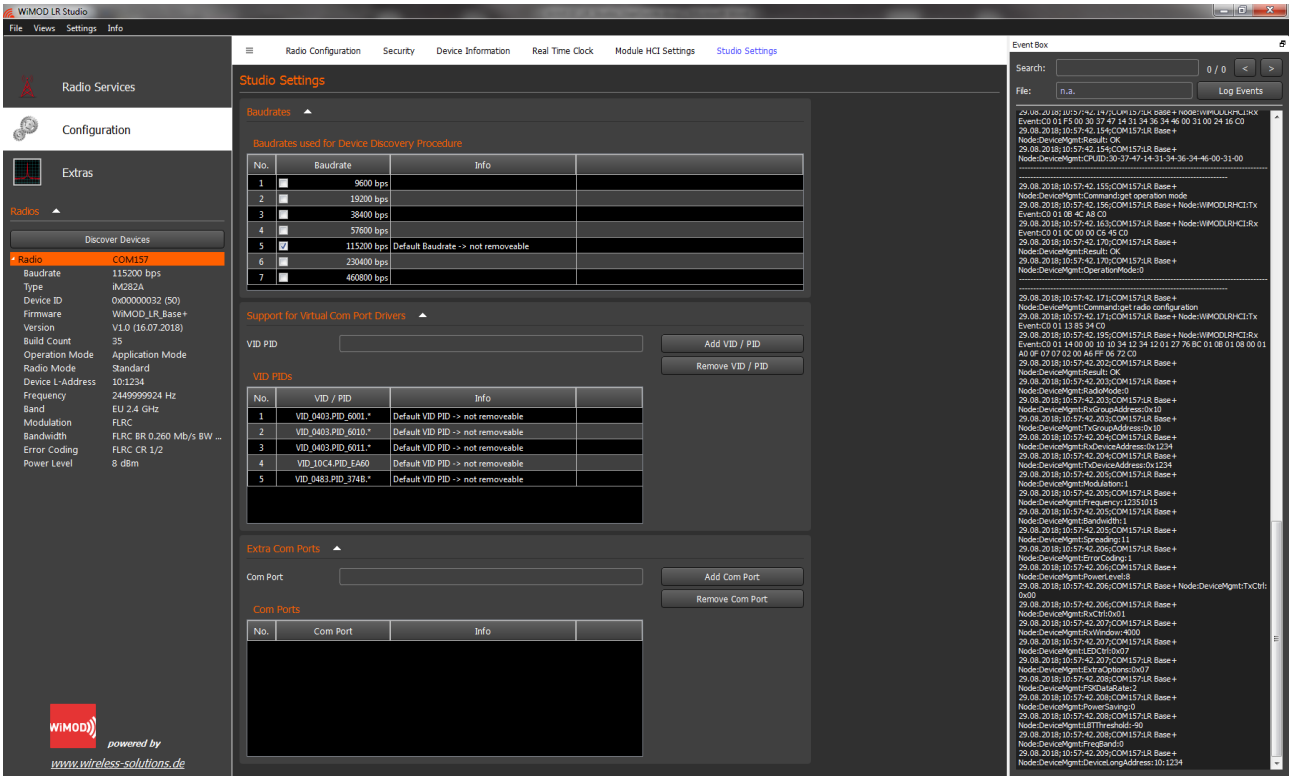

Figure 3-13: Module HCI Settings

VID PIDs

This Studio supports a set of default Vendor IDs (VID) and Product Ids (PID) of different USB to Com Port adapters. If needed it is possible to extend this list by VID PIDs of other manufacturers/products.

Extra Com Ports

An alternative to the USB VID PID might be to add the Com Port name directly for the automatic discovery procedure.

3.3 Extras

This section provides the following extra features:

- Host Controller Interface (HCI) Logging

3.3.1 Host Controller Interface (HCI) Logging & Test Commands

This page allows to enable the HCI logging capabilities of this Studio.

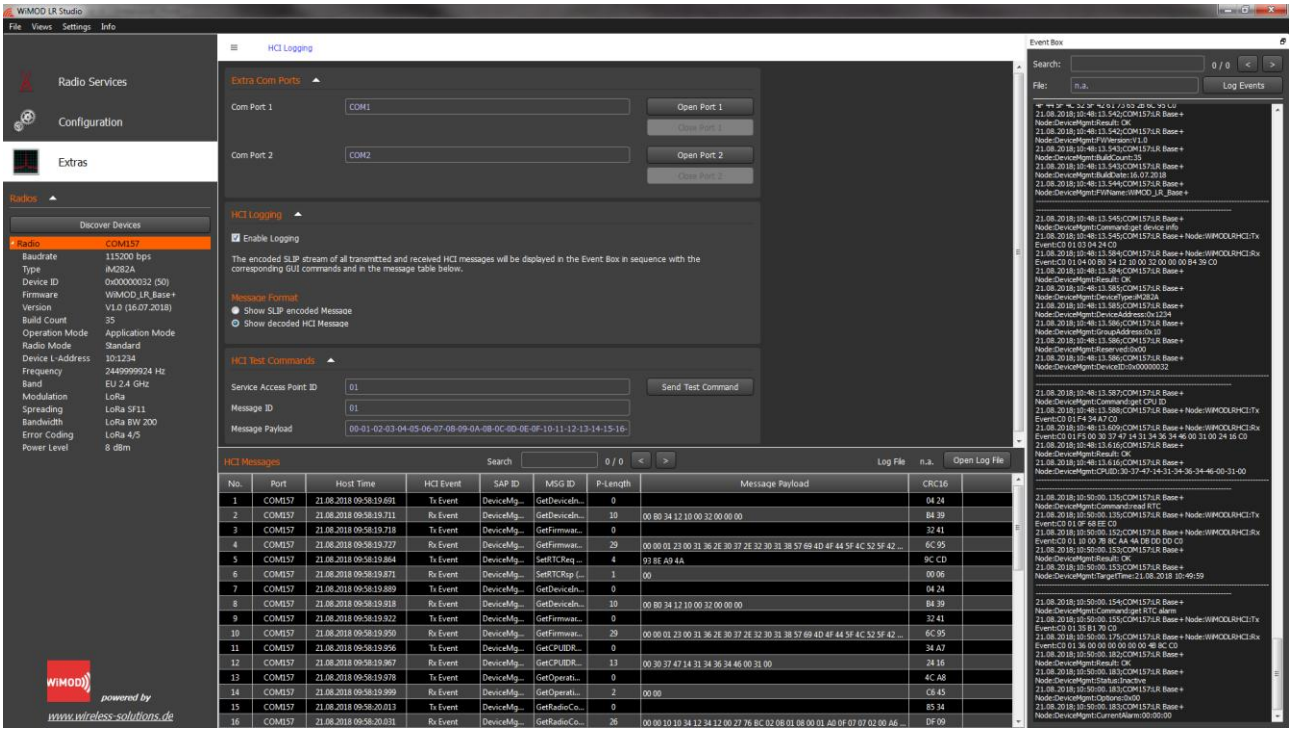

Figure 3-14: Host Controller Interface (HCI) Logging

The table below displays all transmitted and received HCI messages either in SLIP encoded format or as decoded HCI message (see [1] for more details).

Extra Com Ports

In case the radio module is not directly connected to this Studio, but the UART-Rx- and UART-Tx lines can be contacted via standard signal converter cable it is possible to open up to two further COM ports for HCI message sniffing.

HCI Test Commands

Furthermore it is possible to send a user defined test message, i.e. the SLIP encoding and CRC16 calculation is done by the Studio itself.

3.4 Firmware Update

The Studio includes the possibility to update the firmware of a connected radio device through the *File* menu or the Device Information page.

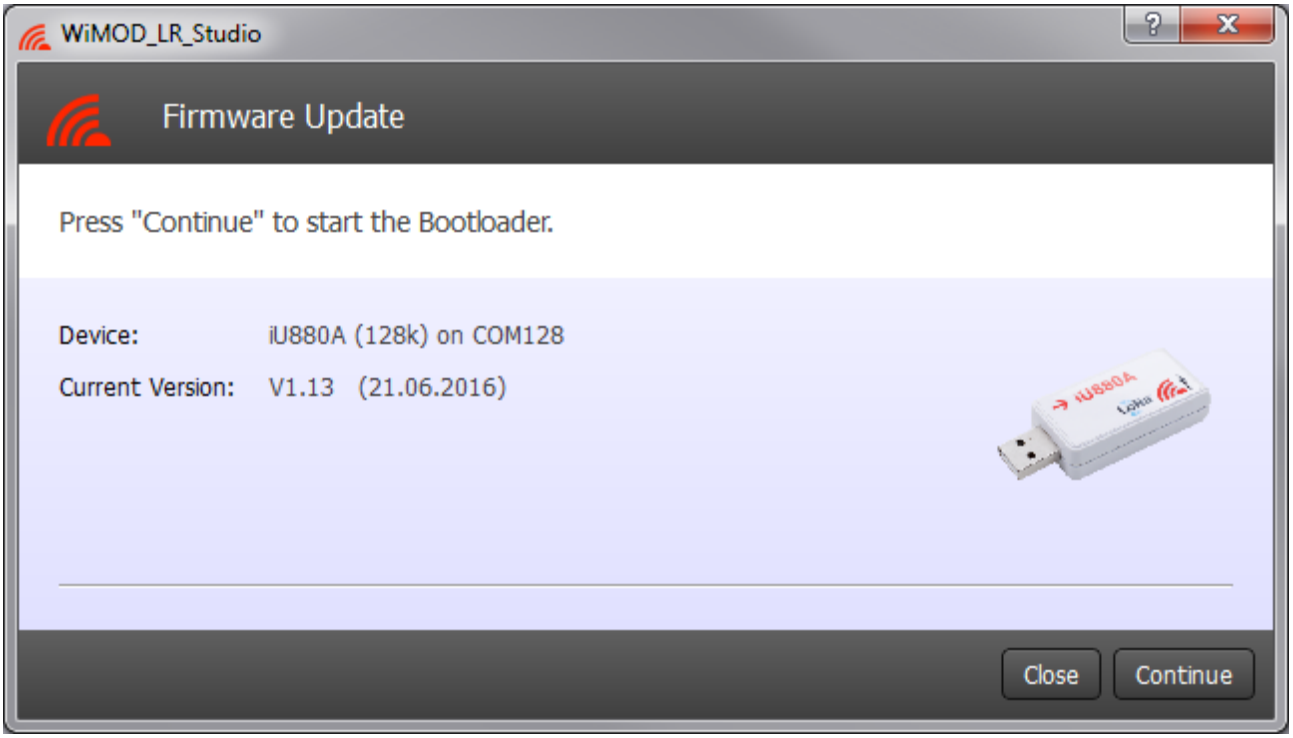

Figure 3-15: Firmware Update

The bootloader activation is implemented in different ways and explained during the update procedure. Latest WiMOD LR Base firmware includes a HCI command which activates the bootoader fully automatically from the firmware itself. Older firmware or customer firmware might require a signal on the dedicated bootloader signal pin of the radio module. For USB-Sticks and modules on the Demoboard this signal can be controlled via FTDI. Beside the VCP driver an additional D2XX driver must be installed for proper operation.

4. Appendix

4.1 List of Abbreviations

DLL	Dynamic Link Library
FSK	Frequency Shift Keying Modulation
FW	Firmware
GUI	Graphical User Interface
HCI	Host Controller Interface
HW	Hardware
NVM	None Volatile Memory
RAM	Random Access Memory
RF	Radio Frequency
RSSI	Received Signal Strength Indicator
RTC	Real Time Clock
SW	Software
UART	Universal Asynchronous Receiver/Transmitter

4.2 List of Figures

4.3 References

[1] WiMOD_LR_Base_HCI_Spec.pdf

[2] WiMOD_LR_Base_Plus_HCI_Spec.pdf

5. Important Notice

5.1 Disclaimer

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