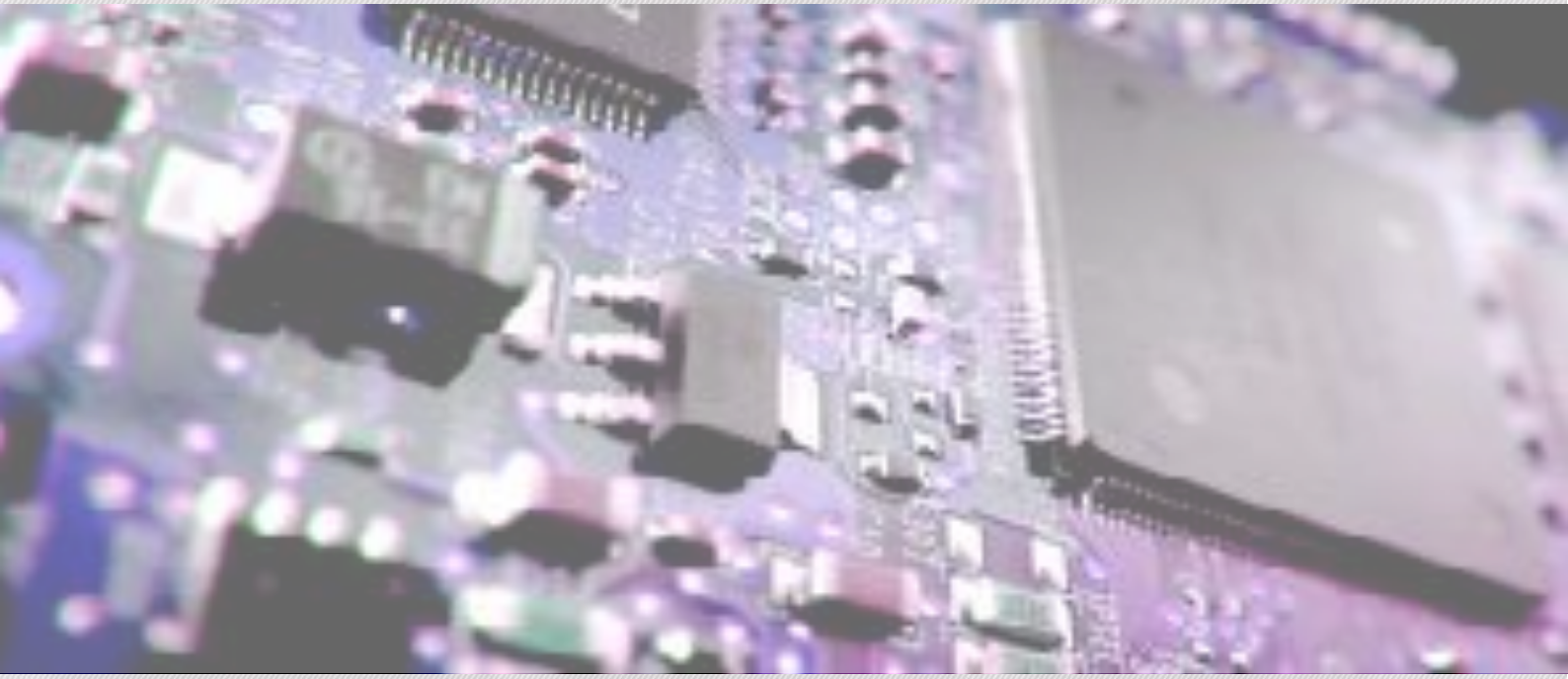
Insight SiP

It's all in the package

PRODUCT CATALOG



Bluetooth® Smart Modules

Revision 2.3 – June 2015

INTRODUCTION - QUALITY

SMART MODULES

SMART BEACONS

SMART SENSORS

DESIGN SERVICE

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

MISSION STATEMENT

The increased demand for wireless connectivity in portable electronic devices has driven manufacturers to deliver ever-smaller, more cost effective solutions. This makes the **integration of RF into a single product more and more complex** and increases technical risk while in the mean time the product development cycle has to be reduced.

At Insight-SiP we rapidly solve these challenges. Based on a **system-in-package approach** we make complex RF systems easy to integrate in any existing or future portable application. We contribute to reduce our customer's product development cycle and accelerate their product's release-to-market.

Insight SiP, it's all in the package!

Nick Wood
President

Chris Barratt
Chief Technical Officer

Michel Beghin
Chief Executive Officer

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

COMPANY PROFILE

Insight SiP provides turn-key design services and creative packaging solutions to customers who need highly integrated systems to meet wireless and portable devices space requirements. Insight SiP expertise in RF circuit miniaturization and system-in-package (SiP) technology enables product development to reach the goals of smaller size and ever increasing functionality requested by the market today. It's all in the package! In shorter time!

Founded in 2005, with headquarter in the hearth of Sophia-Antipolis France, Insight Sip has a global presence with offices Asia and North America.

Design Service

We make complex RF systems easy to integrate in any existing or future portable application. We contribute to reduce our customer's product development cycle and accelerate their product release-to-market. The RF design methodologies we have developed help solve the issue of portability while allowing for greater integration. This novel design methodology is aimed at allowing easy transfer of integrated passive circuit design from one supplier to another and even from one technology to another.

The turn-key design services for highly integrated solutions we propose is based on a unique design methodology that ensures close to first pass design success. We deliver timely high performance and cost-effective solutions.

Antenna-in-Package (AiP) solutions

Insight SiP is leading system miniaturization where the antenna is no longer a separate component within the wireless device but is integrated in the package, thus the concept of antenna-in-package or AiP. Today in each mobile device there are numerous communication modules and it is understandable that the integration of the antenna into the module brings a huge advantage in terms of cost and performance.

Modules

Insight SiP proposes ready-to-use RF modules to module manufacturers and ODMs. They are the optimal solutions for designers looking to add wireless connectivity to a product without a complex and time consuming development cycle. These modules can be personalized to meet customer specific requirements and technical constraints.

Design Successes

Insight SiP has designed a series of ultra-miniature wireless modules for various applications such as 3G, 4G/LTE, 60Ghz, ANT, Antenna Tuning, BLE, Bluetooth®, GSM/W-CDMA, GPS/Glonass, ISM, NFC, RFID, Wireless Sensor Modules, Software Define Radio, Transfer Jet, Ultra-miniature Antennas, UMTS, UWB, WHDI™, Wifi, WLAN, Zigbee ® …

Customers

Insight SiP has a diverse client base which includes tier one OEM's, leading chipset vendors and hi-tech innovative startup companies.

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

CERTIFICATIONS

ISP130301 certifications


QDL Bluetooth® Qualified Design Listing

The Bluetooth SIG Hereby Recognizes

Insight sip
Member Company

ISP130301
Qualified Design Name

Declaration ID: D024444
Qualified Design ID: 55840
Specification Name: 4.0
Product Type: End Product
Model Number: ISP130301
Listing Date: 10 October 2014
Assessment Date: 10 October 2014
Hardware Version Number: C
Software Version Number:

This certificate acknowledges the *Bluetooth*® Specifications declared by the member were achieved in accordance with the *Bluetooth* Qualification Process as specified within the *Bluetooth* Specifications and as required within the current PRD

Bluetooth SPECIAL INTEREST GROUP


telefication

Statement

of Opinion

No.: 142140199/AA/00

With respect to Chapter 10 of the Telecommunications Act of The Netherlands, Telefication declares that to our opinion the listed product complies with the essential requirements, in accordance with Article 3 of the Directive 1999/5/EC, as indicated under Annex 1 of this statement.

Product description: Bluetooth Low Energy Module with antenna
Trademark: Insight SiP
Family name: --
Type designation: ISP130301
Serial No: --
Hardware release No: C

Manufacturer: Insight SiP
Address: 13 Chemin de la halte
City: 06130 Grasse
Country: France

This statement is granted to:

Name: Insight SiP
Address: 13 Chemin de la halte
City: 06130 Grasse
Country: France

This statement has THREE Annexes.

Zevenaar, 29 August 2014

W.J.M. Jong
Manager Product Certification

PRODUCTS RvA C 224

laboratory certification approvals


株式会社立花デバイスコンポーネント殿

工 事 設 計 の 認 証 書
Certificate of Construction Type

特定無線設備の種別 Classification of Specified Radio Equipment	証明規則第２条第１項第１９号の無線設備 ２．４GHz帯高度化小電力データ通信システム
電波の型式、周波数及び空中線電力 Type of Emission, Frequency and Antenna Power	F1D　２４０２～２４８０MHz（２MHz間隔４０波）　０．００２５W
型式又は名称 Model/Name of Equipment	ISP130301
製造者名 Manufacturer Name	Insight SiP
認証番号 Certification Number	001-A03467
工事設計の認証をした年月日 Date of Certification	平成26年 6月23日

上記のとおり、電波法第38条の24第１項の規定に基づく工事設計の認証を行ったものであることを証する。

This is to certify that above type certification has been granted in accordance with the provisions set out in Article 38-24 Paragraph 1 of the Radio Law.

平成26年 6月23日

一般財団法人　テレコムエンジニアリングセンター
Telecom Engineering Center


telefication

CB Industry Canada Industrie Canada

Reg. No. NL0001

TECHNICAL ACCEPTANCE CERTIFICATE / CERTIFICAT D'ACCEPTABILITÉ TECHNIQUE

CERTIFICATION No. / No. DE CERTIFICATION: 11306A-ISP130301
TELEFICATION No. / No. DE TELEFICATION: 142170180/AA/00
TEST SITE No. / No. DE LABORATOIRE: 3699A-1
ISSUED TO / DÉLIVRÉ À: Insight SiP
TYPE OF EQUIPMENT / GENRE DE MATÉRIEL: BLUETOOTH DEVICE
TRADE NAME AND MODEL / MARQUE ET MODÈLE: ISP130301C1347
CERTIFIED TO / CERTIFIÉ SELON LE: SPECIFICATION / CAHIER DES CHARGES RSS-210 ISSUE / EDITION 8

Certification of equipment means only that the equipment has met the requirements of the above-noted specification. Licence applications, where applicable to use certified equipment, are acted on accordingly by the Industry Canada issuing office and will depend on the existing radio environment, service and location of operation. This certificate is issued on condition that the holder complies and will continue to comply with the requirements and procedures issued by Industry Canada. The equipment for which this certificate is issued shall not be manufactured, imported, distributed, leased, offered for sale or sold unless the equipment complies with the applicable technical specifications and procedures issued by Industry Canada.

La certification du matériel signifie seulement que le matériel a satisfait aux exigences de la norme indiquée ci-dessus. Les demandes de licences nécessaires pour l'utilisation du matériel certifié sont traitées en conséquence par le bureau de délivrance d'Industrie Canada et dépendent des conditions radio ambiantes, du service et de l'emplacement d'exploitation. Le présent certificat est délivré à la condition que le titulaire satisfasse et continue de satisfaire aux exigences et aux procédures d'Industrie Canada. Le matériel à l'égard duquel le présent certificat est délivré ne doit pas être fabriqué, importé, distribué, loué, mis en vente ou vendu à moins d'être conforme aux procédures et aux spécifications techniques applicables publiées par Industrie Canada.

ISSUED BY TELEFICATION BV, RECOGNIZED CERTIFICATION BODY BY INDUSTRY CANADA
DÉLIVRÉ PAR TELEFICATION BV, ORGANISME DE CERTIFICATION RECONNU PAR INDUSTRIE CANADA

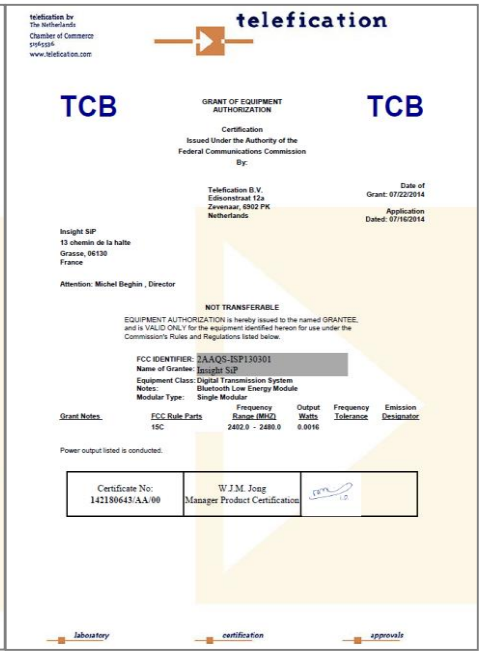
I hereby attest that the subject equipment was tested and found in compliance with the above-noted specification. J'atteste, par la présente, que le matériel a fait l'objet d'essai et a été jugé conforme à la spécification ci-dessus.

DATE 22 July 2014 BY
W.J.M. Jong
Manager Product Certification

This certificate has one annex.

PRODUCTS RvA C 224

laboratory certification approvals


telefication

TCB TCB

GRANT OF EQUIPMENT AUTHORIZATION

Certification
Issued Under the Authority of the
Federal Communications Commission
By:

Telefication B.V.
Edisonstraat 12a
Zevenaar, 6902 PK
Netherlands

Date of Grant: 07/22/2014
Application Dated: 07/16/2014

Insight SiP
13 chemin de la halte
Grasse, 06130
France

Attention: Michel Beghin , Director

NOT TRANSFERABLE

EQUIPMENT AUTHORIZATION is hereby issued to the named GRANTEE, and is VALID ONLY for the equipment identified hereon for use under the Commission's Rules and Regulations listed below.

FCC IDENTIFIER: 2AAQS-ISP130301
Name of Grantee: Insight SiP
Equipment Class: Digital Transmission System
Notes: Bluetooth Low Energy Module
Modular Type: Single Modular

Grant Notes	FCC Rule Parts	Frequency Range (MHz)	Output Watts	Frequency Tolerance	Emission Designator
	15C	2402.0 - 2480.0	0.0016		

Power output listed is conducted.

Certificate No:	
142180643/AA/00	W.J.M. Jong Manager Product Certification

laboratory certification approvals

ISP091201 certifications

EPL Bluetooth® End Product Listing

The Bluetooth SIG Hereby Recognizes

Insight sip
Member Company

ISP091201
Qualified Design Name

Qualified Design ID(s): B017595
Contact Person: Chakib EL HASSANI
Series:
Publish Date: 12 September 2013
EPL Type: Other

This certificate acknowledges the *Bluetooth*® Specifications declared by the member were achieved in accordance with the *Bluetooth* Qualification Process as specified within the *Bluetooth* Specifications and as required within the current PRD

Bluetooth SPECIAL INTEREST GROUP

telefication bv
The Netherlands
Chamber of Commerce
59565516
www.telefication.com

telefication

Statement

of Opinion

No.: 13214144/AA/00

With respect to Chapter 10 of the Telecommunications Act of The Netherlands, Telefication declares that to our opinion the listed product complies with the essential requirements, in accordance with Article 3 of the Directive 1999/5/EC, as indicated under Annex 1 of this statement.

Product description: Bluetooth Low Energy Module with antenna
Trademark: Insight SiP
Family name: --
Type designation: ISP091201
Serial No: --
Hard-/Software release No: D|Rev. D

Manufacturer: Insight SiP
Address: 13 Chemin de la halte
City: 06130 Grasse
Country: France

This statement is granted to:

Name: Insight SiP
Address: 13 Chemin de la halte
City: 06130 Grasse
Country: France

This statement has THREE Annexes.

Zevenaar, 13 August 2013

CE

i.o.

W.J.M. Jong
Manager Product Certification

RvA C 224 PRODUCTS

laboratory certification approvals

telefication bv
The Netherlands
Chamber of Commerce
59565516
www.telefication.com

telefication

CB Industry Canada Industrie Canada

Reg. No. NL0001

TECHNICAL ACCEPTANCE CERTIFICATE / CERTIFICAT D'ACCEPTABILITÉ TECHNIQUE

CERTIFICATION No. / No. DE CERTIFICATION: 11306A-ISP091201
TELEFICATION No. / No. DE TELEFICATION: 13217179/AA/00
TEST SITE No. / No. DE LABORATOIRE: 3699A-1
ISSUED TO / DÉLIVRÉ À: INSIGHT SIP
TYPE OF EQUIPMENT / GENRE DE MATÉRIEL: Bluetooth Device Limited Modular Approval
TRADE NAME AND MODEL / MARQUE ET MODÈLE: Insight SiP ISP091201
CERTIFIED TO / CERTIFIÉ SELON LE: SPECIFICATION / CAHIER DES CHARGES RSS-210 ISSUE / EDITION 8

Certification of equipment means only that the equipment has met the requirements of the above-noted specification. Licence applications, where applicable to use certified equipment, are acted on accordingly by the Industry Canada issuing office and will depend on the existing radio environment, service and location of operation. This certificate is issued on condition that the holder complies and will continue to comply with the requirements and procedures issued by Industry Canada. The equipment for which this certificate is issued shall not be manufactured, imported, distributed, leased, offered for sale or sold unless the equipment complies with the applicable technical specifications and procedures issued by Industry Canada.

La certification du matériel signifie seulement que le matériel a satisfait aux exigences de la norme indiquée ci-dessus. Les demandes de licences nécessaires pour l'utilisation du matériel certifié sont traitées en conséquence par le bureau de délivrance d'Industrie Canada et dépendent des conditions radio ambiantes, du service et de l'emplacement d'exploitation. Le présent certificat est délivré à la condition que le titulaire satisfasse et continue de satisfaire aux exigences et aux procédures d'Industrie Canada. Le matériel à l'égard duquel le présent certificat est délivré ne doit pas être fabriqué, importé, distribué, loué, mis en vente ou vendu à moins d'être conforme aux procédures et aux spécifications techniques applicables publiées par Industrie Canada.

ISSUED BY TELEFICATION BV, RECOGNIZED CERTIFICATION BODY BY INDUSTRY CANADA
DÉLIVRÉ PAR TELEFICATION BV, ORGANISME DE CERTIFICATION RECONNU PAR INDUSTRIE CANADA

I hereby attest that the subject equipment was tested and found in compliance with the above-noted specification.
J'atteste, par la présente, que le matériel a fait l'objet d'essai et a été jugé conforme à la spécification ci-dessus.

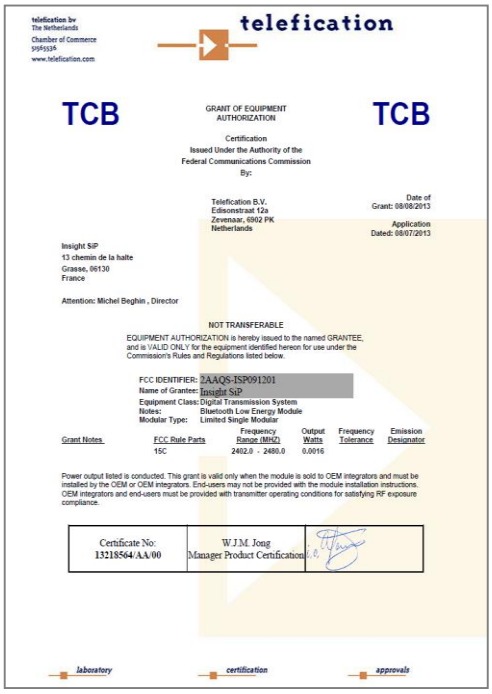
DATE 27 August 2013 BY
W.J.M. Jong
Manager Product Certification

This certificate has one annex.

i.o.

RvA C 224 PRODUCTS

laboratory certification approvals



telefication bv
The Netherlands
Chamber of Commerce
59565516
www.telefication.com

telefication

TCB GRANT OF EQUIPMENT AUTHORIZATION TCB

Certification
Issued Under the Authority of the
Federal Communications Commission
By:

Telefication B.V.
Edisonstraat 12a
Zevenaar, 6902 PK
Netherlands

Date of Grant: 08/08/2013
Application Dated: 08/07/2013

Insight SiP
13 chemin de la halte
Grasse, 06130
France

Attention: Michel Beghin , Director

NOT TRANSFERABLE

EQUIPMENT AUTHORIZATION is hereby issued to the named GRANTEE, and is VALID ONLY for the equipment identified hereon for use under the Commission's Rules and Regulations listed below.

FCC IDENTIFIER: 2AAQS-ISP091201
Name of Grantee: Insight SiP
Equipment Class: Digital Transmission System
Notes: Bluetooth Low Energy Module
Modular Type: Limited Single Modular

Grant Notes	FCC Rule Parts	Frequency Range (MHz)	Output Watts	Frequency Tolerance	Emission Designator
	15C	2402.0 - 2480.0	0.0016		

Power output listed is conducted. This grant is valid only when the module is sold to OEM integrators and must be installed by the OEM or OEM integrators. End-users may not be provided with the module installation instructions. OEM integrators and end-users must be provided with transmitter operating conditions for satisfying RF exposure compliance.

Certificate No:	W.J.M. Jong
13218564/AA/00	Manager Product Certification

i.o.

laboratory certification approvals

Manufacturer Process Certifications

Insight SiP is highly focused on product quality. In order to provide its customer with the best reliability, Insight SiP has qualified global asian CEMs which are offering a huge level of manufacturing certification to produce its Smart Modules range of products.

We can therefore ensure the following quality standards in production:
- ISO9000 standards and several other certifications
- OHSAS18001 – Health and Safety management
- ISO13485 – Medical requirements
- AS9100 – Aerospace requirements
- QS9000 – Automotive requirements

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

PRODUCT DISCONTINUITY

Normally a product will continue to be manufactured as long as all of the following are true:
- The manufacturing method is still available.
- There are no replacement products.
- There is demand for it in the market.

In case of obsolescence, Insight SiP will follow Jedec Standard JSD-48. A Product Discontinuation Notice (PDN) will be sent to all distributors and made available on our website. After this, the procedure goes as follows:
- Last Order Date will be 6 months after the PDN was published.
- Last Shipment Date will be 6 months after Last Order Date, i.e. 12 months after PDN.

DISCLAIMER

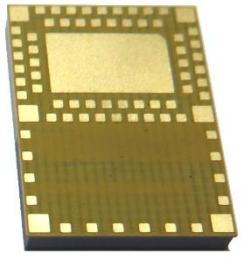
Insight SiP's products are designed and manufactured for general consumer applications, so testing and use of the product shall be conducted at customer's own risk and responsibility. Please conduct validation and verification and sufficient reliability evaluation of the products in actual condition of mounting and operating environment before commercial shipment of the equipment. Please also pay attention (i) to apply soldering method that don't deteriorate reliability, (ii) to minimize any mechanical vibration, shock, exposure to any static electricity, (iii) not to overstress the product during and after the soldering process.

The products are not designed for use in any application which requires especially high reliability where malfunction of these products can reasonably be expected to result in personal injury or damage to the third party's life, body or property, including and not limited to (i) aircraft equipment, (ii) aerospace equipment, (iii) undersea equipment, (iv) power plant control equipment, (v) medical equipment, (vi) transportation equipment, (vii) traffic signal equipment, (viii) disaster prevention / crime prevention equipment.

The only warranty that Insight SiP provides regarding the products is its conformance to specifications provided in datasheets. Insight SiP hereby disclaims all other warranties regarding the products, express or implied, including without limitation any warranty of fitness for a particular purpose, that they are defect-free, or against infringement of intellectual property rights. Insight SiP customers agree to indemnify and defend Insight SiP against all claims, damages, costs and expenses that may be incurred, including without any limitation, attorney fees and costs, due to the use of products.

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

ISP130301
Bluetooth Low Energy Module with Integrated Antenna



Key Features

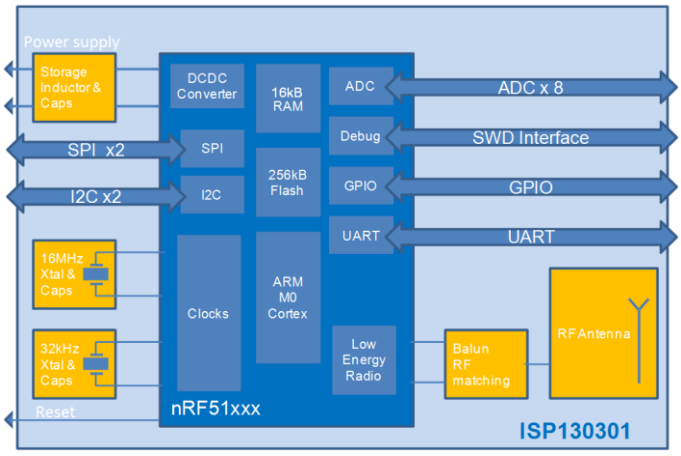
- Single Mode BLE v4.1 Slave or Master
- Based on Nordic Semiconductor nRF51 family
- 2.4GHz low energy RF Transceiver
- 32bit ARM Cortex M0 CPU
- 256kB Flash and 16 kB SRAM
- Analog and Digital peripherals
- Ultra Low Power Consumption
- Single 1.8 to 3.6 V supply
- Very small size 8.0 x 11.0 x 1.2 mm
- Temperature -40 to 75 °C
- Fully integrated RF matching and Antenna
- Integrated 16 MHz and 32.768 kHz Clocks

Applications

- Space constrained BLE Slave Devices
- Sport and fitness sensors
- Health care sensors
- Out of Range (OOR) sensors
- Personal User Interface Devices (PUID)
- Remote controls

Certifications

- Complies with FCC
- Complies with CE
- Complies with IC
- Complies with TELEC
- Bluetooth SIG certified
- RoHS compliant



General Description

This module is based on nRF51822 Nordic Semiconductor 2.4GHz wireless System on Chip (SoC) integrating a 2.4 GHz transceiver, a 32 bit ARM Cortex™-M0 CPU, a flash memory, and analog and digital peripherals. It can support BLE and a range of proprietary 2.4 GHz protocols, such as Gazell from Nordic Semiconductor.

Fully qualified BLE stacks for nRF51822 are implemented in the S100 series of SoftDevices which can be freely downloaded. ISP130301 can then be used in Master and Slave modes for BLE and for both ends of other proprietary protocols. The ANT protocol can be handled on request.

The module is specifically designed for both PC peripherals and ultra low power applications such as sports and wellness sensors. Ultra low power consumption and advanced power management enables battery lifetimes up to several years on a coin cell battery. Even though its very small size 8x11x1.2mm, the module integrates decoupling capacitors, 16 MHz and 32 kHz crystals, load capacitors, DC-DC converter, RF matching circuit and antenna in addition to the wireless SoC.

The module forms a standalone BLE node for which only the addition of a suitable DC power source is necessary for proximity or Out of Range applications. Sensor applications require only the further addition of the appropriate sensors. As the module has several end applications, the antenna was designed to be compatible with several ground plane sizes such as USB dongle or cell phone.

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

Contents

1. Electrical Specifications

Electrical Performance

The specifications of the module follow those of the nRF51822. The following high level parameters are given for the module.

The operating temperature range is -40 to +75 °C with the following performances.

Parameter	Value	Unit
Supply Voltage	1.8 to 3.6	V
Peak current, receiver active (supply at 2.1V)	12.6	mA
Peak current, transmitter active +4 dBm Output Power	16	mA
Peak current, transmitter active 0 dBm Output Power	10.5	mA
Current drain, connection-less state, no RAM retention	0.6	µA
Current drain between connection events	2.6	µA
Crystal stability 32.768 kHz	+/- 20 ppm	

Pin Assignment

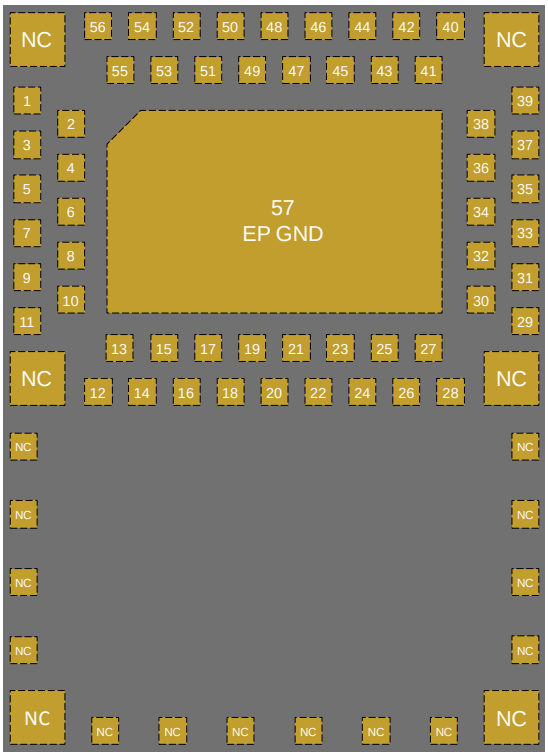
The module uses an LGA format with a double row of pads on a 0.65 mm pitch. The pad layout follows the QFN Jedec standard for 2 row LGA parts.

Pads 1 thru 56 are signal pins 0.4 x 0.4 mm, Pad 57 is an exposed metal pad that is connected to ground. The NC pads are 0.8 x 0.8 or 0.4 x 0.4 mm and are to be connected to isolated metal pads on the application PCB for mechanical stability and reliability (drop test).

Pin	Name	Pin function	Description
1	P0_07	Digital I/O	General purpose I/O pin
2	NC	Not Connected	Isolated pad on application PCB for mechanical stability
3	P0_09	Digital I/O	General purpose I/O pin
4	NC	Not Connected	Isolated pad on application PCB for mechanical stability
5	P0_13	Digital I/O	General purpose I/O pin
6	NC	Not Connected	Isolated pad on application PCB for mechanical stability
7	P0_19	Digital I/O	General purpose I/O pin
8	NC	Not Connected	Isolated pad on application PCB for mechanical stability
9	P0_17	Digital I/O	General purpose I/O pin
10	NC	Not Connected	Isolated pad on application PCB for mechanical stability
11	P0_20	Digital I/O	General purpose I/O pin
12	VSS	Ground	Should be connected to ground plane on application PCB
13	NC	Not Connected	Isolated pad on application PCB for mechanical stability
14	VSS	Ground	Should be connected to ground plane on application PCB
15	NC	Not Connected	Isolated pad on application PCB for mechanical stability
16	VSS	Ground	Should be connected to ground plane on application PCB
17	NC	Not Connected	Isolated pad on application PCB for mechanical stability
18	VSS	Ground	Should be connected to ground plane on application PCB
19	NC	Not Connected	Isolated pad on application PCB for mechanical stability
20	VSS	Ground	Should be connected to ground plane on application PCB
21	NC	Not Connected	Isolated pad on application PCB for mechanical stability
22	VSS	Ground	Should be connected to ground plane on application PCB
23	VSS	Ground	Should be connected to ground plane on application PCB
24	OUT_MOD	Module I/O	This pin is the RF I/O pin of the BLE module. It should be connected to Pin 26 OUT_ANT for normal operation. During certification the pin may be connected via to an RF connector for module measurement using a Bluetooth test setup.
25	VDD_PA	PA supply	PA supply indicates Transmit mode (Active High)
26	OUT_ANT	Antenna I/O	This pin is connected to the internal antenna. It should be connected to Pin 24 OUT_MOD for normal operation. During certification the pin may be connected to an RF connector for antenna measurement
27	VSS	Ground	Should be connected to ground plane on application PCB
28	VSS	Ground	Should be connected to ground plane on application PCB
29	VCC_nRF	Power	Power supply (1.8 – 3.6V). VDD in nRF51822 doc.
30	VSS	Ground	Should be connected to ground plane on application PCB
31	SWDCLK	Digital Output	HW debug and flash programming I/O
32	P0_18	Digital I/O	General purpose I/O pin
33	SWDIO-nRESET	Digital I/O	System reset (active low). Also HW debug and flash programming I/O
34	P0_16	Digital I/O	General purpose I/O pin
35	P0_15	Digital I/O	General purpose I/O pin
36	P0_14	Digital I/O	General purpose I/O pin
37	P0_12	Digital I/O	General purpose I/O pin
38	P0_10	Digital I/O	General purpose I/O pin
39	P0_11	Digital I/O	General purpose I/O pin
40	P0_05-AIN6	Digital I/O Analog input	General purpose I/O pin ADC input 6

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

Pin	Name	Pin function	Description
41	P0_06-AIN7-AREF1	Digital I/O Analog input Analog input	General purpose I/O pin ADC input 7 ADC Reference voltage
42	P0_03-AIN4	Digital I/O Analog input	General purpose I/O pin ADC input 4
43	P0_04-AIN5	Digital I/O Analog input	General purpose I/O pin ADC input 5
44	P0_01-AIN2	Digital I/O Analog input	General purpose I/O pin ADC input 2
45	P0_31	Digital I/O	General purpose I/O pin
46	P0_02-AIN3	Digital I/O Analog input	General purpose I/O pin ADC input 3
47	P0_30	Digital I/O	General purpose I/O pin
48	P0_00-AREF0	Digital I/O Analog input	General purpose I/O pin ADC Reference voltage
49	P0_29	Digital I/O	General purpose I/O pin
50	P0_28	Digital I/O	General purpose I/O pin
51	P0_24	Digital I/O	General purpose I/O pin
52	P0_23	Digital I/O	General purpose I/O pin
53	P0_21	Digital I/O	General purpose I/O pin
54	P0_22	Digital I/O	General purpose I/O pin
55	P0_25	Digital I/O	General purpose I/O pin
56	P0_08	Digital I/O	General purpose I/O pin
57	GND_EP	Ground	Exposed metal pad. Should be connected to ground plane on application PCB

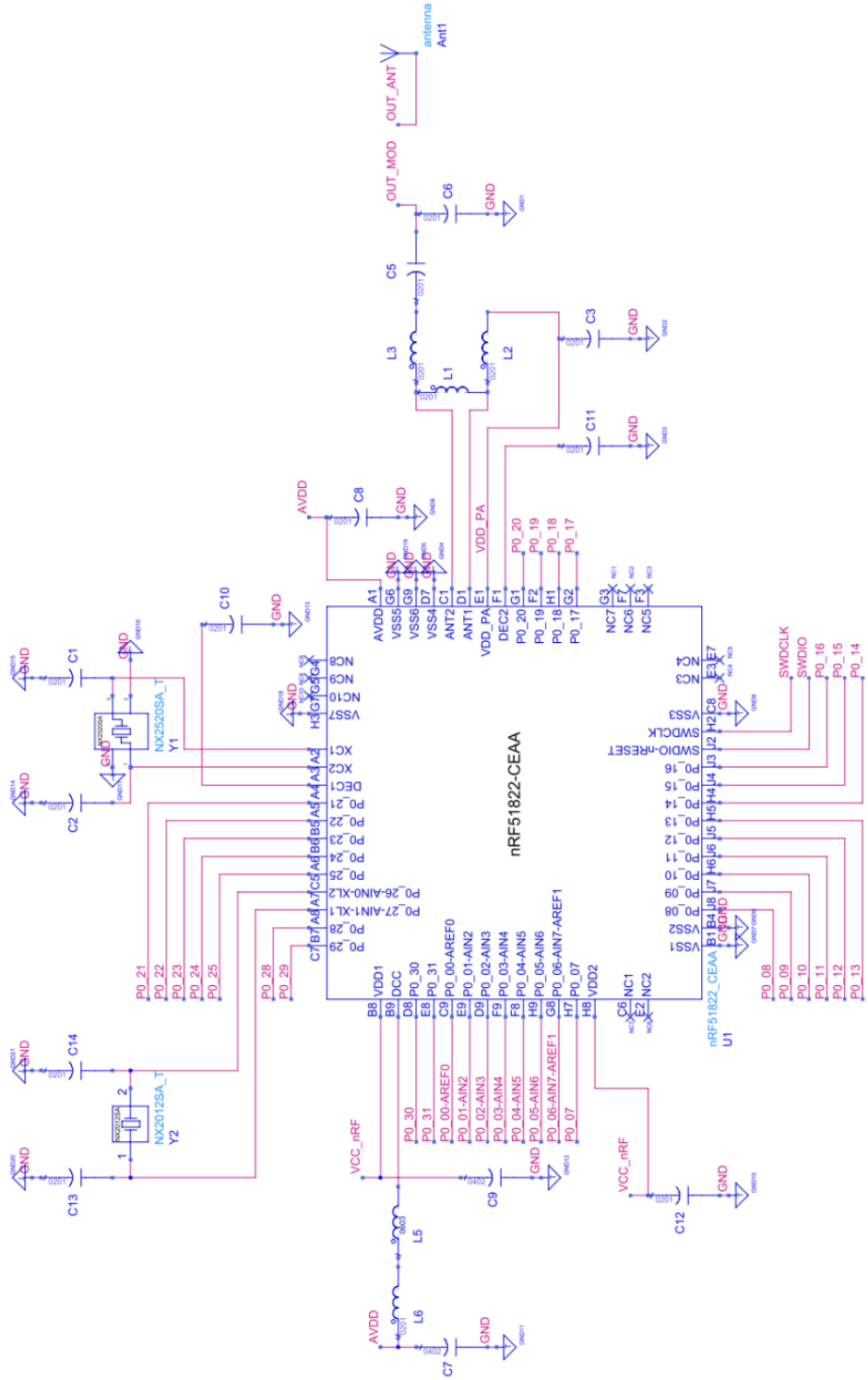


ISP130301pad placement and pin assignment for the LGA QFN package

TOP VIEW

Electrical Schematic

Electrical schematic showing ISP130301 module connections



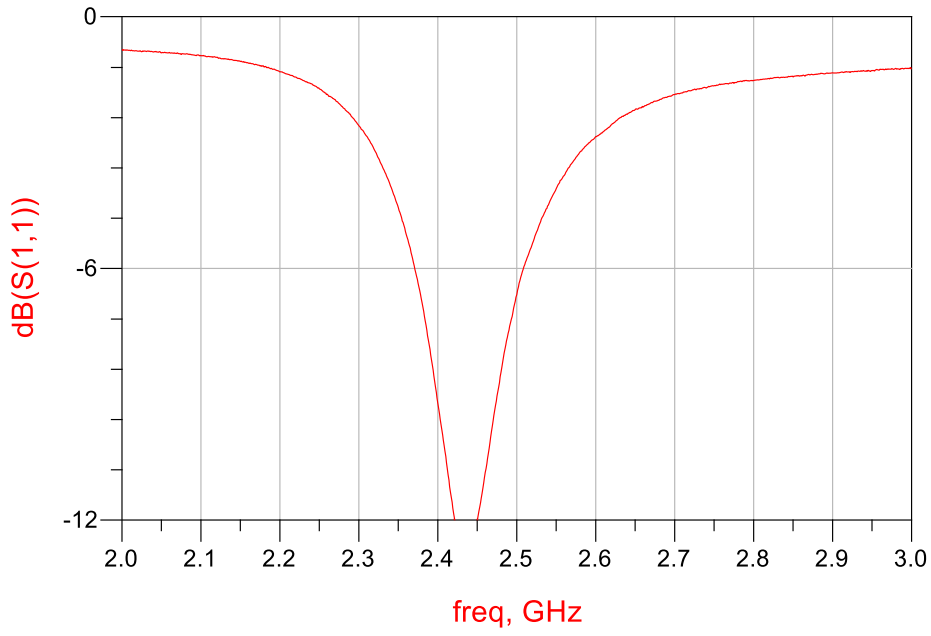
2. RF Performances

RF Specifications according to standards

Parameter	Value	BT V4 Std limit	Unit	Condition
Output Power	-20 to +4	-20 to 10	dBm	Channels 0 to 39
RF Frequency tolerance	Better than +/-20	+/- 50	Hz	Channels 0 to 39
Rx sensitivity	-93	-70	dBm	Level for BER <0,1% ideal Tx
Max range	> 200		m	Open field @1m height
EIRP	4.6		dBm	
Antenna Gain	0.6		dBi	
Rx sensitivity	51.4		dBµV/m	

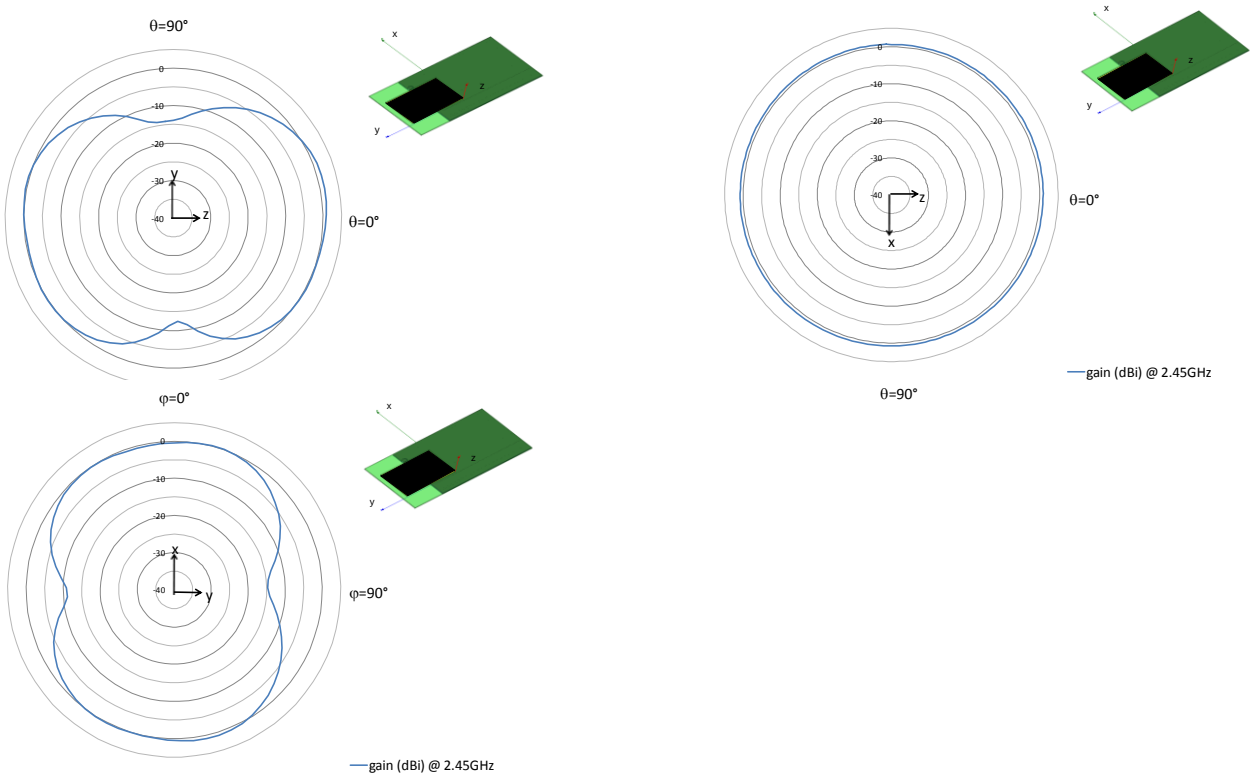
Typical Antenna Return Loss

Module mounted on a USB dongle ground plane

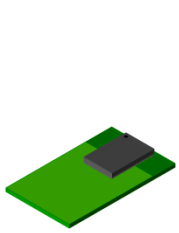


Radiation Pattern in 3 planes

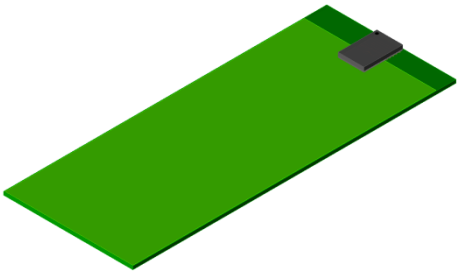
Module mounted on a USB dongle ground plane



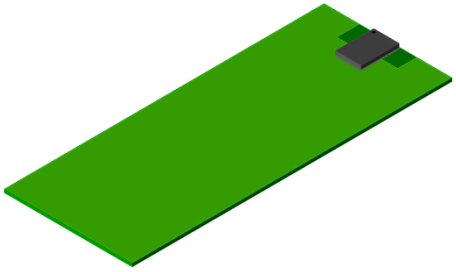
Ground Plane Effect Simulation



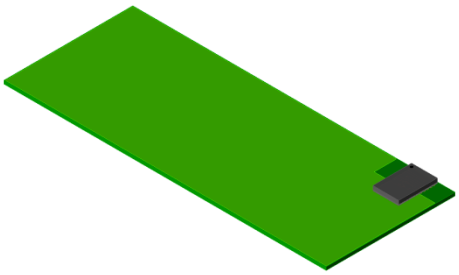
USB dongle
ground plane
(size : 18 x 30 mm²)



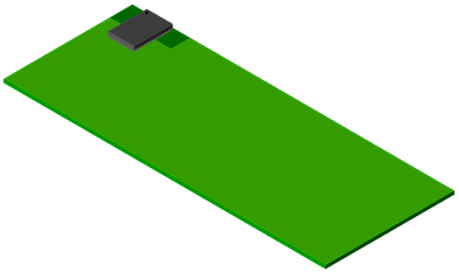
Cell phone config 1
ground plane
(size : 40 x 100 mm²)



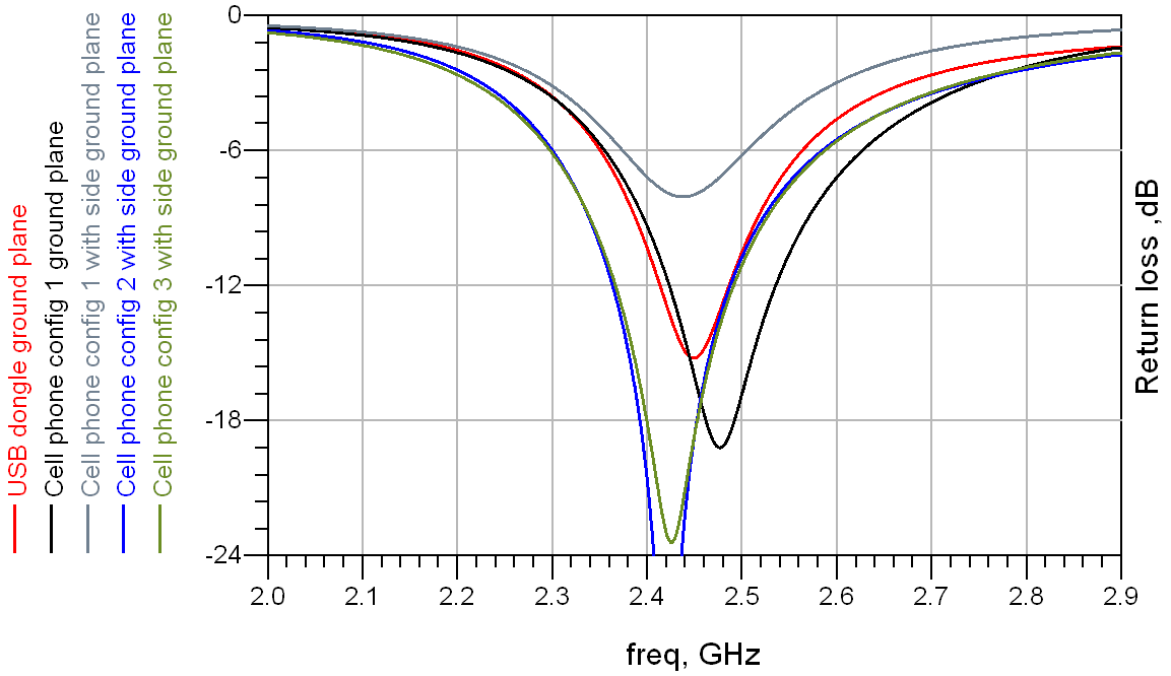
Cell phone config 1 with
side ground plane
(size : 40 x 100 mm²)



Cell phone config 2 with side ground plane
(size : 40 x 100 mm²)



Cell phone config 3 with side ground plane
(size : 40 x 100 mm²)



3. Product Development Tools

Interface

ISP130301 integrates a full microprocessor interface with up to 32 General Purpose I/O pins (GPIO) and several functions (2 x SPI, 2 x I2C, UART, 8 x ADC, SWDIO interface).

Hardware

The following development kit is recommended for using and testing ISP130301 module:

- Insight SiP Development Kit (ISP130301-DK1), need to be purchased separately

Development Tools and Software

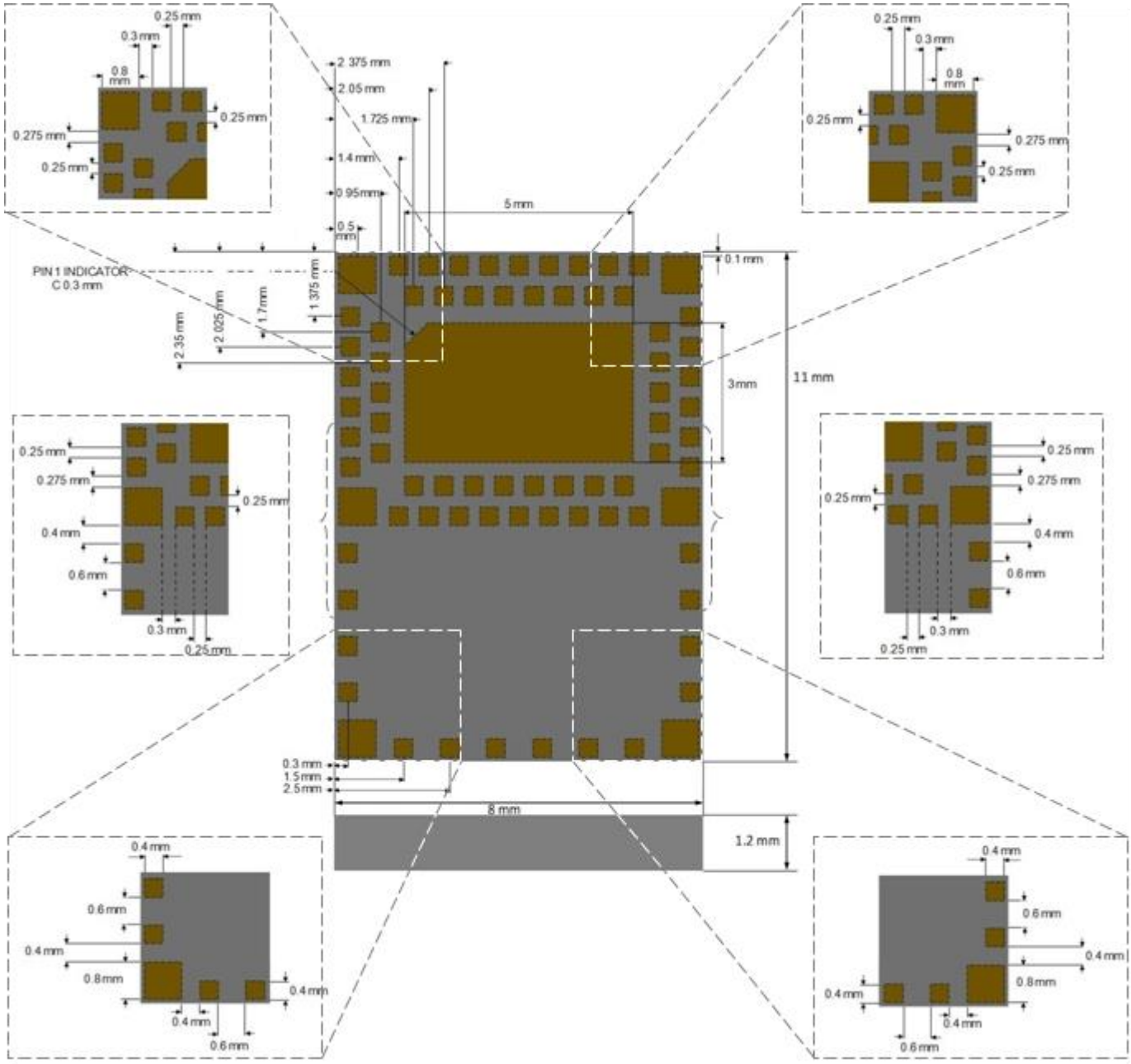
The following development tools and software are recommended for using and testing ISP130301 module:

- Nordic Semiconductor nRFgo Studio (downloadable from www.nordicsemi.com after purchasing ISP130301-DK1)
- Nordic Semiconductor Master Control Panel (downloadable from www.nordicsemi.com after purchasing ISP130301-DK1)
- Keil MDK-ARM Lite (downloadable from https://www.keil.com/demo/eval/arm.htm)
- Segger J-Link Lite (downloadable from http://www.segger.com/jlink-software.html)
- S100 nRF51822 SoftDevice: fully qualified Bluetooth low energy stacks for nRF51822 integrated in ISP130301 module. The S100 series of SoftDevices (object code, no source) can be downloaded from www.nordicsemi.com after purchasing ISP130301-DK1
- nRF51 Software Development Kit (SDK): nRF51 SDK can be downloaded from www.nordicsemi.com after purchasing ISP130301-DK1. It contains example of source codes applications (C language):
  - Precompiled HEX files
  - Source code
  - Keil ARM project files
  - IAR project files
  - GCC project files

4. Mechanical Outlines

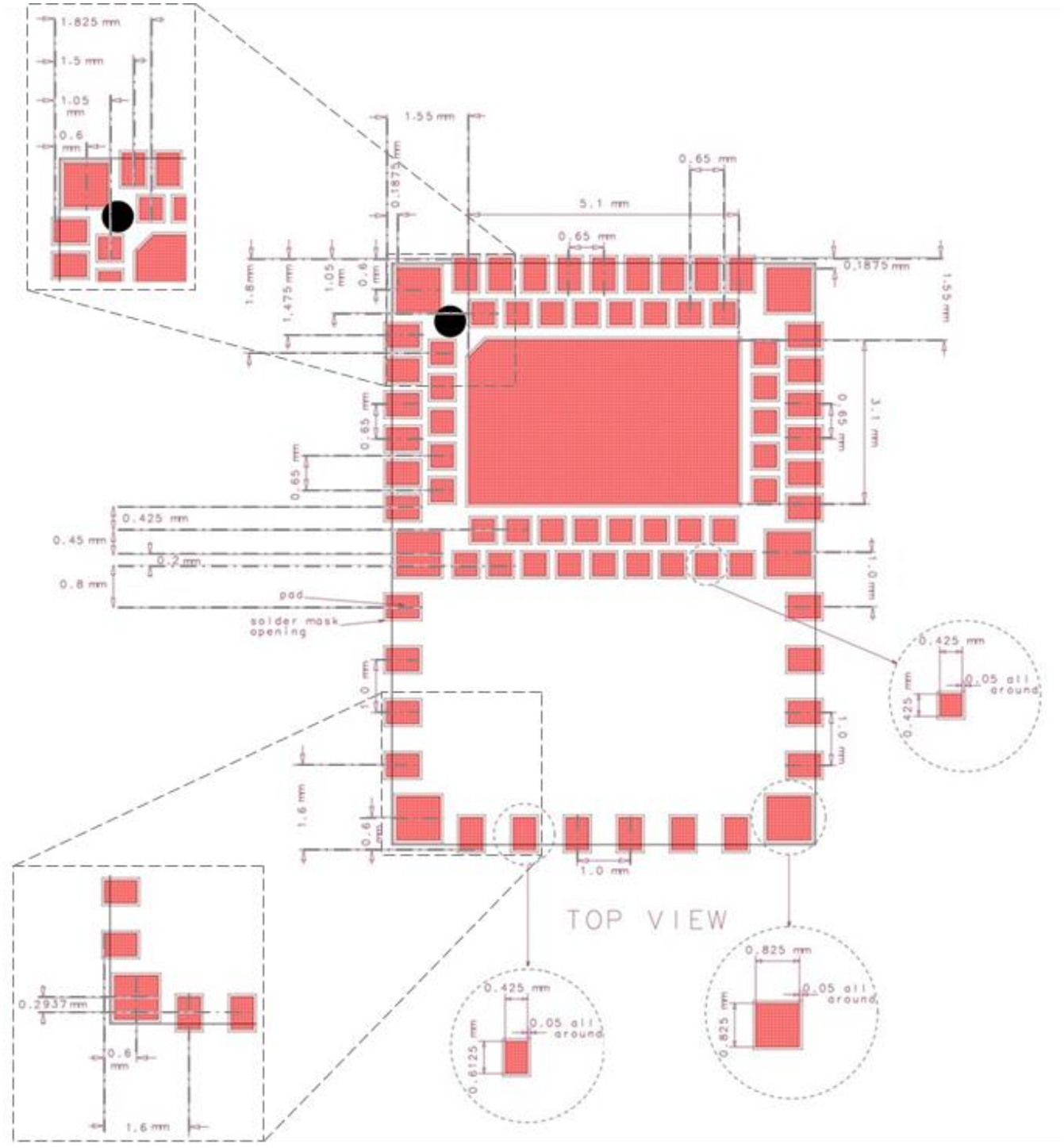
Mechanical Dimensions

Dimensional drawing for 8 x 11 x 1.2 mm, 57-Pad LGA Package



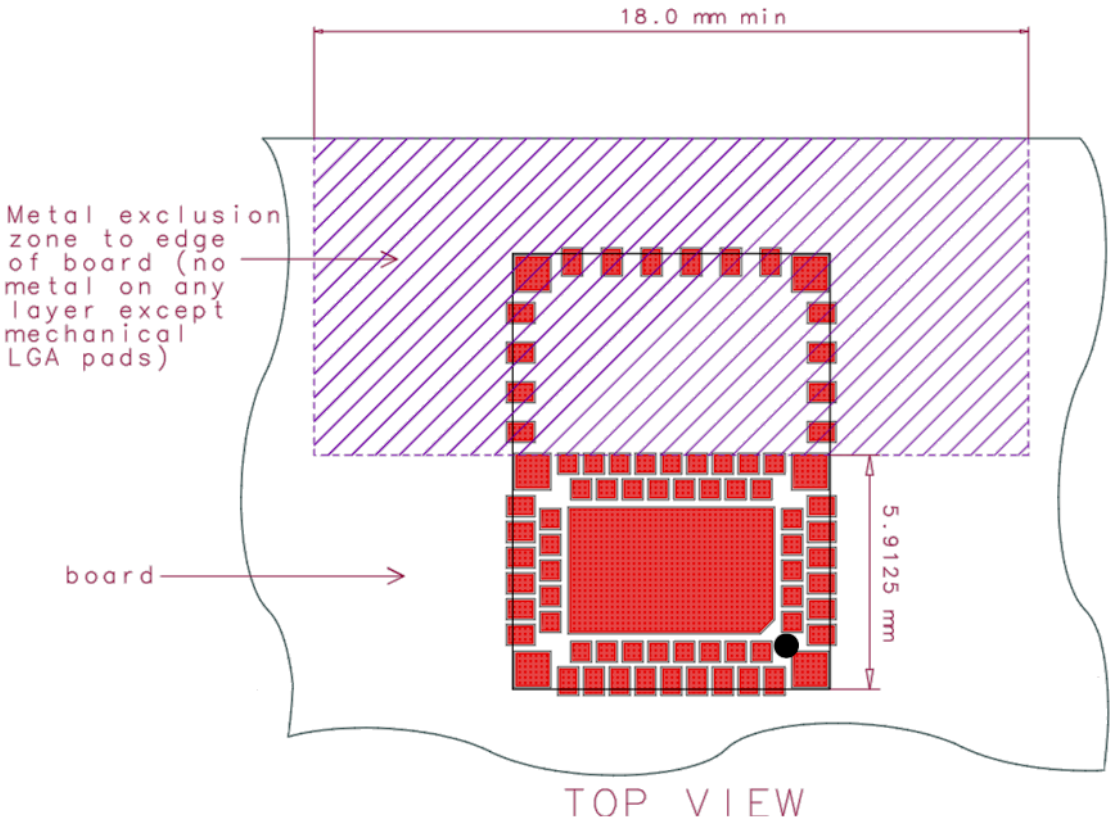
SMT Assembly Guidelines

Recommended PCB Land Pattern and Solder Mask layout. Complete information is available on request.



Antenna Keep-Out Zone

Recommended metal keep out areas for optimal antenna performance:
no metal, no traces and no components on any layer except mechanical LGA pads.

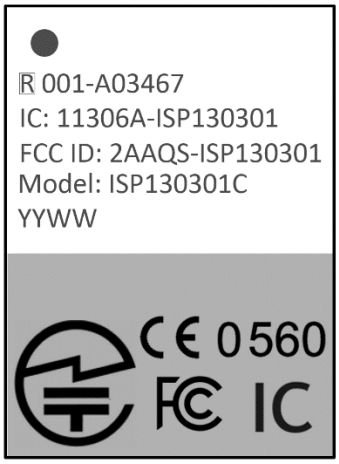


5. Packaging

Marking

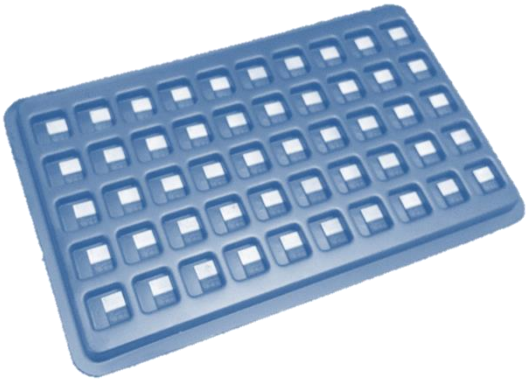
I	S	P	1	3		0	3	0	1	C
Y	Y	W	W							

ISP130301	Product number
C	Hardware version
YY	Two digit year number
WW	Two digit week number



Prototype Packaging

For engineering samples and prototype quantities up to 99 units, deliveries are provided in thermoformed trays.

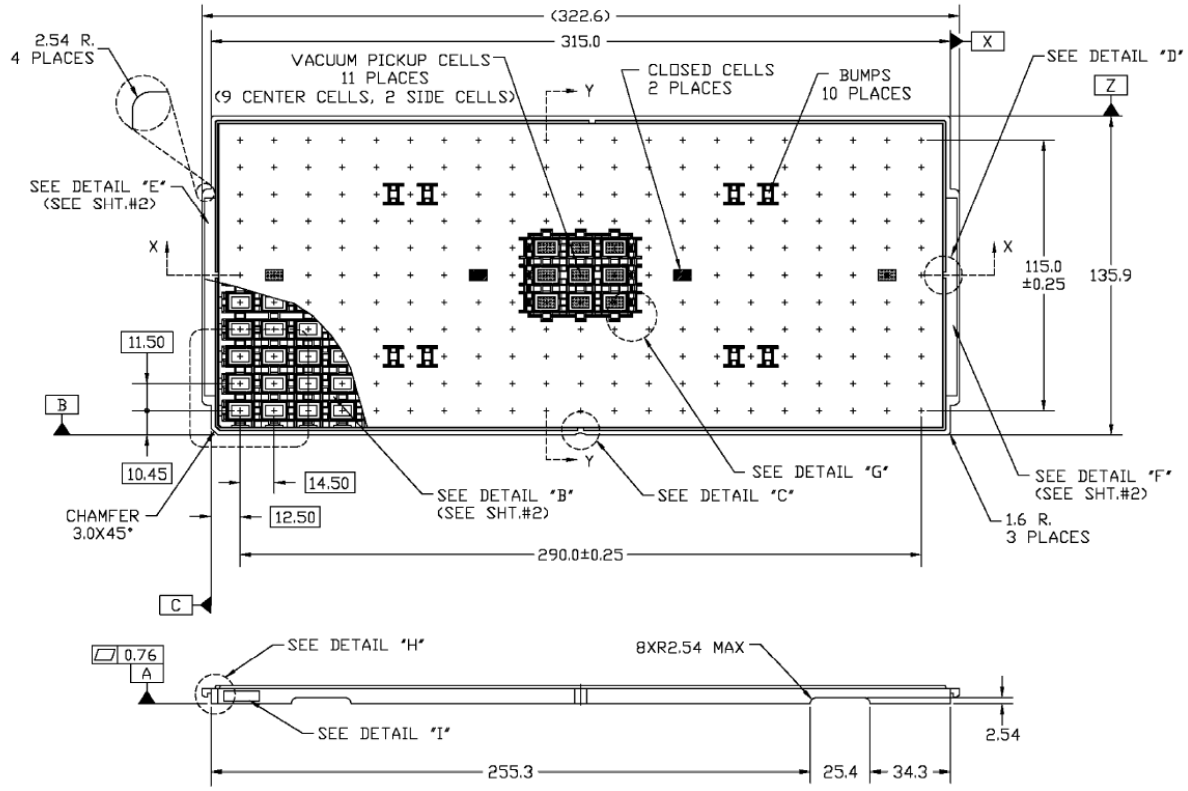


Trays

For higher quantities and volume production, ISP130301 are available in Jedec trays. They are delivered in sealed pack with desiccant pack and humidity sensors. These Jedec trays are also suitable for further baking. Please see section 6 for more information on moisture sensitivity.

Jedec trays are proposed in standard quantities of 100 units, 200 units and multiples of 200 units only.

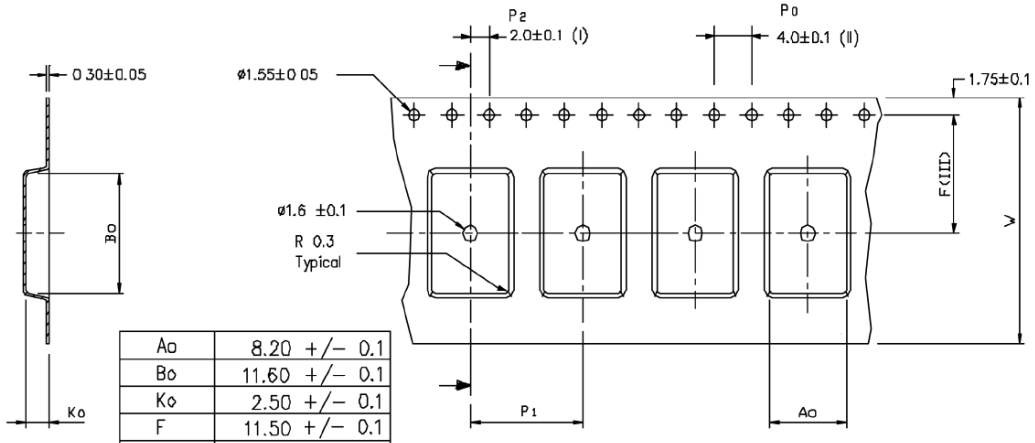
Please refer to tray sizes and module positioning below. Complete information on Jedec trays is available on request.



Tape and Reel

ISP130301 are also available in Tape & Reel. They are delivered in sealed pack with desiccant pack and humidity sensors. Reels are proposed in standard quantities of 500 units (180mm / 7” reel) or 2000 units (330mm / 15” reel) only.

Please refer to tape size below. Complete information is available on request.



Ao	8.20 +/− 0.1
Bo	11.60 +/− 0.1
Ko	2.50 +/− 0.1
F	11.50 +/− 0.1
P1	12.00 +/− 0.1
W	24.00 +/− 0.3

6. Storage & Soldering information

Moisture Sensitivity

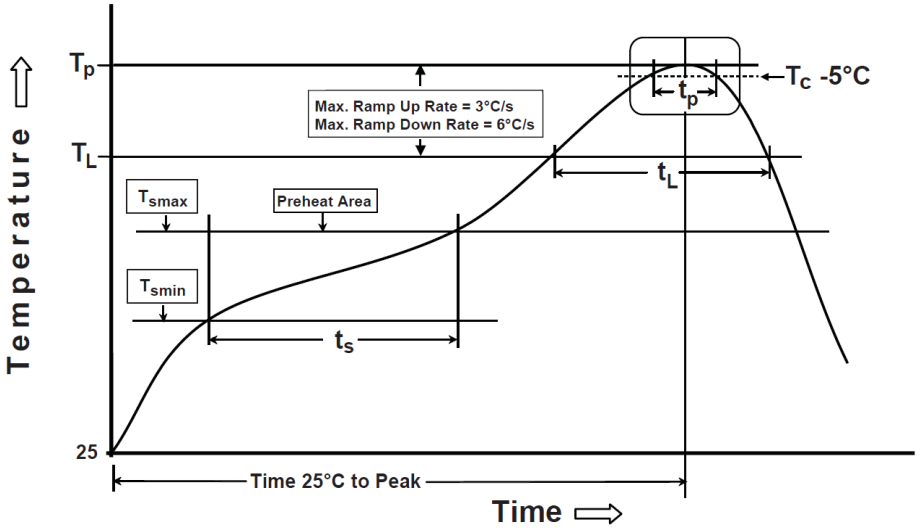
All plastic packages absorb moisture. During typical solder reflow operations when SMDs are mounted onto a PCB, the entire PCB and device population are exposed to a rapid change in ambient temperature. Any absorbed moisture is quickly turned into superheated steam. This sudden change in vapor pressure can cause the package to swell. If the pressure exerted exceeds the flexural strength of the plastic mold compound, then it is possible to crack the package. Even if the package does not crack, interfacial delamination can occur.

Since the device package is sensitive to moisture absorption, it is recommended to bake the product before assembly. The baking process for dry packing is 24 hours at 125°C.

ISP130301 has been tested MSL-5 according to standards. After baking, modules can be exposed to ambient room conditions (approximately 30 °C/60%RH) during 48 hours before assembly on the PCB.

Soldering information

Recommendation for RoHS reflow process is according to Jedec J–STD-020 and 033 standard profiles.



Preheat/Soak Temperature Min (T_{smin}) Temperature Max (T_{smax}) Time (t_s) from (T_{smin} to T_{smax})	 150 °C 200 °C 60-120 sec
Ramp-up rate (T_L to T_p)	3 °C/sec max
Liquidous temperature (T_L) Time (t_L) maintained above T_L	217 °C 60-150 sec

Peak package body temperature (T_p)	260°C (+0/-5°C)
Classification Temperature (T_c) Time (t_p) maintained above T_C-5 °C	260 °C 30 sec
Ramp-down rate (T_p to T_L)	6 °C/sec max
Time 25 °C to peak temperature	8 mn max

7. Quality & User information

Certifications

- FCC Identifier 2AAQS-ISP130301 – Certificate N° 142180643/AA/00
- CE: Complies with 1999/5/EC, EN300328 V1.8.1, Statement N° 142140199/AA/00
- IC Certification N° 11306A-ISP130301 – Telefication N° 142170180/AA/00
- TELEC certification N° 001 – A03467
- Bluetooth SIG certified N° D024444
- RoHS compliant

USA – User information

This intends to inform how to specify the FCC ID of our module “ISP130301” on the product. Based on the Public Notice from FCC, the host device should have a label which indicates that it contains our module.
The label should use wording such as: “Contains FCC ID: 2AAQS-ISP130301”.
Any similar wording that expresses the same meaning may be used.
The label of the host device should also include the below FCC Statement. When it is not possible, this information should be included in the User Manual of the host device:

“This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions.
(1) This device may not cause harmful interference
(2) This device must accept any interference received, including interference that may cause undesired operation.
Caution: Any Changes or modifications not expressly approved by the party responsible for compliance could void the user’s authority to operate the equipment.”

CANADA – User information

This intends to inform how to specify the IC ID of our module “ISP130301” on the product. According to Canadian standards “RSS-210” and “RSS-Gen”, the host device should have a label which indicates that it contains our module.
The label should use wording such as: “Contains IC: 11306A-ISP130301”.
Any similar wording that expresses the same meaning may be used.
The label of the host device should also include the below IC Statement. When it is not possible, this information should be included in the User Manual of the host device:

“This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.”

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

Discontinuity

Normally a product will continue to be manufactured as long as all of the following are true:
- The manufacturing method is still available.
- There are no replacement products.
- There is demand for it in the market.

In case of obsolescence, Insight SiP will follow Jedec Standard JSD-48. A Product Discontinuation Notice (PDN) will be sent to all distributors and made available on our website. After this, the procedure goes as follows:
- Last Order Date will be 6 months after the PDN was published.
- Last Shipment Date will be 6 months after Last Order Date, i.e. 12 months after PDN.

Disclaimer

Insight SiP's products are designed and manufactured for general consumer applications, so testing and use of the product shall be conducted at customer's own risk and responsibility. Please conduct validation and verification and sufficient reliability evaluation of the products in actual condition of mounting and operating environment before commercial shipment of the equipment. Please also pay attention (i) to apply soldering method that don't deteriorate reliability, (ii) to minimize any mechanical vibration, shock, exposure to any static electricity, (iii) not to overstress the product during and after the soldering process.

The products are not designed for use in any application which requires especially high reliability where malfunction of these products can reasonably be expected to result in personal injury or damage to the third party's life, body or property, including and not limited to (i) aircraft equipment, (ii) aerospace equipment, (iii) undersea equipment, (iv) power plant control equipment, (v) medical equipment, (vi) transportation equipment, (vii) traffic signal equipment, (viii) disaster prevention / crime prevention equipment.

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

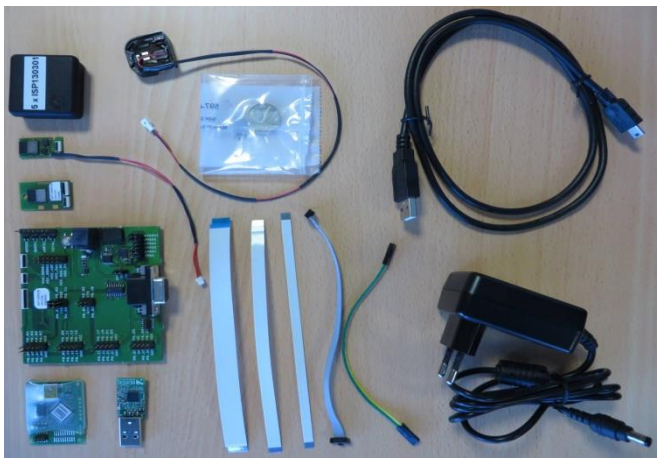
ISP130301-DK1 Bluetooth Low Energy Wireless Sensor Development Kit for ISP130301

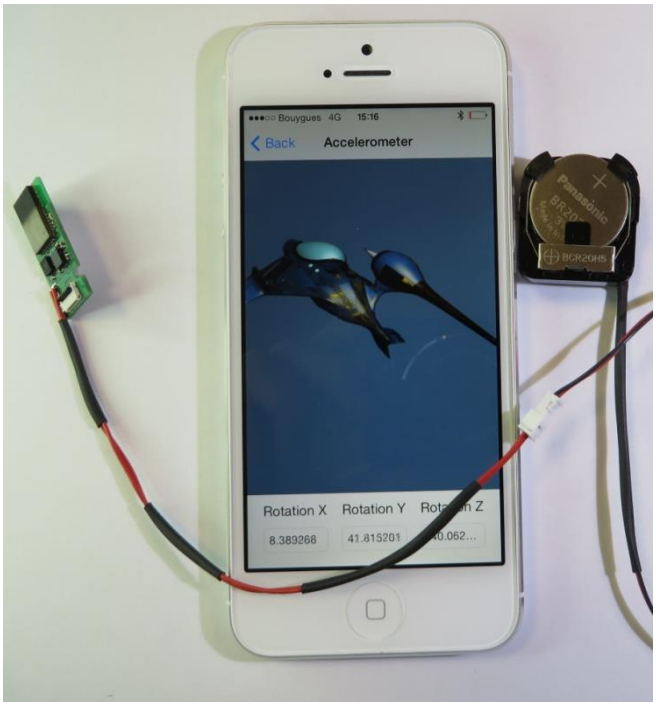
General Description

In order to assist clients in developing their Bluetooth Smart solutions based on the ISP130301, Insight SIP offers a Sensor Development Kit. This consists of the following Sensor Board, containing:

- One Interface Board
- J-Link Lite CortexM-9 JTAG/SWD Emulator
- One Test Board
- One Sensors Board
- A Development Dongle
- 5 ISP130301 module samples
- Cables, power supply and coin battery holder
- Smartphone is NOT included

Using this development kit, product developers can use a working solution as starting point to develop their own products. Time to market is saved by avoiding starting from a blank sheet of paper. In addition, there may be some applications that use the hardware as is.





Applications

Possible applications include:

- Sports accessories (movement etc)
- Healthcare accessories(heart rate)
- Alarms (temperature excess)
- Pressure detection

The miniature size of the Insight solution means it could be comfortably worn, or is able to fit into a small space.

Please refer to the application note AN140101 for more information on kit implementation.

Specific Skills

If a product developer lacks skills in any of the crucial areas to develop a working solution, then Insight SIP can offer custom design services to cover all of the following areas

- Custom hardware development
- Addition/replacement of different sensors
- Software development
  Custom SIP development

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

AN140101
Use of ISP130301-DK1

Introduction

Scope

This document gives details on hardware and software for using and testing Insight SiP Bluetooth Low Energy module ISP130301.

Contents

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

1. Recommended Documentation

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

Documents:

- nRF51822 Development kit User Guide (hardware section should be partially ignored – ISP development kit hardware replaces Nordic Semiconductor hardware).
- nRF51 Series Reference Manual.
- nRF51822 PS (data sheet).
- S110 nRF51822 SoftDevice Specification.
- nRF51 SDK.

Dev kits (software portion):

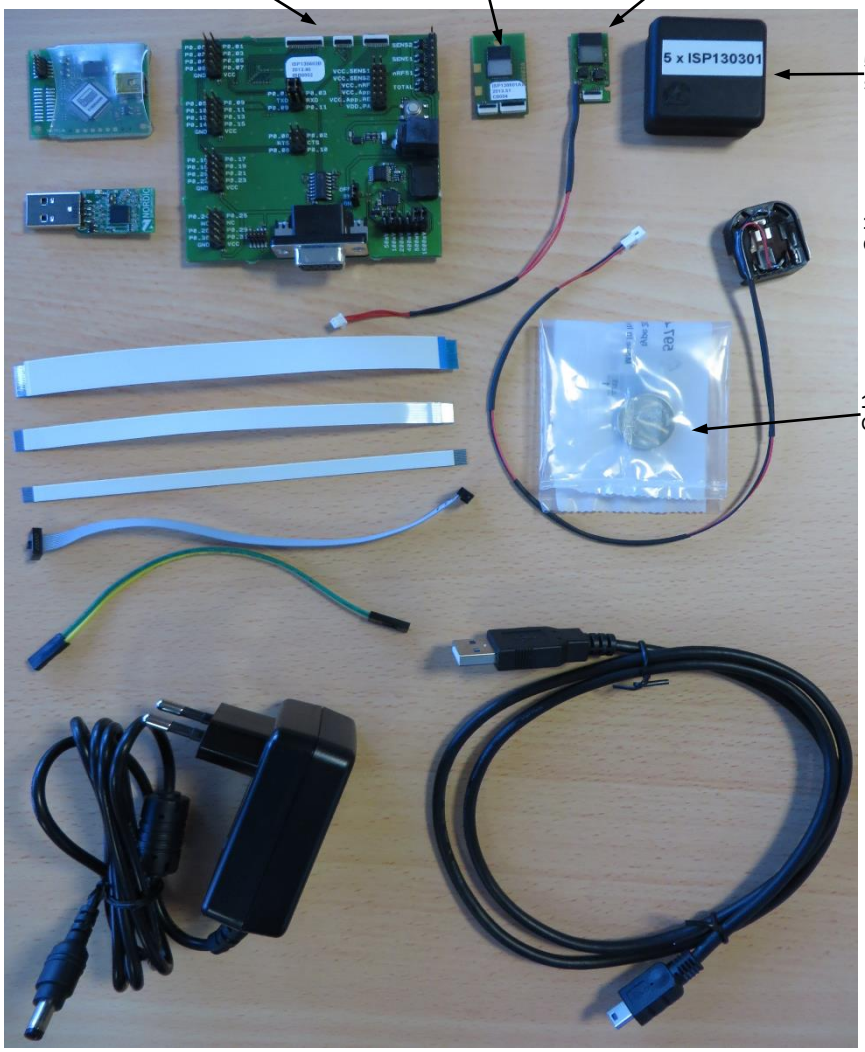
- nRFgo Studio.
- nRF51 Software Development Kit (SDK):
  - Precompiled HEX files.
  - Source code.
  - Keil ARM project files.
- S110 nRF51822 SoftDevice.
- Master Control Panel.

To access these files, go to www.nordicsemi.com and log in to your Nordic My Page account, enter your product key and download the files. Instructions can be found in Chapter 3.

ISP documents that complement the above:

- AN140101 App Note – this document.
- DS130301 module data sheet.
- ISP130601 Test Board schematic SC130602.
- ISP131001 Sensors Board schematic SC131002.
- ISP130603 Interface Board schematic SC130604.

2. ISP130301-DK1 Hardware Content



3. Software Installation

This paragraph shows you the steps to follow for software installation.

1. Download and install Keil MDK-ARM Lite from https://www.keil.com/demo/eval/arm.htm to your hard drive.

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.

4. Select MY KEYS from the left menu. This takes you to the My Keys page.

5. Enter the product key (included in this kit) into the Product Key field and click Add.

6. Click MY PRODUCTS in the left menu.

7. From the Add product dropdown, select the product name and click Add. The chosen product is now listed in the below Overview, My Products table.

8. In the Overview, My Products table click the Downloads link next to the product name to go directly to the relevant product page download section.

9. Download, install and run nRFgo Studio (Make sure to download the last version updated).

10. Download, install and run Master Control Panel. The software is on the CD and if you want the last version, you can find it on the Nordicsemi website. *(x86 is for 32 bits windows and x64 is for 64 bits windows)*

11. Download and run the nRF51 SDK installer. Make sure to choose the Keil MDK-ARM installer option (Make sure to download the last version updated).

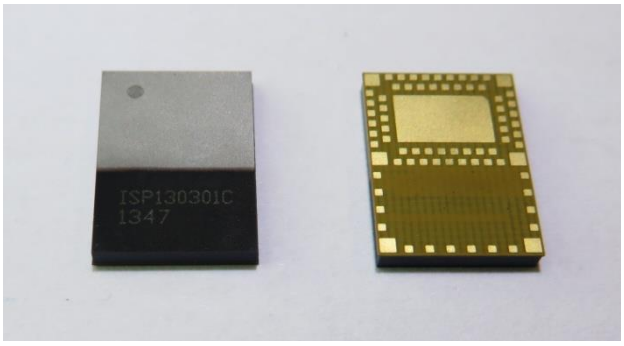
12. Download the S110 / S120 nRF51822 SoftDevice (Make sure to download the last version updated).

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – **www.insightsip.com**

4. Hardware Description

4.1 ISP130301 Module

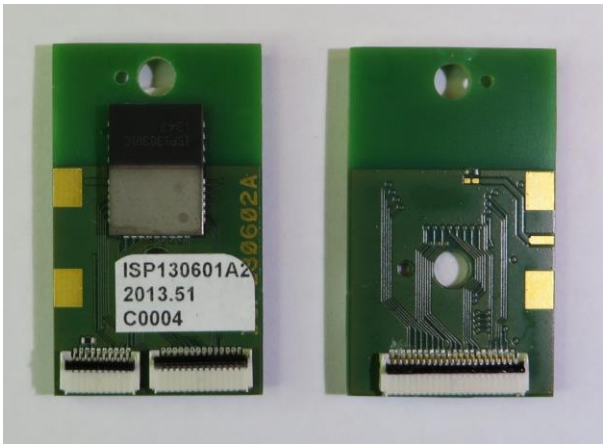
ISP130301 is a Bluetooth Low Energy module with integrated antenna.



This module is based on Nordic Semiconductor nRF51822 2.4 GHz wireless SoC. nRF51822 integrates nRF51 series 2.4 GHz transceiver, a 32 bit ARM Cortex™-M0 CPU, flash memory, and analogue and digital peripherals. nRF51822 can support Bluetooth low energy and a range of proprietary 2.4 GHz protocols. The ISP130301 module measures 8 x 11 x 1.2 mm3. The module integrates all the decoupling capacitors, the 16 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, see Insight SiP module data sheet (document DS130301).

4.2 ISP130601 Test Board

ISP130601 is the basic application test board that has dimensions of 18 x 30 mm².



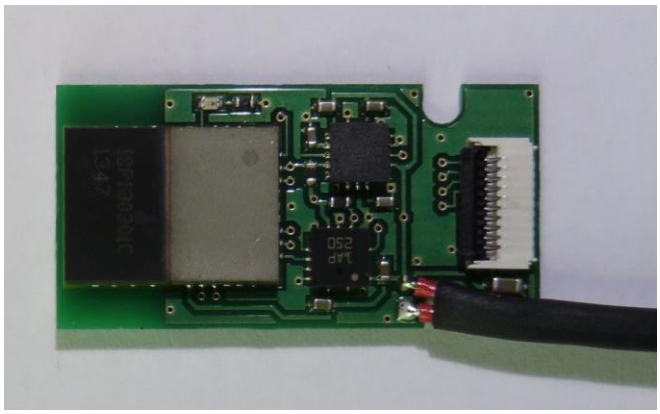
It encloses:

- ISP130301 BLE module
- 3 x FPC connectors in order to access the nRF51822 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 bottom side of the board.

The ISP130601 electrical schematic is presented in document SC130602.

4.3 ISP131001 Sensors Board

ISP131001 is the sensor application board that has dimensions of 12.5 x 25 mm².



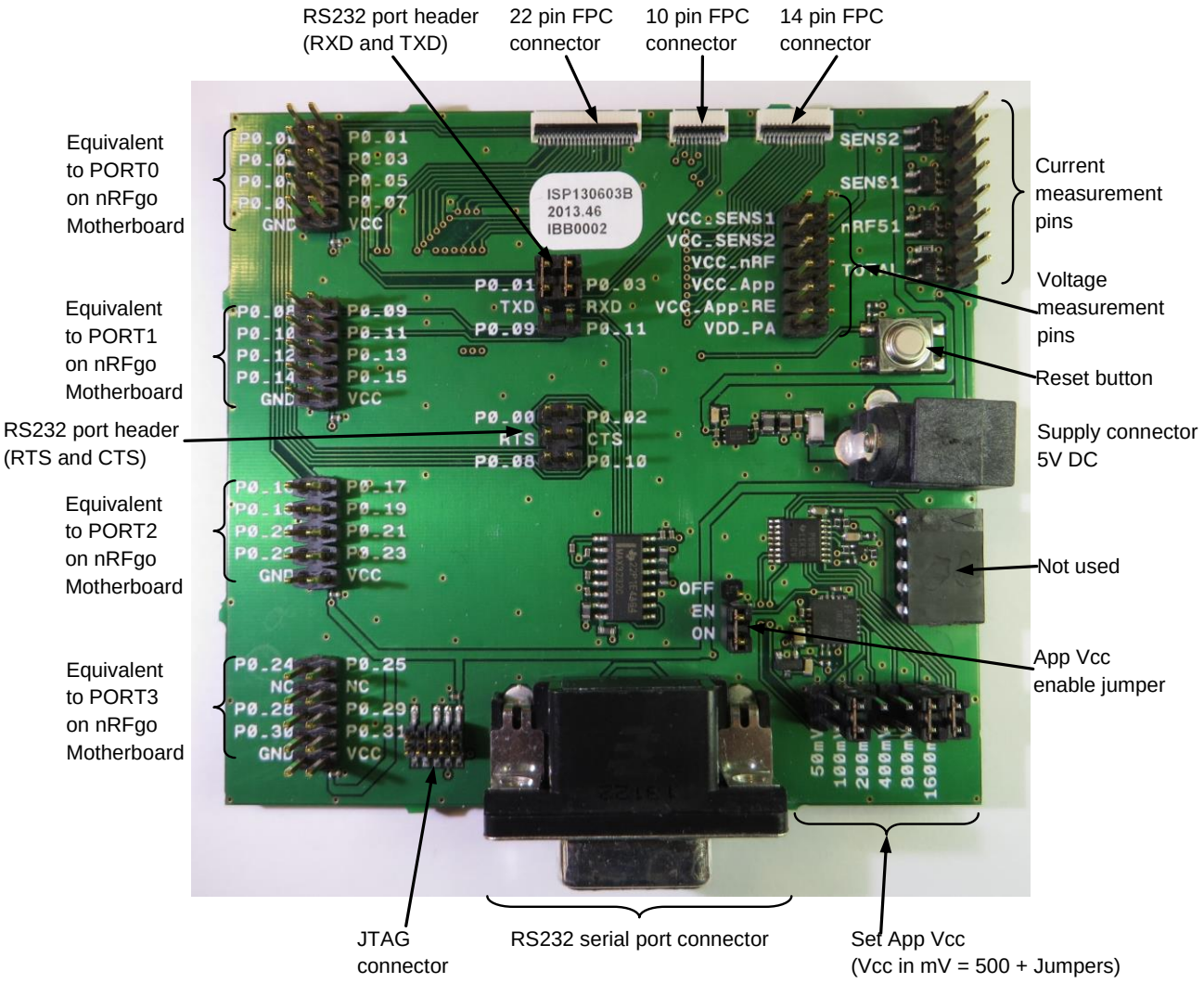
It encloses:

- ISP130301 BLE module.
- ST Micro LPS331AP temperature and barometer sensor.
- Freescale FXOS8700CQ 6-axis linear accelerometer and magnetometer sensor.
- Rohm SML-P11MTT86 mini-LED.
- Software to read/drive the sensors.
- Removable 10 pin FPC connector for software loading.

The ISP131001 electrical schematic is presented in document SC131002.

4.4 ISP130603 Interface Board

ISP130603 is the application type interface board that has dimensions of 86 x 80 mm².



The ISP130603 electrical schematic is presented in document SC130604.

4.5 nRF51822 Development Dongle (PCA10000)

The reader should refer to the corresponding paragraph in nRF51822 Development Kit User Guide document.

5. Basic Application using ISP130601 Test Board

5.1 Basic BLE Proximity Application

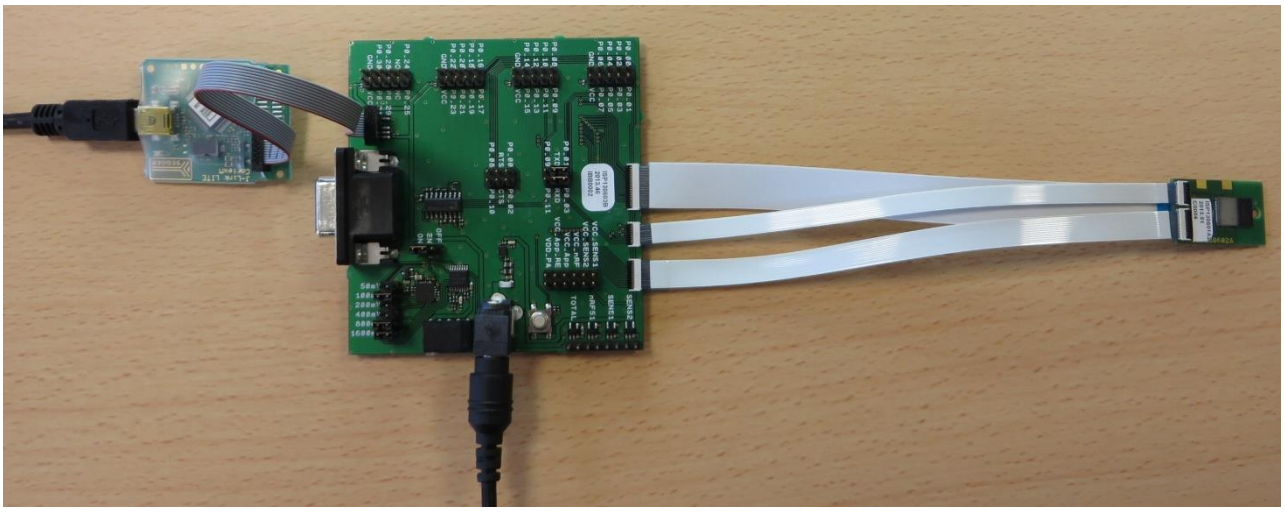
This paragraph shows you how to set up and program a BLE proximity application on top of a SoftDevice that will send data on a Bluetooth link from the ISP130601 Test Board to the Master Emulator. In order to use Bluetooth Low Energy radio, the software is loaded in 2 parts:

- S110 SoftDevice using nRFgo Studio (hex file, no source).
- Proximity Application using Keil uVision4.

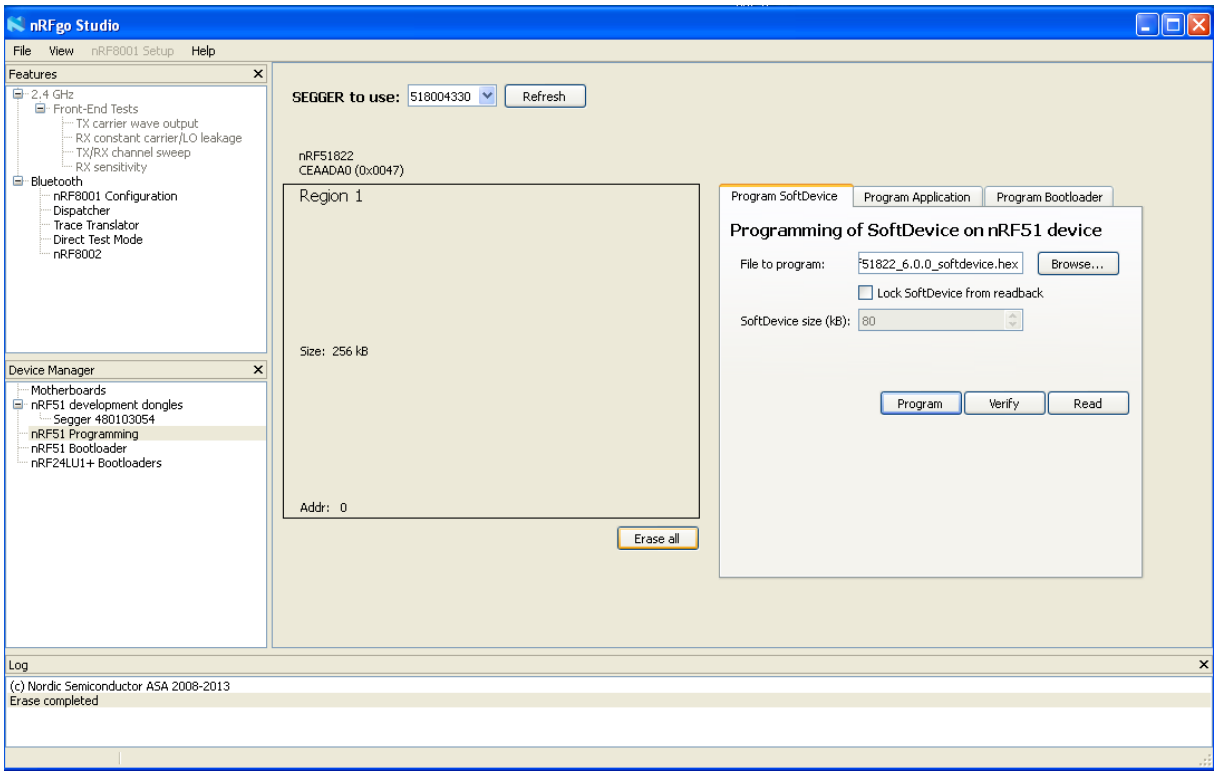
Then Master Emulator is connected and Proximity Application is launched.

S110 SoftDevice loading

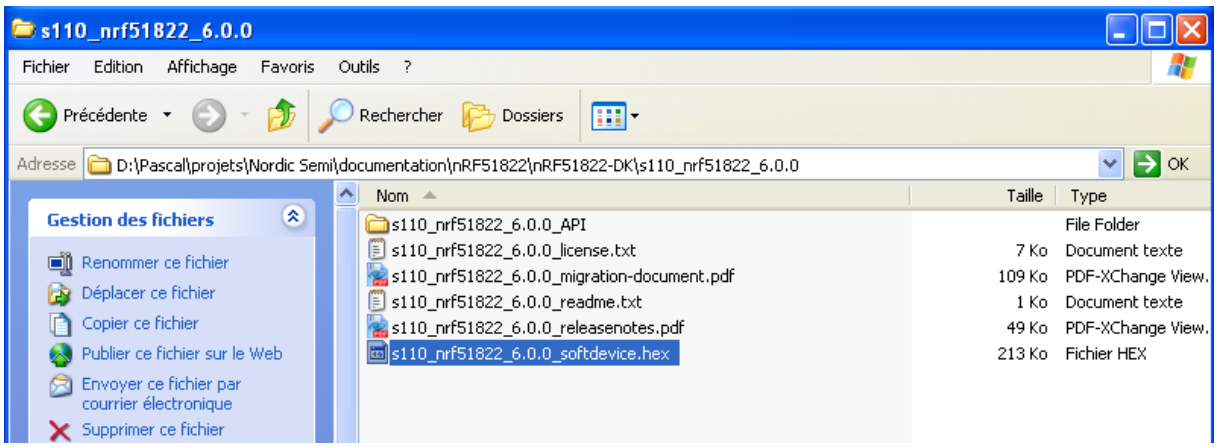
1. Connect the SEGGER J-Link board to the ISP130603 Interface Board with the 10 pin flat cable (1.27 mm pitch, provided in the Development Kit).
2. Connect the provided USB cable from the J-link board to your computer.
3. Connect the ISP130602 Test Board to the ISP130603 Interface Board with the 10 pin, 14 pin and 22 pin FPC jumper cables (0.5 mm pitch, provided in the Development Kit)
4. To ensure that power supply starts correctly, disconnect Enable jumper, connect to OFF and then Enable after supplying 5V from DC power supply (provided in the Development kit).

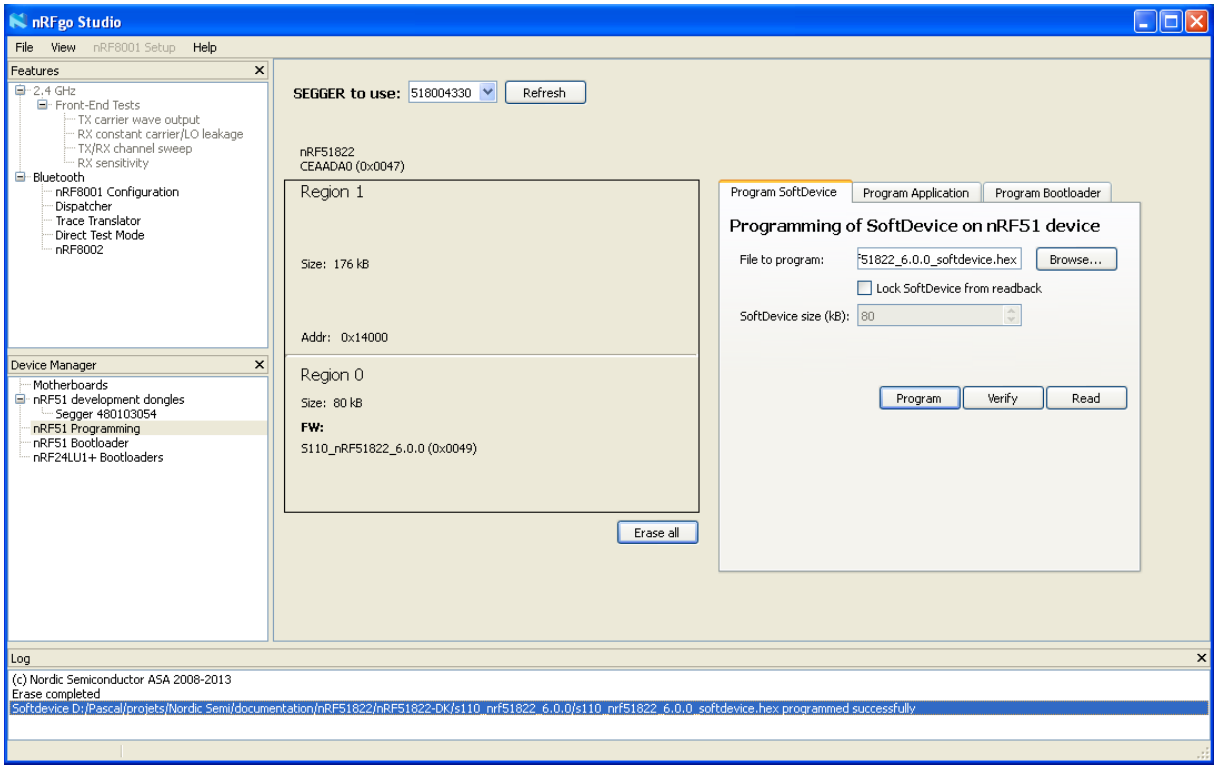


5. Start nRFgo Studio.
6. Select nRF51 Programming.
7. Click Erase all.



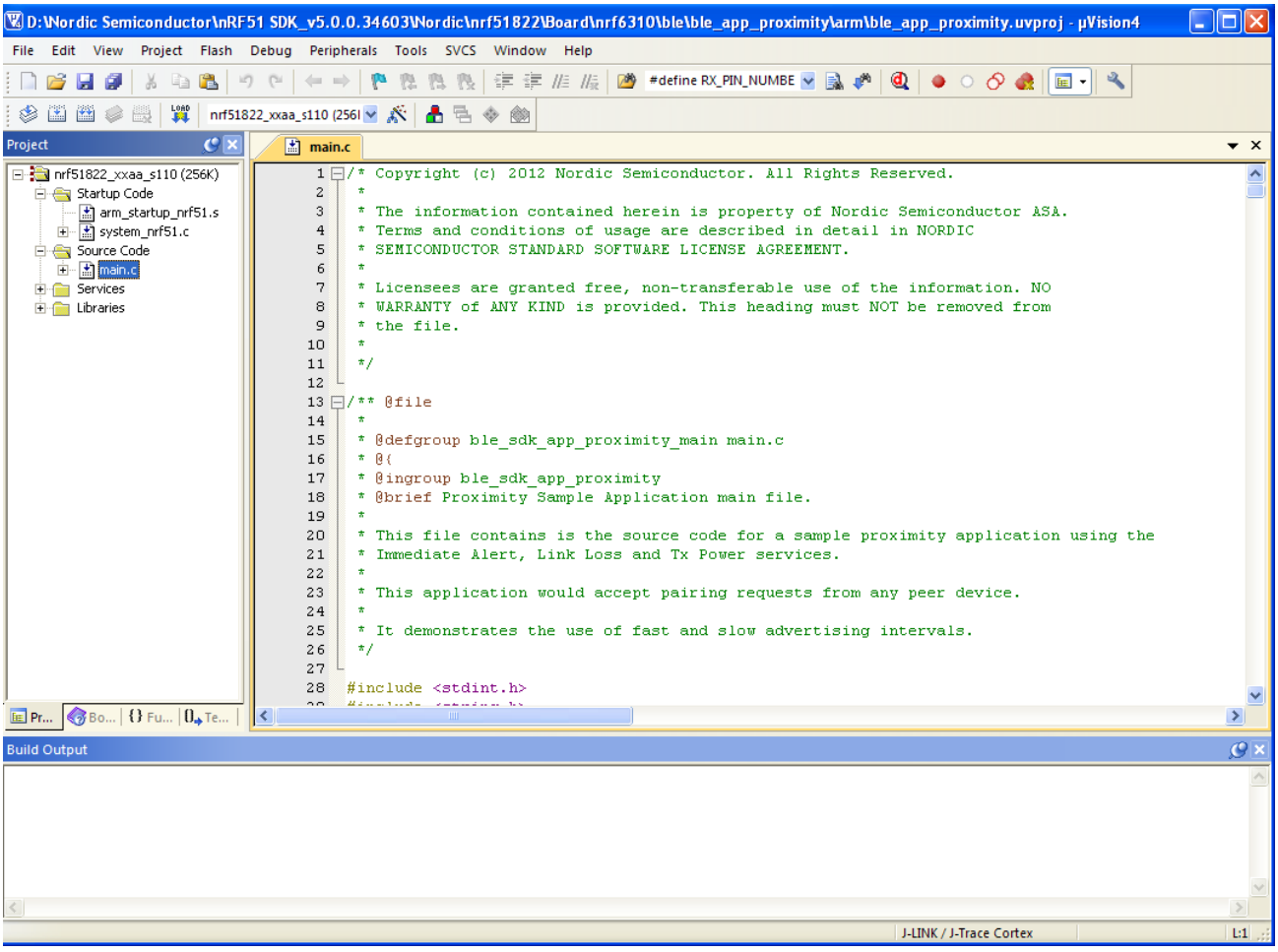
8. Browse to SoftDevice hex file and click Program.





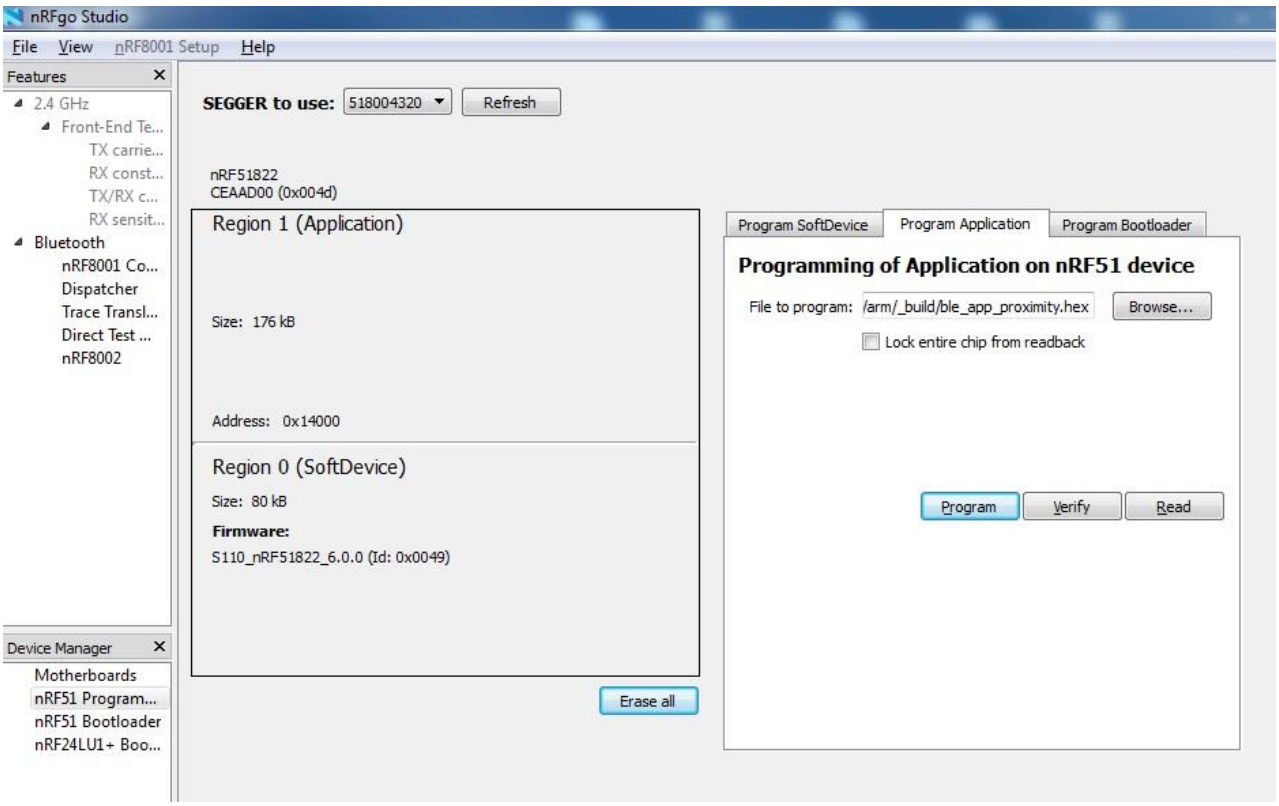
Proximity Application loading

1. Start Keil uVision.
2. Select Project then Open Project in order to open ble_app_proximity. Make sure it is the right file project. *(Ex: C:\Keil_v5\ARM\Device\Nordic\nrf51822\Board\nrf6310\s110\ble_app_proximity\arm).*



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.

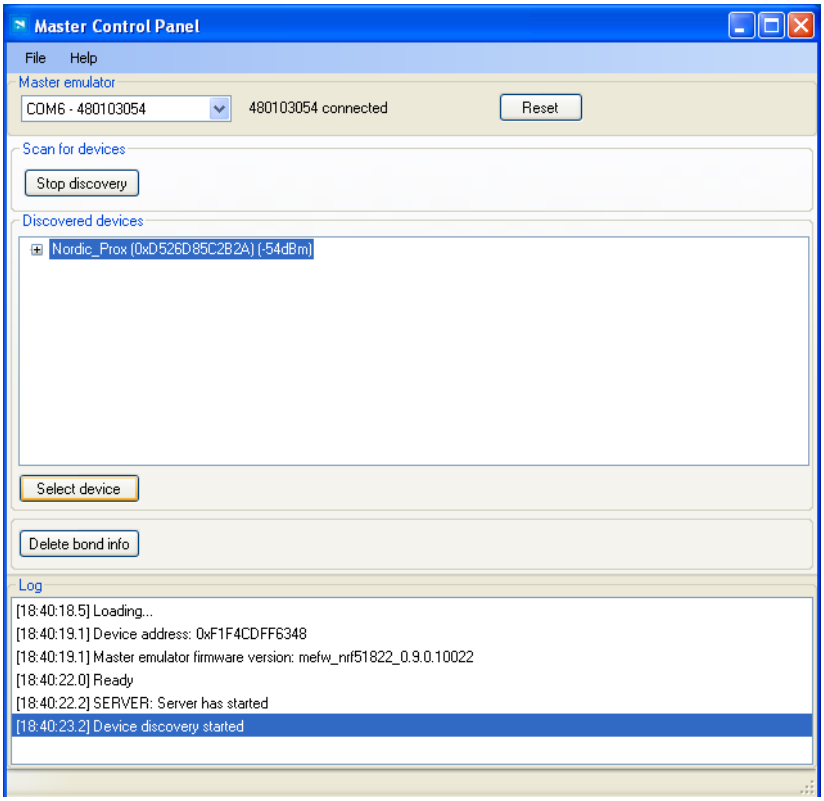
You can also load the hex file (generated after building target with keil uVision) by nRFgo studio in the program application.



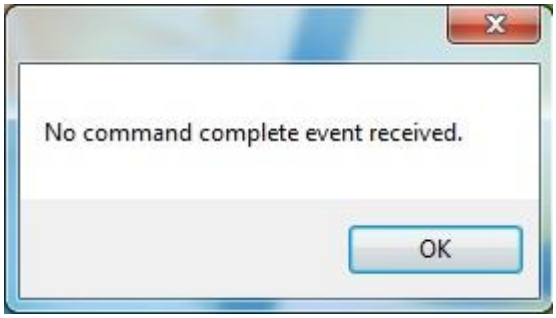
Browse to SoftDevice hex file and click Program. The file project is located for example: *C:\Keil_v5\ARM\Device\Nordic\nrf51_sdk_v6_0_0_43681\nrf51822\Board\nrf6310\s110\ble_app_proximity\arm_build).*

Master Emulator and Proximity Application

1. Connect Development Dongle PCA10000 (Master Emulator) into a USB port on your computer.
2. Start Master Control Panel.
3. Click Start Discovery.



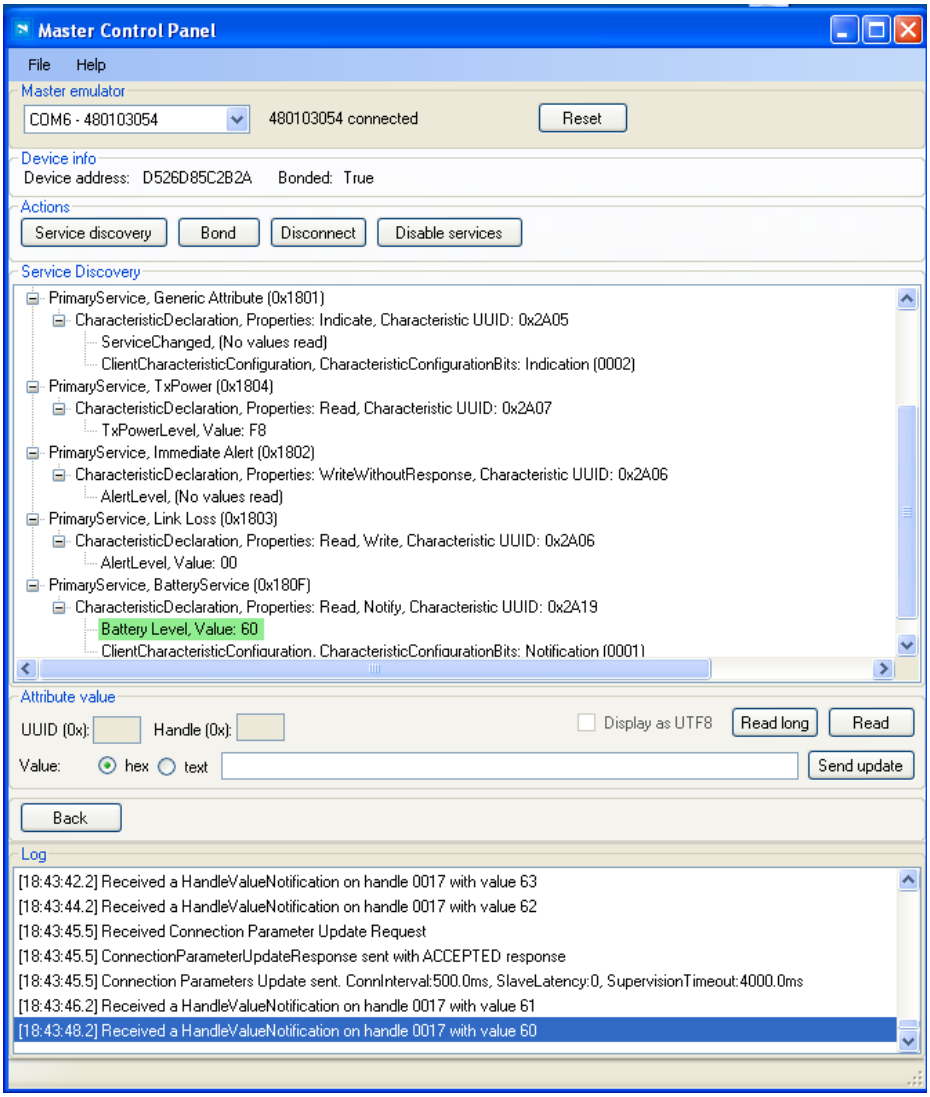
4. After starting discovery, if no device appearing, disconnect and connect again the interface board power supply.
5. If you have an error message as indicated in the photo :



It means that the nRF51822 Development Dongle (PCA10000) 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 dongle (PCA10000) 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-xxxxxxxxx (nn gives the COM port number; xxxxxxxxx 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, Service Discovery and Enable Services.



8. You can note Battery voltage is sent by the ISP130601 Test Board to the Master Emulator via the Bluetooth link. The application is written to send a value that changes cyclically.

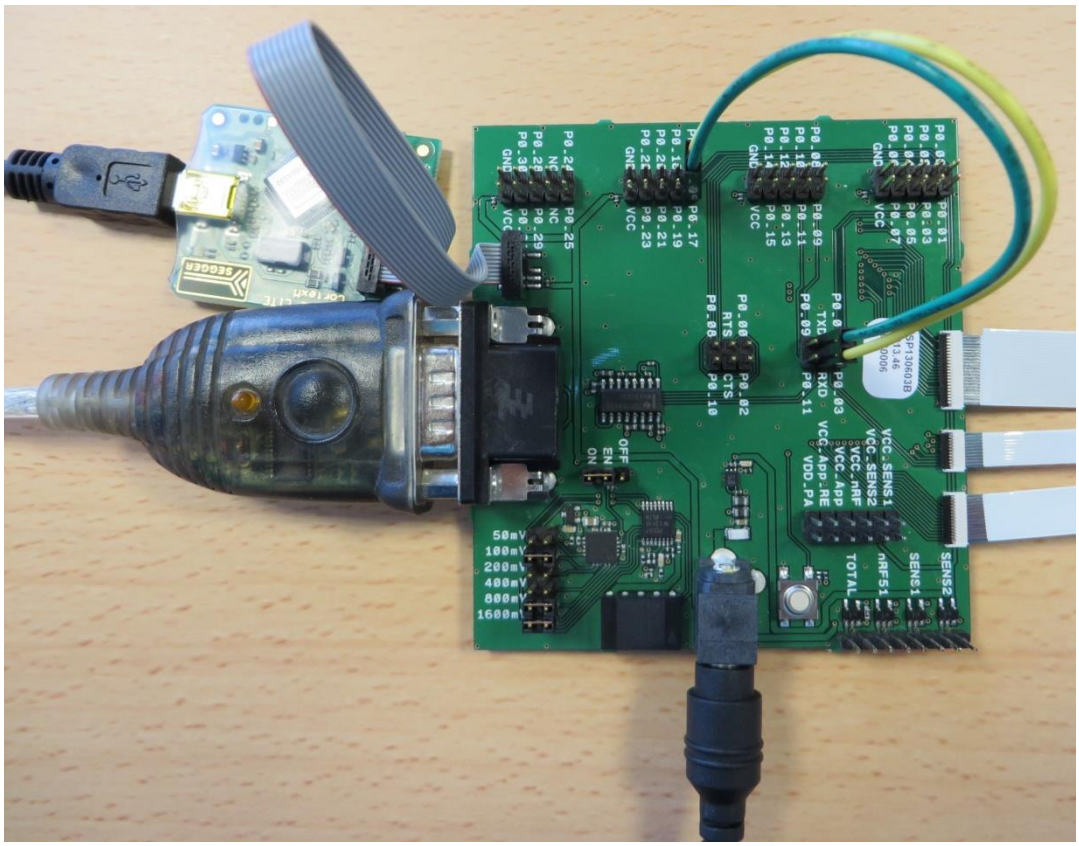
Important notification: The **nrf51_sdk_v6_0_0** examples are only compatible with **SoftDevice s110_nrf51822_7.0.0** due to some API changes in the release. You can use **nrf51_sdk_v5_2_0** instead if you need to use **SoftDevice s110_nrf51822_6.0.0**.

5.2 Direct Test Mode (UART)

This paragraph shows you how to set up and program the Direct Test Mode through the UART on ISP130601 Test Board.

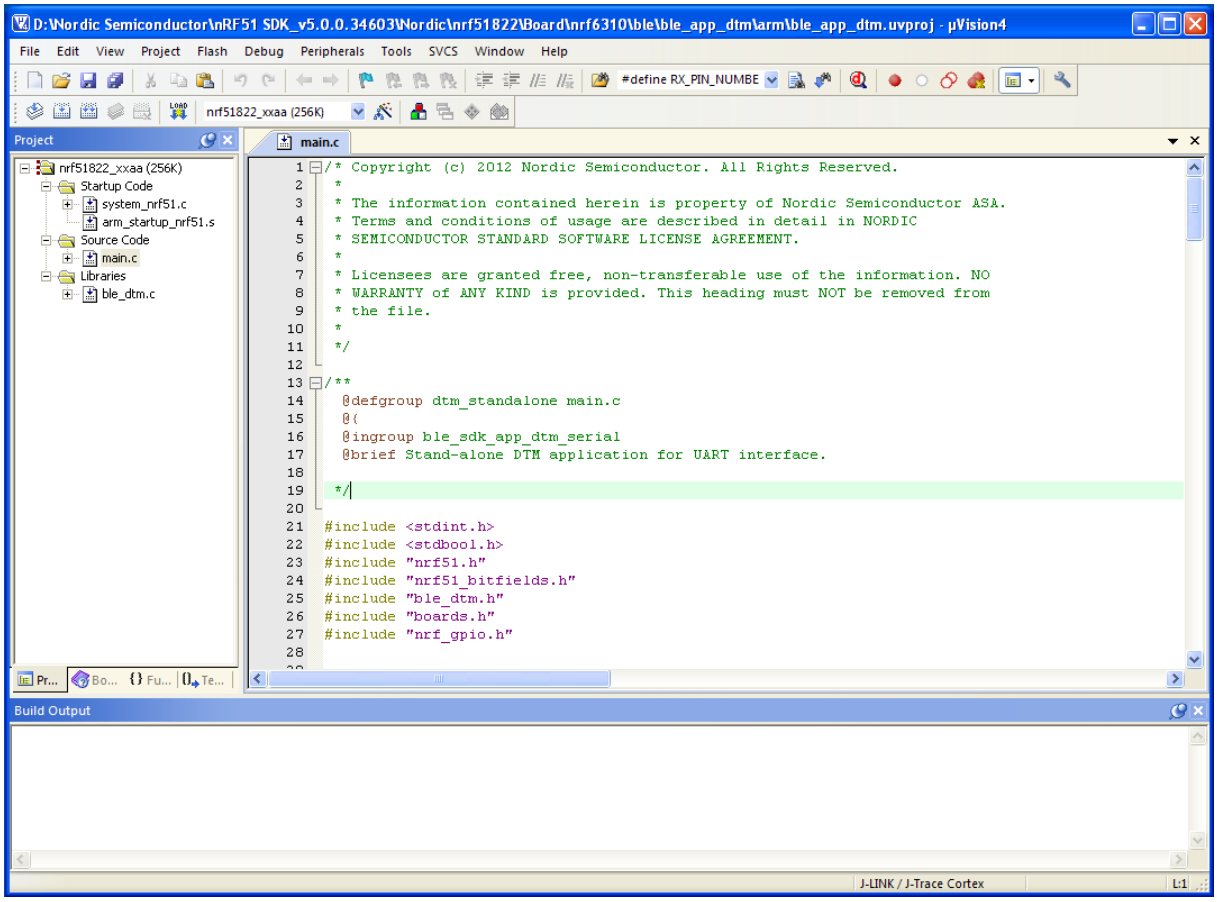
Direct Test Mode Set-up

1. Connect the SEGGER J-Link board to the ISP130603 Interface Board with the 10 pin flat cable (1.27 mm pitch, provided in the Development Kit).
2. Connect the USB cable from the J-link board to your computer.
3. Connect the ISP130601 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)
4. On the ISP130603 Interface Board, connect the 2-lead patch cable in order to connect RXD to P0_16 and TXD to P0_17. Make sure the RXD/TXD labels match for each wire. This matches the default setting in the SDK project ble_app_dtm (be careful: depending on the ble_app_dtm version, the ports used could be different).
5. Connect a USB to serial cable converter from RS232 port connector of the ISP130603 Interface Board to a USB port on your computer.
6. Connect the 5V DC power supply to the ISP130603 Interface Board.

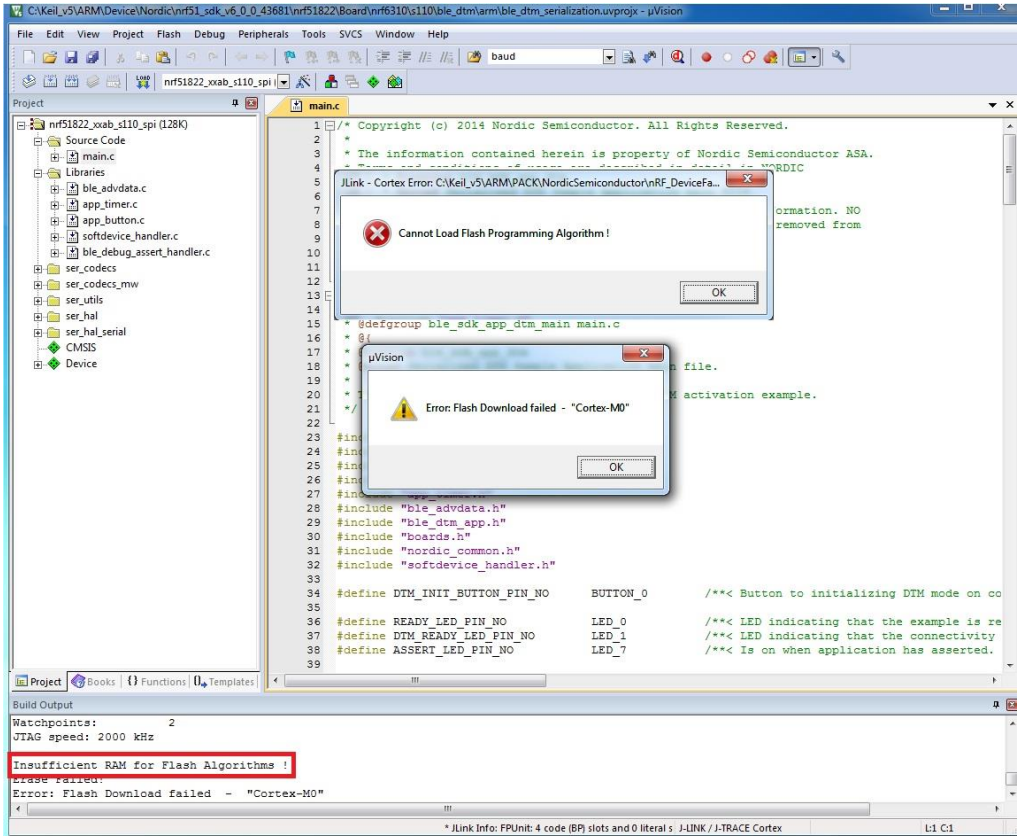


Direct Test Mode Loading

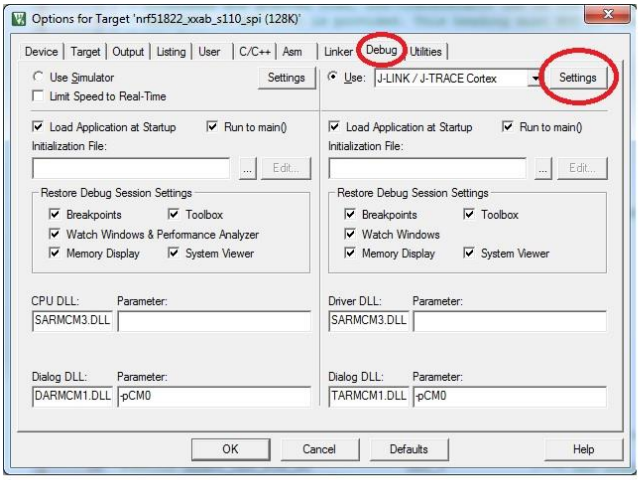
1. Start Keil uVision (Version 4 or 5).
2. Select Project then Open Project in order to open ble_app_dtm (located in the S110 folder as in ***5.1_Proximity Application Loading***).

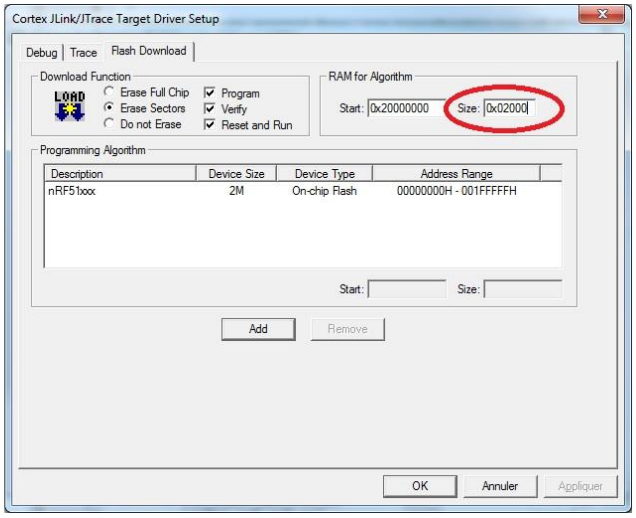


3. Click Build Target and Load.
4. If you have the next error message, it means that you have not enough RAM to flash algorithm.



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).

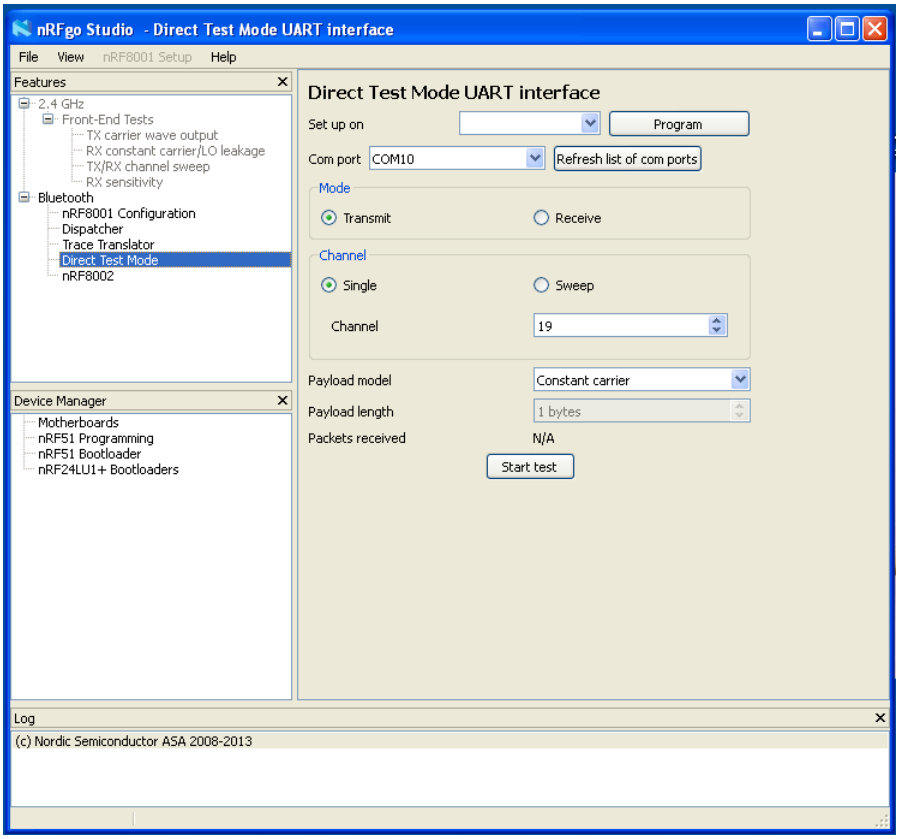




6. Click OK and load again the project.

Direct Test Mode Testing

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



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

Important notification: Erase all before loading the ble_app_dtm. The SoftDevice must not be loaded, only the ble_app_dtm with uvision or with nRFgo studio in “Program Application” (load the ble_app_dtm.hex).

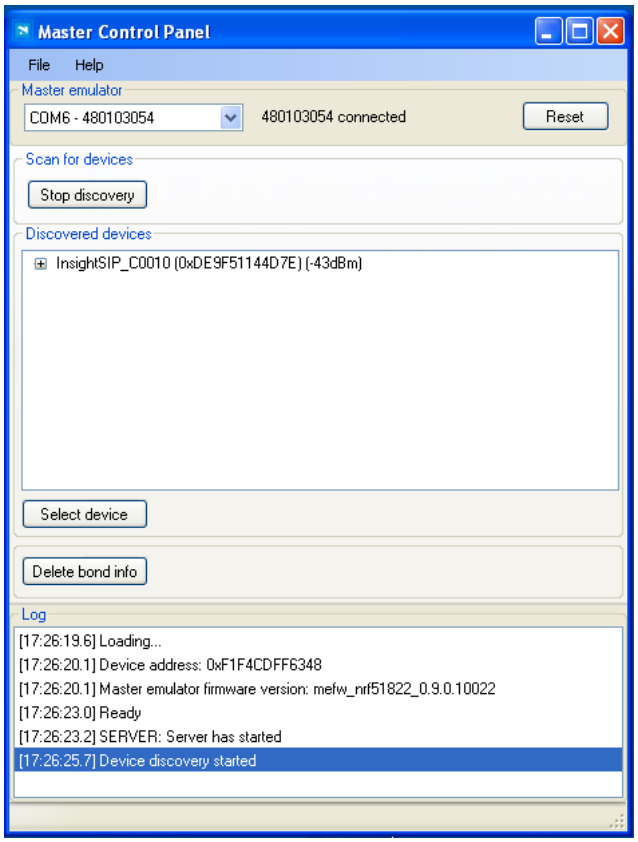
6. Basic Sensor Application with ISP131001

This paragraph shows you how to set up a Sensor application with ISP131001 Sensors Board that will send data via the Bluetooth link to the Master Emulator or to an Apple Device.

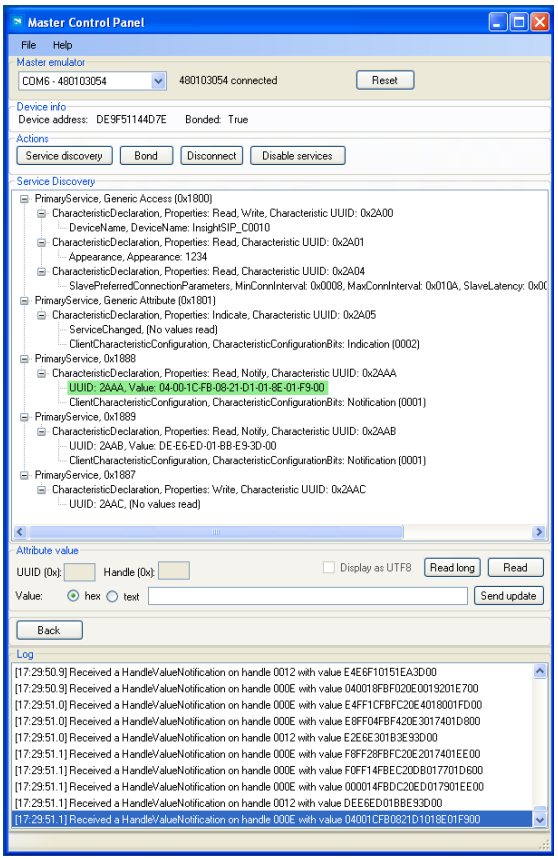
Two types of demonstration are presented. The first one is directly executable with hardware and software provided in the Development Kit using Master Control Panel application. The second demonstration requires the use of an iPhone or an iPad. The iOS application is available on demand only as an App that can be installed for development purposes via the Apple developer program. The procedure to obtain the App from Insight SiP and demonstration of the Sensor application with Apple Device is described hereafter.

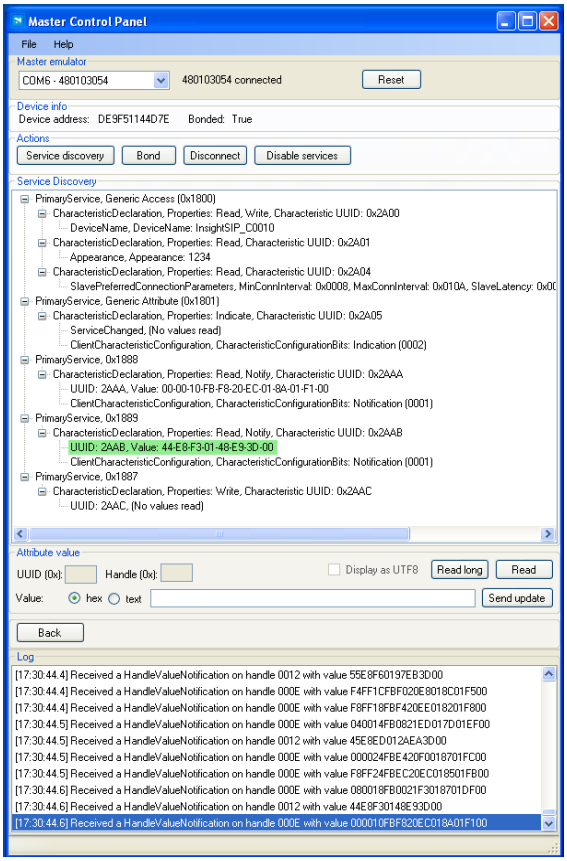
6.1 On Master Control Panel

1. Place the CR2032 lithium battery into the battery holder.
2. Connect the battery holder to the Sensors Board ISP131001.
3. Connect Development Dongle PCA10000 (Master Emulator) into a USB port on your computer.
4. Start Master Control Panel.
5. Click Start Discovery.



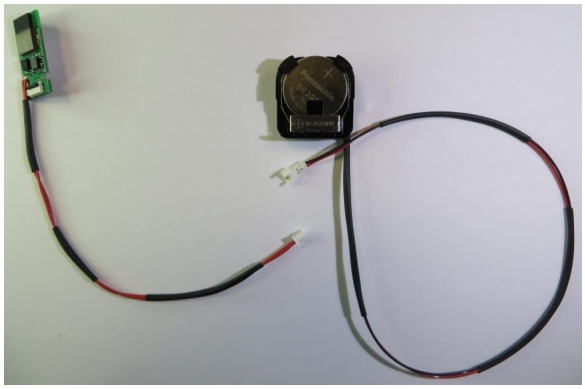
6. Click Select Device.
7. On the following display, click successively on Bond, Service Discovery and Enable Services.





8. You can note data that transit between the ISP131001 Sensors Board and the Master Emulator via the Bluetooth link:
   - Data of the accelerometer/magnetometer on the above left figure
   - Data of the temperature/pressure on the above right figure

9. To switch off ISP131001 Sensors Board, disconnect battery holder as seen in the figure below.



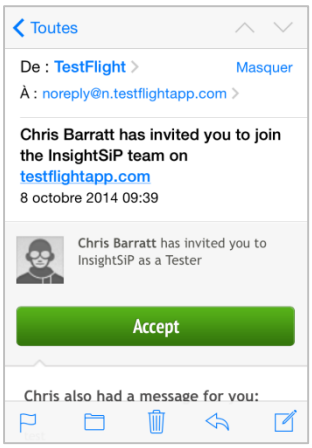
6.2 On iPhone or iPad Device

The Sensor application is available on demand from Insight SiP. The iOS App is a demonstration App that is provided "as is" in order to demonstrate the Smart Bluetooth sensor node. Only one iPhone or iPad is allowed per development kit.

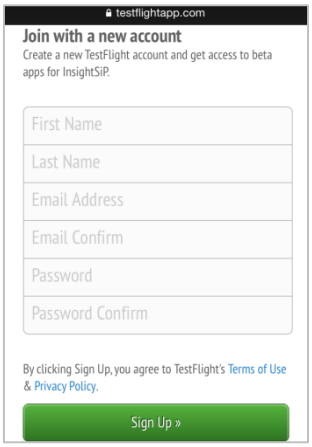
Make sure you iOS device is compatible with Bluetooth 4.0 (iPhone 4S or higher, iPad Air, Mini, 3rd generation and above).

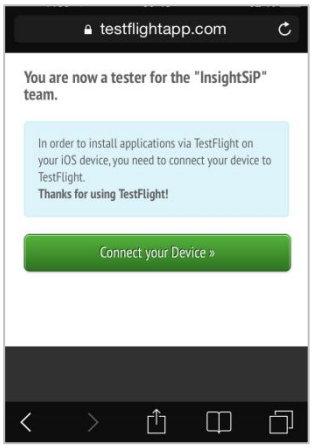
The installation procedure for the Sensor application is described hereafter:

1. Contact Insight SiP at contact@insightsip.com and communicate the kit number and the product key notified on the dev kit.
2. We will send you by email an invitation 24h-48h after. Accept it using your iOS device you want to use for the demo.

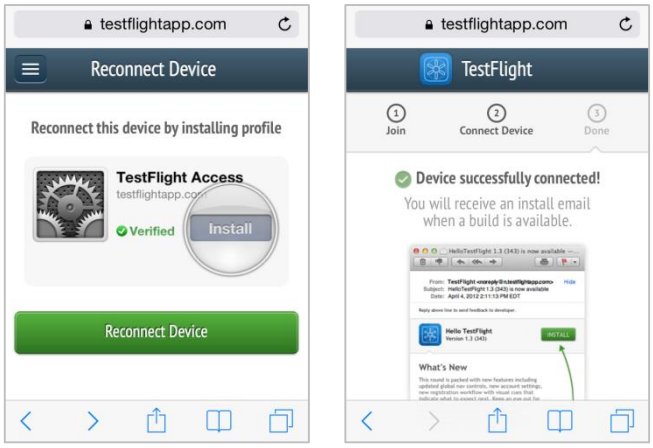


3. Sign up in order to register to TestFlight app

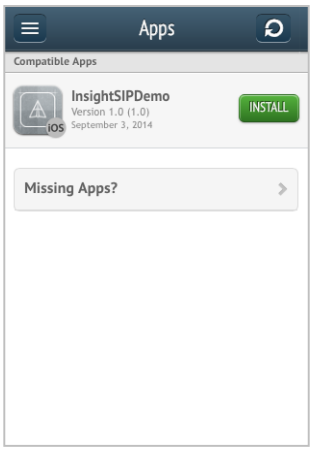




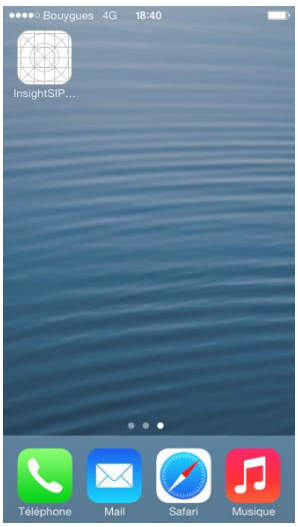
4. Connect your device. It will create a TestFlight icon on your device.



5. Once you receive an install email of available build, open again your TestFlight app from your device. It can take additional 24-48 hours to receive this email.
6. Click on "*View All Apps"* and then click on *"Install".*

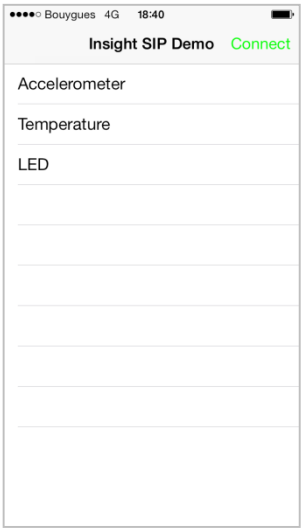


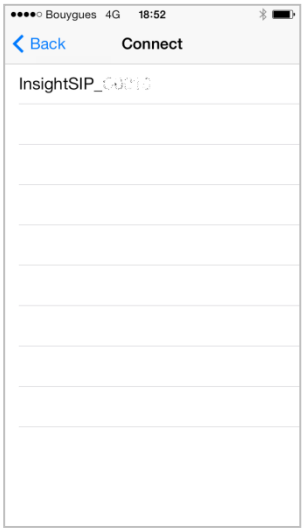
7. The InsightSiPDemo application is downloaded and installed. You should see the following screen on your iOS device.



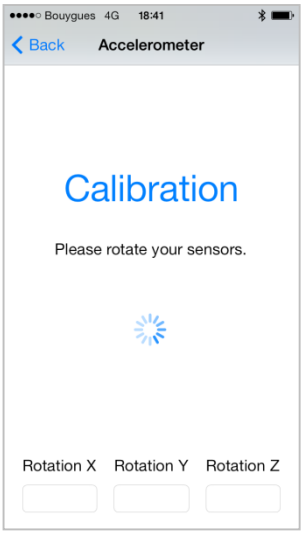
Then you will be able to set up the application demonstration as follows:

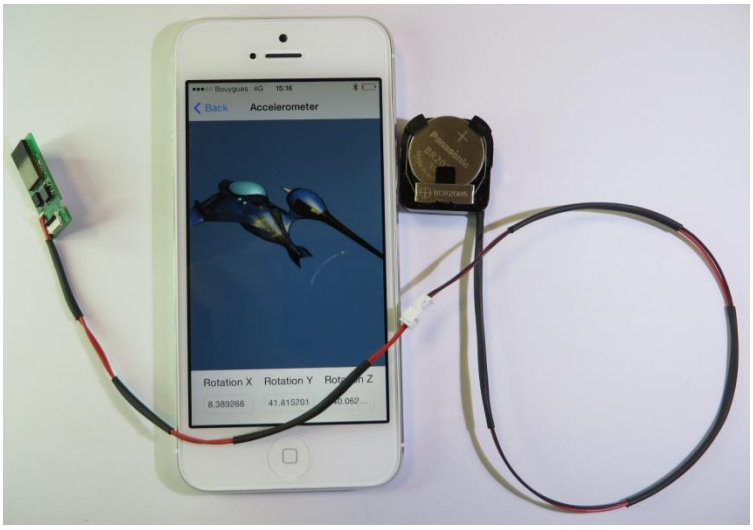
8. Place the CR2032 lithium battery into the battery holder.
9. Connect the battery holder to the Sensors Board ISP131001.
10. Start InsightSiPDemo application on your iOS, click Connect and select your Sensors Board (name is InsightSiP_xxxxx).



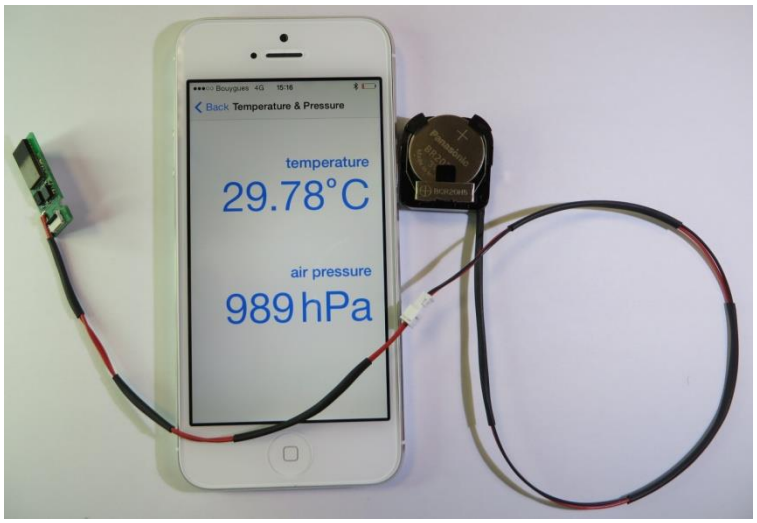


11. Click Accelerometer. A Calibration phase invites you to rotate the ISP131001 Sensors Board. Then, a starship on your iPhone screen follows the Sensors board movement.

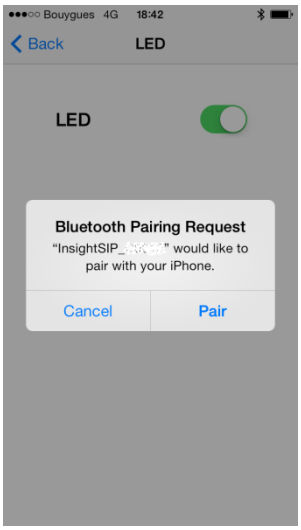


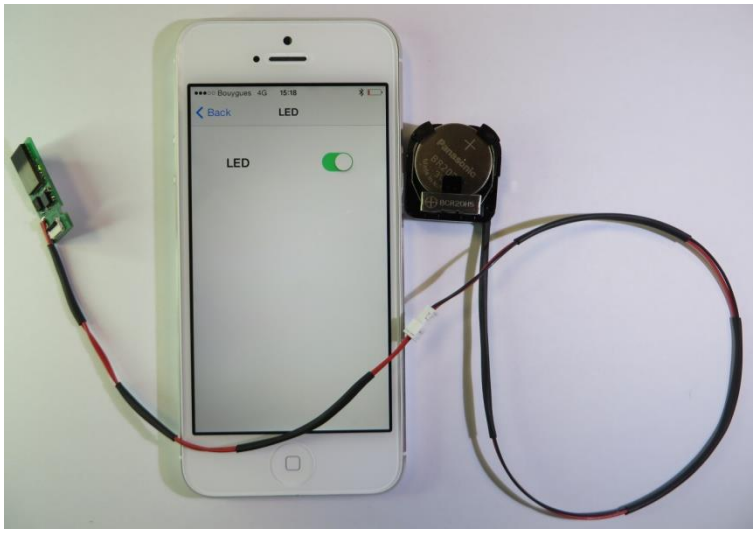


12. Click Back and Temperature to start temperature and pressure demonstration.

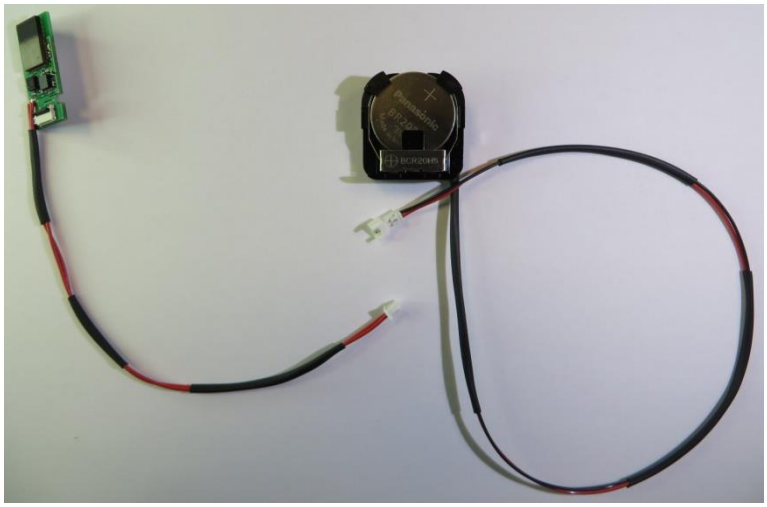


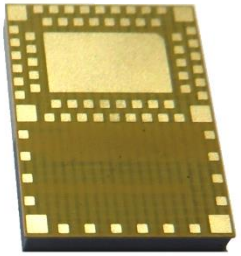
13. Click Back and LED. A prompt will invite you to pair the Sensors Board with the iPhone. Click Pair. The LED lights up.





14. To switch off ISP131001 Sensors Board, disconnect battery holder as seen in the figure below.





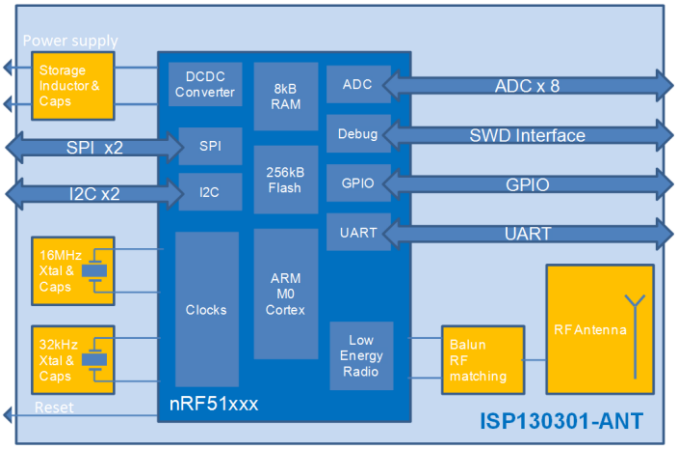
ISP130301-ANT
Dual ANT+™ / BLE Module with Integrated Antenna

Key Features

- ANT / ANT+™ protocols
- Single Mode BLE v4.1
- Proprietary 2.4 GHz protocols
- Based on Nordic Semiconductor nRF51 family
- 2.4GHz low energy RF Transceiver
- 32bit ARM Cortex M0 CPU with 256kB Flash
- Analog and Digital peripherals
- Ultra Low Power Consumption
- Single 2.1 to 3.6 V supply
- Very small size 8.0 x 11.0 x 1.2 mm
- Temperature -25 to 75 °C
- Fully integrated RF matching and Antenna
- Integrated 16 MHz and 32.768 kHz Clocks

Certifications

- Complies with FCC, CE, IC and TELEC
- Bluetooth SIG certified
- RoHS compliant



Applications

- Space constrained ANT+ / BLE Devices
- Sport and fitness sensors
- Health care sensors
- Out of Range (OOR) sensors
- Personal User Interface Devices (PUID)
- Remote controls

General Description

This module is based on nRF51422 Nordic Semiconductor 2.4GHz wireless System on Chip (SoC) integrating a 2.4 GHz transceiver, a 32 bit ARM Cortex™-M0 CPU, a flash memory, and analog and digital peripherals. It can support ANT / ANT+™, Bluetooth® Low Energy and 2.4GHz proprietary ultra low-power wireless protocols.

Fully qualified BLE stacks for nRF51422 are implemented in the S100 series of SoftDevices which can be freely downloaded. nRF51 platform also provides extensive software support for ANT applications with S210 SoftDevices and dual ANT/BLE stack S310 SoftDevices. ISP130301-ANT can then be used for ANT applications, as well as Master and Slave modes for BLE, or proprietary protocols on request.

The module is designed for ultra low power applications such as sports and wellness sensors. Advanced power management enables battery lifetimes up to several years on a coin cell battery. Even though its very small size 8 x 11 x 1.2 mm, the module integrates the wireless SoC, load and decoupling capacitors, 16 MHz and 32 kHz crystals, DC-DC converter, RF matching circuit and antenna.

The module forms a standalone ANT / ANT+ / BLE node for which only the addition of a suitable DC power source and appropriate sensor is necessary for sensor applications. As the module has several end applications, the antenna was designed to be compatible with several ground plane sizes such as USB dongle or cell phone.

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

Contents

1. Electrical Specifications

Electrical Performance

The specifications of the module follow those of the nRF51822. The following high level parameters are given for the module.

The operating temperature range is -25 to +75 °C with the following performances.

Parameter	Value	Unit
Supply voltage		
Supply Voltage	2.1 to 3.6	V
Current consumption		
Static levels		
Peak current, receiver active (supply at 2.1V)	12.6	mA
Peak current, transmitter active +4 dBm Output Power	16	mA
Peak current, transmitter active 0 dBm Output Power	10.5	mA
Current drain, connection-less state	0.5	µA
Current drain between connection events	2.3	µA

Pin Assignment

The module uses an LGA format with a double row of pads on a 0.65 mm pitch. The pad layout follows the QFN Jedec standard for 2 row LGA parts.

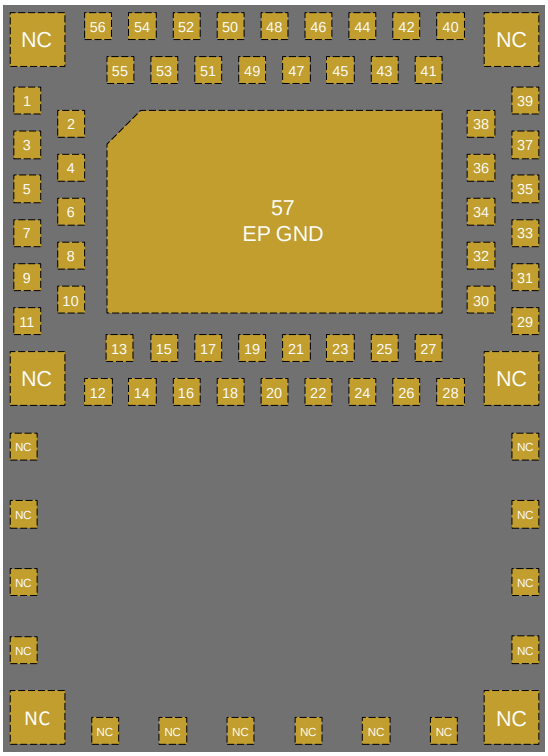
Pads 1 thru 56 are signal pins 0.4 x 0.4 mm, Pad 57 is an exposed metal pad that is connected to ground. The NC pads are 0.8 x 0.8 or 0.4 x 0.4 mm and are to be connected to isolated metal pads on the application PCB for mechanical stability and reliability (drop test).

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

Pin	Name	Pin function	Description
1	P0_07	Digital I/O	General purpose I/O pin
2	NC	Not Connected	Isolated pad on application PCB for mechanical stability
3	P0_09	Digital I/O	General purpose I/O pin
4	NC	Not Connected	Isolated pad on application PCB for mechanical stability
5	P0_13	Digital I/O	General purpose I/O pin
6	NC	Not Connected	Isolated pad on application PCB for mechanical stability
7	P0_19	Digital I/O	General purpose I/O pin
8	NC	Not Connected	Isolated pad on application PCB for mechanical stability
9	P0_17	Digital I/O	General purpose I/O pin
10	NC	Not Connected	Isolated pad on application PCB for mechanical stability
11	P0_20	Digital I/O	General purpose I/O pin
12	VSS	Ground	Should be connected to ground plane on application PCB
13	NC	Not Connected	Isolated pad on application PCB for mechanical stability
14	VSS	Ground	Should be connected to ground plane on application PCB
15	NC	Not Connected	Isolated pad on application PCB for mechanical stability
16	VSS	Ground	Should be connected to ground plane on application PCB
17	NC	Not Connected	Isolated pad on application PCB for mechanical stability
18	VSS	Ground	Should be connected to ground plane on application PCB
19	NC	Not Connected	Isolated pad on application PCB for mechanical stability
20	VSS	Ground	Should be connected to ground plane on application PCB
21	NC	Not Connected	Isolated pad on application PCB for mechanical stability
22	VSS	Ground	Should be connected to ground plane on application PCB
23	VSS	Ground	Should be connected to ground plane on application PCB
24	OUT_MOD	Module I/O	This pin is the RF I/O pin of the BLE module. It should be connected to Pin 26 OUT_ANT for normal operation. During certification the pin may be connected via to an RF connector for module measurement using a Bluetooth test setup.
25	VDD_PA	PA supply	PA supply indicates Transmit mode (Active High)
26	OUT_ANT	Antenna I/O	This pin is connected to the internal antenna. It should be connected to Pin 24 OUT_MOD for normal operation. During certification the pin may be connected to an RF connector for antenna measurement
27	VSS	Ground	Should be connected to ground plane on application PCB
28	VSS	Ground	Should be connected to ground plane on application PCB
29	VCC_nRF	Power	Power supply (2.1 – 3.6V). VDD in nRF51822 doc.
30	VSS	Ground	Should be connected to ground plane on application PCB
31	SWDCLK	Digital Output	HW debug and flash programming I/O
32	P0_18	Digital I/O	General purpose I/O pin
33	SWDIO-nRESET	Digital I/O	System reset (active low). Also HW debug and flash programming I/O
34	P0_16	Digital I/O	General purpose I/O pin
35	P0_15	Digital I/O	General purpose I/O pin
36	P0_14	Digital I/O	General purpose I/O pin
37	P0_12	Digital I/O	General purpose I/O pin
38	P0_10	Digital I/O	General purpose I/O pin
39	P0_11	Digital I/O	General purpose I/O pin
40	P0_05-AIN6	Digital I/O Analog input	General purpose I/O pin ADC input 6

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

Pin	Name	Pin function	Description
41	P0_06-AIN7-AREF1	Digital I/O Analog input Analog input	General purpose I/O pin ADC input 7 ADC Reference voltage
42	P0_03-AIN4	Digital I/O Analog input	General purpose I/O pin ADC input 4
43	P0_04-AIN5	Digital I/O Analog input	General purpose I/O pin ADC input 5
44	P0_01-AIN2	Digital I/O Analog input	General purpose I/O pin ADC input 2
45	P0_31	Digital I/O	General purpose I/O pin
46	P0_02-AIN3	Digital I/O Analog input	General purpose I/O pin ADC input 3
47	P0_30	Digital I/O	General purpose I/O pin
48	P0_00-AREF0	Digital I/O Analog input	General purpose I/O pin ADC Reference voltage
49	P0_29	Digital I/O	General purpose I/O pin
50	P0_28	Digital I/O	General purpose I/O pin
51	P0_24	Digital I/O	General purpose I/O pin
52	P0_23	Digital I/O	General purpose I/O pin
53	P0_21	Digital I/O	General purpose I/O pin
54	P0_22	Digital I/O	General purpose I/O pin
55	P0_25	Digital I/O	General purpose I/O pin
56	P0_08	Digital I/O	General purpose I/O pin
57	GND_EP	Ground	Exposed metal pad. Should be connected to ground plane on application PCB

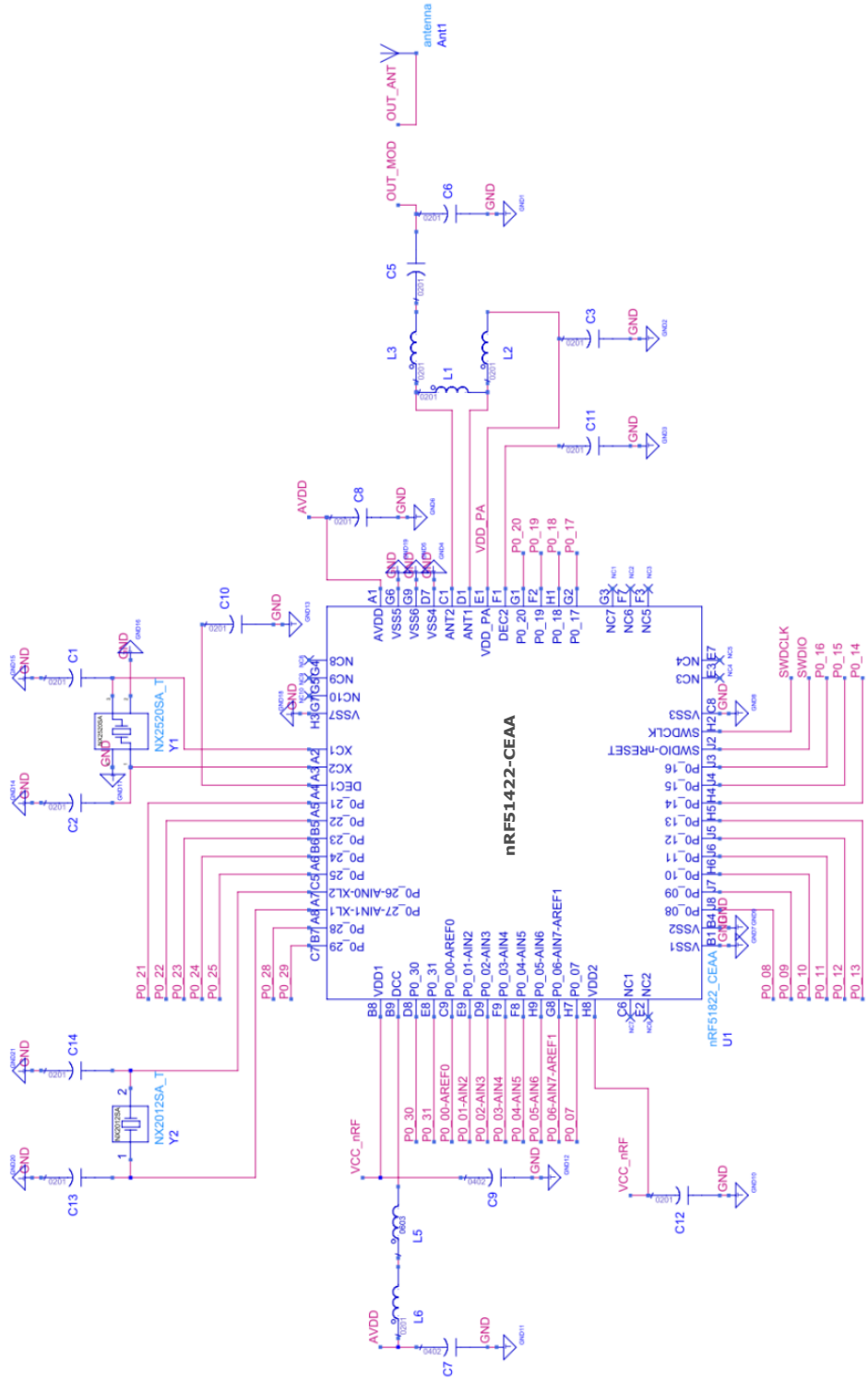


ISP130301-ANT pad placement and pin assignment for the LGA QFN package

TOP VIEW

Electrical Schematic

Electrical schematic showing ISP130301 module connections



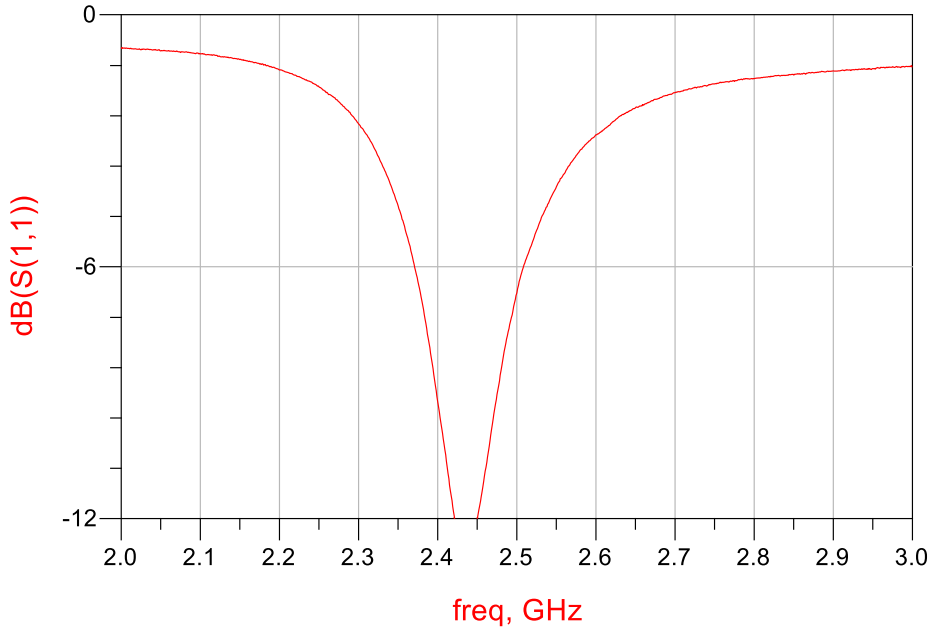
2. RF Performances

RF Specifications according to standards

Parameter	Value	Unit	Condition
Output Power	-20 to +4	dBm	Channels 0 to 39
RF Frequency tolerance	Better than +/-20	Hz	Channels 0 to 39
Rx sensitivity BLE mode	-93	dBm	Level for BER <0,1% ideal Tx
Rx sensitivity ANT mode	-90	dBm	Level for BER <0,1% ideal Tx
Max range	> 200	m	Open field @1m height
EIRP	4.6	dBm	
Antenna Gain	0.6	dBi	
Rx sensitivity	51.4	dBµV/m	

Typical Antenna Return Loss

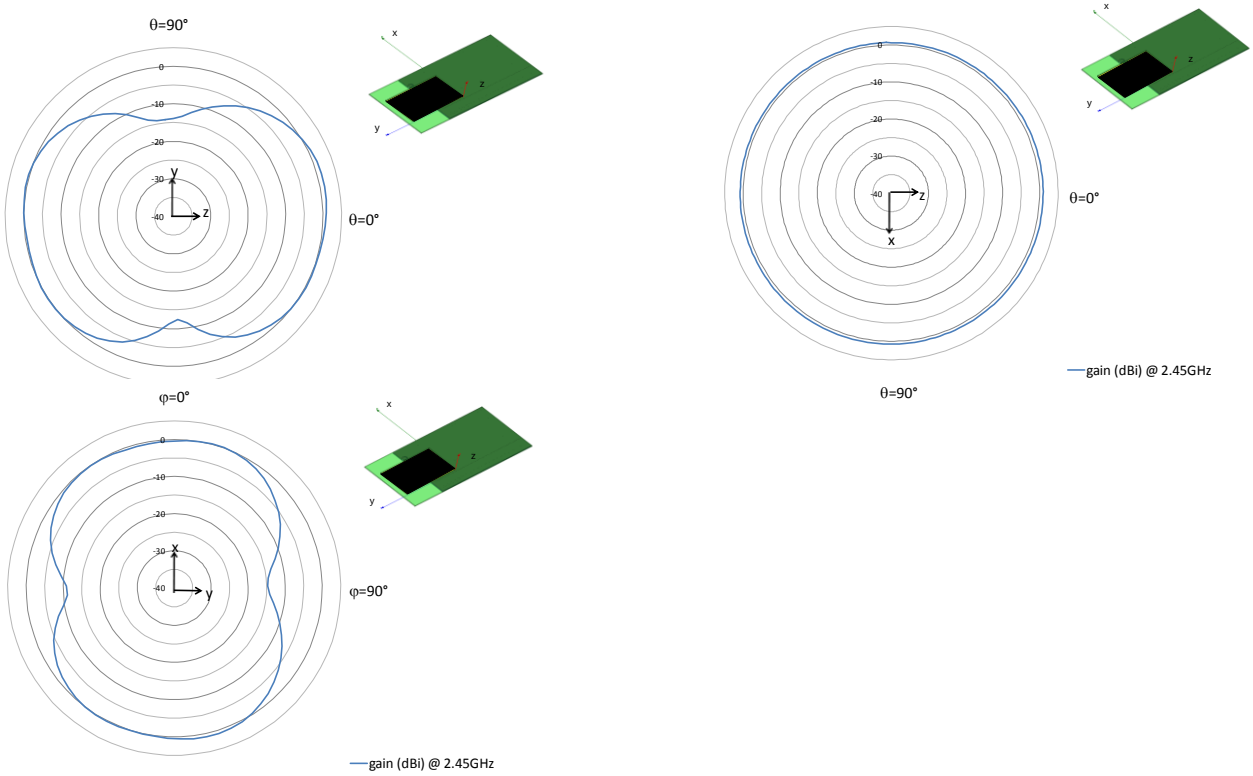
Module mounted on a USB dongle ground plane



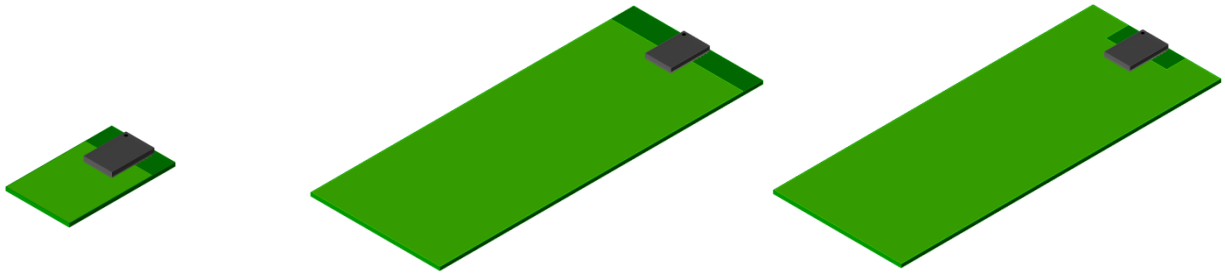
Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

Radiation Pattern in 3 planes

Module mounted on a USB dongle ground plane



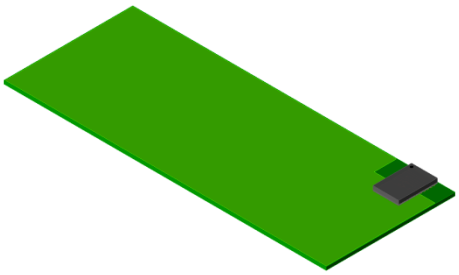
Ground Plane Effect Simulation



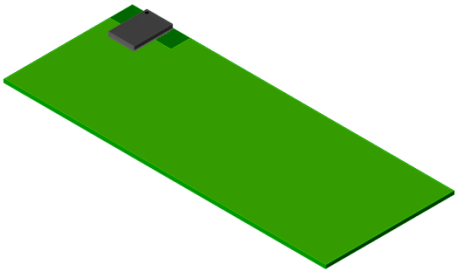
USB dongle ground plane (size : 18 x 30 mm²)

Cell phone config 1 ground plane (size : 40 x 100 mm²)

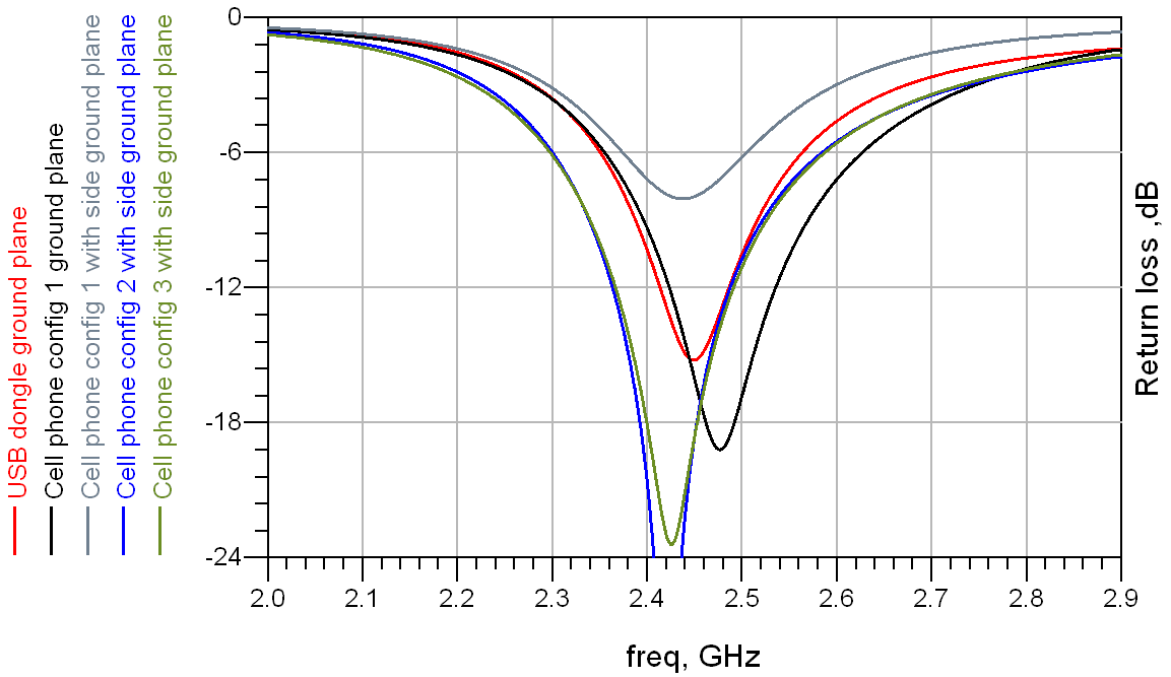
Cell phone config 1 with side ground plane (size : 40 x 100 mm²)



Cell phone config 2 with side ground plane
(size : 40 x 100 mm²)



Cell phone config 3 with side ground plane
(size : 40 x 100 mm²)



3. Product Development Tools

Interface

ISP130301-ANT integrates a full microprocessor interface with up to 32 General Purpose I/O pins (GPIO) and several functions (2 x SPI, 2 x I2C, UART, 8 x ADC, SWDIO interface).

Development Tools and Software

The following development tools and software are recommended for using and testing ISP130301-ANT module:

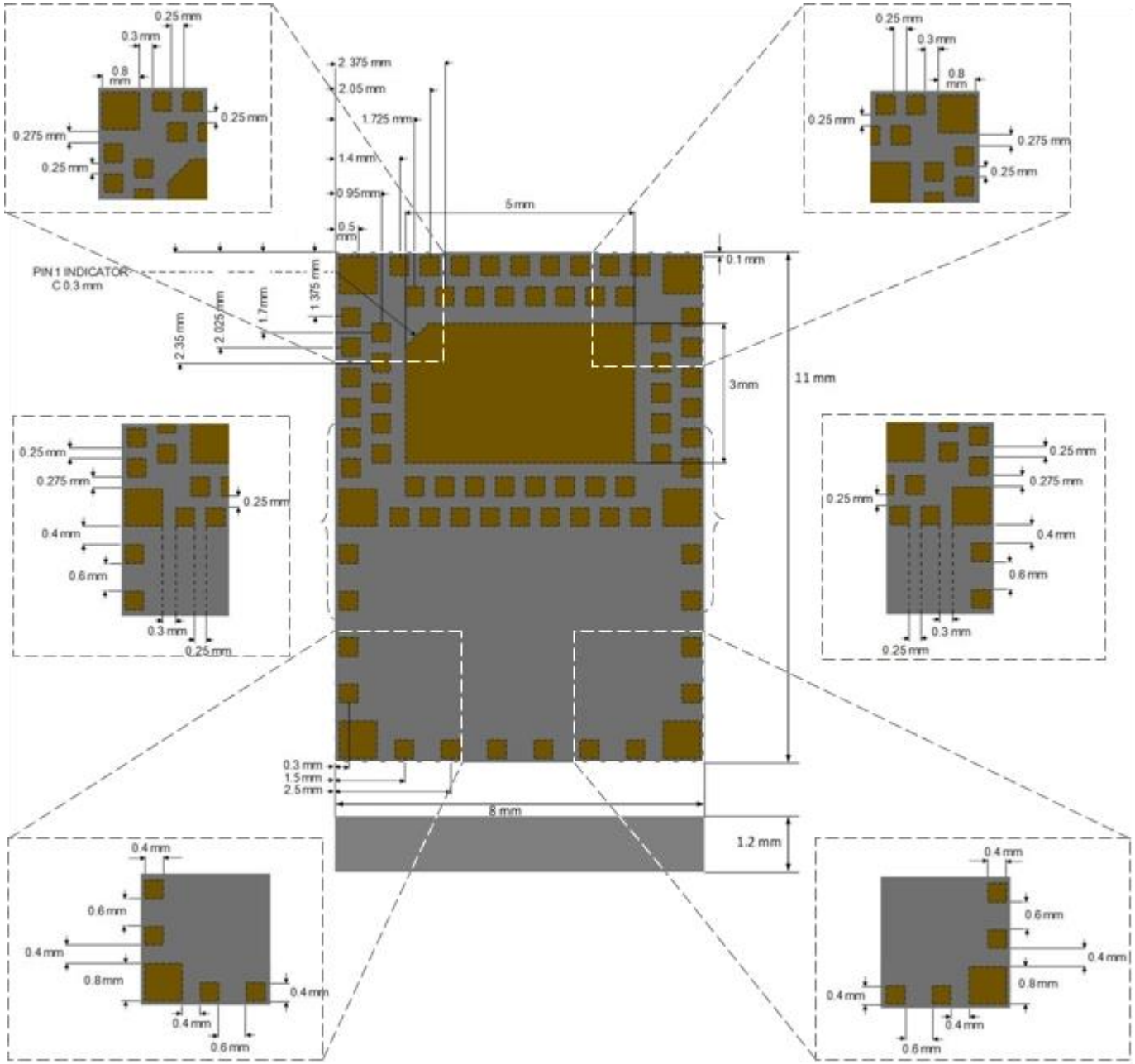
- Nordic Semiconductor nRFgo Studio (downloadable from www.nordicsemi.com)
- Nordic Semiconductor Master Control Panel (downloadable from www.nordicsemi.com)
- Keil MDK-ARM Lite (downloadable from https://www.keil.com/demo/eval/arm.htm)
- Segger J-Link Lite (downloadable from http://www.segger.com/jlink-software.html)
- S100 series (BLE) nRF51 SoftDevice, S210 (ANT) nRF51 SoftDevice and S310 (ANT/BLE) nRF51 SoftDevice: fully qualified Bluetooth low energy stacks for nRF51422 integrated in ISP130301-ANT module. All SoftDevices (object code, no source) can be downloaded from www.nordicsemi.com.
- nRF51 Software Development Kit (SDK): nRF51 SDK can be downloaded from www.nordicsemi.com. It contains example of source codes applications (C language):
  - Precompiled HEX files
  - Source code
  - Keil ARM project files
  - IAR project files
  - GCC project files

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

4. Mechanical Outlines

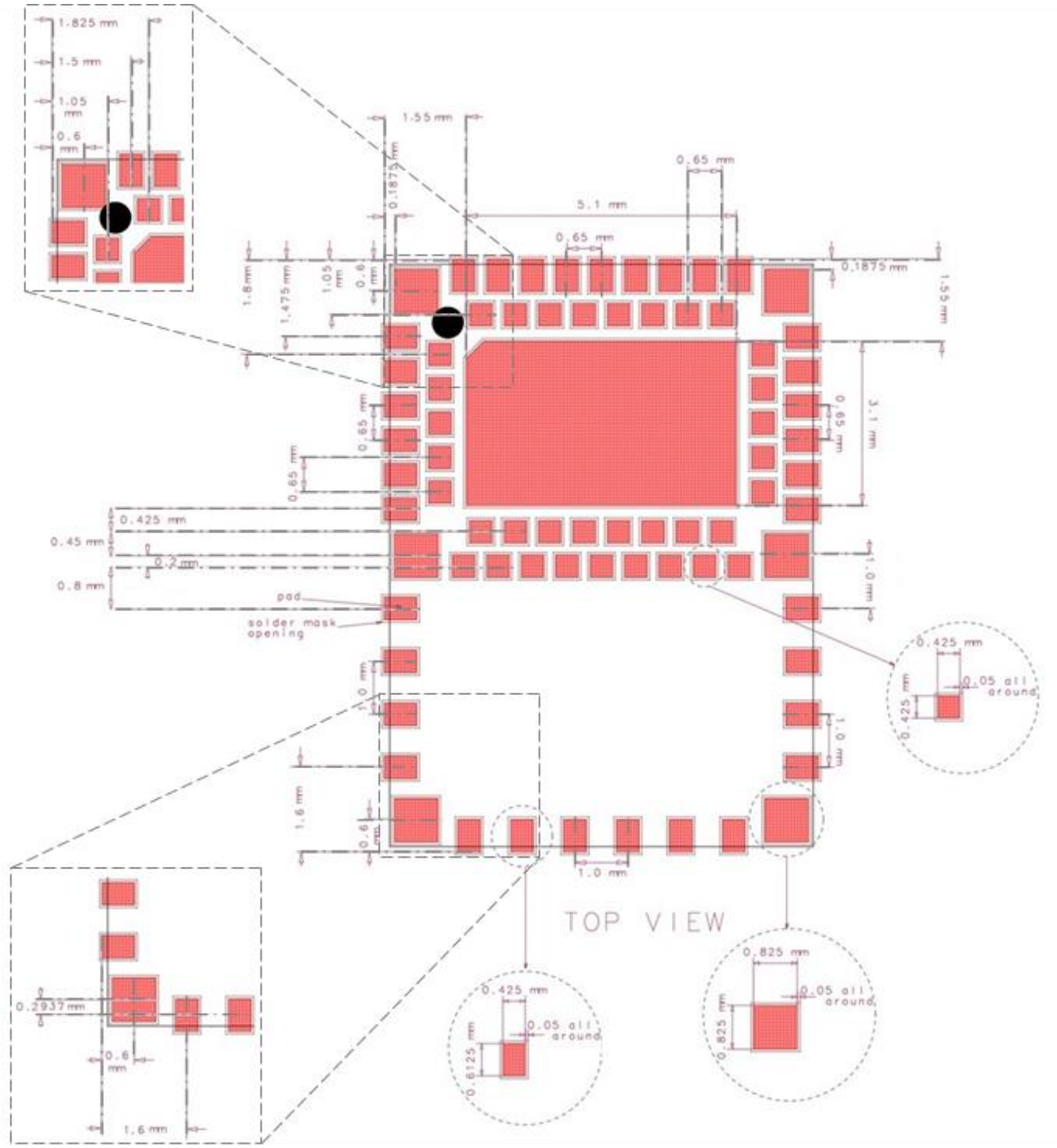
Mechanical Dimensions

Dimensional drawing for 8 x 11 x 1.2 mm, 57-Pad LGA Package



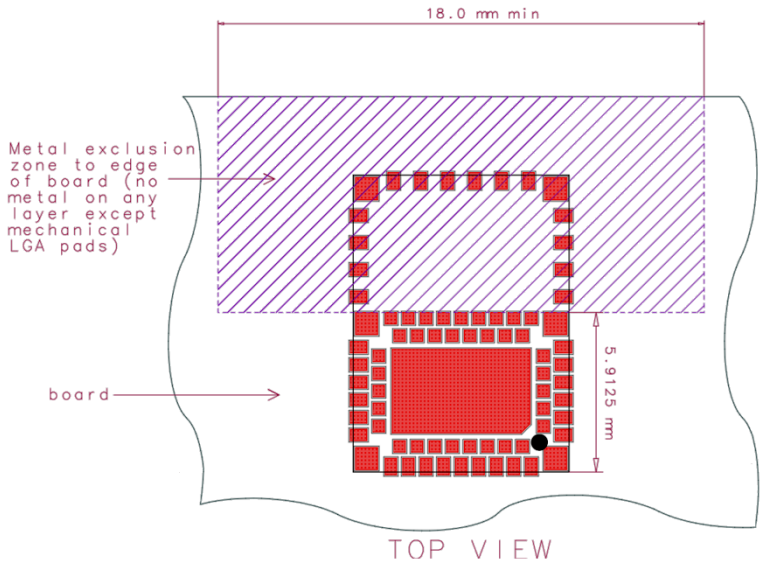
SMT Assembly Guidelines

Recommended PCB Land Pattern and Solder Mask layout



Antenna Keep-Out Zone

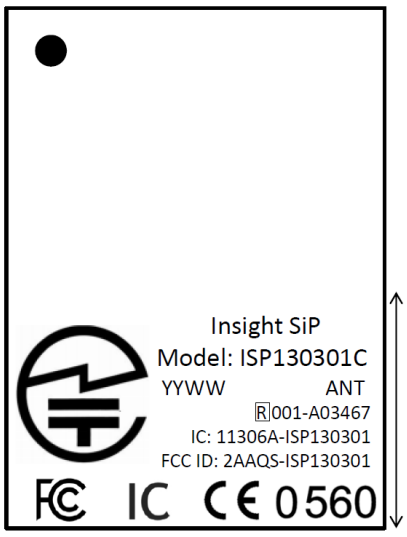
Recommended metal keep out areas for optimal antenna performance:
no metal, no traces and no components on any layer except mechanical LGA pads.



Package marking

I	S	P	1	3	0	3	0	1	C
Y	Y	W	W				A	N	T

ISP130301 ANT	Product number
C	Hardware version
YY	Two digit year number
WW	Two digit week number



5 mm max for laser marking

5. Storage & Soldering information

Moisture Sensitivity

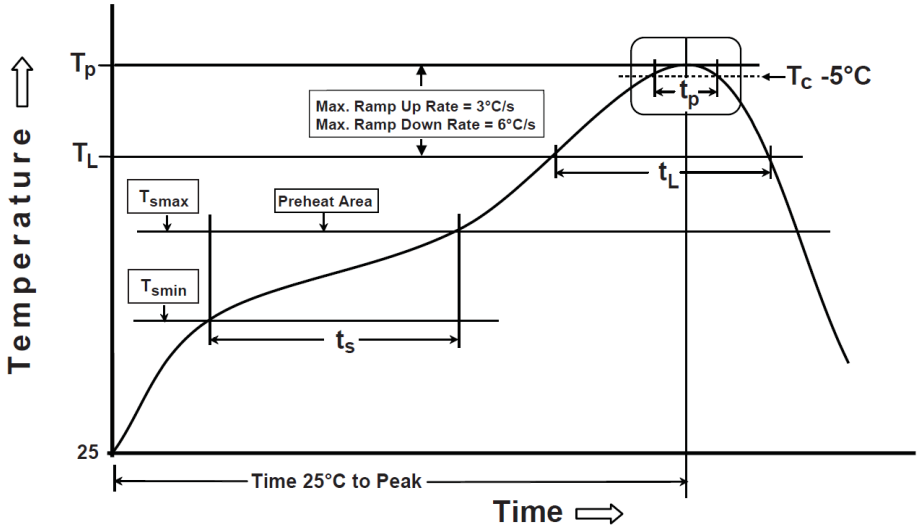
All plastic packages absorb moisture. During typical solder reflow operations when SMDs are mounted onto a PCB, the entire PCB and device population are exposed to a rapid change in ambient temperature. Any absorbed moisture is quickly turned into superheated steam. This sudden change in vapor pressure can cause the package to swell. If the pressure exerted exceeds the flexural strength of the plastic mold compound, then it is possible to crack the package. Even if the package does not crack, interfacial delamination can occur.

Since the device package is sensitive to moisture absorption, it is recommended to bake the product before assembly. The baking process for dry packing is 24 hours at 125°C.

ISP130301 has been tested MSL-5 according to standards. After baking, modules can be exposed to ambient room conditions (approximately 30 °C/60%RH) during 48 hours before assembly on the PCB.

Soldering information

Recommendation for RoHS reflow process is according to Jedec J–STD-020 and 033 standard profiles.



Preheat/Soak Temperature Min (T_{smin}) Temperature Max (T_{smax}) Time (t_s) from (T_{smin} to T_{smax})	 150 °C 200 °C 60-120 sec
Ramp-up rate (T_L to T_p)	3 °C/sec max
Liquidous temperature (T_L) Time (t_L) maintained above T_L	217 °C 60-150 sec

Peak package body temperature (T_p)	260°C (+0/-5°C)
Classification Temperature (T_c) Time (t_p) maintained above T_C-5 °C	260 °C 30 sec
Ramp-down rate (T_p to T_L)	6 °C/sec max
Time 25 °C to peak temperature	8 mn max

6. Quality & User information

Certifications

- FCC Identifier 2AAQS-ISP130301 – Certificate N° 142180643/AA/00
- CE: Complies with 1999/5/EC, EN300328 V1.8.1, Statement N° 142140199/AA/00
- IC Certification N° 11306A-ISP130301 – Telefication N° 142170180/AA/00
- TELEC certification N° 001 – A03467
- Bluetooth SIG certified N° D024444
- RoHS compliant

USA – User information

This intends to inform how to specify the FCC ID of our module “ISP130301” on the product. Based on the Public Notice from FCC, the host device should have a label which indicates that it contains our module.
The label should use wording such as: “Contains FCC ID: 2AAQS-ISP130301”.
Any similar wording that expresses the same meaning may be used.
The label of the host device should also include the below FCC Statement. When it is not possible, this information should be included in the User Manual of the host device:

“This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions.
(1) This device may not cause harmful interference
(2) This device must accept any interference received, including interference that may cause undesired operation.
Caution: Any Changes or modifications not expressly approved by the party responsible for compliance could void the user’s authority to operate the equipment.”

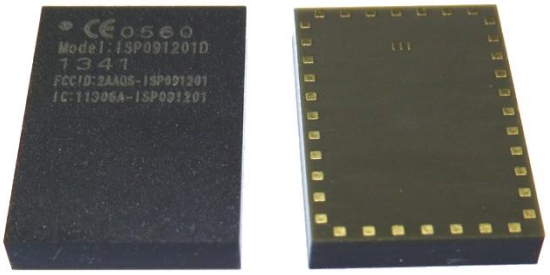
CANADA – User information

This intends to inform how to specify the IC ID of our module “ISP130301” on the product. According to Canadian standards “RSS-210” and “RSS-Gen”, the host device should have a label which indicates that it contains our module.
The label should use wording such as: “Contains IC: 11306A-ISP130301”.
Any similar wording that expresses the same meaning may be used.
The label of the host device should also include the below IC Statement. When it is not possible, this information should be included in the User Manual of the host device:

“This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.”

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com



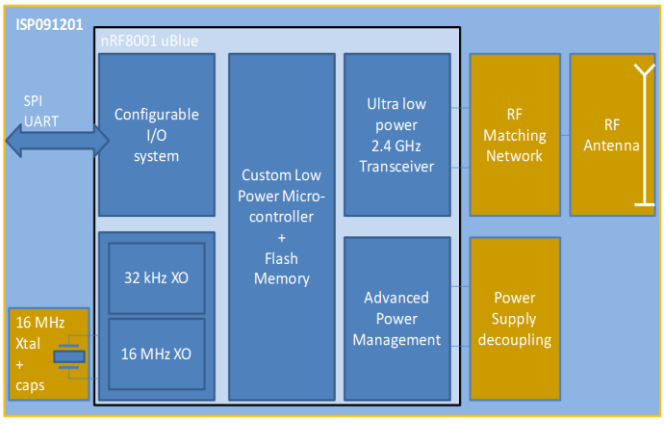
ISP091201
Bluetooth Low Energy Module with Integrated Antenna

Key Features

- Single Mode BLE v4.0 Slave
- Nordic Semiconductor µBlue products based
- Includes transceiver, baseband, software stack
- Ultra Low Power Consumption
- Single 1.9 to 3.6 V supply
- Very small size 8.0 x 12.0 x 1.5 mm
- Temperature -40 to 85 °C
- Fully integrated RF matching and Antenna
- Integrated 16 MHz Crystal Clock

Certifications

- FCC Limited Modular Certification
- Complies with CE
- Complies with IC
- Bluetooth SIG certified
- RoHS compliant



Applications

- Space constrained BLE Slave Devices
- Sport and fitness sensors
- Health care sensors
- Out of Range (OOR) sensors
- Personal User Interface Devices (PUID)
- Remote controls

General Description

This module is based on Nordic Semiconductor nRF8001 µBlue Bluetooth Low Energy Platform. The nRF8001 is a single chip transceiver with an embedded baseband protocol engine, suitable for ultra low power wireless applications conforming to the Bluetooth Low Energy Specification contained within v4.0 of the overall Bluetooth specification. The nRF8001, used in the current revision of ISP091201, is a production product using a RoM for the baseband protocol engine.

The µBlue transceiver is specifically designed for both PC peripherals and ultra low power applications such as sports and wellness sensors. For sensor applications, the ultra low power consumption and advanced power management enables battery lifetimes up to several years on a coin cell battery.

The ISP091201 module size measures 8 x 12 x 1.5 mm. The module integrates all the decoupling capacitors, the 16 MHz crystal and load capacitors plus the RF matching circuit and antenna in addition to the transceiver. As the module has several end applications, the antenna was designed to be compatible with several ground plane sizes including that of a USB dongle and a cell phone. The module can operate as a standalone Bluetooth sensor node with the addition of a transducer, a small external microprocessor to run application software, a 32 kHz crystal and a DC power source.

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

Contents

1. Electrical Specifications

Electrical Performance

Temperature range -40 to +85 °C

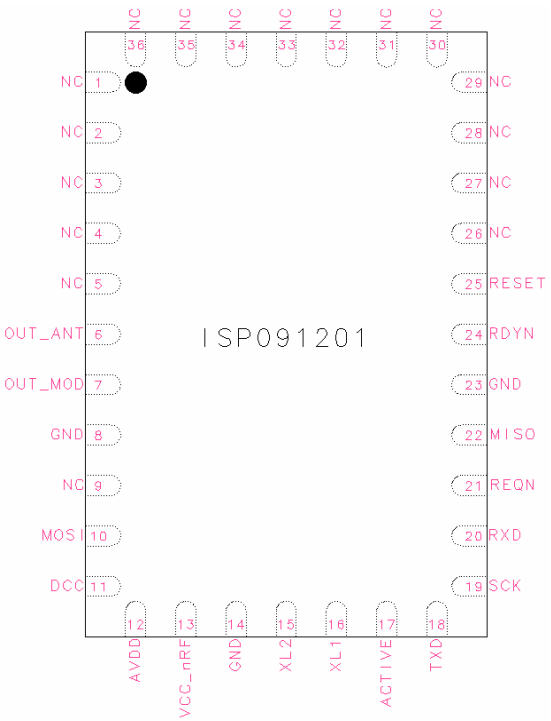
Parameter	Value	Unit
Supply voltage		
Min. Supply Voltage	1.9	V
Current consumption		
Static levels		
Peak current, receiver active	14.6	mA
Peak current, transmitter active	12.7	mA
Current drain, connection-less state	0.5	µA
Current drain between connection events	2	µA

Pin Assignment

Pin	Name	Pin function	Description
1 – 5	NC	Not Connected	Isolated pad on application PCB for mechanical stability
6	OUT_ANT	Antenna In/Out	This pin is connected to the internal antenna. It should be connected to Pin 7 OUT_MOD for normal operation. During certification the pin may be connected to an RF connector for antenna measurement
7	OUT_MOD	Module In/Out	This pin is the RF I/O pin of the BLE module. It should be connected to Pin 6 OUT_ANT for normal operation. During certification the pin may be connected to an RF connector for module measurement using a Bluetooth test setup
8	GND	Ground	Should be connected to ground plane on application PCB
9	NC	Not Connected	Isolated pad on application PCB for mechanical stability
10	MOSI	Digital input	ACI Master Out Slave In

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

Pin	Name	Pin function	Description
11	DCC	PWM driver	PWM driver for the external LC filter if the DC/DC converter is enabled. If the DC/DC converter is disabled this pin shall be not connected
12	AVDD	Power	Analog power supply (1.9 – 3.6V DC)
13	VCC_nRF	Power	Power supply (1.9 – 3.6V) Supplies the DC/DC converter and GPIOs. VDD in nRF8001 doc
14	GND	Ground	Should be connected to ground plane on application PCB
15	XL2	Analog output	Connect to external 32.768kHz crystal oscillator (if internal RC oscillator is enabled then leave not connected)
16	XL1	Analog output	Connect to external 32.768kHz crystal oscillator (if internal RC oscillator is enabled then leave not connected)
17	ACTIVE	Digital output	Device RF front end activity indicator
18	TXD	Digital output	UART (transmit) for Bluetooth low energy Direct Test Mode
19	SCK	Digital input	ACI clock input
20	RXD	Digital output	UART (receive) for Bluetooth low energy Direct Test Mode
21	REQN	Digital input	ACI request pin (handshaking, active low)
22	MISO	Digital output	ACI Master In Slave Out
23	GND	Ground	Should be connected to ground plane on application PCB
24	RDYN	Digital output	ACI device ready indication (handshaking)
25	RESET	Digital Input	Reset (Active Low)
26-36	NC	Not Connected	Isolated pad on PCB for mechanical stability



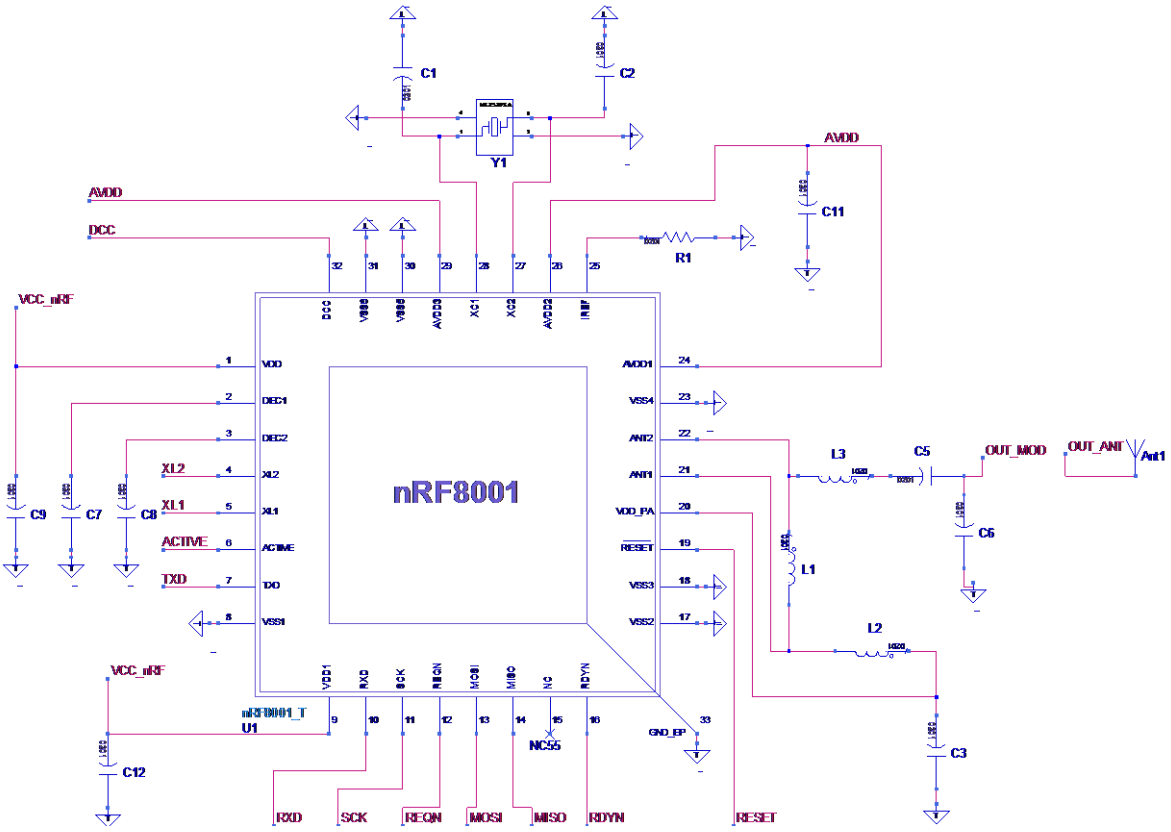
ISP091201 pin assignment
for the LGA QFN package

TOP VIEW

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

Electrical Schematic

Electrical schematic showing ISP091201 module connections



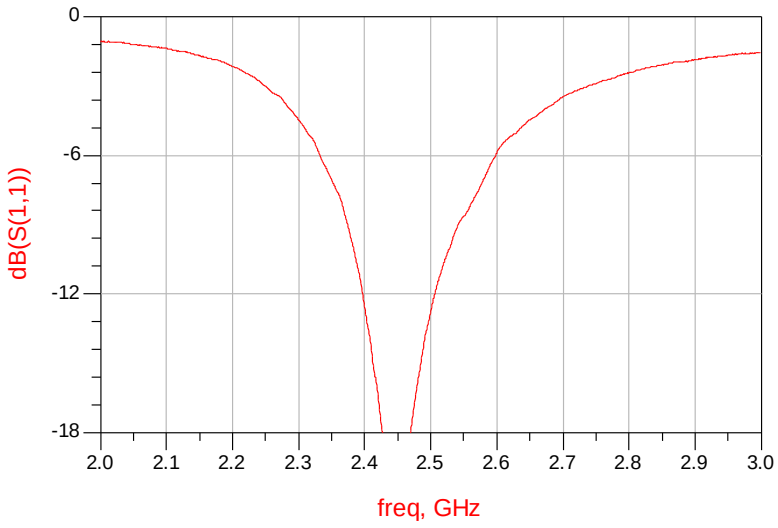
2. RF Performances

RF Specifications according to standards

Parameter	Value	BT V4 Std limit	Unit	Condition
Output Power	-0.9	-20 to 10	dBm	Channels 0 to 39
RF Frequency tolerance	Better than +/-20	+/- 50	Hz	Channels 0 to 39
Rx sensitivity	-87	-70	dBm	Level for BER <0,1% ideal Tx
Max range	> 20		m	Open field @1m height
EIRP	0.3		dBm	
Antenna Gain	1.2		dBi	
Rx sensitivity	56.8		dBµV/m	

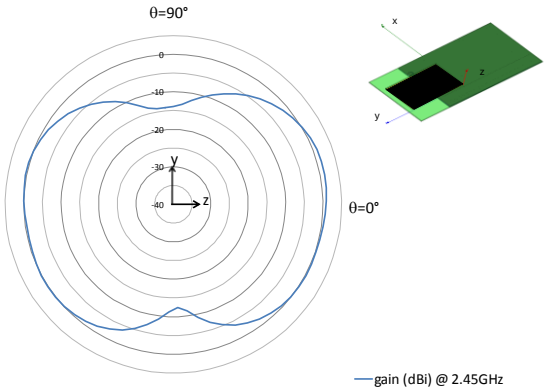
Typical Antenna Return Loss

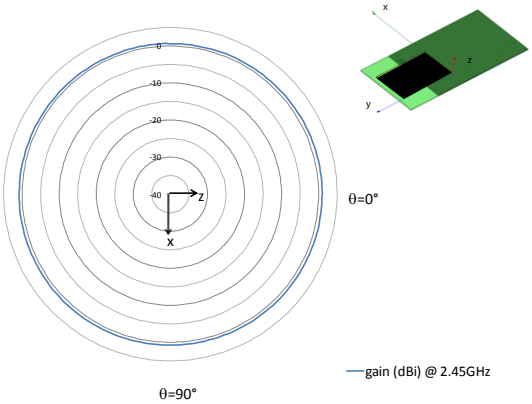
Module mounted on a USB dongle ground plane

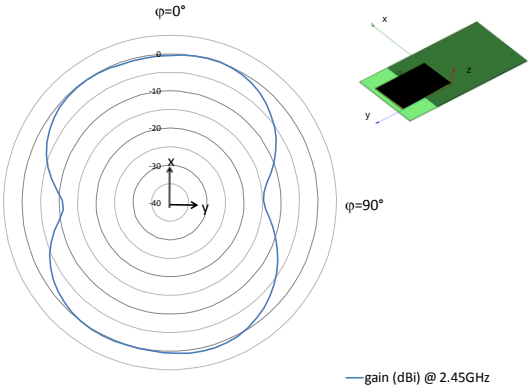


Radiation Pattern in 3 planes

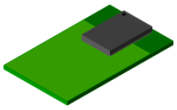
Module mounted on a USB dongle ground plane



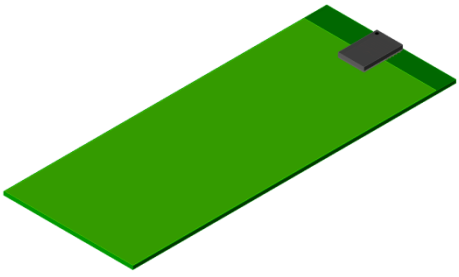




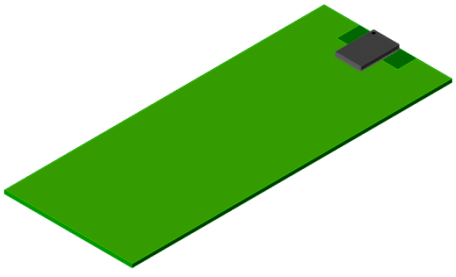
Ground Plane Effect Simulation



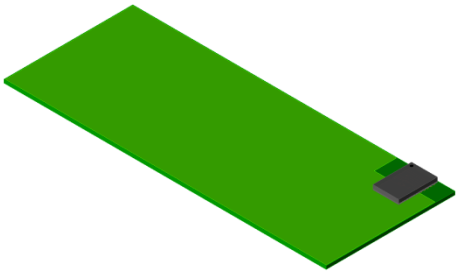
USB dongle
ground plane
(size : 18 x 30 mm²)



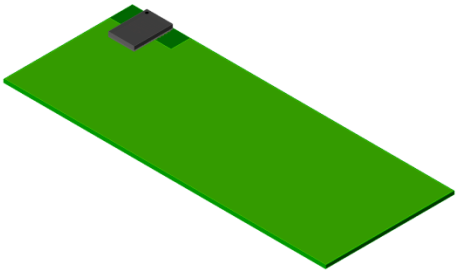
Cell phone config 1
ground plane
(size : 40 x 100 mm²)



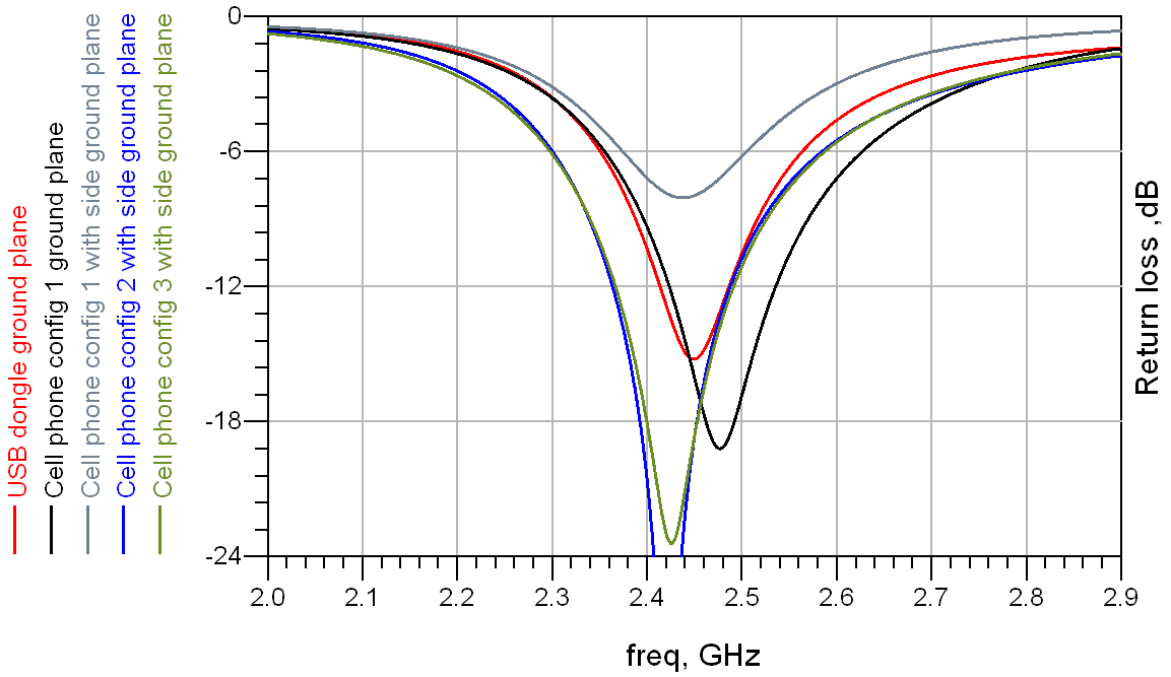
Cell phone config 1 with
side ground plane
(size : 40 x 100 mm²)



Cell phone config 2 with side ground plane
(size : 40 x 100 mm²)



Cell phone config 3 with side ground plane
(size : 40 x 100 mm²)



3. Product Development Tools

Interface

As ISP091201 is designed for operation in the peripheral role, it offers you an easy way to add Bluetooth low energy connectivity to your application. ISP091201 integrates a serial interface (ACI) for configuration and control from your microcontroller. In the following, the microcontroller is referred to as the application controller.

The Application Controller Interface (ACI) is the logical interface between ISP091201 and your application. ACI is a bidirectional serial interface that enables generic application controllers to set up and operate nRF8001 integrated in ISP091201.

Hardware

The following development kits are recommended for using and testing ISP091201 module:

- Nordic Semiconductor nRFgo Starter Kit (nRF6700), need to be purchased separately
- Nordic Semiconductor nRF80001 Development Kit (nRF8001-DK), need to be purchased separately
- Insight SiP Development Kit (ISP091201-DK1), need to be purchased separately

Development Tools and Software

The following development tools and software are recommended for using and testing ISP091201 module:

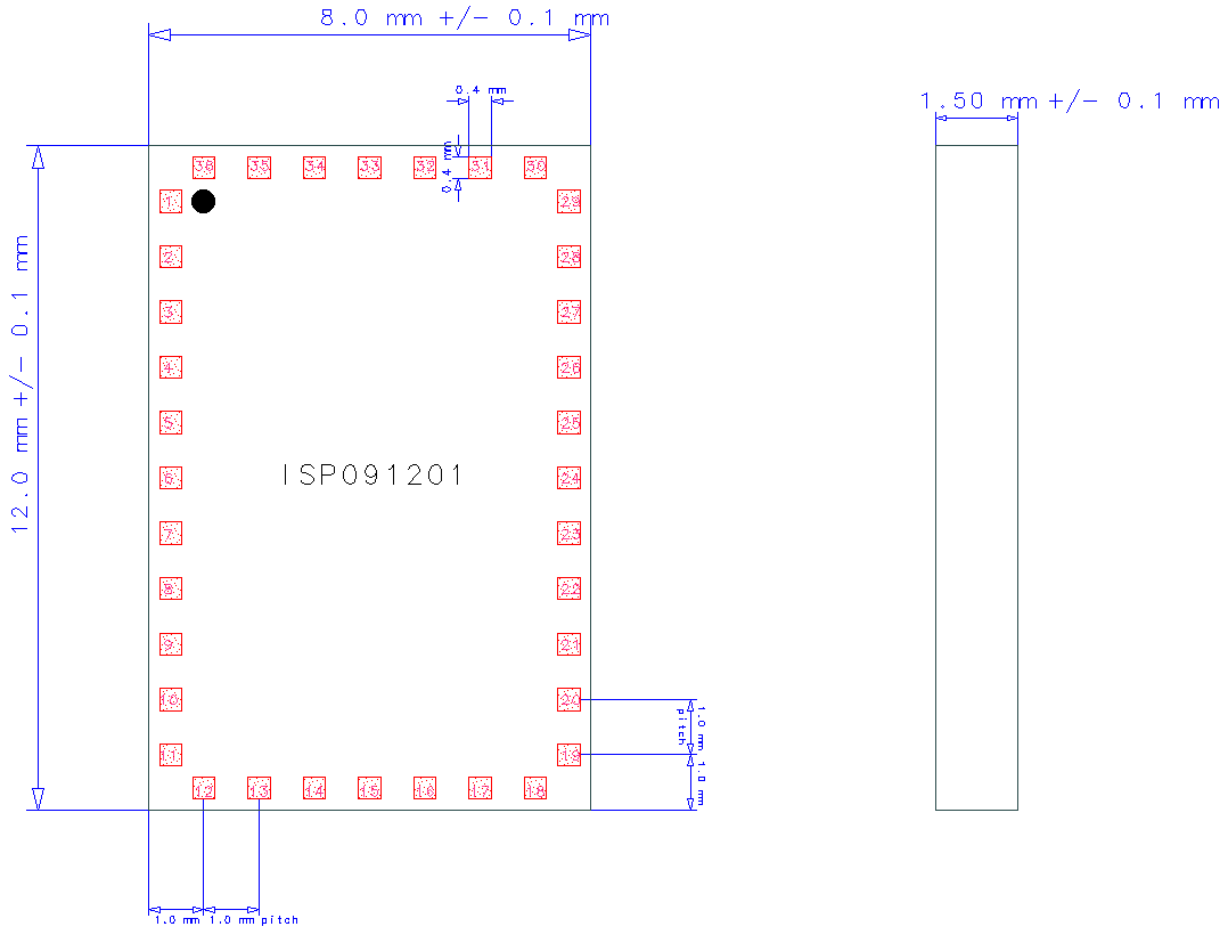
- ACI commands and events are defined in nRF8001 Data Sheet downloadable for free from www.nordicsemi.com
- Nordic Semiconductor Software Development Kit for nRF8001 (nRF8001-SDK, downloadable from www.nordicsemi.com after purchasing nRF8001-DK): give access to software source code examples
- Nordic Semiconductor nRFgo Studio (downloadable from www.nordicsemi.com after purchasing nRFgo Starter Kit nRF6700)
- Nordic Semiconductor Master Control Panel (downloadable from www.nordicsemi.com after purchasing nRF8001-DK)
- IDE compatible with your chosen microprocessor. As ISP091201 is designed for operation in the peripheral role, it offers you an easy way to add Bluetooth low energy connectivity to your application. ISP091201 integrates a serial interface (ACI) for configuration and control from your microcontroller. In the following, the microcontroller is referred to as the application controller.

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

4. Mechanical Outlines

Mechanical Dimensions

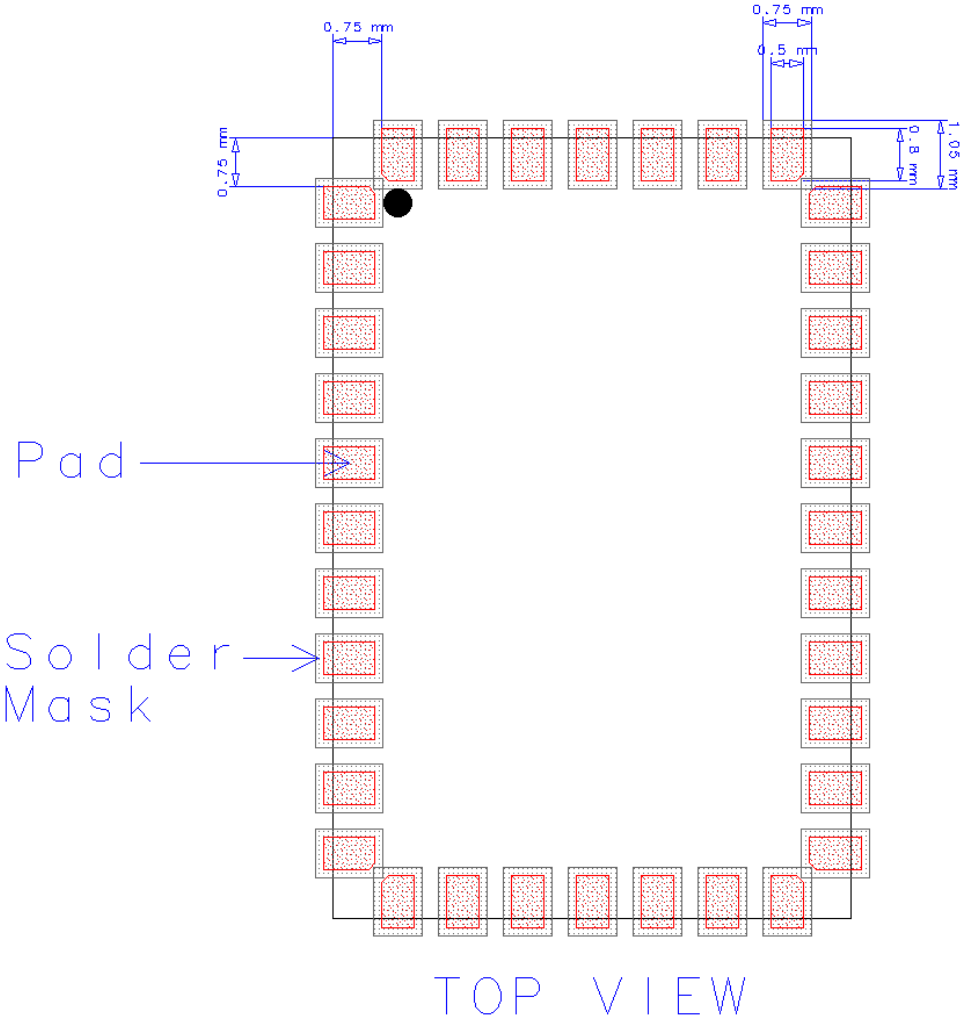
Dimensional drawing for 8 x 12 x 1.5 mm, 36-Pad LGA Package



HOME

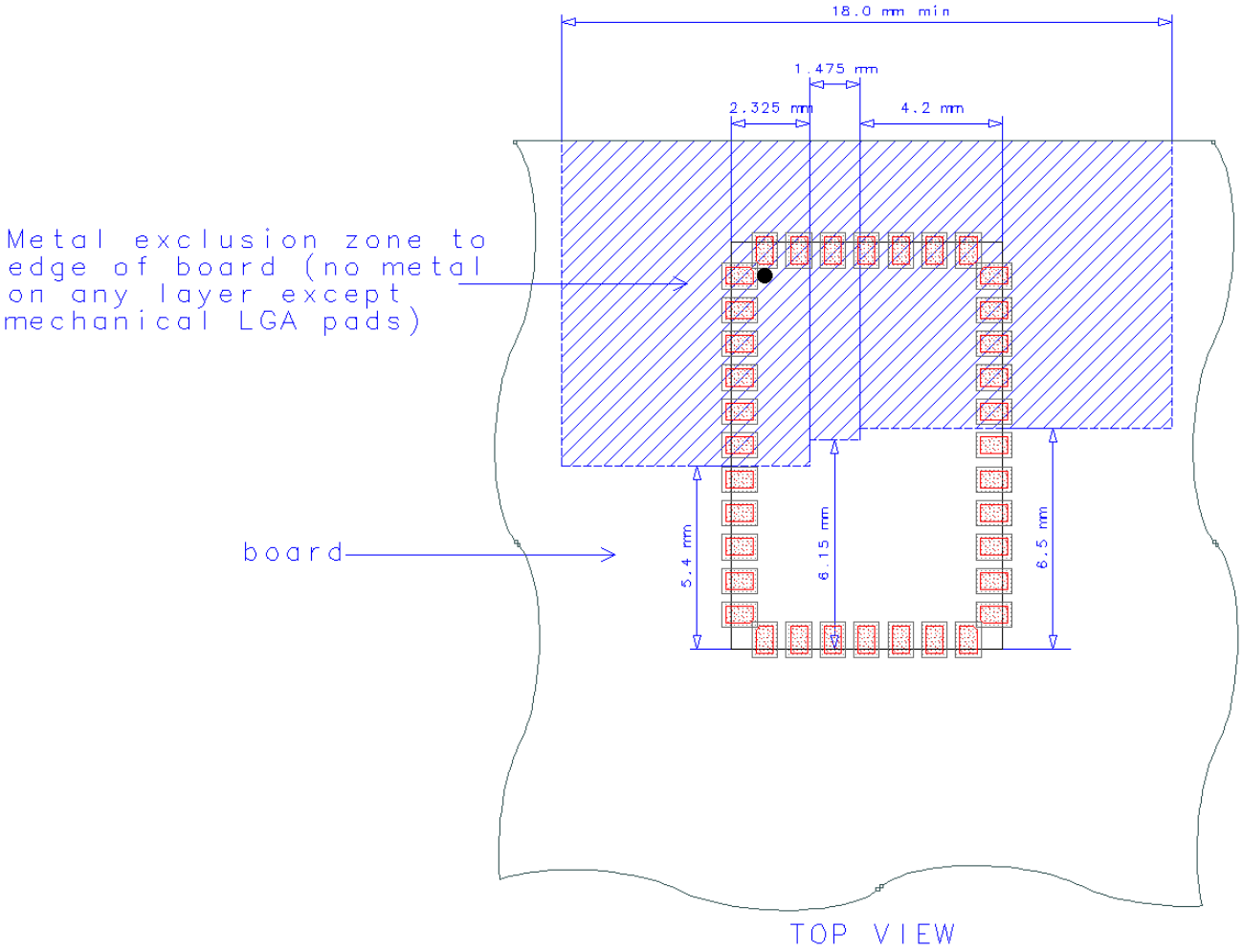
SMT Assembly Guidelines

Recommended PCB Land Pattern and Solder Mask layout



Antenna Keep-Out Zone

Recommended metal keep out areas for optimal antenna performance:
no metal, no traces and no components on any layer except mechanical LGA pads.

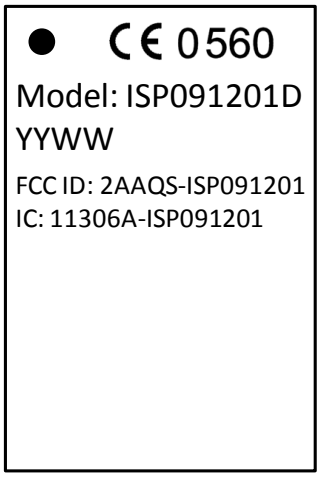


5. Packaging

Marking

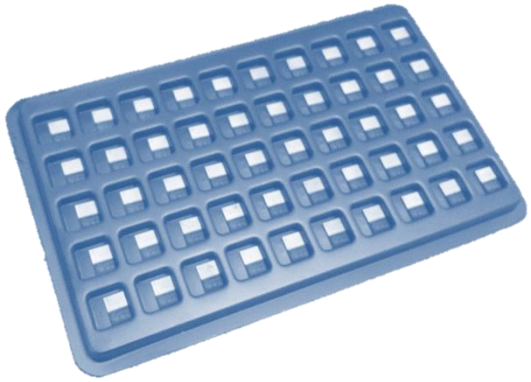
I	S	P	0	9	1	2	0	1	D
Y	Y	W	W						

ISP091201	Product number
D	Hardware version
YY	Two digit year number
WW	Two digit week number



Prototype Packaging

For engineering samples and prototype quantities up to 99 units, deliveries are provided in thermoformed trays.

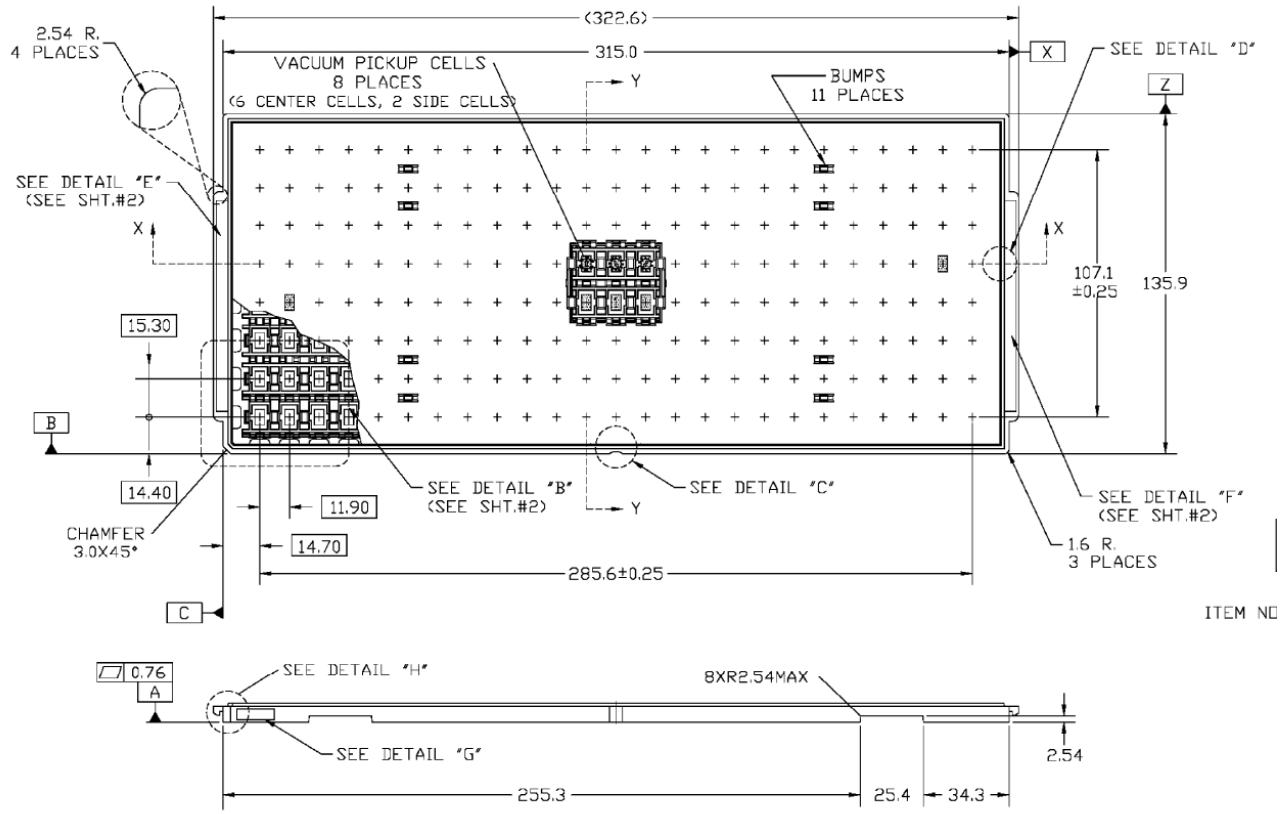


Trays

For higher quantities and volume production, ISP091201 modules are available in Jedec trays. They are delivered in sealed pack with desiccant pack and humidity sensors. These Jedec trays are also suitable for further baking. Please see section 6 for more information on moisture sensitivity.

Jedec trays are proposed in standard quantities of 100 units, 200 units and multiples of 200 units only.

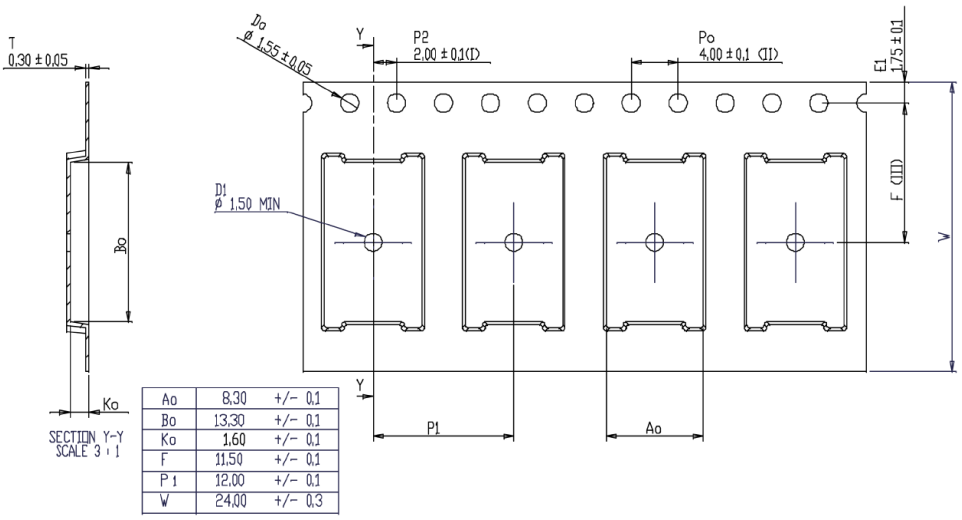
Please refer to tray sizes and module positioning below. Complete information on Jedec trays is available on request.



Tape and Reel

ISP091201 modules are also available in Tape & Reel. They are delivered in sealed pack with desiccant pack and humidity sensors. Reels are proposed in standard quantities of 500 units (180mm / 7" reel) or 2000 units (330mm / 15" reel) only.

Please refer to tape size below. Complete information is available on request.



Ao	8,30	+/- 0,1
Bo	13,30	+/- 0,1
Ko	1,60	+/- 0,1
F	11,50	+/- 0,1
P1	12,00	+/- 0,1
W	24,00	+/- 0,3

6. Storage & Soldering information

Moisture Sensitivity

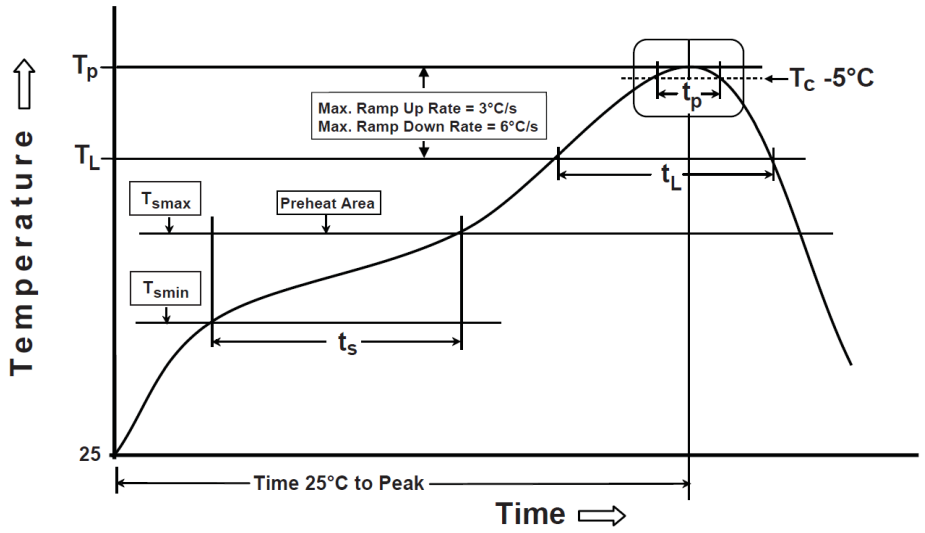
All plastic packages absorb moisture. During typical solder reflow operations when SMDs are mounted onto a PCB, the entire PCB and device population are exposed to a rapid change in ambient temperature. Any absorbed moisture is quickly turned into superheated steam. This sudden change in vapor pressure can cause the package to swell. If the pressure exerted exceeds the flexural strength of the plastic mold compound, then it is possible to crack the package. Even if the package does not crack, interfacial delamination can occur.

Since the device package is sensitive to moisture absorption, it is recommended to bake the product before assembly. The baking process for dry packing is 24 hours at 125°C.

ISP091201 has been tested MSL-5 according to standards. After baking, modules can be exposed to ambient room conditions (approximately 30 °C/60%RH) during 48 hours before assembly on the PCB.

Soldering information

Recommendation for RoHS reflow process is according to Jedec J–STD-020 and 033 standard profiles.



Preheat/Soak Temperature Min (T_{smin}) Temperature Max (T_{smax}) Time (t_s) from (T_{smin} to T_{smax})	 150 °C 200 °C 60-120 sec
Ramp-up rate (T_L to T_p)	3 °C/sec max
Liquidous temperature (T_L) Time (t_L) maintained above T_L	217 °C 60-150 sec

Peak package body temperature (T_p)	260°C (+0/-5°C)
Classification Temperature (T_c) Time (t_p) maintained above T_C-5 °C	260 °C 30 sec
Ramp-down rate (T_p to T_L)	6 °C/sec max
Time 25 °C to peak temperature	8 mn max

7. Quality & User information

Certifications

- FCC Limited Modular Certification 15.212 FCC #2AAQS-ISP091201
- CE: Complies with Directive 1999/5/EC statement N° 13214144/AA/00
- Canada: IC # 11306A-ISP091201
- Bluetooth SIG certified #B017595
- RoHS compliant

FCC grant conditions

ISP091201 is certified under FCC part 15.212 with “Limited Modular Approval”.

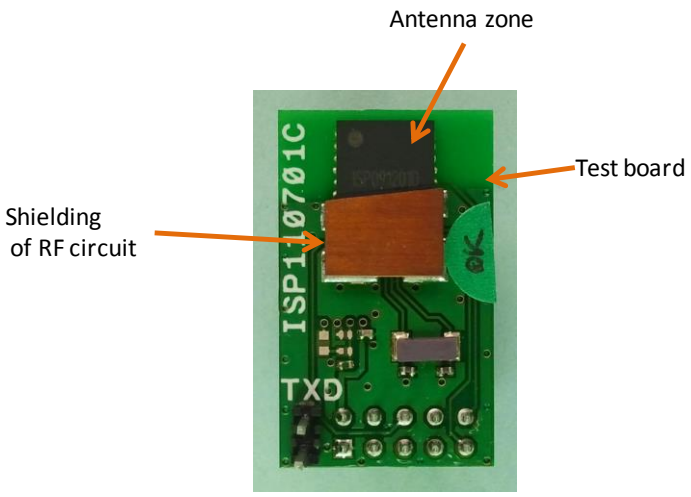
This approval is limited to hosts that use the additional metal shield ISP091205 that is delivered with ISP091201, since certification has been carried out in this way. This ensures that the radio portion of the circuit is fully shielded on all sides with the exception of the antenna access. The module itself contains the lower ground plane so it is not necessary to have a continuous plane under the module in the host.

The ISP091201 is labeled with its own FCC identification number: FCC ID: xxx-ISP091201, when installed into host the outside of the host must display a label with the wording:

“Contains FCC ID xxx-ISP091201” as specified by the CFR47 part15.212 (a – VI)

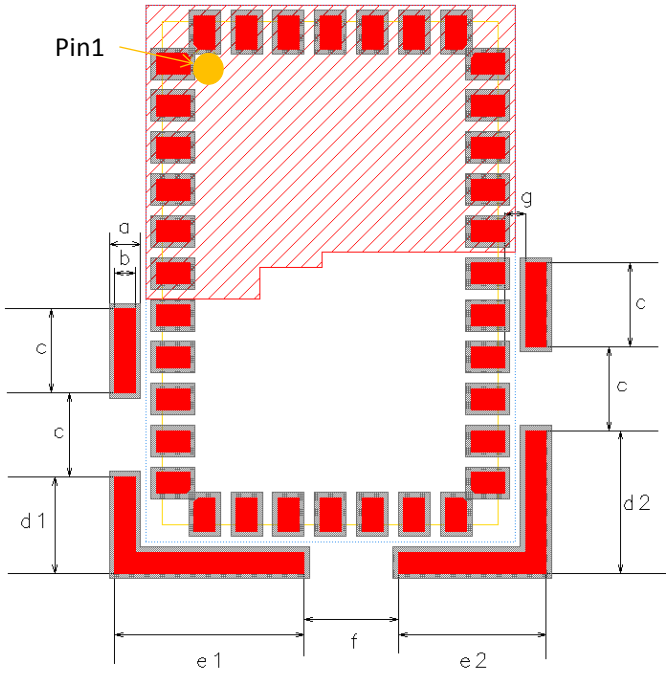
In order to respect FCC regulation, additional metal shield ISP091205 must be implemented following the recommendation below. Note that shield installation is only related to FCC compliance. It has absolutely no influence on the module performance and the ISP091201 can operate according to the present specification with or without the shield.

- Shield installation as used for FCC part 15.212 certification tests

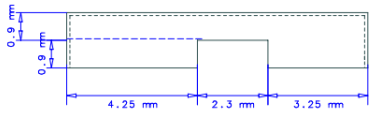


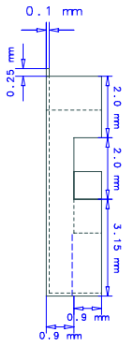
Shield installation land pattern

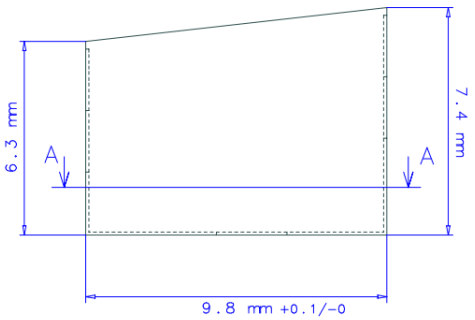
Para-meter	Description	Value in µm
a	Shield SM aperture	750
b	Shield metal trace width	500
	SM registration (a-b)/2	125
g	Module pad edge to shield trace edge	500
c		2000
d1		2300
d2		3400
e1		4525
e2		3525
f		2250

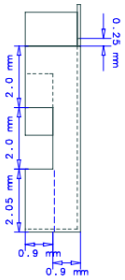


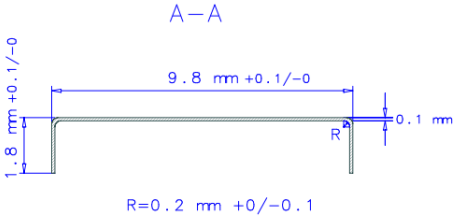
Mechanical drawing of the shield ISP091205











USA – User information

This intends to inform how to specify the FCC ID of our module “ISP091201” on the product. Based on the Public Notice from FCC, the host device should have a label which indicates that it contains our module.
The label should use wording such as: “Contains FCC ID: 2AAQS-ISP091201”.
Any similar wording that expresses the same meaning may be used.
The label of the host device should also include the below FCC Statement. When it is not possible, this information should be included in the User Manual of the host device:

“This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions.
(1) This device may not cause harmful interference
(2) This device must accept any interference received, including interference that may cause undesired operation.
Caution: Any Changes or modifications not expressly approved by the party responsible for compliance could void the user’s authority to operate the equipment.”

CANADA – User information

This intends to inform how to specify the IC ID of our module “ISP091201” on the product. According to Canadian standards “RSS-210” and “RSS-Gen”, the host device should have a label which indicates that it contains our module.
The label should use wording such as: “Contains IC: 11306A-ISP091201”.
Any similar wording that expresses the same meaning may be used.
The label of the host device should also include the below IC Statement. When it is not possible, this information should be included in the User Manual of the host device:

“This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.”

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

Discontinuity

Normally a product will continue to be manufactured as long as all of the following are true:
- The manufacturing method is still available.
- There are no replacement products.
- There is demand for it in the market.

In case of obsolescence, Insight SiP will follow Jedec Standard JSD-48. A Product Discontinuation Notice (PDN) will be sent to all distributors and made available on our website. After this, the procedure goes as follows:
- Last Order Date will be 6 months after the PDN was published.
- Last Shipment Date will be 6 months after Last Order Date, i.e. 12 months after PDN.

Disclaimer

Insight SiP's products are designed and manufactured for general consumer applications, so testing and use of the product shall be conducted at customer's own risk and responsibility. Please conduct validation and verification and sufficient reliability evaluation of the products in actual condition of mounting and operating environment before commercial shipment of the equipment. Please also pay attention (i) to apply soldering method that don't deteriorate reliability, (ii) to minimize any mechanical vibration, shock, exposure to any static electricity, (iii) not to overstress the product during and after the soldering process.

The products are not designed for use in any application which requires especially high reliability where malfunction of these products can reasonably be expected to result in personal injury or damage to the third party's life, body or property, including and not limited to (i) aircraft equipment, (ii) aerospace equipment, (iii) undersea equipment, (iv) power plant control equipment, (v) medical equipment, (vi) transportation equipment, (vii) traffic signal equipment, (viii) disaster prevention / crime prevention equipment.

The only warranty that Insight SiP provides regarding the products is its conformance to specifications provided in datasheets. Insight SiP hereby disclaims all other warranties regarding the products, express or implied, including without limitation any warranty of fitness for a particular purpose, that they are defect-free, or against infringement of intellectual property rights. Insight SiP customers agree to indemnify and defend Insight SiP against all claims, damages, costs and expenses that may be incurred, including without any limitation, attorney fees and costs, due to the use of products.

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

ISP091201-DK1
Bluetooth Low Energy Wireless Development Kit for ISP091201

General Description

In order to assist clients in developing their Bluetooth Smart solutions based on the ISP091201, Insight SIP offers a Development Kit. This consists of the following:

- One Test board
- 5 sample units ISP091201

This development kit must be implemented together with Nordic Semiconductor kits nRFGo Strater Kit and nRF8001 Development Kit.

Using this development kit, product developers can use a working solution as starting point to develop their own products. Time to market is saved by avoiding starting from a blank sheet of paper. In addition, there may be some applications that use the hardware as is.

Applications

Possible applications include:

- Sports accessories (movement etc)
- Healthcare accessories(heart rate)
- Alarms (temperature excess)
- Pressure detection

The miniature size of the Insight solution means it could be comfortably worn, or is able to fit into a small space.

Please refer to the application note AN120102 for more information on kit implementation.

Specific Skills

If a product developer lacks skills in any of the crucial areas to develop a working solution, then Insight SIP can offer custom design services to cover all of the following areas

- Custom hardware development
- Addition/replacement of different sensors
- Software development
  Custom SIP development

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

AN120102
Use of ISP091201-DK1

Introduction

Scope

This document gives details on hardware and software for using and testing Insight SiP Bluetooth Low Energy module ISP091201. The next paragraphs describe hardware and software of three different kits, two from Nordic Semiconductor and one from Insight SiP. The last paragraph presents a simple link test set-up.

Contents

1. Recommended Documentation

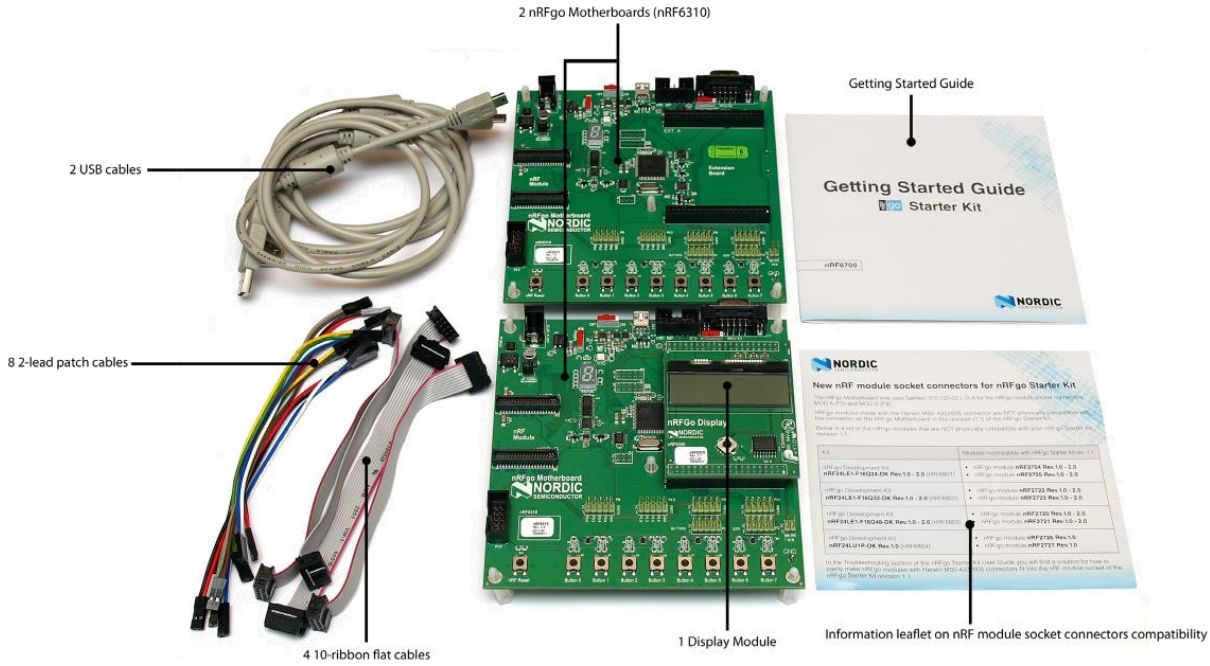
The following documents are recommended reading:

Document	Name	Remark
R1	nRF6700 User Guide v1.6.pdf	Downloaded at www.nordicsemi.com
R2	nRF8001 DK User Guide v1.1.pdf	This pdf file will be located in folder C:\Nordic Semiconductor\nRF8001 SDK v1.7\Documentation **after** installing nRF8001 SDK installer (see §3)
R3	DS091201Rxx.pdf	ISP091201D module data sheet

2. nRFGo Starter Kit (nRF6700)

The nRGo Starter Kit consists of hardware and software components. For more details, see Nordic Semiconductor user guide (document R1- see §1).

nRFGo Starter Hardware Components



Software and Documentation Components

Access to software and documentation at www.nordicsemi.com. Then, download and install latest version of nRFGo Studio.

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

3. nRF8001 Development Kit (nRF8001-DK)

The nRF8001 Development Kit consists of hardware and software components. For more details, see Nordic Semiconductor user guide (document R2 – see §1).

nRF8001-DK Hardware Components

① 5 nRF8200 samples

② 1 patch cable

③ **nRF2739:** *Bluetooth* low energy master emulator

④ **nRF2740:** nRF8001 module with PCB antenna

⑤ **nRF2741:** nRF8001 module with SMA connector

⑥ **nRF2735:** Carrier board with an nRF8200 application processor

⑦ 5 nRF8001 samples

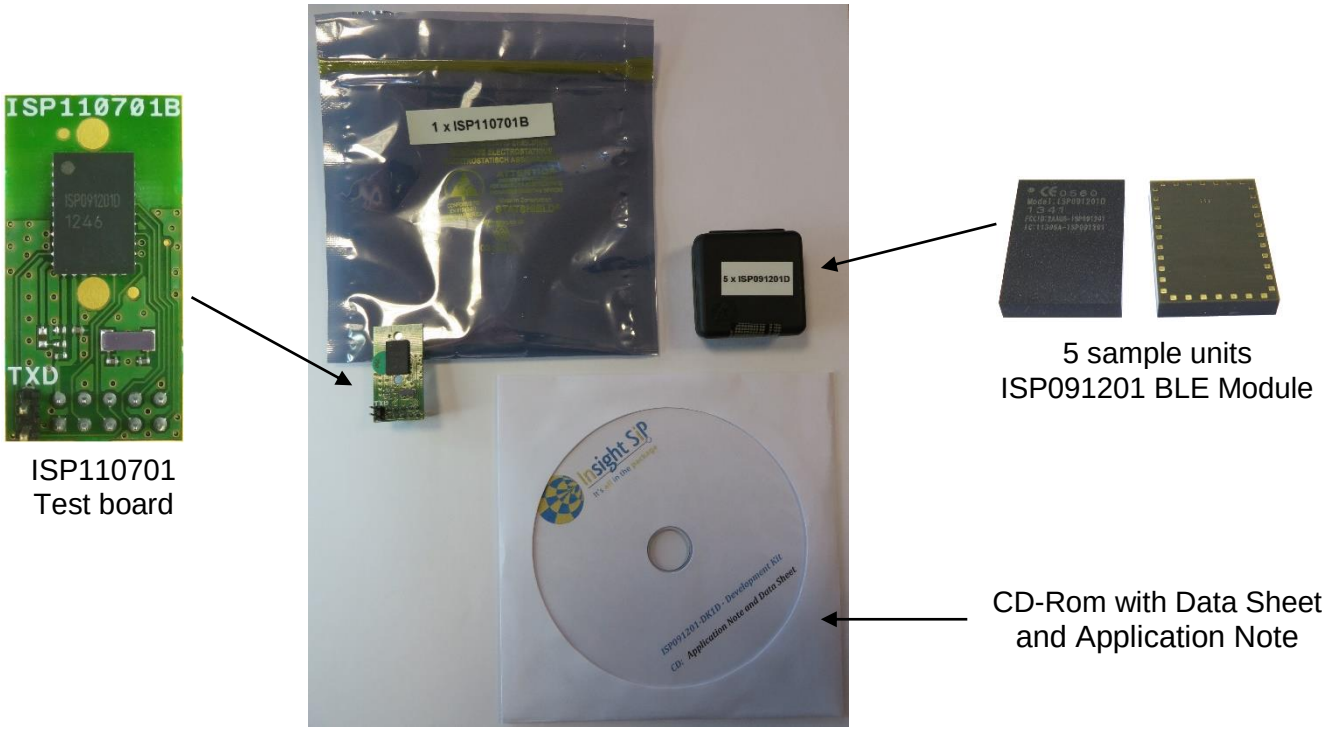
Software and Documentation Components

The SDK (Software Development Kit) can be downloaded from a Nordic MyPage account at www.nordicsemi.com. In order to access the download page, the requested Product Key is written on the nRF8001-DK package. Then, download and install latest version of nRF8001 SDK Installer. Installation will set up the software and will give access to Nordic Semiconductor user guide (document R2 – see §1).

4. ISP091201 Development Kit (ISP091201-DK1)

Hardware Components

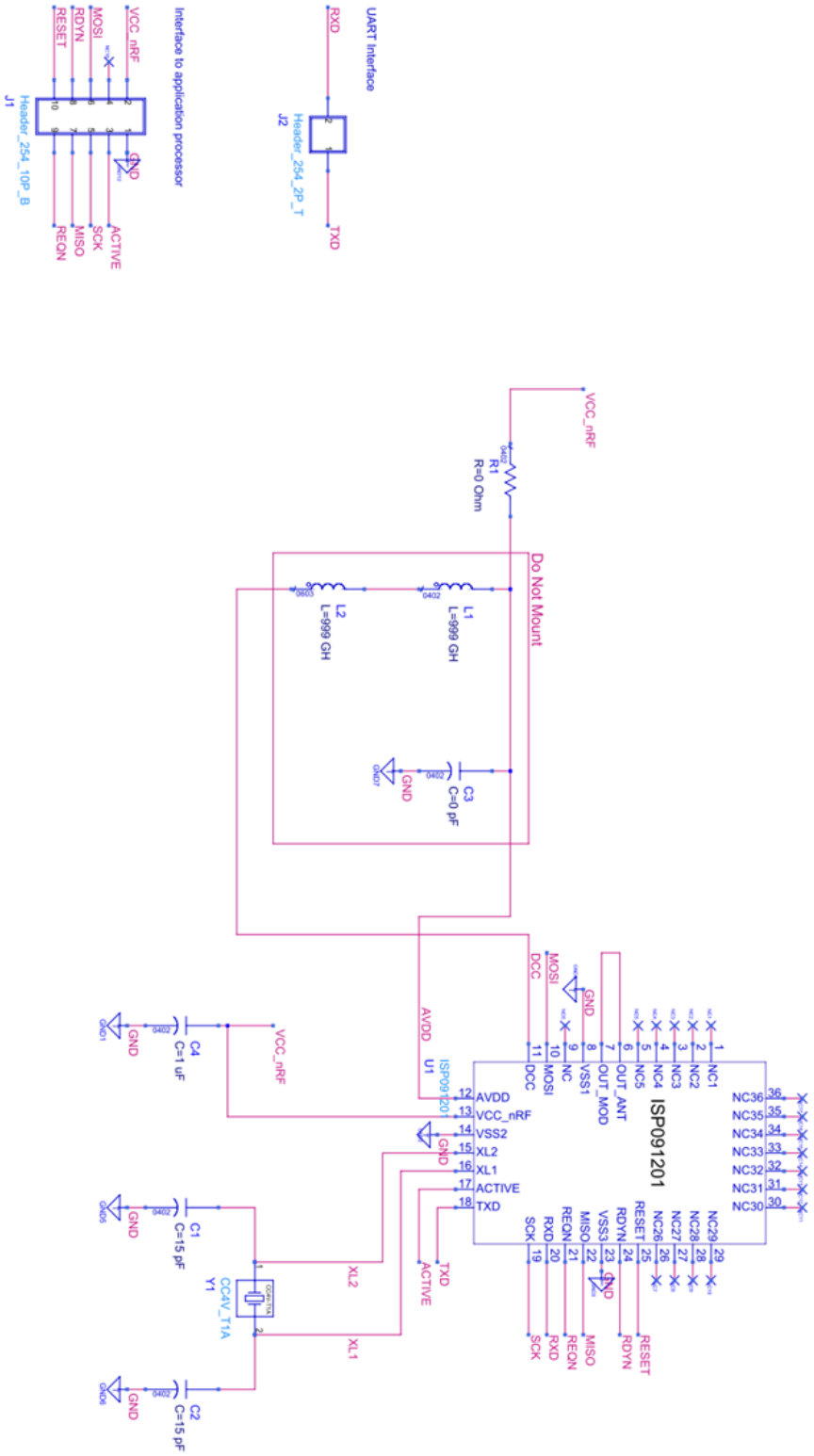
The Insight SiP ISP091201 Development Kit consists of the following hardware components.



- ISP091201 is the Bluetooth Low Energy module with integrated antenna. This module is based on Nordic Semiconductor nRF8001 uBlue Bluetooth Low Energy Platform. The nRF8001 is a single chip transceiver with an embedded baseband protocol engine. The ISP091201 module size measures 8 x 12 x 1.5 mm. The module integrates all the decoupling capacitors, the 16 MHz crystal and load capacitors plus the RF matching circuit and antenna in addition to the transceiver. For more details, see Insight SiP module data sheet (document R3 – see §1).

- ISP110701 is the application type test board. It encloses ISP091201 Bluetooth Low Energy module and has size of 18 x 35 mm. ISP110701 has the same function as Nordic Semiconductor nRF2740 board.

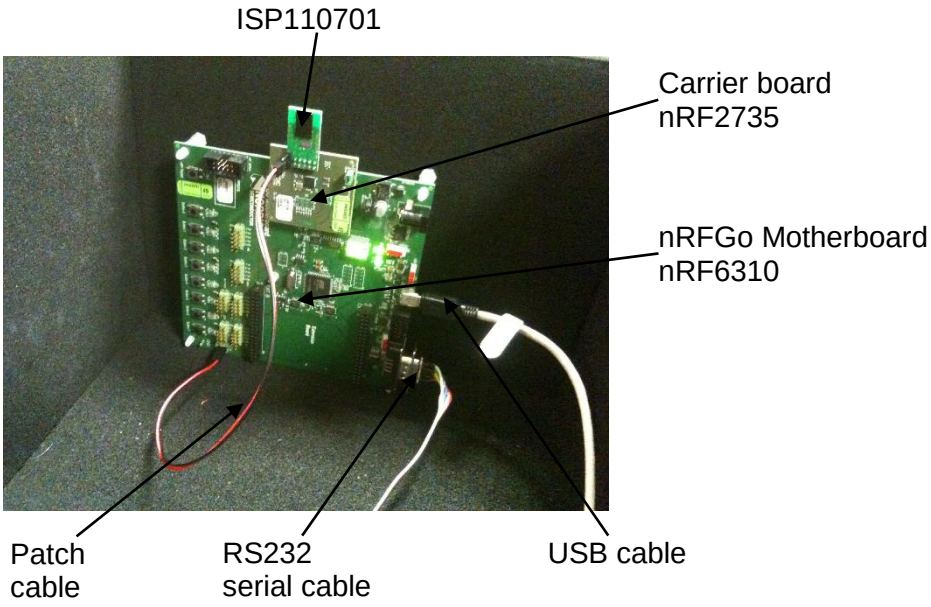
ISP110701 Electrical Schematic



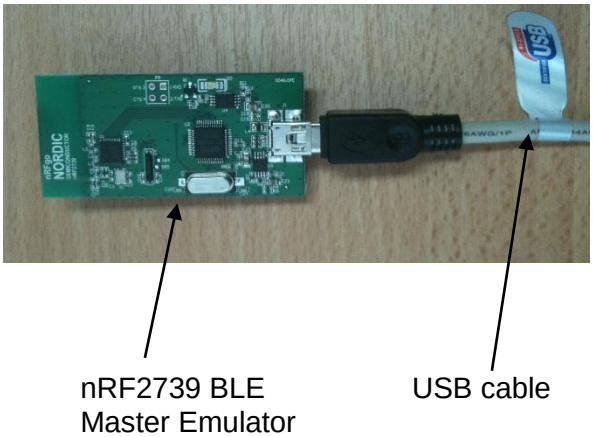
5. Simple Link Test Set-Up

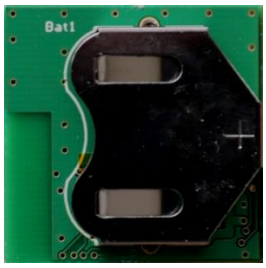
All tests performed in Nordic Semiconductor user guide (document R2) with nRF2740 board can be carried out with ISP110701 instead. Two set-up examples are shown in the following paragraphs.

ISP110701 Test Board Set-Up for Testing with Direct Test Mode



BLE Master Emulator Set-Up

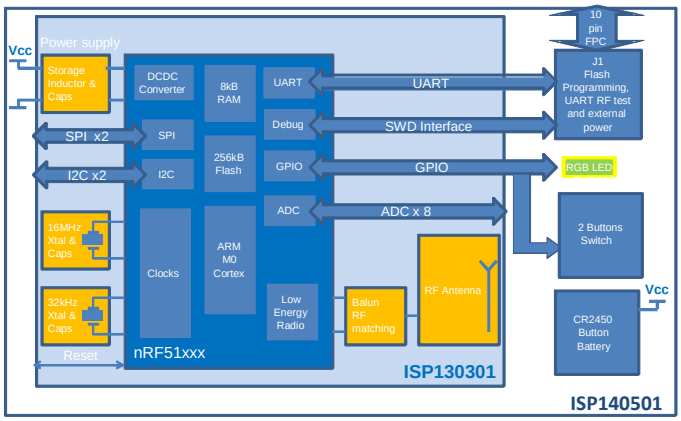




ISP140501
Bluetooth Low Energy Wireless Beacon Detection

Key Features

- Single Mode BLE v4.0 Slave
- Based on Nordic Semiconductor nRF51 family
- 2.4GHz low energy RF Transceiver
- 32bit ARM Cortex M0 CPU with 256kB Flash
- Fully integrated RF matching and Antenna
- Integrated 16 MHz and 32.768 kHz Clocks
- Ultra Low Power Consumption
- Coin cell battery CR2450
- Mini-RGB-LED
- 10 pins FPC connector for software loading
- Overall Size 33 x 33 x 8.7 mm
- Temperature -25 to 75 °C



Applications

- Location sensitive information
- Marketing or retail applications
- Beacon technologies in Healthcare
- Beacon technologies in Education

General Description

ISP140501 is an autonomous low-power device for wireless detection and transmission. The complete device makes use of Insight SiP ISP130301 BLE module together with low power host processor and small primary button cell battery CR2450. Overall size of the device is 33 x 33 x 8.7 mm.

It has been developed to explore the full range of development possibilities for beacons using Bluetooth Smart technology. They allow indoor positioning, letting your phone know that you are in range of a beacon. As the “beacon” name suggests, they transmit packets of data in regular intervals, and this data can be then picked up by devices like smartphones.

Ultra low power consumption and advanced power management enables battery lifetimes up to several years on a coin cell battery.

Even though its very small size 8 x 11 x 1.2mm, the ISP130301 SiP module integrates decoupling capacitors, 16 MHz and 32 kHz crystals, load capacitors, DC-DC converter, RF matching circuit and antenna in addition to the wireless SoC. The host processor that handles the autonomous sensor application, the high level portion of the BLE protocol stack and communication with the RGB-LED is a low power 32-bit MCU (ARM Cortex-M0 based), integrating 256kB flash memory and 8kB SRAM.

The two buttons can be programmed to enable easy switching between modes and/or functionality. As well an RGB-LED can be configured to indicate different events.

An interface board, ISP130603 is available from Insight SIP development kit and allows for easy flash programming the application processor via the 10 pin FPC connector. During firmware modification and debug, the ISP140501 device may be supplied via the DC voltage from the ISP130603 interface board.

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

Contents

1. Electrical Specifications

Current Consumption

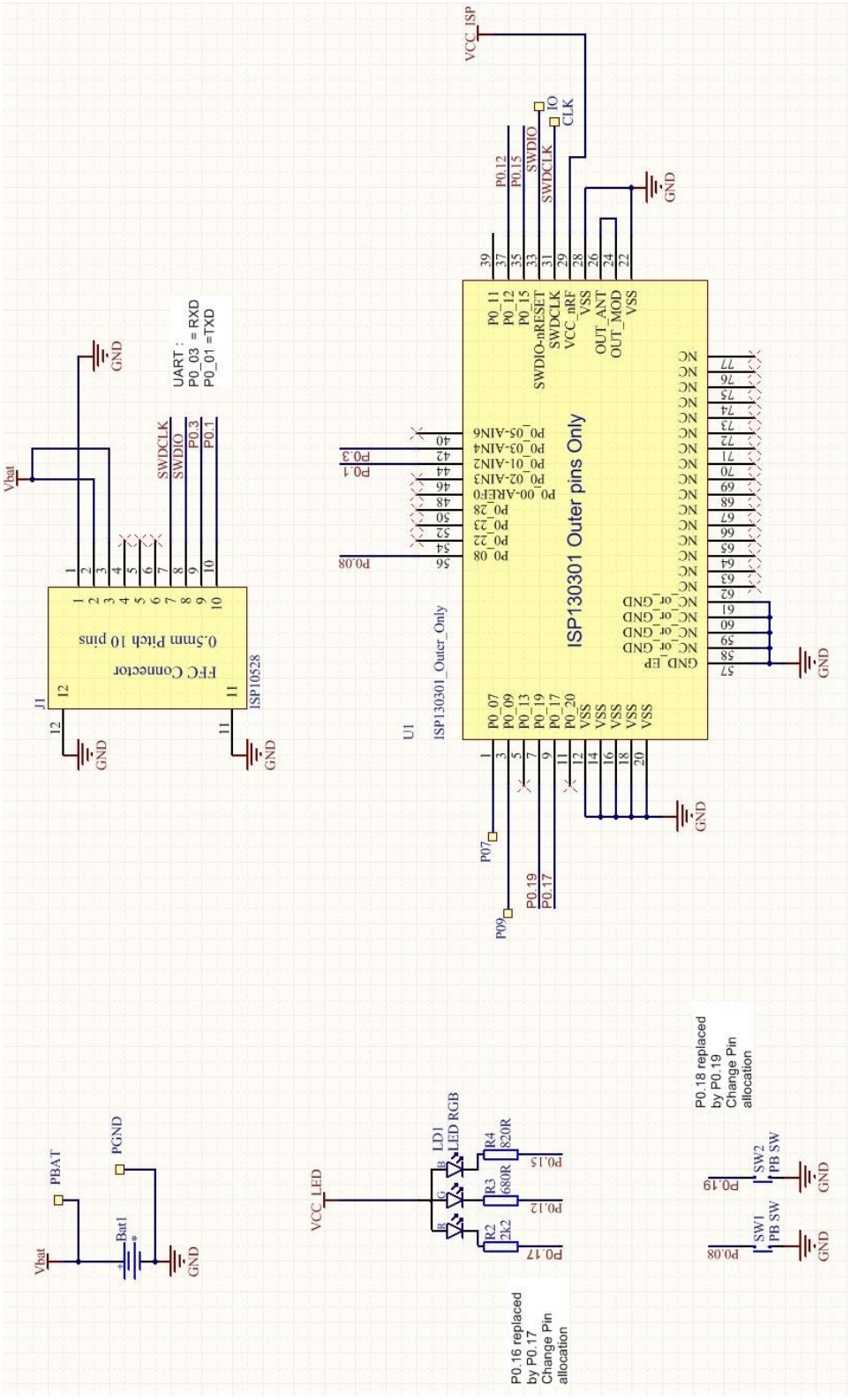
The measured total average current consumption and autonomy of the ISP140501 sensor node supplied by CR2450 or AAA battery for several connection intervals is shown below.

Connection Interval (ms)	Peak Current (mA)	Average Current Consumption (µA)	CR2450 Autonomy (year)*	2 x AAA Autonomy (year)*
100	11.7	245	0.3	1.1
750	11.7	32.7	2.1	8.4**
1000	11.7	24.5	2.8	11.2**

(*) Example with:
- one battery CR2450 (600 mAh)
- two batteries type AAA 1.5V (2400 mAh for 2 batteries)

(**) Limited by the battery lifetime

Electrical Schematic



2. RF Performances

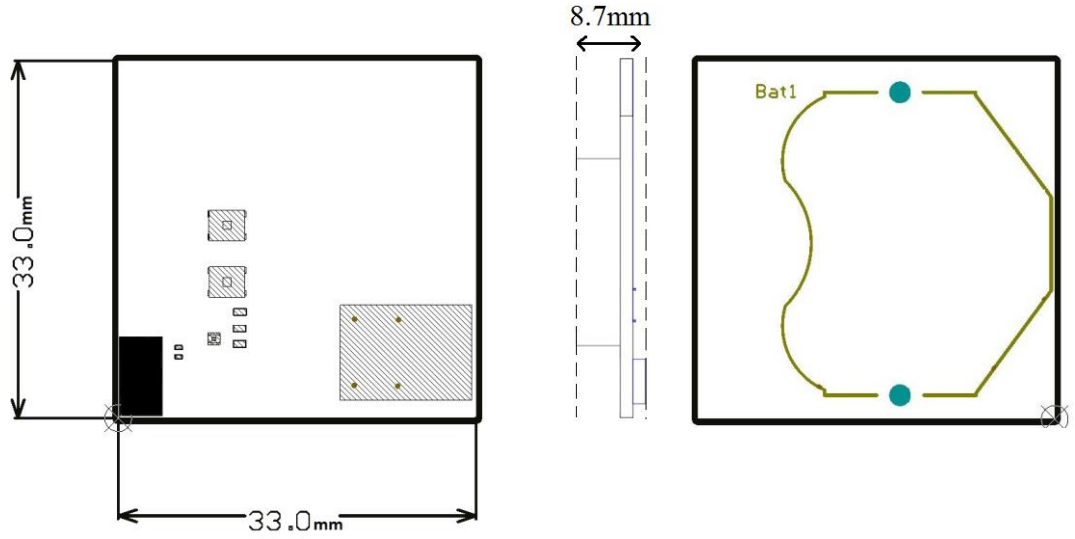
RF Specifications according to standards

The performance of the Bluetooth Low Energy Radio link is that obtained by the ISP130301 module.
Temperature range -25°C to +75°C.

Parameter	Value	BT V4 Std limit	Unit	Condition
Output Power	-20 to +4	-20 to 10	dBm	Channels 0 to 39
RF Frequency tolerance	Better than +/-20	+/- 50	Hz	Channels 0 to 39
Rx sensitivity	-93	-70	dBm	Level for BER <0,1% ideal Tx
Max range	> 200		m	Open field @1m height
EIRP	4.6		dBm	
Antenna Gain	0.6		dBi	
Rx sensitivity	51.4		dBµV/m	

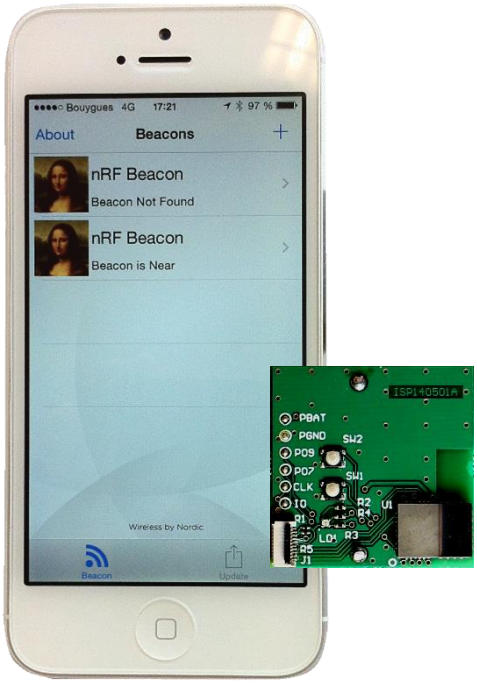
3. Mechanical Outlines

Dimensional drawing



HOME

ISP140501-DK1 Bluetooth Low Energy Wireless Beacon Development Kit

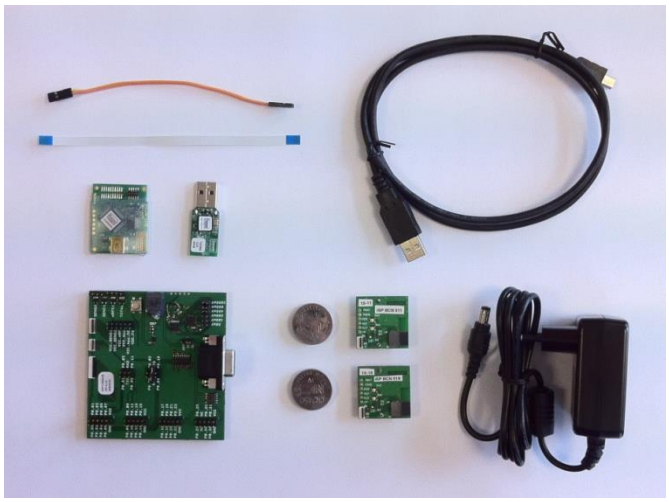


General Description

In order to assist clients in developing their Bluetooth Smart Beacon based on the ISP140501, Insight SIP offers a Sensor Development Kit. This consists of the following Sensor Board, containing:

- One Interface Board
- J-Link Lite CortexM-9 JTAG/SWD Emulator
- 2 ISP140501 BLE beacon samples
- A Development Dongle
- Cables, power supply and coin battery holder
- Smartphone is NOT included

Using this development kit, product developers can use a working solution as starting point to develop their own products. Time to market is saved by avoiding starting from a blank sheet of paper. In addition, there may be some applications that use the hardware as is.



Applications

Possible applications include:

- Location sensitive information
- Marketing or retail applications
- Beacon technologies in Healthcare
- Beacon technologies in Education

The miniature size of the Insight solution means it could be comfortably worn, or is able to fit into a small space.

Please refer to the application note AN140801 for more information on kit implementation.

Specific Skills

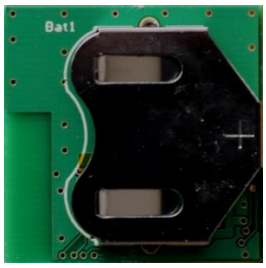
If a product developer lacks skills in any of the crucial areas to develop a working solution, then Insight SIP can offer custom design services to cover all of the following areas

- Custom hardware development
- Addition/replacement of different sensors
- Software development
  Custom SIP development

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

HOME

AN140801
Use of ISP140501-DK1



Introduction

This application note describes how to set up a Beacon application with ISP140501 that will send data via the Bluetooth link to the Master Emulator or to a device (iPhone or Android device).

Two types of demonstration are presented.

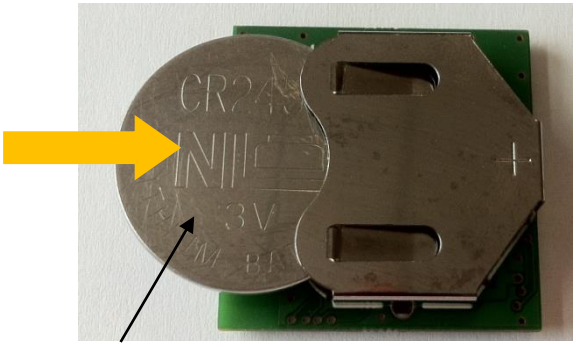
The first one is directly executable with hardware and software provided in the Development Kit using Master Control Panel application.

The second demonstration requires the use of an iPhone (4S or higher) or an Android device (4.3 or higher).

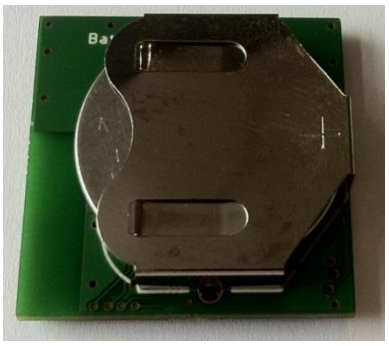
Contents

1. Demonstration with Master Control Panel

1. Place the CR2450 lithium battery into the battery holder.

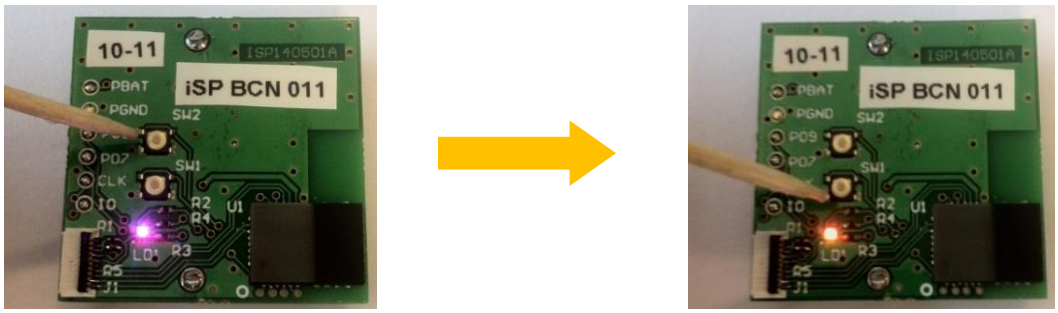


Battery CR2450 POS Terminal UP

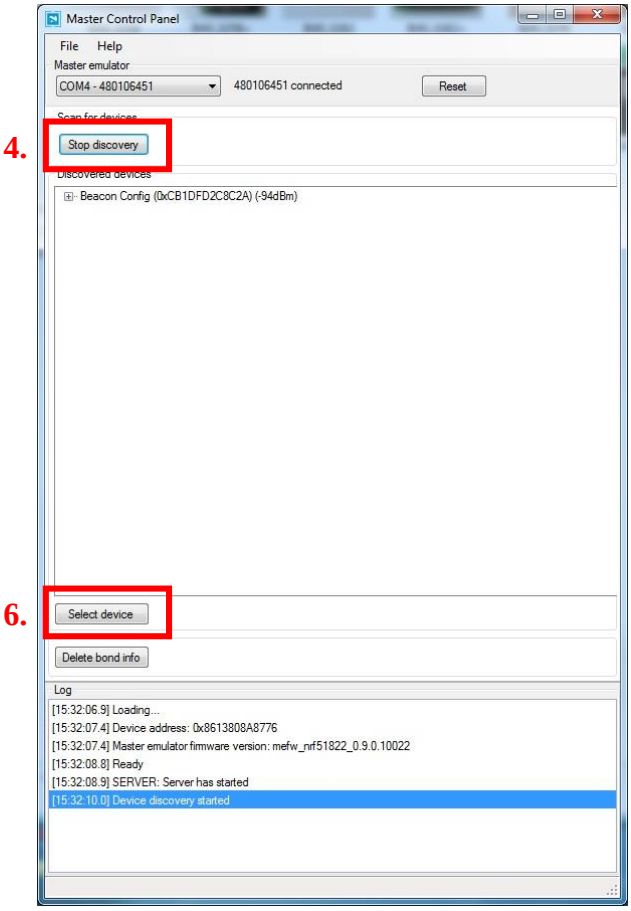


Battery CR2450 Fully Installed

2. Connect Development Dongle PCA10000 (Master Emulator) into a USB port on your computer.
3. Start Master Control Panel.
4. Click Start Discovery.
5. On the beacon, push the switch SW2 to pair with the master (the led become orange).



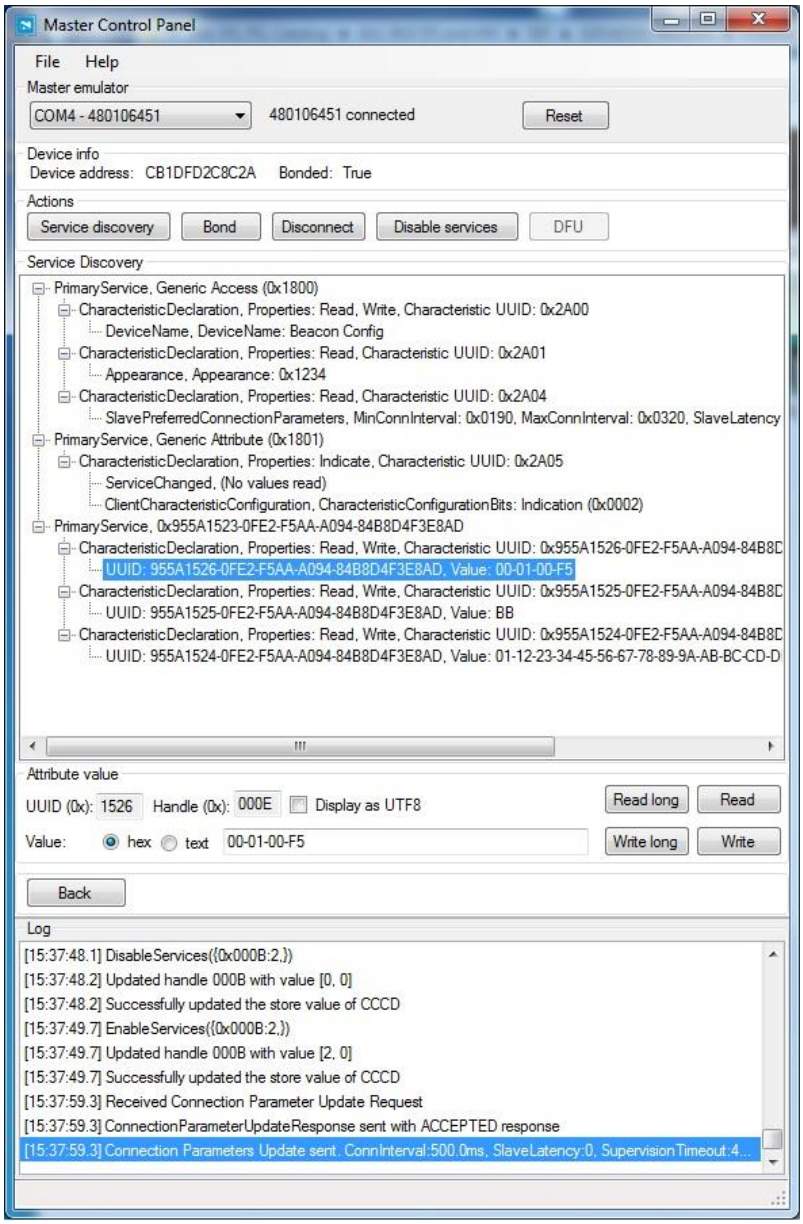
6. Click Select Device.



4.

6.

7. On the following display, click successively on Bond, Service Discovery and Enable Services.



8. You can note data that transit between the ISP140501 and the Master Emulator via the Bluetooth link.

9. To switch off ISP140501, remove the CR2450 battery.

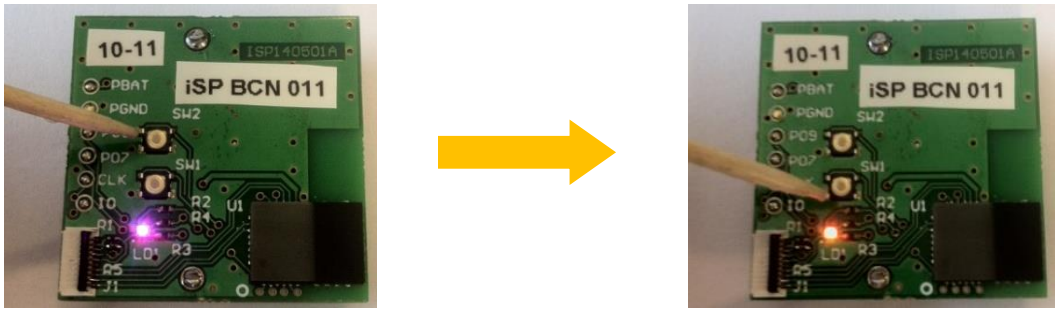
2. Demonstration with Android Device (4.3 & higher)

The free beacon application developed by Nordic Semiconductor is available on the Play Store. Make sure the Bluetooth is activated on your device (go to wireless device settings).

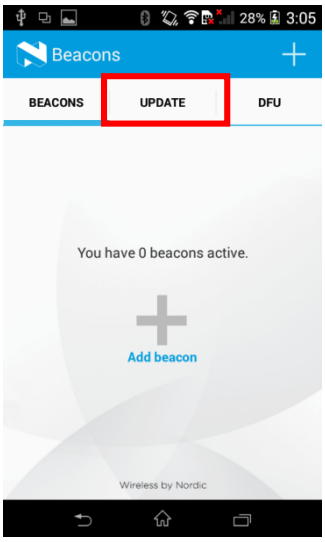
Download and install the *nRF Beacon* app on the Play Store. You should see the following screen on your device.

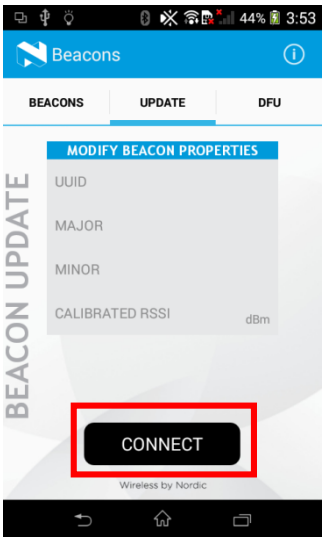
Then you will be able to set up the application demonstration as follows:

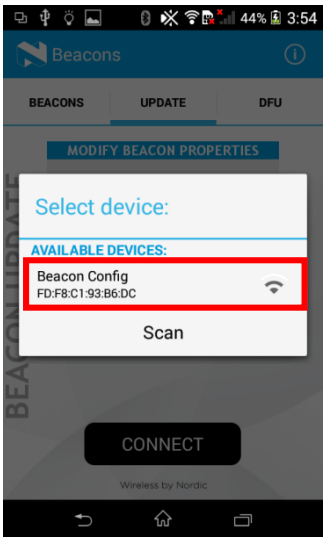
1. Place the CR2450 battery into the Beacon ISP140501.
2. Start nRF Beacon application on your iPhone or on your android device, click Update and Connect.
3. On the beacon, push the switch SW2 to pair with the device (the led become orange).



4. Select your Beacon (name Beacon Config).

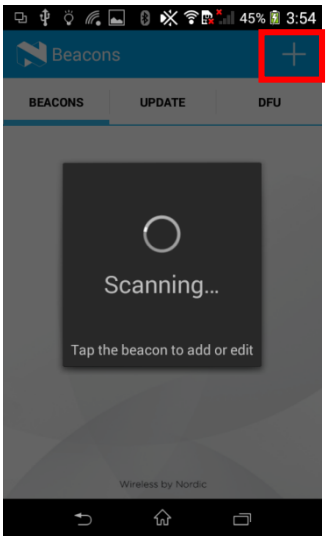


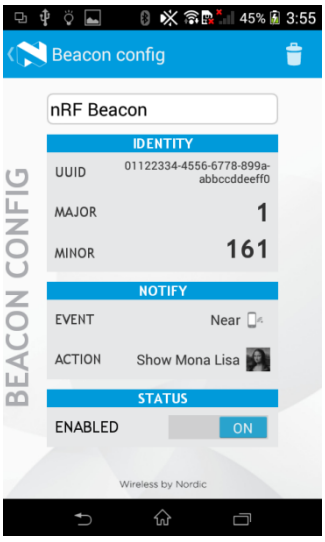




5. Click '+' to add Beacon.
6. Wait until Beacon led turns back to purple.

7. Your beacon is successfully added, you can modify the parameters of the beacon in the configuration option (change the name, the major and minor values, the notification …).





8. Go to Beacons windows and see the notification about the Beacon detection on your device.

9. To switch off ISP140501 Beacon, remove battery.

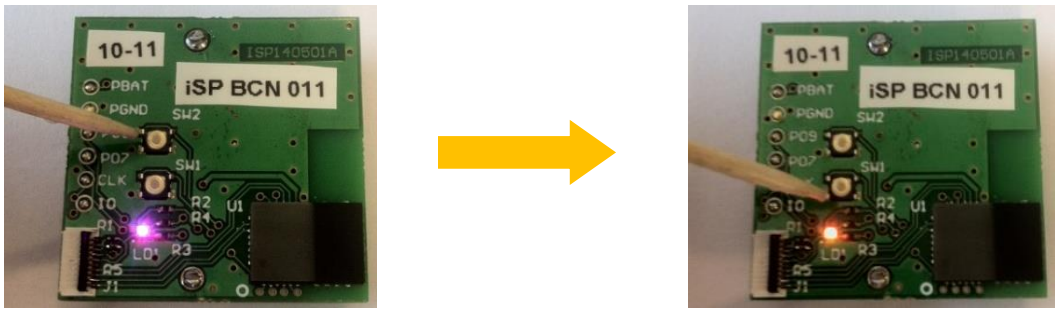
3. Demonstration with iPhone Device (4S & higher)

The free beacon application developed by Nordic Semiconductor is available on the App Store. Make sure the Bluetooth is activated on your device (go to wireless device settings).

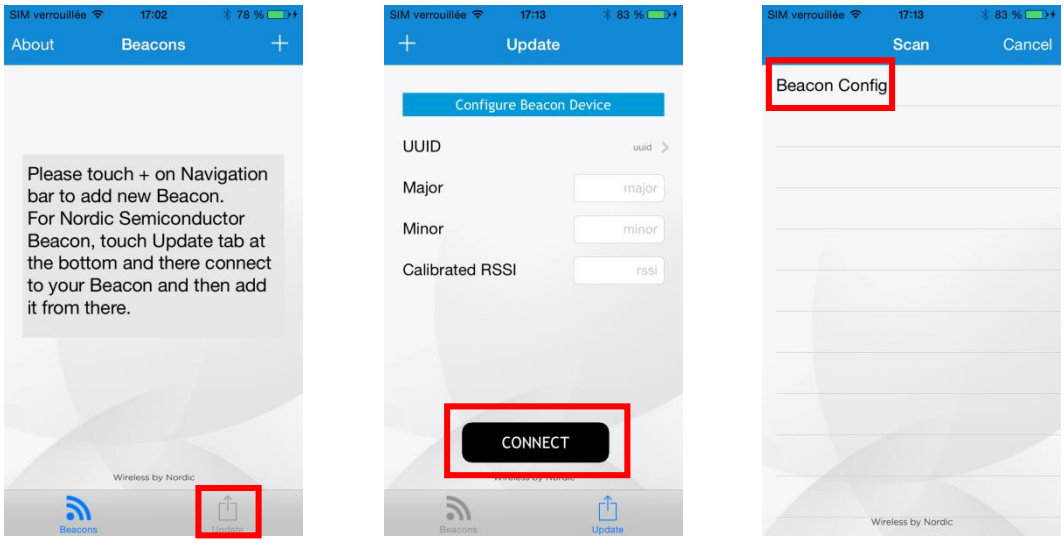
Download and install the *nRF Beacons* app on the App Store. You should see the following screen on your device.

Then you will be able to set up the application demonstration as follows:

1. Place the CR2450 battery into the Beacon ISP140501.
2. Start nRF Beacon application on your iPhone or on your android device, click Update and Connect.
3. On the beacon, push the switch SW2 to pair with the device (the led become orange).

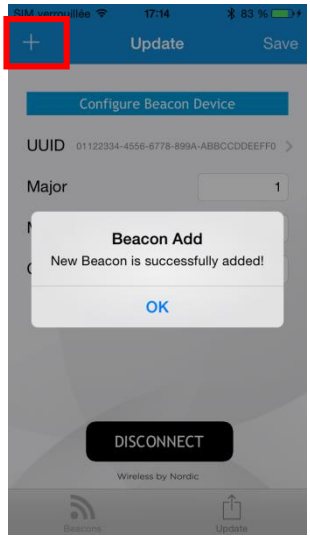


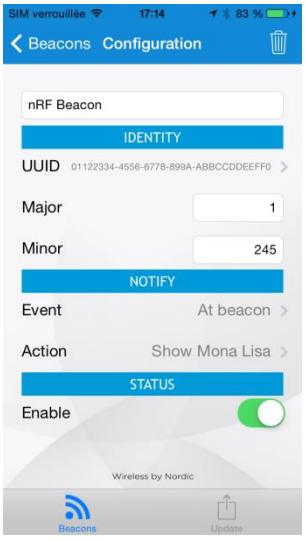
4. Select your Beacon (name Beacon Config).

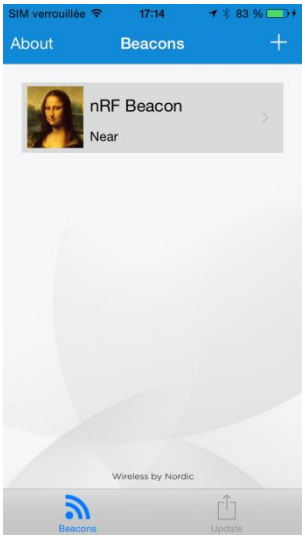


5. Click '+' to add Beacon.
6. Wait until Beacon led turns back to purple.

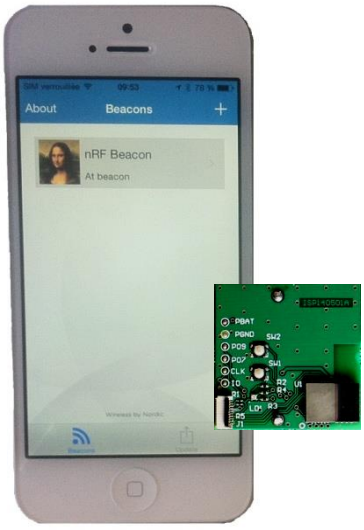
7. Your beacon is successfully added, you can modify the parameters of the beacon in the configuration option (change the name, the major and minor values, the notification …).



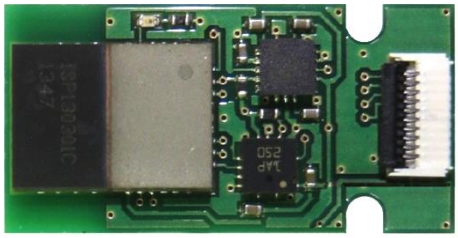




8. Go to Beacons windows and see the notification about the Beacon detection on your device.



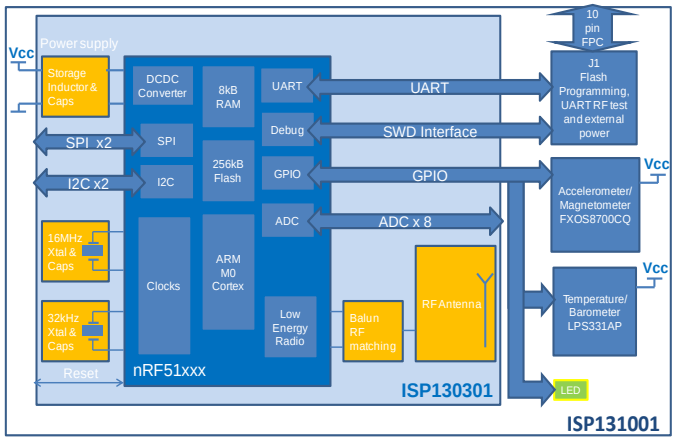
To switch off ISP140501 Beacon, remove battery.



ISP131001
Bluetooth Low Energy Wireless Accelero-Magnetometer, Temperature and Barometer Detection Sensor

Key Features

- Single Mode BLE v4.0 Slave or Master
- Proprietary 2.4 GHz protocols
- Based on Nordic Semiconductor nRF51 family
- 2.4GHz low energy RF Transceiver
- 32bit ARM Cortex M0 CPU with 256kB Flash
- Analog and Digital peripherals
- Ultra Low Power Consumption
- Single 2.1 to 3.6 V supply
- Overall Size 12.5 x 25 x 3 mm
- Temperature -25 to 75 °C
- Fully integrated RF matching and Antenna
- Integrated 16 MHz and 32.768 kHz Clocks
- Coin cell battery CR2032
- Low Power 3-Axis Accelerometer Detection
- Low Power Temperature/Barometer Detection
- Programmable controlled mini LED
- Certified CE, FCC, IC and TELEC



Applications

- Sport and fitness sensors
- Health care sensors
- Industrial sensors
- Gaming sensors
- Motion detection and transmission

General Description

ISP131001 is an autonomous low-power device for wireless acceleration, temperature and barometer detection and transmission. The complete device makes use of Insight SiP ISP130301 BLE module together with low power 3-axis accelerometer and temperature/barometer sensors connected to a primary button cell battery CR2032. Overall size of the device is 12.5 x 25 x 3 mm.

The host processor that handles the autonomous sensor application, the high level portion of the BLE protocol stack and communication with the sensors is a low power 32-bit MCU (ARM Cortex-M0 based), integrating 256 kB flash memory.

The Freescale FXOS8700CQ 3-axis linear accelerometer and 3-axis magnetometer is used to detect acceleration and is combined with ST Micro LPS331AP temperature and barometer sensor. A Rohm SML-P11MTT86 mini-LED is also part of the board and is available to be controlled by software. Data are transmitted via GPIO processor port. Data sampling rate is set to 50 samples/second.

A development kit ISP130301-DK1 is available from Insight SIP and allows for easy flash programming application processor via the 10 pin removable FPC connector. During firmware modification and debug, the ISP131001 device may be supplied via the DC voltage from the development kit interface board. The ISP131001 sensor can be reprogram on the air with the bootloader interface.

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

Contents

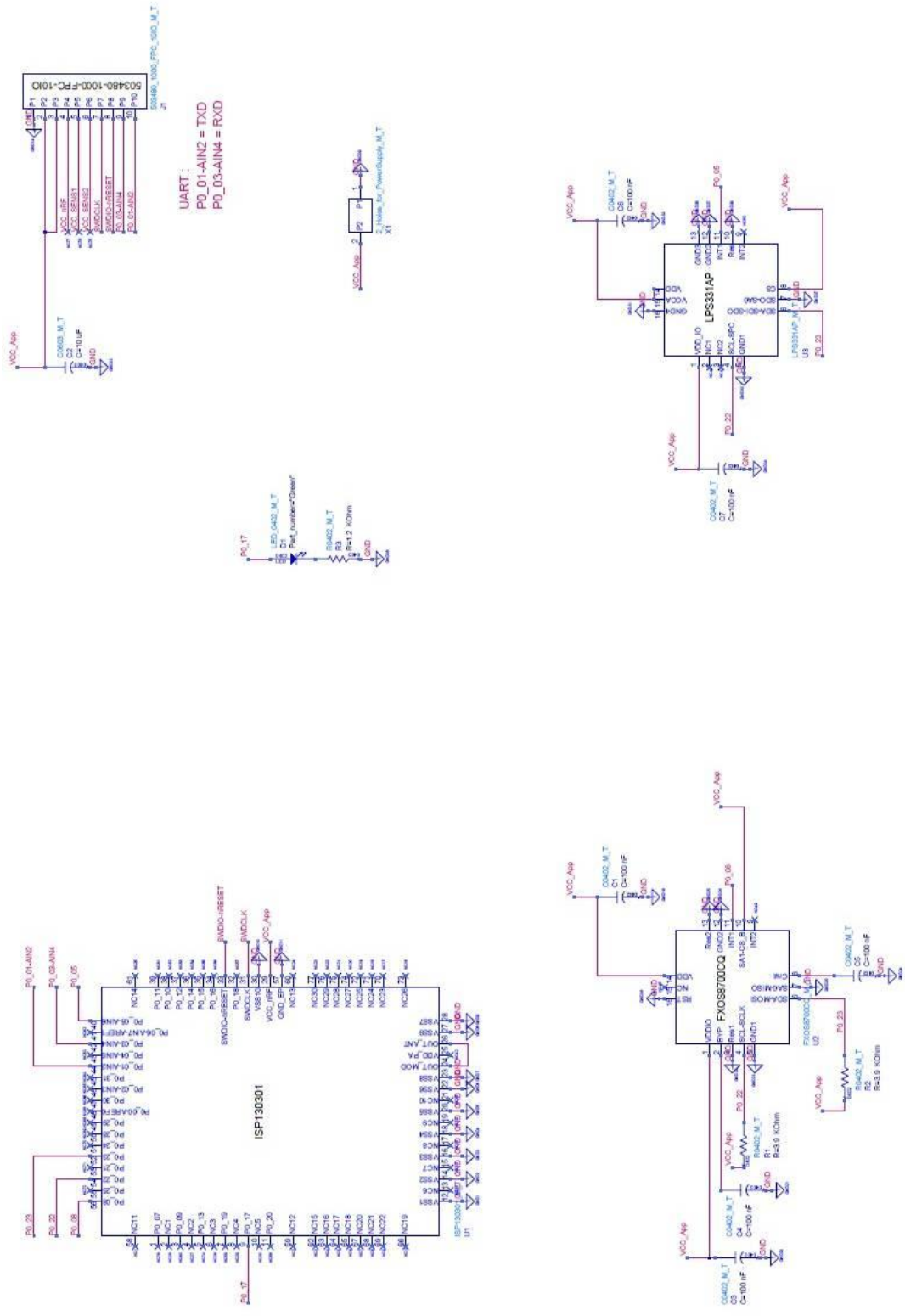
1. Electrical Specifications

Sensor Performance

The performance of the motion sensor is that obtained by the Freescale FXOS8700CQ. Key characteristics are shown below.

Parameter	Value	Unit
Number of axes	6	
Acceleration range	±2g / ±4g / ±8g	g (9.81m/s²)
Magnetic measurement range	±1200 µT	g (9.81m/s²)
Number of bits for full range for each axis (accelerometer)	14	bits
Number of bits for full range for each axis (magnetometer)	16	bits
Data sampling rate (FIFO for acceleration only)	32	samples

Electrical Schematic



2. RF Performances

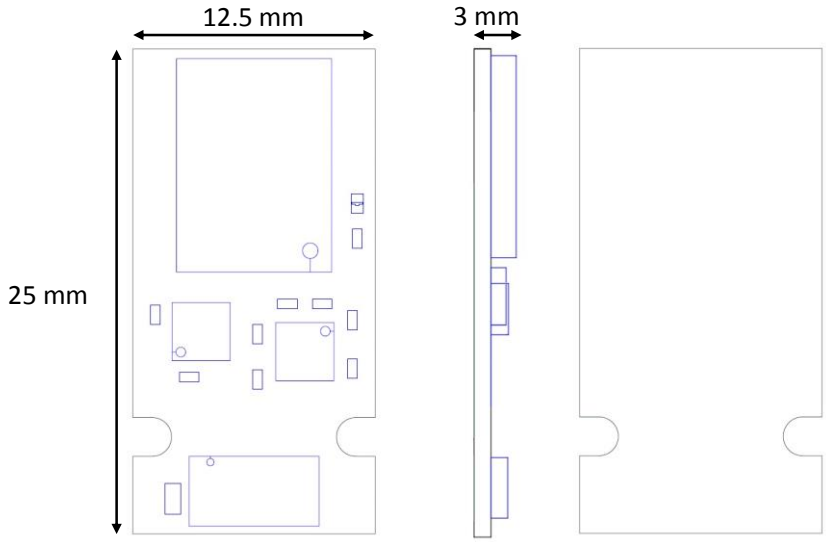
RF Specifications according to standards

The performance of the Bluetooth Low Energy Radio link is that obtained by the ISP130301 module.
Temperature range -25°C to +75°C.

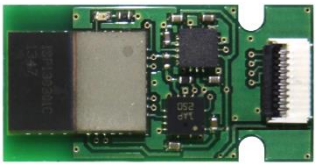
Parameter	Value	BT V4 Std limit	Unit	Condition
Output Power	-20 to +4	-20 to 10	dBm	Channels 0 to 39
RF Frequency tolerance	Better than +/-20	+/- 50	Hz	Channels 0 to 39
Rx sensitivity	-93	-70	dBm	Level for BER <0,1% ideal Tx
Max range	> 200		m	Open field @1m height
EIRP	4.6		dBm	
Antenna Gain	0.6		dBi	
Rx sensitivity	51.4		dBµV/m	

3. Mechanical Outlines

Dimensional drawing



AN140802
Accelero-Magnetometer, Temperature and Barometer Sensor Demonstration



Introduction

This application note describes how to set up a Sensor application with ISP131001 Sensors Board that will send data via the Bluetooth link to the Master Emulator or to an Apple Device.

Two types of demonstration are presented.

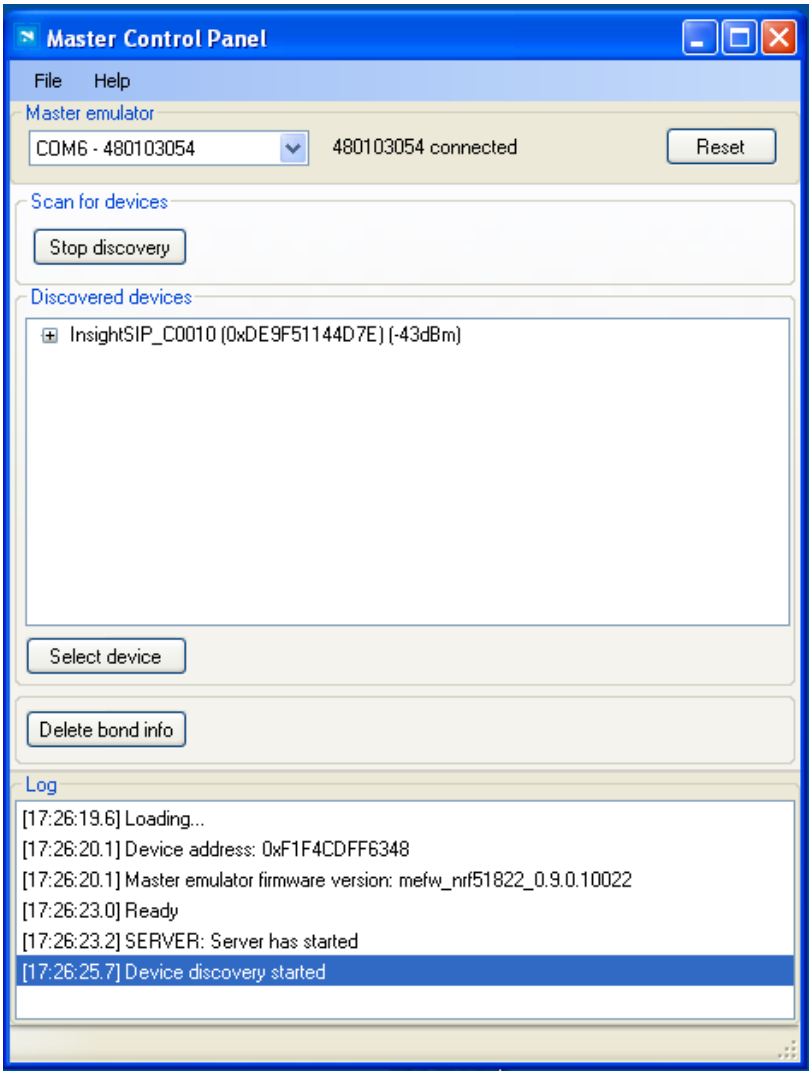
The first one is directly executable with hardware and software provided in the Development Kit using Master Control Panel application.

The second demonstration requires the use of an iPhone or an iPad. The iOS application is available on demand only as an App that can be installed for development purposes via the Apple developer program. The procedure to obtain the App from Insight SiP and demonstration of the Sensor application with Apple Device is described hereafter.

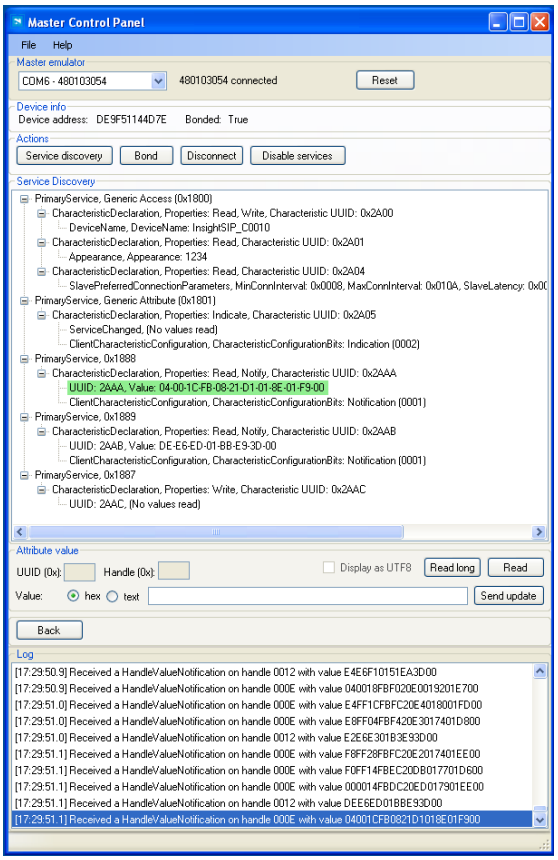
Contents

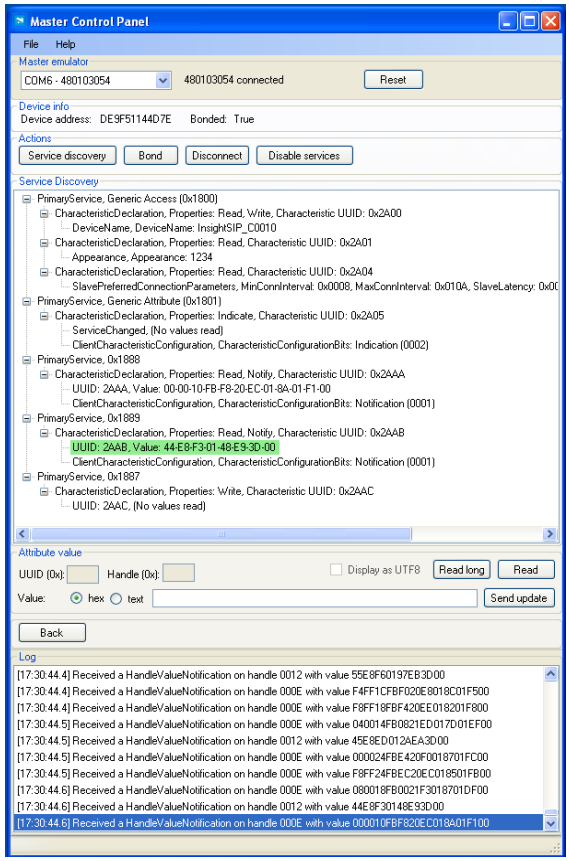
1. Demonstration with Master Control Panel

1. Place the CR2032 lithium battery into the battery holder.
2. Connect the battery holder to the Sensors Board ISP131001.
3. Connect Development Dongle PCA10000 (Master Emulator) into a USB port on your computer.
4. Start Master Control Panel.
5. Click Start Discovery.



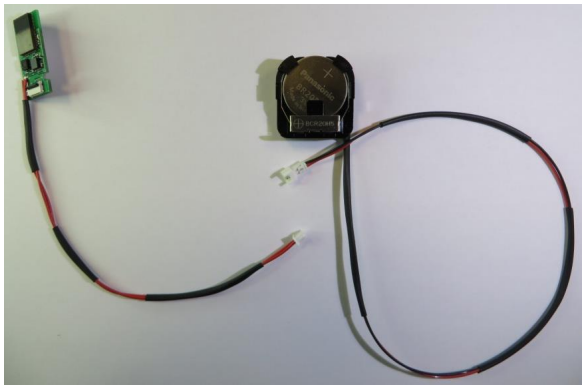
6. Click Select Device.
7. On the following display, click successively on Bond, Service Discovery and Enable Services.





8. You can note data that transit between the ISP131001 Sensors Board and the Master Emulator via the Bluetooth link:
   - Data of the accelerometer/magnetometer on the above left figure
   - Data of the temperature/pressure on the above right figure

9. To switch off ISP131001 Sensors Board, disconnect battery holder as seen in the figure below.



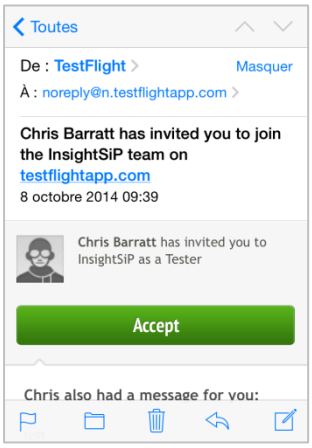
2. Demonstration with iPhone or iPad Device

The Sensor application is available on demand from Insight SiP. The iOS App is a demonstration App that is provided "as is" in order to demonstrate the Smart Bluetooth sensor node. Only one iPhone or iPad is allowed per development kit.

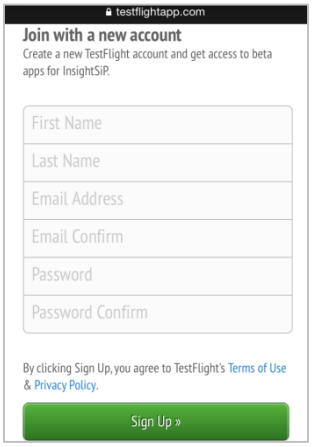
Make sure you iOS device is compatible with Bluetooth 4.0 (iPhone 4S or higher, iPad Air, Mini, 3rd generation and above).

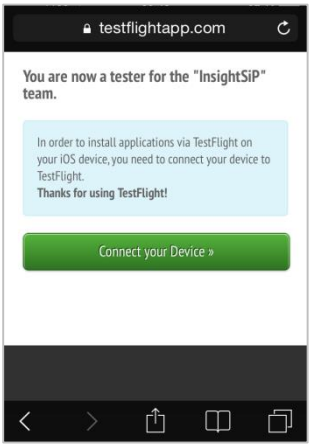
The installation procedure for the Sensor application is described hereafter:

1. Contact Insight SiP at contact@insightsip.com and communicate the kit number and the product key notified on the dev kit.
2. We will send you by email an invitation 24h-48h after. Accept it using your iOS device you want to use for the demo.

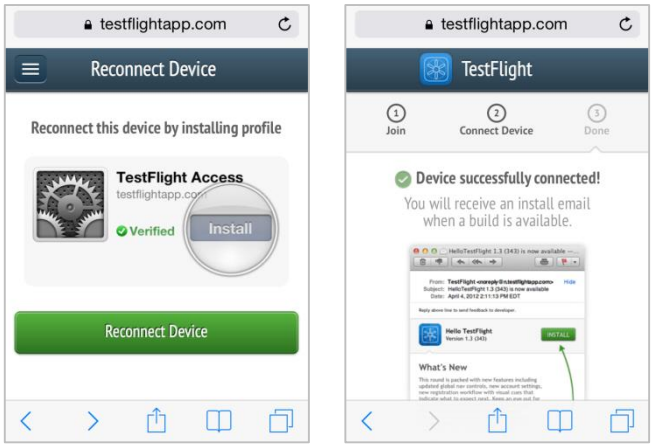


3. Sign up in order to register to TestFlight app

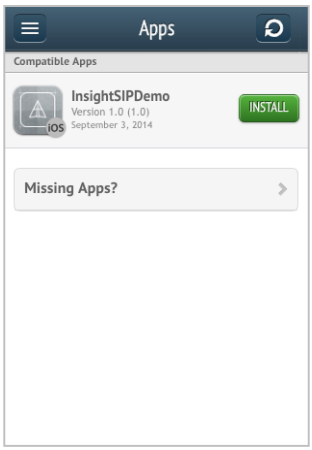




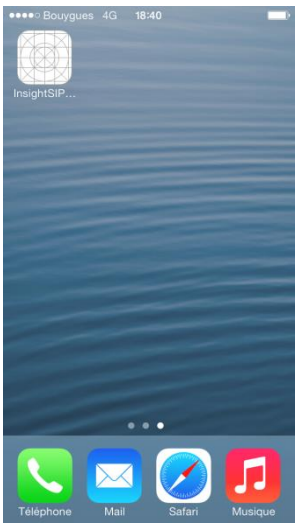
4. Connect your device. It will create a TestFlight icon on your device.



5. Once you receive an install email of available build, open again your TestFlight app from your device. It can take additional 24-48 hours to receive this email.
6. Click on "*View All Apps"* and then click on *"Install".*

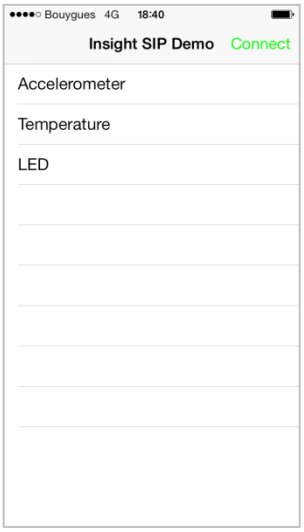


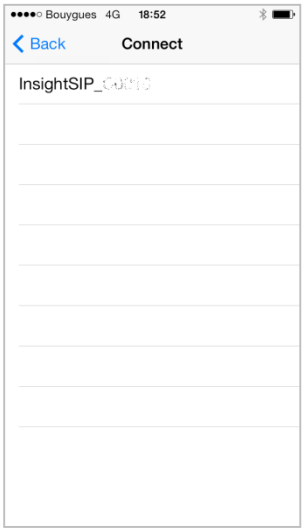
7. The InsightSiPDemo application is downloaded and installed. You should see the following screen on your iOS device.



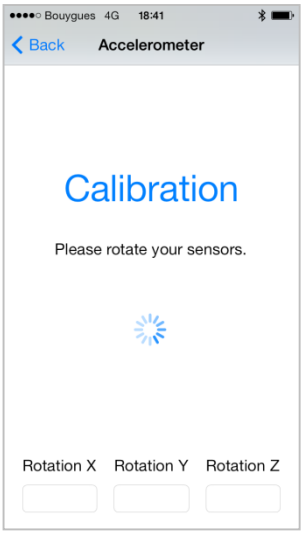
Then you will be able to set up the application demonstration as follows:

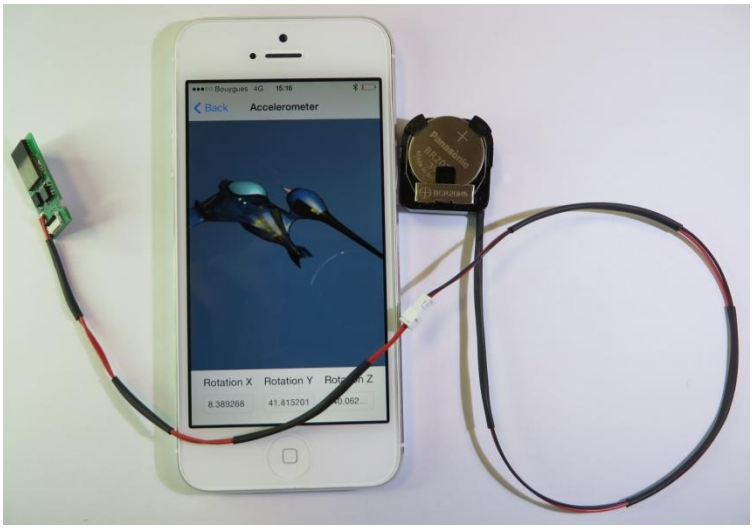
8. Place the CR2032 lithium battery into the battery holder.
9. Connect the battery holder to the Sensors Board ISP131001.
10. Start InsightSiPDemo application on your iOS, click Connect and select your Sensors Board (name is InsightSiP_xxxxx).



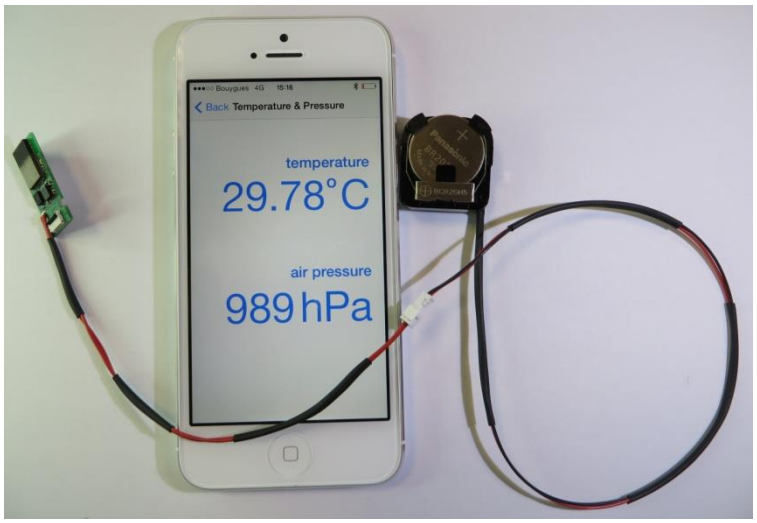


11. Click Accelerometer. A Calibration phase invites you to rotate the ISP131001 Sensors Board. Then, a starship on your iPhone screen follows the Sensors board movement.

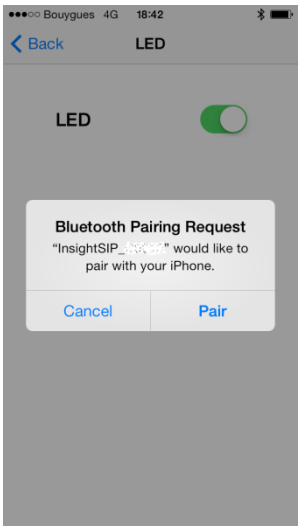


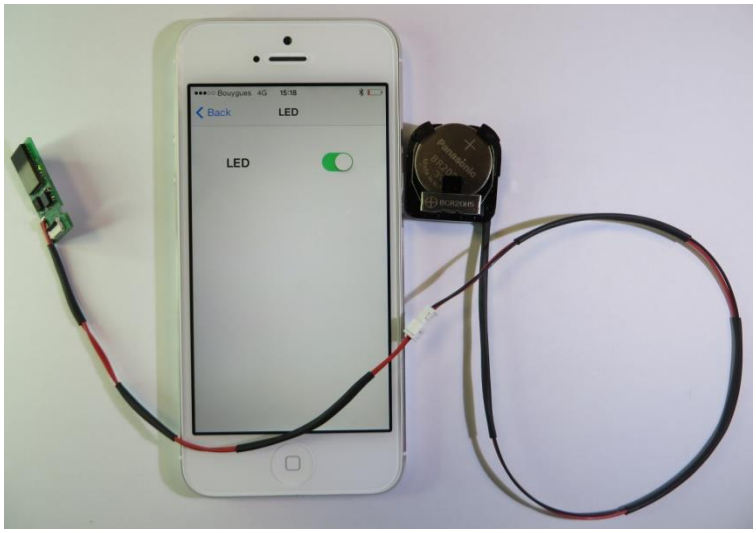


12. Click Back and Temperature to start temperature and pressure demonstration.

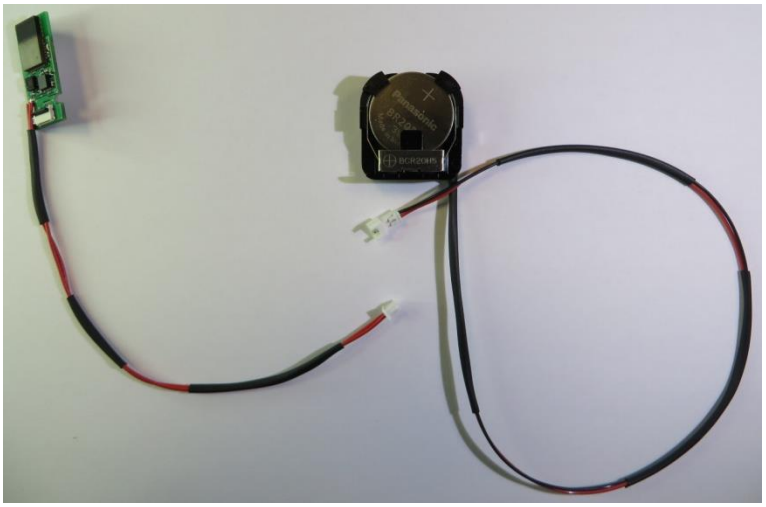


13. Click Back and LED. A prompt will invite you to pair the Sensors Board with the iPhone. Click Pair. The LED lights up.

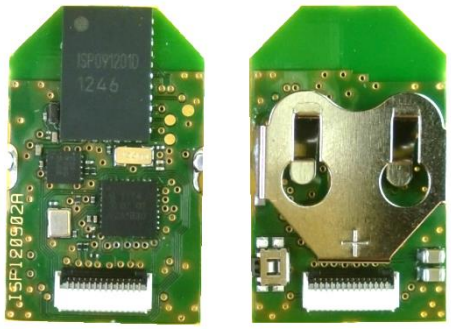




14. To switch off ISP131001 Sensors Board, disconnect battery holder as seen in the figure below.

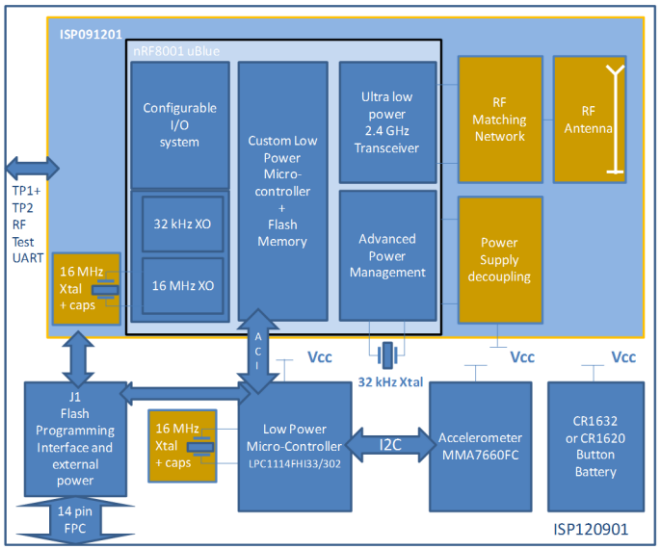


ISP120901
Bluetooth Low Energy Wireless Orientation/Motion Detection Sensor



Key Features

- Single Mode BLE v4.0 Slave Module
- Based on Nordic Semiconductor µBlue family
- Includes transceiver, baseband, software stack
- Fully integrated RF matching and Antenna
- Integrated 16 MHz Crystal Clock
- Ultra Low Power Consumption
  Coin cell battery CR1632 or CR1620
- Low Power 3-Axis Orientation/Motion Detection
- Ultra Low Power Application Processor
- 16 MHz Crystal Clock for Application Processor
- 32.768 kHz Crystal for BLE Protocol Sync.
- Overall Size 18 x 29 x 6 mm
- Temperature -40 to 85 °C



Applications

- Sport and fitness sensors
- Health care sensors
- Out of Range (OOR) sensors
- Gaming sensors : Motion detection and transmission

General Description

ISP120901 is an autonomous low-power device for wireless orientation/motion detection and transmission. The complete device makes use of Insight SiP ISP091201 BLE module together with low power host processor, 3-axis orientation/ motion sensor and small primary button cell battery CR1632 or lower capacity CR1620. Overall size of the device is 18x29x6 mm.

The host processor that handles the autonomous sensor application, the high level portion of the BLE protocol stack and communication with the 3-axis sensor is a low power 32-bit MCU (ARM Cortex-M0 based), the NXP LPC1114FHI33/302, integrating 56kB flash memory and 8kB SRAM.

The Freescale MMA7660FC, a 3-axis orientation/ motion detection sensor is used to detect acceleration and orientation transmitted via the I2C bus. The MMA7660FC has an auto-Wake/ Sleep feature for low power consumption. Data sampling rate is configurable from 1 to 120 samples/second. The MMA7660FC has orientation detection and gesture detection capabilities.

An interface board, ISP120907 is available from Insight SIP and allows for easy flash programming the LPC1114FHI33/302 application processor via the 14 pin FPC connector. During firmware modification and debug, the ISP120901 device may be supplied via the DC voltage from the ISP120907 interface board. An optional UART interface (TP1+TP2) with direct connection to the nRF8001 uBlue is available for Bluetooth Low Energy radio testing as specified by the Bluetooth standard.

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

Contents

1. Electrical Specifications

Current Consumption

The measured total average current consumption and autonomy of the ISP120901 orientation/motion sensor node supplied by a CR1632 battery for several connection intervals is shown below.

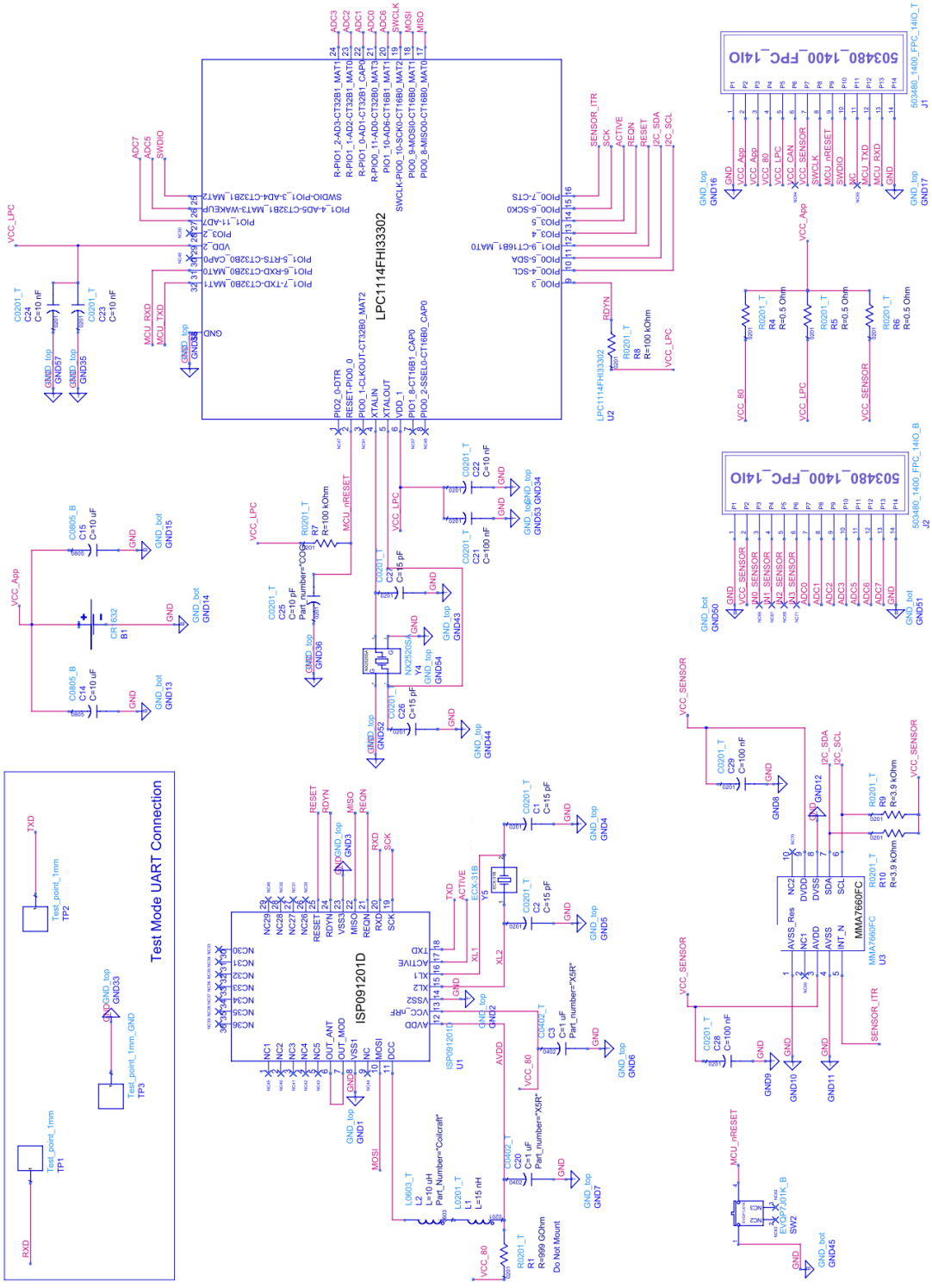
Connection Interval (ms)	Average Current Consumption (µA)	Autonomy (year)
1000	63.6	0.25
2000	36.0	0.44
3000	26.9	0.60
4000	22.3	0.72

Sensor Performance

The performance of the motion sensor is that obtained by the Freescale MMA7660FC. Key characteristics are shown below.

Parameter	Value	Unit
Number of axes	3	
Acceleration range	+/- 1.5	g (9.81m/s²)
Number of bits for full range for each axis	6	bits
Data sampling rate (each sample is 3 axis acceleration data)	1 to 120	samples/s

Electrical Schematic



2. RF Performances

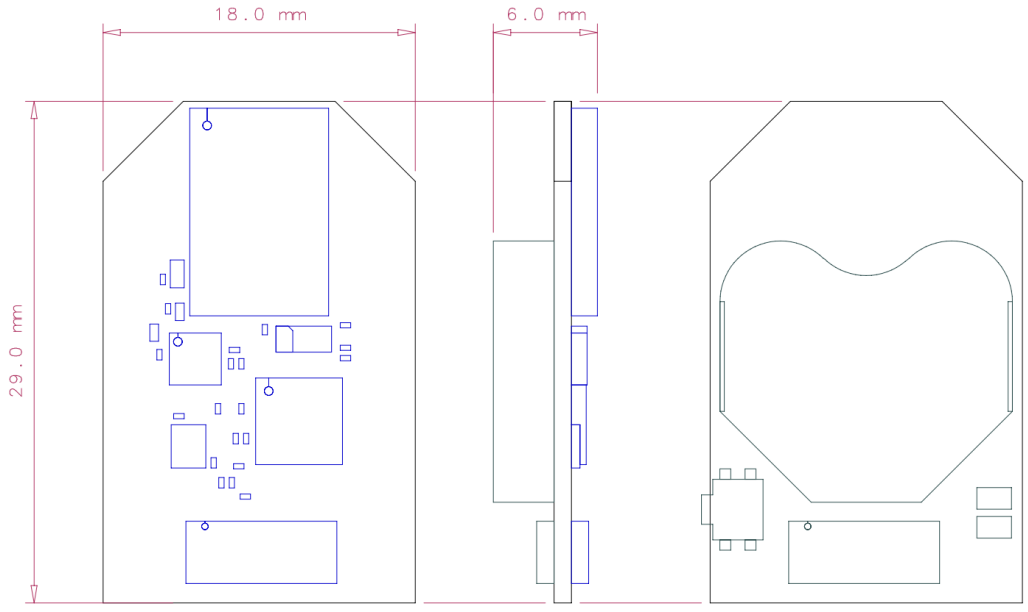
RF Specifications according to standards

The performance of the Bluetooth Low Energy Radio link is that obtained by the ISP091201 module.
Temperature range -40°C to +85°C.

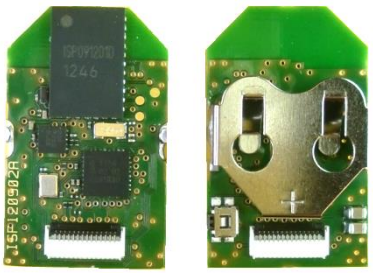
Parameter	Value	BT V4 Std limit	Unit	Condition
Output Power	-0.9	-20 to 10	dBm	Channels 0 to 39
RF Frequency tolerance	Better than +/-20	+/- 50	Hz	Channel 0 to 39
Rx sensitivity	-87	-70	dBm	Level for BER <0,1% ideal Tx
Max range	> 20		m	Open field at 1m height
EIRP	0.3		dBm	
Antenna Gain	1.2		dBi	
Rx sensitivity	56.8		dBµV/m	

3. Mechanical Outlines

Dimensional drawing



AN130402
Orientation / Motion Sensor Demonstration



Introduction

This application note describes the PC software setup to use the ISP120901 accelerometer demonstration program. The demonstration requires a ISP120901 accelerometer with a 1632 battery, a Windows PC running XP, Vista or Windows 7, a Nordic Semiconductor Master Emulator nRF2739 (delivered with uBlue SDK) and appropriate software from Insight SiP.

The note describes the software installation procedure and the operating mode.

Software Installation

In order for the demonstration to operate the following software packages need to be installed on the PC:

- Microsoft .NET framework 4
- Microsoft XNA Framework Redistribuable 4.0
- Nordic Semiconductor nRF8001 SDK v1.7 (for Master Emulator USB drivers)
- Accelerometer Demo folder from Insight SIP with executable file and dll files

Microsoft .NET framework 4 Re-distribuable package

This can be downloaded from Microsoft at the following address http://www.microsoft.com/en-us/download/details.aspx?id=17718. To install this package follow the instructions on the Microsoft website.

Microsoft XNA Framework Re-distribuable 4.0

This can be downloaded from Microsoft at the following address http://www.microsoft.com/en-us/download/details.aspx?id=20914. To install this package follow the instructions on the Microsoft website. This is necessary since the visual representation of the orientation of the accelerometer uses Microsoft Game studio.

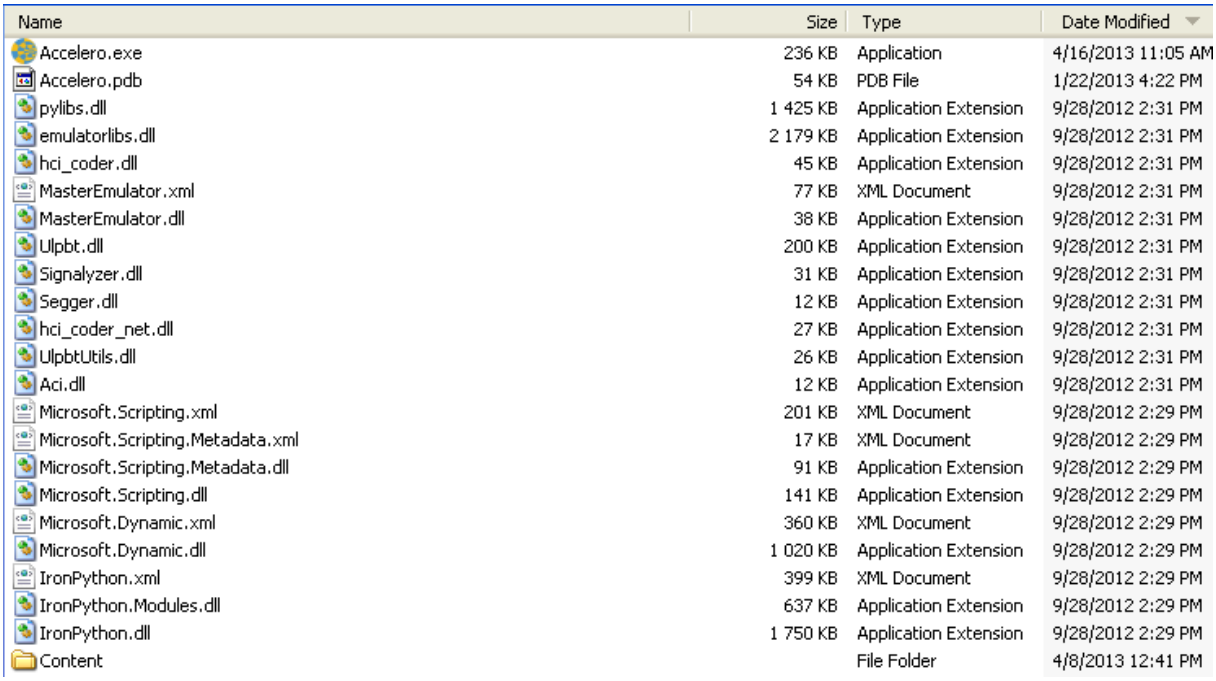
Nordic Semiconductor nRF8001 SDK v1.7

Run the nRF8001 SDK so as to be able to use the Master Emulator (USB drivers).

Accelerometer Demo Folder

The Accelero_Demo_EXE.zip file should be un zipped at any suitable location on the PC. This contains the executable file and all the dll files necessary for the demonstration to run.

The directory should be as shown below:



Name	Size	Type	Date Modified
Accelero.exe	236 KB	Application	4/16/2013 11:05 AM
Accelero.pdb	54 KB	PDB File	1/22/2013 4:22 PM
pylibs.dll	1 425 KB	Application Extension	9/28/2012 2:31 PM
emulatorlibs.dll	2 179 KB	Application Extension	9/28/2012 2:31 PM
hci_coder.dll	45 KB	Application Extension	9/28/2012 2:31 PM
MasterEmulator.xml	77 KB	XML Document	9/28/2012 2:31 PM
MasterEmulator.dll	38 KB	Application Extension	9/28/2012 2:31 PM
Ulpbt.dll	200 KB	Application Extension	9/28/2012 2:31 PM
Signalyzer.dll	31 KB	Application Extension	9/28/2012 2:31 PM
Segger.dll	12 KB	Application Extension	9/28/2012 2:31 PM
hci_coder_net.dll	27 KB	Application Extension	9/28/2012 2:31 PM
UlpbtUtils.dll	26 KB	Application Extension	9/28/2012 2:31 PM
Aci.dll	12 KB	Application Extension	9/28/2012 2:31 PM
Microsoft.Scripting.xml	201 KB	XML Document	9/28/2012 2:29 PM
Microsoft.Scripting.Metadata.xml	17 KB	XML Document	9/28/2012 2:29 PM
Microsoft.Scripting.Metadata.dll	91 KB	Application Extension	9/28/2012 2:29 PM
Microsoft.Scripting.dll	141 KB	Application Extension	9/28/2012 2:29 PM
Microsoft.Dynamic.xml	360 KB	XML Document	9/28/2012 2:29 PM
Microsoft.Dynamic.dll	1 020 KB	Application Extension	9/28/2012 2:29 PM
IronPython.xml	399 KB	XML Document	9/28/2012 2:29 PM
IronPython.Modules.dll	637 KB	Application Extension	9/28/2012 2:29 PM
IronPython.dll	1 750 KB	Application Extension	9/28/2012 2:29 PM
Content		File Folder	4/8/2013 12:41 PM

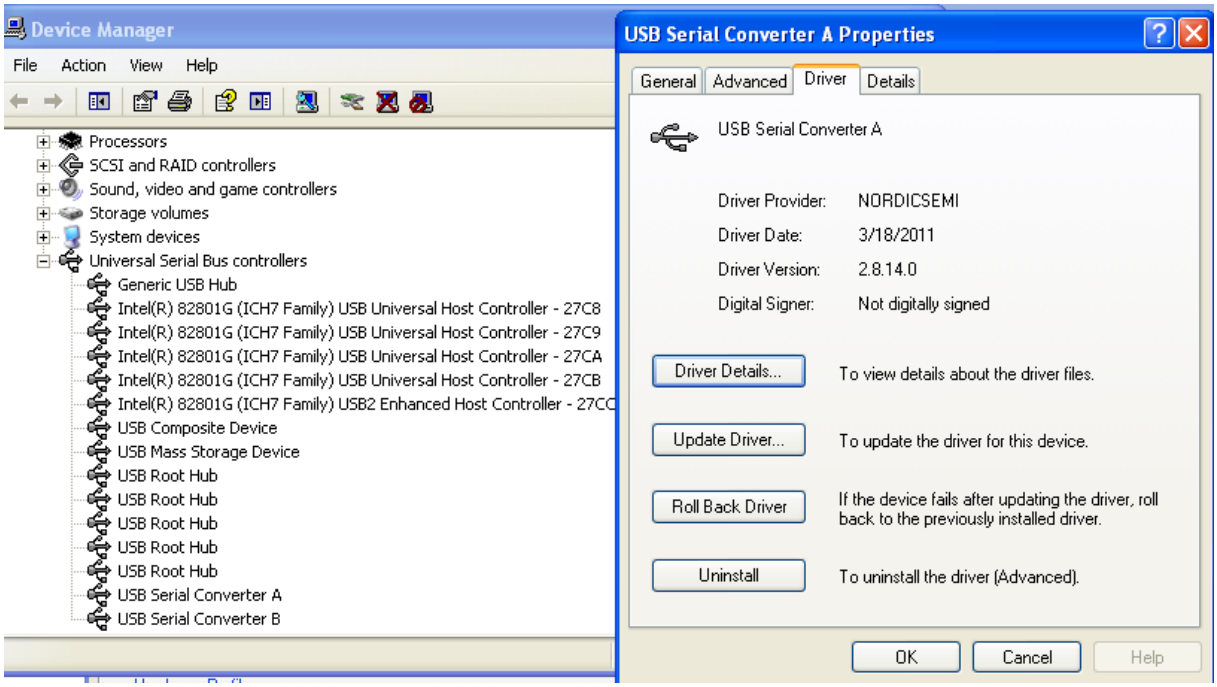
Hardware Setup

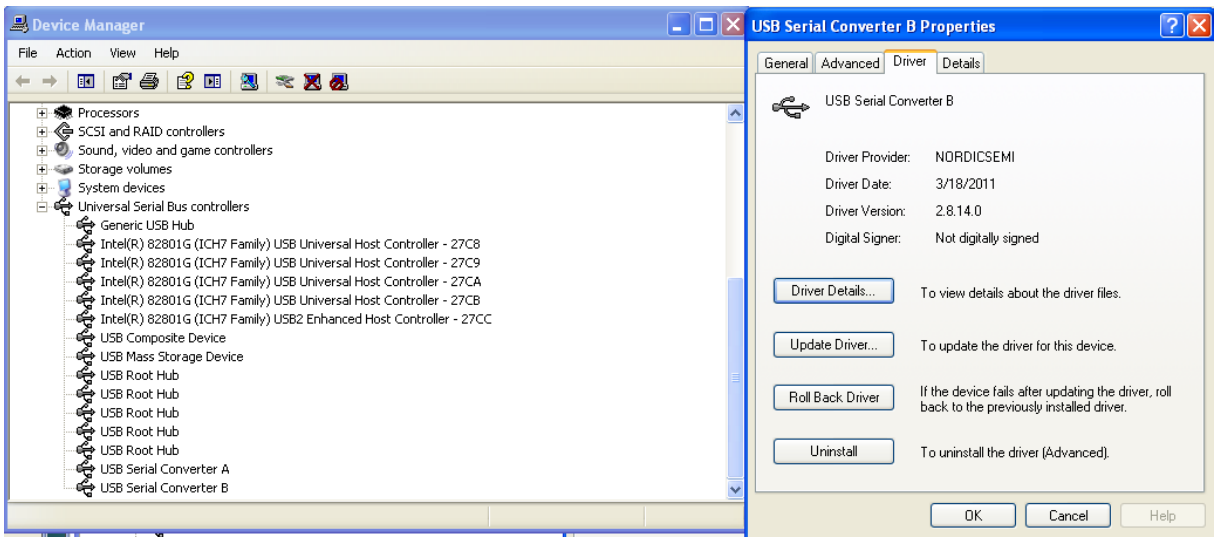
Master Emulator

Connect the nRF2739 Master Emulator to the PC and check to ensure that the USB drivers are correctly installed.

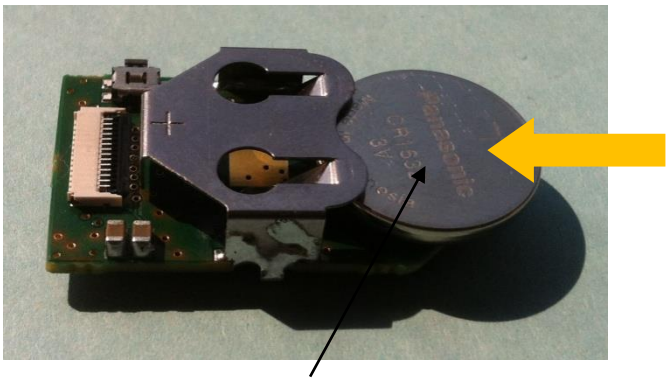
This can be checked on the Control Panel Device Manager under USB Controllers:
USB Serial Converter A
USB Serial Converter B

Should both be installed see below for details:

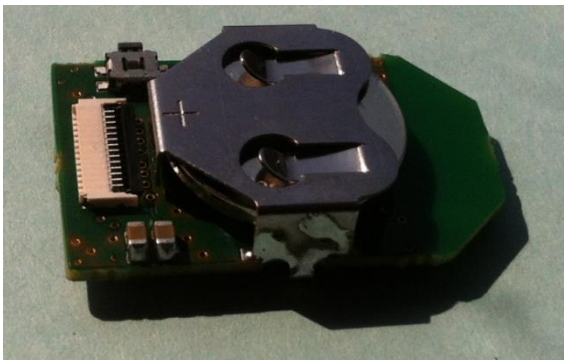




Connect Battery to ISP120901 Accelerometer as shown below:



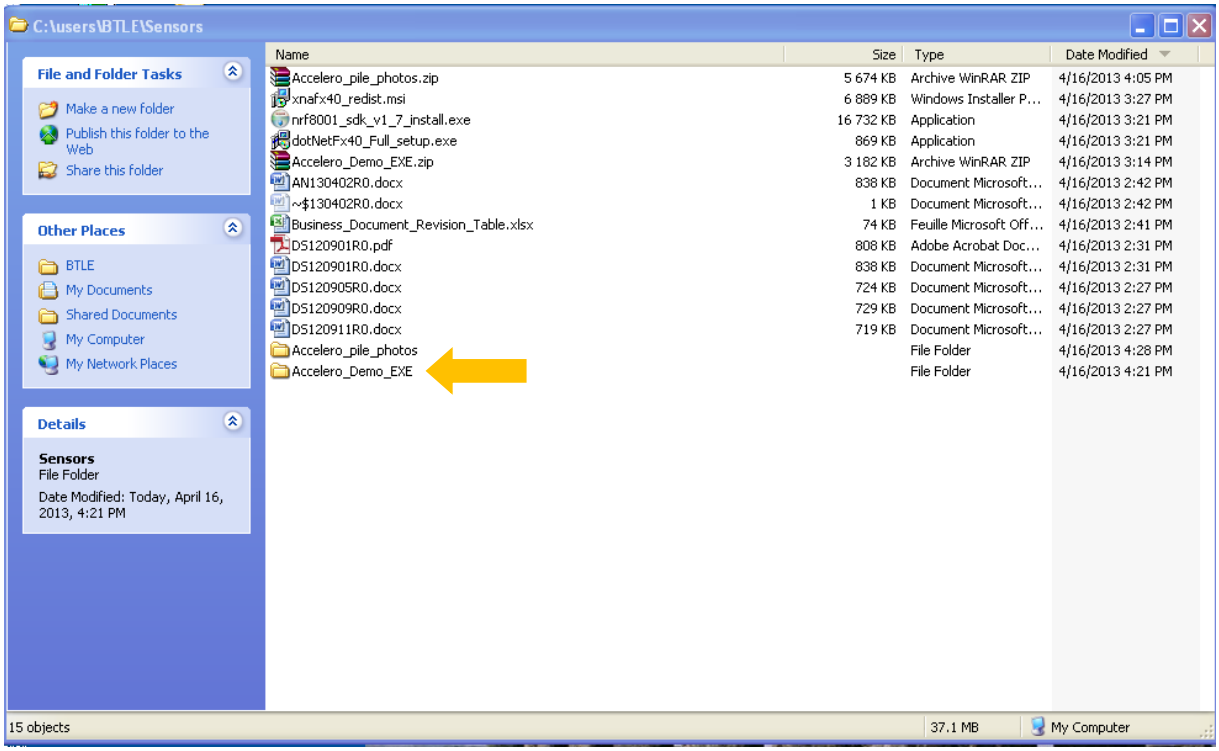
Battery CR1632 POS Terminal UP



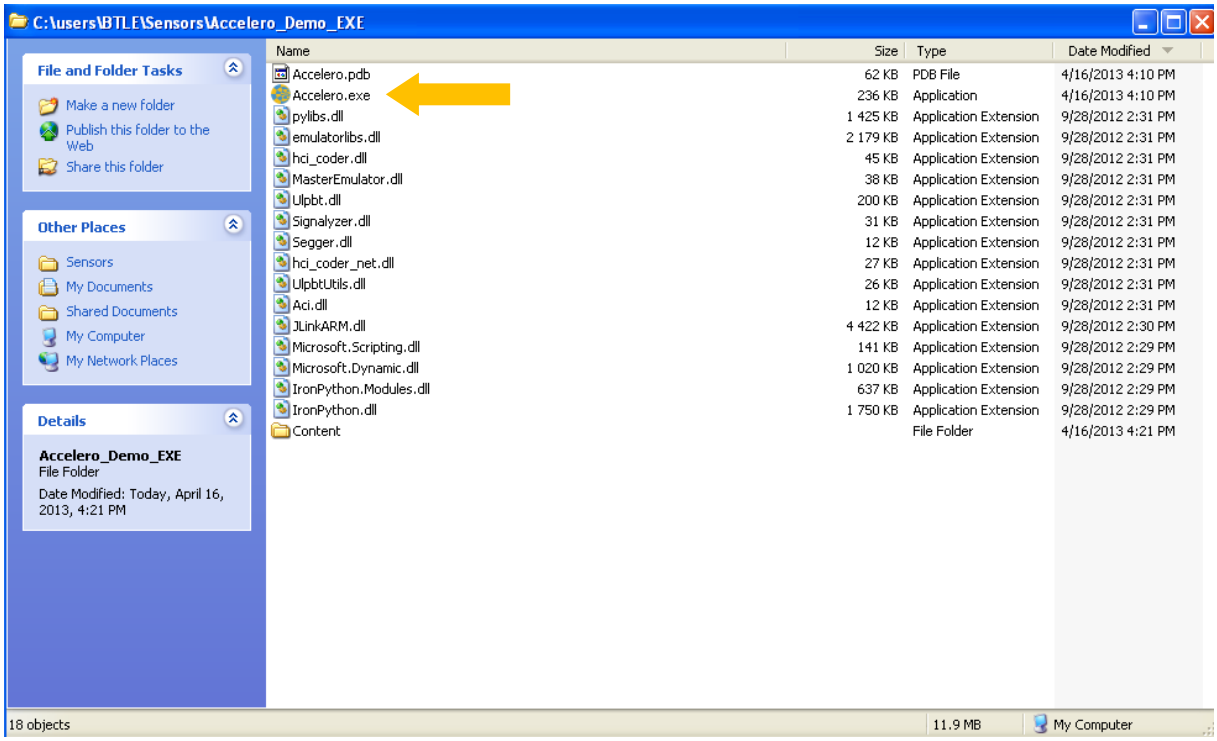
Battery CR1632 Fully Installed

Run Software

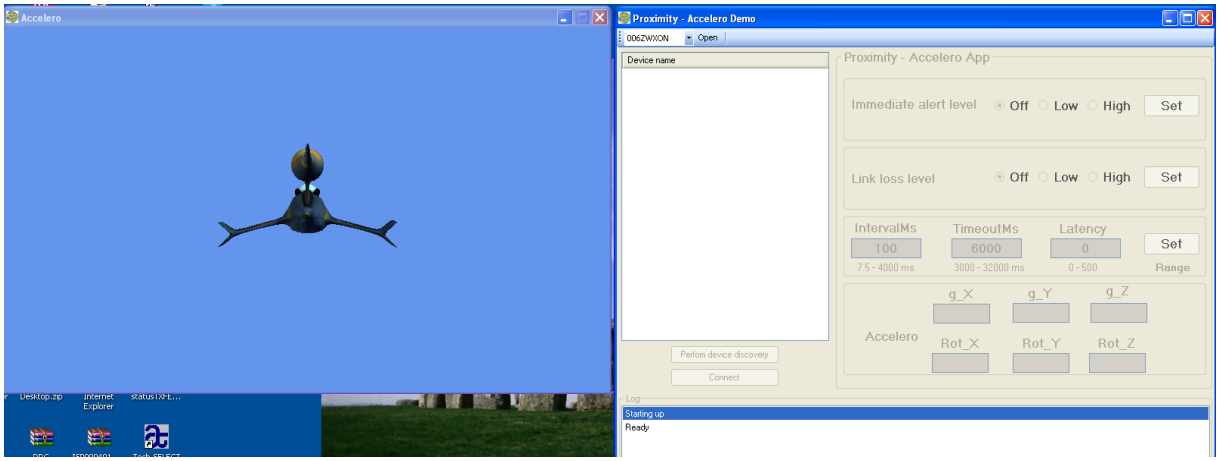
Navigate to the Accelero_Demo_EXE folder:



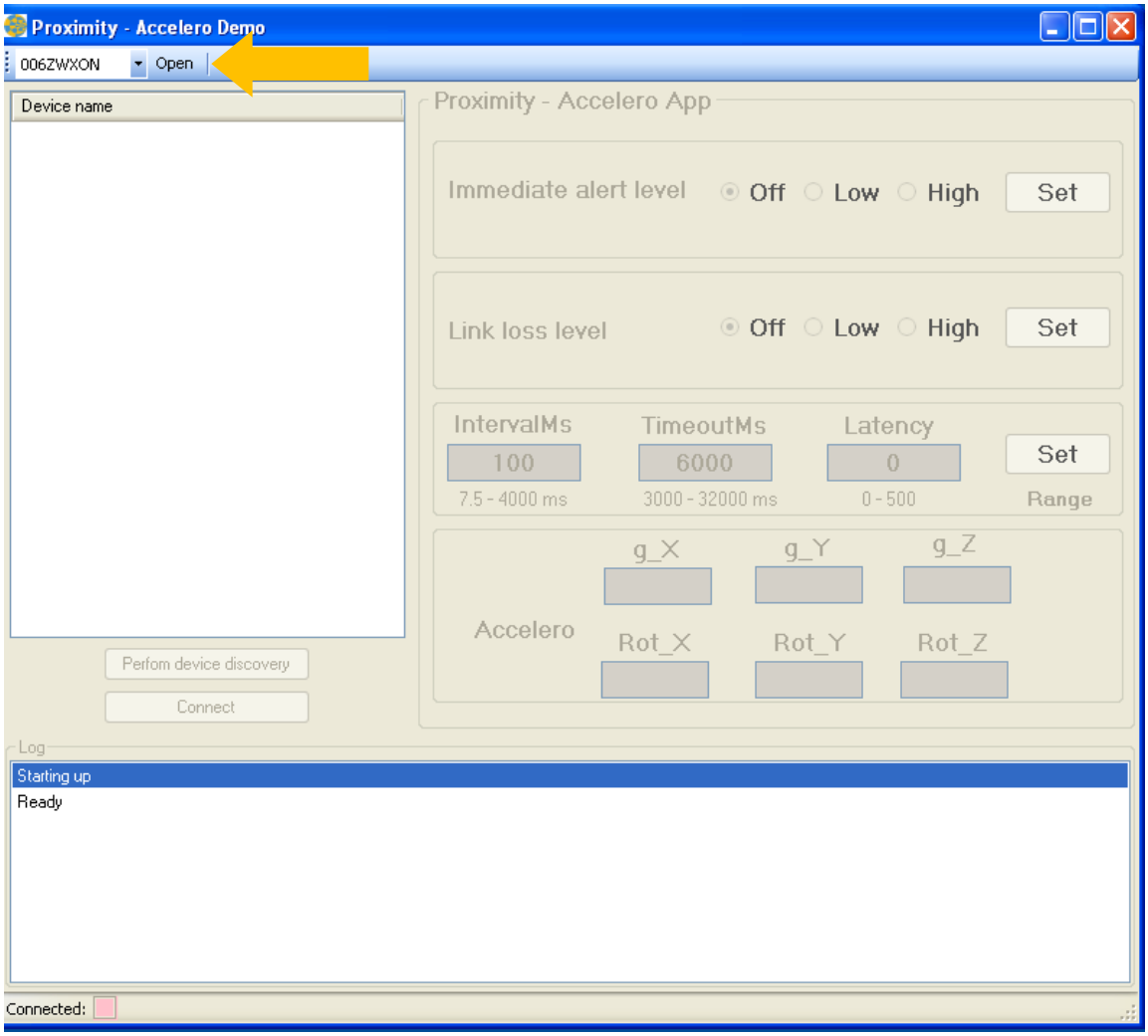
Launch Accelero.exe (on some systems you may need to launch using “run as administrator”)



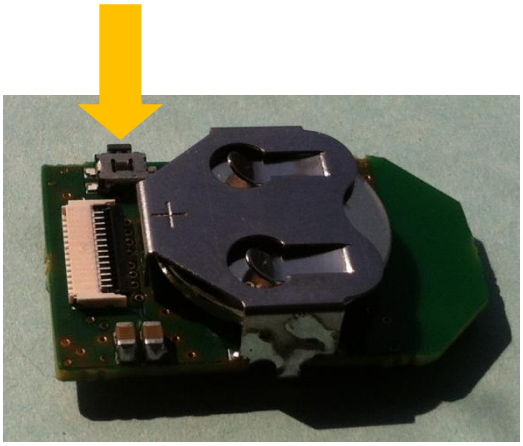
Two screens should open:



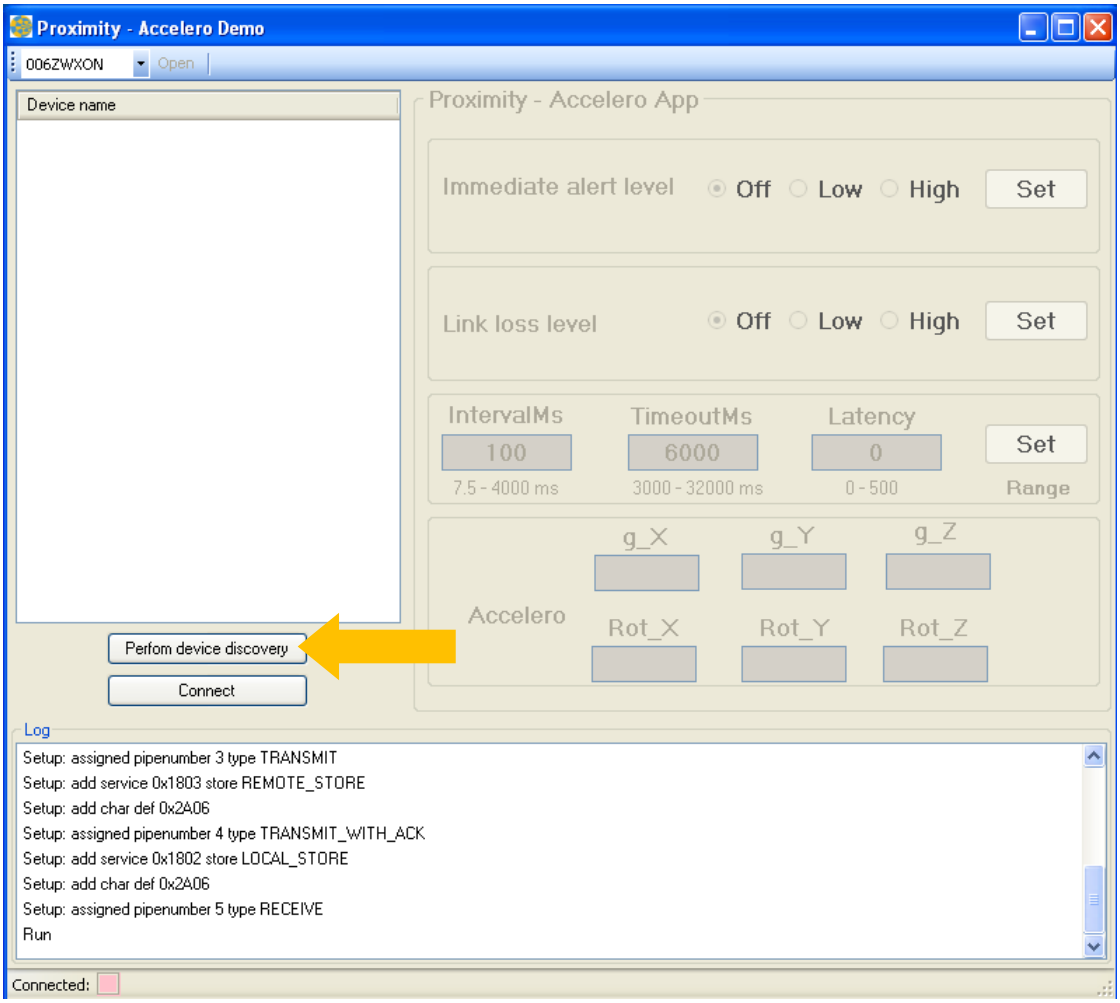
On the Right hand screen click on Open



Reset Accelerometer with small reset button:

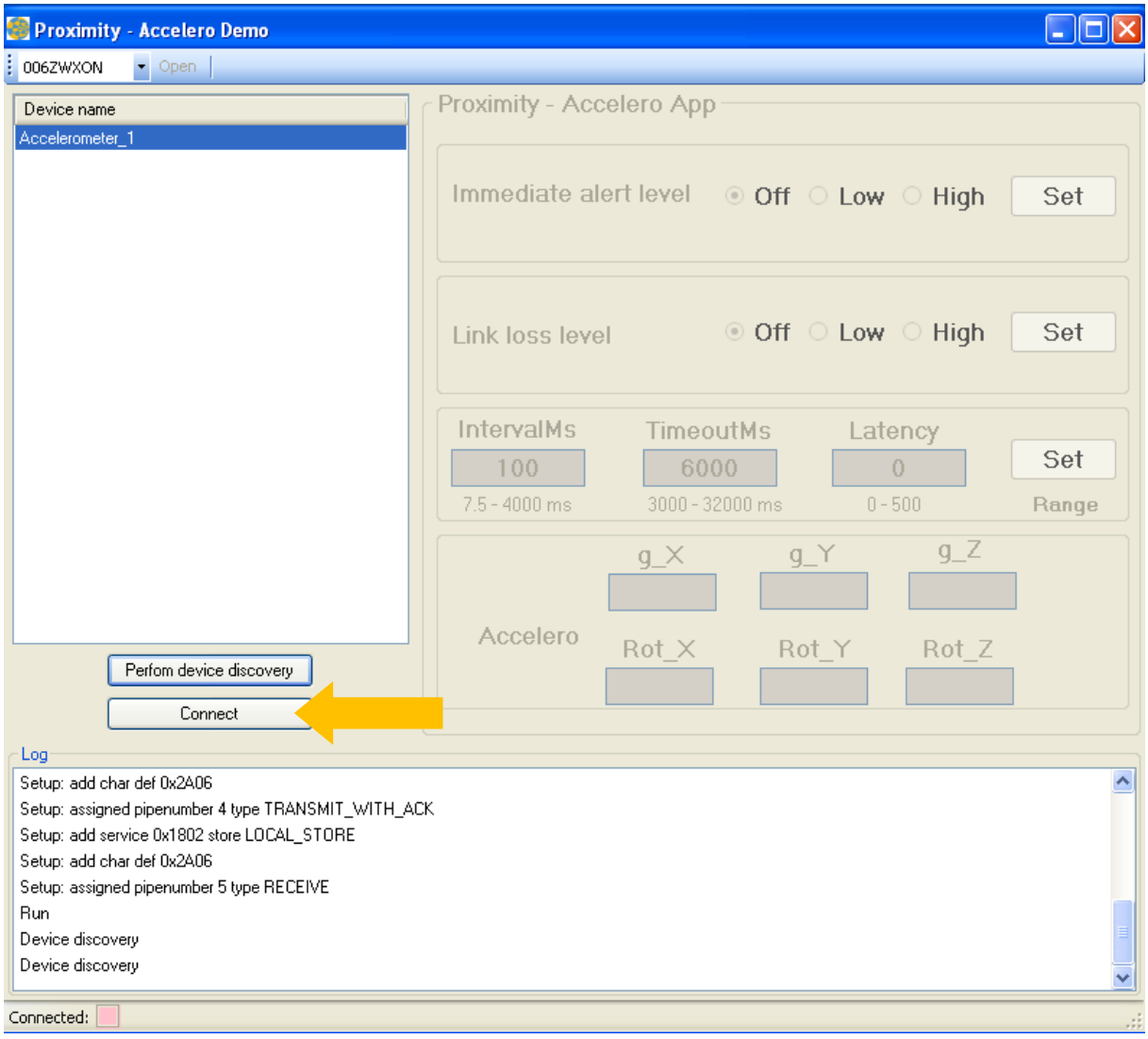


On Panel “Perform Device Discovery”

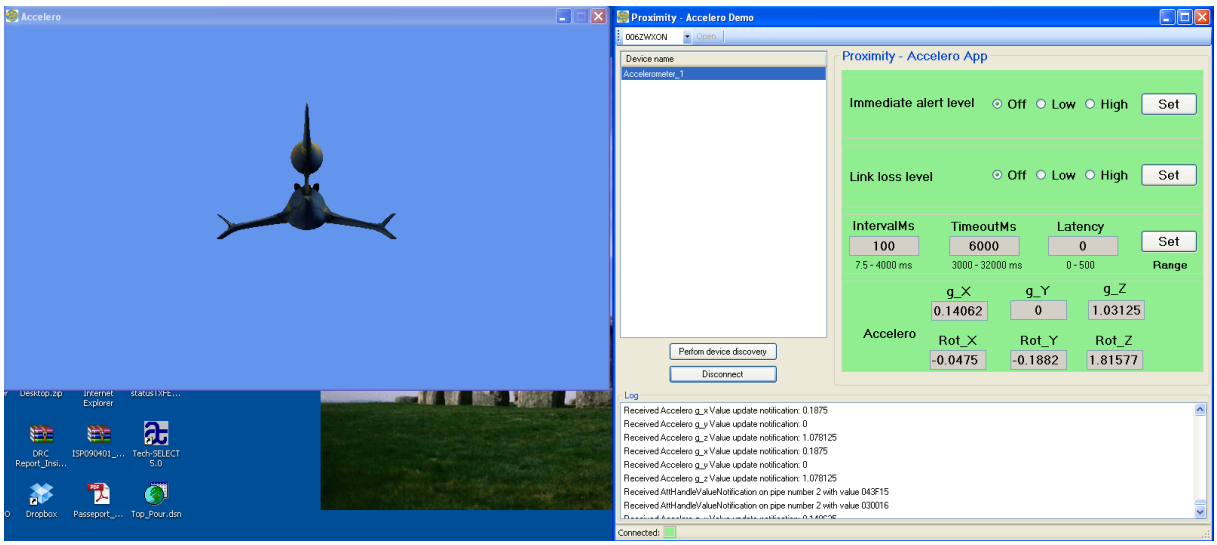


Accelerometer_x should appear. If this fails, reset accelerometer (to put into advertising mode) and perform device discovery again.

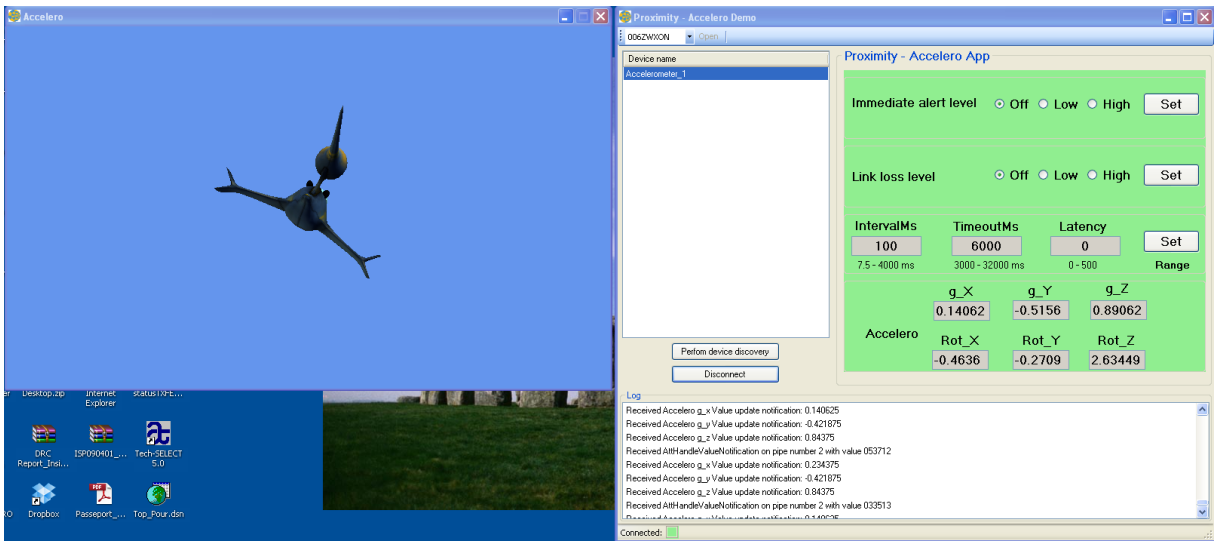
Press on “Connect”



Both Displays should change and be updated every 100ms:



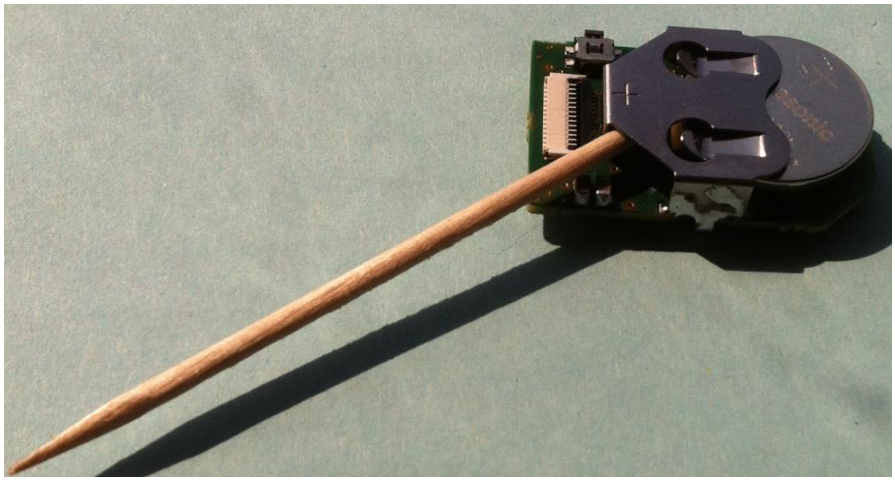
As the orientation of the module changes so will the position of the aircraft on the Left Hand Screen:

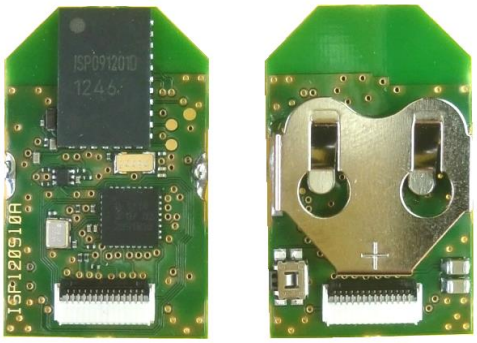


Stop Software

To switch off PC program, click on top Right Corner of both windows.

To switch off accelerometer remove battery as shown:

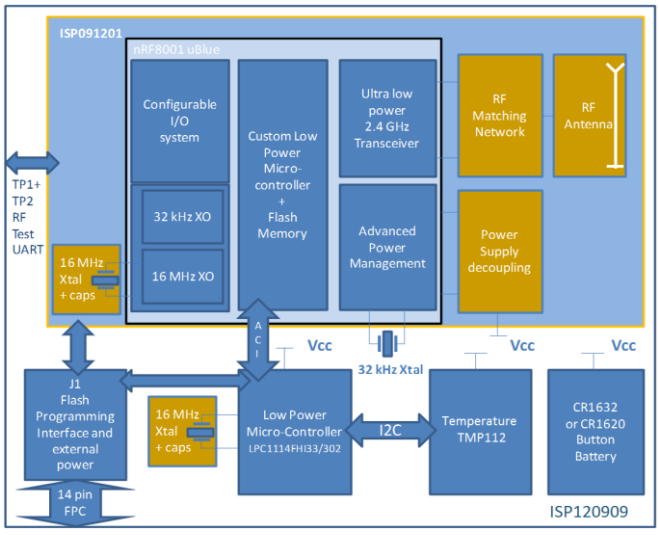




ISP120909
Bluetooth Low Energy Wireless Temperature Detection Sensor

Key Features

- Single Mode BLE v4.0 Slave Module
- Based on Nordic Semiconductor uBlue family
- Includes transceiver, baseband, software stack
- Fully integrated RF matching and Antenna
- Integrated 16 MHz Crystal Clock
- Ultra Low Power Consumption
  Coin cell battery CR1632 or CR1620
- Low Power Digital Temperature Sensor
- Ultra Low Power Application Processor
- 16 MHz Crystal Clock for Application Processor
- 32.768 kHz Crystal for BLE Protocol Sync.
- Overall Size 18 x 29 x 6 mm
- Temperature -40 to 85 °C



Applications

- Temperature monitoring sensors
- Thermostat controls sensors
- Health care sensors
- Out of Range (OOR) sensors

General Description

ISP120909 is an autonomous low-power device for wireless temperature detection and transmission. The complete device makes use of Insight SiP ISP091201 BLE module together with low power host processor, digital temperature sensor and small primary button cell battery CR1632 or lower capacity CR1620. Overall size of the device is 18x29x6 mm.

The host processor that handles the autonomous sensor application, the high level portion of the BLE protocol stack and communication with the temperature sensor is a low power 32-bit MCU (ARM Cortex-M0 based), the NXP LPC1114FHI33/302, integrating 56kB flash memory and 8kB SRAM.

The Texas Instruments TMP112, a digital temperature detection sensor is used to detect room temperature transmitted via the I2C bus. The TMP112 TMP112 is capable of reading temperatures to a resolution of 0.0625°C. It is specified for operation over a temperature range of -40°C to 125°C.

An interface board, ISP120907 is available from Insight SIP and allows for easy flash programming the LPC1114FHI33/302 application processor via the 14 pin FPC connector. During firmware modification and debug, the ISP120901 device may be supplied via the DC voltage from the ISP120907 interface board. An optional UART interface (TP1+TP2) with direct connection to the nRF8001 uBlue is available for BLE radio testing as specified by the Bluetooth standard.

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

Contents

1. Electrical Specifications

Current Consumption

The measured total average current consumption and autonomy of the ISP120909 temperature sensor node supplied by a CR1632 battery for several connection intervals is shown below.

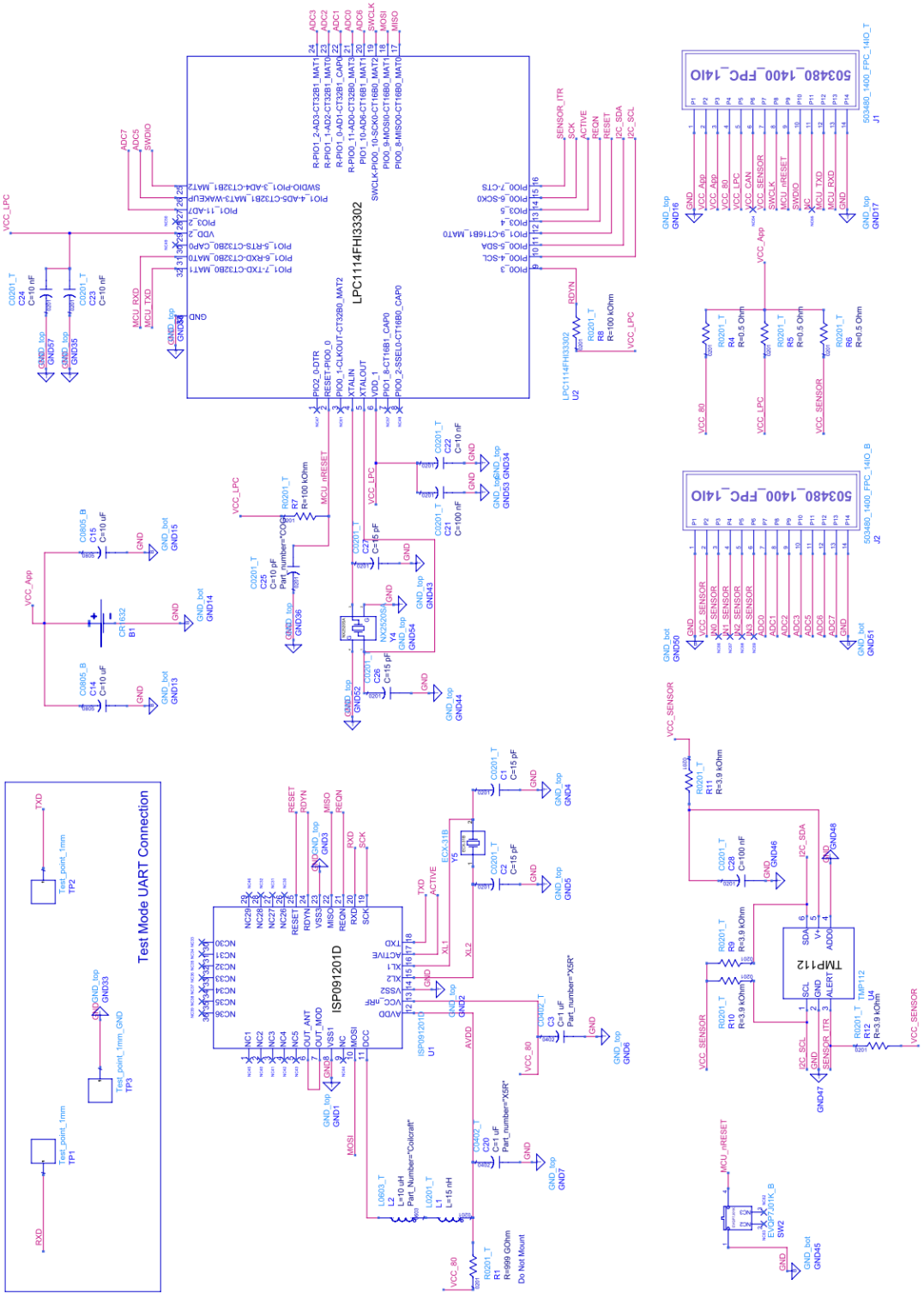
Connection Interval (ms)	Average Current Consumption (µA)	Autonomy (year)
1000	55.1	0.29
2000	31.8	0.50
3000	24.0	0.67
4000	20.1	0.79

Sensor Performance

The performance of the temperature sensor is that obtained by the Texas Instruments TMP112. Key characteristics are shown below.

Parameter	Value	Unit
Accuracy	+/-0.0625	°C
Temperature range	-40 to +125	°C
Resolution	12	bits

Electrical Schematic



2. RF Performances

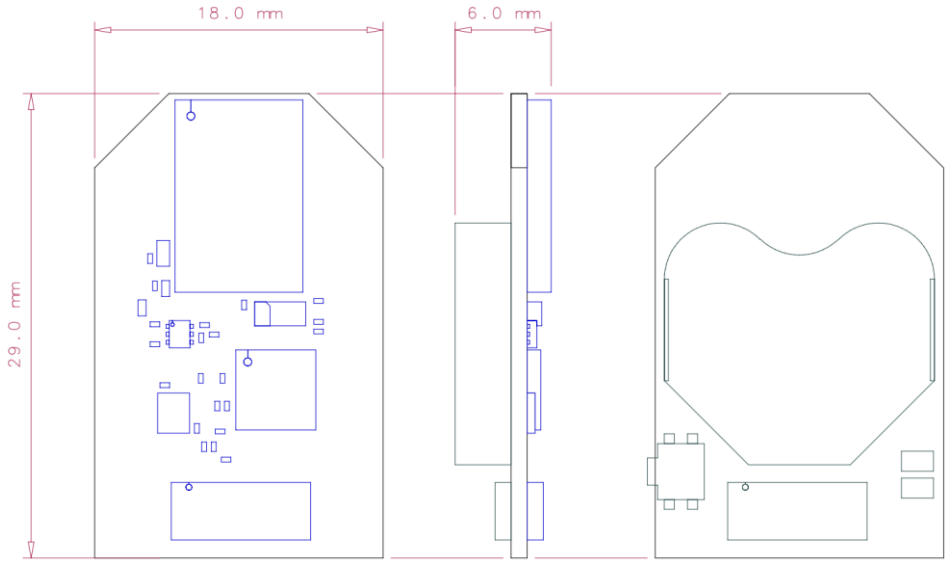
RF Specifications according to standards

The performance of the Bluetooth Low Energy Radio link is that obtained by the ISP091201 module.
Temperature range -40°C to +85°C.

Parameter	Value	BT V4 Std limit	Unit	Condition
Output Power	-0.9	-20 to 10	dBm	Channels 0 to 39
RF Frequency tolerance	Better than +/-20	+/- 50	Hz	Channel 0 to 39
Rx sensitivity	-87	-70	dBm	Level for BER <0,1% ideal Tx
Max range	> 20		m	Open field at 1m height
EIRP	0.3		dBm	
Antenna Gain	1.2		dBi	
Rx sensitivity	56.8		dBµV/m	

3. Mechanical Outlines

Dimensional drawing



HOME

AN130404
Temperature Sensor Demonstration

Introduction

This application note describes the PC software setup to use the ISP120909 temperature demonstration program. The demonstration requires a ISP120909 Temperature Sensor with a CR1632 battery, a Windows PC running XP, Vista or Windows 7, a Nordic Semiconductor Master Emulator nRF2739 (delivered with uBlue SDK) and appropriate software from Insight SiP.

The note describes the software installation procedure and the operating mode.

Software Installation

In order for the demonstration to operate the following software packages need to be installed on the PC:

- Microsoft .NET framework 4
- Nordic Semiconductor nRF8001 SDK v1.7 (for Master Emulator USB drivers)
- Temperature Demo folder from Insight SIP with executable file and dll files

Microsoft .NET framework 4 Re-distribuable package

This can be downloaded from Microsoft at the following address http://www.microsoft.com/en-us/download/details.aspx?id=17718. To install this package follow the instructions on the Microsoft website.

Nordic Semiconductor nRF8001 SDK v1.7

Run the nRF8001 SDK so as to be able to use the Master Emulator (USB drivers).

Temperature Demo Folder

The Temp_Lum_Demo_EXE.zip file should be unzipped at any suitable location on the PC. This contains the executable file and all the dll files necessary for the demonstration to run.

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

The directory should be as shown below:

Nom	Taille	Type	Date de modification
Aci.dll	12 Ko	Application Extension	09/28/2012 2:31 PM
emulatorlibs.dll	2,179 Ko	Application Extension	09/28/2012 2:31 PM
hci_coder.dll	45 Ko	Application Extension	09/28/2012 2:31 PM
hci_coder_net.dll	27 Ko	Application Extension	09/28/2012 2:31 PM
IronPython.dll	1,750 Ko	Application Extension	09/28/2012 2:29 PM
IronPython.Modules.dll	637 Ko	Application Extension	09/28/2012 2:29 PM
IronPython.xml	399 Ko	Document XML	09/28/2012 2:29 PM
JLinkARM.dll	4,422 Ko	Application Extension	09/28/2012 2:30 PM
log.txt	1 Ko	Document texte	02/07/2013 1:38 AM
MasterEmulator.dll	38 Ko	Application Extension	09/28/2012 2:31 PM
MasterEmulator.xml	77 Ko	Document XML	09/28/2012 2:31 PM
Microsoft.Dynamic.dll	1,020 Ko	Application Extension	09/28/2012 2:29 PM
Microsoft.Dynamic.xml	360 Ko	Document XML	09/28/2012 2:29 PM
Microsoft.Scripting.dll	141 Ko	Application Extension	09/28/2012 2:29 PM
Microsoft.Scripting.Metadata.dll	91 Ko	Application Extension	09/28/2012 2:29 PM
Microsoft.Scripting.Metadata.xml	17 Ko	Document XML	09/28/2012 2:29 PM
Microsoft.Scripting.xml	201 Ko	Document XML	09/28/2012 2:29 PM
Proximity Temp-Lumino Demo.exe	233 Ko	Application	04/16/2013 11:01 AM
Proximity Temp-Lumino Demo.pdb	56 Ko	Fichier PDB	04/16/2013 11:01 AM
Proximity Temp-Lumino Demo.vshost.exe	12 Ko	Application	04/16/2013 11:02 AM
Proximity Temp-Lumino Demo.vshost.exe.manifest	1 Ko	Fichier MANIFEST	03/17/2010 10:39 PM
ProximityDemo.vshost.exe.manifest	1 Ko	Fichier MANIFEST	03/17/2010 10:39 PM
pylibs.dll	1,425 Ko	Application Extension	09/28/2012 2:31 PM
Segger.dll	12 Ko	Application Extension	09/28/2012 2:31 PM
Signalyzer.dll	31 Ko	Application Extension	09/28/2012 2:31 PM
Ulpbt.dll	200 Ko	Application Extension	09/28/2012 2:31 PM
UlpbtUtils.dll	26 Ko	Application Extension	09/28/2012 2:31 PM

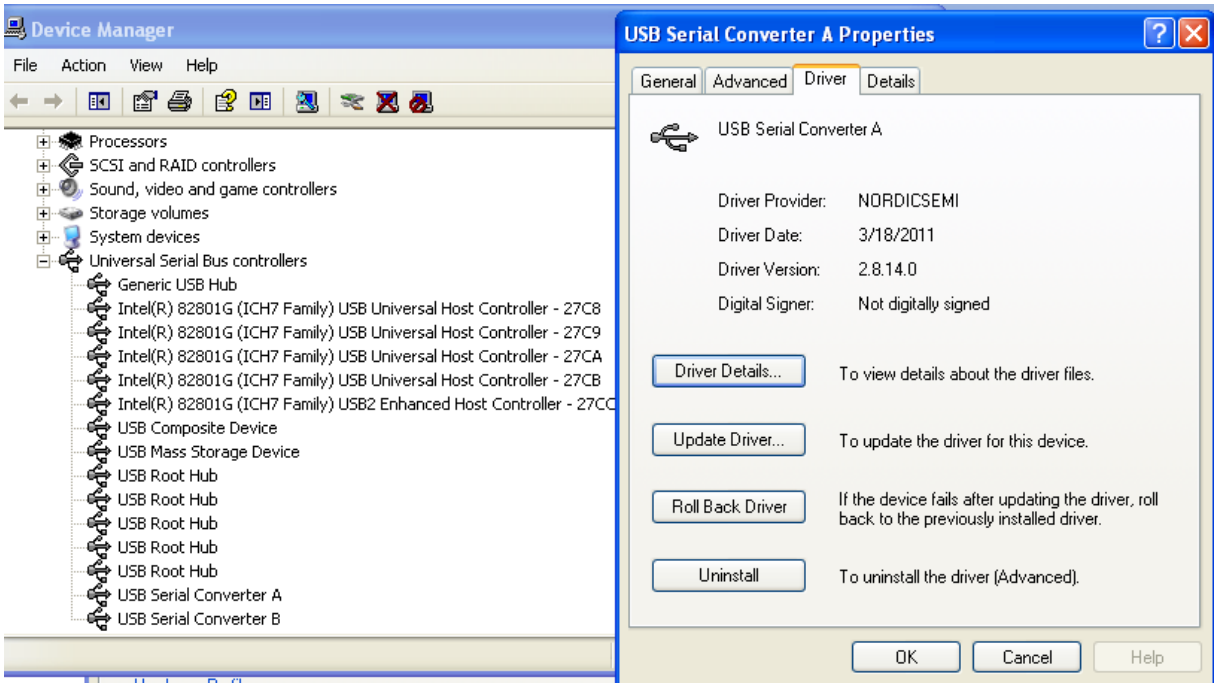
Hardware Setup

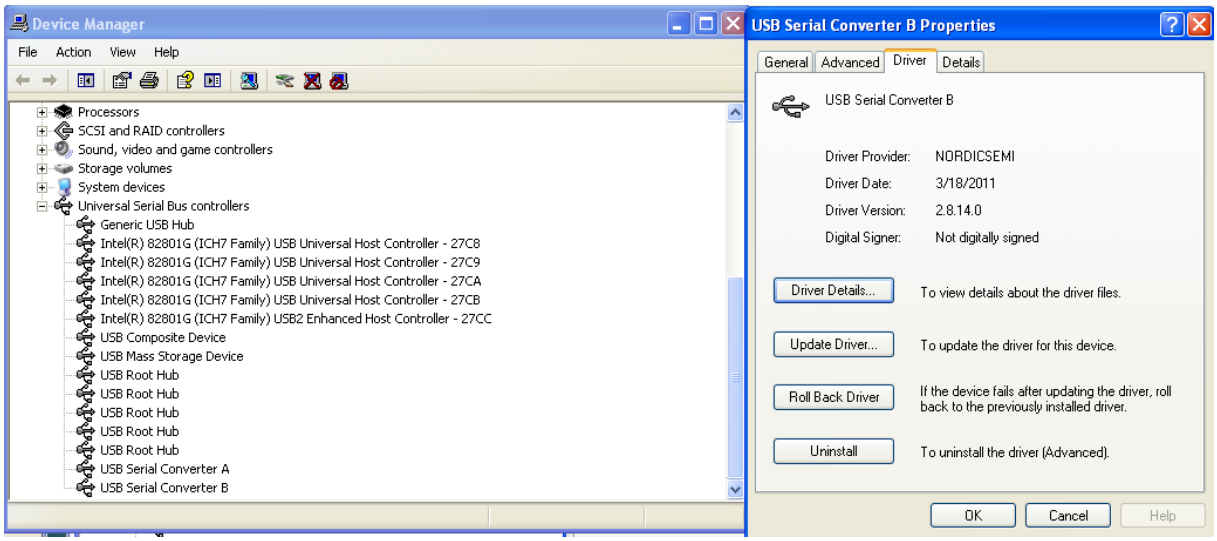
Master Emulator

Connect the nRF2739 Master Emulator to the PC and check to ensure that the USB drivers are correctly installed.

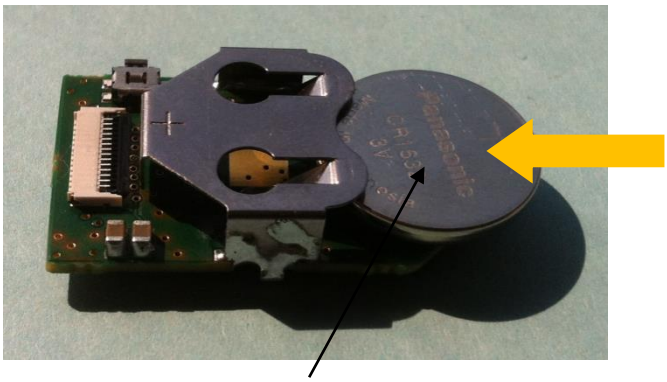
This can be checked on the Control Panel Device Manager under USB Controllers:
USB Serial Converter A
USB Serial Converter B

Should both be installed see below for details:

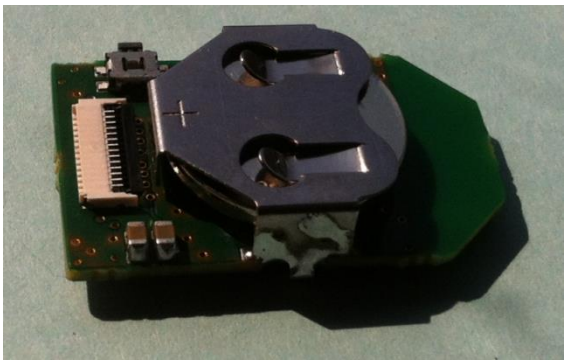




Connect Battery to ISP120909 Temperature Sensor as shown below:



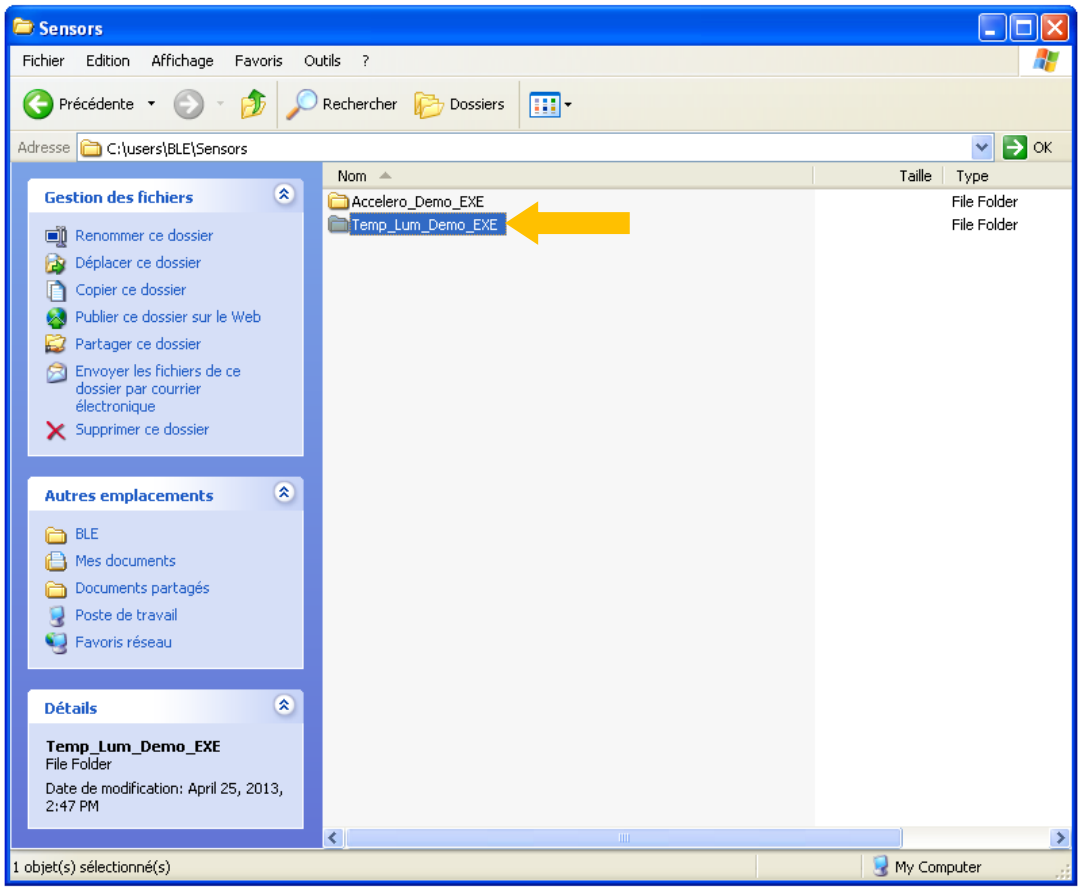
Battery CR1632 POS Terminal UP



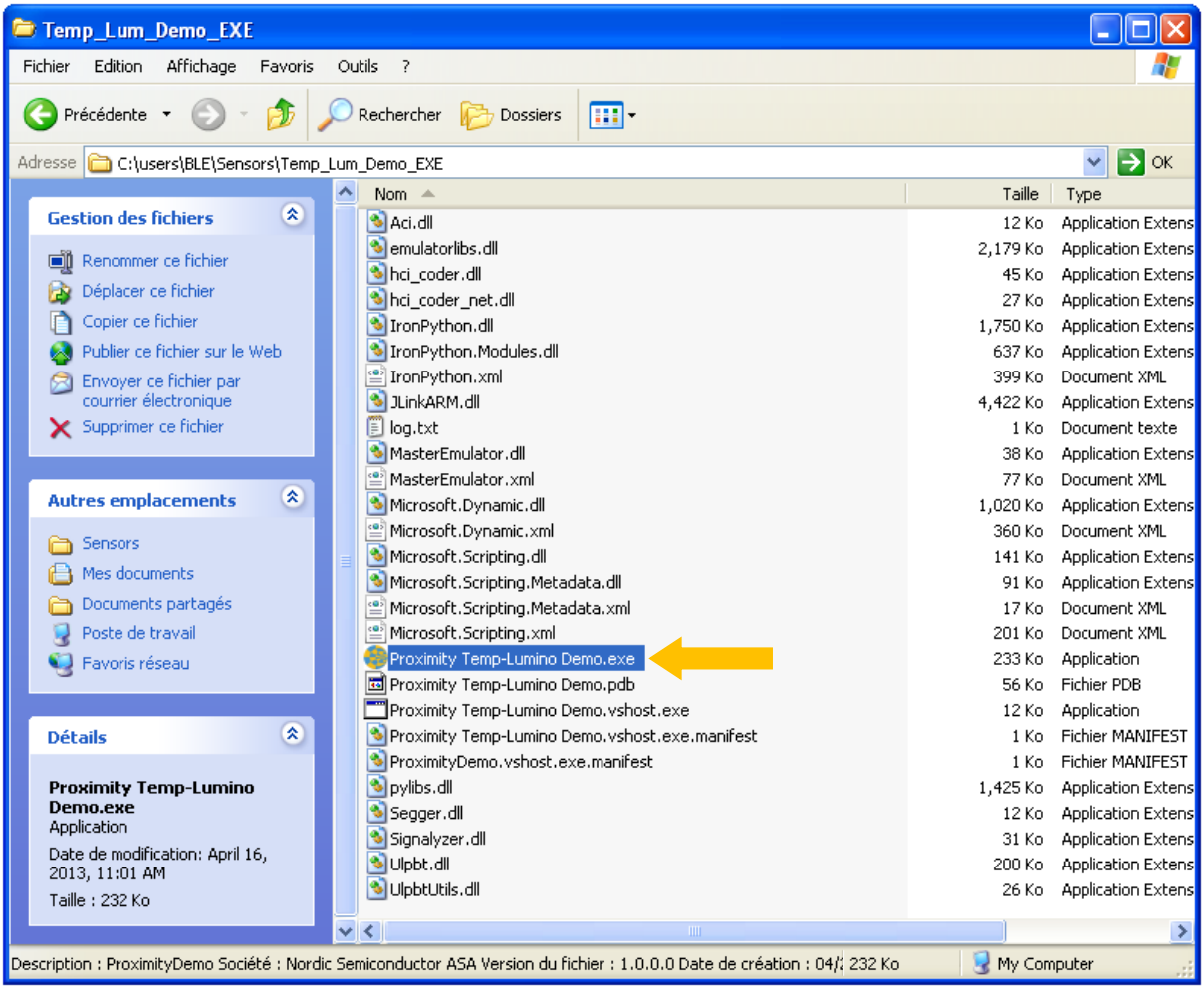
Battery CR1632 Fully Installed

Run Software

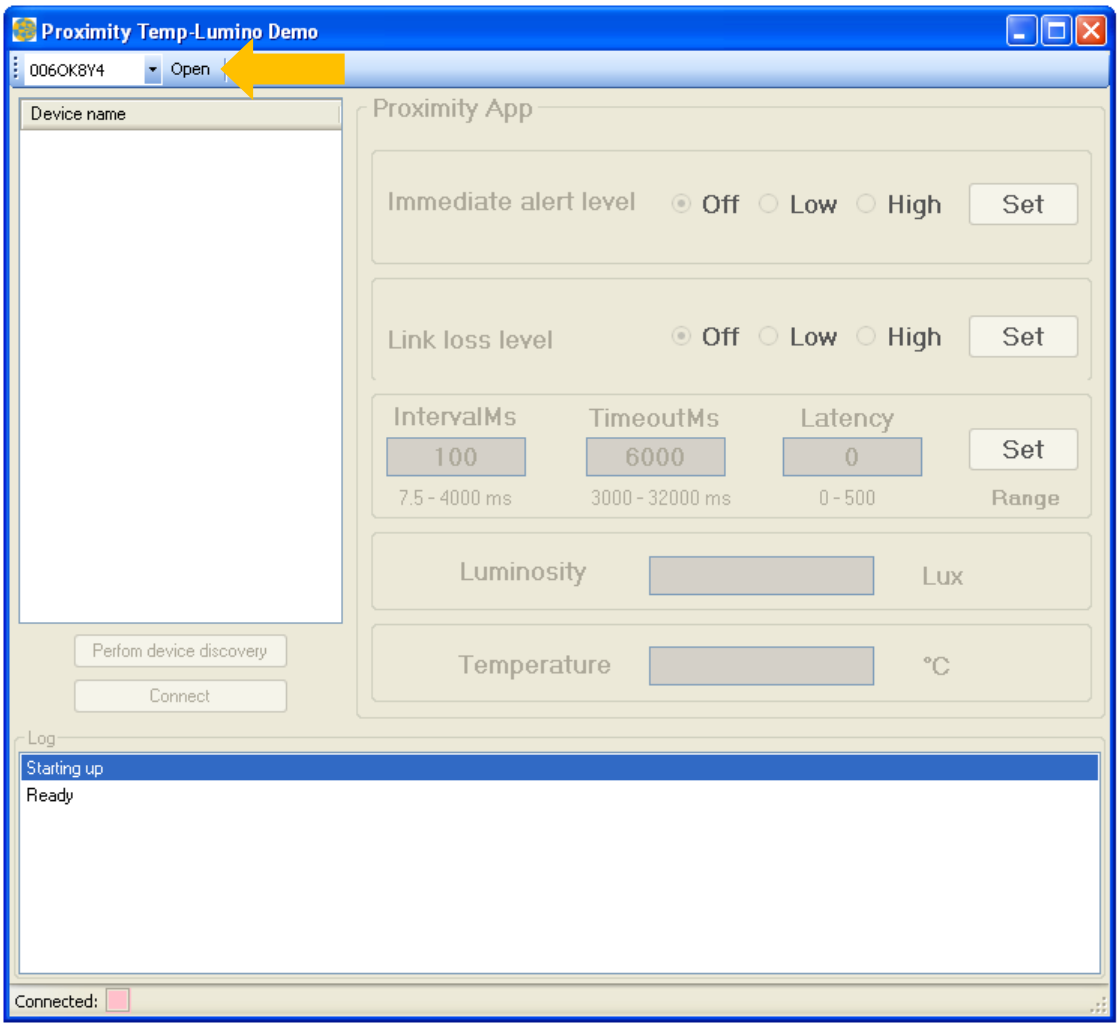
Navigate to the “Temp_Lum_Demo_EXE” folder:



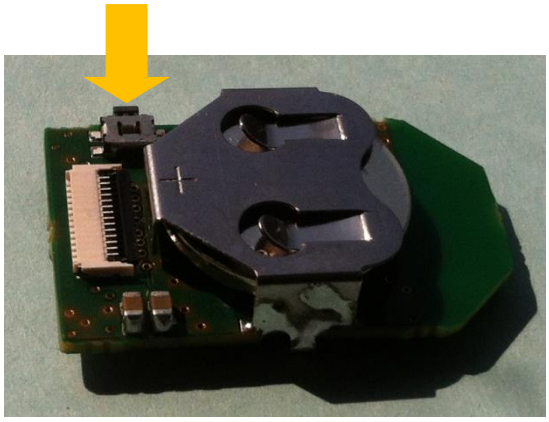
Launch “Proximity Temp-Lumino Demo.exe” (on some systems you may need to launch using “run as administrator”):



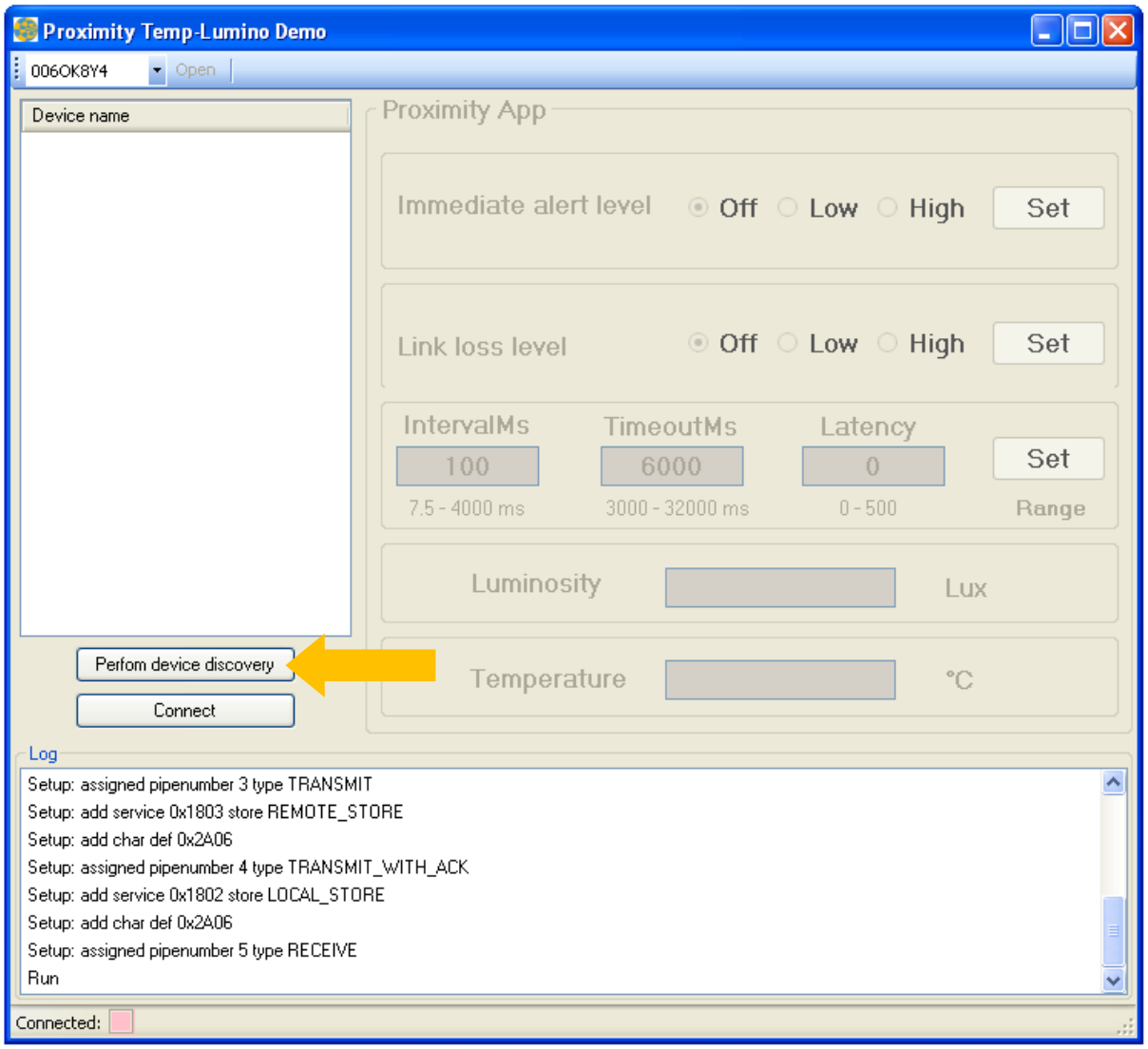
One screen should open. On this screen, click on “Open”:



Reset Temperature Sensor with small reset button:

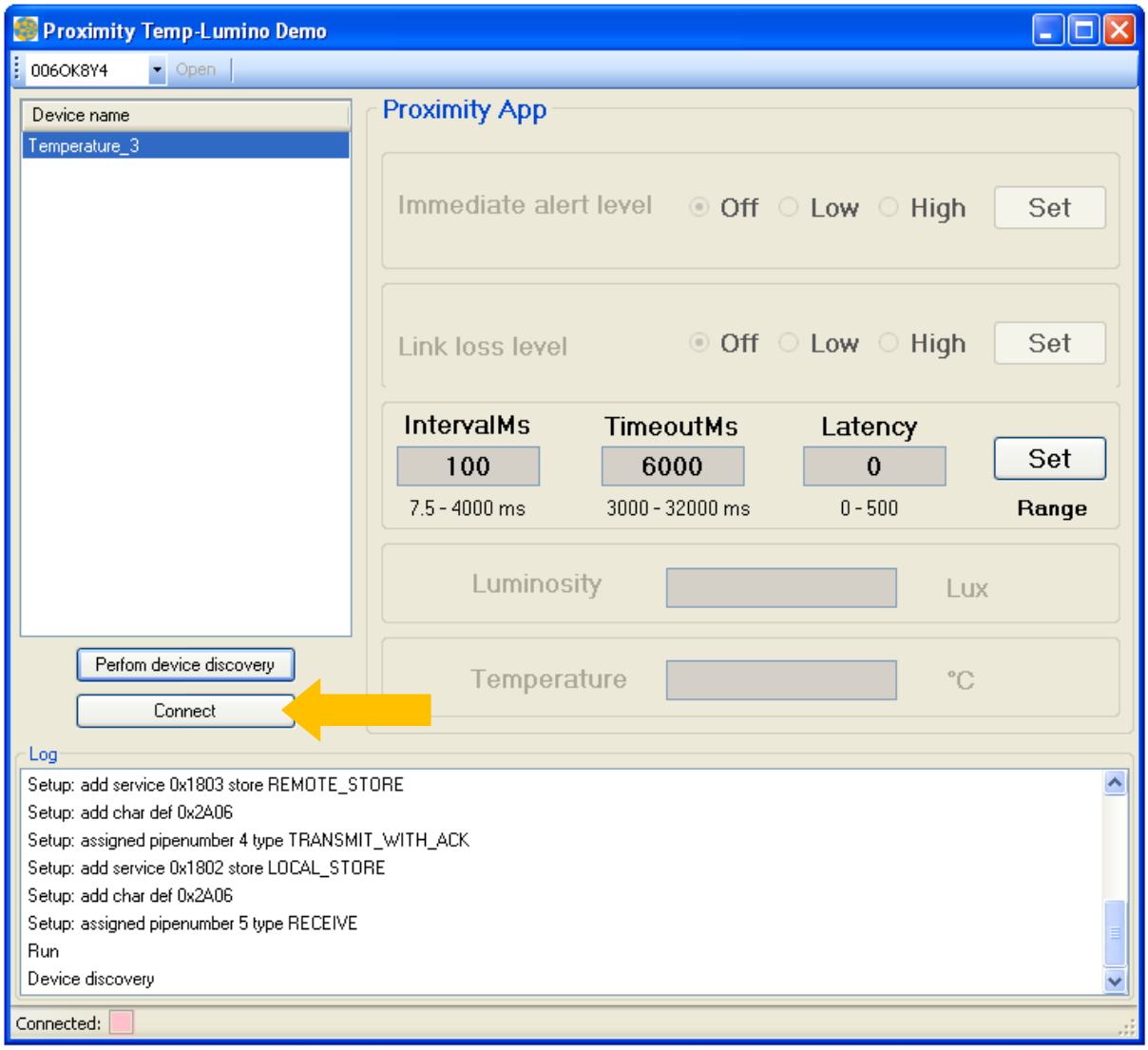


On Panel, click on “Perform Device Discovery”:

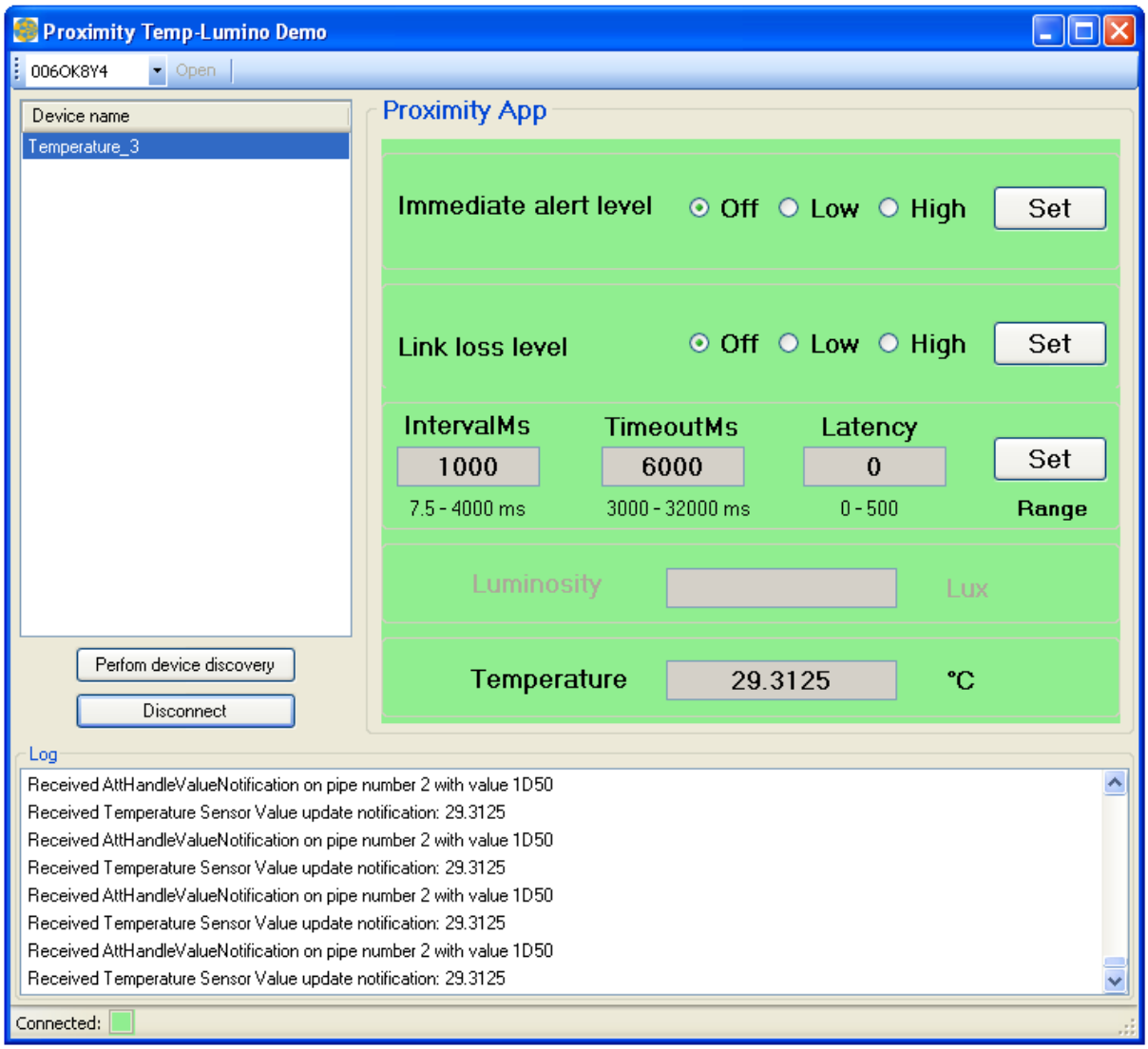


"Temperature_x" should appear. If this fails, reset Temperature Sensor (to put into advertising mode) and perform device discovery again.

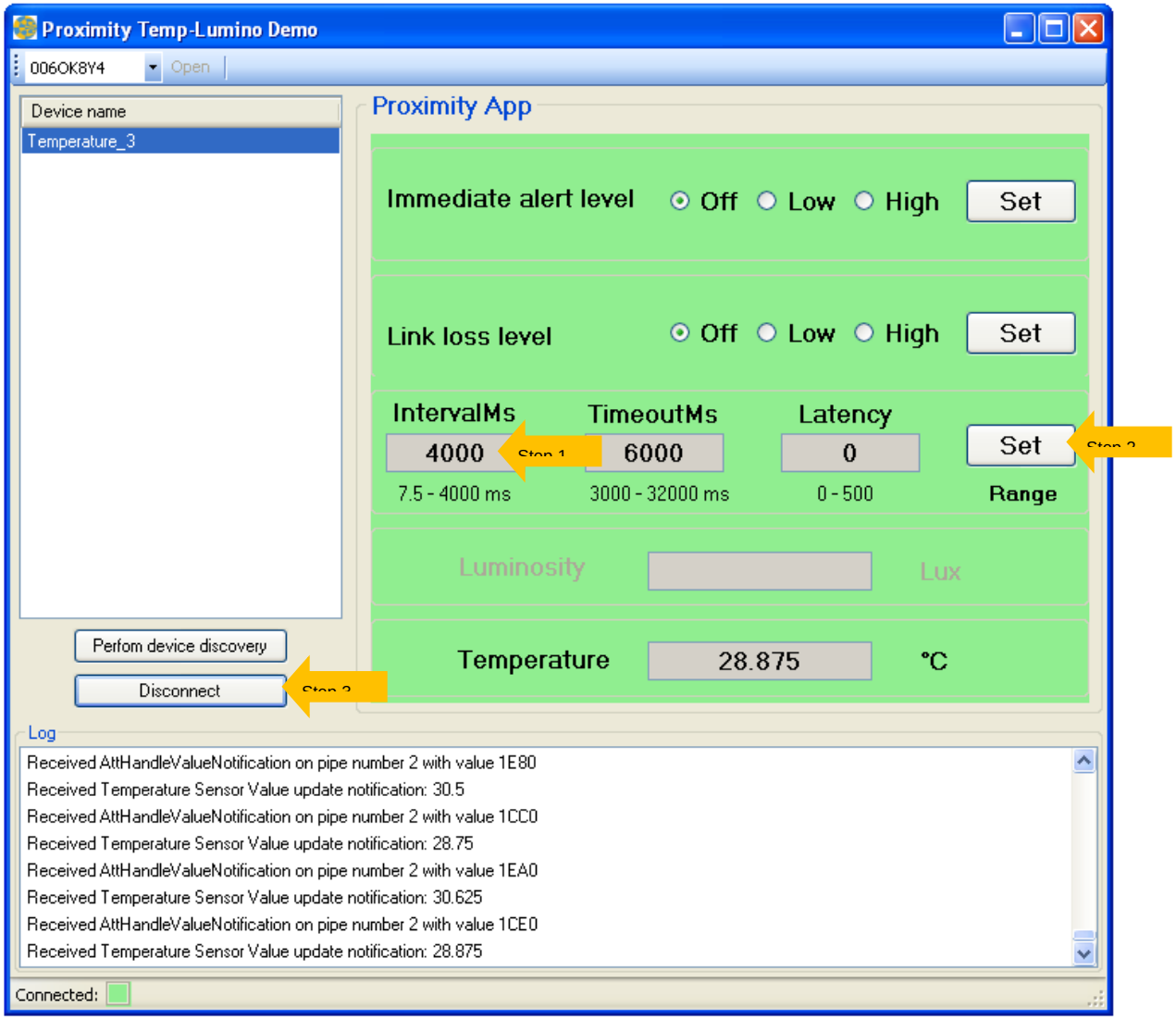
Press on "Connect":



Display should change and be updated every Interval Connection (IntervalMs). Interval Connection is adjustable between 7.5 to 4000 ms. Hereunder, Interval Connection is configured to 1000 ms:



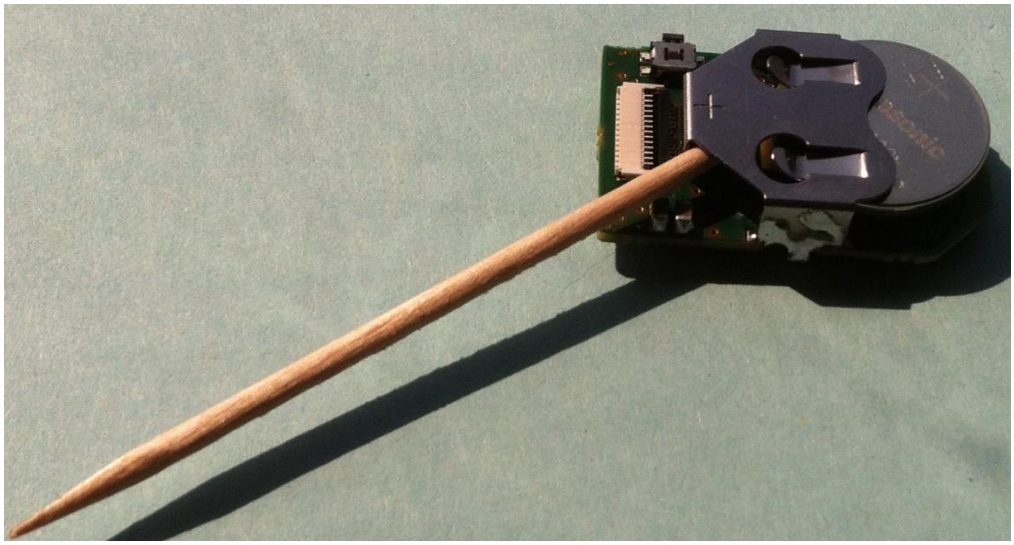
To change Interval Connection to 4000 ms for example, write 4000 in tab “IntervalMs” (step 1), then click on “Set” (step 2). Then click successively on “Disconnect” and “Connect” (step 3):

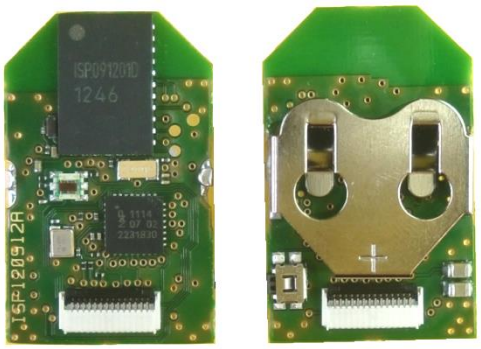


Stop Software

To switch off PC program, click on top Right Corner of the window.

To switch off Temperature Sensor, remove battery as shown below:

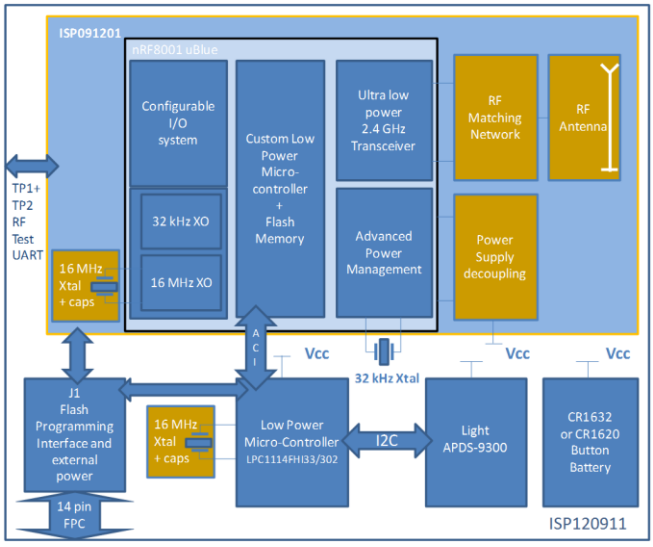




ISP120911
Bluetooth Low Energy Wireless Light Detection Sensor

Key Features

- Single Mode BLE v4.0 Slave Module
- Based on Nordic Semiconductor uBlue family
- Includes transceiver, baseband, software stack
- Fully integrated RF matching and Antenna
- Integrated 16 MHz Crystal Clock
- Ultra Low Power Consumption.
  Coin cell battery CR1632 or CR1620
- Low Power Digital Light Sensor
- Ultra Low Power Application Processor
- 16 MHz Crystal Clock for Application Processor
- 32.768 kHz Crystal for BLE Protocol Sync.
- Overall Size 18 x 29 x 6 mm
- Temperature -40 to 85 °C



Applications

- Home light monitoring sensors
- Small business light monitoring sensors
- Out of Range (OOR) sensors

General Description

ISP120911 is an autonomous low-power device for wireless light detection and transmission. The complete device makes use of Insight SiP ISP091201 BLE module together with low power host processor, digital temperature sensor and small primary button cell battery CR1632 or lower capacity CR1620. Overall size of the device is 18x29x6 mm.

The host processor that handles the autonomous sensor application, the high level portion of the BLE protocol stack and communication with the light sensor is a low power 32-bit MCU (ARM Cortex-M0 based), the NXP LPC1114FHI33/302, integrating 56kB flash memory and 8kB SRAM.

The Avago APDS-9300, a digital light detection sensor is used to detect ambient light transmitted via the I2C bus. Each APDS-9300 consists of one broadband photodiode (visible plus infrared) and one infrared photodiode. Two integrated ADSs convert the photodiode currents to a digital output that represents the irradiance measured on each channel. This digital output is addressed to the NXP application processor where illuminance (ambient light level) in lux is derived using an empirical formula to approximate the human-eye response.

An interface board, ISP120907 is available from Insight SIP and allows for easy flash programming the LPC1114FHI33/302 application processor via the 14 pin FPC connector. During firmware modification and debug, the ISP120901 device may be supplied via the DC voltage from the ISP120907 interface board. An optional UART interface (TP1+TP2) with direct connection to the nRF8001 uBlue is available for BLE radio testing as specified by the Bluetooth standard.

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

Contents

1. Electrical Specifications

Current Consumption

The measured total average current consumption and autonomy of the ISP120911 light sensor node supplied by a CR1632 battery for several connection intervals is shown below.

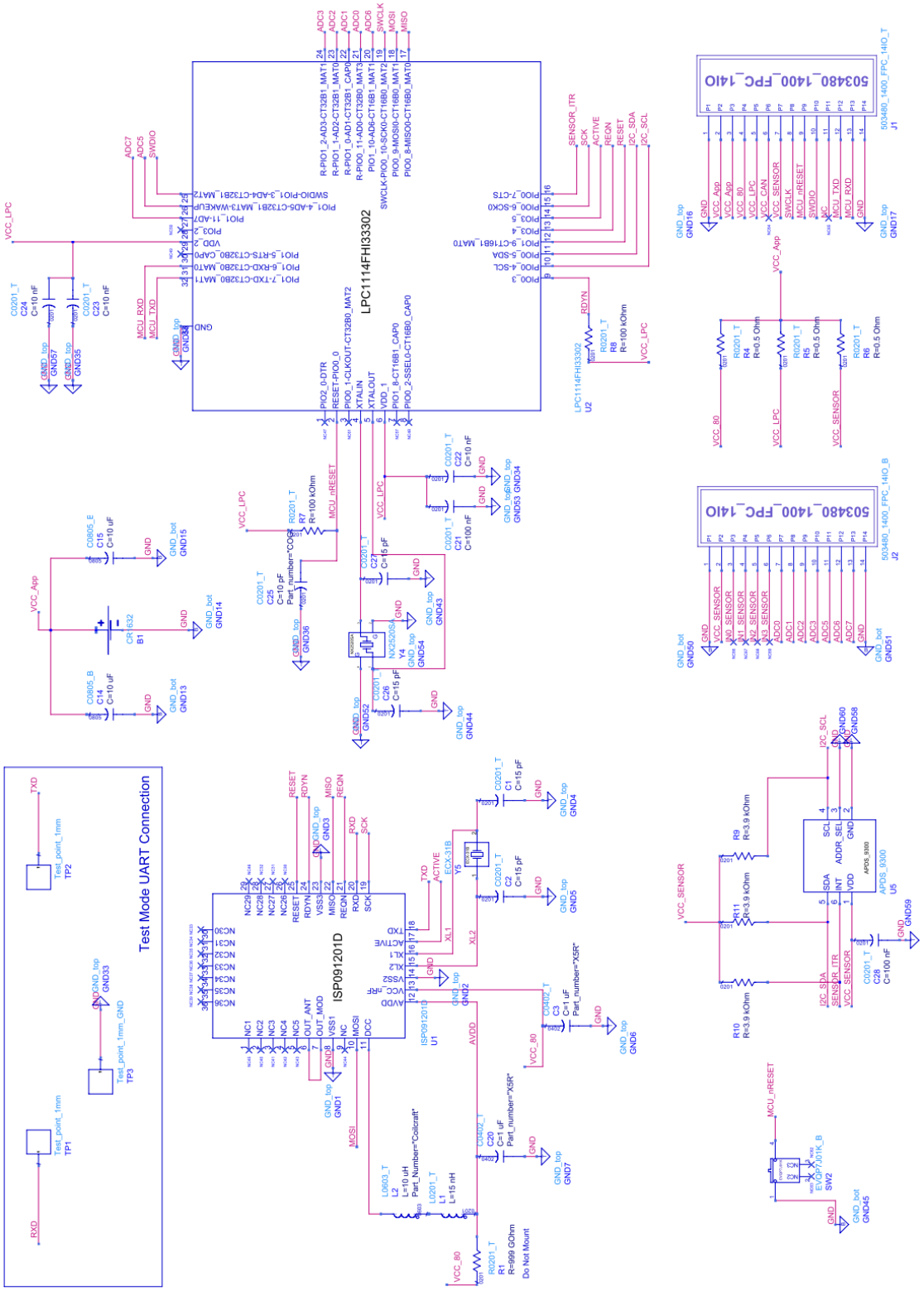
Connection Interval (ms)	Average Current Consumption (µA)	Autonomy (year)
1000	67.8	0.24
2000	40.3	0.40
3000	31.1	0.51
4000	26.5	0.60

Sensor Performance

The performance of the light sensor is that obtained by the Avago APDS-9300. Key characteristics are shown below:

Parameter	Value	Unit
Light range	Dark to bright sun	
Resolution	16	bits

Electrical Schematic



2. RF Performances

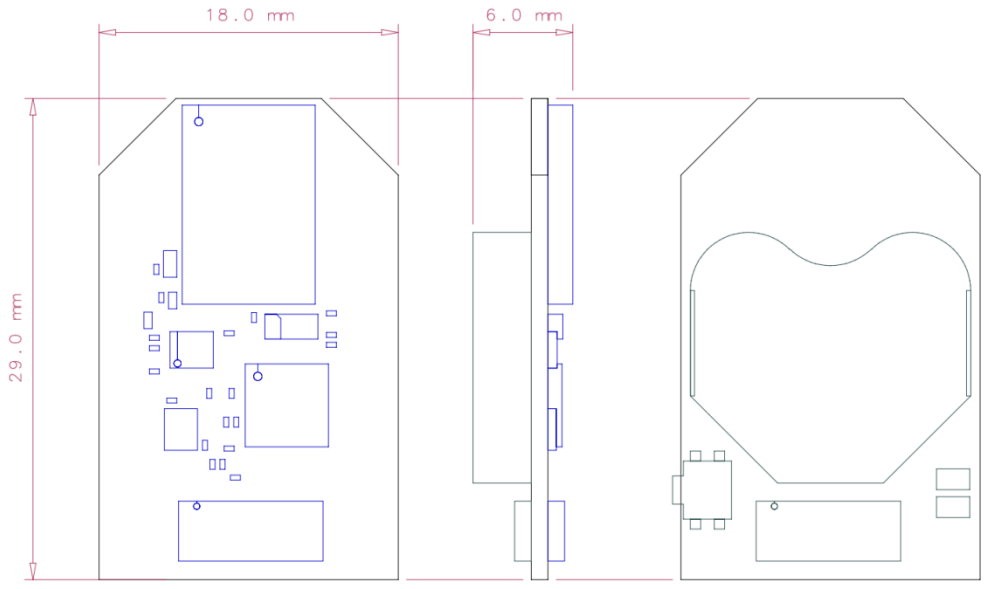
RF Specifications according to standards

The performance of the Bluetooth Low Energy Radio link is that obtained by the ISP091201 module.
Temperature range -40°C to +85°C.

Parameter	Value	BT V4 Std limit	Unit	Condition
Output Power	-0.9	-20 to 10	dBm	Channels 0 to 39
RF Frequency tolerance	Better than +/-20	+/- 50	Hz	Channel 0 to 39
Rx sensitivity	-87	-70	dBm	Level for BER <0,1% ideal Tx
Max range	> 20		m	Open field at 1m height
EIRP	0.3		dBm	
Antenna Gain	1.2		dBi	
Rx sensitivity	56.8		dBµV/m	

3. Mechanical Outlines

Dimensional drawing



HOME

AN130405
Luminosity Sensor Demonstration

Introduction

This application note describes the PC software setup to use the ISP120911 luminosity demonstration program. The demonstration requires a ISP120911 Luminosity Sensor with a CR1632 battery, a Windows PC running XP, Vista or Windows 7, a Nordic Semiconductor Master Emulator nRF2739 (delivered with uBlue SDK) and appropriate software from Insight SiP.

The note describes the software installation procedure and the operating mode.

Software Installation

In order for the demonstration to operate the following software packages need to be installed on the PC:

- Microsoft .NET framework 4
- Nordic Semiconductor nRF8001 SDK v1.7 (for Master Emulator USB drivers)
- Luminosity Demo folder from Insight SIP with executable file and dll files

Microsoft .NET framework 4 Re-distribuable package

This can be downloaded from Microsoft at the following address http://www.microsoft.com/en-us/download/details.aspx?id=17718. To install this package follow the instructions on the Microsoft website.

Nordic Semiconductor nRF8001 SDK v1.7

Run the nRF8001 SDK so as to be able to use the Master Emulator (USB drivers).

Luminosity Demo Folder

The Temp_Lum_Demo_EXE.zip file should be unzipped at any suitable location on the PC. This contains the executable file and all the dll files necessary for the demonstration to run.

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

The directory should be as shown below:

Nom	Taille	Type	Date de modification
Aci.dll	12 Ko	Application Extension	09/28/2012 2:31 PM
emulatorlibs.dll	2,179 Ko	Application Extension	09/28/2012 2:31 PM
hci_coder.dll	45 Ko	Application Extension	09/28/2012 2:31 PM
hci_coder_net.dll	27 Ko	Application Extension	09/28/2012 2:31 PM
IronPython.dll	1,750 Ko	Application Extension	09/28/2012 2:29 PM
IronPython.Modules.dll	637 Ko	Application Extension	09/28/2012 2:29 PM
IronPython.xml	399 Ko	Document XML	09/28/2012 2:29 PM
JLinkARM.dll	4,422 Ko	Application Extension	09/28/2012 2:30 PM
log.txt	1 Ko	Document texte	02/07/2013 1:38 AM
MasterEmulator.dll	38 Ko	Application Extension	09/28/2012 2:31 PM
MasterEmulator.xml	77 Ko	Document XML	09/28/2012 2:31 PM
Microsoft.Dynamic.dll	1,020 Ko	Application Extension	09/28/2012 2:29 PM
Microsoft.Dynamic.xml	360 Ko	Document XML	09/28/2012 2:29 PM
Microsoft.Scripting.dll	141 Ko	Application Extension	09/28/2012 2:29 PM
Microsoft.Scripting.Metadata.dll	91 Ko	Application Extension	09/28/2012 2:29 PM
Microsoft.Scripting.Metadata.xml	17 Ko	Document XML	09/28/2012 2:29 PM
Microsoft.Scripting.xml	201 Ko	Document XML	09/28/2012 2:29 PM
Proximity Temp-Lumino Demo.exe	233 Ko	Application	04/16/2013 11:01 AM
Proximity Temp-Lumino Demo.pdb	56 Ko	Fichier PDB	04/16/2013 11:01 AM
Proximity Temp-Lumino Demo.vshost.exe	12 Ko	Application	04/16/2013 11:02 AM
Proximity Temp-Lumino Demo.vshost.exe.manifest	1 Ko	Fichier MANIFEST	03/17/2010 10:39 PM
ProximityDemo.vshost.exe.manifest	1 Ko	Fichier MANIFEST	03/17/2010 10:39 PM
pylibs.dll	1,425 Ko	Application Extension	09/28/2012 2:31 PM
Segger.dll	12 Ko	Application Extension	09/28/2012 2:31 PM
Signalyzer.dll	31 Ko	Application Extension	09/28/2012 2:31 PM
Ulpbt.dll	200 Ko	Application Extension	09/28/2012 2:31 PM
UlpbtUtils.dll	26 Ko	Application Extension	09/28/2012 2:31 PM

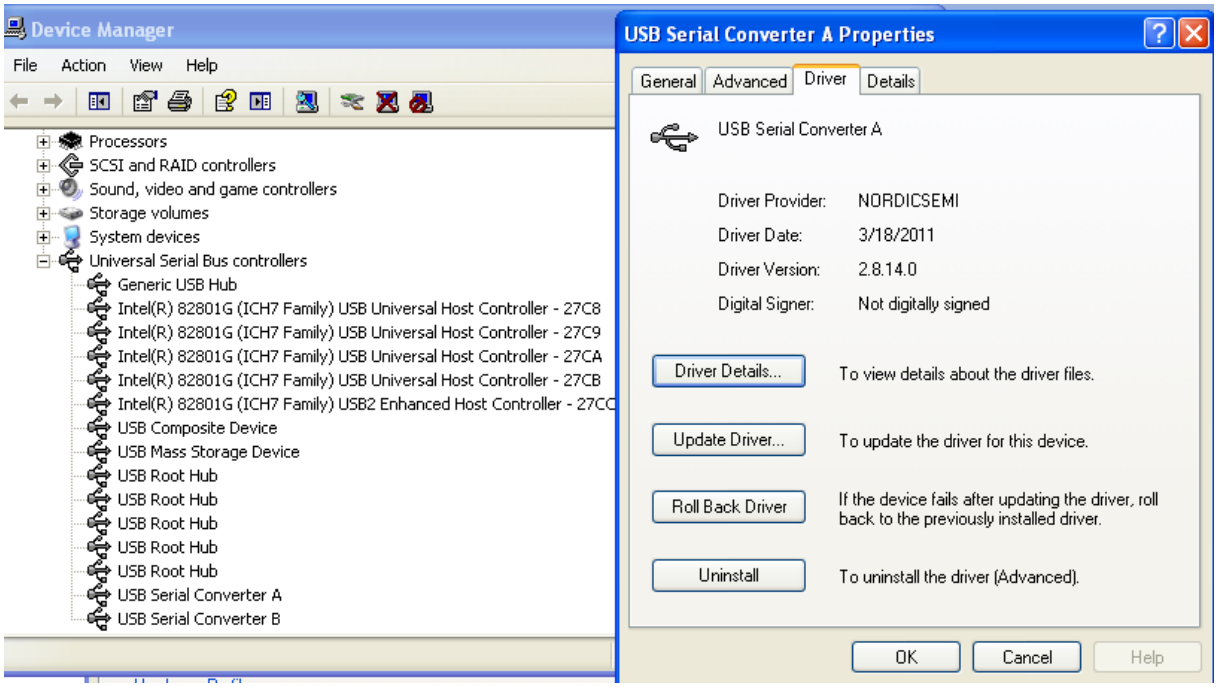
Hardware Setup

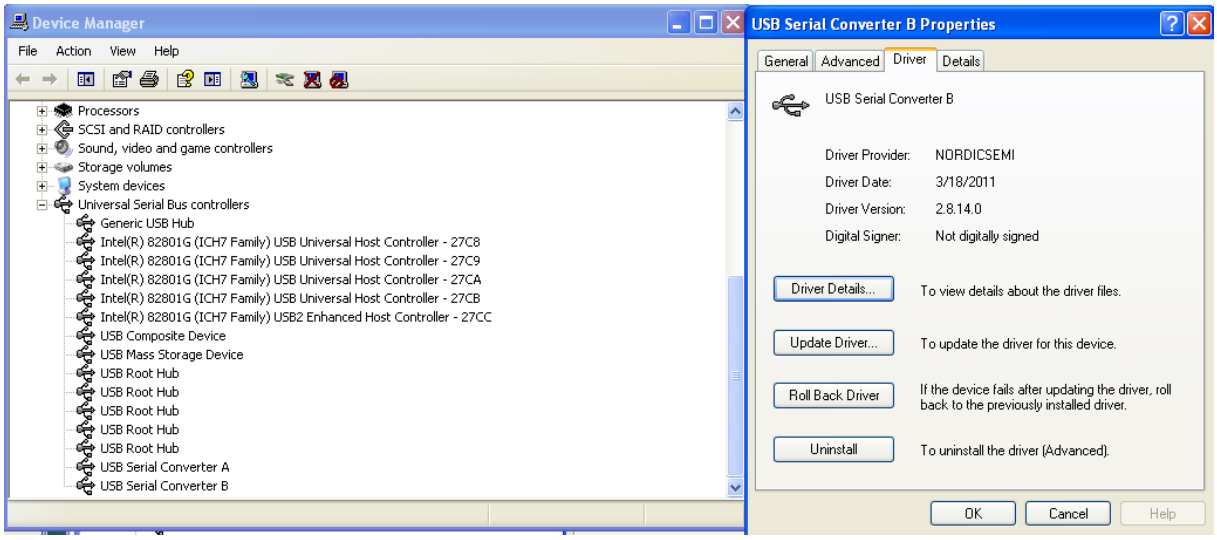
Master Emulator

Connect the nRF2739 Master Emulator to the PC and check to ensure that the USB drivers are correctly installed.

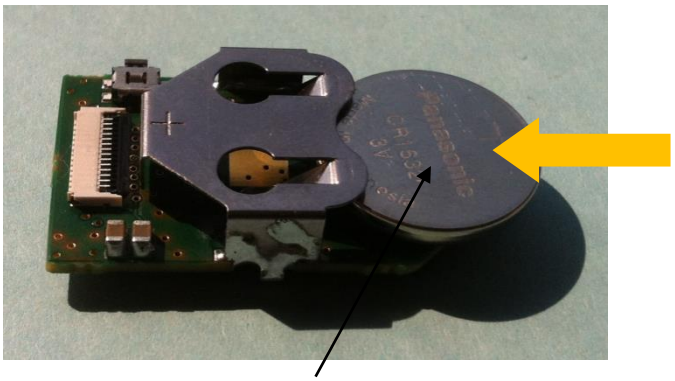
This can be checked on the Control Panel Device Manager under USB Controllers:
USB Serial Converter A
USB Serial Converter B

Should both be installed see below for details:

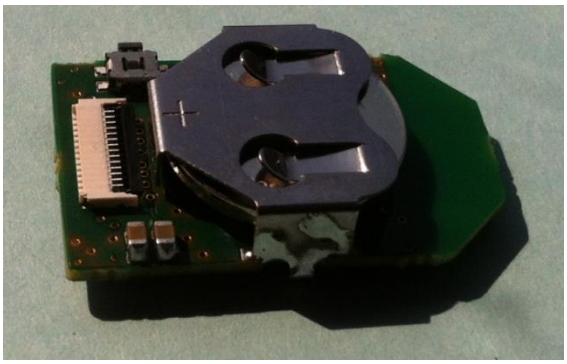




Connect Battery to ISP120911 Luminosity Sensor as shown below:



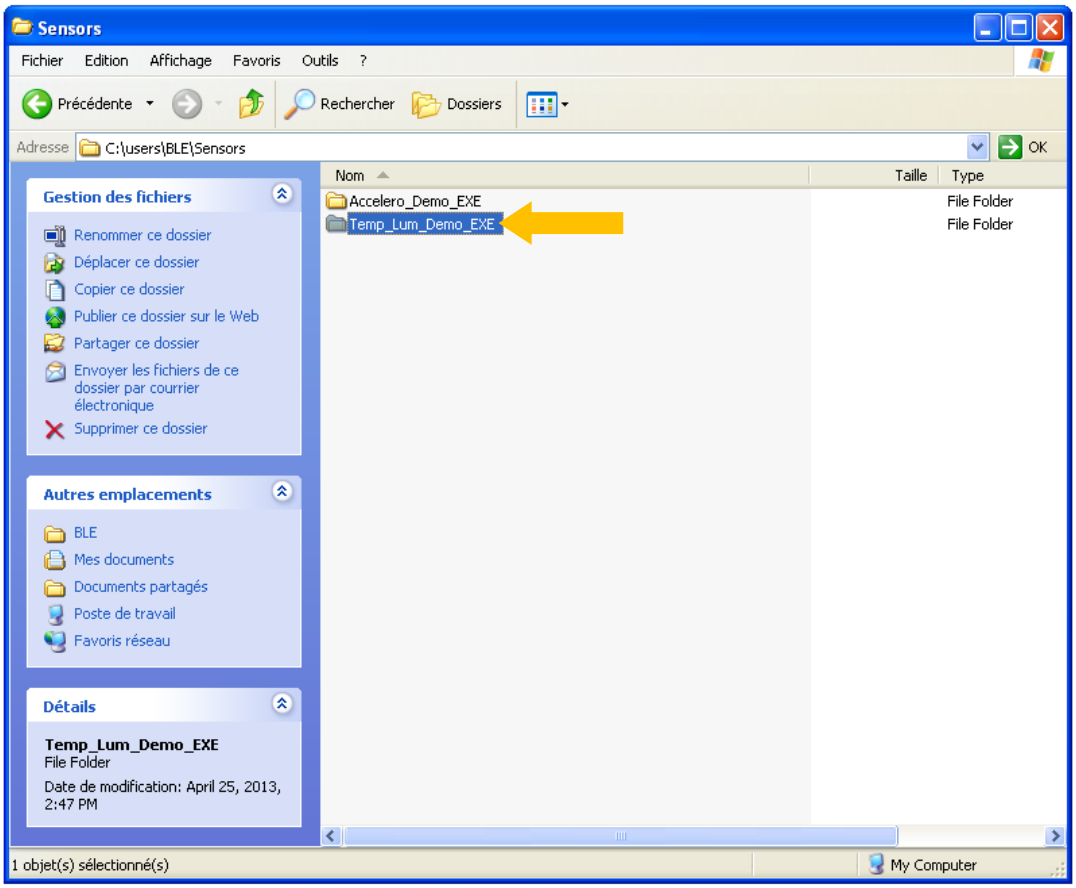
Battery CR1632 POS Terminal UP



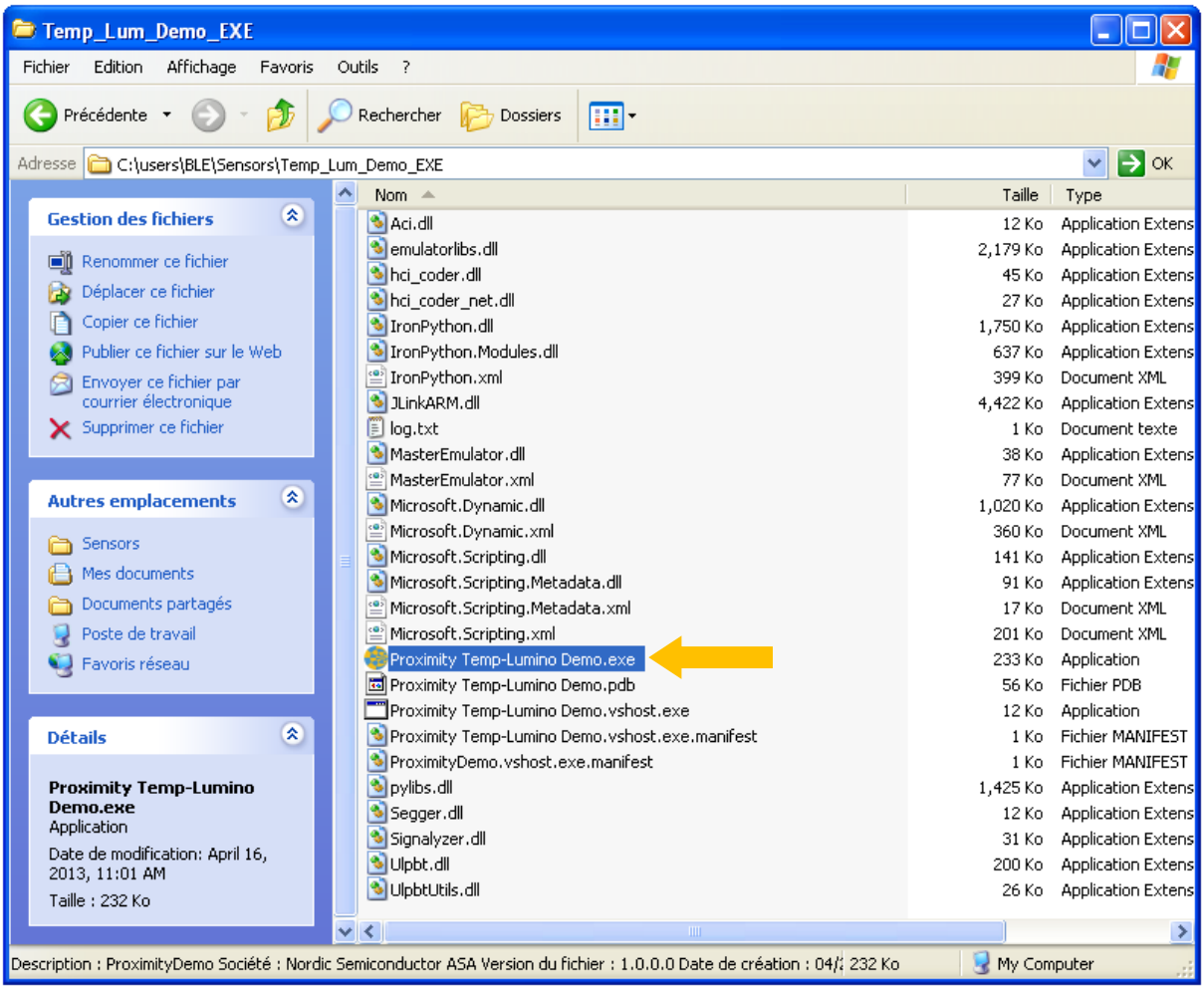
Battery CR1632 Fully Installed

Run Software

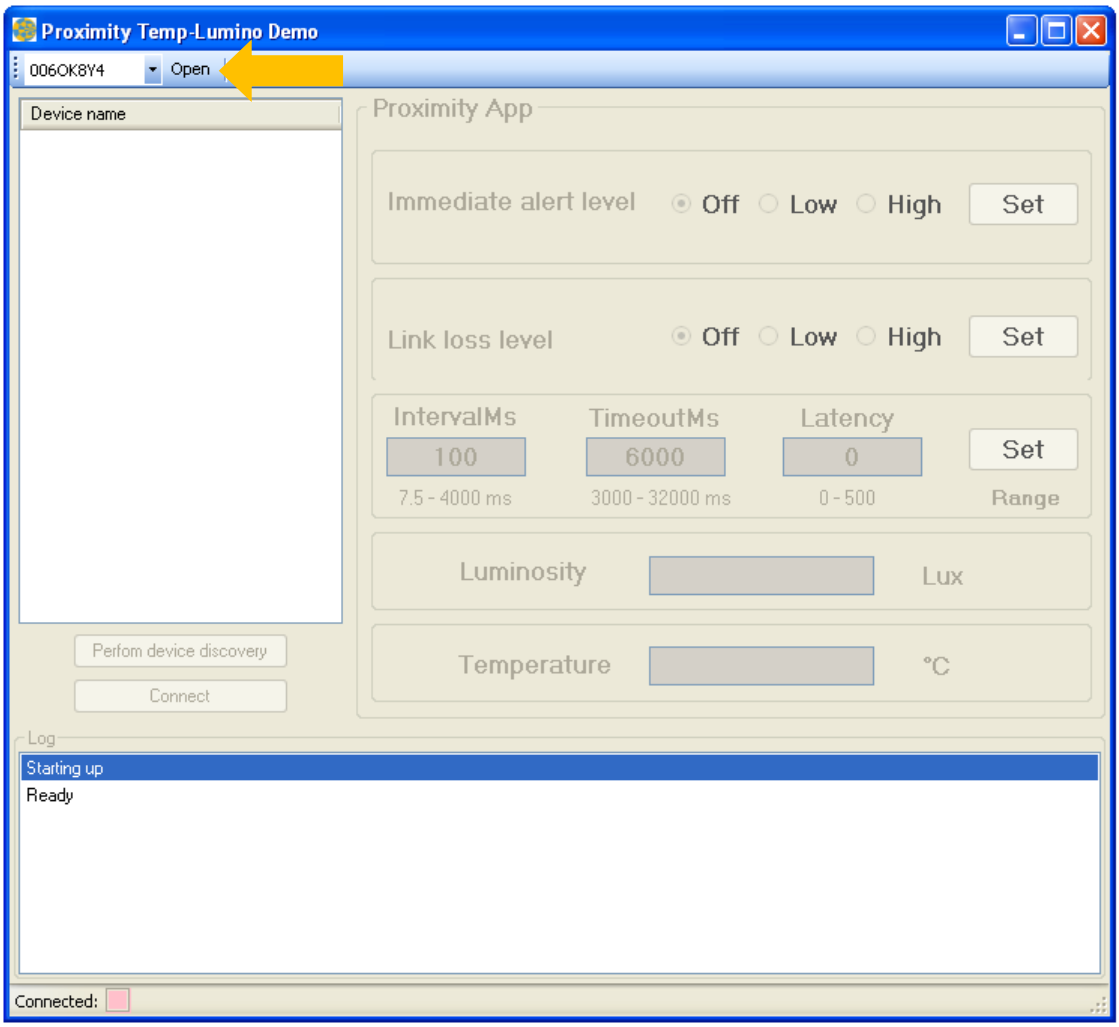
Navigate to the “Temp_Lum_Demo_EXE” folder:



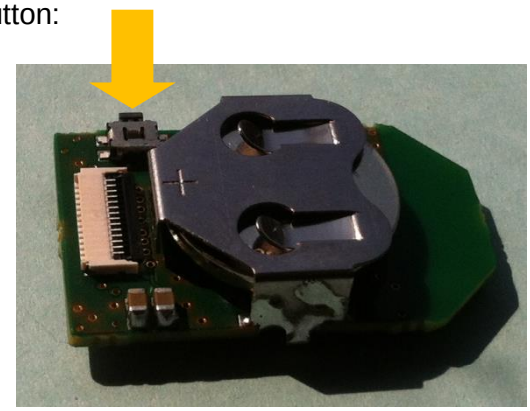
Launch “Proximity Temp-Lumino Demo.exe” (on some systems you may need to launch using “run as administrator”):



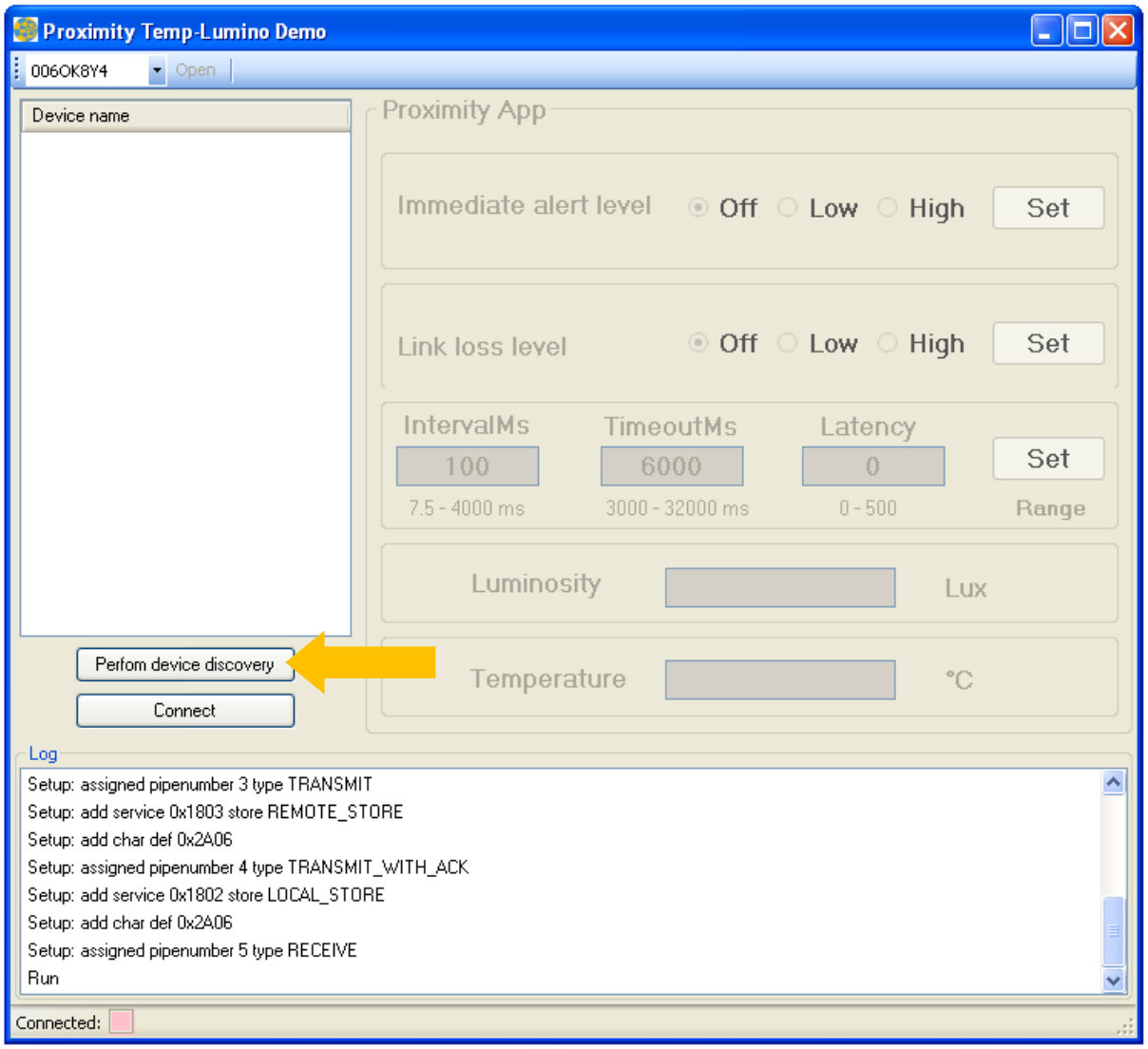
One screen should open. On this screen, click on “Open”:



Reset Luminosity Sensor with small reset button:

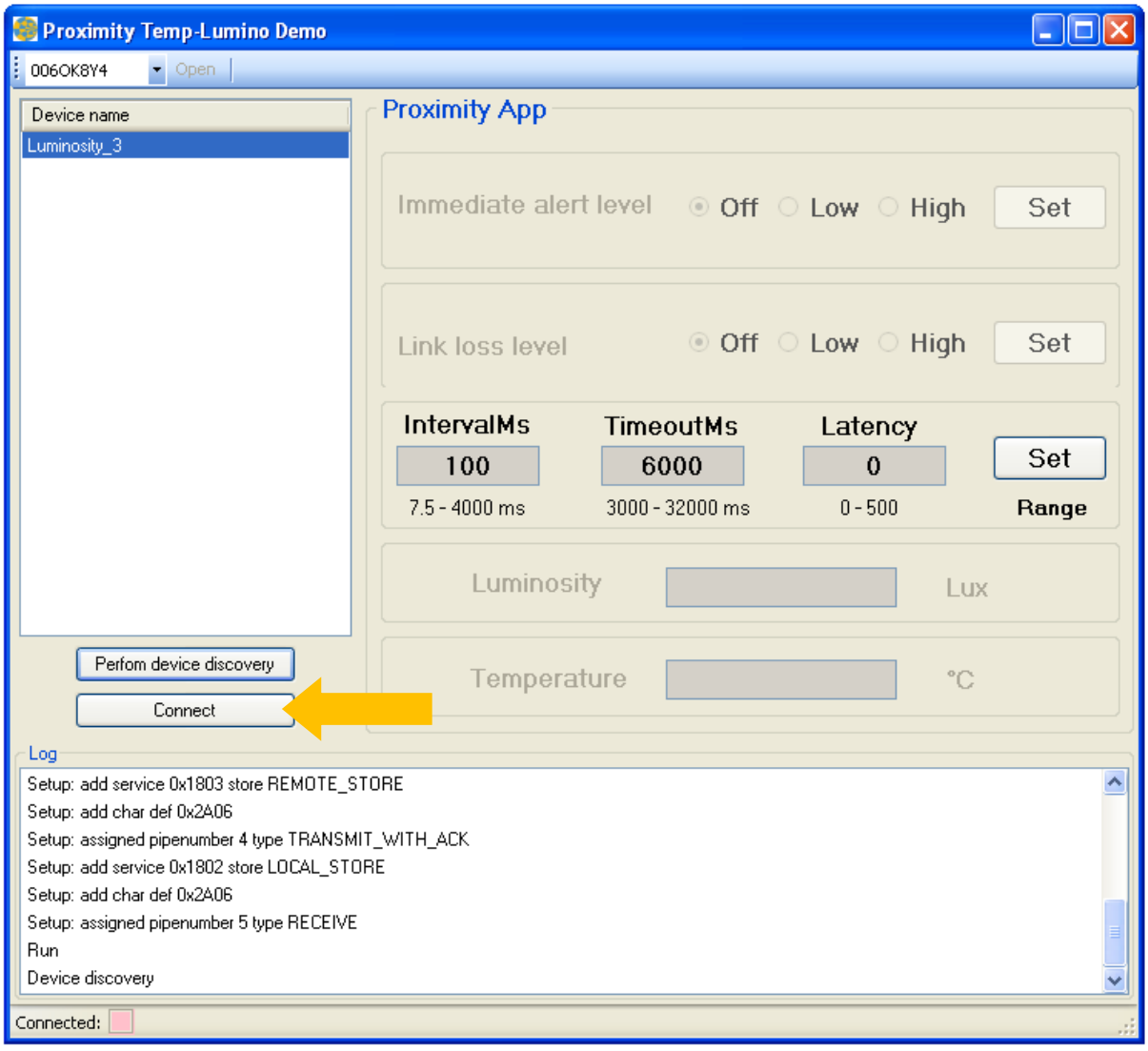


On Panel, click on “Perform Device Discovery”:

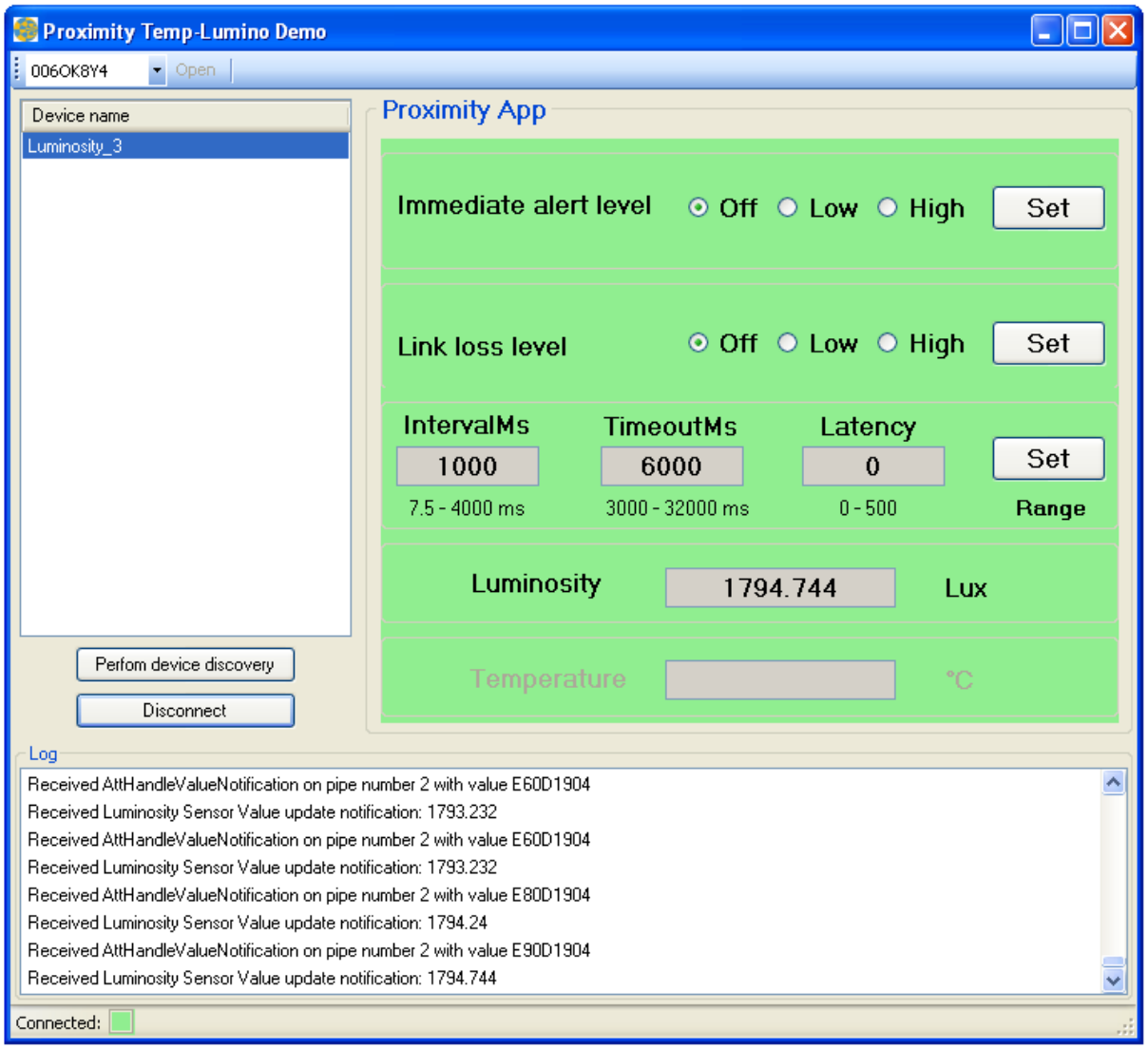


"Luminosity_x" should appear. If this fails, reset Luminosity Sensor (to put into advertising mode) and perform device discovery again.

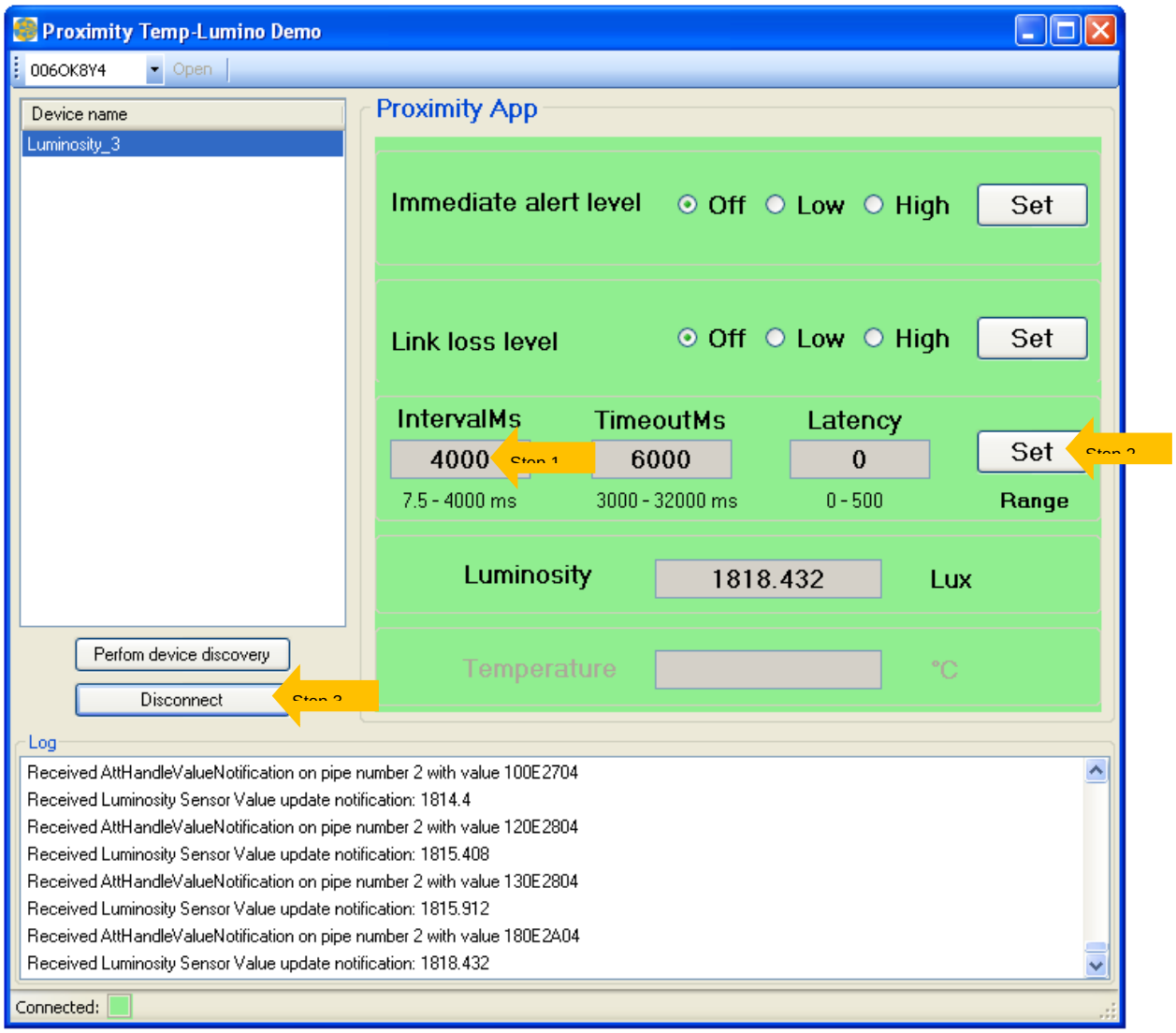
Press on "Connect":



Display should change and be updated every Interval Connection (IntervalMs). Interval Connection is adjustable between 7.5 to 4000 ms. Hereunder, Interval Connection is configured to 1000 ms:



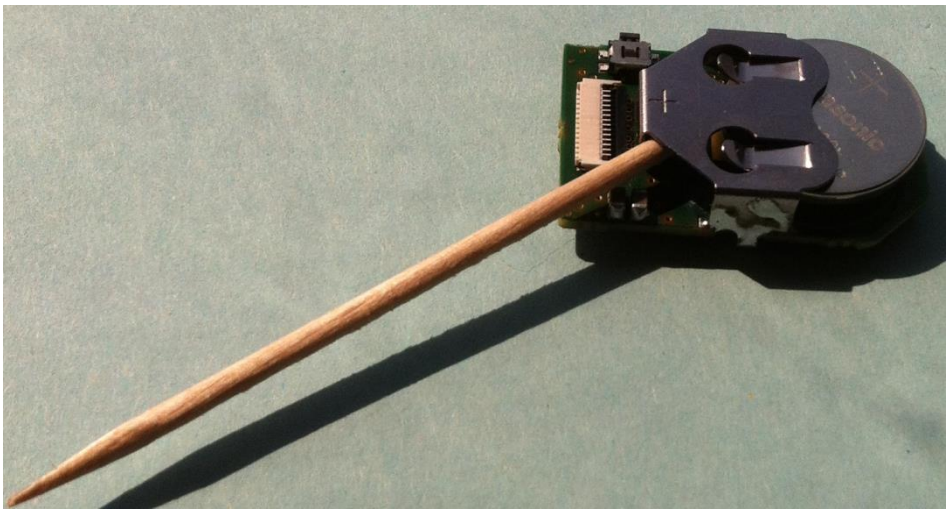
To change Interval Connection to 4000 ms for example, write 4000 in tab “IntervalMs” (step 1), then click on “Set” (step 2). Then click successively on “Disconnect” and “Connect” (step 3):



Stop Software

To switch off PC program, click on top Right Corner of the window.

To switch off Luminosity Sensor, remove battery as shown below:



AN130501
Power Optimization Bluetooth Sensors

Contents

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

1. Introduction

1.1 Scope

This application note describes the performance of three different Bluetooth Smart© sensor nodes, especially the low-power hardware/software platform design. The design of these sensor nodes contain a low power System-in-Package (SiP) module "ISP091201" which integrates both a miniature Antenna-in-Package (AiP), and all the electronic components (transceiver, quartz, SMT components) to ensure RF communication at 2.4 GHz. The node also contains a low power sensing device and the low power host microprocessor LPC1114FHI33/302 from NXP.

The resulting sensor node with 3V coin cell battery CR1632 has overall PCB dimensions of 18 x 29 x 6 mm that make it ideally suited to highly space constrained applications. Different sensor nodes can be implemented using the same PCB with minor modifications related to the sensor.

The first sensor device is ISP120909A Bluetooth Low Energy (BLE) Wireless Temperature Detection Sensor, using TMP112 from Texas Instruments. The second one is ISP120911A Bluetooth Low Energy Wireless Light Detection Sensor, using APDS-9300 from Avago Technologies. The last one is ISP120901A Bluetooth Low Energy Wireless Orientation/Motion Detection Sensor, using MMA7660FC from Freescale Semiconductor.

The Bluetooth Smart© sensor nodes described herein are slave devices may be used in a wireless sensor network, to capture environmental information and send it back to a base station (Master).

1.2 Bluetooth Low Energy Wireless sensor nodes

The design of Bluetooth Smart© sensor nodes contain low power System-in-Package (SiP) module "ISP091201", the low power host microprocessor LPC1114FHI33/302 (NXP) and low power sensing device, as presented in Figure 1.

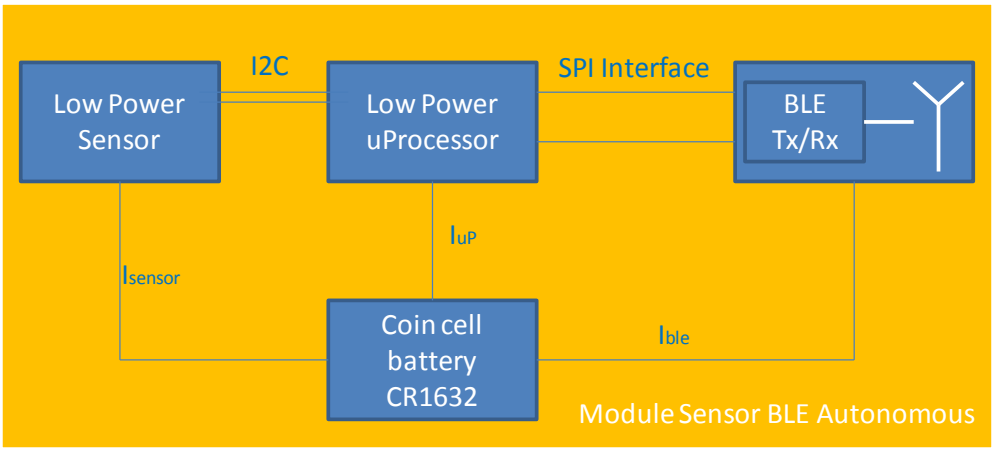


Figure 1: Schema Block of Bluetooth Smart© sensor modules

The microprocessor uses the SPI interface to communicate with the BLE and the I2C interface to communicate with the used sensing device. The specifications of these nodes depend on the used sensing device, as presented in Table 1.

Module	Parameter	Value	Unit
	Power supply	3	V
	Coin cell Battery	CR1632	
	Connection Interval	7.5 to 4000	ms
	PCB dimensions	18 x 29 x 6	mm
Temperature Detection	Accuracy	+/- 0.0625	°C
	Temperature range	-40 to +125	°C
	Resolution	12	bits
Light Detection	Light range	Dark to bright sun	Lux
	Resolution	16	bits
Orientation/Motion Detection	Number of axes	3	
	Acceleration range	+/- 1.5	g (9.81m/s²)

Table 1: specifications of the three Bluetooth Smart© sensor modules

2. Current Consumption Methods

2.1 Generalities

In this paragraph, we present the current drain over time for the three subsets of Bluetooth Smart© sensor node: module “ISP091201”, microprocessor “LPC1114FHI33/302” and sensing device (temperature, light and orientation/motion).

The functioning of these Bluetooth Smart© sensor nodes can be separated in two phases:

- Phase 1: phase of slave-master communication or connection phase: in this phase, the BLE module communicates with the master to send the measurements read by the sensing devices and sent to BLE module by the microprocessor. Thus, the BLE module, the microprocessor and sensing device are active and consume the maximum of current.

- Phase 2: Standby (Sleep) phase: in this phase, there is no communication between the BLE module and the master. Thus, the BLE module and the microprocessor are in Standby mode.

Figure 2 illustrates the two functioning phases of the Bluetooth Smart© temperature node. The measurements presented in Figure 2 are realized by the oscilloscope.

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

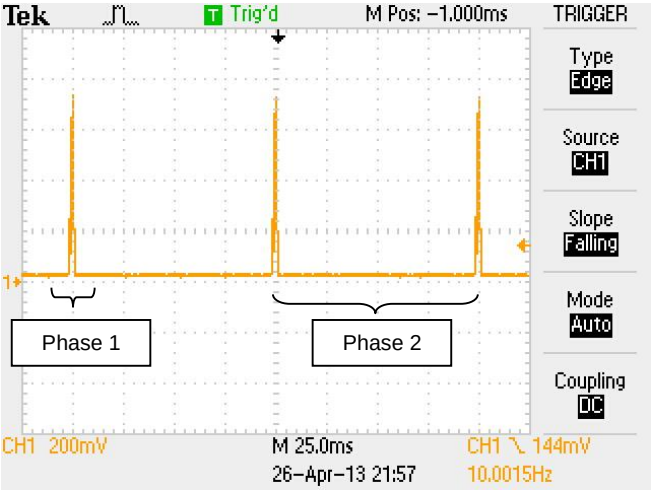


Figure 2: Functioning phases of the Bluetooth Smart© sensor nodes

We present next, the current consumption of the three subsets of Bluetooth Smart© sensor node: module BLE, microprocessor and sensing device (temperature, light and orientation/motion) according to their data sheets. Then, we present two measurement methods of current consumption to each subset and/or total current consumption.

2.1.1 BLE module, Microprocessor and Sensing device current consumption

Figure 3, illustrates the principle of current drain profile for a typical Bluetooth low energy (BLE) module "ISP091201" that is connected (Figure 3-a). It illustrates also the principle of current drain profile for the microprocessor LPC1114FHI33/302 (Figure 3-b) and for the sensing device (Figure 3-c).

For the BLE module, each connection event consists of the following states and operations (different periods related to each connection event), as presented in Figure 3-a. The current consumption profile is related to each state and operation. The numbers and related currents below correspond to that displayed in Figure 3:

- 1 : Radio pre-processing period (I_{MCU_LL} and $I_{Standby}$),
- 2 : Active radio receive time (I_{Rx}),
- 3 : Radio Inter frame Space (I_{TFS}),
- 4 : Active transmit time (I_{Tx}),
- 5 : Link layer post processing period (I_{MCU_LL}),
- 6 : Data post processing period, enabled only if data has been received (I_{MCU_HOST}).

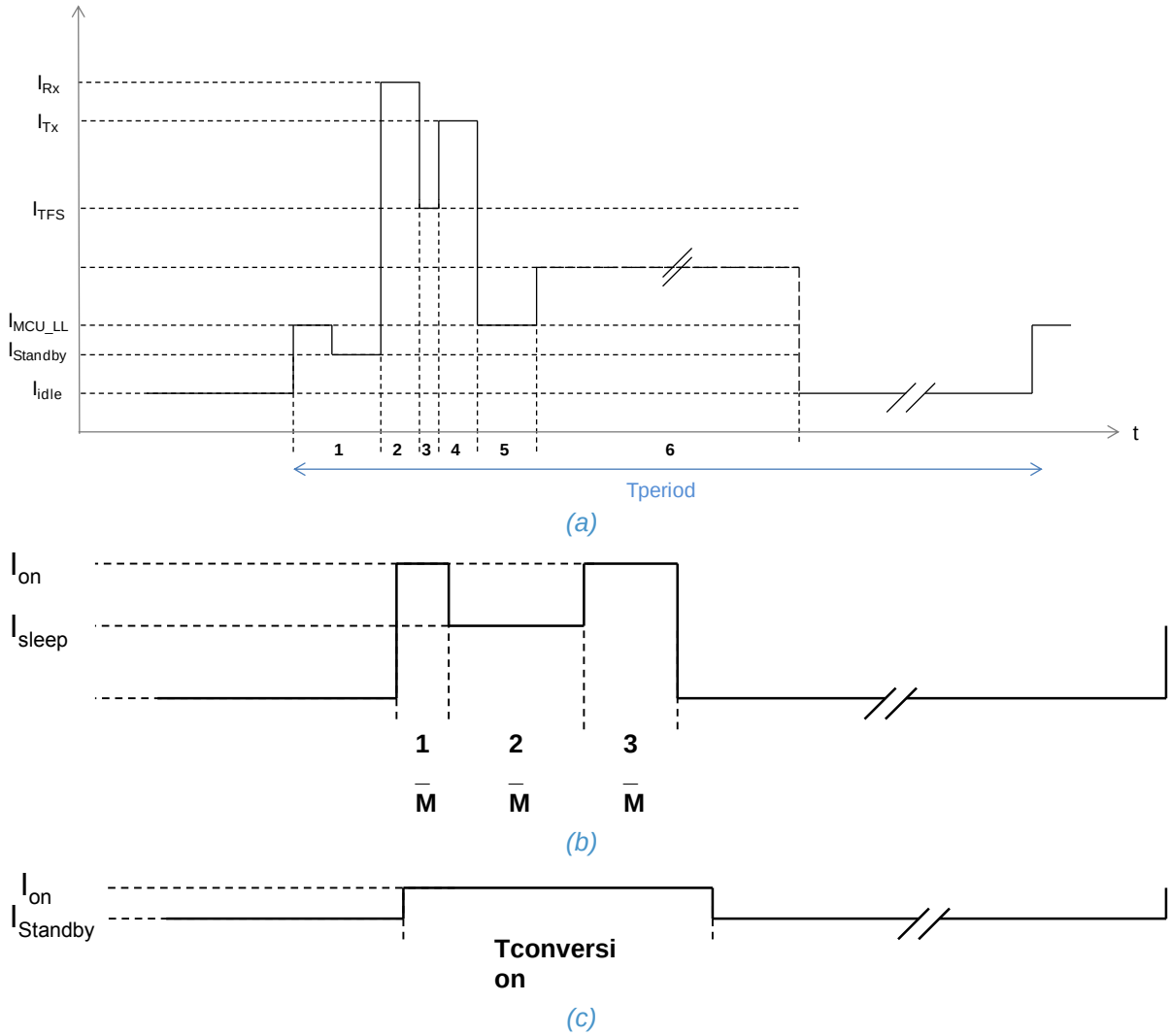


Figure 3: Current consumption over time for a typical module ISP091201(a), microprocessor "LPC1114FHI33/302" (b) and for sensing device (c)

The values of static current consumption of BLE module "ISP091201" for its different states and operations in each connection event are defined in Table 2.

Symbol	Parameter (condition)	Nom	Unit
I_{Rx}	Peak current, receiver active	14.6	mA
I_{Tx}	Peak current, transmitter active	12.7	mA
I_{TFS}	Peak current when switching between Receive and transmit	7	mA
I_{MCU_HOST}	Peak current for host processing	5	mA
I_{MCU_LL}	Peak current for LL processing	3.5	mA
$I_{Standby}$	Standby current	1.6	mA
I_{idle}	Current drain between connection/advertising events ACI=active mode, 32kHz Osc active	2	uA

Table 2: Current consumption static values of BLE module

For the microprocessor LPC1114FHI33/302, each connection event consists of three states and periods, as presented in Figure 3-b:

- 1_M : Read period (I2C communication with sensing device to read measurements),
- 2_M : Waiting time (related to post-processing period),
- 3_M : Send period (SPI communication with the BLE to send the measurements).

For certain sensing devices and depending to the application, the order of these three states can changed, or the 2_M state can be not used to reduce the microprocessor current consumption.

The values of current consumption of microprocessor LPC1114FHI33/302 for its different states and operations in each connection event are defined in Table 3.

Symbol	Parameter (condition)	Nom	Unit
I_{on}	Current of active mode	3 to 4	mA
I_{sleep}	Current of Sleep mode All the clocks are active	2	mA
$I_{deep-sleep}$	Current of Deep-Sleep mode All the clocks are turned off	6	uA

Table 3: Current consumption values of microprocessor LPC1114FHI33/302

Finaly, for the sensing device, each connection event consists of two states and periods, as presented in Figure 3-c:

- $I_{Standby}$: Standby period current,
- I_{on}: Active period current (I2C communication with microprocessor + conversion time).

The used sensing devices are: temperature sensor “TMP112”, light sensor “APDS-9300” and orientation/motion sensor “MMA7660FC”. The values of current consumption of these three sensing devices in each connection event are defined in Table 4.

Temp sensor TMP112 – Symbol	Nom	Unit
I_{on}	40	uA
$I_{Standby}$	2.2	uA
Light sensor APDS – Symbol	**Nom**	**Unit**
I_{on}	0.24	mA
$I_{Standby}$	3.2	uA
Orientation/Motion sensor MMA7660FC – Symbol	**Nom**	**Unit**
I_{on}	0.047 to 0.294 Depending on Sampling Rate	mA
$I_{Standby}$	2	uA

Table 4: Current consumption values of temperature, light and orientation/motion sensors

2.1.2 Power management and optimization of current consumption

The power management consists to minimize the current consumption of the three subsets BLE, microprocessor and sensor in the two phases of operation.

For the first phase, where the BLE, microprocessor and sensing device are active, we must choose the operation parameters of the three subsets that reduce the current consumption to the minimum. We must therefore manage the time and the level of current consumption while maintaining the proper functioning according to the intended application.

For the second phase, where the subsets are in Standby (Sleep) mode, it is to operate the BLE and the microprocessor in Sleep mode and deactivate the sensing device. The goal is to reduce the total current consumption during this long phase to near zero.

It is important to know that the total current consumption depend on the data size to be read by the sensing device and to be send by the microprocessor (after I2C communication) to BLE module using SPI interface, then the BLE module will send these data to Master using BLE wireless connection.

In fact, the total current consumption depends on the type and the number of used services defined in Bluetooth Low Energy protocol for a given application. The transmitted data between the microprocessor and the BLE module are managed by these services. Thus, the number of defined services and the data size of each service will define Data Layer post-processing period, together with the TX time and, consequently, the level of current consumption.

For example, for the temperature node, we have defined just one service with data size of 2 bytes which are the temperature measurements. While for the light node, we have defined just one service with data size of 4 bytes, which will lead to more current consumption. Clearly, larger the data size to be transmitted, greater Data Layer post-processing period and the Ion time of both microprocessor and sensing device, greater the level of current consumption by consequence.

In the next paragraph, we present two complementary methods for current consumption measurements. The first one using oscilloscope to measure the current consumption of BLE module and microprocessor during the connection phase (Phase 1), where the consumption is maximum. The sensing device consumption is very weak (of the order of a few uA), we will see that this measurement method using just the oscilloscope is not suitable for measuring low currents. Thus, we have developed another method, based on the principle of charging and discharging a capacitor to measure the total current consumption, including low-consumption sensing device. In addition, this method can measure the total consumption during the Standby-sleep phase (Phase 2), where current consumption of each subset is very weak.

2.2 Oscilloscope measurement method

Oscilloscope measurement method is a simple one, based on fact to connect a low-value resistor (0.5 Ohm) to the power feed of each subset BLE, microprocessor and sensing device, as presented in Figure 4. These resistors have been integrated into the wireless miniature nodes. Voltages at each end of the resistance are returned to a measurement board by means of FPC cable for this purpose.

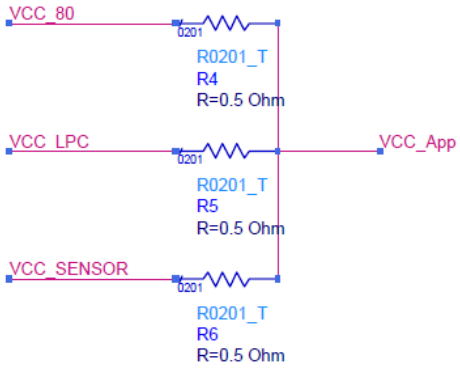


Figure 4: Electric Schema of current measurement for oscilloscope measurement method

On the measurement board, an INA195 amplifier (Texas Instruments) with gain 100 is used to amplify the differential voltage across the ends of each resistor. So by measuring the voltage at the output of each INA195, we measure the current consumption $(I = V/0.5)$ of each subset, then the total current consumption. The high gain of the INA195 allows us to measure relatively low currents.

2.2.1 Temperature sensor node

Figure 5 illustrates the two functioning phases of BLE module and microprocessor measured by oscilloscope method for temperature sensor node.

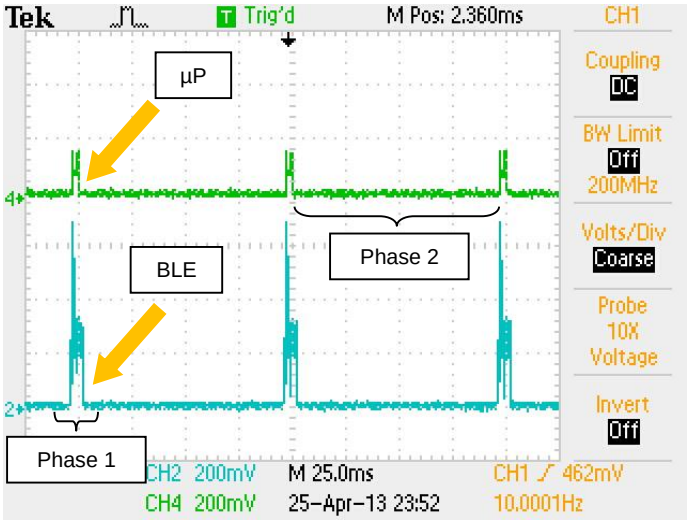


Figure 5: Temperature sensor node: two functioning phases of BLE module and microprocessor, as measured by oscilloscope method

To measure the current consumption of BLE module and microprocessor during phase 1, simply measure the voltage and duration of each segment of consumption displayed on the oscilloscope, as presented in Figure 6.

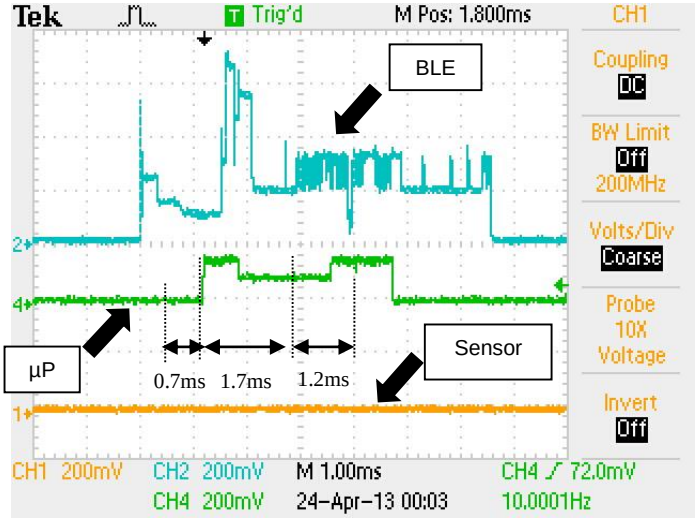


Figure 6: Temperature sensor node: current consumption measurements of BLE module, microprocessor and sensing device, as measured by oscilloscope method

For the microprocessor current consumption measurements in temperature sensor node, we have three consumption segments (0.7 ms, 1.7ms and 1.2 ms), as presented in Figure 6. The corresponding current and charge consumption values in these three segments is presented in Table 5. These three segments correspond to events presented in Table 3. The current and charge consumption calculations associated with each segment are based on the following two equations:

$$I = \frac{V_{osc}/_{100}}{R} = \frac{V_{osc}/_{100}}{0.5} = \frac{V_{osc}}{50}, Q = I \times T$$

Temperature sensor node: Microprocessor LPC1114 Consumption				
Symbol	**Time (ms)**	**Voltage (mV)**	**Current (mA)**	**Charge (µC)**
I_{on} (Read)	0.7	170	3.4	2.38
I_{sleep} (Wait)	1.7	100	2.0	3.40
I_{on} (Data send)	1.2	170	3.4	4.08
Total	3.6			9.86

Table 5: Temperature sensor node: current and charge consumption measurements of microprocessor, as measured by oscilloscope method

Similarly, to measure the BLE module current consumption in temperature sensor node, we have 6 consumption segments. These 6 segments correspond to events presented in Table 2.

Table 6, presents the corresponding current and charge consumption values of BLE module, as measured by oscilloscope method using the two precedent equations. BLE module current consumption measurements are consistent with the values given by the software provided by Nordic Semiconductor (nRFgo Studio). In this software, depending on the type and the number of defined services and depending on the measurement time (Connection Interval), we can estimate the current consumption of BLE module.

Temperature sensor node: BLE module Consumption				
Symbol	**Time (ms)**	**Voltage (mV)**	**Current (mA)**	**Charge (µC)**
I_{MCU_LL}	1.14	230	4.60	5.24
$I_{Standby}$	1.20	136	2.72	3.26
I_{Rx}	0.24	660	13.20	3.17
I_{TFS}	0.10	480	9.60	0.96
I_{Tx}	0.25	560	11.20	2.80
I_{MCU_HOST}	3.64	260	5.20	18.93
Total	6.57			34.36

Table 6: Temperature sensor node: current and charge consumption measurements of BLE module, as measured by oscilloscope method

For Temperature sensor node, for example, if we define just one service with data size of 2 bytes and for connection interval of one second, the estimated current consumption is about 35.04 µA, as presented in Figure 7. This is consistent with our measurements presented in Table 6, where the measured charge is 34.36 µC, thus:

$$I_{measured} = \frac{Q_{measured}}{\Delta t} = \frac{34.36\ \mu C}{T_{period}} = \frac{34.36\ \mu C}{1s} = 34.36\ \ \mu A$$

The measurement time (Connection Interval) of one second corresponds to parameter T_{period} in Figure 3, which is the sum of Phase 1 time and Phase 2 time. If we consider that the current consumption of BLE module in Phase 2 is negligible (2 µA, cf Table 2), so our measurements using oscilloscope method during Phase 2 are consistent with the data sheet and specifications given by the constructor.

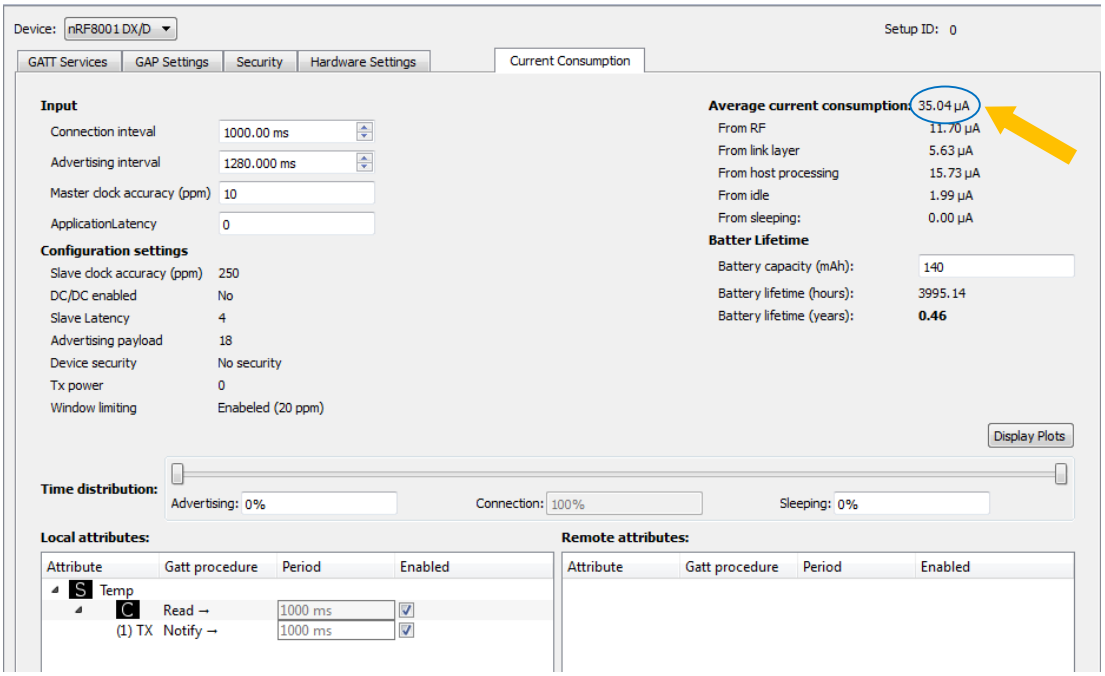


Figure 7: Temperature sensor node: BLE module current consumption, as estimated by nRFgo Studio software

2.2.2 Light sensor node

Figure 8 illustrates the two functioning phases of BLE module and microprocessor measured by oscilloscope method for light sensor node.

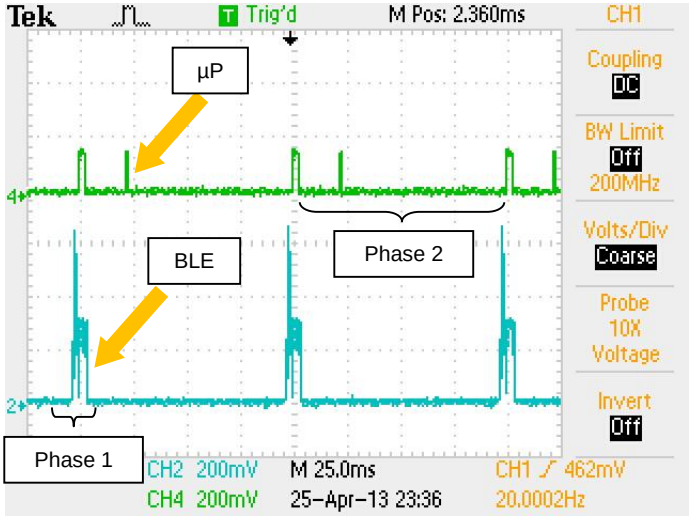


Figure 8: Light sensor node: 2 functioning phases of BLE module and microprocessor, as measured by oscilloscope method

To measure the current consumption of BLE module and microprocessor during phase 1, simply measure the voltage and duration of each segment of consumption displayed on the oscilloscope, as presented in Figure 9.

Figure 9: Light sensor node: current consumption measurements of BLE module and microprocessor, as measured by oscilloscope method

For the microprocessor current consumption measurements in light sensor node, we have two consumption segments (2.52 ms and 0.92 ms), as presented in Figure 9. The corresponding current and charge consumption values in these two segments are presented in Table 7.

The third segment (I_{sleep}) is not used in light sensor node (I_{sleep}_time=0), because the Read operation (I2C communication between the sensing device and the microprocessor) is done after Radio activities to minimize the current consumption of the sensing device. In fact, the light sensing device has a relatively high current consumption when it is active (0.24 mA, cf Table 4), and it hasn't Shut_Down option after its conversion time as in temperature sensing device case. The power management, we have proposed, is to turn on the sensing device during the first microprocessor activity, waiting its conversion time (min_time > 13.7ms) using Deep Sleep mode, then read sensing device measurements and turn it off.

Light sensor node: Microprocessor LPC1114 Consumption				
Symbol	**Time (ms)**	**Voltage (mV)**	**Current (mA)**	**Charge (µC)**
I_{on} (Data send)	2.52	170	3.4	8.57
I_{sleep} (Wait)	0.00	100	2.0	0.00
I_{on} (Read)	0.92	170	3.4	3.13
Total	3.44			11.7

Table 7: Light sensor node: current and charge consumption measurements of microprocessor, as measured by oscilloscope method

Similarly, to measure the BLE module current consumption in light sensor node, we have 6 consumption segments. These 6 segments correspond to events presented in Table 2. Table 8 presents the corresponding current and charge consumption values of BLE module, as measured by oscilloscope method.

Light sensor node: BLE module Consumption				
Symbol	**Time (ms)**	**Voltage (mV)**	**Current (mA)**	**Charge (µC)**
I_{MCU_LL}	1.14	230	4.60	5.24
$I_{Standby}$	1.20	136	2.72	3.26
I_{Rx}	0.24	660	13.20	3.17
I_{TFS}	0.10	480	9.60	0.96
I_{Tx}	0.25	560	11.20	2.82
I_{MCU_HOST}	4.96	260	5.20	25.79
Total	7.89			41.25

Table 8: Light sensor node: current and charge consumption measurements of BLE module, as measured by oscilloscope method

2.2.3 Orientation/Motion sensor node

Figure 10 illustrates the two functioning phases of BLE module and microprocessor measured by oscilloscope method for orientation/motion sensor node.

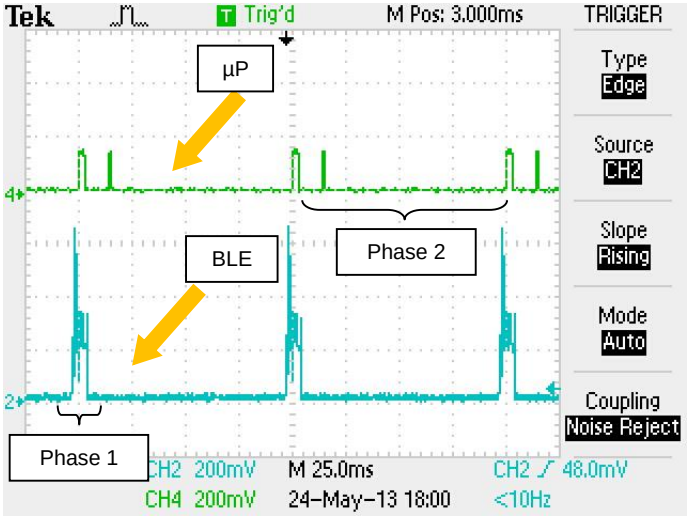


Figure 10: Orientation/Motion sensor node: 2 functioning phases of BLE module and microprocessor, as measured by oscilloscope method

To measure the current consumption of BLE module and microprocessor during phase 1, simply measure the voltage and duration of each segment of consumption displayed on the oscilloscope as presented in Figure 11.

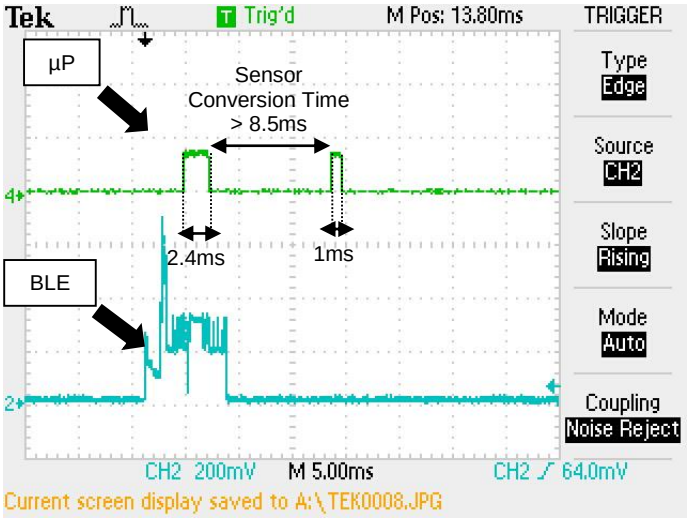


Figure 11: Orientation/Motion sensor node: current consumption measurements of BLE module and microprocessor, as measured by oscilloscope method

As for light sensor node, we have two consumption segments (2.4 ms and 1 ms), as presented in Figure 11 for the microprocessor current consumption measurements in orientation/motion sensor node. The corresponding current and charge consumption values in these two segments are presented in Table 9. The third segment (I_{sleep}) is not used in orientation/motion sensor node (I_{sleep}_time=0), as the case of light sensor node, to minimize the current consumption of the orientation/motion sensing device. The minimum conversion time for orientation/motion sensing device is 8.333 (120 Samples/second).

Orientation/Motion sensor node: Microprocessor LPC1114 Consumption				
Symbol	**Time (ms)**	**Voltage (mV)**	**Current (mA)**	**Charge (µC)**
I_{on} (Data send)	2.4	170	3.4	8.16
I_{sleep} (Wait)	0.0	100	2	0.00
I_{on} (Read)	1.0	170	3.4	3.40
Total	3.4			11.56

Table 9: Orientation/Motion sensor node: current and charge consumption measurements of microprocessor, as measured by oscilloscope method

Similarly, to measure the BLE module current consumption in orientation/motion sensor node, we have 6 consumption segments. These 6 segments correspond to events presented in Table 2. Table 10 presents the corresponding current and charge consumption values of BLE module, as measured by oscilloscope method.

Orientation/Motion sensor node: BLE module Consumption				
Symbol	**Time (ms)**	**Voltage (mV)**	**Current (mA)**	**Charge (µC)**
I_{MCU_LL}	1.14	230	4.60	5.24
$I_{Standby}$	1.20	136	2.72	3.26
I_{Rx}	0.24	660	13.20	3.17
I_{TFS}	0.10	480	9.60	0.96
I_{Tx}	0.25	560	11.20	2.81
I_{MCU_HOST}	4.70	260	5.20	24.44
Total	7.63			39.88

Table10: Orientation/Motion sensor node: current and charge consumption measurements of BLE module, as measured by oscilloscope method

According to Table 7 and Table 8 for temperature sensor node, and comparing to Table 5 and Table 6 for light sensor node, or Table 9 and Table 10 for orientation/motion sensor node, we find that the current consumption of light or orientation/motion sensor nodes is more important than the current consumption of the temperature sensor node, especially the consumption of BLE module. In fact, this increase in current consumption of BLE module is mainly related to the consumption time of ''I_{MCU_HOST}'', which is longer in the case of light or orientation/motion sensor nodes, because of the greater data size (4 bytes for the light sensor node and 3 bytes for orientation/motion sensor node) relative to the 2 bytes in the case of temperature sensor node. The greater number of bytes (data size) also increases the consumption of the microprocessor, because it also requires a longer consumption time of ''I_{on}'' for reading measurements made by the sensing device and for sending them to BLE module.

Regarding the current consumption of the sensing device, it is very low (in the order of a few uA). Because of an intrinsic offset of INA195 component used in the oscilloscope measurement method, we cannot characterize this low current with this method. This is confirmed by Figure 6, where we cannot measure the consumption of the temperature sensing device.

2.3 Capacitor measurement method

To overcome low currents limitation of oscilloscope measurement method and to obtain more accurate measurements, we developed another measurement method: the Capacitor Approach. This method is based on the principle of charging calibrated capacitor, then turns off the power supply and feed the sensor node by this charged capacitor. Total current consumption of sensor node will discharge this capacitor and decrease its voltage. By measuring the voltage drop across the capacitor as a function of time, we can determine the total current consumption and/or the total charge consumption, as presented in the two following equations:

$$I = \frac{Q}{\Delta t} \text{ où } Q = C \times \Delta V$$

This method allows the measurement of low currents (in the order of a few uA), particularly to characterize the current consumption of sensing device during the connection phase (Phase 1),
but also to characterize the total current consumption during the Standby-sleep (Phase 2), where the current consumption of BLE module, microprocessor and sensing device is very low.

The capacitor used in this method is a ceramic capacitor of about 600 uF. To know the precise value of this capacitance, we have used an RC circuit to calibrate the capacitance value. For this, we have connected the capacitor to resistor with an accurate value of 1 KΩ, as shown in Figure 12.

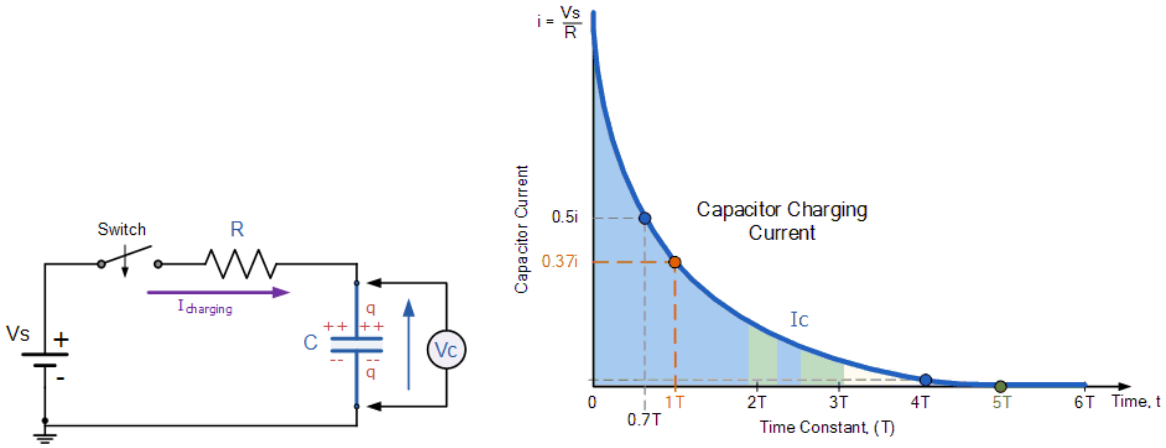


Figure 12: Electric Schema of RC circuit and its discharging curve, versus time

The time constant of this circuit is given as:

$$T = R \times C$$

So by measuring the time constant on the oscilloscope, we can calibrate the capacitance that we will use to accurately measure the current consumption. Figure 13 shows the discharge curve of the measured RC circuit.

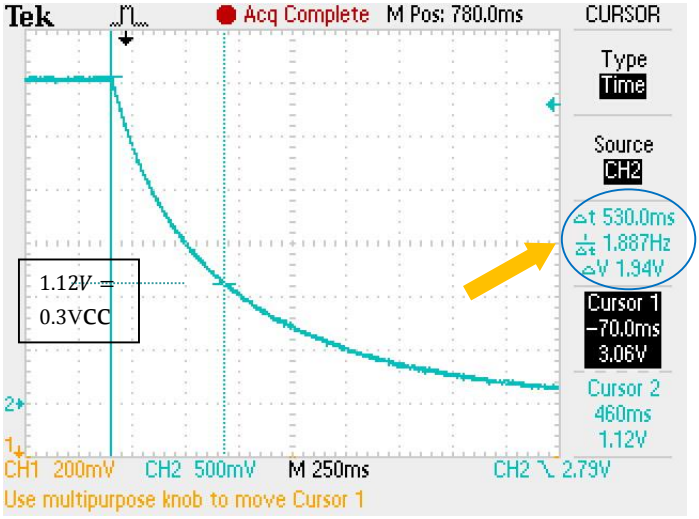


Figure 13: Discharging curve of RC circuit to calibrate the measurement capacitance, as measured

From Figure 13, the time constant is 530 ms, so the precise value of the capacitance is:

$$C = \frac{530\ ms}{1\ KOhm} = 530\ \mu F$$

Once the capacitance is calibrated, we applied the capacitor measurement method to measure total current consumption. Figure 14 shows the electric schema for measuring the total current consumption of sensor nodes using capacitor measurement method.

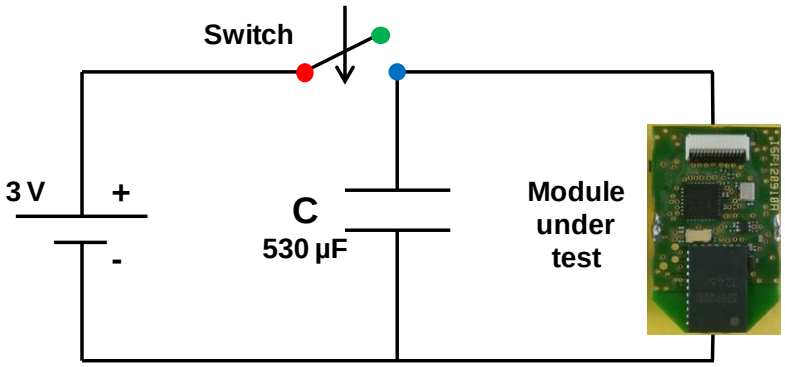


Figure 14: Electric schema to measure the total current consumption of sensor nodes using capacitor measurement method

2.3.1 Temperature sensor node

Figure 15 shows the measurements of total current consumption of temperature sensor node for the two functioning phases (Phase 1+Phase 2), carried out by the capacitor method for measurement time (Connection Interval) of 1 second.

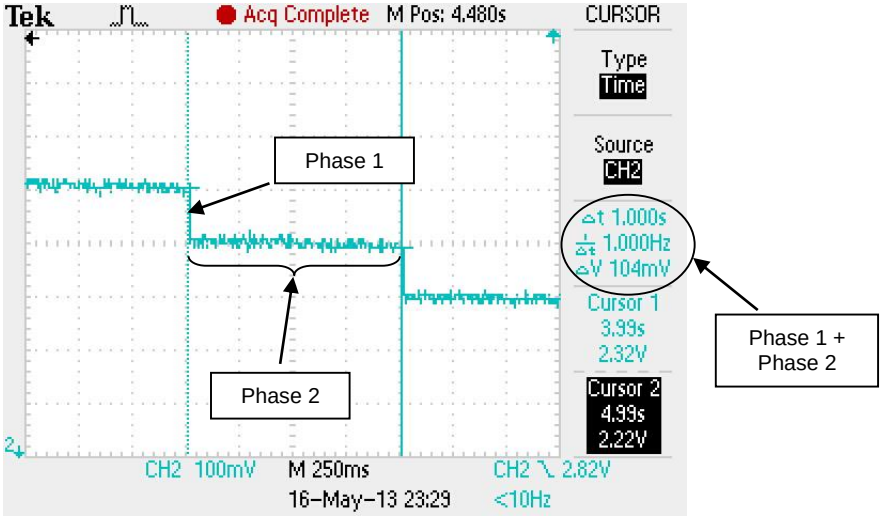


Figure 15: Temperature sensor node: total current consumption measurements, as measured by capacitor method

In these measurements that look like a staircase, the voltage drop is related to the total current consumption of the sensor node during the communication phase (Phase 1) where there is a high consumption for a short time (6-10 ms). However the low slope of consumption is related to the total consumption of the sensor node for the Standby-sleep phase (Phase 2).

The total charge consumption of the temperature node sensor for (Connection Interval) ($T_{period} = 1s$), as presented in Figure 15, is of the order of:

$$Q_{Phase\ 1+Phase\ 2} = C \times \Delta V = 530\mu F \times 0.104V = 55.12\ \mu C$$

Figure 16 presents the measurements of total consumption of temperature sensor node during the communication phase (Phase 1). We observe a voltage drop of 88 mV during this phase, so the total charge consumption in the communication phase is of the order of:

$$Q_{Phase\ 1} = C \times \Delta V = 530\mu F \times 0.088V = 46.64\ \mu C$$

This is consistent with measurements made for the BLE module and the microprocessor by the oscilloscope method presented in the previous paragraph (Table 5 and Table 6), where:
$Q_{BLE} = 34.36\ \mu C$ and $Q_{\mu P} = 9.86\ \mu C$.
The difference between the two measurements is the consumption of the sensing device during the communication phase (Phase 1), so:
$Q_{sensor} = 46.64 - (34.36 + 9.86) = 2.42\ \mu C$.

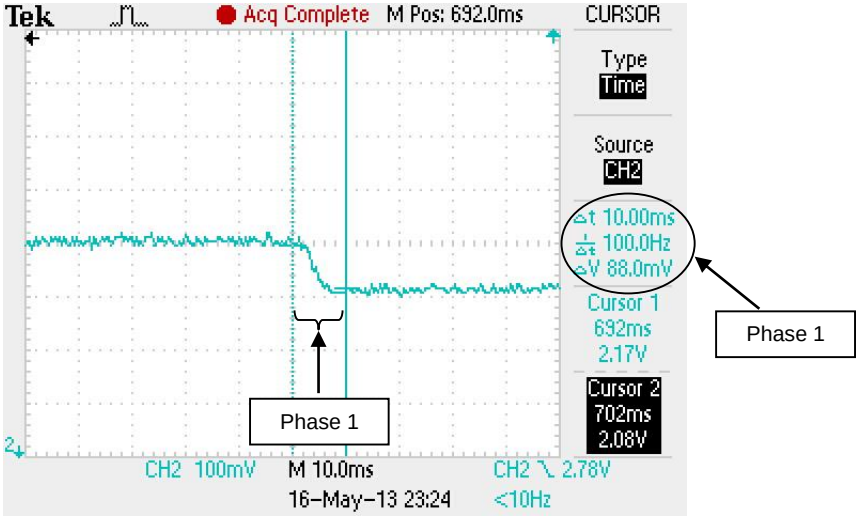


Figure 16: Temperature sensor node: total current consumption measurements during Phase 1, as measured by capacitor method

Figure 17 presents the measurements of total consumption of temperature sensor node during the Standby-sleep (Phase 2). We observe a voltage drop of 16 mV during this phase, so the total charge consumption in the Standby-sleep phase, is of the order of:

$$Q_{Phase\ 2} = C \times \Delta V = 530\mu F \times 0.016V = 8.48\ \mu C$$

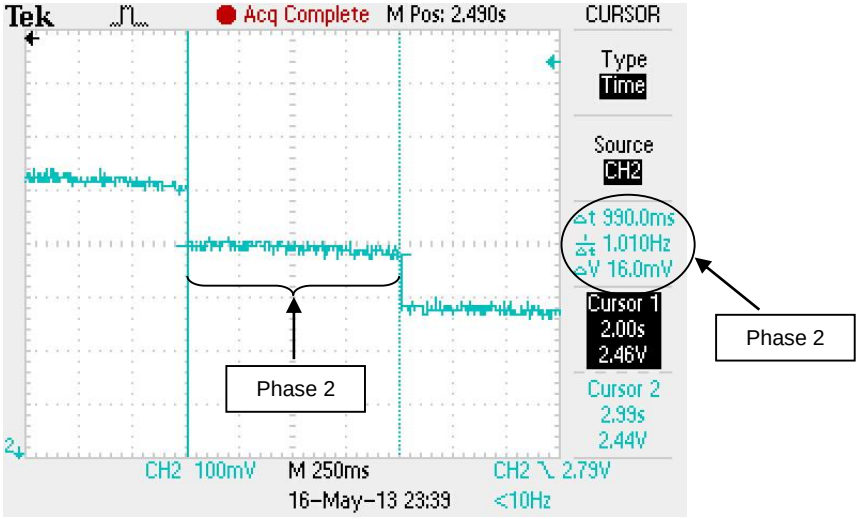


Figure17: Temperature sensor node: total current consumption measurements during Phase 2, as measured by capacitor method

So the total average current consumption of the temperature sensor node for the period ($T_{period} = 1s$) is of the order of:

$$I_{T_{period}=1s} = \frac{Q_{Phase\ 1} + Q_{Phase\ 2}}{1s} = (46.64 + 8.48)\mu A = 55.12\ \mu A$$

2.3.2 Light sensor node

Figure 18 shows the measurements of total current consumption of light sensor node for the two functioning phases (Phase 1+Phase 2), carried out by the capacitor method for measurement time (Connection Interval) of 1 second.

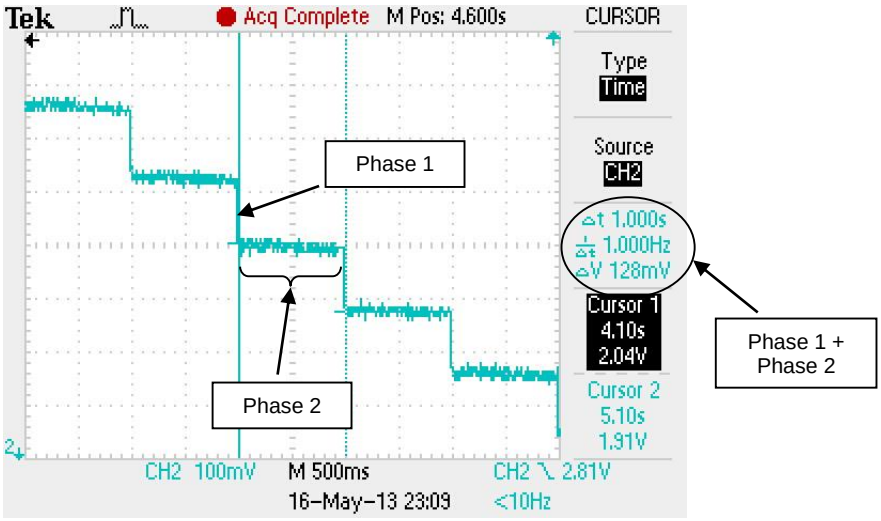


Figure18: Light sensor node: total current consumption measurements, as measured by capacitor method

The total charge consumption of the light sensor node for (Connection Interval) ($T_{period} = 1s$), as presented in Figure 18, is of the order of:

$$Q_{Phase\ 1+Phase\ 2} = C \times \Delta V = 530\mu F \times 0.128V = 67.84\ \mu C$$

Figure 19 and Figure 20 show the total consumption in Phase 1 and Phase 2, respectively.

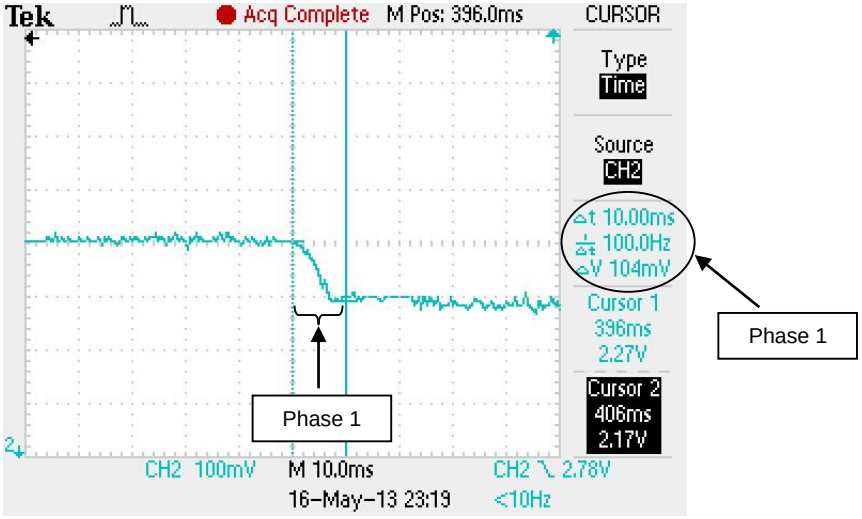


Figure19: Light sensor node: total current consumption measurements during Phase 1, as measured by capacitor method

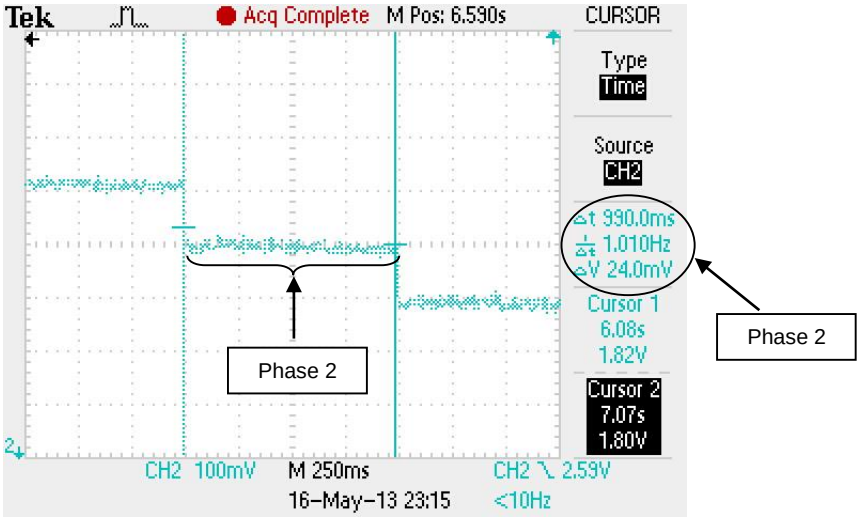


Figure 20: Light sensor node: total current consumption measurements during Phase 2, as measured by capacitor method

According to Figure 19, the total charge consumption of the light sensor node in the communication phase (Phase 1), is about:

$$Q_{Phase\ 1} = 530\mu F \times 0.104V = 55.12\ \mu C$$

This is also consistent with measurements made for the BLE module and the microprocessor by the oscilloscope method (Table 7 and Table 8), where: $Q_{BLE} = 41.25\ \mu C$ and $Q_{\mu P} = 11.7\ \mu C$. The difference between the two measurements is the consumption of the sensing device during the communication phase (Phase 1), so $Q_{sensor} = 55.12 - (41.25 + 11.7) = 2.17\ \mu C$.

Similarly, according to Figure 20, the total charge consumption of the light sensor node in the Standby-sleep phase (Phase 2), is about:

$$Q_{Phase\ 2} = 530\mu F \times 0.024V = 12.72\mu C$$

So the total average current consumption of the of light sensor node for the period ($T_{period} = 1s$) is of the order of:

$$I_{T_{period}=1s} = \frac{Q_{Phase\ 1} + Q_{Phase\ 2}}{1s} = (55.12 + 12.72)\mu A = 67.84\ \mu A$$

As we have already seen, the current consumption of the light sensor node is higher than the temperature sensor node in the two phases of operation.

For the communication phase (Phase 1), this increase in current consumption of the light sensor node is related to the larger number of bytes to measure and to send. For the Standby-sleep (Phase 2), this increase is due to a higher current consumption of light sensing device compared to temperature sensing device (cf Table 4).

2.3.3 Orientation/Motion sensor node

Figure 21 shows the measurements of total current consumption of orientation/motion sensor node for the two functioning phases (Phase 1+Phase 2), carried out by the capacitor method for measurement time (Connection Interval) of 1 second.

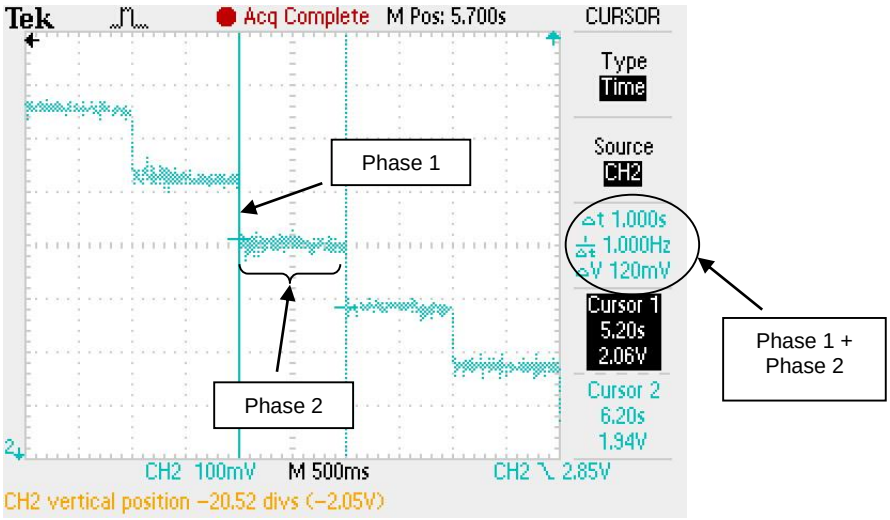


Figure 21: Orientation/Motion sensor node: total current consumption measurements, as measured by capacitor method

The total charge consumption of the orientation/motion sensor node for (Connection Interval) ($T_{period} = 1s$), as presented in Figure 21, is of the order of:

$$Q_{Phase\ 1+Phase\ 2} = C \times \Delta V = 530\mu F \times 0.120V = 63.6\ \mu C$$

Figure 22 and Figure 23 show the total consumption in Phase 1 and Phase 2, respectively.

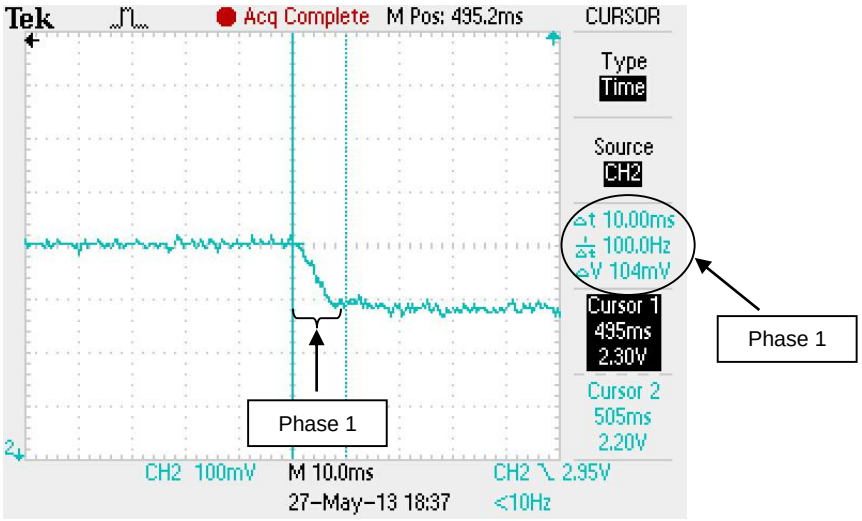


Figure 22: Orientation/Motion sensor node: total current consumption measurements during Phase 1, as measured by capacitor method

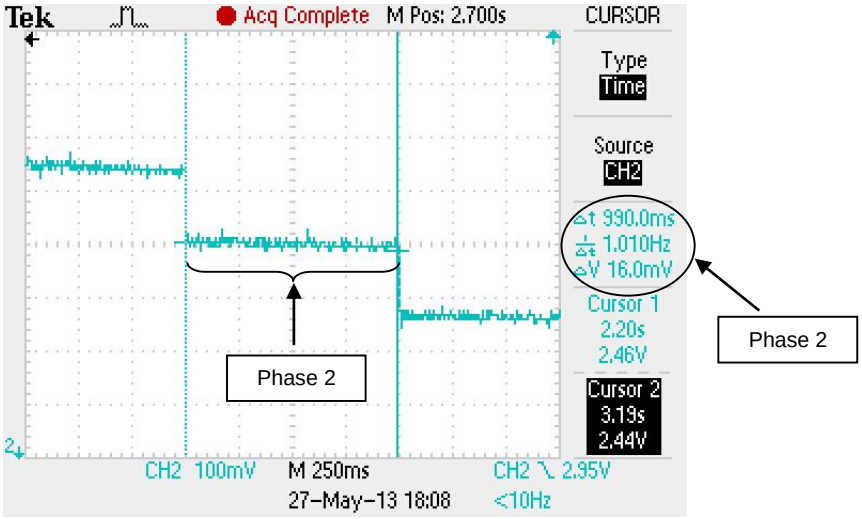


Figure 23: Orientation/Motion sensor node: total current consumption measurements during Phase 2, as measured by capacitor method

According to Figure 22, the total charge consumption of the orientation/motion sensor node in the communication phase (Phase 1), is about:

$$Q_{Phase\ 1} = 530\mu F \times 0.104V = 55.12\ \mu C$$

This is also consistent with measurements made for the BLE module and the microprocessor by the oscilloscope method (Table 9 and Table 10), where: $Q_{BLE} = 39.88\,\mu C$ and $Q_{\mu P} = 11.56\,\mu C$. The difference between the two measurements is the consumption of the sensing device during the communication phase (Phase 1), so $Q_{sensor} = 55.12 - (39.88 + 11.56) = 3.68\,\mu C$. This difference is higher than that of the light sensor node, because during Phase 1, the current consumption of orientation/motion sensing device for maximum Sampling rate (120 Samples/second) is more than current consumption of light sensing device (cf Table 4).

Similarly, according to Figure 23, the total charge consumption of the orientation/motion sensor node in the Standby-sleep phase (Phase 2), is about:

$$Q_{Phase\ 2} = 530\mu F \times 0.016V = 8.48\mu C$$

However, during Phase 2, the current consumption of orientation/motion sensing device is lower than that of light sensing device and equal to that of temperature sensing device (cf Table 4).

The total average current consumption of the of light sensor node for the period ($T_{period} = 1s$) is of the order of:

$$I_{T_{period}=1s} = \frac{Q_{Phase\ 1} + Q_{Phase\ 2}}{1s} = (55.12 + 8.48)\mu A = 63.6\,\mu A$$

As we have already seen, the differences in total current consumption of the three sensor nodes are related to characteristics of the used sensing device. In the next paragraph, we present the total consumption measurements results of the three sensor nodes for different measurements times (Connection Intervals).

3. Measurement Results

3.1 Temperature sensor node

Table 11 presents total current consumption measurements of the temperature sensor node, which integrates BLE module designed by Insight SiP, LPC1114FHI33/302 microprocessor and temperature sensing device TMP112. The battery used in this sensor node is 3V coin cell battery CR1632 has a capacity of$140\ mAh$, so a charge capacity of $504\ C$. The autonomy of this sensor node is given by the following equation:

$$Autonomy = \frac{504\ (C)}{Total\ average\ charge\ consumption\ of\ sensor\ node\ (C)} \times Connection\ Interval$$

Measurement specifications for different measurement times (Connection Intervals) are described in Table 11:

Temperature sensor node				
Connection Interval (ms)	Phase 1 (µC)	Phase 2 (µC)	Average Total Consumption (µC)	Autonomy (year)
1000	46.64	8.48	55.12	0.290
2000	46.64	2×8.48=16.96	63.60	0.503
3000	46.64	3×8.48=25.44	72.08	0.665
4000	46.64	4×8.48=33.92	80.56	0.794

Table11: Temperature sensor node: measurements results

3.2 Light sensor node

Table 12 presents total current consumption measurements of the light sensor node, which integrates BLE module designed by Insight SiP, LPC1114FHI33/302 microprocessor and light sensing device APDS-9300. The battery used in this sensor node is 3V coin cell battery CR1632. Measurement specifications for different measurement times (Connection Intervals) are described in Table 12:

Light sensor node				
Connection Interval (ms)	Phase 1 (µC)	Phase 2 (µC)	Average Total Consumption (µC)	Autonomy (year)
1000	55.12	12.72	67.84	0.236
2000	55.12	2×12.72=25.44	80.56	0.397
3000	55.12	3×12.72=38.16	93.28	0.514
4000	55.12	4×12.72=50.88	106.0	0.603

Table 12: Light sensor node: measurements results

3.3 Orientation / Motion sensor node

Table 13 presents total current consumption measurements of the orientation/motion sensor node, which integrates BLE module designed by Insight SiP, LPC1114FHI33/302 microprocessor and orientation/motion sensing device MMA7660FC. The battery used in this sensor node is 3V coin cell battery CR1632. Measurement specifications for different measurement times (Connection Interval) are described in Table 13:

Orientation/Motion sensor node				
Connection Interval (ms)	Phase 1 (µC)	Phase 2 (µC)	Average Total Consumption (µC)	Autonomy (year)
1000	55.12	8.48	63.6	0.251
2000	55.12	2×8.48=16.96	72.08	0.443
3000	55.12	3×8.48=25.44	80.56	0.595
4000	55.12	4×8.48=33.92	89.04	0.718

Table 13: Orientation/Motion sensor node: measurements results

4. Model / Measurement Comparison

In this section, we present a model for calculating current consumption of temperature, light and orientation/motion sensor nodes. This model is based on the data sheets of the components, that is to say, the current consumption values of each subset BLE module, microprocessor and sensing device, as they are given in their data sheets. This model can calculate the average consumption of each subset, the total consumption and the autonomy of sensor nodes for different Connection Intervals and for different types of batteries.

4.1 Consumption calculating model of temperature sensor node

Table 14 presents the calculating model of total current consumption of temperature sensor node. The specifications of each subset for one measurement per second are described below.

- BLE module (nRF8001) :
  - 1 connection per second,
  - 2 bytes data size,
  - Average consumption = 33.48 uA.

- Microprocessor LPC1114FHI33/302 :
  - 1 connection per second,
  - 2 bytes data size,
  - Average consumption = 15.84 uA.

- Temperature sensing device TMP112 :
  - Measurement time = 26 ms,
  - Average consumption = 2.99 uA.

The total average consumption is around 52.30 uA, which makes an autonomy of 0.31 year using a coin cell battery CR1632 that has a capacity of $140\ mAh$.

nRF8001 BLE					
Current	(mA)	Time	(us)	Charge (nC	Notes
Imcu_II	3.5	Tstart	1140	3990	Needed for Xtal Startup+ Tpost-processing Radio
Istandby	1.6	Tpre-processing Radio	1200	1920	Tpre-processing Radio
Irx	14.6	TRx for 1 x 2 octets payload	240	3504	Assumes 1 packet with payload of 2 bytes =8 +2 bytes
Itfs	7	Tifs for 1 Rx and 1 Tx packets	100	700	100 us interframe space
Itx	12.7	TTx for 1 Tx packets	250	3175	Assumes 1 packet with payload of 2 bytes
Imcu_host	5	Tstop	3640	18200	Needed to transmit bits to Host processor = house keeping
Total Charge for 2*8 bits received				31489	
Iidle	0.002	Tperiod	993430	1986.86	1 Measurements /second
Total charge per cycle of 1 second				33475.86	
Estimated Average Current			33.48	uA	BLE
Sensor TEMP112					
Ion	0.04	Measurement	26000	1040	26 ms measurement time (conversion time)
Ion	0.04	I2C	60	2.4	Time to send to uP via I2C
Total Charge per measurement				1042.4	
Istandby	0.002	Shutdown	973940	1947.88	Time between measurements (1 Measurements /second)
Total charge per cycle of 1 second				2990.28	
Estimated Average Current			2.99	uA	Sensor
uP LPC1114FHI33/302					
Ion	3.4	I2C	700	2380	I2C Time to communicante to Sensor (read time)
Isleep	2	Waiting time besfore Host	1700	3400	Time before Host
Ion	3.4	uP Host time	1200	4080	Needed to transmit bits
Total Charge per Tx/Rx				9860	
Istandby (Deep-Sleep)	0.006	Tperiod	996400	5978.4	1 Measurements /second
Total charge per cycle of 1 second				15838.4	
Estimated Average Current			15.84	uA	µP
Total estimated current			52.30	uA	cf 52.30 uA due to standby alone
		mAh			Total
Lifetime for CR1632		140	2676.6	hour	
			111.5	day	
			0.31	year	Autonomy

Table 14: Temperature sensor node: Consumption calculating model

4.2 Consumption Calculating model of Light sensor node

Table 15 presents calculating model of total current consumption of light sensor node. The specifications of each subset for one measurement per second are described below.

- Module BLE (nRF8001) :
  - 1 connection per second,
  - 4 bytes data size,
  - Average consumption = 40.10 uA.
- Microprocessor LPC1114FHI33/302 :
  - 1 connection per second,
  - 4 bytes data size,
  - Average consumption = 17.68 uA.

- Light sensing device APDS-9300 :
  - Measurement time (20 ms ≥ 13.7 ms),
  - Average consumption = 7.95 uA.

The total average consumption is around 65.72 uA, which makes an autonomy of 0.24 year using a coin cell battery CR1632 that has a capacity of 140 mAh.

nRF8001 BLE					
Current	(mA)	Time	(us)	Charge (nC	Notes
Imcu_II	3.5	Tstart	1140	3990	Needed for Xtal Startup+ Tpost-processing Radio
Istandby	1.6	Tpre-processing Radio	1200	1920	Tpre-processing Radio
Irx	14.6	TRx for 1 x 4 octets payload	240	3504	Assumes 1 packet with payload of 4 bytes =8 +4 bytes
Itfs	7	Tifs for 1 Rx and 1 Tx packets	100	700	100 us interframe space
Itx	12.7	TTx for 1 Tx packets	252	3200.4	Assumes 1 packet with payload of 4 bytes
Imcu_host	5	Tstop	4960	24800	Needed to transmit bits to Host processor = house keeping
Total Charge for 4*8 bits received				38114.4	
Iidle	0.002	Tperiod	992108	1984.216	1 Measurements /second
Total charge per cycle of 1 second				40098.616	
Estimated Average Current			40.10	uA	BLE
Sensor APDS-9300					
Ion	0.24	Measurement	20000	4800	26 ms measurement time (conversion time)
Ion	0.24	I2C	60	14.4	Time to send to uP via I2C
Total Charge per measurement				4814.4	
Istandby	0.0032	Shutdown	979940	3135.808	Time between measurements (1 Measurements /second)
Total charge per cycle of 1 second				7950.208	
Estimated Average Current			7.95	uA	Sensor
uP LPC1114FHI33/302					
Ion	3.4	I2C	2520	8568	I2C Time to communicante to Sensor (read time)
Isleep	2	Waiting time besfore Host	0	0	Time before Host
Ion	3.4	uP Host time	920	3128	Needed to transmit bits
Total Charge per Tx/Rx				11696	
Istandby (Deep-Sleep)	0.006	Tperiod	996560	5979.36	1 Measurements /second
Total charge per cycle of 1 second				17675.36	
Estimated Average Current			17.68	uA	µP
Total estimated current			65.72	uA	cf 65.72 uA due to standby alone
		mAh			Total
Lifetime for CR1632		140	2130.1	hour	
			88.8	day	Autonomy
			0.24	year	

Table 15: Light sensor node: Consumption calculating model

4.3 Consumption Calculating model of Orientation/Motion sensor node

Table 16 presents calculating model of total current consumption of orientation/motion sensor node. The specifications of each subset for one measurement per second are described below.

- Module BLE (nRF8001) :
  - 1 connection per second,
  - 3 bytes data size,
  - Average consumption = 38.79 uA.
- Microprocessor LPC1114FHI33/302 :
  - 1 connection per second,
  - 3 bytes data size,
  - Average consumption = 17.54 uA.
- Orientation/motion sensing device MMA7660FC :
  - Measurement time (15 ms ≥ 8.5 ms),
  - Average consumption = 6.40 uA.

The total average consumption is around 62.72 uA, which makes an autonomy of 0.25 year using a coin cell battery CR1632 that has a capacity of 140 mAh.

nRF8001 BLE					
Current	(mA)	Time	(us)	Charge (nC)	Notes
Imcu_Il	3.5	Tstart	1140	3990	Needed for Xtal Startup+ Tpost-processing Radio
Istandby	1.6	Tpre-processing Radio	1200	1920	Tpre-processing Radio
Irx	14.6	TRx for 1 x 4 octets payload	240	3504	Assumes 1 packet with payload of 3 bytes =8 +3 bytes
Itfs	7	Tifs for 1 Rx and 1 Tx packets	100	700	100 us interframe space
Itx	12.7	TTx for 1 Tx packets	251	3187.7	Assumes 1 packet with payload of 3 bytes
Imcu_host	5	Tstop	4700	23500	Needed to transmit bits to Host processor = house keeping
Total Charge for 3*8 bits received				36801.7	
Iidle	0.002	Tperiod	992369	1984.738	1 Measurements /second
Total charge per cycle of 1 second				38786.438	
Estimated Average Current			38.79	uA	BLE
Sensor MMA7660FC					
Ion	0.294	Measurement	15000	4410	26 ms measurement time (conversion time)
Ion	0.294	I2C	60	17.64	Time to send to uP via I2C
Total Charge per measurement				4427.64	
Istandby	0.002	Shutdown	984940	1969.88	Time between measurements (1 Measurements /second)
Total charge per cycle of 1 second				6397.52	
Estimated Average Current			6.40	uA	Sensor
uP LPC1114FHI33/302					
Ion	3.4	I2C	2400	8160	I2C Time to communicante to Sensor (read time)
Isleep	2	Waiting time besfore Host	0	0	Time before Host
Ion	3.4	uP Host time	1000	3400	Needed to transmit bits
Total Charge per Tx/Rx				11560	
Istandby (Deep-Sleep)	0.006	Tperiod	996600	5979.6	1 Measurements /second
Total charge per cycle of 1 second				17539.6	
Estimated Average Current			17.54	uA	µP
Total estimated current			62.72	uA	cf 62.72 µA due to standby alone
		mAh			Total
Lifetime for CR1632		140	2232.0	hour	
			93.0	day	
			0.25	year	Autonomy

Table 16: Orientation/Motion sensor node: Consumption calculating model

4.4 Model / Measurements comparison

Table 17, 18 and 19 respectively presents model / measurements comparison of the total current consumption and the autonomy of temperature, light and orientation / motion sensor nodes for different Connection intervals.

Temperature sensor node				
Connection Interval (ms)	Total Consumption "Model" (µC)	Total Consumption "Measurements" (µC)	Autonomy "Model" (year)	Autonomy "Measurements" (year)
1000	52.30	55.12	0.31	0.29
2000	62.30	63.60	0.51	0.50
3000	72.30	72.08	0.66	0.67
4000	82.30	80.56	0.78	0.79

Table 17: Temperature sensor node: Model/measurements comparison

Light sensor node				
Connection Interval (ms)	Total Consumption "Model" (µC)	Total Consumption "Measurements" (µC)	Autonomy "Model" (year)	Autonomy "Measurements" (year)
1000	65.72	67.84	0.24	0.24
2000	76.92	80.56	0.42	0.40
3000	88.12	93.28	0.54	0.51
4000	99.32	106.0	0.64	0.60

Table 18: Light sensor node: Model/measurements comparison

Orientation/motion sensor node				
Connection Interval (ms)	Total Consumption "Model" (µC)	Total Consumption "Measurements" (µC)	Autonomy "Model" (year)	Autonomy "Measurements" (year)
1000	62.72	63.60	0.25	0.25
2000	72.72	72.08	0.44	0.44
3000	82.72	80.56	0.58	0.60
4000	92.72	89.04	0.69	0.72

Table 19: Orientation/Motion sensor node: Model/measurements comparison

From these three tables, we can find that the calculating model of current consumption is quite reliable and provides good estimations of consumption and autonomy close enough to the real operation case in the range of measurement time (Connection Interval) 7.5 ms to 4000 ms announced in the specifications of temperature, light and orientation/motion sensor nodes (cf Table 1).

BLE custom design service based on nRF8001 from Nordic Semiconductor

Insight SIP has designed a “ready to use” module based on Nordic Semiconductor’s Bluetooth Low Energy nRF8001 chip. For many applications, this module represents the ideal solution, as it is ready to use, and minimizes design risk and time-to-market.

Insight SIP offers its world class design expertise and Intellectual Property blocks used in designing the BLE module to rapidly make miniature designs to meet specific customer requirements. As an existing partner of Nordic Semiconductor, Insight SIP is ideally placed to deliver high quality designs based on Nordic Semiconductor’s chipset.

Key Features

- “Antenna in Package” technology
  Smallest package size on market
  8 x 12 x 1.45mm
- High performance – up to 40m range
- Pre-certified
- Minimal RF experience required
- All RF elements inside
- Specific form factors and metal housings
- Very-high volume, low margin applications
- Integration of other technologies

Specific Skills

- Direct experience with nRF8001 BLE and nRF51822 chip
- Class leading miniaturisation and integration of RF elements, based on unique design methodology
- Advanced miniature PCB antenna design capability, based on years of research and extensive Electromagnetic Simulation experience
- Application Software capability via software partner

Applications

- Space constrained BLE Slave Devices
- Sport and fitness sensors
- Health care sensors
- Out of Range (OOR) sensors
- Personal User Interface Devices (PUID)
- Remote controls

Case Study

A leading watch manufacturer required a Bluetooth Low Energy solution in a metal cased watch.

The product requirement was to integrate the BLE elements onto the main circuit board of the watch.

Insight SIP designed the BLE RF elements, including a matched PCB antenna. The antenna was specifically designed to meet the constraints of the metal housing. The RF matching elements were placed optimally in the tiny space reserved on the watch board.

For more information, visit us at www.insightsip.com, or email us at sales@insightsip.com.

Insight SiP – Green Side – 400 avenue Roumanille – BP 309 – 06906 Sophia-Antipolis Cedex – France – www.insightsip.com

SALES OFFICES & CONTACTS

HOME

EUROPE

AUSTRIA – GERMANY – SWITZERLAND
TEKMODUL
Willibaldstrasse 14a
80687 München
Germany
Phone: +49 89 51 39 96 24
Email: info@tekmodul.de
Web: www.tekmodul.de

BELGIUM – DENMARK – GERMANY – NETHERLAND
TEXIM-EUROPE
Elektrostraat 17
Postbus 23 - 7480 AA Haaksbergen
The Netherlands
Phone: +31 53 573 32 01
Email: info@texim-europe.com
Web: www.texim-europe.com

FRANCE
ACAL BFI
4, Allée du Cantal
ZI La Petite Montagne Sud - CE1834 Lisses
91018 EVRY Cedex
France
Phone: +33 (0)1 60 79 59 00
Email: sales-fr@acalbfi.fr
Web: www.acalbfi.com/fr

IRELAND – UK
IO Components
Units 3, 4 & 5 Holes Bay Park,
Sterte Avenue West - Poole
BH15 2AA Dorset
United Kingdom
Phone: +44(0)1202 440422
Email: enquiries@io-components.com
Web: www.io-components.com

HEADQUARTER

INSIGHT SIP
Green Side
400 Avenue de Roumanille - BP309
06906 Sophia Antipolis Cedex
France
Phone: +33(0)4 93 00 88 80
Email: contact@insightsip.com
Web: www.insightsip.com

MEA

ISRAEL
CIDEV ELECTRONICS
Habanai 3 St. Hod Hasharon
P.O Box 1552
Zip 45115
Israel
Phone: +972 73 70 01 212
Email: site@cidev.co.il
Web: www.cidev.co.il

AMERICA

CANADA
MOTION MICRO
300 March Road
Kanata
K2K 2E2 Ontario
Canada
Phone: +1 613 667 9157
Email: sales@motionmicro.com
Web: www.motionmicro.com

USA
INSIGHT SIP
C/O EHS&H – Suite 400
7979 East Tufts Avenue
Denver CO80237
USA
Phone: +33(0)6 07 77 14 74
Email: contactus@insightsip.com
Web: www.insightsip.com

ASIA

JAPAN
INSIGHT SIP
J-1405 CI Heights
1380 Yamazaki-cho - Machida-shi
195-0074 Tokyo
Japan
Phone: +81 4 2705 5170
Email: aki.tsukagoshi@insightsip.com
Web: www.insightsip.com

KOREA
ESUPPLY
Room 408, Yu Sung Bldg
#43-1 yeoido-dong - yeongdeungpo-gu
Seoul Zip 150-889
Korea
Phone: +82-2-782-7744
Email: sales@esupply.co.kr
Web: www.esupply.co.kr