

Use of BT Module Evaluation Boards

ISP1507-AL / ISP1507-AX
ISP1807-LR
ISP1907-LL / ISP1907-HT



Contents

Scope

This document gives details on hardware and software for using and testing Insight SiP Bluetooth Low Energy modules ISP1507-AL, ISP1507-AX, ISP1807-LR, ISP1907-LL and ISP1907-HT.

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Document Revision History

Revision	Date	Ref	Change Description
R0	15/02/2021	ys pg	Initial release
R1	14/06/2022	pd pg	Document layout update
R2	28/02/2023	Jf pg	New interface board

1. Recommended Documentation

The following Nordic Semiconductor documents and Software Dev Kits are required to understand the complete setup and programming methods.

Nordic Semiconductor Documents

- nRF528xx Development kit User Guide, hardware section should be partially ignored – Insight SiP development kit hardware replaces Nordic Semiconductor hardware.
- nRF52 Series Reference Manual.
- nRF528xx Product Specification – make sure you have the last document version updated.
- S100 series SoftDevice Specification.
- nRF5 SDK for software development on nRF52 Series.

To access documentation, information, go to:

- Official Nordic Semi website <http://www.nordicsemi.com>
- The Nordic Semiconductor Infocenter is a "comprehensive library" containing technical documentation for current and legacy solutions and technologies <http://infocenter.nordicsemi.com/index.jsp>
- Ask any Nordic related question and get help <https://devzone.nordicsemi.com/questions>
- For any question, you can also open a case on the <http://www.nordicsemi.com>

Software Dev kits

- nRF Connect.
- nRF5 Software Development Kit (SDK) which includes precompiled HEX files, source code as well as SES and Keil ARM project files.
- S100 series SoftDevice, namely S112, S113, S122, S132 and S140.
- nRF Connect application for Smartphone.
- nRF Toolbox application for Smartphone.

To access these files, go to www.nordicsemi.com and download the files.

Other Insight SiP documents

To complete the above, following documents are available on Insight SiP website or/and on request:

- AN201101 App Note – this document.
- BLE module data sheet.
- BLE Test Board schematic.
- ISP130603 Interface Board schematic.

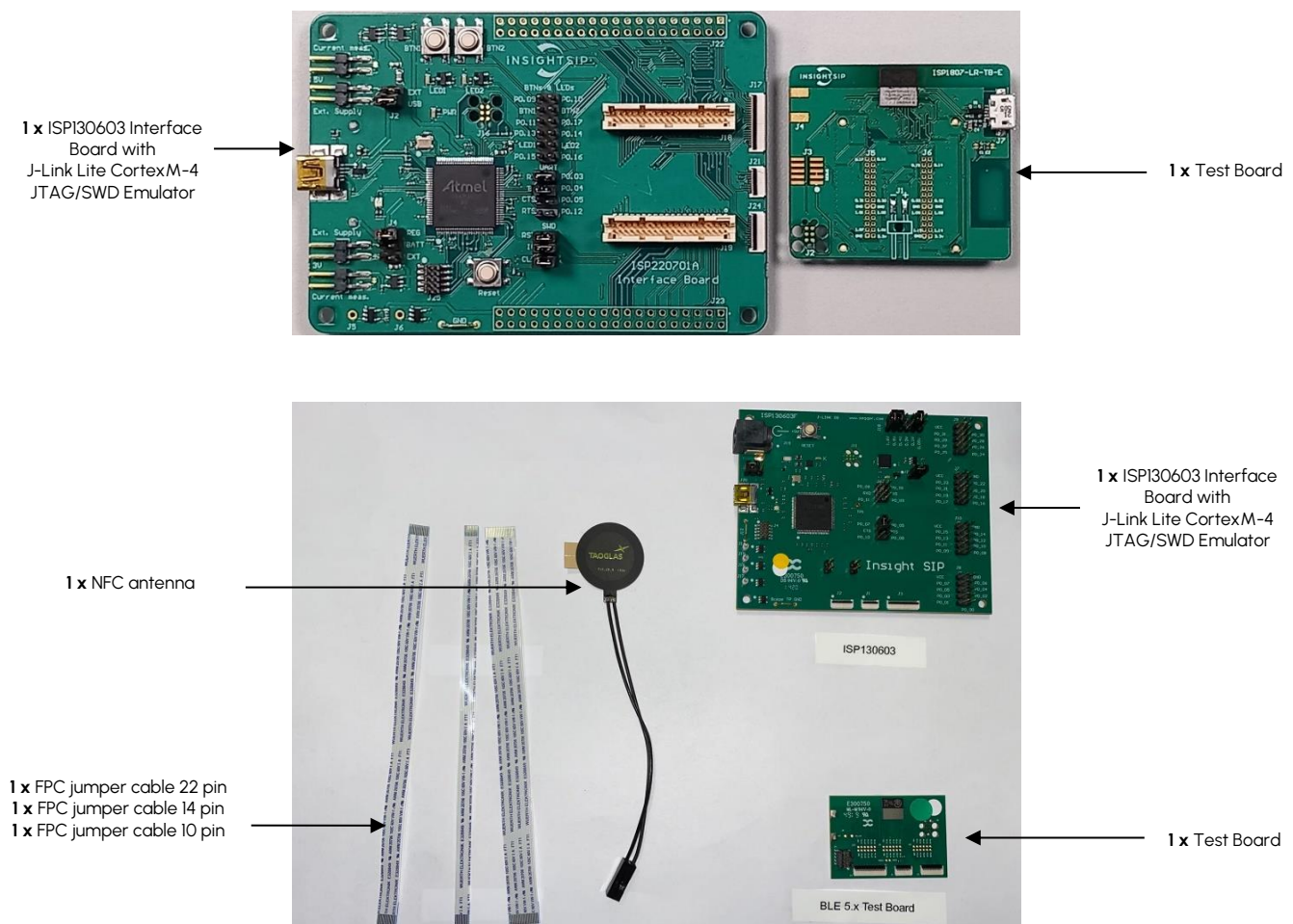
2. Hardware Content

2.1. Global Description

The Evaluation Board hardware includes:

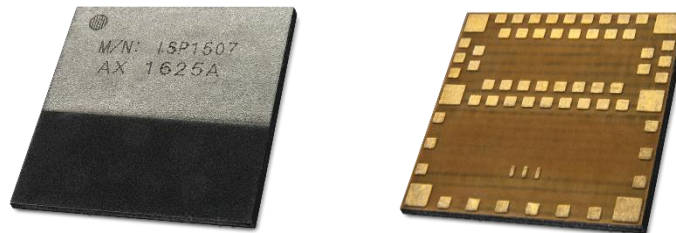
- an Interface Board named ISPI30603,
- a Test Board, either an ISPI507-AL-TB, ISPI507-AX-TB, ISPI807-LR-TB, ISPI907-LL-TB or ISPI907-HT-TB, depending on the BLE module model,
- if relevant, 3 FPC jumper cables to connect the Interface Board to the Test Board (delivered only with former generations, while new generation proposes onboard connectors),
- if applicable, an external NFC antenna (delivered only with former generations, while new generation proposes onboard antenna),

It appears like the underneath pictures, whether it complies with the latest generation or former ones:



2.2. About Insight SiP BT5 Module

ISP15, ISP18 and ISP19 module series provide a BT 5 connectivity with an embedded antenna.



They are based on Nordic Semiconductor nRF52 series 2.4 GHz wireless SoC. They integrate a 2.4 GHz transceiver, a 32bit ARM Cortex™- M4 CPU, flash memory, and analog and digital peripherals. They all support Bluetooth low energy and a range of proprietary 2.4 GHz protocols, and depending on the model, additional protocols like ANT+, Zigbee, Thread and Bluetooth Mesh.

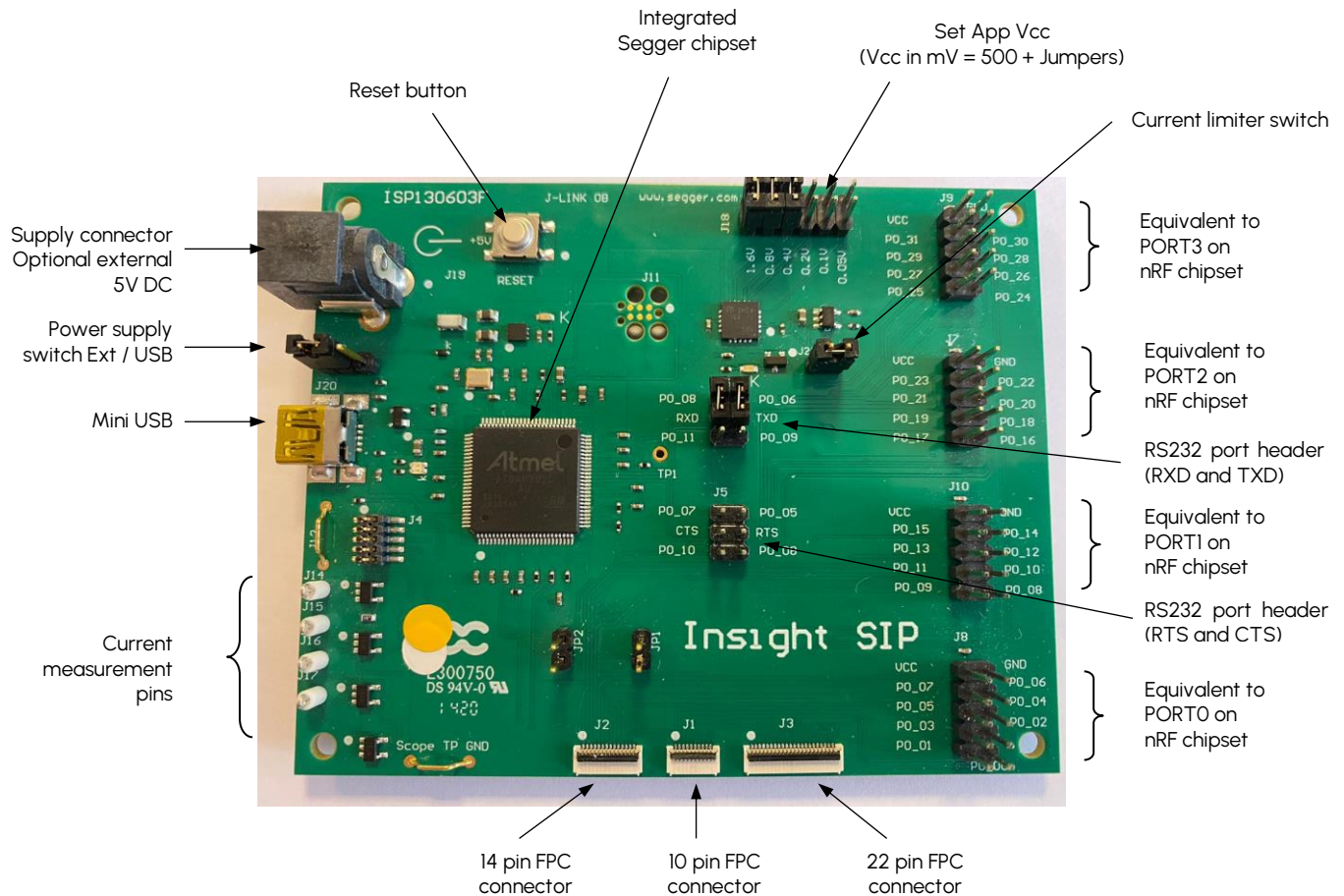
These modules measure 8 x 8 x 1 mm. They integrate all the decoupling capacitors, the 32 MHz and 32 kHz crystals, their load capacitors, the DC-DC converter component, the RF matching circuit and the antenna in addition to the wireless SoC. For more details, please refer to related Insight SiP module data sheet.

The following chart highlights the differences between the different modules and respective evaluation boards.

Module Type	ISP1507-AL	ISP1507-AX	ISP1807-LR	ISP1907-LL	ISP1907-HT
Chip	nRF52810	nRF52832	nRF52840	nRF52811	nRF52833
CPU	Cortex-M4 64 MHz	Cortex-M4 64 MHz & FPU	Cortex-M4 64 MHz & FPU	Cortex-M4 64 MHz	Cortex-M4 64 MHz & FPU
Flash	192 kB	512 kB	1 MB	192 kB	512 kB
RAM	24 kB	64 kB	256 kB	24 kB	128 kB
UART connection	RXD to P0_08 TXD to P0_11 CTS to P0_14 RTS to P0_15	RXD to P0_08 TXD to P0_06 CTS to P0_07 RTS to P0_05	RXD to P0_08 TXD to P0_06 CTS to P0_07 RTS to P0_05	RXD to P0_08 TXD to P0_11 CTS to P0_14 RTS to P0_15	RXD to P0_08 TXD to P0_06 CTS to P0_07 RTS to P0_05
Compatible SoftDevices	S112, S113, S132	S112, S113, S132	S113, S140	S112, S113, S122, S140	S113, S122, S140
Nordic Board	PCA10040e	PCA10040	PCA10056	PCA10056e	PCA10100

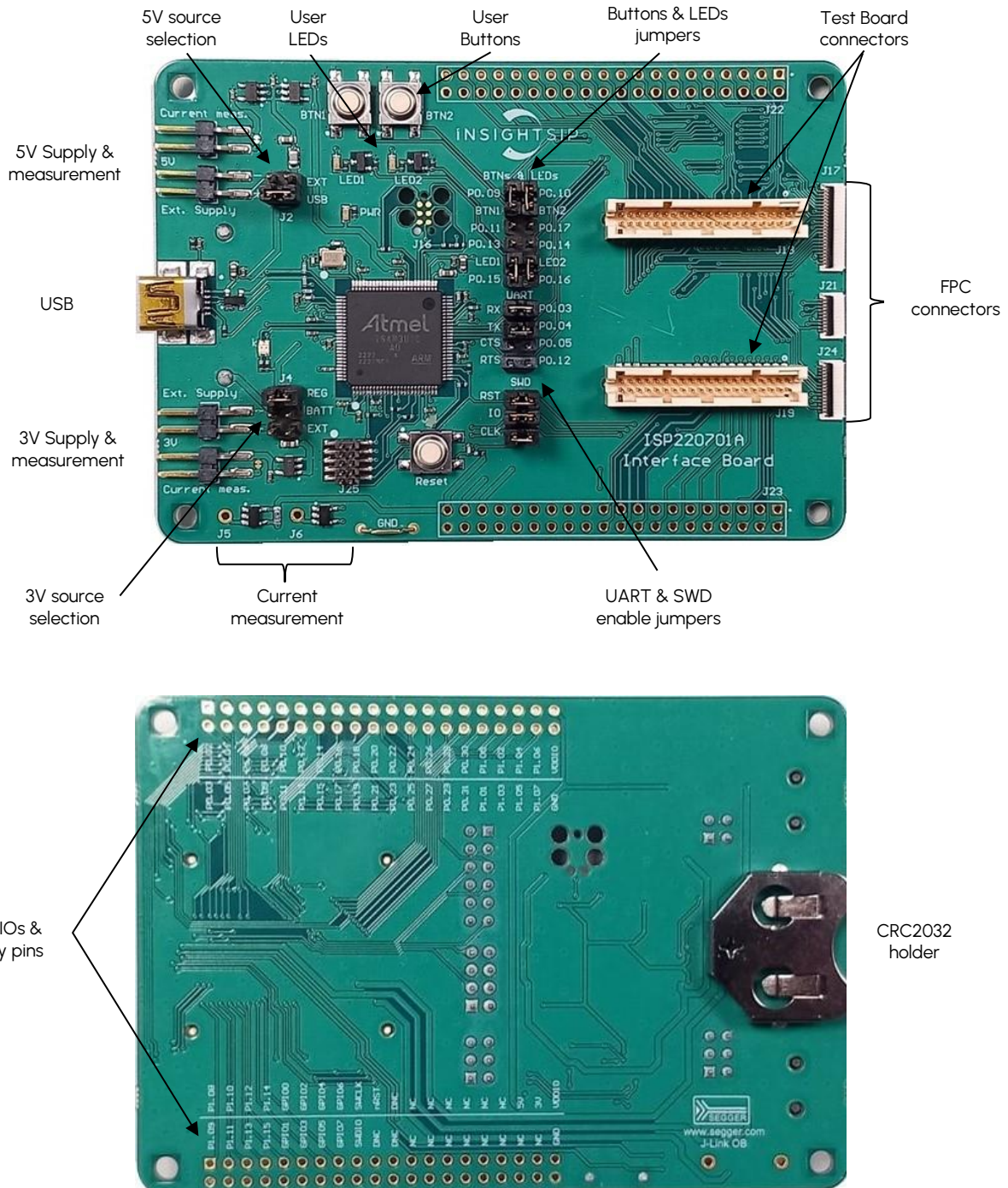
2.3. ISP130603 Interface Board – Revision F or earlier

ISP130603 is an interface board that has dimensions of 100 x 80 mm². The ISP130603 electrical schematic is presented in document SCI30603F which is available upon request.



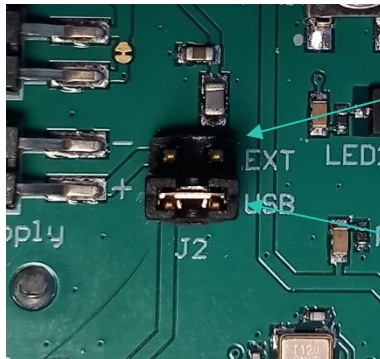
2.4. ISP130603 Interface Board – Revision G or higher

Board overview:



Jumper configurations:

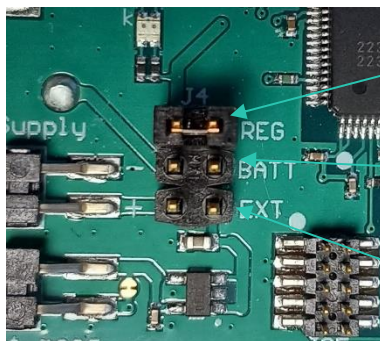
- J2 jumpers selects the 5V power supply source:



5V Supplied from external source
(max 5.5V)

5V Supplied from USB

- J4 jumpers select the 3V power supply source:

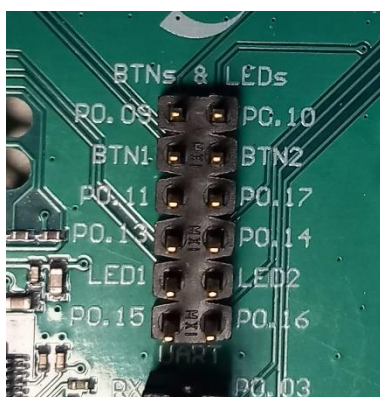


3V Supplied by the embedded regulator

3V Supplied by the CRC2032 battery

3V Supplied from external source
(1.7V – 3.6V)

- SWD & UART jumpers can connect or disconnect Debug and UART lines from the test board. It is recommended when powering up the board with a CRC2032 battery or external 3V. With such supply sources the debugger will not be supplied.
- BTNs & LEDs jumpers gives the possibility to connect up to 2 buttons & 2 LEDs to the test board:



Using a jumper allows to connect:

- BTN1 to P0.09 or P0.11
- BTN2 to P0.010 or P0.17
- LED1 to P0.13 or P0.15
- LED2 to P0.14 or P0.16

2.5. ISP1507-AL-TB Test Board

Board dimensions are 43.7 x 29 mm². It includes:

- ISP1507-AL BLE module
- 3 x FPC connectors on top side of the board (1 x 10 pins, 1 x 14 pins and 1 x 22 pins) to access the nRF52810 GPIOs and JTAG via ISP interface board
- 2 x 5 pin header for programming and debug when connected to a Nordic Evaluation Board
- JTAG footprint for programming and debug when connected to a Segger J-Link



The electrical schematic is available from the website.

2.6. ISP1507-AX-TB Test Board

Board dimensions are 44.8 x 31 mm². It includes:

- ISP1507-AX BLE module
- 3 x FPC connectors on top side of the board (1 x 10 pins, 1 x 14 pins and 1 x 22 pins) to access the nRF52832 GPIOs and JTAG via ISP interface board
- 2 x 5 pin header for programming and debug when connected to a Nordic Evaluation Board
- JTAG footprint for programming and debug when connected to a Segger J-Link



The electrical schematic is available from the website.

2.7. ISP1807-LR-TB Test Board – Revision D or earlier

Board dimensions are 50 x 37 mm². It includes:

- ISP1807-LR BLE module
- 3 x FPC connectors on top side of the board (1 x 10 pins, 1 x 14 pins and 1 x 22 pins) to access the nRF52840 GPIOs and JTAG via ISP interface board
- 2 x 5 pin header for programming and debug when connected to a Nordic Evaluation Board
- JTAG footprint for programming and debug when connected to a Segger J-Link
- USB female connector



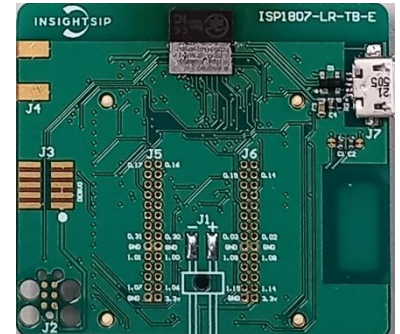
The electrical schematic is available from the website.

2.8. ISP1807-LR-TB Test Board - Revision E or higher

Board dimensions are 47 x 42 mm². It includes:

- ISP1807-LR BLE module
- 2 2x20 pins connectors at the bottom for Interface Board connection
- 2x5 pin header for programming and debug when connected to a Nordic Evaluation Board
- JTAG footprint for programming and debug when connected to a Segger J-Link
- USB female connector
- Printed NFC antenna

The electrical schematic is available from the website.



2.9. ISP1907-LL-TB Test Board - Revision C or earlier

Board dimensions are 43.7 x 29 mm². It includes:

- ISP1907-LL BLE module
- 3 x FPC connectors on top side of the board (1 x 10 pins, 1 x 14 pins and 1 x 22 pins) to access the nRF52811 GPIOs and JTAG via ISP interface board.
- 2 x 5 pin header for programming and debug when connected to a Nordic Evaluation Board
- JTAG footprint for programming and debug when connected to a Segger J-Link

The electrical schematic is available from the website.

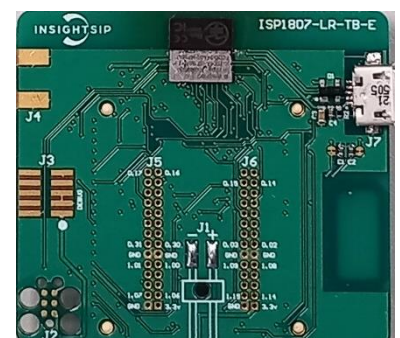


2.10. ISP1907-LL-TB Test Board - Revision D or higher

Board dimensions are 47 x 42 mm². It includes:

- ISP1907-LL BLE module
- 2 2x20 pins connectors at the bottom for Interface Board connection
- 2x5 pin header for programming and debug when connected to a Nordic Evaluation Board
- JTAG footprint for programming and debug when connected to a Segger J-Link

The electrical schematic is available from the website.



2.11. ISP1907-HT-TB Test Board – Revision A

Board dimensions are 50 x 37 mm². It includes:

- ISP1907-HT BLE module
- 3 x FPC connectors on top side of the board (1 x 10 pins, 1 x 14 pins and 1 x 22 pins) to access the nRF52833 GPIOs and JTAG via ISP interface board.
- 2 x 5 pin header for programming and debug when connected to a Nordic Evaluation Board
- JTAG footprint for programming and debug when connected to a Segger J-Link
- USB female connector

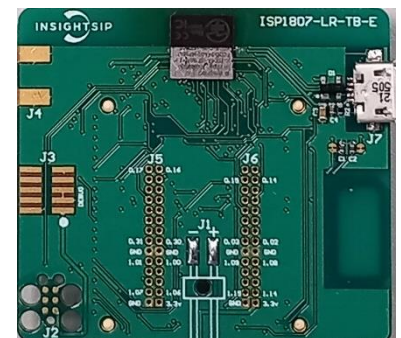


The electrical schematic is available from the website.

2.12. ISP1907-HT-TB Test Board – Revision B or higher

Board dimensions are 47 x 42 mm². It includes:

- ISP1907-HT BLE module
- 2 2x20 pins connectors at the bottom for Interface Board connection
- 2x5 pin header for programming and debug when connected to a Nordic Evaluation Board
- JTAG footprint for programming and debug when connected to a Segger J-Link
- USB female connector
- Printed NFC antenna



The electrical schematic is available from the website.

3. Software Installation

3.1. PC Software Installation

This paragraph describes the steps to follow for software installation.

1. Download and install Segger Embedded Studio (SES) from <https://www.segger.com/downloads>. Go to <https://license.segger.com/Nordic.cgi> and fill the form. A free license key will be emailed to you, start SES, go to Tools -> License Manager and activate your license. This option allows compilation and loading of large applications.
2. Download the latest version and run the J-Link Software and documentation pack for Windows from <http://www.segger.com/jlink-software.html>.
3. Go to <https://www.nordicsemi.com/Products/Low-power-short-range-wireless/Bluetooth-low-energy>. You will have access to the different BLE products:
 - a. nRF52 Series: Click on nRF528xx and on the download section you have access to the documentation, SoftDevice, Master control panel, nRFgo Studio, SDK ... etc.
 - b. nRF52 Development Tools: You can download the last nRF5 SDK.
3. You can also download the SDK in the following link: <https://developer.nordicsemi.com/>.
4. Download and install nRF Connect for Desktop (with the programmer plug-in), make sure to download the last version updated. Go to: <https://www.nordicsemi.com/Software-and-Tools/Development-Tools/nRF-Connect-for-desktop>.
5. Download and install Realterm from https://realterm.sourceforge.io/index.html#downloads_Download

3.2. Smartphone Software Installation

Download the smartphone application "nRF Connect" available on the Play Store (Android version) and the App Store (IOS).

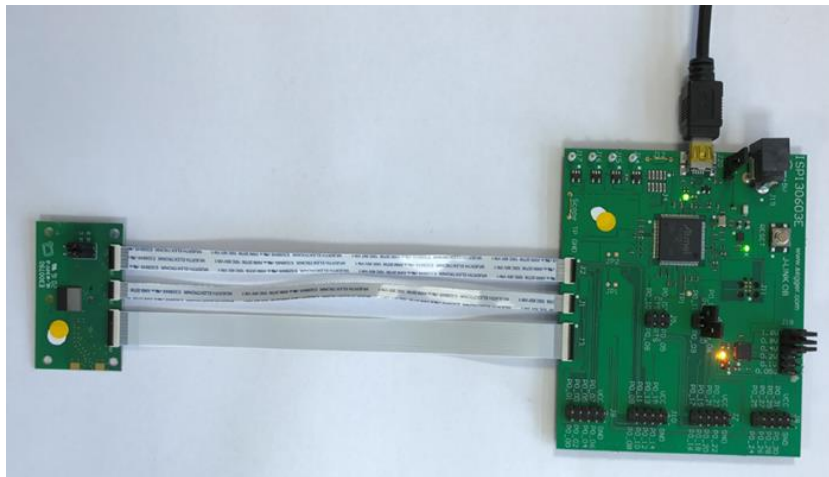
Note

You can also use NRF5 Development Dongle by purchasing it separately from Nordic Semiconductor <https://www.nordicsemi.com/Software-and-tools/Development-Kits>, please refer to the corresponding paragraph nRF528xx Kit User Guide document.

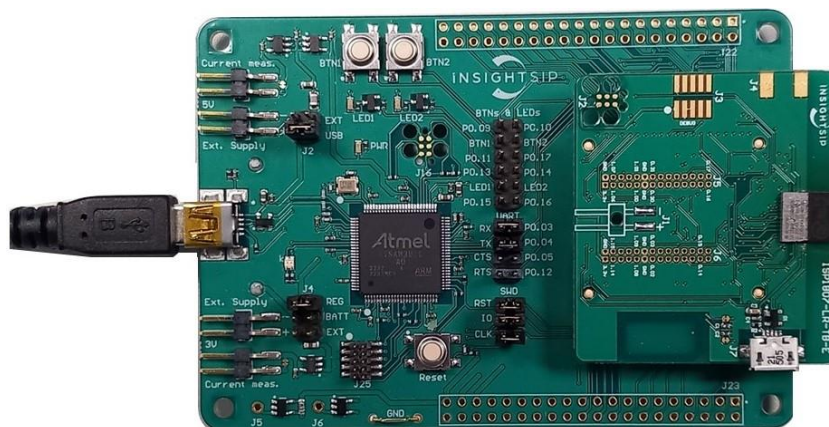
4. Generic Setup

4.1. Hardware setup

- Connect the USB cable from the Interface Board ISPI30603 to your computer.
- If the ISPI30603 is available, connect the BLE Test Board to the Interface Board with the 10 pin, 14 pin and 22 pin FPC jumper cables.

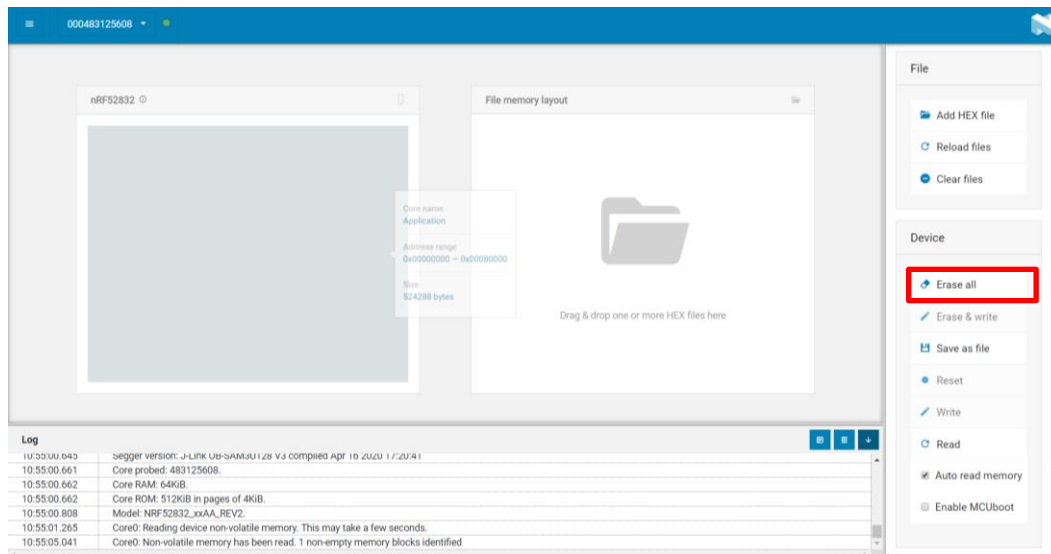


- If the ISPI30603 Revision G or higher is available, Plug the BLE Test Board to the Interface Board using the 2x20 connectors.



4.2. Softdevice Loading

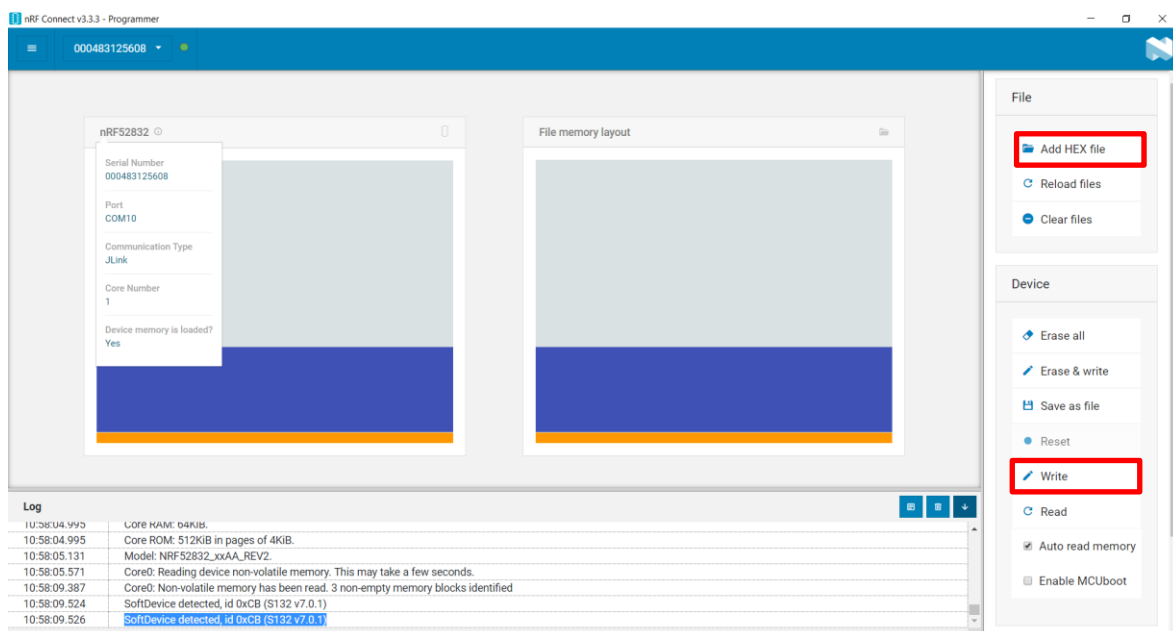
- Start nRF Connect.
- Select Programmer.
- Click Erase all.



- Select the compatible SoftDevice for your module (please refer to the table below), then click Write.

Module Type	ISP1507-AL	ISP1507-AX	ISP1807-LR	ISP1907-LL	ISP1907-HT
Compatible SoftDevices	S112, S113, S132	S112, S113, S132	S113, S140	S112, S113, S122, S140	S113, S122, S140
Nordic Board	PCA10040e	PCA10040	PCA10056	PCA10056e	PCA10100

For instance, the compatible softdevice of ISP1507-AX is S132, and it is at following location:
 ..\nRF5_SDK_17.0.2_d674dde\components\softdevice\s132\hex\s132_nrf52_7.2.0_softdevice.hex



4.3. Application Loading

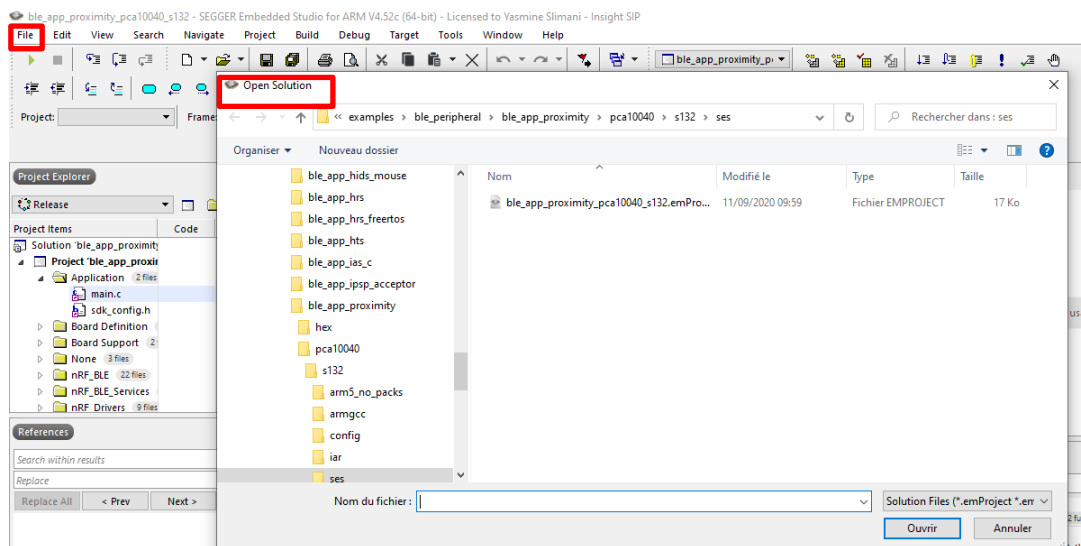
A ready to run standard application is available in hex file format. In this case, load the Application program (hex file) using nRF Connect programmer and click on Write.

Alternatively, the standard application can be modified by the user. In this case:

- Start SEGGER Embedded Studio.
- Select File then Click on "Open Solution". And select the application project you want to modify (with .emProject extension from examples in *nRF5_SDK_17.0.2_d674dde*).

For instance, to modify the *ble_app_proximity* for ISP1507-AX with PCA10040 and S132 SoftDevice, the file location is:

`..\\nRF5_SDK_17.0.2_d674dde\\nRF5_SDK_17.0.2_d674dde\\examples\\ble_peripheral\\ble_app_proximity\\pca10040\\s132\\ses\\ble_app_proximity_pca10040_s132.emProject`



In this example, we add a line in the main section to enable the DCDC.

```
main.c
1098 ret_code_t err_code = sd_ble_gap_tx_power_set(BLE_GAP_TX_POWER_ROLE_ADV, m_advertising.adv_handle, TX_POWER_LEVEL);
1099 APP_ERROR_CHECK(err_code);
1100
1101 /**@brief Function for application main entry.
1102 */
1103 int main(void)
1104 {
1105     bool erase_bonds;
1106
1107     // Initialize.
1108     log_init();
1109     timers_init();
1110     buttons_leds_init(&erase_bonds);
1111     power_management_init();
1112     ble_stack_init();
1113     sd_power_dcdc_mode_set(NRF_POWER_DCDC_ENABLE);
1114
1115     adc_configure();
1116     gap_params_init();
1117     gatt_init();
1118     advertising_init();
1119     db_discovery_init();
1120     services_init();
1121     conn_params_init();
1122     peer_manager_init();
1123
1124     // Start execution.
1125     NRF_LOG_INFO("Proximity example started.");
1126     advertising_start(erase_bonds);
1127     tx_power_set();
1128
1129     // Enter main loop.
1130     for (;;)
1131     {
1132         idle_state_handle();
1133     }
1134
1135 /**
1136 * @}
1137 */
```

5. BLE Proximity Application

This paragraph shows you how to set up and program a BLE Application with a SoftDevice that will send data on a Bluetooth link from the BLE Test Board to your smartphone. In order to use Bluetooth Low Energy radio, the software is loaded in 2 parts (SoftDevice + Application).

This example uses the ISP1507-AX with PCA10040 and with SoftDevice S132. Please refer to the table for choosing the appropriate example for the module you are using.

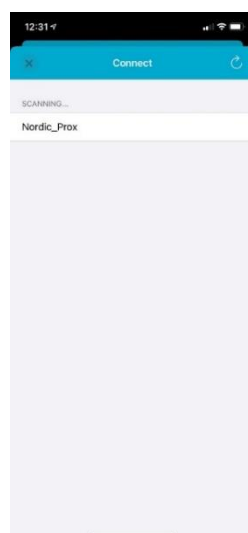
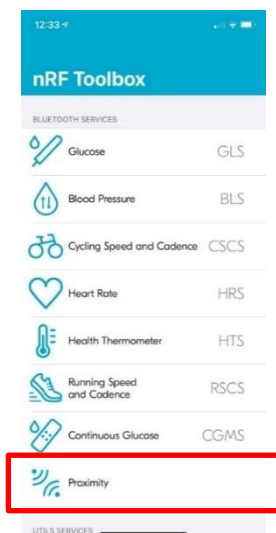
Module Type	ISP1507-AL	ISP1507-AX	ISP1807-LR	ISP1907-LL	ISP1907-HT
Compatible SoftDevices	S112, S113, S132	S112, S113, S132	S113, S140	S112, S113, S122, S140	S113, S122, S140
Nordic Board	PCA10040e	PCA10040	PCA10056	PCA10056e	PCA10100

1. Load SoftDevice as per Section 4.2.
2. Load the appropriate proximity application example with correct board definition for the module.

For instance, for ISP1507-AX with PCA10040 and S132, the file location is:

- For nRF Connect:
`...\\nRF5_SDK_17.0.2_d674dde\\examples\\ble_peripheral\\ble_app_proximity\\hex\\ble_app_proximity_pca10040_s132.hex`
- For Segger Embedded Studio as per Section 4.3:
`...\\nRF5_SDK_17.0.2_d674dde\\examples\\ble_peripheral\\ble_app_proximity\\pca10040\\s132\\ses\\ble_app_proximity_pca10040_s132.emProject`

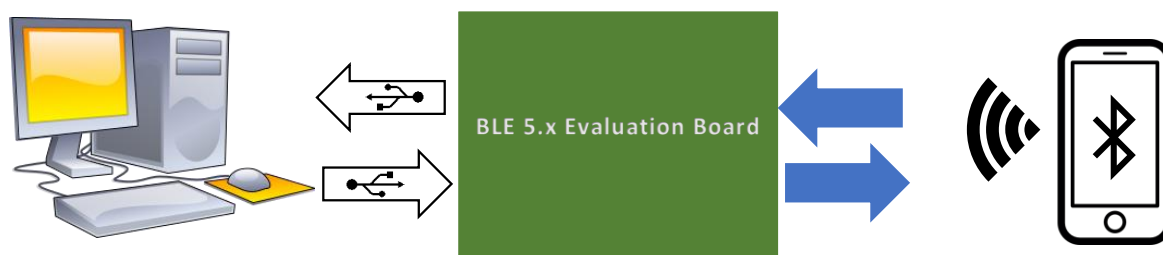
3. Open nRF Toolbox on your smartphone, go to proximity, connect to Nordic_Prox and test your application.



6. BLE UART Mode Example

6.1. Overview

This paragraph shows how to set up and program an example that emulates a serial port over BLE. In this example, Nordic Semiconductor's development board serves as a peer to the phone application "nRF Toolbox", which is available for iOS from Apple Store and for Android from Play Store. In addition, the example demonstrates how to use a proprietary (vendor-specific) service and characteristics with the SoftDevice. In order to use Bluetooth Low Energy and UART interface, the software is loaded in 2 parts.



6.2. BLE UART Mode Setup

On the ISP130603 Interface Board, connect with jumpers or wires provided in the kit:

Module Type	ISP1507-AL	ISP1507-AX	ISP1807-LR	ISP1907-LL	ISP1907-HT
UART connection	RXD to P0_08 TXD to P0_11 CTS to P0_14 RTS to P0_15	RXD to P0_08 TXD to P0_06 CTS to P0_07 RTS to P0_05	RXD to P0_08 TXD to P0_06 CTS to P0_07 RTS to P0_05	RXD to P0_08 TXD to P0_11 CTS to P0_14 RTS to P0_15	RXD to P0_08 TXD to P0_06 CTS to P0_07 RTS to P0_05

Make sure the RXD/TXD/CTS/RTS labels match for each wire. The above are default settings when using the appropriate Nordic Board and Softdevice as described in the table below.

Module Type	ISP1507-AL	ISP1507-AX	ISP1807-LR	ISP1907-LL	ISP1907-HT
Compatible SoftDevices	S112, S113, S132	S112, S113, S132	S113, S140	S112, S113, S122, S140	S113, S122, S140
Nordic Board	PCA10040e	PCA10040	PCA10056	PCA10056e	PCA10100

Then, load the SoftDevice as per Section 4.2.

6.3. Application Loading & Modification

Load the appropriate ble_app_uart example for your module with the correct Nordic board and the appropriate SoftDevice as per Section 4.3 in nRF Connect.

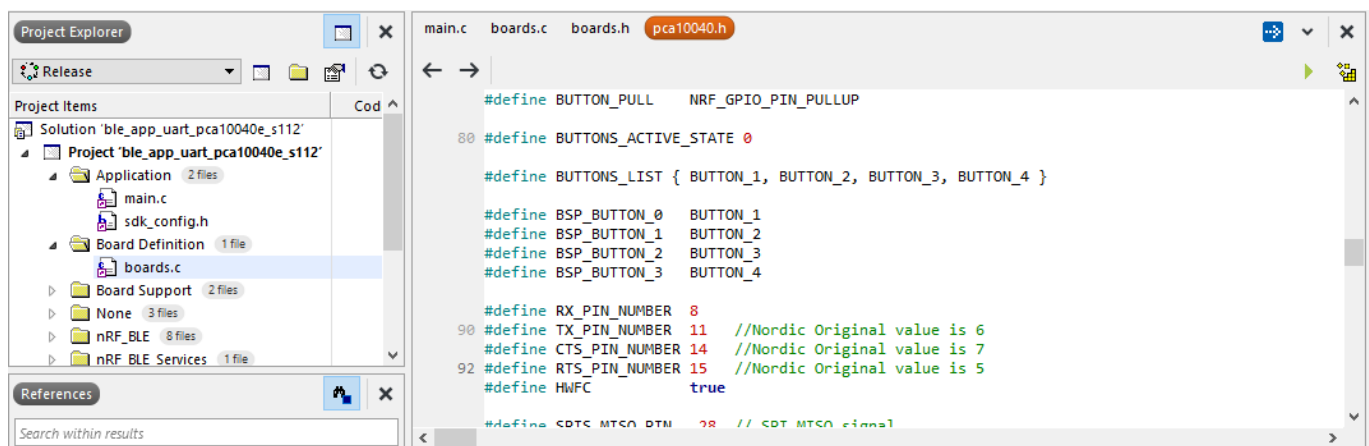
For example, for ISPI507-AX with PCA10040 and S132 SoftDevice, the file to load is:

...\\nRF5_SDK_17.0.2_d674dde\\examples\\ble_peripheral\\ble_app_uart\\hex\\ble_app_uart_pca10040_s132.hex

Note for ISPI507-AL and ISPI907-LL

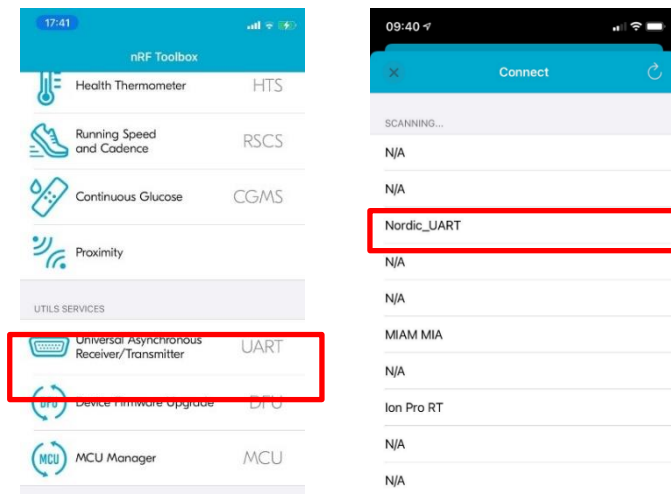
For the ISPI507-AL and ISPI907-LL, the source code must be changed in Segger Embedded Studio. In this case, load the project as per Section 4.3, then follow the steps hereafter:

- Open Board Definition and open boards.c
- Right click and Go to definition to open board.h
- Right click on pca100xx.h and Go to definition.
- Change TX_PIN_NUMBER, CTS_PIN_NUMBER and the RTS_PIN_NUMBER definition as in the figure below.
- Compile link and load the modified application.

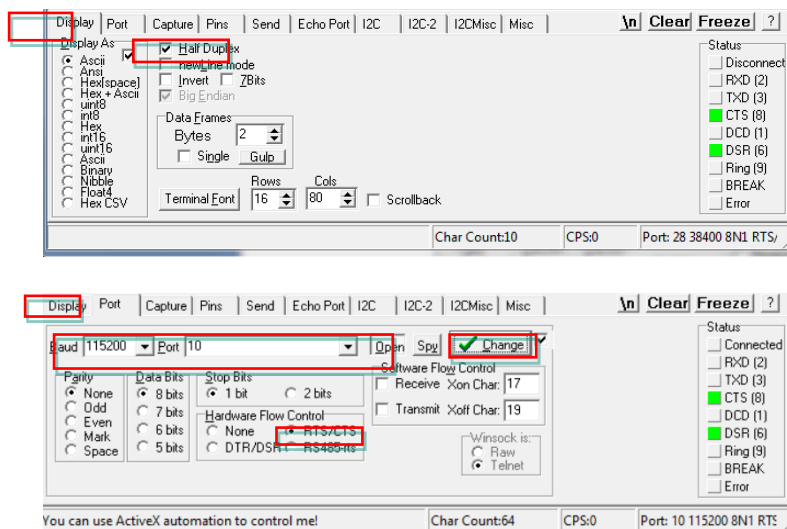


6.4. BLE UART Testing

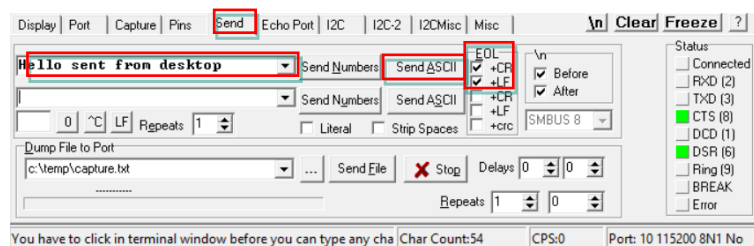
1. Open nRF Toolbox and click on UART, click to connect and select the device: Nordic_UART.

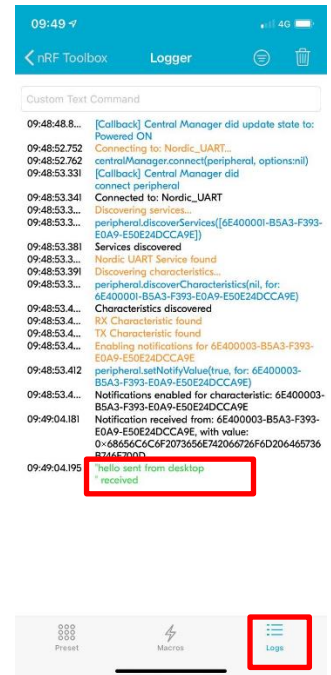
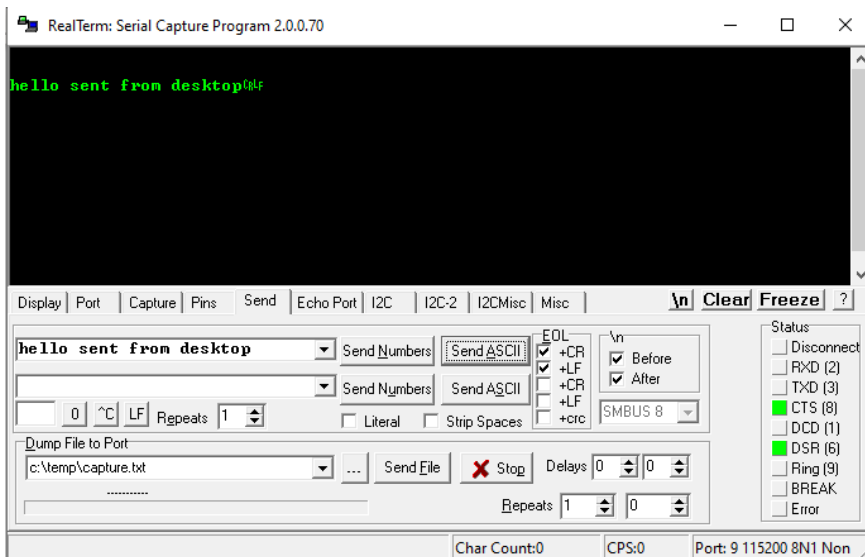


2. Run "RealTerm" on your desktop in order to configure the baudrate, the port COM, ...

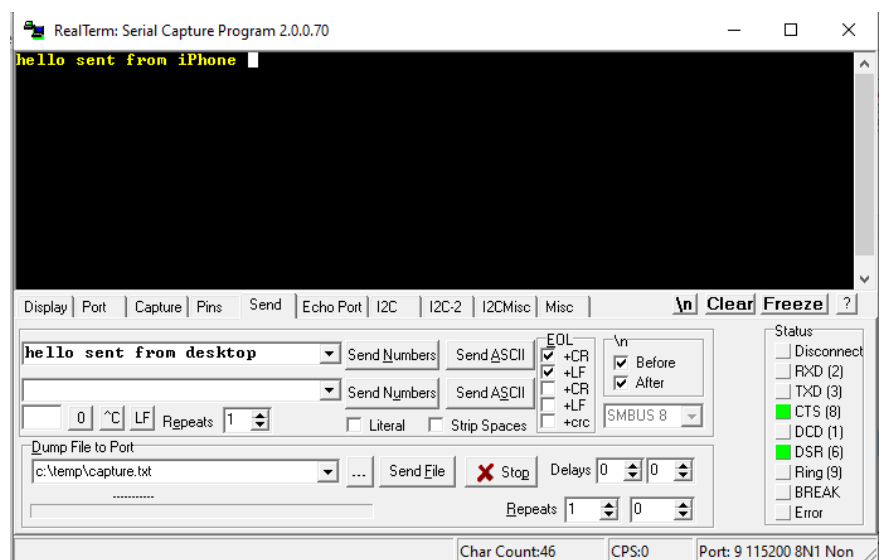
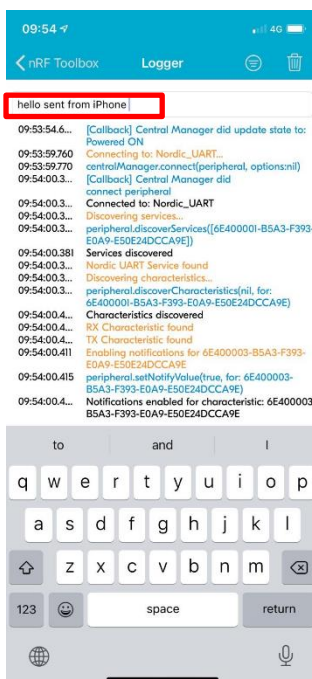


3. Write some characters and click on "Send ASCII".





4. Write some characters on your smartphone and click on send.



The communication is established, you are now able to emulate a serial port over BLE.

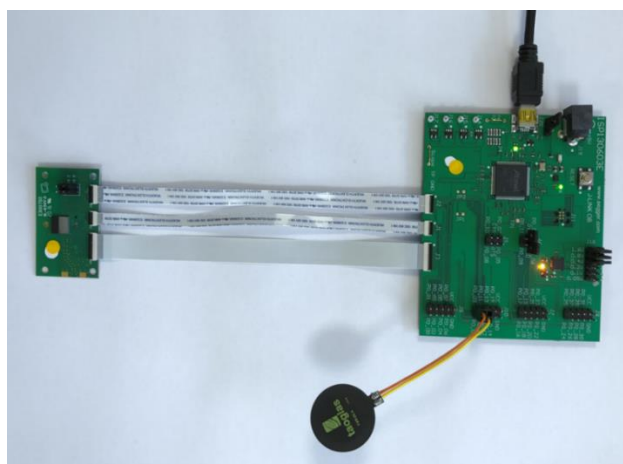
7. NFC Launch App Example

7.1. NFC Mode Set-up

The Launch App Example shows how to use the NFC tag to launch an app on a device that supports NFC and runs Android (4.0 or later) or Windows Phone (8.0 or later). This example is applicable only for the ISPI507-AX, ISPI807-LR and the ISPI907-HT.

On the ISPI30603 Interface Board, connect the 2-lead patch cable in order to connect:

- NFC_1 to PO_09
- NFC_2 to PO_10



7.2. NFC Mode Loading

Load the NFC Launch example with the appropriate Nordic board for your module:

Module Type	ISPI507-AL	ISPI507-AX	ISPI807-LR	ISPI907-LL	ISPI907-HT
Nordic Board	<i>Not applicable</i>	PCA10040	PCA10056	<i>Not applicable</i>	PCA10100

For instance, for ISPI507-AX with PCA10040, the file to load is:

- For nRF Connect
`...\nRF5_SDK_17.0.2_d674dde\examples\nfc\record_launch_app\hex\nfc_launchapp_record_pca10040.hex`
- For Segger Embedded Studio:
`..\nRF5_SDK_17.0.2_d674dde\nRF5_SDK_17.0.2_d674dde\examples\nfc\record_launch_app\pca10040\blank\ses\nfc_launchapp_record_pca10040.emProject`

7.3. NFC Mode Testing

Test the Launch App Example with a Smartphone or a tablet with NFC support by performing the following steps:

1. Touch the NFC antenna with the Smartphone or tablet.
2. Observe that the Smartphone/tablet tries to:
 - Launch the nRF Toolbox app if it is installed.
 - Download the nRF Toolbox app from the store if it is not installed.

8. Direct Test Mode

The Direct Test Mode is used during certification and test, Output power and receive sensitivity can be measured using this mode. This paragraph shows you how to set up and program the Direct Test Mode through the UART BLE Test Board.

8.1. Direct Test Mode Set-up

On the ISPI30603 Interface Board, connect with jumpers or wires provided in the kit:

Module Type	ISPI507-AL	ISPI507-AX	ISPI807-LR	ISPI907-LL	ISPI907-HT
UART connection	RXD to P0_08 TXD to P0_11	RXD to P0_08 TXD to P0_06	RXD to P0_08 TXD to P0_06	RXD to P0_08 TXD to P0_11	RXD to P0_08 TXD to P0_06

Make sure the RXD/TXD labels match for each wire. The above are default settings when using the appropriate Nordic Board and Softdevice as described in the table below.

Module Type	ISPI507-AL	ISPI507-AX	ISPI807-LR	ISPI907-LL	ISPI907-HT
Nordic Board	PCAI0040e	PCAI0040	PCAI0056	PCAI0056e	PCAI0100

8.2. Direct Test Mode Loading

Load the appropriate Direct Test Mode example for your module by referring to the table above.

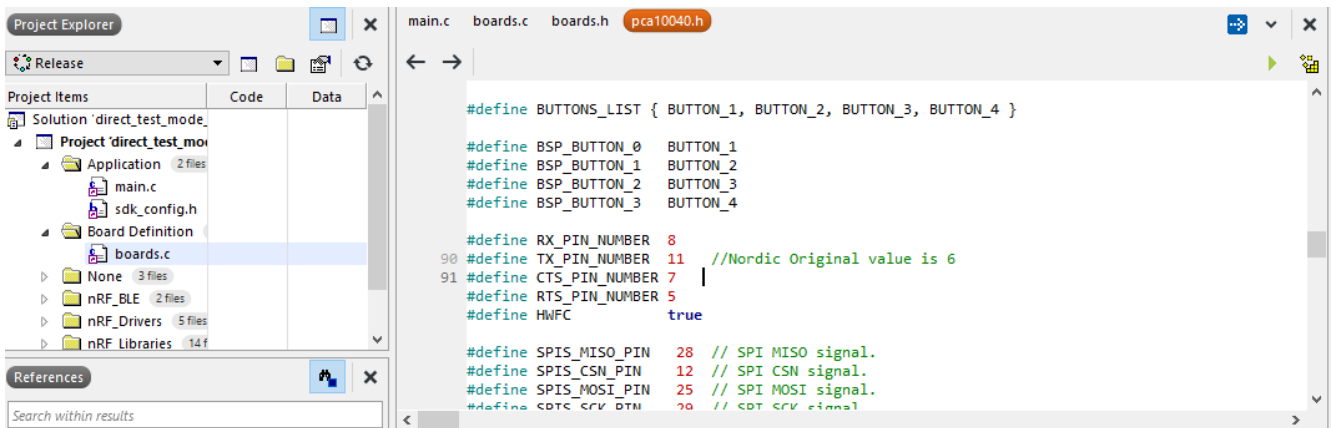
For ISPI507-AX with PCAI0040, the file to load is:

...\\nRF5_SDK_17.0.2_d674dde\\examples\\dtm\\direct_test_mode\\hex\\direct_test_mode_pcal0040.hex

Note for ISPI507-AL and ISPI907-LL

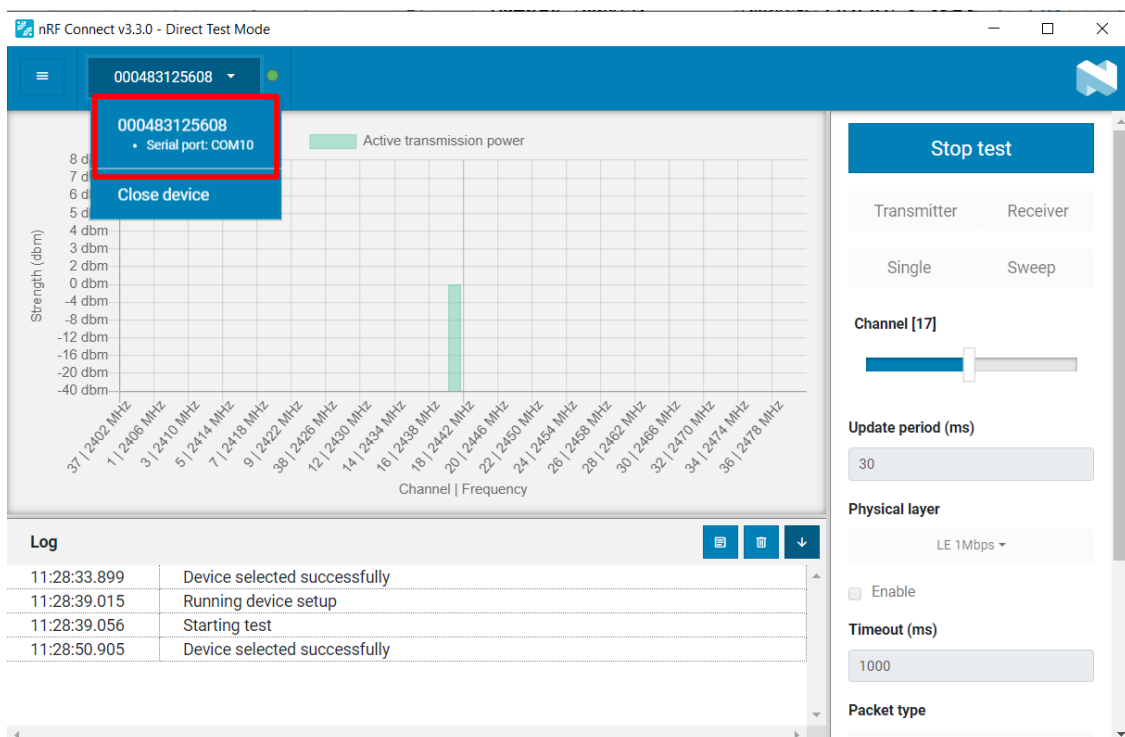
For the ISPI507-AL and ISPI907-LL, the source code must be changed in Segger Embedded Studio:

- Open the appropriate project for your module with the correct Nordic board.
- For ISPI507-AL with PCAI0040e, the file location is:
- ..\\nRF5_SDK_17.0.2_d674dde\\nRF5_SDK_17.0.2_d674dde\\examples\\dtm\\direct_test_mode\\pcai0040e\\blank\\ses\\direct_test_mode_pcai0040e.emProject
- Open Board Definition and open boards.c
- Right click and Go to definition to open board.h
- Right click on pcai00xx.h and Go to definition
- Change TX_PIN_NUMBER definition as in the figure below:



8.3. Direct Test Mode Testing

1. Open Direct Test Mode in nRF Connect.
2. Select device and start Test.
3. If an error while setting up the device has occurred, reboot the interface board.



Note

Erase all before loading Direct Test Mode program. The SoftDevice should not be loaded.