



ANR014 PROTEUS QUICKSTART

CONNECT A SMART PHONE TO A PROTEUS
BLUETOOTH LOW ENERGY RADIO MODULE

VERSION 1.1

JANUARY 3, 2020

Revision history

Manual version	Notes	Date
1.0	<ul style="list-style-type: none">• Initial version	July 2019
1.1	<ul style="list-style-type: none">• Added description for Proteus-III• Updated address of Division Wireless Connectivity & Sensors location	January 2020

Abbreviations and abstract

Abbreviation	Name	Description
BTMAC		Bluetooth® conform MAC address of the module used on the RF-interface.
CS	Checksum	Byte wise XOR combination of the preceding fields.
Central		Bluetooth® LE device role that scans for advertising packets & initiates connections, e.g. smart phone.
DTM	Direct test mode	Mode to test Bluetooth® specific RF settings.
GAP	Generic Access Profile	The GAP provides a basic level of functionality that all Bluetooth® devices must implement.
I/O	Input/output	Pinout description.
LPM	Low power mode	Mode for efficient power consumption.
MAC		MAC address of the module.
MTU	Maximum transmission unit	Maximum packet size of the Bluetooth® connection.
Payload		The intended message in a frame / package.
Peripheral		Bluetooth® Low Energy device role that provides services & advertises, e.g. sensor or our Proteus module.
RF	Radio frequency	Describes wireless transmission.
RSSI	Receive Signal Strength Indicator	The RSSI indicates the strength of the RF signal. Its value is always printed in two's complement notation.
SoC		System on Chip.
Soft device		Operating system used by the nRF52 chip.
UART	Universal Asynchronous Receiver Transmitter	Allows the serial communication with the module.
[HEX] 0xhh	Hexadecimal	All numbers beginning with 0x are hexadecimal numbers. All other numbers are decimal, unless stated otherwise.

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1 Introduction

The Proteus series is a radio module series that is based on Nordic Semiconductors SoC which presents various Bluetooth® LE and low power features.

By default, a radio module of the Proteus series can be controlled and configured by the host using predefined commands, in the so called command mode.

This application note describes how to setup a connection between a Bluetooth® LE enabled smart device, e.g. smart phone or tablet, to a Proteus module and how to interchange data in command mode. These steps are described with help of the nRF Connect App which is an open source App providing standard Bluetooth® LE functions for iOS as well as for Android devices.



There is a second operation mode, that offers a transparent UART interface to transmit data without any overhead on the UART. For more information concerning this mode, please refer to the application node **AN-R004_Proteus_Peripheral_Only_Mode**.

2 Prerequisites

To follow the description in this application note, the following prerequisites may be helpful:

- A Bluetooth® LE enabled smart phone and the Nordic Semiconductor **nRF Connect** App
- A USB cable
- A Proteus evaluation board in factory state, for example
 - the Proteus-I evaluation board with jumpers set as specified in figure 1. Other jumpers not set.
 - the Proteus-II evaluation board with jumpers set as specified in figure 1. Other jumpers not set.
 - the Proteus-III evaluation board with jumpers set as specified in figure 2. Other jumpers not set.

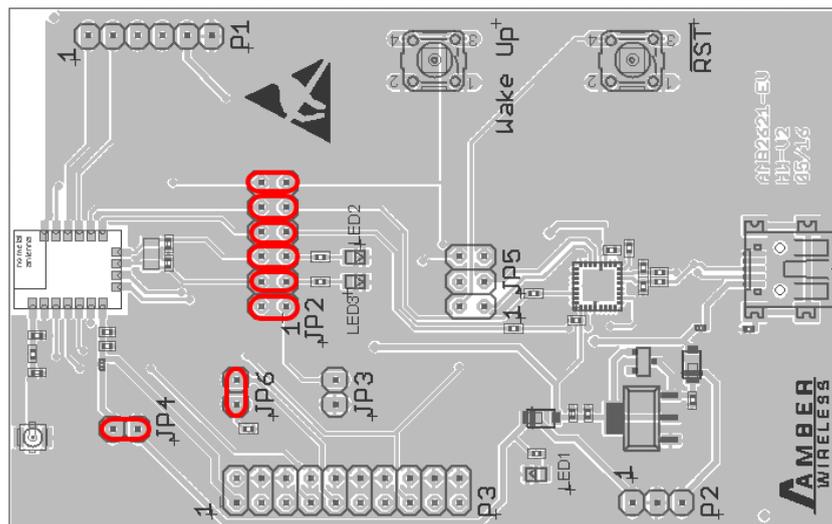


Figure 1: Default jumper placement of the Proteus-I and Proteus-II evaluation board. Red means "jumper must be set".

The complete description of Proteus modules can be found in the respective radio module manual and application notes. This may be helpful to understand the background of the following quick start:

- Proteus-I
 - Proteus-I reference manual
 - Proteus-I advanced user guide **ANR002_Proteus-I_Advanced_Developer_Guide**
- Proteus-II
 - Proteus-II reference manual
 - Proteus-II advanced user guide **ANR005_Proteus-II_Advanced_Developer_Guide**
- Proteus-III

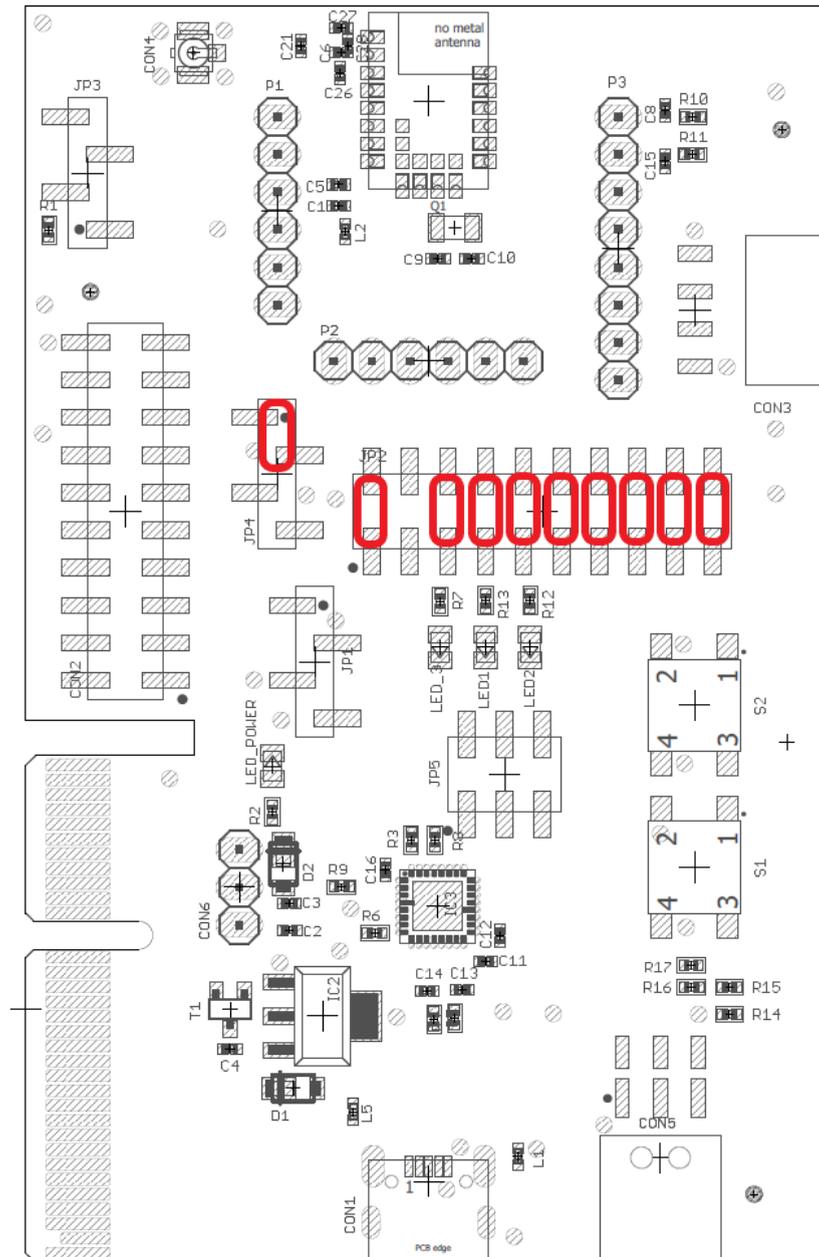


Figure 2: Default jumper placement of the Proteus-III evaluation board. Red means "jumper must be set".

- Proteus-III reference manual
- Proteus-III advanced user guide **ANR009_Proteus-III_Advanced_Developer_Guide**



Figure 3: USB cable and evaluation board of the Proteus-I and Proteus-II radio module

3 Quick start

The following description demonstrates how to setup a connection with a smart phone to a Proteus radio module.

3.1 Basics

The setup of a Bluetooth® LE connection to a Proteus module contains several steps:

1. Physical connection establishment

First of all, a physical connection has to be established. Therefore, a central device (usually smart phone) has to connect to the Proteus module which runs as peripheral.

2. Optional: Pairing process

Second, the pairing process is run that consists of the authentication and exchange of encryption information. The central device must request at least the same security level to access the characteristics of the Proteus module.

- In factory state, the Proteus module has no security enabled and this step can be neglected.
- Security can be enabled by modifying the user setting `RF_SecFlags`.



If the security level of the central device is lower than the security mode of the peripheral, the central cannot access the peripheral's characteristics. In this case, the central sends the notification enable message, which is ignored by the peripheral. Thus, the central signalizes an open connection, although it does not have access to the peripheral and thus data cannot be transmitted!

3. Optional: Exchange of the maximum transmission unit (MTU)

Next, the maximum transmission unit can be increased to allow the transmission of larger data packets. The Proteus module allows an MTU of up to 247 bytes, which results in a payload of up to 243 bytes. This step is optional. Not selecting a higher MTU will use the Bluetooth® 4.0 default MTU which results in 19 bytes payload for the user but will be compatible to pre Bluetooth® 4.2 devices.

4. Discover the characteristics of the Proteus module SPP-like profile

Afterwards, the characteristics offered by the Proteus module have to be discovered by the central. This is needed to share the information how data can be transmitted.

5. Notification enable

To finalize the connection setup, the notification enabled message has to be send. With this feature, the peripheral device lets the central know, when there is new data, which is important for bidirectional data transmission. After this step, the channel is open and data transmission can start.

For the description, we assume that a smart phone is the initiator of the connection. Thus, it acts as central and the Proteus module acts as peripheral in figure 4.

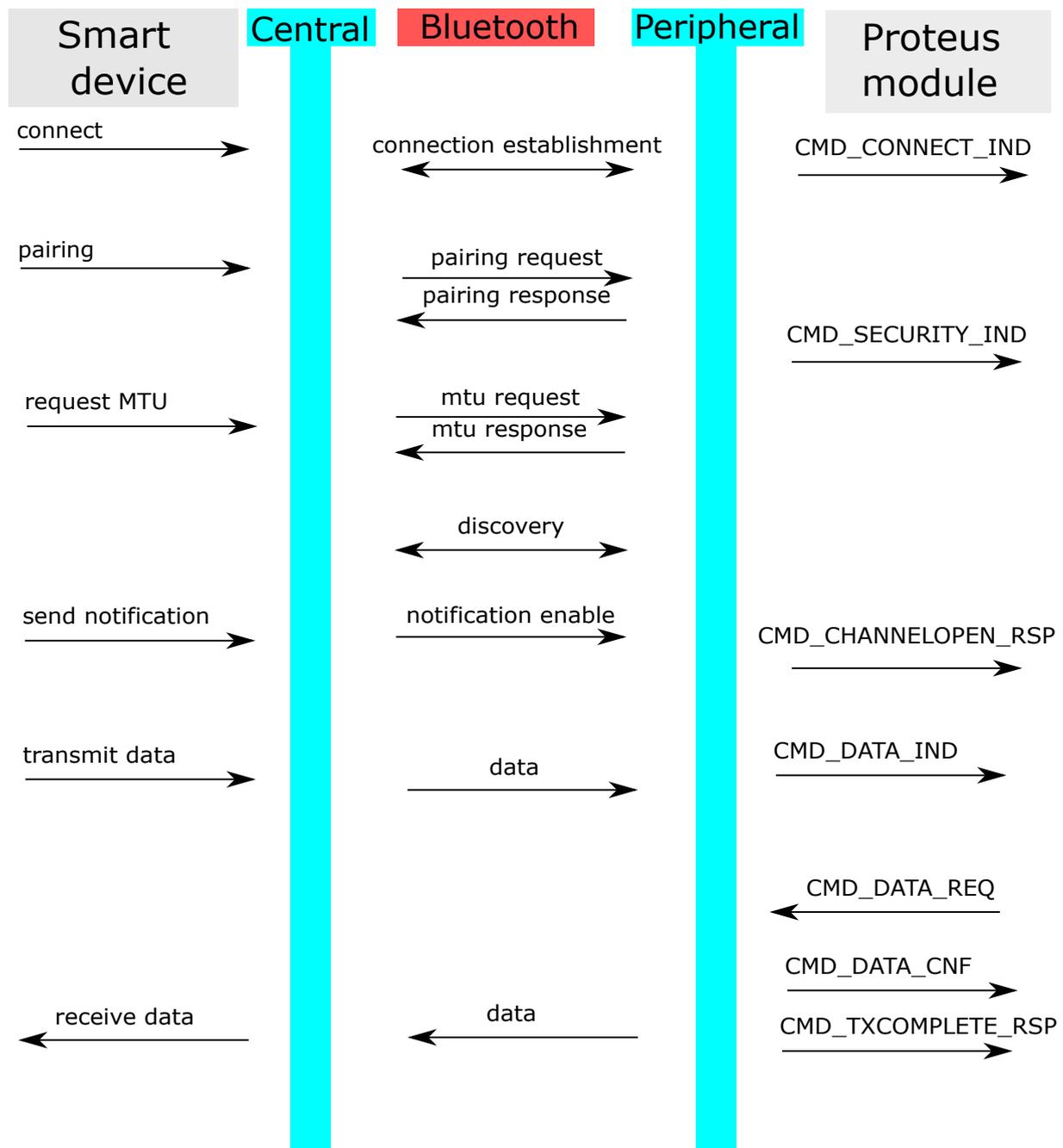
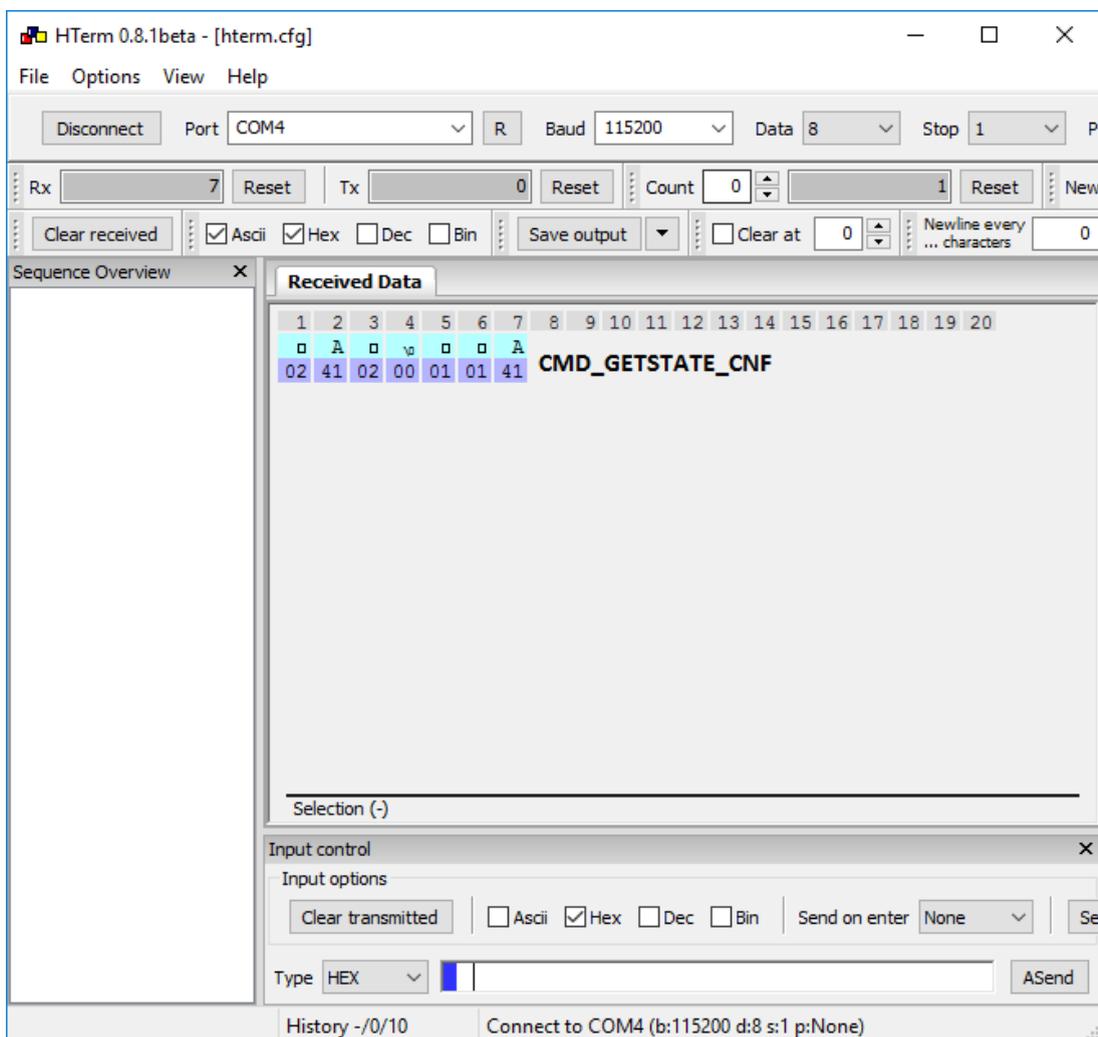


Figure 4: Steps for the connection setup

3.2 Connection setup example using the nRF Connect App

This chapter describes how to setup a connection to the Proteus module in command mode, when a smart phone and the **nRF Connect** App are used. Please perform the following steps:

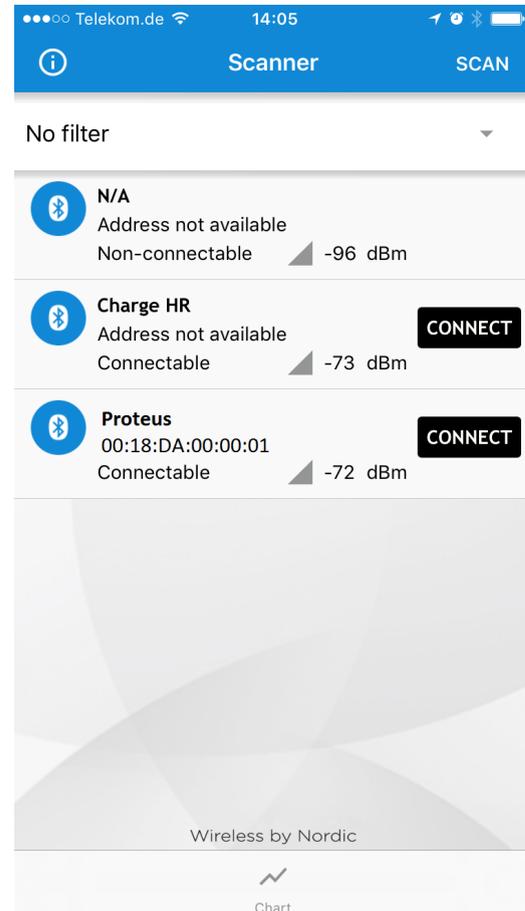
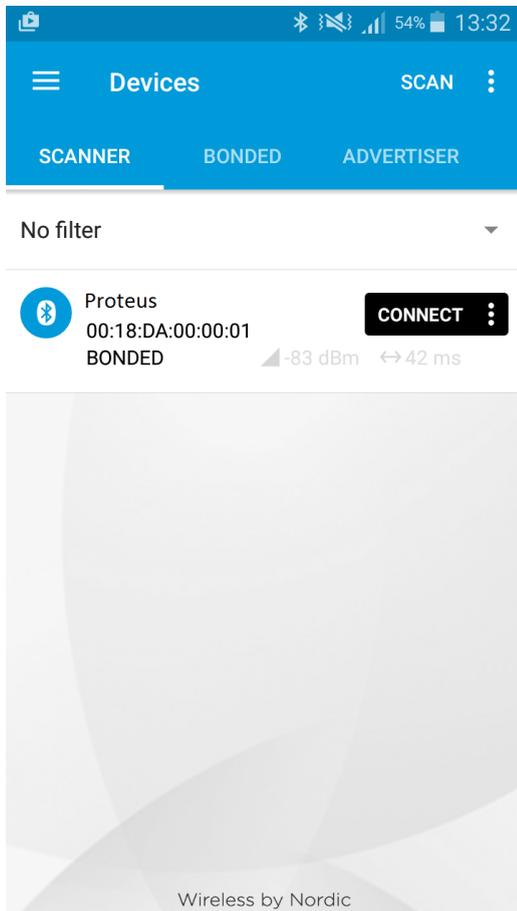
- Connect the Proteus evaluation board to a PC using an USB cable.
- Open a terminal program using the Proteus default UART settings (115200 Baud, 8n1). In this example we use the terminal program *hterm*, a free tool that can be downloaded www.der-hammer.info.
- Press the reset button on the Proteus evaluation board. The Proteus module outputs a `CMD_GETSTATE_CNF` (0x02410200010141) to indicate that it is ready for operation.



Android

iOS

- Initially, the module is advertising. Thus, one LED of the Proteus evaluation board is blinking.
- Start your smart phone, enable the Bluetooth® LE feature and start the **nRF Connect App**.
- Press "SCAN" to find the module on the radio. In case several Proteus modules are found, the Bluetooth® MAC 0x0018DAxxxxxx can be used to detect the right one. The Bluetooth® MAC consists of the module's serial number, that can be also found on the module label.

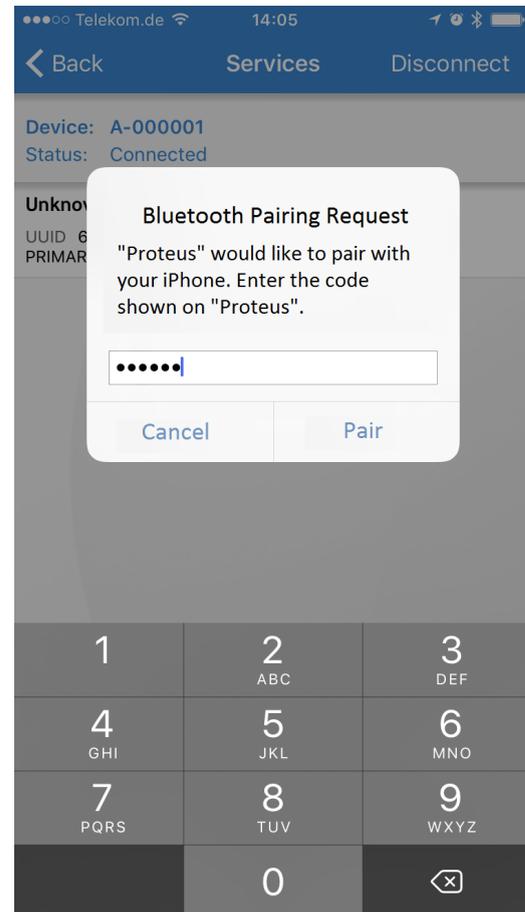
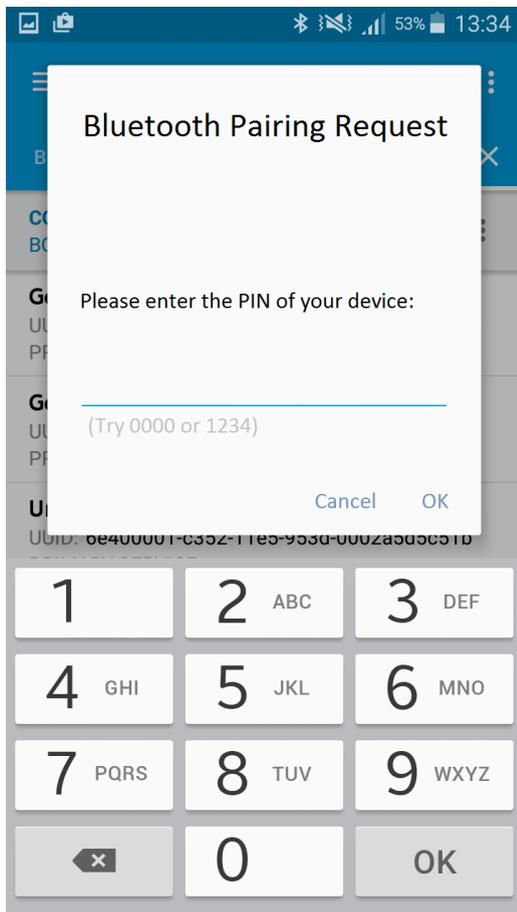


- When the module appears, press "CONNECT".

Android

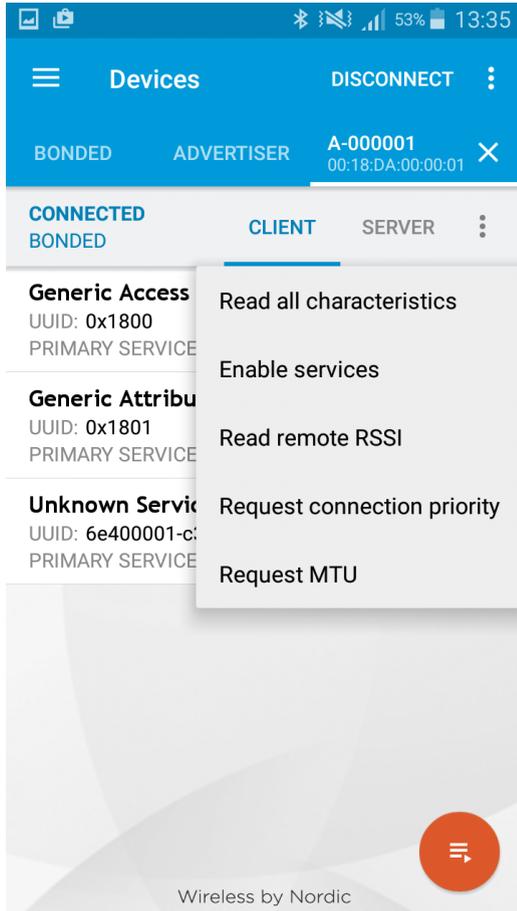
iOS

- As soon as the module has received the connection request from the smart phone the blinking LED will switch to constant on.
- Optional pairing: In case security has been configured before, the smart phone requests the user for pairing actions. In case of the static passkey authentication, the Proteus requests to enter the static passkey. The default passkey is "123123". The Bluetooth® coupling requirement pop-up is shown on your smart phone. When the bonding feature is enabled in the authentication settings and the bonding information already exists, a re-entering of the passkey is not required when reconnecting.



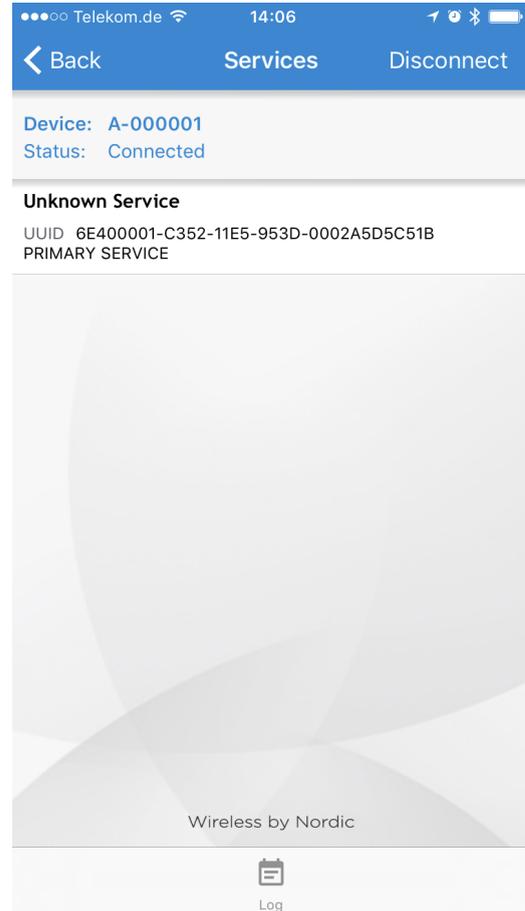
Android

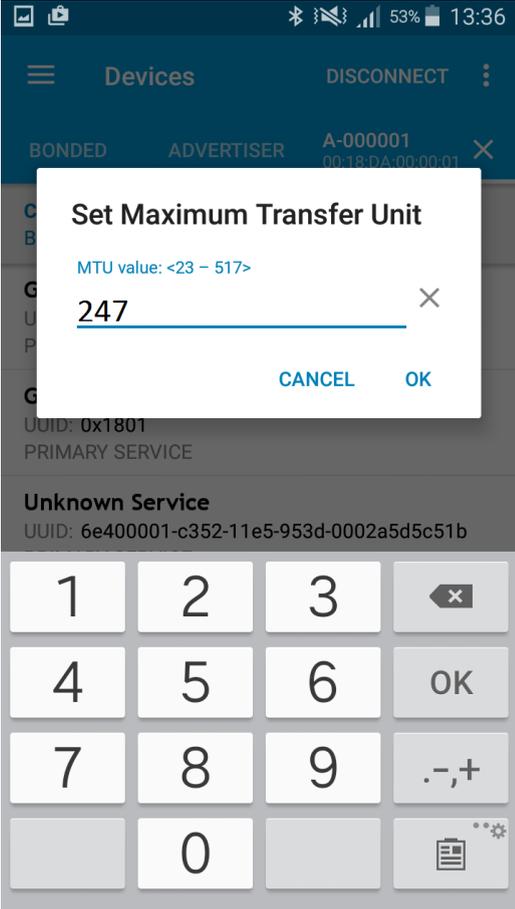
- Please click on the menu bullets on the right and press "Request MTU" to request for a larger MTU.



iOS

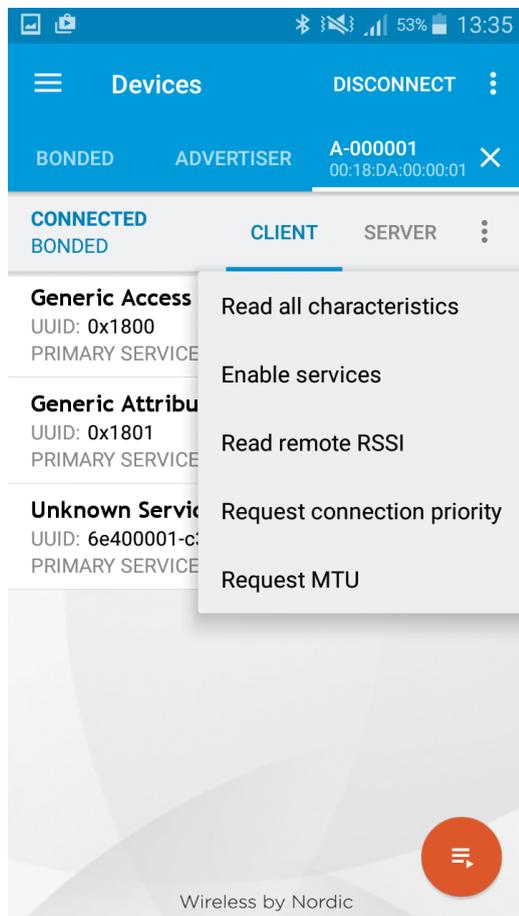
- Please click on the "Unknown Service" to start the service discovery and the MTU request.



Android	iOS
<ul style="list-style-type: none">The Proteus module allows a MTU of up to 247 bytes, which results in a payload size of 243 bytes.  <p>The screenshot shows an Android application interface. At the top, there's a status bar with icons for Bluetooth, signal strength, and battery (53%) at 13:36. Below that is a 'Devices' screen with a 'DISCONNECT' button. A modal dialog box titled 'Set Maximum Transfer Unit' is open, showing 'MTU value: <23 - 517>' and a text input field with '247'. The dialog has 'CANCEL' and 'OK' buttons. Below the dialog is a numeric keypad with buttons for digits 1-9, 0, a backspace key, and an 'OK' key.</p>	<ul style="list-style-type: none">The iOS App runs this step simultaneously in the background, a user-defined MTU is not possible.

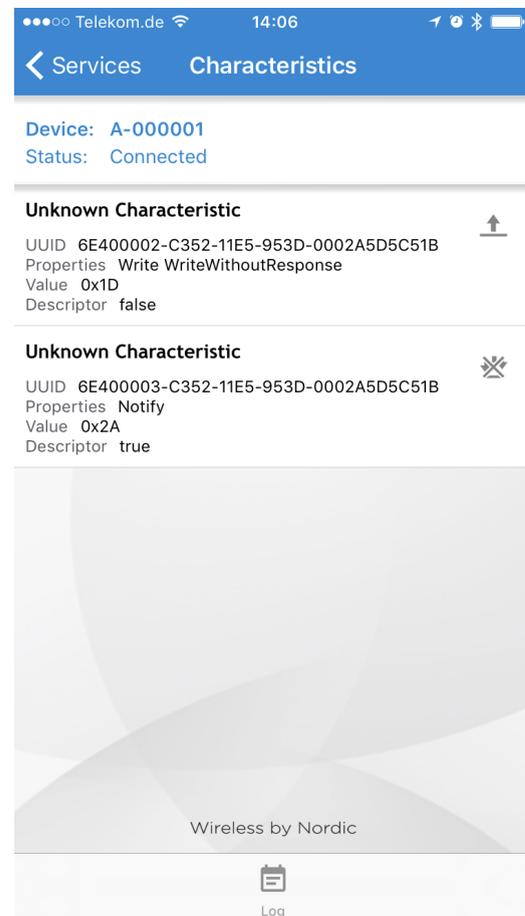
Android

- Again click on the menu bullets on the right and press "Enable services" to enable the notifications.



iOS

- Press the arrow on the RX-characteristic 6E400003- C352-11E5- 953D -0002A5D5C51B to enable the notifications. Press it until a cross appears (see below, it has to be pressed at least once). If a cross is already shown press it twice so the cross disappears and then reappears.

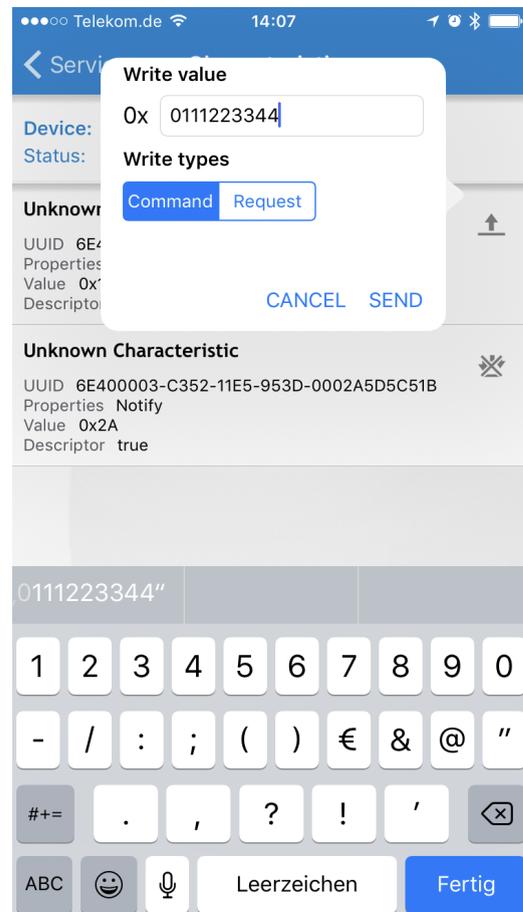
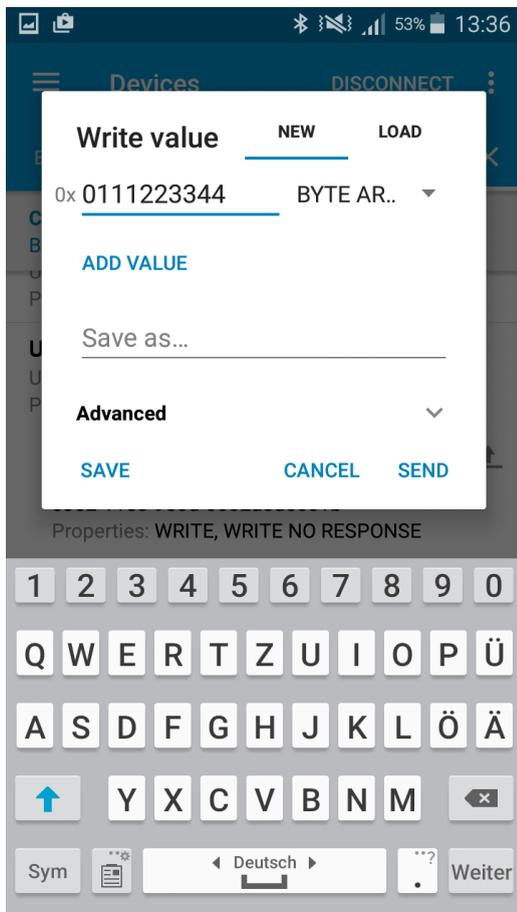


- As soon as the module has received the notification enable request the second LED on the Proteus evaluation board is turned on. Now you are fully connected and you can access the characteristics to transmit and receive data.

Android

iOS

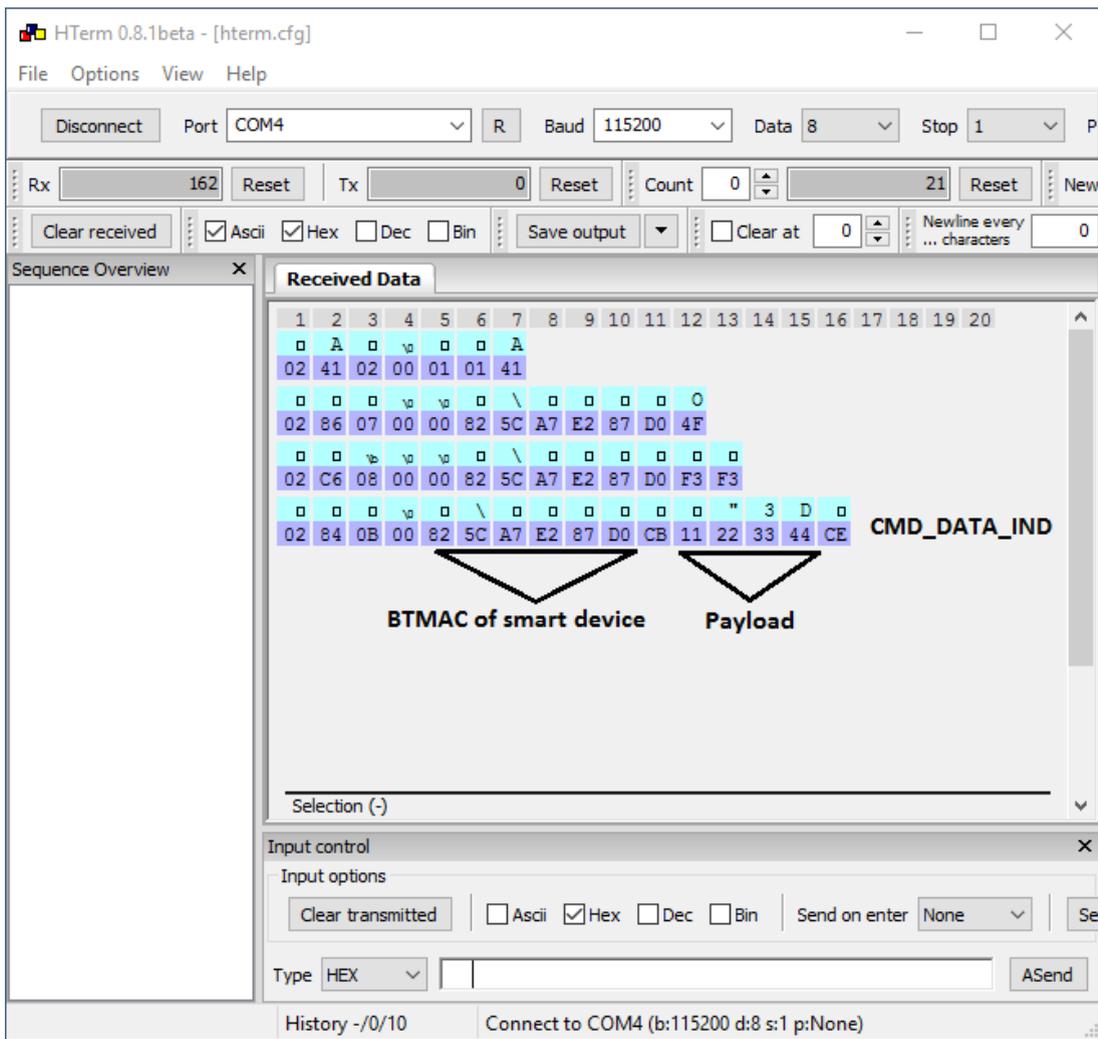
- To send data to the Proteus module, press the arrow next to the TX-characteristic 6E400002-C352-11E5-953D-0002A5D5C51B in the **nRF Connect** App.
- First enter 01 right behind the 0x as header byte, followed by your payload (for example 0x11 0x22 0x33 0x44) and press "SEND" to start the transmission. The maximum allowed payload size is dependent on the MTU that was selected in the connection process (see CMD_CHANNELOPEN_RSP message on the previous page).



Android	iOS
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- The payload that has been sent is output by the Proteus module via UART. In the terminal program a CMD_DATA_IND message has been received that contains the BTMAC of the sending device and the transmitted payload 0x11 0x22 0x33 0x44. The format of the CMD_DATA_IND message is as follows:

Start signal	Command	Length	BTMAC	RSSI	Payload	CS
0x02	0x84	2 Bytes	6 Bytes	1 Byte	(Length - 7) Bytes	1 Byte
0x02	0x84	0x0B 0x00	0x82 0x5C 0xA7 0xE2 0x87 0xD0	0XCB	0x11 0x22 0x33 0x44	0xCE



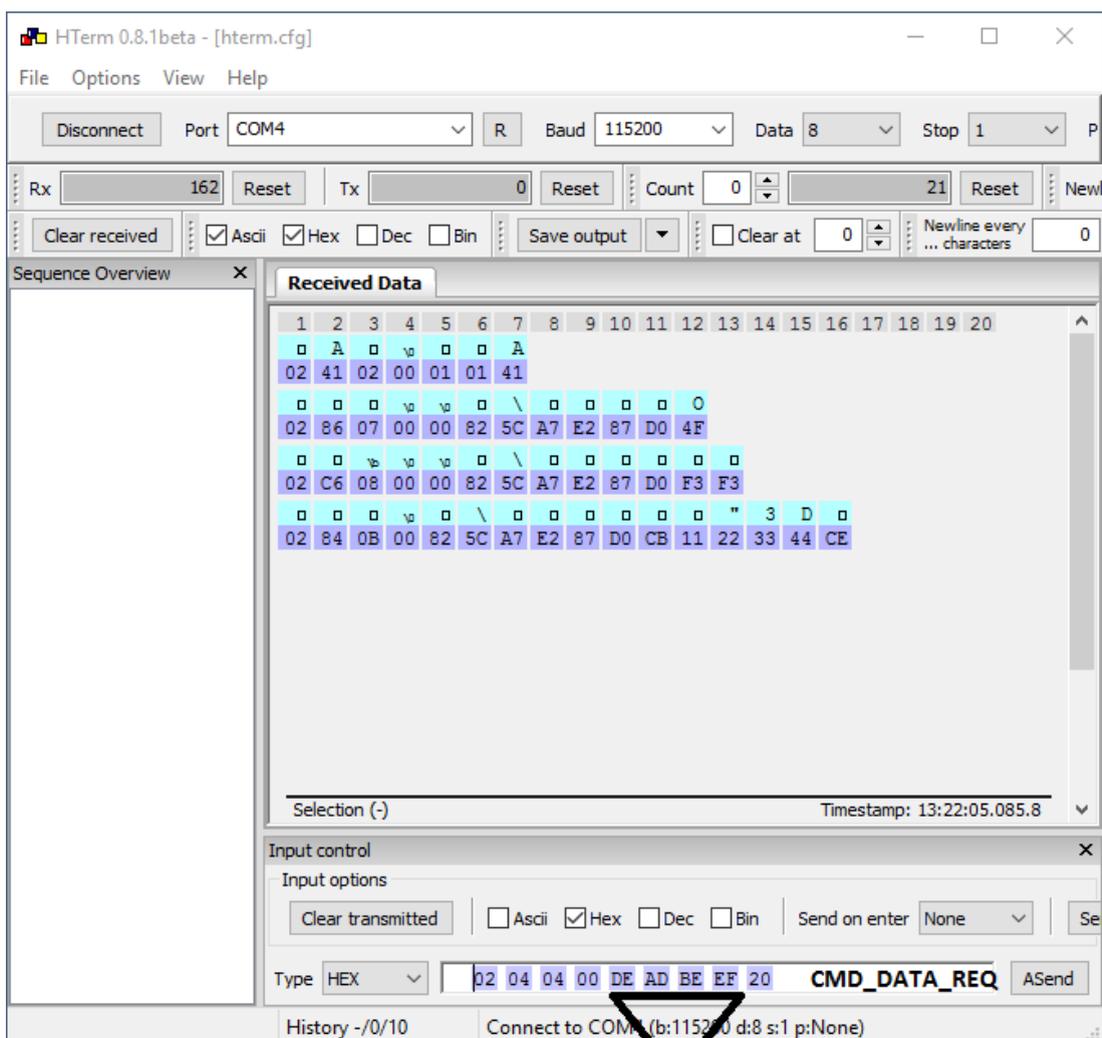
Android

iOS

- To send back data to the smart device simply insert your payload (here we choose 0xDE 0xAD 0xBE 0xEF) in a CMD_DATA_REQ message. The format of the CMD_DATA_REQ message is as follows, where the check sum (CS) is calculated as XOR of the preceding bytes:

Start signal	Command	Length	Payload	CS
0x02	0x04	2 Bytes	Length Bytes	1 Byte
0x02	0x04	0x04 0x00	0xDE 0xAD 0xBE 0xEF	0x20

- The header 0x01 of the radio frame header will be automatically applied by the module and is not part of the payload of the CMD_DATA_REQ message.

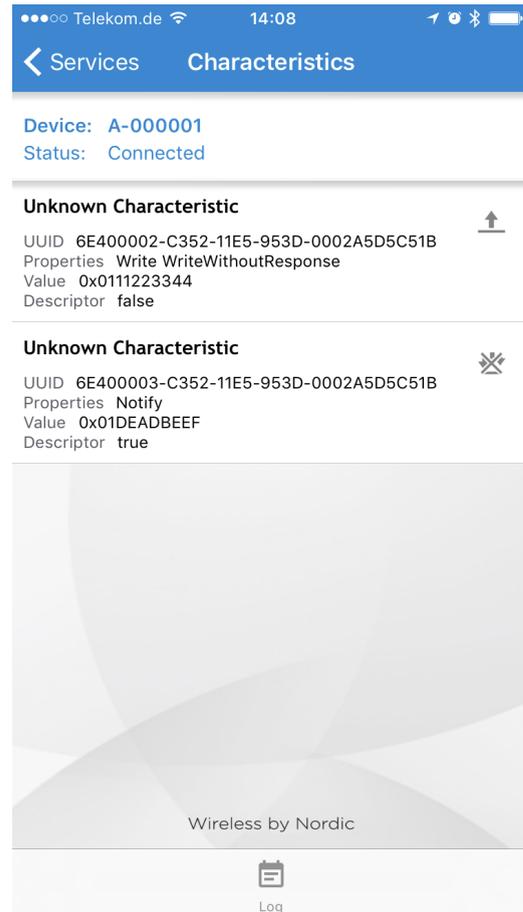
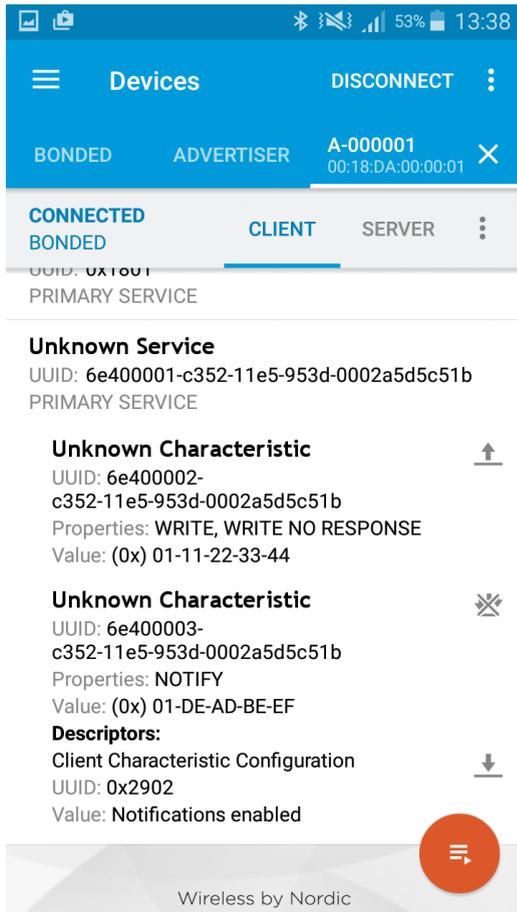


**Payload, no header
0x01 needed**

Android

iOS

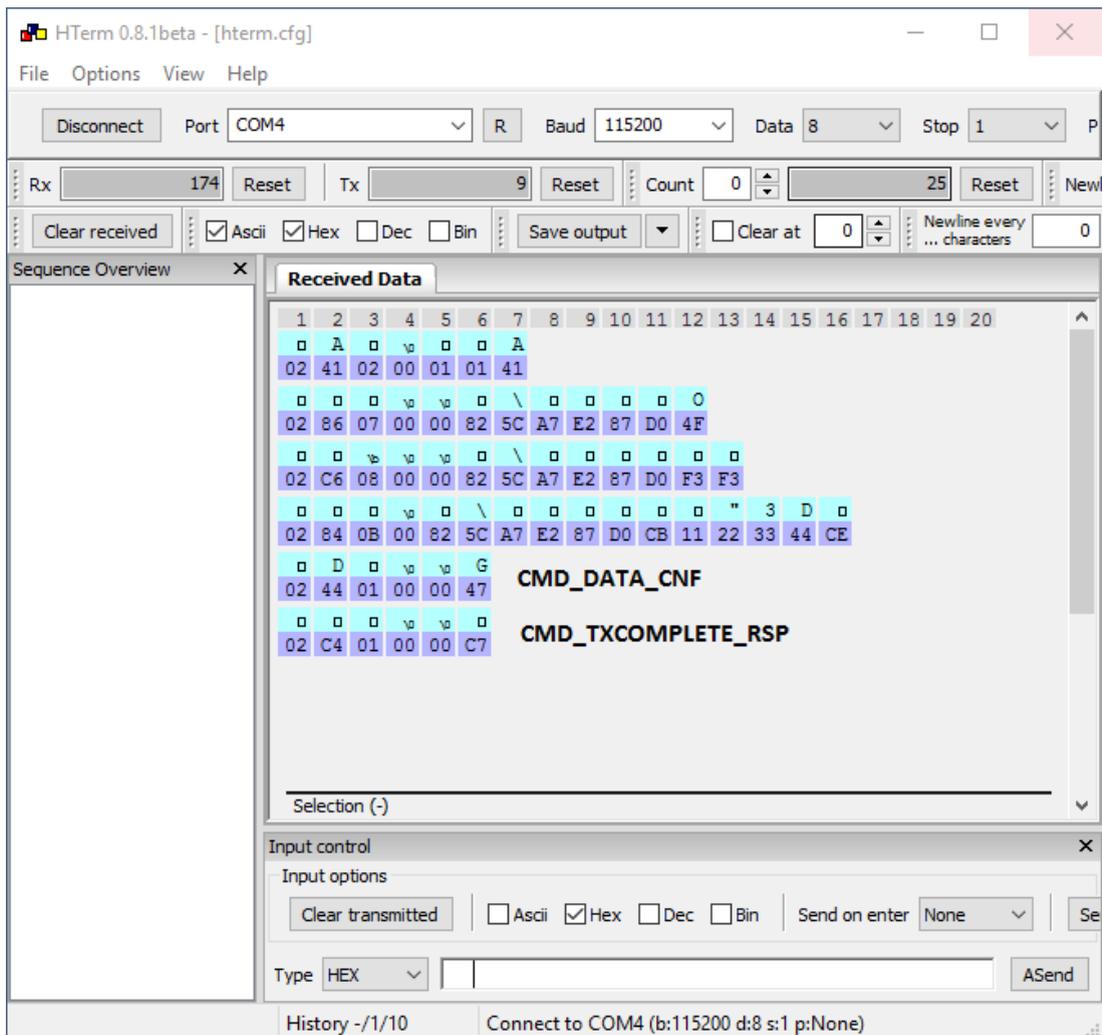
- The received data can be found in the RX-characteristic 6E400003-C352-11E5-953D-0002A5D5C51B. It contains the header byte 0x01 and the payload 0xDE 0xAD 0xBE 0xEF.



Android

iOS

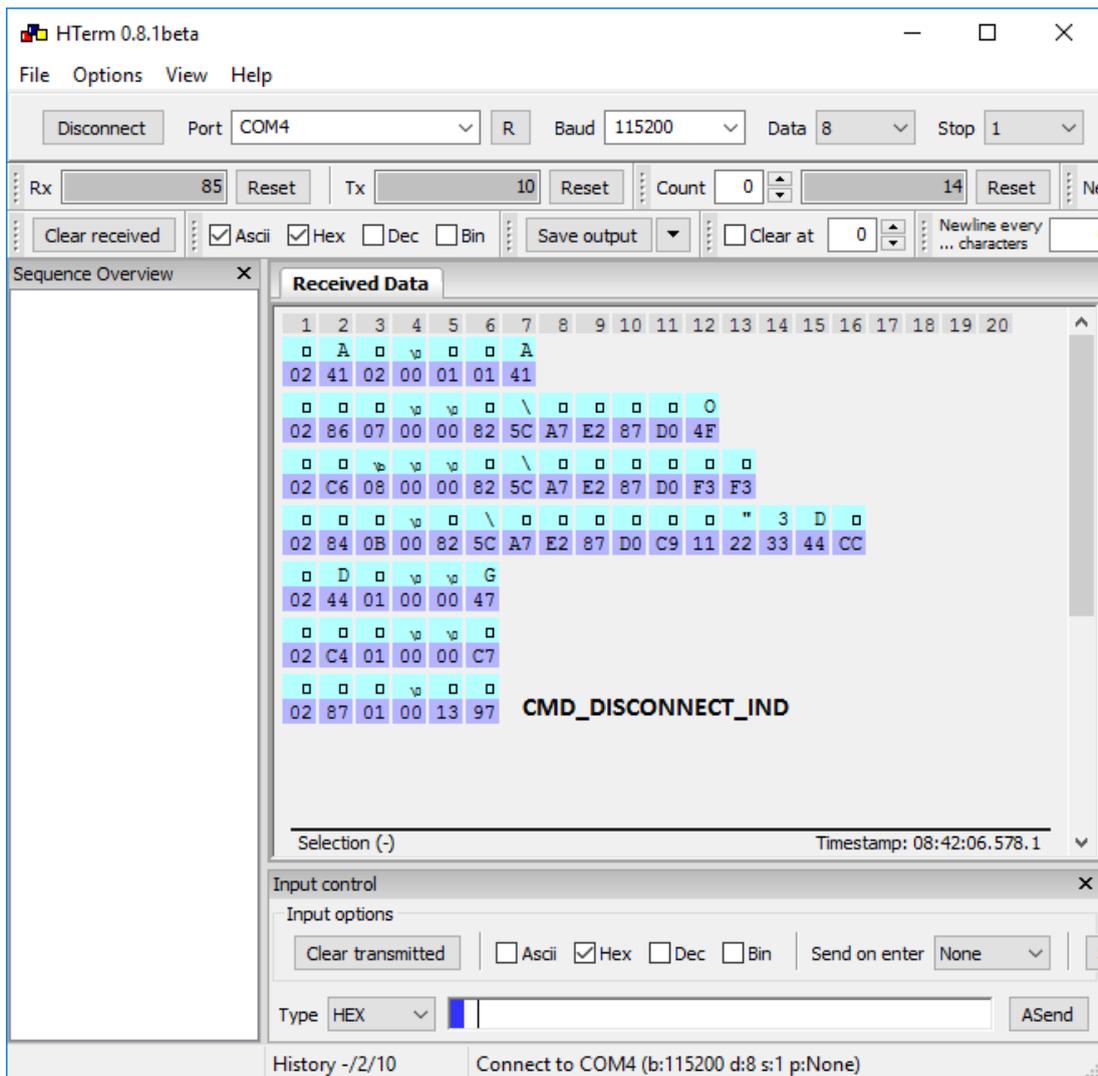
- When sending the CMD_DATA_REQ to the Proteus module, it responds with two different messages. First a CMD_DATA_CNF (0x024401000047) message is returned, as soon as the request was interpreted. Then a CMD_TXCOMPLETE_RSP (0x02C4010000C7) message is returned as soon as the data has been transmitted.



Android

iOS

- To disconnect the smart phone from the Proteus module, press the "DISCONNECT" button in the **nRF Connect** App. The Proteus module will output a `CMD_DISCONNECT_IND` (0x028701001397) message to indicate that the connection has been closed.



- After disconnecting the Proteus module starts advertising again, such that a re-connection can be performed.

3.3 Summary

In this application note, we demonstrated how to setup a connection between a smart phone and a Proteus Bluetooth® LE module. Furthermore, it has been shown how to transmit data from smart phone to a Proteus radio module and vice versa.

When developing a custom app, the same steps for connection setup have to be implemented. The **nRF Connect** App from Nordic Semiconductor can be taken as base for any custom app development, as its source code is freely available on the GitHub account of Nordic Semiconductor (*nRF Connect Android* and *nRF Connect iOS*).

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4.3 Best care and attention

Any product-specific data sheets, manuals, application notes, PCN's, warnings and cautions must be strictly observed in the most recent versions and matching to the products firmware revisions. This documents can be downloaded from the product specific sections on the wireless connectivity homepage.

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6.3 Ownership

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6.4 Firmware update(s)

You have the opportunity to request the current and actual Firmware for a bought wireless connectivity Product within the time of warranty. However, Würth Elektronik eiSos has no obligation to update a modules firmware in their production facilities, but can offer this as a service on request. The upload of firmware updates falls within your responsibility, e.g. via ACC or another software for firmware updates. Firmware updates will not be communicated automatically. It is within your responsibility to check the current version of a firmware in the latest version of the product manual on our website. The revision table in the product manual provides all necessary information about firmware updates. There is no right to be provided with binary files, so called "Firmware images", those could be flashed through JTAG, SWD, Spi-Bi-Wire, SPI or similar interfaces.

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If a provision of this license terms is or becomes invalid, unenforceable or null and void, this shall not affect the remaining provisions of the terms. The parties shall replace any such provisions with new valid provisions that most closely approximate the purpose of the terms.

6.9 Miscellaneous

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**Monitoring
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**Automated Meter
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