

Application Note AN170701

Use of ISP1510 **Development Kit**



Introduction

Scope

This document gives details on hardware and software for using and testing Insight SiP Bluetooth Low Energy module ISP1510 (model ISP1510-UX).

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1. Recommended Documentation

t's all in the package

The following documents and Dev Kits (software portion) are required to understand the complete setup and programming methods:

Nordic Semiconductor Documents:

- Insight SiP development kit User Guide (hardware section should be partially ignored Insight SiP development kit hardware replaces Nordic Semiconductor hardware).
- Index nRF52 Series Reference Manual.
- IRF52832 PS (data sheet).
- S132 nRF52832 SoftDevice Specification.
- InRF5 SDK (for software development on the nRF51 and nRF52 Series).

To access documentation, information, go to:

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

Nordic Semiconductor Dev kits (software portion):

- \rm hRFgo Studio.
- nRF5 Software Development Kit (SDK):
 - Precompiled HEX files.
 - Source code.
- Keil ARM project files.
- S132 nRF52832 SoftDevice.
- Master Control Panel.

To access these files, go to <u>www.nordicsemi.com</u> and download the files. Instructions can be found in Chapter 3.

DecaWave Documents:

- DW1000 Data Sheet
- 🔸 DW1000 User Manual
- APS013: DW1000 and Two Way Ranging

To access documentation, information, go to:

<u>https://www.decawave.com/support</u> (Official DecaWave website, registration required)



Other ISP documents that complete the above:

- **4** AN1606 App Note this document.
- DS1510 module data sheet.
- ISP1510-UX-TB Test Board schematic "Schematic_ ISP1510-UX-TB".
- ISP130603 Interface Board schematic "SC130604".
- ISP1510 Tag Board schematic "Schematic_ ISP1510-UX-TG".
- ISP1510 Anchor Board schematic "Schematic_ ISP1510-UX-AN".



2. ISP1510 Dev Kit Hardware Content



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3. Software Installation

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This paragraph describes the steps to follow for software installation.

1. Download and install Keil MDK-ARM from https://www.keil.com/demo/eval/arm.htm to your hard drive. After installation, a Pack Installer window appears. Click on the "Packs" section and "Check for updates". After you can show in the Device section "Nordic Semiconductor" on the left side of the screen and different Packs available on the right side of the screen.

Devices Boards		A Packs Examples		
Search: • ×		k	Action	Description
levice	/ Summary	Device Specific	18 Packs	nRF52832_xxAA selected
All Devices	3515 Devices	NordicSemiconductor::nRF_ANT	📀 Install	ANT services and data modelling support modules.
ABOV Semiconductor	5 Devices	NordicSemiconductor::nRF_BLE	🔶 Up to date	Bluetooth Low Energy (Bluetooth Smart) services and software modules for Nordic Semic
+ 🔮 Ambia Micro	8 Devices		🚸 Update	Nordic Semiconductor nRF ARM devices Device Family Pack.
Analog Devices	16 Devices	NordicSemiconductor::nRF_Drivers	🔶 Up to date	Drivers for Nordic Semiconductor nRF family.
+ + ARM	26 Devices		🔶 Up to date	Drivers for external hardware used by Nordic Semiconductor nRF family examples.
+ 🔶 Atmel	260 Devices	NordicSemiconductor::nRF_Examples	🔶 Up to date	Examples and BSP for Nordic Semiconductor nRF family.
- V Cypress	381 Devices	-NordicSemiconductor::nRF_Libraries	🔶 Up to date	Software modules for Nordic Semiconductor nRF family.
+ + Freescale	241 Devices	NordicSemiconductor::nRF_NFC	🚸 Install	NFC services and data modelling support modules.
+ 🔮 GigaDevice	40 Devices	NordicSemiconductor::nRF_Properitary_RF	🛞 Install	Proprietary RF protocols for Nordic Semiconductor nRF family.
Holtek	19 Devices	NordicSemiconductor::nRF_RTX	🚸 Install	Port of the ARM CMSIS-RTOS based RTX for Nordic Semiconductor nRF family.
+ 🔮 Infineon	144 Devices	NordicSemiconductor::nRF_Serialization	🔶 Up to date	Serialization for Nordic Semiconductor nRF family Bluetooth Low Energy (Bluetooth Smar
Maxim	4 Devices	NordicSemiconductor::nRF_SoftDevice_Common	🔶 Up to date	Common components for Nordic Semiconductor nRF family SoftDevices.
- 🖗 Mediatek	2 Devices	NordicSemiconductor::nRF_SoftDevice_S110	🔶 Up to date	Components for Bluetooth Low Energy (Bluetooth Smart) S110 SoftDevice for Nordic Sen
Image: A microsemi	6 Devices	■ NordicSemiconductor::nRF_SoftDevice_S120	Install	Components for Bluetooth Low Energy (Bluetooth Smart) S120 SoftDevice for Nordic Ser
+ 🔮 MindMotion	2 Devices	NordicSemiconductor::nRF_SoftDevice_S130	🚸 Update	Components for Bluetooth Low Energy (Bluetooth Smart) S130 SoftDevice for Nordic Ser
Nordic Semiconductor	8 Devices	NordicSemiconductor::nRF_SoftDevice_S132	🔶 Up to date	Components for Bluetooth Low Energy (Bluetooth Smart) S132 SoftDevice for Nordic Sen
+ 🔧 nRF51 Series	7 Devices		X Remove	Components for Bluetooth Low Energy (Bluetooth Smart) S132 SoftDevice for Nordic Sen
nRF52 Series	1 Device	Previous		NordicSemiconductor::nRF_SoftDevice_S132 - Previous Pack Versions
nRF52832 xxAA	ARM Cortex-M4, 64 MHz, 64 kB RAM, 512 kB ROM		🚸 Install	Components for Bluetooth Low Energy (Bluetooth Smart) S132 SoftDevice for Nordic Sen
+ · Nuvoton	433 Devices		Install	Components for ANT/ANT+ S210 SoftDevice for Nordic Semiconductor nRF family.
E → NXP	275 Devices	-NordicSemiconductor::nRF_SoftDevice_S310	Install	Components for Bluetooth Low Energy (Bluetooth Smart) and ANT/ANT+ S310 SoftDevia
Renesas	2 Devices	Generic	18 Packs	
Silicon Labs	397 Devices	ARM::CMSIS	🔶 Up to date	CMSIS (Cortex Microcontroller Software Interface Standard)
- SONIX	49 Devices	ARM::CMSIS-Driver_Validation	Install	CMSIS-Driver Validation
B → STMicroelectronics	768 Devices	ARM::CMSIS-RTOS_Validation	Install	CMSIS-RTOS Validation
Texas Instruments	341 Devices	- ARM::mbedClient	Install	ARM mbed Client for Cortex-M devices
 Toshiba 	88 Devices		Install	ARM mbed Cryptographic and SSL/TLS library for Cortex-M devices
Toshiba	do Devices	ARM::minar	Install	mbed OS Scheduler for Cortex-M devices
		· Keil::ARM Compiler	🚸 Update	Keil ARM Compiler extensions
		-Keil::Jansson	Install	Jansson is a C library for encoding, decoding and manipulating JSON data
		Keil::MDK-Middleware	📀 Update	Keil MDK-ARM Professional Middleware for ARM Cortex-M based devices
		E-Keil::XMC1000 DFP		Infineon XMC1000 Series Device Support, deprecated: Use "Infineon::XMC1000 DFP" inste
		E-Keil::XMC4000 DFP		Infineon XMC4000 Series Device Support, deprecated: Use "Infineon::XMC4000_DFP" inste
		E-IwIP::IwIP		WIP is a light-weight implementation of the TCP/IP protocol suite
		Micrium:RTOS		Micrium software components

On the "Packs" section, you can download and update Nordic example, nRF SoftDevice, nRF DeviceFamilyPack, nRF examples..., etc ...

All the Packs are installed on the following directory: C:\Keil_v5\ARM\Pack\NordicSemiconductor.

- 2. Download and run the J-Link Software and documentation pack for Windows from http://www.segger.com/jlink-software.html. The serial number from your SEGGER J-Link hardware is needed to identify your device and can be found printed on the chip on the J-Link Lite emulator board.
- 3. Go to www.nordicsemi.com and log in to your Nordic My Page account.

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- 4. Go to Products and click on Bluetooth Smart/Bluetooth Energy. You will have access to the different product :
 - a. <u>nRF52 Series</u> : Click on nRF52832 and on the download section you have access to the documentation, SoftDevice, Master control panel, nRFgo studio, SDK ... etc ...
 - b. <u>nRF52 Development Tools</u>: You can download the last nRF5 SDK.
- 5. You can also download the SDK in the following link: <u>https://developer.nordicsemi.com/</u>.
- 6. Download and install nRFgo Studio (Make sure to download the last version updated).
- 7. Download and install Master Control Panel (x86 is for 32 bits windows and x64 is for 64 bits windows).

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4. Hardware Description

lt's <mark>all</mark> in the <mark>package</mark>

4.1. ISP1510-UX Module

ISP1510-UX is a Bluetooth Low Energy and UWB module with integrated antennas.

Despite its small size of 9.0 x 16.0 x 1.9 mm, the ISP1510 module integrates the DecaWave DW1000 chipset which is an Ultra Wide Band transceiver dedicated to indoor localization applications. This chipset needs an external processor to operate and Insight SiP decided to integrate the Nordic Semi nRF52 SoC. In addition to the powerful ARM Cortex M4F MCU, this chip also provides a BLE and NFC connectivity for wireless set up and control of the UWB chip.



ISP1510 also integrates all passives, crystals and DC/DC converters to optimize the power consumption. And last but not least, it integrates 2 antennas in the same package. This is a new and unique concept developed by Insight SiP within a SIP package. For BLE function, we keep using our usual PCB trace antenna design. For UWB function, the second antenna is printed directly on top of the molding.

For more details, see Insight SiP module data sheet (document DS1510).

4.2. ISP1510-UX-TB Test Board

ISP1510-UX-TB is the basic application test board that has dimensions of 50 x 60 mm².



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It encloses:

- ISP1510-UX UWB and BLE module
- **4** 3 x FPC connectors in order to access the nRF52832 GPIOs:
- 1 x 10 pin FPC connector on top side of the board.
- 1 x 14 pin FPC connector on top side of the board.
- 1 x 22 pin FPC connector on top side of the board.
- 1 x 10 pin header order to access the decaWave GPIOs

The ISP1510-UX-TB electrical schematic is presented in document Schematic_ ISP1510-UX-TB.

4.3. ISP130603 Interface Board

ISP130603 is the application type interface board that has dimensions of $100 \times 80 \text{ mm}^2$. The ISP130603 electrical schematic is presented in document SC130604.



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4.4. ISP1510-AN Anchor Board

ISP1510 Anchor Board is one of two the application boards that is used for the ranging demonstration. It has dimensions of $62.5 \times 40 \text{ mm}^2$.

It encloses:

4 ISP1510-UX UWB and BLE module

- 4 2 x mini-LEDs
- 4 USB connector
- Removable 10 pin FPC connector for software loading
- \rm FTDI USB-to-Serial adapter
- UWB Antenna on PCB
- Ranging firmware

The ISP1510-AN Anchor Board electrical schematic is presented in the document Schematic_ISP1510-UX-AN.



4.5. ISP1510-TG Tag Board

ISP1510 Tag Board is one of two the application boards that is used for the ranging demonstration. It has dimensions of $31 \times 18 \text{ mm}^2$.

It encloses:

- ISP1510-UX UWB and BLE module
- 4 2 x mini-LEDs
- Battery holder
- Removable 10 pin FPC connector for software loading
- 4 Ranging firmware

The ISP1510-TG Tag Board electrical schematic is presented in the document Schematic_ISP1510-UX-TG.





4.6. nRF5 series Development Dongle

The reader should refer to the corresponding paragraph in nRF52832 Development Kit User Guide document.



5. Basic Application using ISP1510-UX-TB Test Board

5.1. Basic BLE Proximity Application

This paragraph shows you how to set up and program a BLE proximity application on top of a SoftDevice that will send data on a Bluetooth link from the ISP1510-UX-TB Test Board to the Master Emulator. In order to use Bluetooth Low Energy radio, the software is loaded in 2 parts:

- 4 S132 SoftDevice using nRFgo Studio (hex file, no source).
- Proximity Application using Keil uVision.

Then Master Emulator is connected and Proximity Application is launched.

S132 SoftDevice loading

- 1. Connect the provided USB cable from the Interface Board ISP130603 to your computer.
- 2. Connect the ISP1510-UX-TB Test Board to the ISP130603 Interface Board with the 10 pin, 14 pin and 22 pin FPC jumper cables (0.5 mm pitch, provided in the Development Kit).



- 3. Start nRFgo Studio.
- 4. Select nRF5x Programming.



5. Click Erase all.

eatures ×		
 2.4 GHz Front-End Te TX carrie 	SEGGER to use: 518004334 Refresh	
RX const TX/RX c	nRF51822 QFAAHX0 (0x007d)	
RX sensit Bluetooth	Region 1 (Application)	Program SoftDevice Program Application Program Bootloader
 Bluetooth nRF8001 Co Dispatcher 		Programming of SoftDevice on nRF5x device
Trace Transl		File to program: rf51822_8.0.0_softdevice.hex Browse
Direct Test nRF8002		Lock SoftDevice from readback
11110002		SoftDevice size (kB): 0
		Enable SoftDevice protection (UICR.CLENR0)
	Size: 128 kB	
		Program Verify Read
nRF5x Bootloader nRF24LU1+ Boo		

6. Browse to SoftDevice hex file and click Program. The SoftDevice is available on the Nordic Website or by installing the SoftDevice S132 with the Pack Installer, for example : C:\Keil_v5\ARM\Pack\NordicSemiconductor\nRF_SoftDevice_S132\2.0.0-7.alpha\hex

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🔀 nRFgo Studio		
<u>File View n</u> RF8001	Setup Help	
Features ×		
 2.4 GHz Front-End Te TX carrie RX const 	SEGGER to use: 518004330 Refresh	
TX/RX c RX sensit	Region 1 (Application)	Program SoftDevice Program Application Program Bootloader
 Bluetooth nRF8001 Co 		Programming of SoftDevice on nRF5x device
Dispatcher Trace Transl	Size: 404 kB	File to program: 2.0.0-7.alpha_softdevice.hex Browse
Direct Test nRF8002		Lock SoftDevice from readback SoftDevice size (kB): 108
	Address: 0x1b000	Enable SoftDevice protection (UICR.CLENR0)
	Region 0 (SoftDevice)	
	Size: 108 kB	Program Verify Read
	Firmware: S132_nRF52_2.0.0-7.alpha (Id: 0x0079)	
Device Manager X Motherboards nRF5x Program nRF5x Bootloader nRF24LU1+ Boo	Erase all	
Log		×
Unable to find or open Recover completed Erase completed	the JLinkARM dll	
	RM/Pack/NordicSemiconductor/nRF_SoftDevice_S132/2.0.0-7.alpha/hex/	s132_nrf52_2.0.0-7.alpha_softdevice.hex programmed successfully

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Proximity Application loading

- 1. Start Keil uVision.
- 2. Select Project then Open Project in order to open Proximity app. Make sure it is the right file project. The project is locked, it is read only, if you want to modify it, you have to change the right in the file App directory properties.

(Ex: C:\Keil_v5\ARM\Pack\NordicSemiconductor\nRF_Examples\11.0.0-2.alpha\ble_peripheral\ble_app_proximity\pca10040\s132\arm5 \ ble_app_proximity_s132_pca10040.uvprojx).



If some Install Softwares Packs is missing, a window appears, and you can install it.

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3. Click Build Target and Load. If you have this message after click Load, it means that the power is not enough and you have to increase the voltage by adding jumpers on the interface board.



You can also load the hex file (generated after building target with keil uVision) by nRFgo studio in the program application.

😒 nRFgo Studio		
Eile View nRF8001 S	etup <u>H</u> elp	
Features X 2.4 GHz Front-End Te TX carrie RX const	SEGGER to use: 518004330 • Refresh	
TROUTL TRRC Wennik Bloetooth nRRBOI Co Dippether Tret Find Direct Text nRF8002	Region 1 (Application) Size: 40148 Address: 0x10000 Region 0 (SoftDevice) Size: 1088 Firmware: 5132_nRF32_2.0.0-7.alpha (dd: 0x0079)	Program SoftDevice Program Application Program Bootbader Programming of Application on nRF5x device File to program: 5/_budg/mf52832_yxaa_s132.hex Bronse Lock entire drip from readback Program terrfy Bead
Device Menager X Motherboards InR55: Bootoards InR524U01+ Boo	Erec al	
Log		
Erase completed Softdevice C:/Keil_v5/AR	M/Pack/NordicSemiconductor/nRF_SoftDevice_S132/2.0.0-7.alpha/hex/ RM/Pack/NordicSemiconductor/nRF_Examples/11.00-2.alpha/ble_perip ""	

The file project is located for example:

C:\Keil_v5\ARM\Pack\NordicSemiconductor\nRF_Examples\11.0.0-2.alpha\ble_peripheral\ ble_app_proximity\pca10040\s132\arm5_build _build\ nrf52832_xxaa_s132.hex).



Master Emulator and Proximity Application

- 1. Connect nRF51 Dongle (Master Emulator) into a USB port on your computer.
- 2. Start Master Control Panel. If you have no master emulator found, you have to flash the dongle in Flash programming section.



3. Click Start Discovery.

16:58:13.2] Device discovery stopped	Master Control Panel	
COM113 - 680791841 680791841 connected Reset Scan for devices Stop discovery Discovered devices Image: Control of the store of the s		
Scan for devices Stop discovery Discovered devices O- Nordic_Prox (0xC9E7671F2E15) (-67dBm) Select device Delete bond info Log 16:57:49.1] Ready 16:57:49.1] SERVER: Server has started 16:57:49.6] Device discovery started 16:58:13.2] Device discovery started 16:58:13.2] Device discovery stopped		
Stop discovery Discovered devices	COM113 - 680791841 680/91841 connected	Reset
Discovered devices Discovered devices Select device Delete bond info Log 16:57:49.1] Ready 16:57:49.1] SERVER: Server has started 16:57:49.6] Device discovery started 16:58:13.2] Device discovery stopped	Scan for devices	
B - Nordic_Prox (0xC9E7671F2E15) (-67dBm) Select device Delete bond info Log 16:57:49.1] Ready 16:57:49.1] SERVER: Server has started 16:57:49.6] Device discovery started 16:57:49.6] Device discovery started 16:58:13.2] Device discovery stopped	Stop discovery	
Select device Delete bond info Log [16:57:49.1] Ready [16:57:49.1] SERVER: Server has started [16:57:49.6] Device discovery started [16:58:13.2] Device discovery stopped	Discovered devices	
Log [16:57:49.1] Ready [16:57:49.1] SERVER: Server has started [16:57:49.6] Device discovery started [16:58:13.2] Device discovery stopped		
16:57:49.1] Ready 16:57:49.1] SERVER: Server has started 16:57:49.6] Device discovery started 16:58:13.2] Device discovery stopped		
16:57:49.1] SERVER: Server has started [16:57:49.6] Device discovery started [16:58:13.2] Device discovery stopped		
16:57:49.6] Device discovery started [16:58:13.2] Device discovery stopped		
	[16:57:49.6] Device discovery started	[
16:58:13.9] Device discovery started	[16:58:13.2] Device discovery stopped	
	[16:58:13.9] Device discovery started	

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- 4. After starting discovery, if no device appearing, disconnect and connect again the interface board power supply.
- 5. If you have an error message as indicated in the photo :



It means that the nRF5 Dongle is not programmed. For your information, please refer to the nRF51822 Development Kit User Guide document as indicated in our application note ISP130301-DK1 part 4.5 on page 14-7. You can find this user guide on the Nordicsemi website. The procedure to program the nRF51 Dongle is described on page 13. I enclose a copy of the user guide for your convenience.

- 1) Open the Master Control Panel from the Start menu (Start > All Programs > Nordic Semiconductor > Master Control Panel).
- 2) Make sure the Development Dongle is detected. The Master Emulator item list should show COMnn-xxxxxxxx (nn gives the COM port number; xxxxxxxx is the SEGGER serial number printed on the dongle). Restart the application if it doesn't appear in the item list. Before continuing, make sure you have selected the correct device by verifying the serial number in the item list with the serial number printed on the Development Dongle.
- 3) When you use the Development Dongle for the first time, you must first program it with the Master Emulator Firmware.
 - a. In the Master Control Panel menu click File and select Flash Programming.
 - b. Click Browse. This opens a browser that automatically points to the location of the
 - c. mefw_nrf51822_<version>_firmware.hex (<version> will be replaced by a number
 - d. giving the version of the actual firmware).
 - e. The Master Control Panel Firmware file is located in:
 - f. C:\Program Files (x86) \ Nordic Semiconductor \ Master Control Panel \<version>\firmware\
 - g. pca10000/MEFW_nRF51822_<version>_firmware.hex.
 - h. Select the Master Emulator Firmware file and click Open.
 - *i.* Click Program to start programming the selected device.
 - j. When the programming is finished click Exit to go back to the main window.
- 6. Click Select Device.
- 7. On the following display, click successively on Bond, Discover Services and Enable Services.

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🖻 Master Control Panel
File Help
Master emulator
COM113 - 680791841
Device info Device address: C9E7671F2E15 Bonded: True
Actions
Disconnect Bond Update Discover services Disable services DFU
Service Discovery
PrimaryService, Value: 02-18, Immediate Alert (0x1802) OracteristicDeclaration, Value: 04-0E-00-06-2A, Properties: WriteWithoutResponse, Cha AlertLevel, (No values read) PrimaryService, Value: 03-18, Link Loss (0x1803) OracteristicDeclaration, Value: 0A-11-00-06-2A, Properties: Read, Write, Characteristic L AlertLevel, (No values read) PrimaryService, Value: 0F-18, BatteryService (0x180F) OracacteristicDeclaration, Value: 12-14-00-19-2A, Properties: Read, Notify, Characteristic L Battery Level, Value: 64 III Attribute value
UUID (0x): Handle (0x): Display as UTF8 Read long Read
Value: hex text Write long Write
Back
Log
[17:00:21.7] ConnectionParameterUpdateResponse sent
[17:00:22.0] Connection Parameters Updated. ConnInterval:500ms, SlaveLatency:0, Supervisio
[17:00:22.9] Enable Services({0x0015:1,})
[17:00:23.5] Updated handle 0015 with value [1, 0]
[17:00:23.5] Successfully updated the store value of CCCD

It's all in the package

- 8. You can note Battery voltage is sent by the ISP1510-UX-TB Test Board to the Master Emulator via the Bluetooth link. The application is written to send a value that changes cyclically.
- 9. You can also use the "nRF Master Control Panel" application which is available for iOS from Apple Store and for Android from Play Store. Download, install and run the application, click to SCAN and select the device: Nordic_PROX.

<u>Important notification</u>: Pay attention to the compatibility between the IC revision, the SoftDevice, the nRF5 SDK, etc, ... Please read the compatibility matrix available on the "infocenter" website from Nordic.

http://infocenter.nordicsemi.com/index.jsp



5.2. Direct Test Mode (UART)

This paragraph shows you how to set up and program the Direct Test Mode through the UART on ISP1510-UX-TB Test Board.

Direct Test Mode Set-up

- 1. Connect the USB cable from the Interface Board ISP130603 to your computer.
- 2. Connect the ISP1510-UX-TB Test Board to the ISP130603 Interface Board with the 10 pin, 14 pin and 22 pin FPC jumper cables (0.5 mm pitch, provided in the Development Kit)
- 3. On the ISP130603 Interface Board, connect the 2-lead patch cable in order to connect:
 - RXD to P0_08
 - TXD to P0_06

Make sure the RXD/TXD labels match for each wire. This matches the default setting if you are using the Nordic Board PCA10040 in the SDK project (be careful: depending on the Nordic Board version you are using, the ports used could be different, see next part: Direct Test Mode loading).

Direct Test Mode Loading

- 1. Start Keil uVision.
- Select Project then Open Project in order to open Direct Test Mode application: C:\Keil_v5\ARM\Pack\NordicSemiconductor\nRF_Examples\11.0.0-2.alpha\ dtm\direct_test_mode\ pca10040\blank\arm5\direct_test_mode_blank_pca10040.uvprojx.

<u>Warning</u>: Regarding the Nordic Board you are using, the RX and TX pin number could be different. In the following pictures, the Nordic board PCA10040 is used (you can modify the Nordic Board model in : Flash \rightarrow Configure Flash Tools \rightarrow C/C++, by writing the correct Board name in the "Define" area with the name indicated in the boards.h).



🗋 🚰 🛃 🔬 🛵 🙀 Download	F8 [18 18] 律 律 //: //:: 20	💽 🔜 🥐 🔍 💿 🔿 👧 💷 - 🔦
🕮 🗃 🥔 🔜 🙀 Erase	l 🚠 🗟 🗇 🌚	
t Configure Fla	ash Tools nrf6310.h 🛐 main.c	
Configure Fi Configure Fi Project: direct_test_mode_blank_pco Project: direct_test_mode_blank_pco Application Completer abstraction Completer abstraction Core_cmletch Completer abstraction Comple	Immoslum #; main. Immoslum #; main.	is property of Nordic Semiconductor ASA. e described in detail in NORDIC

In the following picture, the Nordic board PCA10040 is used by default and the RX and TX pin number are 08 and 06.



C:\Keil_v5\ARM\Pack\NordicSemiconducto	nnRF_Examples\11.0.0-2.alpha\dtm\direct_test_mode\pca10040(blank\arm5\direct_test_mode_blank_pca10040.uvprojx[Read Only]
File Edit View Project Flash Debug	Peripherals Tools SVCS Window Help
🗋 💕 🖬 🥔 🐰 🛍 🛍 🗠 (*)	← → 陀 豫 豫 澤 澤 ///// //// 🖄 ADIO_TXPOWER_TXPOW 🖳 🗟 🌮 Q ● ○ 🔗 🅀 🔤 🔍
🔗 🖾 🕮 🧼 🔜 🙀 🔤 nrf52832_xxaa	토 🔊 🛔 🖻 🔶 🗇 🏟
Project 🛛 🗣 🔯	[™] pca10040.h 🐙 main.c
Project: direct_test_mode_blank_pca	34 #define BSP LED 2 MASK (1< <bsp 2)<="" led="" td=""></bsp>
🖨 ᇶ nrf52832_xxaa	35 #define BSP_LED_3_MASK (1< <bsp_led_3)< td=""></bsp_led_3)<>
- 🗁 Application	36
🖃 🕷 main.c	37 #define LEDS_MASK (BSP_LED_0_MASK BSP_LED_1_MASK BSP_LED_2_MASK BSP_LED_3_MASK)
ble_dtm.h	38 /* all LEDs are lit when GPIO is low */
boards.h	39 #define LEDS_INV_MASK_LEDS_MASK 40
	41 #define BUTTONS NUMBER 4
bsp.h	
🙄 cmsis_armcc.h	43 #define BUTTON START 13
- 🖑 compiler_abstraction	44 #define BUTTON 1 13
- 🚰 core_cm4.h	45 #define BUTTON_2 14
🗳 core_cmFunc.h	46 #define BUTTON_3 15
Core cmInstr.h	47 #define BUTTON_4 16
ore cmSimd.h	48 fdefine BUTTON STOP 16
mrf.h	49 #define BUTTON_PULL NRF_GPIO_PIN_PULLUP 50
	<pre>51 #define BUTTONS_LIST { BUTTON_1, BUTTON_2, BUTTON_3, BUTTON_4 }</pre>
mrf51_to_nrf52.h	
nrf52.h	53 #define BSP BUTTON 0 BUTTON 1
nrf52_bitfields.h	54 #define BSP BUTTON 1 BUTTON 2
📲 🔐 nrf_gpio.h	55 #define BSP_BUTTON_2 BUTTON_3
宁 pca10040.h	56 #define BSP_BUTTON_3 BUTTON_4
stdbool.h	57
stdint.h	58 fdefine BSP BUTTON 0 MASK (1
System_nrf52.h	59 #define BSP_BUTTON_1_MASK (1< <bsp_button_1) 60 #define BSP_BUTTON 2 MASK (1<<bsp_button 2)<="" td=""></bsp_button></bsp_button_1)
	61 #define BSP_BUITON_3 MASK (I
Documentation	
	63 #define BUTTONS MASK 0x001E0000
- CMSIS	64
🗉 🥎 Device	65 #define RX_PIN_NUMBER 8
🖽 🐟 nRF_BLE	66 #define TX_PIN_NUMBER 6
• nRF_Drivers	67 #define CTS_PIN_NUMBER 7
· -	68 #define RTS_PIN_NUMBER 5 69 #define HWFC true
	69 #define HWFC true 70
	71 #define SPIS MISO PIN 28 // SPI MISO signal.
	72 #define SPIS CSN FIN 12 // SPI CSN signal.
	73 #define SPIS MOSI FIN 25 // SPI MOSI signal.
	74 #define SPIS_SCK_PIN 29 // SPI SCK signal.
	75 75
	76 #define SPIMO_SCK_PIN_29 // SPI clock GPIO pin number.
	77 #define SPIMO_MOSI_PIN_25 // SPI Master Out Slave In GPIO pin number.
	78 #define SPIMO_MISO_PIN_28 // SPI Master In Slave Out GPIO pin number. 79 #define SPIMO_SS_PIN_12 // SPI Slave Select GPIO pin number.
	79 <mark>#define SPIMO_SS_PIN 12 // SPI Slave Select GPIO pin number.</mark> 80
<u> ۲</u>	81 #define SPIM1 SCK PIN 2 // SPI clock GPIO pin number.
E Project Books { Func 0. Temp	۲

- 3. Click Build Target and Load.
- 4. If you have the next error message, it means that you have not enough RAM to flash algorithm.

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🗋 🚰 🛃 🖉 🕉 🛵 🖎 🗠 🖓 🗠	rais Tools SVCS Window Help 陀 熟 熟 慧 譚 //:///:/ // //: //: //: //: //: //: /	
 Image: Second sec		
voject 4 🖾 🖉 👬		•
Source Code	<pre> * Copyright (c) 2014 Nordic Semiconductor. All Rights Reserved. * The information contained herein is property of Nordic Semiconductor ASA. * The information contained herein is property of Nordic Semiconductor ASA. * The information contained herein is property of Nordic Semiconductor ASA. * The information contained herein is property of Nordic Semiconductor ASA. * The information contained herein is property of Nordic Semiconductor ASA. * The information contained herein is property of Nordic Semiconductor ASA. * The information contained herein is property of Nordic Semiconductor ASA. * The information contained herein is property of Nordic Semiconductor ASA. * The information contained herein is property of Nordic Semiconductor ASA. * The information contained herein is property of Nordic Semiconductor ASA. * The information contained herein is property of Nordic Semiconductor ASA. * Geffgroup ble_sdk_app_dtm_main main.c * Geffgroup ble_sdk_</pre>	
	35	ctivity
	39	rerocu.
	< <u> </u>	
Project Books {} Functions 0, Templates uild Output		ą

5. You can modify the size of the RAM Algorithm in : *Flash→ Configure Flash Tools…* and on the windows click on *Debug → Settings* Click on *Flash Download* and modify the size (put 0x02000).

evice Target Output Listing User C/C++ Asm C Use §imulator Settings Umit Speed to Real-Time	Linker Debug Utilities	Debug Trace Rash Download Download Function Frase Full Chip ✓ Program LORD ← Erase Sectors ✓ Verify Start: [bx20000000 Size: [bx000000
Load Application at Startup Run to main() Initialization File:	✓ Load Application at Startup ✓ Run to main() Initialization File:	Conot Erase Free And Run Programming Algorithm
Edit	Edit	Description Device Size Device Type Address Range
Restore Debug Session Settings F Breakpoints	Restore Debug Session Settings ↓ Breakpoints ↓ Toolbox ↓ Watch Windows ↓ Memory Display ↓ ↓ System Viewer	nRF51xx 2M On-chip Flash 00000000H - 001FFFFFH
CPU DLL: Parameter:	Driver DLL: Parameter:	Start: Size:
SARMCM3.DLL	SARMCM3.DLL	Add Remove
Dialog DLL: Parameter: DARMCM1.DLL pCM0	Dialog DLL: Parameter: TARMCM1.DLL pCM0	
ОКС	ancel Defaults Help	

6. Click OK and load again the project.



Direct Test Mode Testing

- 1. Start nRFgo Studio.
- 2. Select Direct Test Mode.

nRFgo Studio - Dire	ct Test Mode UART inte	rface		
ile <u>V</u> iew <u>n</u> RF8001	Setup <u>H</u> elp			
eatures ×	Direct Test Mod	e UART interface		
 2.4 GHz Front-End Te 	Set up on	Program		
TX carrie				
RX const	Com port COM28	 Refresh list of com ports 		
TX/RX c RX sensit	Mode			
Bluetooth	Transmit	Receive		
nRF8001 Co	Channel			
Dispatcher Trace Transl	Single	🔘 Sweep		
Direct Test				
nRF8002	Channel	19	×	
	-	(
	Payload model	Constant carrier	•	
	Payload length	1 bytes	(A) (Y)	
	Packets received	N/A		
		Start test		
evice Manager X				
Motherboards				
nRF5x Program nRF5x Bootloader				
nRF24LU1+ Boo				

3. For details on how to use the Direct Test Mode, press F1 to open the nRFgo Studio help.

<u>Important notification</u>: Erase all before loading Direct Test Mode program. The SoftDevice must not be loaded, only the Program Application with uvision or with nRFgo studio in "Program Application" (load the .hex generated by uvision).



5.3. UART Mode Example

This paragraph shows you how to set up and program a communication by sending some characters through the UART interface on ISP1510-UX-TB Test Board. This example just echoes input characters from the PC terminal.

UART Mode Set-up

- 1. Connect the USB cable from the Interface Board ISP130603 to your computer.
- 2. Connect the ISP1510-UX-TB Test Board to the ISP130603 Interface Board with the 10 pin, 14 pin and 22 pin FPC jumper cables (0.5 mm pitch, provided in the Development Kit)
- 3. On the ISP130603 Interface Board, connect the 2-lead patch cable in order to connect:
 - RXD to P0_11
 - TXD to P0_06
 - CTS to P0_07
 - RTS to P0_05

Make sure the RXD/TXD and CTS/RTS labels match for each wire. This matches the default setting if you are using the Nordic Board pca10040 in the SDK project (be careful: depending on the Nordic Board version you are using, the ports used could be different, see next part: UART Mode loading). CTS and RTS are needed because in the UART process when the TX is ready to send (RTS), the RX needs to allow the TX send data (CTS) and vice versa.

UART Mode Loading

- 1. Start Keil uVision.
- 2. Select Project then Open Project in order to open UART_example application: C:\Keil_v5\ARM\Pack\NordicSemiconductor\nRF_Examples\11.0.0-2.alpha\peripheral\uart \pca10040\arm5\uart_pca10040.uvprojx.



	luctor\nRF_Examples\11.0.0-2.alpha\peripheral\uart\pca10040\arm5\uart_pca10040.uvprojx - µVision ig Peripherals Tools SVCS Window Help	
🗋 💕 🛃 🥔 🐰 🐚 🛍 🎐 🤇		
Image:		
Project #		•
Project: uart_pca10040	49 #define BUTION FULL NRF GPIO FIN FULLUF	
🖻 🚂 nrf52832_xxaa	50	
🖨 🦢 Application	51 #define BUTTONS_LIST { BUTTON_1, BUTTON_2, BUTTON_3, BUTTON_4 } 52	
🗉 🏭 main.c	53 #define BSP BUTTON 0 BUTTON 1	
Documentation	54 #define BSP_BUTTON_1 BUTTON_2	
Board Support	55 define BSP_BUTTON 2 BUTTON 3	
CMSIS	56 #define BSP_BUTTON_3 BUTTON_4 57	
🗈 🍫 Device	58 #define BSP_BUTTON_0_MASK (1< <bsp_button_0)< td=""><td></td></bsp_button_0)<>	
nRF_Drivers	59 #define BSP_BUTTON_1_MASK (1< <bsp_button_1)< td=""><td></td></bsp_button_1)<>	
🗄 🍫 nRF_Libraries	60 #define BSP_BUTTON_2_MASK (1< <bsp_button_2) 61 #define BSP_BUTTON_3 MASK (1<<bsp_button_3)< td=""><td></td></bsp_button_3)<></bsp_button_2) 	
	63 #define BUTTONS_MASK 0x001E0000	
	64 65 #define RX PIN NUMBER 11 //8	
	66 tdefine TX PIN NUMBER 6	
	67 #define CTS_PIN_NUMBER 7	
	68 #define RTS_PIN_NUMBER 5 69 #define HWPC true	
	70	
	71 #define SPIS_MISO_PIN 28 // SPI MISO signal.	
	72 #define SPIS CSN PIN 12 // SPI CSN signal. 73 #define SPIS MOSI PIN 25 // SPI MOSI signal.	
	73 #define SPIS_MOSI_PIN 25 // SFI MOSI Signal.	
	75	
	76 #define SPIMO_SCK_PIN_29 // SPI clock GPIO pin number.	
	77 #define SPIMO_MOSI_PIN_25 // SPI Master Out Slave In GPIO pin number. 78 #define SPIMO_MISO_PIN_28 // SPI Master In Slave Out GPIO pin number.	
	79 define SPINO_SS PIN 12 // SPI Slave Select GPIO pin number.	
	80	
	81 #define SPIMI_SCK_PIN 2 // SPI clock GPIO pin number. 82 #define SPIMI_MOSI_PIN 3 // SPI Master Out Slave In GPIO pin number.	
	83 #define SPIMI_MOS_PIN 5 // SPI Master out Side in Grid pin number.	
	84 #define SPIM1_SS_PIN 5 // SPI Slave Select GPIO pin number.	
	85	
	86 #define SPIM2_SCK_PIN 12 // SPI clock GPIO pin number. 87 #define SPIM2_MOSI_PIN 13 // SPI Master Out Slave In GPIO pin number.	
	88 #define SPIM2 MISO PIN 14 // SPI Master In Slave Out GPIO pin number.	
	89 #define SPIM2_SS_PIN 15 // SPI Slave Select GPIO pin number.	
	90 91 // serialization APPLICATION board - temp. setup for running serialized MEMU tests	
	92 #define SER APP RX PIN 31 // UART RX pin number.	
	93 #define SER_APP_TX_PIN 30 // UART TX pin number.	
	94 define SER APP CTS PIN 28 // UART Clear To Send pin number.	
	95 #define SER_APP_RTS_PIN 29 // UART Request To Send pin number. 96	
	97 #define SER_APP_SPIM0_SCK_PIN 2 // SPI clock GPIO pin number.	
	98 #define SER APP SPIMO MOSI PIN 4 // SPI Master Out Slave In GPIO pin number	
🖻 Project 종 Books {} Func 🗛 Temp	99 #define SER_APP_SPIMO_MISO_PIN 3 // SPI Master In Slave Out GPIO pin number	

3. Click Build Target and Load.

Document Ref: isp_ble_AN170701_R0.docx



UART Mode Testing

1. Download and install the program "Putty.exe" (or equivalent like TTERM for example) in order to configure the baudrate, the port COM, .. etc ...

Real PuTTY Configuration	States and the second	×
Category:		
	Options controlling	local serial lines
Logging	Select a serial line	
Keyboard	Serial line to connect to	COM28
Bell Features	Configure the serial line	
Window	Speed (baud)	38400
Appearance Behaviour	Data <u>b</u> its	8
	Stop bits	1
Selection Colours	<u>P</u> arity	None 👻
Connection	Flow control	RTS/CTS ▼
Data Proxy Rlogin @-SSH <mark>Senal</mark>		
About	C	Dpen <u>C</u> ancel

- 2. Click to Open.
- 3. You can write and/or delete some characters. Sometimes you have to reset the ISP130603 Interface Board in case if it is not working.

P COM28 - PuTTY	
	A
Start: Welcome to UART_example program !!!!q	
Exit!	
	-

4. Press 'q' to exit



5.4. BLE UART Mode Example

This paragraph shows you how to set up and program an example that emulates a serial port over BLE. In the example, Nordic Semiconductor's development board serves as a peer to the phone application "nRF UART", 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:

- The SoftDevice: **S132**.
- ble_app_uart using Keil uVision.

UART Mode Set-up

- 1. Connect the USB cable from the Interface Board ISP130603 to your computer.
- 2. Connect the ISP1510-UX-TB Test Board to the ISP130603 Interface Board with the 10 pin, 14 pin and 22 pin FPC jumper cables (0.5 mm pitch, provided in the Development Kit)
- 3. On the ISP130603 Interface Board, connect the 2-lead patch cable in order to connect:
 - RXD to P0_11
 - TXD to P0_06
 - CTS to P0_07
 - RTS to P0_05

Make sure the RXD/TXD and CTS/RTS labels match for each wire (be careful: depending on the Nordic Board version you are using, the ports used could be different, see next part: UART Mode loading).

CTS and RTS are needed because in the UART process when the TX is ready to send (RTS), the RX needs to allow the TX send data (CTS) and vice versa.

S132 SoftDevice loading

- 1. Start nRFgo Studio
- 2. Select nRF5x Programming
- 3. Click Erase all
- Browse to SoftDevice hex file and click Program. The SoftDevice is available on the Nordic Website or by installing the SoftDevice with the Pack Installer, for example: C:\Keil_v5\ARM\Pack\NordicSemiconductor\nRF_SoftDevice_S132\2.0.0-7.alpha\hex



UART Mode Loading

- 1. Start Keil uVision.
- Select Project then Open Project in order to open ble_app_uart application: C:\Keil_v5\ARM\Pack\NordicSemiconductor\nRF_Examples\11.0.0-2.alpha\ble_peripheral\ ble_app_uart\pca10040\s132\arm5 \ble_app_uart_s132_pca10040.
- 3. Click Build Target and Load.

Insight SiP can provide the Hex files on demand at contact@insightsip.com



Document Ref: isp_ble_AN170701_R0.docx



BLE Mode Testing

- 1. Download and install "nRF UART" on your iOS or Android device, which is available for iOS from Apple Store and for Android from Play Store.
- 2. Run the App, click to Connect and select the device: Nordic_UART.

* ¥ © ‴্রা 24% এ 11:11 nRF UART v2.0	■ ★ ≤ ∅ 𝑘 🖬 24% ≜ 11:11 ■ nRF UART v2.0	■ * ¥ © ₩/ 24% = 11:11	nRF UAR		≹≮∅⊈""	24% 🗎	11:11
Connect	nRF UART v2.0 ^{00nnect}	Disconnect		Disconr	nect		
	Select a device Image: Construction of the second sec	[11:11:17] Connected to: Nordic_UART	[11:11:17] Connec [11:11:28] TX: allo		dic_UART		
	Cancel					\$	Send
			Device: Nordic_U	ART - ready			-
			LEAT	je	рс	our	>
			1 2 3	4 5	6 7 8	9	0
			a z e	r t y	y u i	0	р
			q s d	f g l	h j k	1	m
Send	Send	Send	↑ w	xc	v b n		×
Device: <select a="" device=""></select>	Device: <select a="" device=""></select>	Device: Nordic_UART - ready	Sym ,*	 Français((FR) •	·	4

3. You are now able to send and receive data through the BLE. Next step is to establish the communication with the UART interface.

UART Mode Testing

1. Download and install the program "RealTerm" (or equivalent like Putty, TTERM for example) in order to configure the baudrate, the port COM, .. etc ...

Display Port	Capture Pins Send Echo Port 12C 12C-	2 I2CMisc Misc	<u>\n</u>	Clear Freeze ?
Display As ← Ascii ← Ansi ← Hextspacel ← Hextspacel ← Hext+Ascii ← Hext+Ascii ← Hext+Ascii ← Hext+Ascii ← HextSv ← Nibble ← Nibble ← HextSv ← HextSv	Half Duplex newLine mode Invert ZBits BigEndian Data Frames Bytes 2 € Single Gulp Terminal Font 16 € 80 € Scrollba	ck		Status Disconnect RXD (2) TXD (3) CTS (8) DCD (1) DSR (6) Ring (9) BREAK Error
		Char Count:10	CPS:0	Port: 28 38400 8N1 RTS/ //



Display Port Capture Pins Send	Echo Port 12C 12C-2	2 I2CMisc Misc	7	n Clear Freeze ?
C Odd C 7 bits Hardware Flow	C 2 bits Control © RTS/CTS	Pul Change Flow Control ve Xon Char: 17 mit Xoff Char: 19 Winsock is: C Raw © Telnet		Status
You can use ActiveX automation to contro	ol me!	Char Count:10	CPS:0	Port: 28 38400 8N1 RTS/ //

Display Port Capture Pins Send Echo Port 120	C 12C-2 12CMisc Misc	lear Freeze ?
yes Send N		Status Disconnect RXD (2)
C LF Repeats 1 €	umbers Send ASCII +CR After	TXD (3) CTS (8)
Dump File to Port		DCD (1) DSR (6)
c:\temp\capture.txt	Send Eile X Stop Delays 0 € 0 € <u>Repeats</u> 1 € 0 €	Ring (9) BREAK
You can use ActiveX automation to control me!	Error	

2. Click to Send, write some characters and click to "Send ASCII".

Par RealTerm: Serial Capture Program 2.0.0.70	1					**	\$Ø ‼	^e .dí 2	4% 🗎	1:11
allo4 yesû		nRF	UA	RT v2	2.0					
				D	isco	nne	ct			
	(11:11 (11:11 (11:11	28] T	X: all	lo	to: Ne	ordic,	UAR	r		
	.1								s	end
Display Port Capture Pins Send Echo Port 12C 12C-2 12CMisc Misc 1 Clear Freeze ?	Device	: No	ordic_	UART	- read	ły				
yes Send Numbers Send ASCI Reference Status Disconnect	L	EAT	I		je		I.	ροι	ır	>
→ → → → → → → → → → → → → → → → → → →	1	2	3	4	5	6	7	8	9	0
✓ Send Numbers Send ASCII -4CF Atter	а	z	е	r	t	у	u	i	0	р
Dump File to Port C:\temp\capture.txt ↓ Send Eile X Stop Delays ↓ 0 ↓ 0 ↓ 0 ↓ 0 ↓ 0 ↓ 0 ↓ 0 ↓ 0 ↓ 0 ↓ 0 ↓ 0 ↓ 0 ↓ 0 ↓ 0 ↓ 0 ↓ 0 ↓ ↓	q	s	d	f	g	h	j	k	I	m
BREAK	+		w	x	c	v	b	n		×
You can use ActiveX automation to control me! Char Count:10 CPS:0 Port: 28 38400 8N1 RTS/	Sym	ı ,	*	4	França	iis(FR)	•		•	4

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



5.5. NFC Launch App Example

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).

NFC Mode Set-up

- 1. Connect the USB cable from the Interface Board ISP130603 to your computer.
- 2. Connect the ISP1510-UX-TB Test Board to the ISP130603 Interface Board with the 10 pin, 14 pin and 22 pin FPC jumper cables (0.5 mm pitch, provided in the Development Kit)
- 3. On the ISP130603 Interface Board, connect the 2-lead patch cable in order to connect:
 - NFC_1 to P0_09
 - NFC_2 to P0_10



NFC Mode Loading

- 1. Start Keil uVision.
- 2. Select Project then Open Project in order to open UART_example application: C:\Keil_v5\ARM\Pack\NordicSemiconductor\nRF_Examples\11.0.0-2.alpha \nfc\experimental_record_launch_app\pca10040\arm5\ nfc_launchapp_record_pca10040.uvprojx.
- 3. Click Build Target and Load.



NFC Mode Testing

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

- 1. After programming the application, 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.



5.6. Simple UWB transmissions using Decawave

DecaWave provides various example codes in C language: simple transmission, simple reception, ranging etc.

However, these examples are made to be used by the IDE CooCox with an STM32 target. This chapter will explain how to use decaWave driver and example code in an nRF52 Keil project.

- Download "DW1000 Application Programming Interface with application examples" from decawave website: <u>https://www.decawave.com/support/software</u>. This package contains drivers and example codes for the DW1000.
- 2. Create a Keil project. In this chapter we will start from the Nordic's template_project provided in their SDK. Open project in \pca10040\blank\arm5_no_packs.
- 3. Copy the decadriver directory of the decawave package into your project directory. Add deca_device.c and deca_param_init.c to your project. Add the decadriver directory to your Include Paths.



July 5, 2017

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4. Copy the content of examples/ex_01a_simple_tx main.c of the decawave package into your main.c.

Modify the "config" static variable which holds the decawave's signal parameters. We will be using channel 5.

Remove the following lines of code we don't need:

- #include "lcd.h", #include "sleep.h" and #include "port.h"
- #define APP_NAME "SIMPLE TX v1.2"
- lcd_display_str(APP_NAME);
- reset_DW1000();
- lcd_display_str("INIT FAILED");

Building the project now will result in the following errors:

```
.\_build\nrf52832_xxaa.axf: Error: L6218E: Undefined symbol peripherals_init (referred from main.o).
.\_build\nrf52832_xxaa.axf: Error: L6218E: Undefined symbol sleep_ms (referred from main.o).
.\_build\nrf52832_xxaa.axf: Error: L6218E: Undefined symbol spi_set_rate_high (referred from main.o).
.\_build\nrf52832_xxaa.axf: Error: L6218E: Undefined symbol spi_set_rate_low (referred from main.o).
.\_build\nrf52832_xxaa.axf: Error: L6218E: Undefined symbol deca_sleep (referred from deca_device.o).
.\_build\nrf52832_xxaa.axf: Error: L6218E: Undefined symbol decamutexoff (referred from deca_device.o).
.\_build\nrf52832_xxaa.axf: Error: L6218E: Undefined symbol decamutexon (referred from deca_device.o).
.\_build\nrf52832_xxaa.axf: Error: L6218E: Undefined symbol decamutexon (referred from deca_device.o).
.\_build\nrf52832_xxaa.axf: Error: L6218E: Undefined symbol readfromspi (referred from deca_device.o).
.\_build\nrf52832_xxaa.axf: Error: L6218E: Undefined symbol readfromspi (referred from deca_device.o).
.\_build\nrf52832_xxaa.axf: Error: L6218E: Undefined symbol readfromspi (referred from deca_device.o).
```

Now we need to implement these 9 missing functions.

5. Implement the peripherals_init function; this is where the SPI peripheral will be initialized. Don't forget to add "nrf_drv_spi.h" in your include list.

```
#define SPI_INSTANCE 0 /**< SPI instance index. */
static const nrf_drv_spi_t spi = NRF_DRV_SPI_INSTANCE(SPI_INSTANCE); /**< SPI instance. */
static void peripherals_init ()
        nrf_drv_spi_config_t spi_config = NRF_DRV_SPI_DEFAULT_CONFIG;
        spi_config.frequency =
                                  NRF_DRV_SPI_FREQ_1M;
        spi_config.mode =
                                  NRF_DRV_SPI_MODE_0;
        spi_config.bit_order =
                                  NRF_DRV_SPI_BIT_ORDER_MSB_FIRST;
        spi_config.miso_pin =
                                  24;
        spi_config.mosi_pin =
                                  17;
        spi_config.sck_pin =
                                  8:
        spi_config.orc
                                  0x00:
        APP_ERROR_CHECK(nrf_drv_spi_init(&spi, &spi_config, NULL));
        // Set chip select high
        nrf_gpio_cfg_output (23);
        nrf_gpio_pin_write(23, 1);
```

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6. Implement readfromspi function.

7. Implement writetospi function.

```
int writetospi(uint16 headerLength, const uint8 *headerBuffer, uint32 bodylength, const uint8 *bodyBuffer)
{
     // prepare TX buffer
     uint8_t txBuff[headerLength+bodylength];
     for(uint8_t i=0;i<headerLength;i++) txBuff[i] = headerBuffer[i];
     for(uint8_t i=0;i<bodylength;i++) txBuff[headerLength+i] = bodyBuffer[i];
     // Drive CS Low
     nrf_gpio_pin_write (23, 0);
     // send data
     nrf_drv_spi_transfer (&spi, txBuff, headerLength+bodylength, NULL, 0);
     // Drive CS High
     nrf_gpio_pin_write (23, 1);
     return 0;
}</pre>
```

8. Implement spi_set_rate_high and spi_set_rate_low functions.



9. Implement deca sleep and sleep ms functions.

void sleep_ms(unsigned int time_ms) { nrf_delay_ms (time_ms); } void deca_sleep(unsigned int time_ms) { nrf_delay_ms (time_ms); }

10. Implement decamutexon and decamutexoff functions.



11. Build the project (This should now succeed). Load the firmware to the ISP1510. The module is now emitting an UWB packet every second. The UWB signal can be observed using a Signal Analyzer at 6.5GHz.



July 5, 2017

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APPLICATION NOTI ISP1510 DEV KI

6. Basic Range Application with ISP1510

This paragraph shows you how to set up the Insight SiP's Range application between ISP1510 Anchor and Tag Board. The range is calculated using UWB and results are sent via the Bluetooth link to the Master Emulator or to a smartphone / tablet.

In this demo, the Anchor and the Tag operate as a pair. The Tag is the one initiating the ranging exchange and the "Anchor" is listening for the tag messages and responding to it. At the end of the ranging exchange the Anchor can then calculate the time of flight thus the range between the Tag and the Anchor.

Two types of demonstration are presented. The first one is directly executable with hardware and software provided in the Development Kit using Master Control Panel application. The second demonstration requires the use of an Android device. The Android application is available on the Google Play.

6.1. On Master Control Panel

- 1. Place the CR2032 lithium battery into the battery holder of the Tag Board.
- 2. Plug the Anchor Board into an USB port.

lt's **all** in the **package**

- 3. Connect nRF51 Dongle (Master Emulator) into a USB port on your computer.
- 4. Start Master Control Panel.

Click Start Discovery.	Master Control Panel	– 🗆 ×								
·	File Help									
	Master emulator									
	COM7 - 680791841 ~ 680791841 connected Reset									
	Scan for devices Start discovery									
	Discovered devices									
	Delete bond info									
	Log									
	[10:25:42.6] Device discovery started	^								
	[10:25:55.7] Device discovery stopped									
	[10:26:03.2] Device discovery started									
	[10:26:06.1] Device discovery stopped									
	[10:26:07.0] Device discovery started									
	[10:26:15.7] Device discovery stopped	×								

5.

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- 6. Two devices should appear: UWB_TAG_SNXXX and UWB_ANC_SNXXX. Select UWB_ANC_SNXXX and click on "Select Device".
- 7. On the following display, click successively on Connect, Discover Services and Enable Services.

Master Control Panel	-		\times	
File Help				
Master emulator				
COM7 - 680791841 V 680791841 connected R	eset			
Device info Device address: CEFCF81AA388 Bonded: False				
Actions				
Disconnect Bond Update Discover services Disable services	ces D	FU		
Service Discovery				
OharacteristicDeclaration, Value: 12-12-00-19-2A, Properties: Read, Notify, Battery Level, Value: 00 ClientCharacteristicConfiguration, Value: 01-00, CharacteristicConfiguration, Value: 0				Range value
- PrimaryService, Value: 00-11-22-33-44-55-66-77-88-99-AA-BB-00-11-EE-FF, 0xl				
CharacteristicDeclaration, Value: 12-16-00-00-11-22-33-44-55-66-77-88-99-			rope	
 UUID: FFEE1101-BBAA-9988-7766-554433221100, Value 68-5D-3A-7 ClientCharacteristicConfiguration. Value: 01-00. CharacteristicConfiguration. 				
ClientCharactensticConfiguration, Value: 01-00, CharactensticConfiguration, Value: 12-19-00-00-11-22-33-44-55-66-77-88-99-				
UUID: FFEE1102-BBAA-9988-7766-554433221100. Value: AB-77-72-7			Tope	
ClientCharacteristicConfiguration, Value: 01-00, CharacteristicConfiguration			000x0	
- Characteristic Declaration Value: 0A-1C-00-00-11-22-33-44-55-66-77-88-99	AA-RR-03-1	1-FF-FF	Pmpe Y	
<			>	
Attribute value UUID (0x): Display as UTF8	Read lo	ng l	Read	
	Mar In	-	Nrite	
Value: hex () text	Write lo	ng	white	
Back				
Log				
[10:31:19.2] Received a HandleValueNotification on handle 0016 with value C9C44	40FE5F1E0	C3F	^	
[10:31:19.7] Received a HandleValueNotification on handle 0016 with value 809F7				
[10:31:19.7] Received a HandleValueNotification on handle 0019 with value AB777				
[10:31:20.2] Received a HandleValueNotification on handle 0016 with value 93A56				
[10:31:20.7] Received a HandleValueNotification on handle 0016 with value 384EC			- 11	
[10:31:21.2] Received a HandleValueNotification on handle 0016 with value 685D3	A72A500E	A3F	~	
1				

- You can see data that transit between the ISP1510 Anchor Board and the Master Emulator via the Bluetooth link.
 The distance range is located in the service 0xFFEE1100BBAA99887766554433221100. In this example data is 0x3FEA00A5723A5D68 which is the 64bit floating point representation of 0.81 m.
- 9. To switch off the ISP1510 Tag Board, remove battery from the Tag Board, unplug the Anchor Board from the USB port.



6.2. On Android Device

An App is also available for Android Devices. On Google Play, search "sip sensor" or "insight sip" and download the App. The android App is a demonstration App that is provided "as is" in order to demonstrate the Smart Bluetooth sensor node.

Make sure your Android device is compatible with Bluetooth 4.0 (Android v4.3 at least).

After the application is downloaded and installed you should see the application on your Android device. Then you will be able to set up the application demonstration as follows:

- (For Android v6 or older) In order to be able to scan for BLE devices, the application needs to have "Location" permission. You have to enable "Location" service in the settings and give permission to the Sensor App to use Location (Settings -> Application Manager -> Sensor -> Permission).
- 2. Power up both boards: Place the CR2032 lithium battery into the battery holder of the Tag Board and plug the Anchor Board into an USB port.
- 3. Start "ISP1510 UWB Demo" application on your Android, In the "Anchor part" click Connect and select your Anchor Board (UWB_ANC_SNxxx). Do the same for the Tag Board.



NB: Ranging data is only provided by the Anchor Board, thus only BLE connection to the Anchor Board is necessary.



4. Ranging should automatically starts at power up. Instant and average range should be updating.



5. By pressing the "Configure" buttons you have access to a number of settings of the Tag/Anchor.

□ ▷ ▶ > ▶ > </th <th>□ ▷ ★ >★ >★ > 12:10 ← ● Anchor Settings :</th>	□ ▷ ★ >★ >★ > 12:10 ← ● Anchor Settings :
Anchor settings Sample size for Average value 9	Door closing Threshold (cm) 120 UWB Signal Settings
Door opening Threshold (cm) 100	Pulse Repetition Frequency 64 MHz
Door closing Threshold (cm) 120	Data Rate 6.81Mbits/s
UWB Signal Settings Pulse Repetition Frequency	Preamble Length 128
64 MHz	Preamble Code 9
6.81Mbits/s	Channel 5 – 6489.6 MHz BW 499.2 MHz
128	Non-Standard SFD
Preamble Code	

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The list of Anchor parameters is :

- Average : set the number of sample used to calculte the average range value
- Door opening Threshold : set distance which trigger the opening of the door in cm
- Door ClosingThreshold : set distance which trigger the the closing of the door in cm

The list of Tag parameters is:

• Delay : set the delay in ms between each range update in

The list of Decawave specific parameters is:

- Pulse Repetition Frequency : 16 MHz or 64 MHz
- Data Rate : 110 Kbit/s, 850 Kbits/s or 6.81 Mbits/s
- Preamble Length : 64, 128, 256, 512, 1024, 1536, 2048 or 4096 symbols
- Preamble Code : Preamble pattern selection
- Channel : Frequency channel selection
- Non-Standard SFD : Enable to use the DecaWave defined non-standard SFD

It is not recommanded to change this parameters.

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