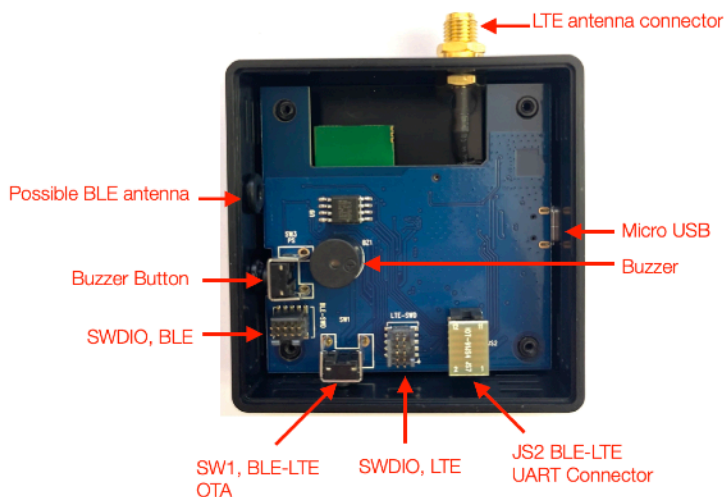


# BLG840FB4, Open Source Medical IoT Gateways

## Optimized for Remote Patient Monitoring

BLG840FB4 is a very low cost solution to relay monitoring data from Bluetooth, Thread, or Zigbee sensors to the cloud server.

- Nordic nRF9160 SICA SIP module supporting both LTE-M and NB-IoT.
- Long range BLE 5.3 module BT840F, 2300 meters range when no obstruction.
- Or, BLE 5.3 module BT40F, an nRF5340 module. It is globally certified with +3.4 dBm TX power.
- Flash memory to store patient data and forward to cloud upon LTE reconnection.
- A buzzer for audio alerting and a control button.



## BLE/802.15.4 to LTE Gateways

Unlike the standard BLG840F LTE to BLE gateway using a M.2 module, a Fanstel Bluetooth module and a Nordic

nRF9160 SICA LTE module are integrated on the medical gateway host board.

The SIM card connector is accessible from outside of gateway.

## Basic Edge Computing BLE to LTE Gateways

The 128 MHz application core in nRF5340 can perform basic edge computing function. An external 16 MB flash provides data storage. Sensor data can be processed and stored before forwarding to a cloud server.

## Miscellaneous

- Gateway size: 60x60x22 mm.
- 2 RGB LED indicators
- The external LTE antenna, ANT032E, has an AVX P822601 antenna inside.
- The BLE antenna is integrated.
- Includes an AC adapter, USB cable, wall mount bracket.

## Development and Programming Kits

Hardware required to load firmware.

- Nordic nRF9160DK for programming nRF9160 and nRF52840 modules.
- Nordic nRF5340DK for nRF5340 modules.
- Fanstel PK-BLG840F. (a) 10-pin flat cable for connecting gateway to Nordic DK (b) USB to UART bridge board and cable for monitoring LTE traffic.



## Certifications

- FCC ID: 2ANPO00NRF9160; X8WBT840F or X8WBT40F.
- ISED ID: 24529-NRF9160; 4100A-BT840F or 4100A-BT40F.

## Gateway Summaries

Interfaces	Bluetooth to LTE Gateway		
Gateway	BLG840FB4	BLG840FB16	BLG40FB16
Bluetooth module/TX power	BT840F/+8.5 dBm	BT840F/+8.5 dBm	BT40F/+3.4 dBm
Bluetooth antenna	PCB trace	PCB trace	PCA trace
LTE/TX power/antenna	nRF9160/+23dBm/ANT030	nRF9160/+23dBm/ANT030	nRF9160/+23dBm/ANT030
Ext. flash	4MB	16MB	16MB
Certifications	FCC, ISED	FCC, ISED	FCC, ISED
QDID	108621, 182626	108621, 182626	119517, 182626
Availability	Production	Non stock	Production

# BLG840FB4, Open Source Medical IoT Gateways

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# BLG840FB4, Open Source Medical IoT Gateways

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## 1. Introduction

BLG840FB4 Series gateway is optimized for remote patient monitoring application. It has a Nordic nRF9160 SICA LTE module and a Fanstel Bluetooth module using a Nordic nRF52840 or a Nordic nRF5340 SoC. The nRF5340 has a dual core Cortex M33 MCU. The 128 MHz application core can provide basic edge computing capabilities.

It is a very low cost device to relay patient monitoring data to cloud. A flash memory chip is added for local storage. The local data are uploaded to the cloud when the LTE connection is reestablished. A buzzer is available to send an audio alerting signal to the end user. A control button can be used to disable the audio alerting signal.

### LTE-M, 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 (cloT) 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 broad selection of general interfaces and peripherals and are included on nRF9160 including 12-bit ADC, RTC, SPI, I<sup>2</sup>C, I<sup>2</sup>S, 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 has a SIM connector for connection and authentication with mobile network operators.

### Bluetooth Interface

BLG840FB4 integrates BT840F (nRF52840) module with 2300 meter range at 125 Kbps when no obstruction.

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.

## **BLG840FB4, Open Source Medical IoT Gateways**

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### **Edge Computing**

The nRF5340 has a dual core Cortex M33 processor. The network processor is clocked at 64 MHz and is optimized for low power and efficiency (101 CoreMark/mA). It has 256 KB Flash and 64 KB RAM.

The application processor is optimized for performance and can be clocked at either 128 or 64 MHz, using voltage-frequency scaling. It has 1 MB Flash, 512 KB RAM, a floating-point unit (FPU), an 8 KB 2-way associative cache and DSP instruction capabilities. It can perform basic edge computing function before sending sensor data to a cloud server. An external 16 MB flash memory provides local storage of sensor and control data. It can reduce network traffic and in case of network failure, hold data till reconnection.

BT40E is globally certified with +3.4 dBm TX power and ANT060, a 6 dBi external antenna. It is just under the +10 dBm limitation of some regions.

# BLG840FB4, Open Source Medical IoT Gateways

## 2. Hardware Description

### BLG840FB4 Series Hardware

A BLG840FB4 Series gateway consists of the following hardware items:

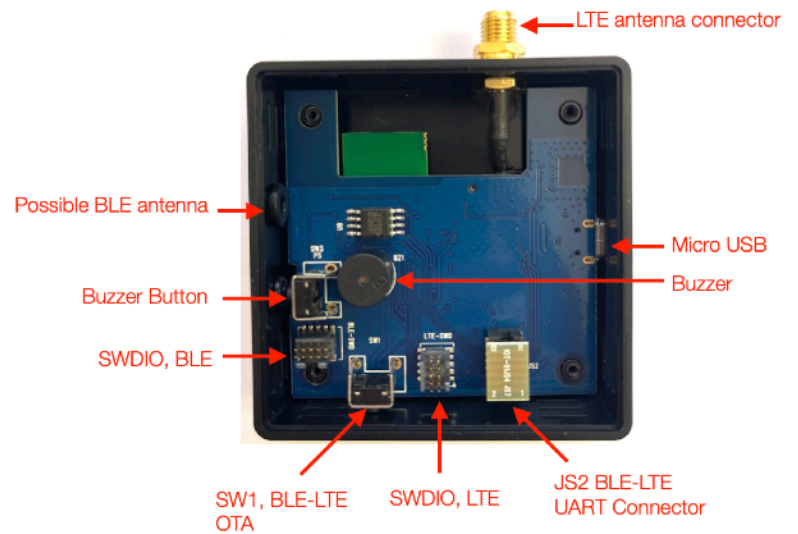
- The gateway main body
- A wall mount bracket.
- ANT032E, an LTE antenna with P822601, not pre-installed.
- An AC adapter.
- An USB cable.



Size of gateway is 60x60x22mm.

After removing 4 screws at the bottom of BLG840FB4, the following is shown. From the top, clockwise:

- An SMA connector for mounting an LTE antenna ANT032E.
- A micro USB connector for power.
- A buzzer, to provide an audio alerting signal to the user.
- JS2 BLE-LTE UART Connector. You can replace the small JS7 PCB with the PCB from PK-BLG840F to provide external access to LTE module or BLE module UART port. For normal operation, the JS7 board must be inserted.
- LTE-SWD. SWDIO connector for the LTE module.
- SW1, reset button. It can be used to begin DFU OTA upgrade.
- BLE-SWDIO connector for the BLE module.
- SW3 PS: Buzzer disable button.
- Possible BLE antenna. For gateway with an external BLE antenna, the SMA connector is installed here.



# BLG840FB4, Open Source Medical IoT Gateways

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## Gateway Summaries

### BLG840FB4

- Bluetooth interface: BT840F, an nRF52840 module with +8.5 dBm TX power, integrated PCB antenna.
- A 4MB flash memory connected to the BLE module.
- LTE interface: Nordic nRF9160 SICA and ANT032,
- Includes a 5V, 1Amp AC adapter and a 2-meters USB cable.
- A buzzer for audio alerting and a control button.

### BLG840FB16

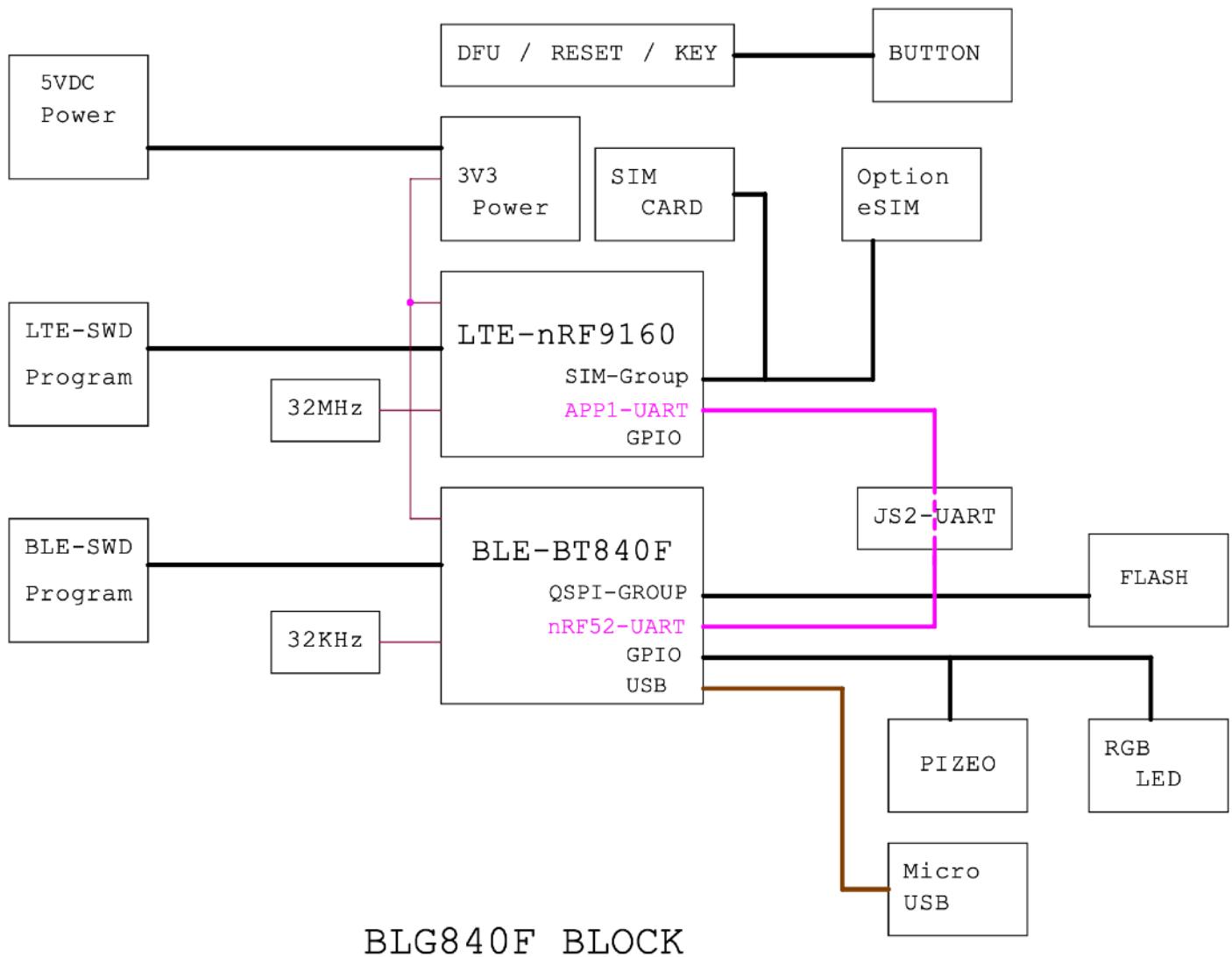
- All features of BLG840FB4.
- A 16MB flash memory connected to the BLE module.

### BLG40FB16

- All features of BLG840FB4.
- Bluetooth interface: BT40F, an nRF5340 module with +3.4 dBm TX power.
- A 16 MB flash memory connected to the BLE module.

## BLG840FB4 Block Diagram

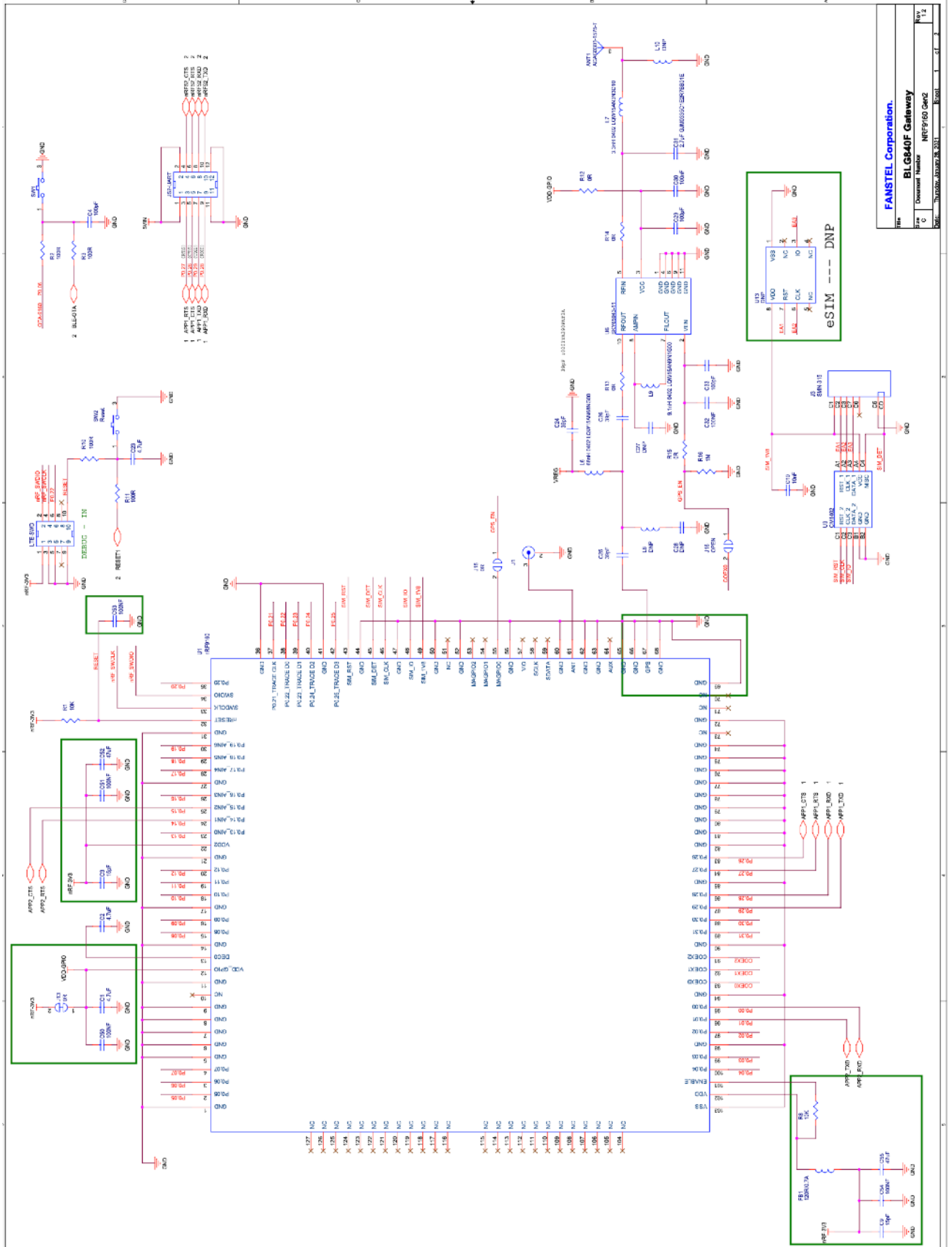
Block diagram of BLG840FB4 is below.



BLG840F BLOCK

- Nordic nRF9160 SICA is used for the LTE interface.
- A connector for nano SIM card is on board. It is accessible without opening the enclosure.
- BLE features can be supported by an nRF52840 or nRF5340 module.
- To monitor data traffic at LTE interface, insert UART-USB bridge board into JS2-UART connector. An UART-USB bridge board and an USB cable are included in PK-BLG840F Programming Kit.
- Two RGB LEDs are available as indicators.
- To program the BLE module, a Nordic nRF52840DK or nRF5340DK is needed. A 10-pin flat cable included in PK-BLG840F is required to connect a Nordic DK to to the corresponding module.
- To program the LTE module, a Nordic nRF9160DK is needed.

## Schematics for the LTE interface

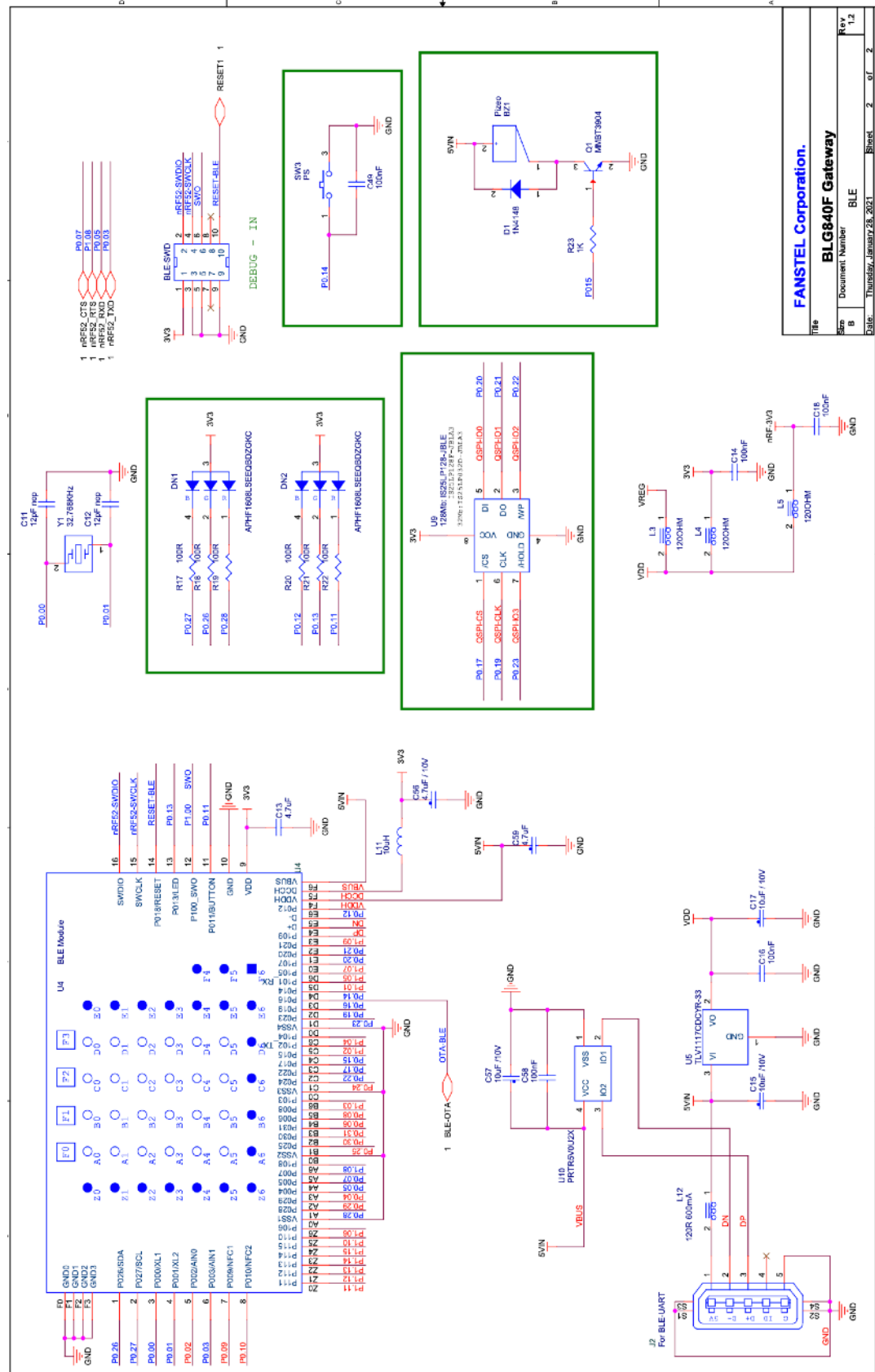




# BLG840FB4, Open Source Medical IoT Gateways

Ver 1.01, Jan. 2023

## Schematics for the Bluetooth interface



FANSTEL Corporation.			
BLG840F Gateway			
Size	Document Number	BLE	Rev
B			1.2
Date:	Thursday, January 28, 2021	Sheet	2 of 2

## BLG840FB4, Open Source Medical IoT Gateways

### 3. Establishing Cloud and Sensor Connection

#### PK-BLG840F, the LTE Monitor Board

PK-BLG840F can be used:

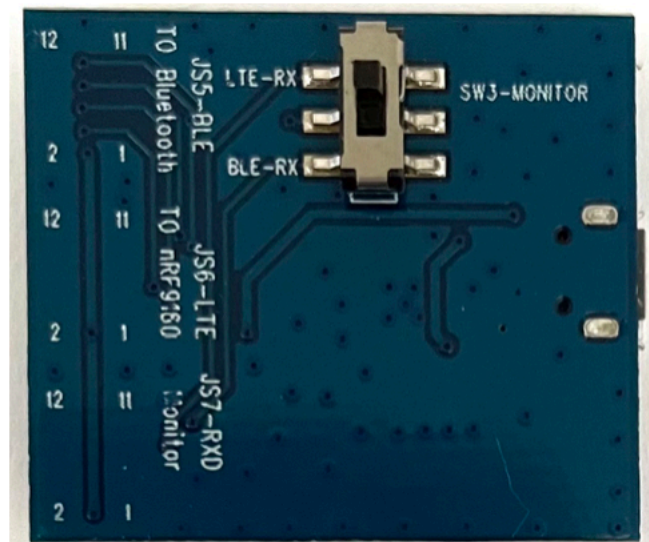
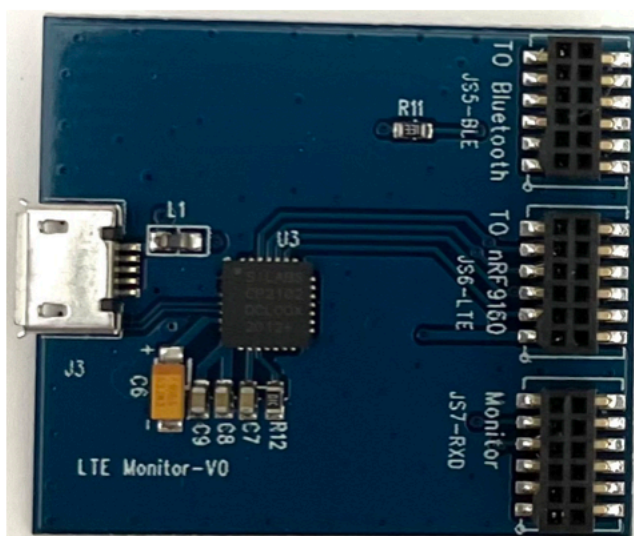
- to interface with the BLE module or the LTE module in BLG840F Series gateways.
- To monitor UART data traffic to the LTE module or the BLE module.

It contains:

- an UART to USB bridge board, called **LTE Monitor** board,
- a 10-pin flat cable,
- and an USB cable.

There are three 12-pins square connectors on the **LTE Monitor** board.

- JS5-BLE for connection to the BLE module in BLG840F gateway.
- JS6-LTE for connection to the LTE module in BLG840F gateway.
- JS7-RXD for monitor UART data to the receiver of the BLE or the LTE module. It can be selected by the SW3 switch on the back side.



# BLG840FB4, Open Source Medical IoT Gateways

## BLG840FB4

The BLG840FB4 is pre-loaded with Nordic modem mfw\_nrf9160\_1.2.0 and MQTT application.

MQTT tool or MQTT APP<->MQTT broker <-> LN60E40F <->BLE Sensor

The default application is for NB IoT. If you need to run CAT M. Please download the HEX file from Fanstel website.

The BLG840F preloaded firmware will send the temperature and humidity preset data to Fanstel MQTT server. One can use Fanstel MQTT PC tool or mobile APP to monitor data.

## Download and set up Basic Software tools for LN60G840F.

nRF command line tool 10.2.1 or newer.

<https://www.nordicsemi.com/Software-and-Tools/Development-Tools/nRF-Command-Line-Tools/Download>

nRF Connect desktop 3.2.0 or newer.

<https://www.nordicsemi.com/Software-and-Tools/Development-Tools/nRF-Connect-for-desktop>

Fanstel MQTT PC tool to test default firmware.

[https://www.dropbox.com/s/27xzy1kytb8t918/MQTT\\_PC\\_Tool190916.rar?dl=0](https://www.dropbox.com/s/27xzy1kytb8t918/MQTT_PC_Tool190916.rar?dl=0)

Fanstel LTE PC tool to test default firmware.

[https://www.dropbox.com/s/beyhbh78lowlzal/LTE\\_PC\\_Tool190718.rar?dl=0](https://www.dropbox.com/s/beyhbh78lowlzal/LTE_PC_Tool190718.rar?dl=0)

## Establishing an LTE Connection to a Cloud Server

The following example establishes a connection between the nRF9160 in BLG840FB4 gateway and Fanstel development server. You will enter artificial temperature and humidity data for uploading to the Fanstel MQTT server.

Assuming the nRF9160 only HEX code is programmed. You don't need to open the enclosure.

- Connect the external antenna. **The antenna in this photo and subsequent photos, is an LTE antenna not ANT032E as certified by FCC.**
- The small JS7 board is pre-installed. If not, insert it to JS-LTE connector.
- Connect the micro USB port to an AC adapter with an USB cable.



## BLG840FB4, Open Source Medical IoT Gateways

- Open Fanstel LTE monitor and MQTT listener PC tools.
- Select the COM port.
- Reset the BLG840FB4, the log appears.
- Configure Publish ID and artificial temperature.

The screenshot shows the 'LTE AT tool190611' application window. The title bar includes the text 'LTE AT tool190611' and standard window controls. The main content area is titled 'LTE MQTT' in blue text. Below the title, there are two blue buttons: 'Disconnect' and 'Clr Log'. The configuration section includes a 'Server' dropdown menu set to 'Fanstel', a 'Publish ID' text box containing '000123', and a note below it: 'Setup 6 Bytes ID then reset the EVB'. To the right, there are two data display boxes: 'temperature' showing '23' with '2 Bytes' below it, and 'humidity' showing '65' with '2 Bytes' below it. A green circular arrow icon is in the top right corner. At the bottom, a terminal window displays the following log output:

```
Data updated
H<- ***** Booting Zephyr OS v1.14.99-ncs2 *****\r\n
H<- The Fanstel MQTT 190904 \r\n
H<- UART enabled\r\n
H<- Waitting for MQTT ID!\r\n
H<- LTE Link Connecting ... \r\n
H-> SetID=000123\r\n
H-> RawData=023,065\r\n
```

## BLG840FB4, Open Source Medical IoT Gateways

When nRF9160 module is connected to the MQTT server, you will see the temperature and humidity data uploaded.

```
H<- IPv4 Address found 59.124.228.194\r\nH<- Got MQTT ID\r\nH<- Got MQTT ID=000123\r\nH<- AT+MQTT=1\r\nH<- Subscribing to: /my/9160_sub len 12\r\nH<- Publishing: Temp:023,Humi:065,ID:001\r\nH<- to topic: esp32_000123/Odemo len: 18\r\nH<- [mqtt_evt_handler:267] SUBACK packet id: 1234\r\nH<- Publishing: Temp:023,Humi:065,ID:002\r\nH<- to topic: esp32_000123/Odemo len: 18\r\n
```

- Open the MQTT PC tool and enter the same Publish ID you just setup.
- Press start icon.
- The data from nRF9160 is displayed.

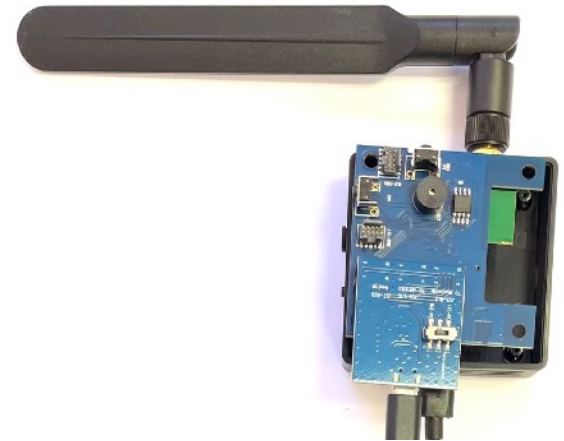


## BLG840FB4, Open Source Medical IoT Gateways

### Relaying Sensor Data to a Cloud Server

This application example relays temperature and humidity sensor data from Fanstel sensors through a LTE connection to the Fanstel cloud server.

- Remove BLG840FB4 PCBA from the enclosure.
- Programming mqtt9160NB\_210115.HEX code.
- Remove the small JS7 board from JS2 connector.
- Insert the JS7-RXD connector of the **LTE Monitor** board (the USB to UART bridge board included in PK-BLG840F) to JS2 connector of BLG840FB4 board.
- Use SW3 on the **LTE Monitor** board to select monitoring the UART data to the BLE or to the LTE receiver.
- Check both nRF9160 and nRF52840 UART logs, running normally.



You can use this set up to monitor traffic at the UART interface when developing your own code.

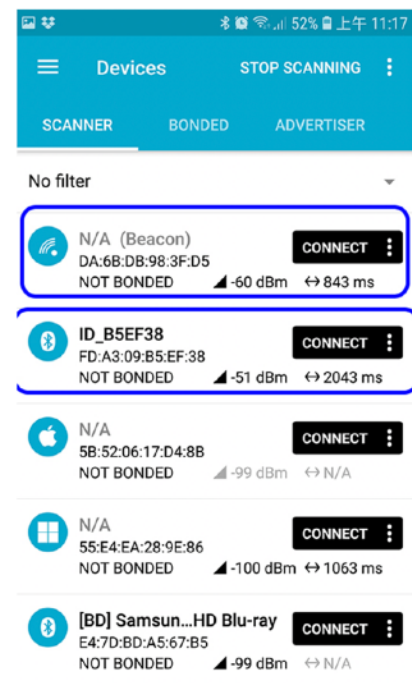
After checking the log, insert the small JS7 board back to JS3 connector.

### Using Android OS

Download and install nRF Connect mobile App.

<https://play.google.com/store/apps/details?id=no.nordicsemi.android.mcp&hl=zh-TW>

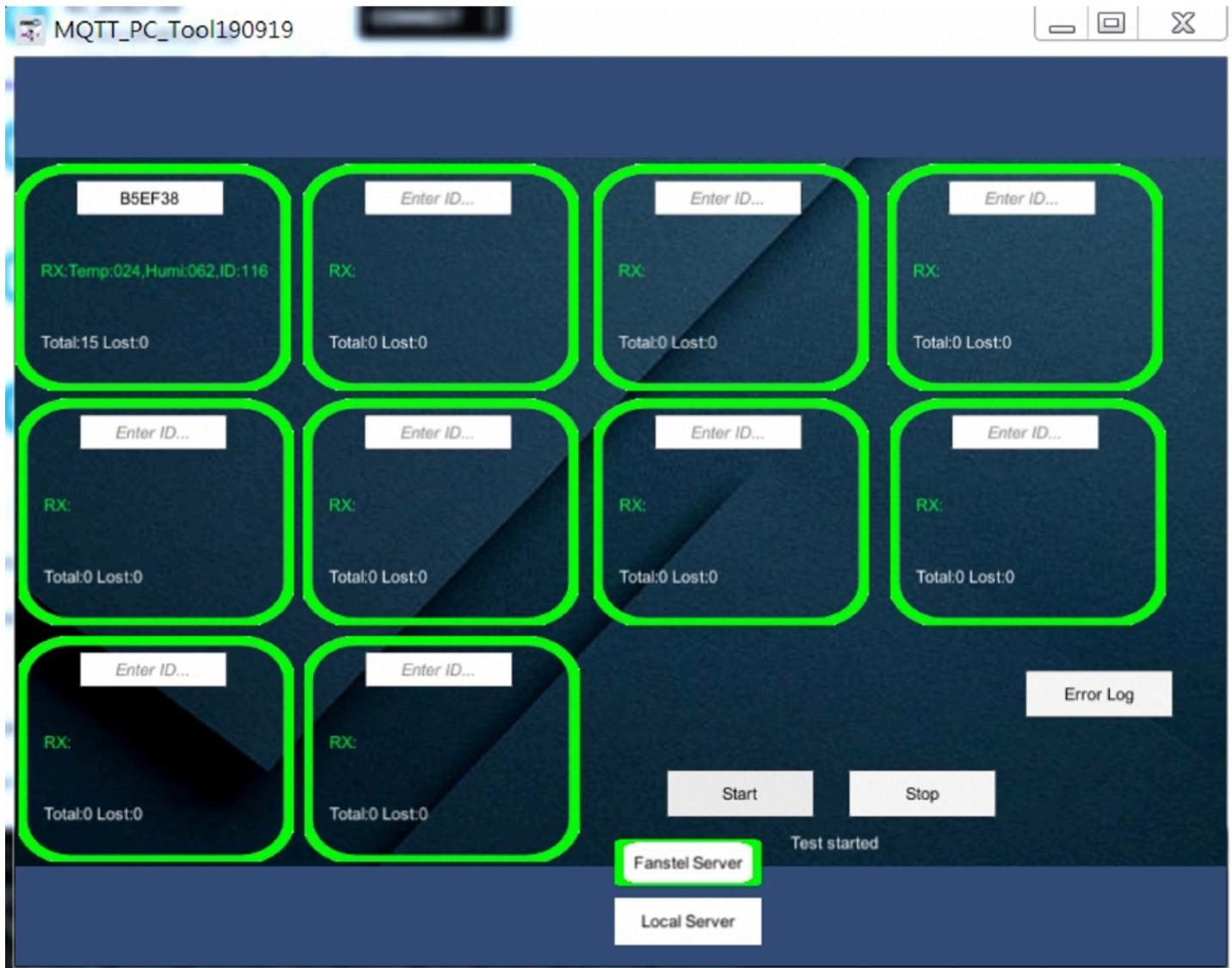
Open the nRF Connect mobile App when a Fanstel sensor is powered up nearby. The sensor is advertising the 6 bytes ID.



# BLG840FB4, Open Source Medical IoT Gateways

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Enter the sensor ID into Fanstel MQTT tool. The real sensor data are displayed on the tool.



## BLG840FB4, Open Source Medical IoT Gateways

### 4. BLG840FB4 Firmware Development

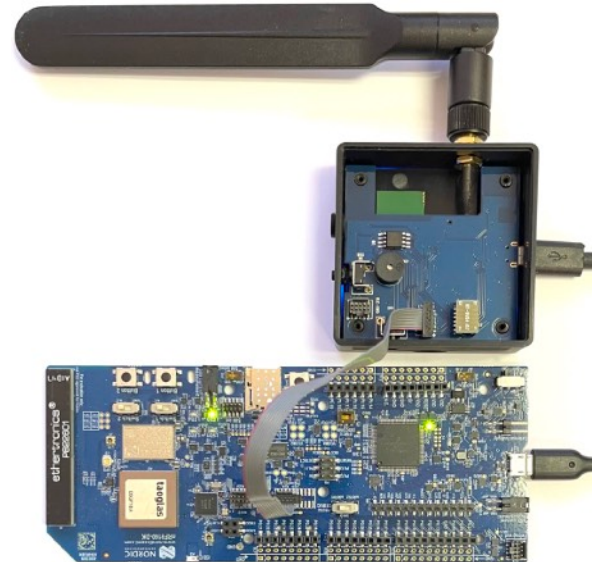
The following hardware is required to program a BLG840FB4 Series gateway.

- A Nordic nRF9160-DK to program the nRF9160 module and an nRF52840 module (BT840F, BT840E).
- A Nordic nRF5340-DK to program an nRF5340 module, BT40F.
- A 10-pin flat cable included in PK-BLG840F, Programming Kit.

#### Programming nRF9160

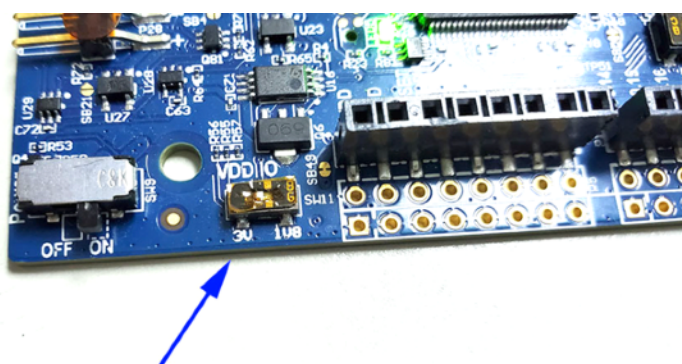
To program the nRF9160 module:

1. Use the 10-pin flat cable to connect nRF9160-DK **Debug out** to the connector marked **LTE-SWD** on the BLG840FB4 board.
  2. Set the **PROG/DEBUG** slide switch **SW10** to nRF91.
  3. Set the **VDD** slide switch **SW9** to 3V.
4. Connect the nRF9160 DK **External supply** connector to a PC or Mac USB port.
  5. Use the included USB AC adapter to power up BLG840FB4.
  6. Use Nordic nRF Connect software tools to program the nRF9160 module.
- Open the command line and go to the folder where the HEX file located.
  - Execute the programming command  
`"nrfjprog --program mqtt9160NB_190904.hex --chiperase -f nrf91 --reset"`



```
C:\Users\Administrator\Desktop\Nordic Firmware\LTE9160_MQTT190904>nrfjprog --pro
gram mqtt9160NB_190904.hex --chiperase -f nrf91 --reset
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.
Applying system reset.
Run.
```

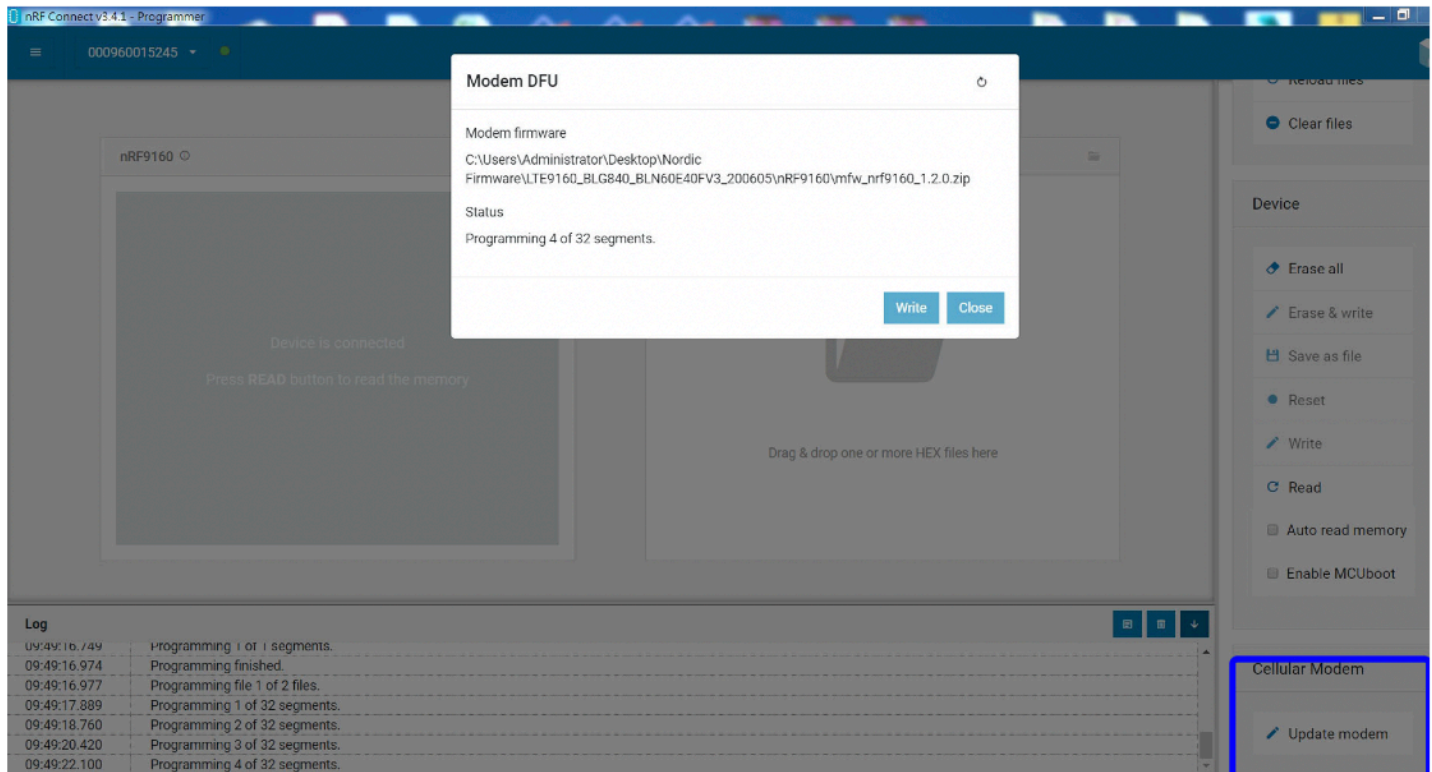
Note: The voltage supported by external debugging/programming is the VDD voltage. This voltage can be selected to 1.8 V or 3 V using slide switch SW11. Make sure the voltage level of the external board matches the VDD of the nRF9160 DK. Please select 3V if programming the BLG840FB4 gateway.





# BLG840FB4, Open Source Medical IoT Gateways

Programming the nRF9160 with nRF Connect for desktop.  
Upgrade modem.



## Upgrade application

The screenshot displays the nRF Connect v3.4.1 Programmer interface. The top bar shows the device ID 000960015245. The main area is divided into two panels: 'nRF9160' on the left, which indicates 'Device is connected' and prompts the user to 'Press READ button to read the memory', and 'File memory layout' on the right, which shows a memory map with green and orange segments. A right-hand sidebar contains 'File' and 'Device' sections with various actions like 'Add HEX file', 'Reload files', 'Clear files', 'Erase all', 'Erase & write', 'Save as file', 'Reset', 'Write', 'Read', 'Auto read memory', and 'Enable MCUboot'. At the bottom, a 'Log' window shows the following entries:

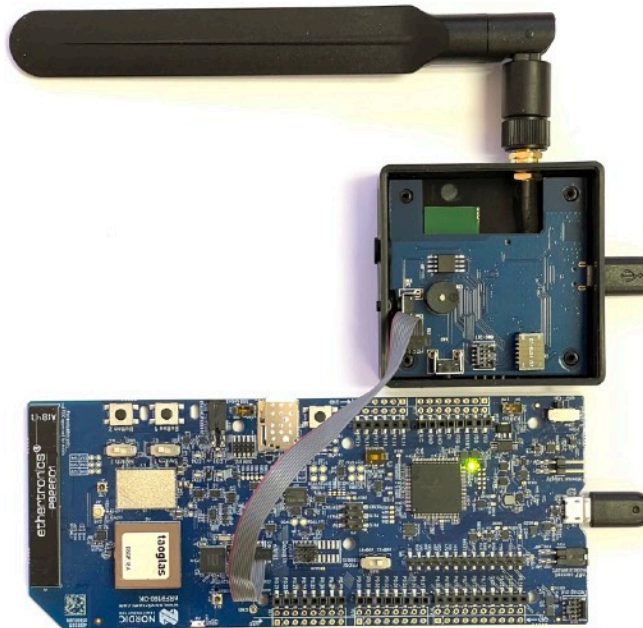
Time	Message
09:53:18.993	Segger version: J-Link OB-K22-Nordicsemi compiled Jan 21 2020 17:33:01
09:53:19.000	Core probed: 960015245.
09:53:19.000	Core RAM: 256KiB.
09:53:19.000	Core ROM: 1024KiB in pages of 4KiB.
09:53:19.316	Model: NRF9160_xxAA_REV1.
09:53:20.090	Core0: Reading device non-volatile memory. This may take a few seconds.
09:53:20.290	Core0: UICR has been read. Click read button to read full non-volatile memory.

## BLG840FB4, Open Source Medical IoT Gateways

### Programming BT840F

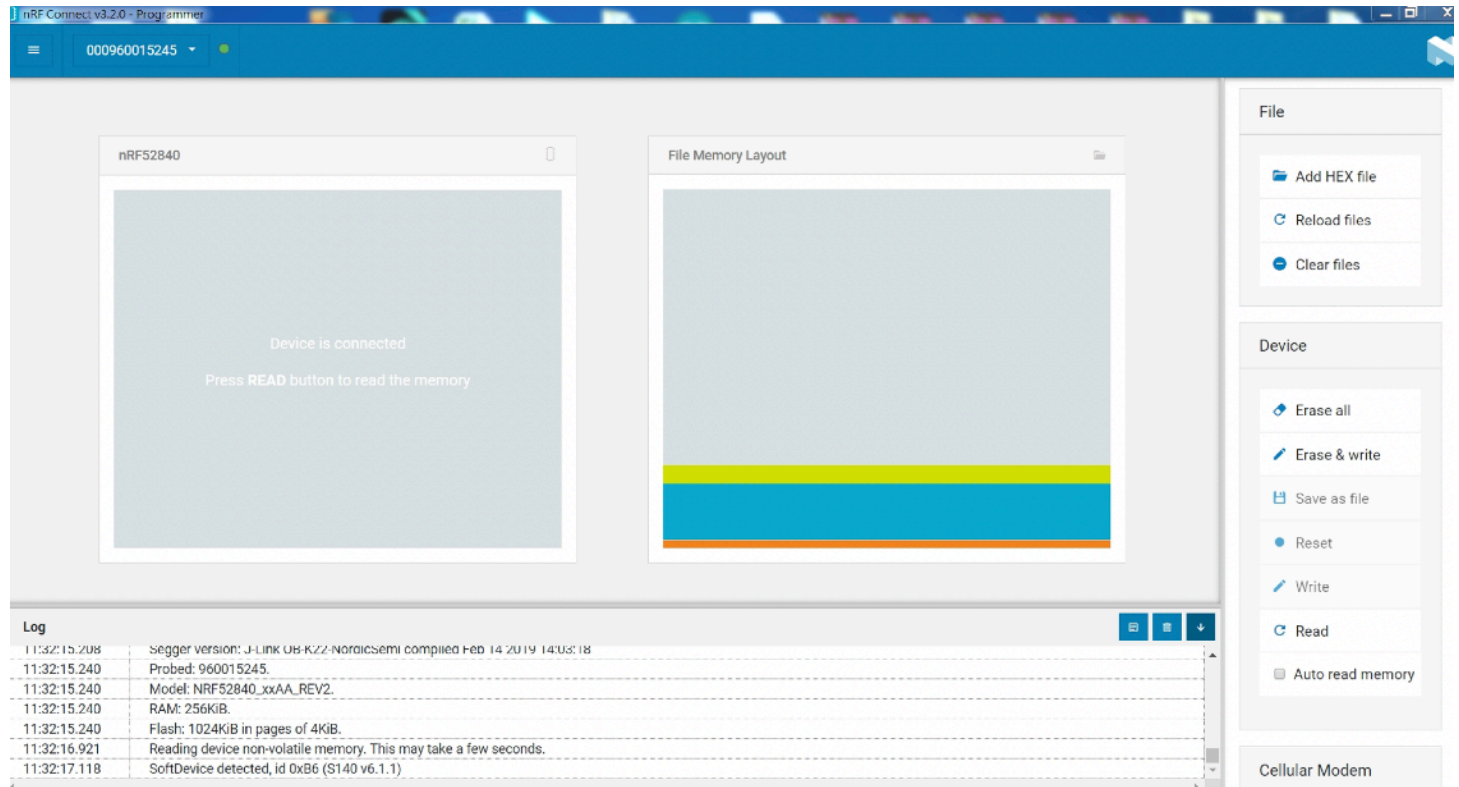
You can use an nRF9160-DK to program the nRF52840 module:

1. Use the 10-pin flat cable to connect nRF9160-DK **Debug out** to the connector marked **BLE-SWD** on the BLG840FB4 board.
2. Set the **PROG/DEBUG** slide switch **SW10** to nRF52.
3. Set the **VDD** slide switch **SW9** to 3V.
4. Connect the nRF52840 DK **External supply** connector to a PC or Mac USB port.
5. Use the included USB AC adapter to power up BLG840FB4.
6. Use Nordic nRF Connect software tools to program the nRF52840 module.



## BLG840FB4, Open Source Medical IoT Gateways

Open nRF connect programmer and load the HEX code.  
Execute Erase & Write.  
The log will show write success.



The screenshot displays the nRF Connect v3.2.0 Programmer interface. The top bar shows the device ID 000960015245. The main area is divided into two panels: 'nRF52840' and 'File Memory Layout'. The 'nRF52840' panel shows 'Device is connected' and 'Press READ button to read the memory'. The 'File Memory Layout' panel shows a memory map with a yellow bar at the bottom. The right sidebar contains 'File' (Add HEX file, Reload files, Clear files), 'Device' (Erase all, Erase & write, Save as file, Reset, Write, Read, Auto read memory), and 'Cellular Modem'. A 'Log' window at the bottom shows the following entries:

Time	Message
11:32:15.208	Segger version: J-Link OB-K22-Nordicsemi compiled Feb 14 2019 14:03:18
11:32:15.240	Probed: 960015245.
11:32:15.240	Model: NRF52840_xxAA_REV2.
11:32:15.240	RAM: 256KIB.
11:32:15.240	Flash: 1024KIB in pages of 4KIB.
11:32:16.921	Reading device non-volatile memory. This may take a few seconds.
11:32:17.118	SoftDevice detected, id 0xB6 (S140 v6.1.1)

# BLG840FB4, Open Source Medical IoT Gateways

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

### Firmware Development

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

A Nordic nRF9160-DK and Fanstel PK-BLG840F are needed to program gateway.

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 and nRF52840DK are used to develop BT840F/X codes. Open source codes are available

<http://www.fanstel.com/download-opensource/>

## Firmware to Control Power Amplifier in BLG840X

The following codes are used to set up and control power amplifier SKY66112 in BT840X. Codes can be downloaded from:

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

Additional instructions for controlling SKY66112 are in BT840F product specifications, downloadable from the same webpage.

## **BLG840FB4, Open Source Medical IoT Gateways**

### **Revision History**

- Feb. 2022, Ver. 0.90: draft release
- July 2022, Ver 0.91: Add support for BT40NE module.
- Nov. 2022, Ver. 1.00: Add FCC and ISED certifications, initial release.
- January 2023, Ver. 1.01: Add photo of certified LTE antenna ANT032E.

## BLG840FB4, Open Source Medical IoT Gateways

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