BLG840F/X LTE Gateways and BN60E LTE Beacon

OpenSource with Market Ready Enclosure

BLG840F/X gateways support Bluetooth 5, Thread, or Zigbee radio protocols. Both LTE-M and NB-IoT are supported on the network side. They are in market ready enclosure and pre-certified. OpenSource codes are available to expedite your firmware development.

BLG840F Gateway

BLG840F integrates a long-range module BT840F with nRF9160 SIP module. Range between 2 BT840F modules (not in enclosure) is 2300 meters at 125 Kbps. GPS antenna is integrated. An external LTE antenna is included.

BLG840X Gateway

Using BT840X with +22.9 dBm TX, BLG832X can penetrate multiple walls or be used in wide area mesh applications. Range between 2 BT840X is more than 4500 meters at 125 Kbps.

BN60E LTE Beacon

With integrated GPS receiver and LTE connectivity, BN60 can be used for wide area tracking.

Miscellaneous

- Gateway size: 60x60x22 mm.
- Antenna length: 170mm.
- Includes AC adapter, USB cable, wall mount bracket.

DK-BLG840F Development Kit

Pre-loaded modem firmware supports both LTE-M and NB-IoT. Pre-loaded non-secure application is AT command. Additional AT command information is available at:

https://infocenter.nordicsemi.com/topic/ref_at_commands/REF/at_commands/intro.html?cp=2_1

To develop nRF91 firmware please download **nRF Connect for Desktop** and install **Getting Started Assistant.**

https://www.nordicsemi.com/?sc_itemid=%7B49D2264D-62FD-4C16-811F-88B477833C5D%7D

AC adapter with USB cable

10 pin cable

LTE antenna and adapter cable

A Nordic nRF9160-DK is needed to program gateway or beacon.

LTE Link Monitor of nRF Connect is not compatible, please download and use Fanstel LTE PC tool for testing.

https://www.fanstel.com/download-opensource

Nordic nRF52 Development Environment

Nordic nRF52 development environment is used to develop BT840F/X codes. Open source codes are available **http://www.fanstel.com/download-opensource/**

LTE Gateway Summaries

	BN60E Beacon	BLG840F Gateway	BLG840X Gateway
Network Interface	LTE-M, NB-IoT	LTE-M, NB-IoT	LTE-M, NB-IoT
BLE module	None	BT840F	BT840X
FCC			
Industrial Canada			
QDID		108621	108621

Table Of Contents

1. Introduction

BLG840F Series gateways integrate Nordic nRF9160 SIP module and Fanstel long range Bluetooth, Thread, Zigbee module BT840F or BT840X. BN60 has an LTE modem for wide area location tracking. All products are referred as BLG840F Series in this user's manual.

Network Interface Supports LTE-M and NB-IoT

It makes the latest low power LTE technology and advanced processing and security accessible, and easy to use, for a wide range of single device low power cellular IoT (cIoT) designs.

Incorporating an Arm Cortex-M33 application processor solely for applications, a full LTE modem, RF Front End (RFFE) and power management system. The nRF9160 is the most compact, complete and energy-efficient cellular IoT solution on the market.

The integrated modem supports both LTE-M and NB-IoT and can operate globally removing any need for regional variants. All power saving features including eDRX and PSM are supported as is with IPv4/IPv6 support up to transport and security (TCP/TLS) level. The modem firmware is upgradable via secure, encrypted Firmware Over The Air (FOTA) updates.

The Arm Cortex-M33 application processor is supported by 1MB of flash and 256kB RAM making advanced application development possible in a single device solution.

A GPS receiver is integrated into the radio offering various modes of operation to suit a wide selection of applications that employ location-tracking functionality.

A broad selection of general interfaces and peripherals and are included on nRF9160 including 12-bit ADC, RTC, SPI, I²C, I²S, UARTE, PDM and PWM.

Security is best-in-class with Arm TrustZone technology for isolation and protection of normal and secure zones for firmware and elements of hardware including memory and peripherals. Arm TrustZone helps build solid and secure IoT applications that feature secure boot, trusted firmware updates and root of trust implementations without performance compromise.

Arm CryptoCell enhances security still further by offering cryptographic and security resources to help to protect your IoT applications from various attack threats. CryptoCell is designed for high performance cryptography solutions optimized for energy-constrained devices.

Gateway and beacon have a SIM connector for connection and authentication with mobile network operators.

Bluetooth, Thread, and Zigbee Interfaces

BLG840F integrates BT840F (nRF52840) module with 2300 meter range at 125 Kbps. BLG840X integrates BT840X (nRF52840 + SKY66112 PA) with >4500 meter range at 125 Kbps. BN60E doesn't integrate a Bluetooth module.

The nRF52840 is fully multiprotocol capable with full protocol concurrency. It has protocol support for Bluetooth 5, Bluetooth mesh, Thread, Zigbee, 802.15.4, ANT and 2.4 GHz proprietary stacks.

It is built around the 32-bit ARM® Cortex™-M4 CPU with floating point unit running at 64 MHz. It has NFC-A Tag for use in simplified pairing and payment solutions. The ARM TrustZone® CryptoCell cryptographic unit is included on-chip and brings an extensive range of cryptographic options that execute highly efficiently independent of the CPU.

2. Hardware Description

BLG840F/X Hardware

BLG840F and BLG840X use the same enclosure and host PCB. The only difference is Bluetooth 5 module installed. Gateway can be desk mounted. A wall mount bracket in included for wall mounting.

Three antennas are supported:

• Bluetooth/Thread, Zigbee antenna is integrated.
• GPS antenna is integrated.
• An external LTE antenna is included.

Additional external hardwire features:
• Two user definable LED indicators, red and blue.
• A micro USB connector for powering gateway
• A push button

Size of gateway is 60x60x22mm.

BN60E LTE Beacon Hardware Description

BN60E is BLG840F without BT840F BLE 5 module. With an integrated GPS receiver and LTE modem, it can be used for wide area location tracking.
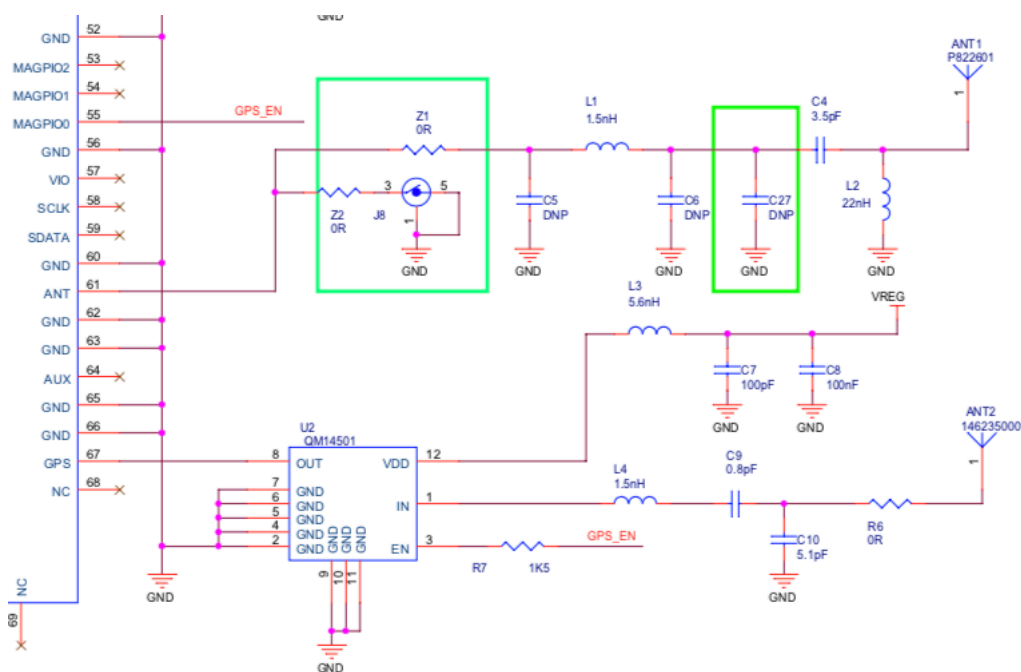
Development Kit
Download DK-BLG840F development kit schematics from this webpage.

https://www.fanstel.com/download-opensource

LTE and GPS antennas.
The u.FL connector for LTE antenna, J8 has a buillt-in switch. Normal connection is with the integrated antenna, ANT1. When an u.FL connector is plugged-in, RF signal is routed to the external antenna. Production BLG840F includes an external antenna. The included antenna should be used for LTE signal reception and transmission testing.

A GPS antenna and signal amplifier is integrated.

USB Connectors
There are two USB connectors in DK-BLG840F. Development kit can be powered by connecting either one to a PC USB port.
*   J11 is for connection to nRF9160 module.
*   J12 is for connection to BT840F or BT840X module.

You can download LTE PC tools from this webpage.
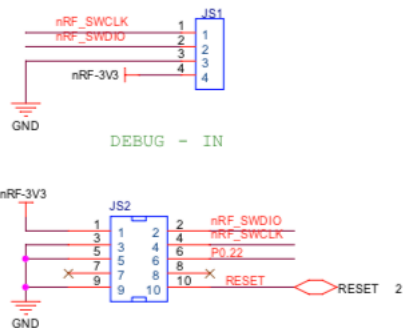https://www.fanstel.com/download-opensource

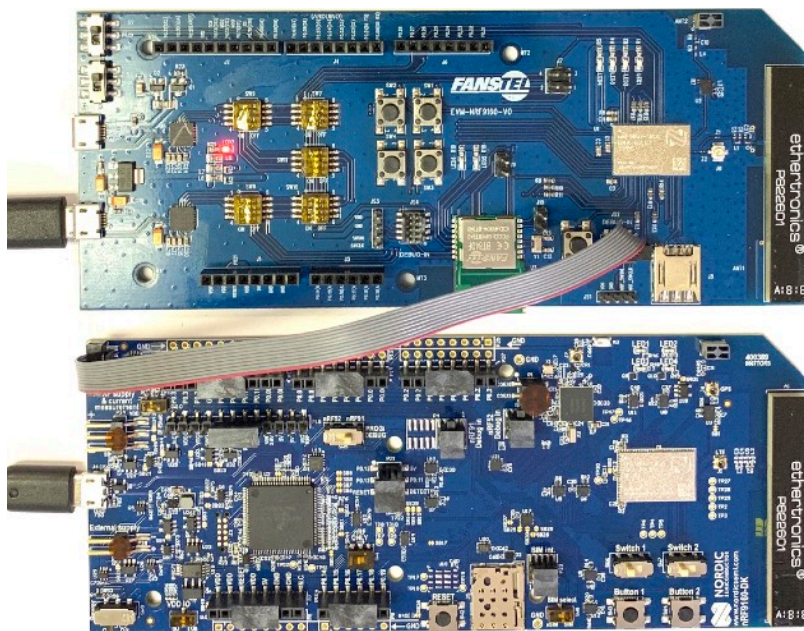This LTE PC tools is for use with Window PC only.

3. nRF9160 Firmware Development and Testing

Set Up for Programming nRF9160

Both 4-pin and 10-pin programming interfaces are provided. A 10-pin cable is included for connection between DK-BLG840F and nRF9160.

To program nRF9160 module, connect **Debug out** of nRF9160DK to JS2 **(Debug in**) of DK-BLG840F.

Modem Firmware

Module nRF9160 is pre-loaded with Modem firmware supporting LTE-M and NB-IoT.

Version 0.7.0-29.alpha is loaded in May 2019. It supports the following bands.
Cat-M1 operation is enabled on E-UTRA Bands 1, 2, 3, 4, 5, 8, 12, 13, 14, 17, 20, 25, 26, 28 and 66.
Cat-NB1 operation is enabled on E-UTRA Bands 1, 2, 3, 4, 5, 8, 12, 13, 17, 20, 25, 26, 28 and 66.

AT Commands

Non-secure application AT command is preloaded. Additional information is available at Nordic website.
https://infocenter.nordicsemi.com/topic/ref_at_commands/REF/at_commands/intro.html?cp=2_1

nRF Connect

To develop the nRF91 firmware please download the **nRF Connect** desk top version and install ***Getting Started Assistant***.
You can download **nRF Connect** desk top from following link.
https://www.nordicsemi.com/?sc_itemid=%7B49D2264D-62FD-4C16-811F-88B477833C5D%7D
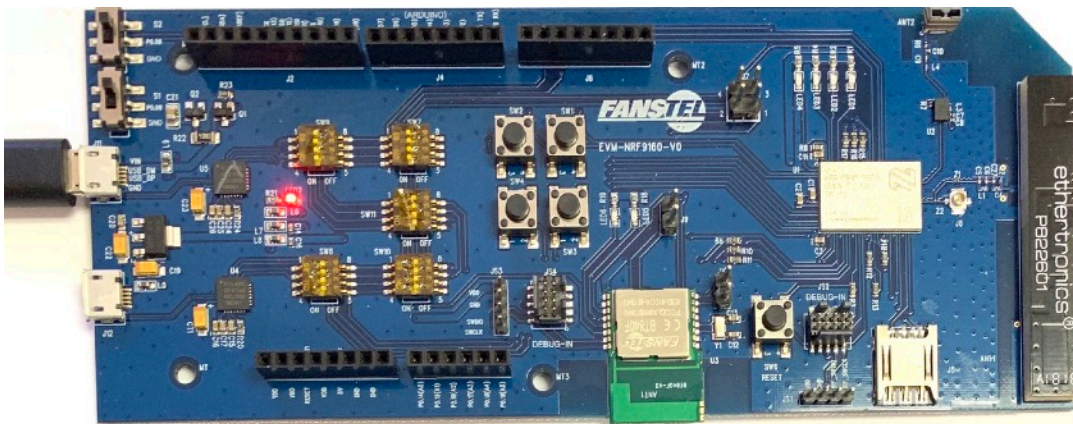

BlueNor LTE PC Tools

LTE Monitor features in **nRF Connect** is not compatible with Fanstel DK-BLG840F.

To test Fanstel board, please download BlueNor LTE PC tools from Fanstel website.
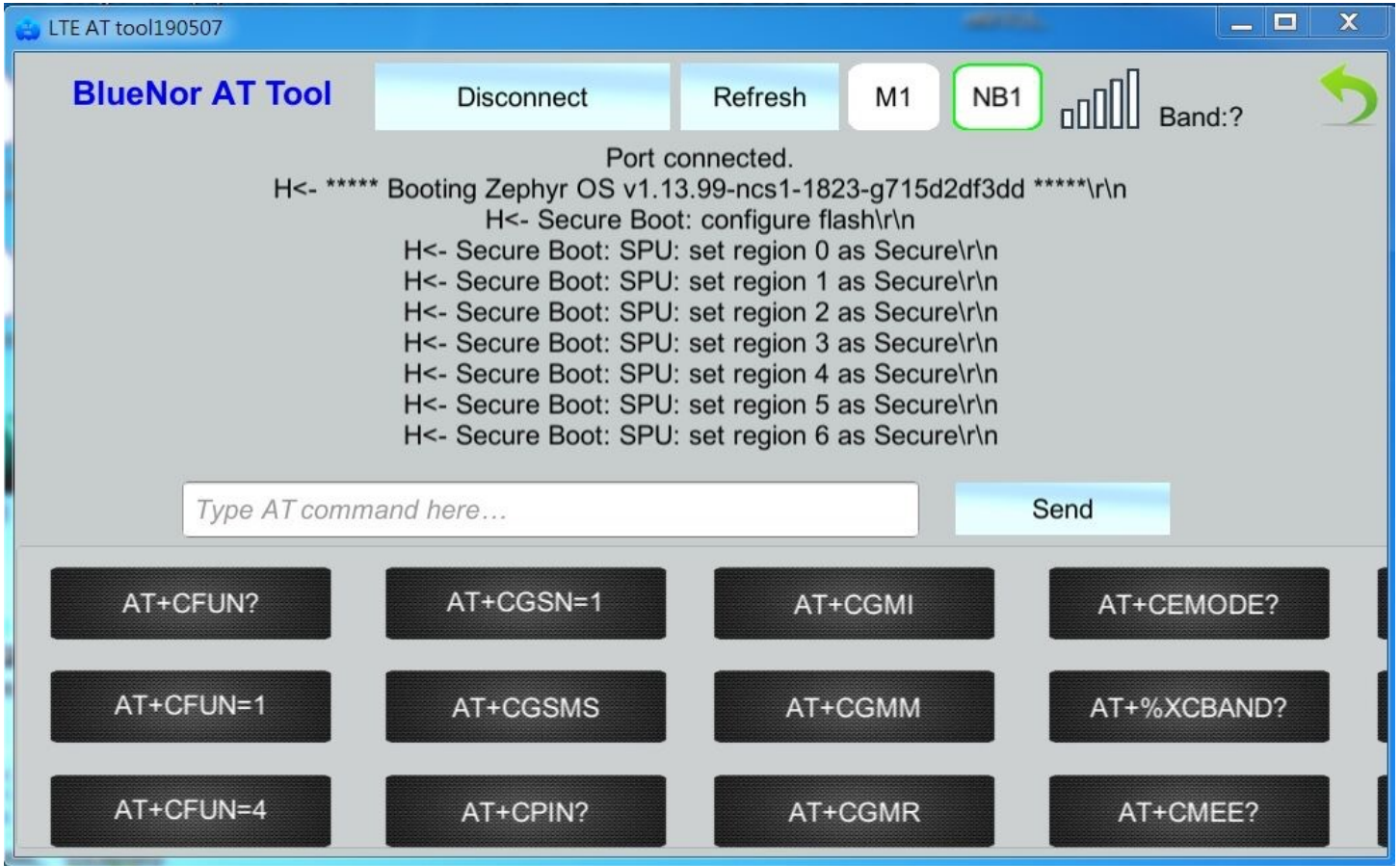
https://www.fanstel.com/download-opensource

Unzip and install this application.

Connect J11 of DK-BLD840F to a PC USB port.

- Press the reset button SW?.
- Insert SIM card obtained from your local carrier into J5. Click on **Refresh** icon.

- Wait for one minute.
- If everything is OK, the LTE icon becomes green and the signal strength is shown.

Modem Firmware Update

To update modem firmware, follow the steps listed below. More instructions are available in README.rst inside nrf9160_mdm_dfu.zip.

1) Install DFU-tool (nrf9160_mdm_dfu.zip)
2) Run `nrf9160_mdm_dfu —update`. The modem will be installed to board.

```
C:\mfwnrf916007029alpha>nrf9160_mdm_dfu --update
Configure APP IPC as non-secure
Configure IPC HW for DFU
Configure APP RAM as non-secure
Store DFU indication into shared memory
Power up / reset modem
Start polling IPC.MODEM_CTRL_EVENT to receive root key digest
Modem responded with a5000001
Modem root key digest received: 72b3d7c13e549acf08bbc48cb936b9b861e4cbae28a7537c
9859a6d945ee9489
Store IPC DFU executable into shared memory
Send IPC.APP_CTRL_TASK
Start polling IPC.MODEM_CTRL_EVENT To receive 'Started' indication from DFU exec
utable
IPC DFU 'Started' indication from DFU received
Updating modem firmware
Programming pages from address 0x59602000
Programming pages from address 0x6000
Programming pages from address 0x50000
Programming pages from address 0x60000
Programming pages from address 0x70000
Programming pages from address 0x80000
Programming pages from address 0x90000
Programming pages from address 0xa0000
Programming pages from address 0xb0000
Programming pages from address 0xc0000
Programming pages from address 0xd0000
Programming pages from address 0xe0000
Programming pages from address 0xf0000
Programming pages from address 0x100000
Programming pages from address 0x110000
Programming pages from address 0x120000
Programming pages from address 0x130000
Programming pages from address 0x140000
Programming pages from address 0x150000
Programming pages from address 0x160000
Programming pages from address 0x170000
Programming pages from address 0x180000
Programming pages from address 0x190000
Programming pages from address 0x1a0000
Programming pages from address 0x1b0000
Programming pages from address 0x1c0000
Programming pages from address 0x1d0000
Programming pages from address 0x1e0000
```

To install AT command application, type command as below.

```
C:\Python27\Scripts>nrfjprog --program 9160boot.hex --chiperase -f nrf91
Parsing hex file.
Erasing user available code and UICR flash areas.
Applying system reset.
Checking that the area to write is not protected.
Programming device.

C:\Python27\Scripts>nrfjprog --program 9160at.hex --sectorerase -f nrf91 --reset

Parsing hex file.
Erasing page at address 0x40000.
Erasing page at address 0x41000.
Erasing page at address 0x42000.
Erasing page at address 0x43000.
Erasing page at address 0x44000.
Erasing page at address 0x45000.
Erasing page at address 0x46000.
Erasing page at address 0x47000.
Erasing page at address 0x48000.
Erasing page at address 0x49000.
Erasing page at address 0x4A000.
Erasing page at address 0x4B000.
Erasing page at address 0x4C000.
Erasing page at address 0x4D000.
Erasing page at address 0x4E000.
Erasing page at address 0x4F000.
Erasing page at address 0x50000.
Erasing page at address 0x51000.
Erasing page at address 0x52000.
Erasing page at address 0x53000.
Applying system reset.
Checking that the area to write is not protected.
Programming device.
Applying system reset.
Run.

C:\Python27\Scripts>
```
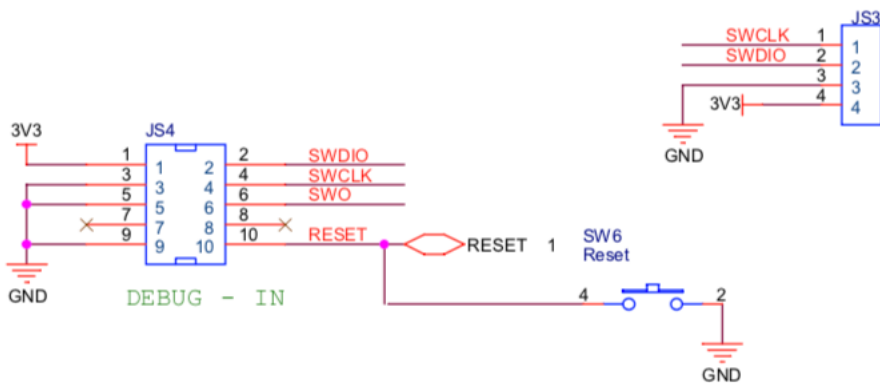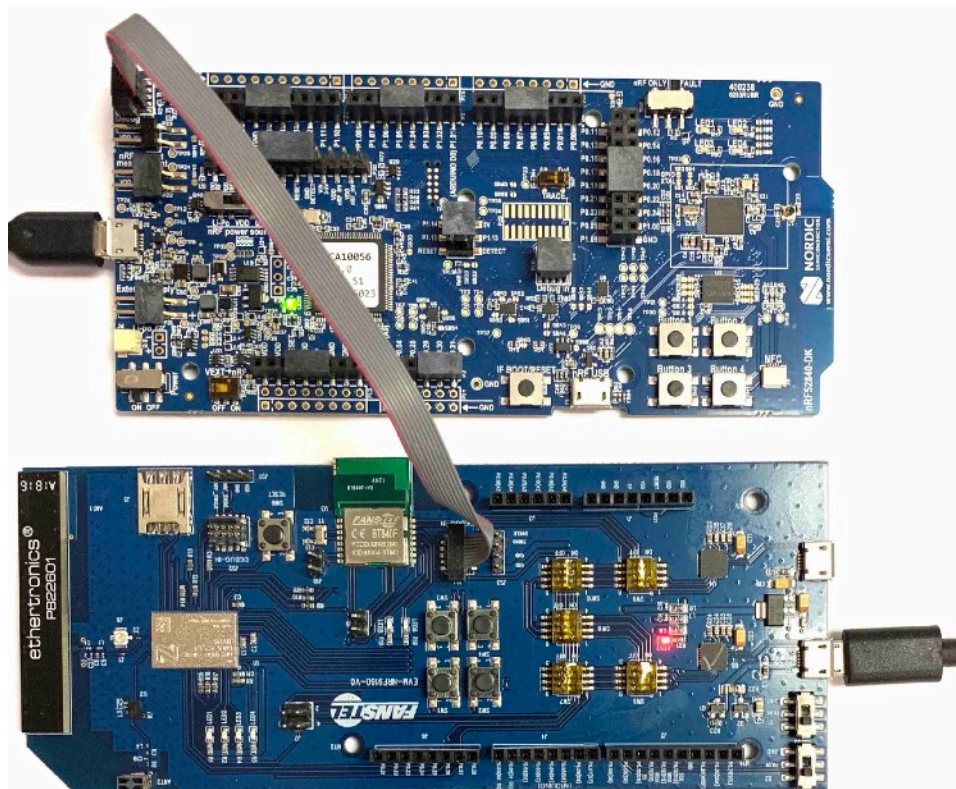
4. nRF52840 Firmware Development

Set up for Programming BT840F or BT840X
Both 10-pin and 4-pin programming interfaces are provided. A 10-pin cable is included.

To program BT840F/X module, connect **Debug out** of PCA10056 (nRF52840DK) to JS4 **(Debug in)** of DK-BLG840F

Nordic Development Environment

Nordic Semiconductor provides a complete range of hardware and software development tools for the nRF52 Series devices. nRF52 DK board is recommended for firmware development. Document and Software development tools can be downloaded by the following links.

Get start with Nordic chip and all online documents.
http://infocenter.nordicsemi.com/index.jsp?topic=/com.nordic.infocenter.nrf52/dita/nrf52/development/nrf52_dev_kit.html&cp=1_1

Nordic SDK with many example projects.
https://developer.nordicsemi.com/nRF5_SDK/

Nordic development zone. You can search or ask a question there.
https://devzone.nordicsemi.com/tutorials/b/getting-started/posts/development-with-gcc-and-eclipse

Programming the Nordic chip
Download and install Nrf5x-Command-Line Tools
https://www.nordicsemi.com/eng/nordic/Products/nRF52840/nRF5x-Command-Line-Tools-Win32/58850

Download and install nRF Connect

https://www.nordicsemi.com/?sc_itemid={B935528E-8BFA-42D9-8BB5-83E2A5E1FF5C}

Firmware to Control Power Amplifier in BLG840X

The following codes are used to set up and control power amplifier SKY66112 in USB840X. Codes can be downloaded from:

https://www.fanstel.com/download-document

Header files

```
#ifndef PA_LNA_H__
#define PA_LNA_H__

#include "ble.h"
#include "app_error.h"
#include "nrf_drv_gpiote.h"
#include "nrf_drv_ppi.h"

void pa_lna_init(uint32_t gpio_pa_pin, uint32_t gpio_lna_pin);

#endif
```

Main program.

```
#include "pa_lna.h"


#define APP_PA_LAN


#ifdef APP_PA_LAN

#define APP_PA_PIN      17

#define APP_LNA_PIN     19

#define APP_CHL_PIN8

#define APP_CPS_PIN         6


int main(void)

{

....

#ifdef APP_PA_LAN

        nrf_gpio_cfg_output(APP_CPS_PIN);

        nrf_gpio_cfg_output(APP_CHL_PIN);

        nrf_gpio_pin_set(APP_CHL_PIN);

        nrf_gpio_pin_clear(APP_CPS_PIN); //enable

        pa_lna_init(APP_PA_PIN,APP_LNA_PIN);
```

```
#endif

....

}
```

SKY66112 control codes.

```
#include <stdint.h>
#include <string.h>

#include "pa_lna.h"
#include "ble.h"
#include "app_error.h"
#include "nrf_drv_gpiote.h"
#include "nrf_drv_ppi.h"

void pa_lna_init(uint32_t gpio_pa_pin, uint32_t gpio_lna_pin)
{
   ble_opt_t opt;
   uint32_t gpiote_ch = NULL;
   ret_code_t err_code;

   memset(&opt, 0, sizeof(ble_opt_t));

   err_code = nrf_drv_gpiote_init();
   if(err_code != NRF_ERROR_INVALID_STATE)
      APP_ERROR_CHECK(err_code);

   err_code = nrf_drv_ppi_init();
   //if(err_code != MODULE_ALREADY_INITIALIZED)
      APP_ERROR_CHECK(err_code);

   nrf_ppi_channel_t ppi_set_ch;
   nrf_ppi_channel_t ppi_clr_ch;

   err_code = nrf_drv_ppi_channel_alloc(&ppi_set_ch);
   APP_ERROR_CHECK(err_code);

   err_code = nrf_drv_ppi_channel_alloc(&ppi_clr_ch);
   APP_ERROR_CHECK(err_code);

   nrf_drv_gpiote_out_config_t config = GPIOTE_CONFIG_OUT_TASK_TOGGLE(false);

   if((gpio_pa_pin == NULL) && (gpio_lna_pin == NULL))
   {
      err_code = NRF_ERROR_INVALID_PARAM;
      APP_ERROR_CHECK(err_code);
   }

   if(gpio_pa_pin != NULL)
```

```
    {
        if(gpiote_ch == NULL)
        {
            err_code = nrf_drv_gpiote_out_init(gpio_pa_pin, &config);
            APP_ERROR_CHECK(err_code);

            gpiote_ch = nrf_drv_gpiote_out_task_addr_get(gpio_pa_pin);
        }

        // PA config
        opt.common_opt.pa_lna.pa_cfg.active_high = 1;   // Set the pin to be active high
        opt.common_opt.pa_lna.pa_cfg.enable      = 1;   // Enable toggling
        opt.common_opt.pa_lna.pa_cfg.gpio_pin    = gpio_pa_pin; // The GPIO pin to toggle tx
    }

    if(gpio_lna_pin != NULL)
    {
        if(gpiote_ch == NULL)
        {
            err_code = nrf_drv_gpiote_out_init(gpio_lna_pin, &config);
            APP_ERROR_CHECK(err_code);

            gpiote_ch = nrf_drv_gpiote_out_task_addr_get(gpio_lna_pin);
        }

        // LNA config
        opt.common_opt.pa_lna.lna_cfg.active_high  = 1; // Set the pin to be active high
        opt.common_opt.pa_lna.lna_cfg.enable       = 1; // Enable toggling
        opt.common_opt.pa_lna.lna_cfg.gpio_pin     = gpio_lna_pin;  // The GPIO pin to toggle rx
    }

    // Common PA/LNA config
    opt.common_opt.pa_lna.gpiote_ch_id  = (gpiote_ch - NRF_GPIOTE_BASE) >> 2;   // GPIOTE channel used for
radio pin toggling
    opt.common_opt.pa_lna.ppi_ch_id_clr = ppi_clr_ch;   // PPI channel used for radio pin clearing
    opt.common_opt.pa_lna.ppi_ch_id_set = ppi_set_ch;   // PPI channel used for radio pin setting

    err_code = sd_ble_opt_set(BLE_COMMON_OPT_PA_LNA, &opt);
    APP_ERROR_CHECK(err_code);
}
```

Revision History

• July 2019, Ver. 0.51: draft release

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