

WiMOD – Application StarterKit

User's Guide Version 1.1

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Aim of this Document

Aim of this document is to give an overview to the WiMOD standard firmware application "AppStarterKit", which consists of basic host controller interface (HCI) features and a basic set of sample applications.

For detailed information please refer to the help file of the WiMOD StarterKit and especially to the specification of the host controller interface [1].

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1 General

This document describes the WiMOD standard application “AppStarterKit”, an embedded firmware for the WiMOD radio modules. The firmware offers lots of features which enable the user to reduce implementation effort on the host controller. With the PC tool WiMOD Studio these features can easily be explored. Additionally the supported radio modules include a bootloader which allows easy firmware update via UART interface.

1.1 Feature Overview

The following features are part of the StarterKit application and can be configured and used via serial interface. See Chapter 2 for detailed information.

Host Controller Interface:

One part of the StarterKit application is the host controller interface (HCI). With this message based serial protocol the user is able to connect the radio module to a host system. It can be used for configuration, data exchange and device control. Each message to or from the radio module is embedded in a specific message frame (see chapter 2.1).

Sample Application Chat:

The “*Chat Application*” is the most important application and provides a bidirectional data exchange between two or more radio modules.

Sample Application Radio link Test:

The “*Radio Link Test*” provides metrics to evaluate the RF link quality between two modules.

Sample Application Remote Control:

The “*Remote Control Application*” enables pairing of modules for remote control via RF.

Sample Application Sensor Control:

The “*Sensor Control Application*” demonstrates how to access a sensor device via RF.

Sample Application Sensor Network:

The “*Sensor Network Application*” demonstrates monitoring of multiple sensor devices via RF.

Note: The sample applications are aligned to be used with the WiMOD Studio. It is not recommended to run all applications in parallel.

1.2 Supported radio modules

Supported WiMOD radio modules:

- iM201A
- iM221A
- iM240A
- iM820A
- iM860A

Note: The WiMOD radio modules are pre-qualified, but nevertheless it is the operator's duty, to bear responsibility for compliance with applicable legal regulations when using the WiMOD firmware applications.

1.3 Pin Configuration

The sample applications of the firmware "AppStarterKit" use partially some of the module I/O's. Table 1-1 gives an overview of all possible I/O's and Chapter 2 describes which of them are used by the different sample applications. To find out the physical pin numbers of the appropriate radio module refer to Chapter 5.1.

| Pin Label | Description | Demo Board Unit <small>see note 2</small> |
|-----------|--|---|
| RXD | UART receive pin | TxD of USB-Controller |
| TXD | UART transmit pin | RxD of USB-Controller |
| IN_1 | Digital Input 1 | Button 1 |
| IN_2 | Digital Input 2 | Button 2 |
| IN_3 | Digital Input 3 / BTL (enter bootloader) <small>see note 1</small> | Button 3 (BTL) |
| OUT_1 | Digital Output 1 | LED 1 |
| OUT_2 | Digital Output 2 | LED 2 |
| OUT_3 | Digital Output 3 | LED 3 |
| OUT_4 | Digital Output 4 | LED 4 (Status) |
| ADC | Analog Input | Potentiometer |

Notes:

- 1) Switching IN_3 to low level during/after RESET, the bootloader is activated to update or exchange the firmware with the WiMOD Studio.
- 2) Typical unit when using the default jumper configuration on the WiMOD DemoBoard.

Table 1-1: Pin Usage

Hardware Note:

- Digital output 4 (OUT_4) is always used as status pin and indicates that the module is alive.

2 Firmware Description

The StarterKit application includes a serial host controller interface and a bundle of sample applications for demonstration. This chapter gives a short description of these units.

The sample applications except the host controller interface are aligned to be used with the WiMOD StarterKit/Studio and uses several I/O's for controlling and status indication. A detailed description of these applications in combination with the WiMOD DemoBoard is given in the Help-File of the WiMOD Studio PC tool. Please contact us to get more information for using them in an embedded system.

2.1 Host Controller Interface

The supported radio modules can be controlled and configured via serial interface (UART). On enquiry some modules can also be driven by Serial Peripheral Interface (SPI). The HCI Protocol (see [1]) uses a SLIP wrapping layer when transmitting over asynchronous serial interface (UART). For Windows PC applications a library (DLL) can be used (see [2] for detailed information). To connect the radio module to embedded systems example code is available.

Note: In this chapter only a short summary of the serial interface commands is given. For detailed information please refer to the HCI specification [1] and for general radio settings of the corresponding radio module please refer to the appropriate datasheet ([3] - [7]).

2.1.1 Connection Settings

The UART baud rate which is required for communication between host controller and radio module is 38400 baud. Further 8 data bits, 1 stop bit and no parity bit have to be configured.

2.1.2 Host Controller Protocol

The host controller interface uses a specific host controller message protocol. With this message based serial protocol the user is able to connect the radio modules to a host system. It can be used for configuration, data exchange and device control. Each message to or from the radio module is embedded in a specific message frame.

| Type Field | Control Field | Destination ID | Source ID | Opcode | Payload Length | Payload (0...max octetts) |
|------------|---------------|----------------|-----------|--------|----------------|---------------------------|
| 8 Bit | 8 Bit | 8 Bit | 8 Bit | 8 Bit | 8 Bit | p * 8 Bit |

Figure 2-1: Message Format on Serial Interface

The "AppStarterKit" firmware currently provides a maximum payload of 32 octets, other payload

lengths are available on request.

2.1.3 Device Management Services

The following device management services of the WiMOD HCl are supported by the firmware "AppStarterKit".

Ping Request

This command can be used to check the wired communication interface and if the connected device is alive.

Reset Request

This command can be used to perform a software reset of the connected WiMOD. The reset will be executed after approx. 500 ms.

Get Device Information

This command can be used to read out some information elements (device address, module type, firmware version, ...) of the connected device.

Get and Set Device Configuration

The firmware provides several configurable system parameters which are stored in a non volatile memory. During start-up these parameters are readout to configure the firmware components and hardware units. With command "Get Device Parameter" these parameters can be readout, "Set Device Parameter" can be used to change the parameters of the connected device.

New parameter settings get valid after a system reset of the connected WiMOD.

Factory Reset

This command can be used to reset the device parameters of the connected device. All parameters except the device address will be set to default factory settings. Via resetFlag parameter the user defines if a software reset should be initiated automatically or not. This reset will be executed after approx. 500 ms.

RF Ping

This command can be used to check via RF link if a device is alive.

Get Peer Device Information

This command can be used to get device information from a peer device via RF link.

Get Peer Device Configuration

This command allow to readout device parameters from a peer device via RF link.

2.1.4 RF Data Exchange Services

The RF Data Exchange services can be used to send data packets from one host controller to another and is represented by the chat application.

Unreliable Data Request

This command can be used to send data packets via RF without acknowledgement from the peer device. The local WiMOD converts the incoming HCI message into a RF message which is sent out over the air. It is possible to send this message as broadcast message to all WiMODs in range.

Via event message "Unreliable Data Indication" the host controller will be informed by the WiMOD as a result of a received "Unreliable Data Request" message.

Acknowledged Data Request

This command can be used to send out data packets via RF with acknowledgement from the peer WiMOD. If an RF Ack message is not received within a specific timeout a retransmission of the data packet will be initiated. Timeout and the maximum number of retransmissions are configurable.

Via event message "Acknowledged Data Indication" the host controller will be informed by the WiMOD as a result of a received "Acknowledged Data Request" message.

2.2 Sample Application Chat

This application is the most important sample application and demonstrates a bidirectional data transmission from one host PC to another via radio link by using the unreliable data request of the HCI.

Hardware Notes:

- Digital output 2 (OUT_2) toggles if the module transmits a RF message.
- Digital output 3 (OUT_3) toggles if the module receives a RF message.

2.3 Sample Application Radio Link Test

This application offers the possibility to validate the radio link quality between two WiMOD radio modules. During this test a configurable number of packets including a TX packet counter is sent from a local device (connected to the WiMOD Studio) to a peer device. The peer device returns the number of received packets back to the sender.

Hardware Notes:

- Digital output 1 (OUT_1) is switched to high level on local and peer device if PER \geq Error threshold (adjusted in WiMOD Studio).
- Digital output 2 (OUT_2) toggles on local device if a RF packet is sent.
- Digital output 3 (OUT_3) toggles on local and peer device if a RF packet is received.

2.4 Sample Application Remote Control

This application provides simple remote control functionality. Setting one of the digital input pins to low level initiates an appropriated RF broadcast message. Any device which accepts this message will toggle the corresponding digital output pin. Additionally the user is able to pair two devices and if a device is paired, it sends out the RF message only to the address of the paired device. Un-pairing is done by doing a factory reset on both devices.

Note: A factory reset restores the module factory settings except the device address.

Hardware Notes:

- Digital output OUT_1 toggles if RF message from remote input IN_1 was received.
- Digital output OUT_2 toggles if RF message from remote input IN_2 was received.
- Digital output OUT_3 toggles if RF message from remote input IN_3 was received.
- Digital input 3 (IN_3) on peer device has to be set to low level during pairing command from the local device.

2.5 Sample Application Sensor Control

This application demonstrates wireless sensor measurements. It allows to sample different kind of sensor values from a certain peer device (sensor device) and to report them over HCI. Additionally a repetitive measurement is possible.

Note: For repetitive measurements a sample period greater than 1 s is recommended.

Currently two module internal sensors¹ (temperature and voltage measurement) and one external sensor (GND to approx. 0.7 V) on analog input pin ADC can be read out.

Hardware Notes:

- Digital output OUT_1 is switched to high level on the sensor device to indicate an enabled repetitive measurement.
- Digital output OUT_2 toggles on the sensor device if it transmits a sensor message.
- Digital output OUT_3 toggles if a sensor message is received.

2.6 Sample Application Sensor Network

This application configures a sensor network with star topology. The star consists of a central access point and several surrounding sensor nodes. The access point coordinates the radio traffic by means of a TDMA scheme (Time Division Multiple Access) to avoid RF message collisions. Every sensor node is synchronized to the access point and requests a dedicated time slot to send out its sample values. The access point reserves the time slots for all sensor nodes and forwards received sensor messages via HCI.

Hardware Notes:

- Digital output OUT_1 is switched to high level to indicate an enabled Sensor Network.
- Digital output OUT_2 toggles if a sensor device transmits a sensor message or if an access point transmits a sync message.
- Digital output OUT_3 toggles if a sensor message is received.

Note: The sensor network application is not supported by the iM860A.

¹ The iM860A does not support the temperature sensor.

3 Bootloader

Additionally to the application firmware the WiMOD radio modules consists of a special bootloader which is located in a separated flash section. This functionality can be used to update or exchange the application firmware via UART interface (RXD and TXD) if needed.

Digital input IN_3 is used as bootloader pin. It has to be set to low level during/after a reset to enter the bootloader mode. Digital output OUT_4 indicates the status and is set to high level if the bootloader mode is entered and a firmware update is in progress. Moreover OUT_4 indicates an invalid application firmware by fast toggling.

To perform a firmware update by a PC, we provide the WiMOD Studio (part of the WiMOD Starter Kit) which contains a simple update tool. Refer to the WiMOD Studio help file for more information about its update functionality. To perform an update by a host controller please contact us to get more information.

Hardware Notes:

- Digital input IN_3 is used to enter the bootloader mode.
- Digital output OUT_4 is switched to high level if the firmware update is in progress.
- Digital output OUT_4 toggles fast to indicate an invalid application firmware.

4 WiMOD Studio

The WiMOD Studio is delivered as part of the WiMOD StarterKit and is a Windows Tool which allows the user to evaluate the capabilities of several WiMOD radio modules from IMST GmbH.

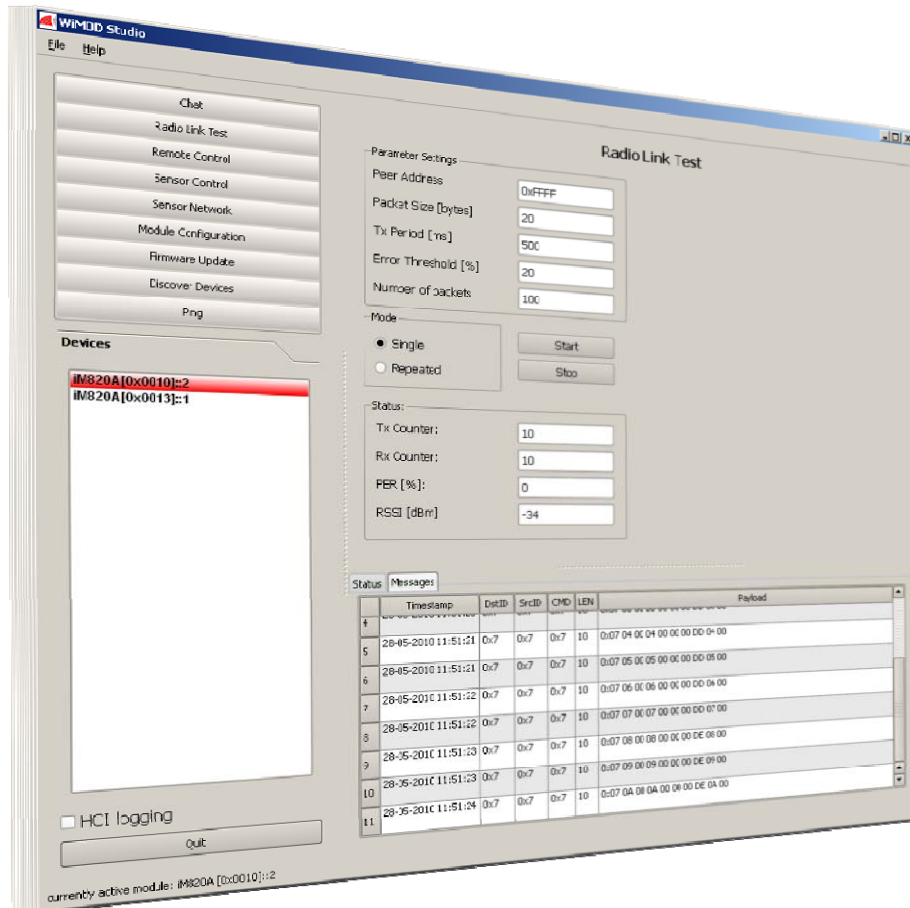


Figure 4-1: WiMOD Studio

The tool provides an easy and common way to configure and control the radio modules and its basic sample applications (AppStarterKit). Additionally it enables the user to update the radio modules over the UART interface.

For more information please refer to the WiMOD Studio help file.

5 Module Specifications

5.1 Pin Assignment

Table 5-1 shows the assignment of the pin label used in the StarterKit application and the physical pin numbers of the appropriate radio module.

| Pin Label | Pin Assignment | | | | |
|-----------|----------------|--------|--------|--------|--------|
| | iM201A | iM221A | iM240A | iM820A | iM860A |
| RxD | Pin 18 | Pin 22 | Pin 18 | Pin 22 | Pin 18 |
| TxD | Pin 19 | Pin 23 | Pin 19 | Pin 23 | Pin 19 |
| IN_1 | Pin 13 | Pin 9 | Pin 13 | Pin 9 | Pin 13 |
| IN_2 | Pin 12 | Pin 7 | Pin 12 | Pin 7 | Pin 12 |
| IN_3 | Pin 14 | Pin 11 | Pin 14 | Pin 11 | Pin 14 |
| OUT_1 | Pin 29 | P 6 | Pin 15 | P 6 | Pin 29 |
| OUT_2 | Pin 25 | Pin 30 | Pin 25 | Pin 30 | Pin 25 |
| OUT_3 | Pin 24 | Pin 27 | Pin 24 | Pin 27 | Pin 24 |
| OUT_4 | Pin 20 | Pin 21 | Pin 20 | Pin 21 | Pin 20 |
| ADC | Pin 9 | Pin 20 | Pin 9 | Pin 20 | Pin 9 |

Table 5-1: Pinout of the Radio Modules

6 Appendix

6.1 List of Abbreviations

| | |
|------|---|
| ADC | = Analog-to-Digital Converter |
| DLL | = Dynamic Link Library |
| IO | = Input/Output |
| HCI | = Host Controller Interface |
| RF | = Radio Frequency |
| SPI | = Serial Peripheral Interface |
| TDMA | = Time Division Multiple Access |
| UART | = Universal Asynchronous Receiver/Transmitter |

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6.4 References

- [1] WiMODHCI_Spec.pdf, IMST GmbH
- [2] WiMODDLL_Spec.pdf, IMST GmbH
- [3] iM201A_Datasheet.pdf, IMST GmbH
- [4] iM221A_Datasheet.pdf, IMST GmbH
- [5] iM240A_Datasheet.pdf, IMST GmbH
- [6] iM820A_Datasheet.pdf, IMST GmbH
- [7] iM860A_Datasheet.pdf, IMST GmbH

7 Regulatory Compliance Information

The use of radio frequencies is limited by national regulations. The radio module has been designed to comply with the European Union's R&TTE (Radio & Telecommunications Terminal Equipment) directive 1999/5/EC and can be used free of charge within the European Union. Nevertheless, restrictions in terms of maximum allowed RF power or duty cycle may apply.

The radio module has been designed to be embedded into other products (referred as "final products"). According to the R&TTE directive, the declaration of compliance with essential requirements of the R&TTE directive is within the responsibility of the manufacturer of the final product. A declaration of conformity for the radio module is available from IMST GmbH on request.

The applicable regulation requirements are subject to change. IMST GmbH does not take any responsibility for the correctness and accuracy of the aforementioned information. National laws and regulations, as well as their interpretation can vary with the country. In case of uncertainty, it is recommended to contact either IMST's accredited Test Center or to consult the local authorities of the relevant countries.

8 Important Notice

8.1 Disclaimer

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