

# nRF9160 DK

## Getting Started Guide

v1.1

# Contents

Revision history . . . . .	iii
<b>1 Introduction . . . . .</b>	<b>4</b>
<b>2 Related documentation . . . . .</b>	<b>5</b>
<b>3 Minimum requirements . . . . .</b>	<b>6</b>
<b>4 Testing a prebuilt application . . . . .</b>	<b>7</b>
4.1 Installing the required software . . . . .	7
4.2 Updating the DK firmware . . . . .	7
4.2.1 Downloading the DK firmware . . . . .	7
4.2.2 Updating the application firmware . . . . .	8
4.2.3 Updating the modem firmware . . . . .	9
4.3 Creating an nRF Connect for Cloud account . . . . .	10
4.4 Updating the nRF Connect for Cloud certificate . . . . .	10
4.4.1 Downloading the nRF Connect for Cloud certificate . . . . .	10
4.4.2 Provisioning the nRF Connect for Cloud certificate . . . . .	11
4.5 Connecting the DK to nRF Connect for Cloud . . . . .	12
4.6 Testing the application . . . . .	13
4.6.1 Testing the GPS functionality . . . . .	13
<b>5 Building and testing a sample application . . . . .</b>	<b>15</b>
5.1 Installing the nRF Connect SDK . . . . .	15
5.2 Programming a sample . . . . .	15
5.3 Testing the cellular connection with the AT Client sample . . . . .	16
5.4 Building and testing the Asset Tracker . . . . .	17
<b>6 Developing your own application . . . . .</b>	<b>18</b>
Glossary . . . . .	19
Acronyms and abbreviations . . . . .	21
Legal notices . . . . .	23

# Revision history

Date	Version	Description
August 2020	1.1	Updated <a href="#">Testing the cellular connection with the AT Client sample</a> on page 16
July 2020	1.0	First release

# 1 Introduction

This guide will help you get started with your nRF9160 DK. Before you start developing your own application, you should update the firmware (both the application firmware and the modem firmware) and the certificates of the *Development Kit (DK)* and conduct some initial tests.

The nRF9160 DK is a hardware development platform used to design and develop application firmware on the nRF9160 LTE *Cat-M1* and *Cat-NB1 System in Package (SiP)*. See [nRF9160 DK Hardware](#) for detailed information about the *DK*.

The *DK* is preprogrammed with the [nRF9160: Asset Tracker](#) application, which simulates sensor data and transmits it to Nordic Semiconductor's cloud solution, *nRF Connect for Cloud*. Both the Asset Tracker application and *nRF Connect for Cloud* are constantly being improved. Therefore, you should update the application and the modem firmware before you start working with the nRF9160 DK.

# 2 Related documentation

In addition to the information in this document, you may need to consult other documents.

## User guides

- [nRF9160 DK Hardware](#)
- [nRF Connect SDK documentation](#)
- [nRF Connect for Desktop](#)
- [nRF Connect Programmer](#)
- [nRF Connect LTE Link Monitor](#)

## Reference information

- [nRF9160 Product Specification](#)
- [nRF9160 Revision 1 Errata](#)
- [nRF9160 Compatibility Matrix](#)
- [nRF9160 Modem Firmware Release Notes \(included in the latest nRF9160 modem firmware\)](#)
- [nRF91 AT Commands Reference Guide](#)

# 3 Minimum requirements

Ensure that you have all the required hardware and that your computer fulfills the software requirements.

## Hardware requirements

- nRF9160 DK
- nano-SIM card that supports *LTE-M* or *Narrowband Internet of Things (NB-IoT)* (the nRF9160 DK contains an iBasis *Subscriber Identity Module (SIM)* card)
- Micro-USB 2.0 cable
- Personal computer (PC)

## Software requirements

One of the following operating systems:

- Windows 8 or Windows 10
- macOS
- Linux

# 4 Testing a prebuilt application

Before you start developing, program and run a precompiled application on your *DK* to ensure that the kit functions as expected and the communication between your computer, the *DK*, and the cloud works.

If you want to see a demonstration of these first steps, watch the videos on [nRF9160 DK Get started](#). These videos cover the contents of this chapter.

## 4.1 Installing the required software

To be able to update the nRF9160 DK firmware and certificates, you must install several apps for nRF Connect for Desktop.

[nRF Connect for Desktop](#) is a cross-platform framework for development applications. It contains apps for programming firmware, monitoring LTE links, power optimization, and more.

You can download nRF Connect for Desktop from our [website](#).

**Note:** On macOS and Linux, you must download and install the [SEGGER J-Link Software](#) separately.

After installing and starting the main application, you see an overview of available apps. Click the **arrow down** button to display additional information about each app.

You must install the following apps:

- Programmer
- LTE Link Monitor

To install the app:

1. Open nRF Connect for Desktop.
2. Find the app in the list of apps and click **Install**.

Once the app is installed, you can launch it by clicking **Open**.

For easy access, you can create a desktop shortcut by clicking the **arrow down** button and selecting **Create shortcut**.

If a new version of the app becomes available, an **Update** button is displayed next to the **Open** button. Click this button to install the latest version. To uninstall the app, click the **arrow down** button and select **Uninstall**.

If you plan to build your own application, you must install the nRF Connect SDK in addition. This installation requires big downloads, which can take some time. Therefore, you might want to start the installation while you continue with the initial test. See [Installing the nRF Connect SDK](#) on page 15 for instructions.

## 4.2 Updating the DK firmware

To update the nRF9160 DK firmware, you must program the latest version of the application firmware and the modem firmware.

### 4.2.1 Downloading the DK firmware

The nRF9160 DK firmware is available from the Nordic Semiconductor website.

Download the latest nRF9160 DK application and modem firmware from the [nRF9160 DK Downloads](#) page and extract it to a folder of your choice.

The zip file contains the following firmware:

#### Application firmware

The `images_full` folder contains full firmware images for different applications. When following this guide, use the image for the asset tracker application. Depending on where you are located, you need the image with either *LTE-M* or *NB-IoT* support. See [iBasis IoT network coverage](#) for information about which mode is supported where.

#### Application firmware for *Device Firmware Update (DFU)*

The `images_dfu_bin` and `images_dfu_hex` folders contain firmware images for *DFU*. When following this guide, ignore these images.

#### Modem firmware

The modem firmware is located in the root folder of the zip file. When following this guide, use the `mfwnrf9160*.zip` file to update the modem firmware. Do not unzip the file.

## 4.2.2 Updating the application firmware

After downloading the *DK* firmware, use nRF Connect Programmer to program the latest application firmware.

Complete the following steps to update the application firmware:

1. Open nRF Connect for Desktop and launch [nRF Connect Programmer](#).
2. Set the **PROG/DEBUG (SW5)** switch on the nRF9160 DK to **nRF91** so that the application firmware is programmed to the nRF9160 *SiP*.
3. Connect the nRF9160 DK to the computer with a micro-USB cable, and turn it on. In the navigation bar, **No devices available** changes to **Select device**.
4. Click **Select device** and select the device from the drop-down list.

You can identify the nRF9160 DK by the fact that it has three COM ports. If the three COM ports are not visible, it could be because of the following reasons:

- When the nRF9160 DK is reset while it is still connected to the Programmer app. Press **Ctrl+R** in Windows and **command+R** in macOS to restart Programmer and to correctly view the COM ports.
- Other errors.

The button text changes to the SEGGER ID of the selected device, and the **Device Memory Layout** section indicates that the device is connected.

5. If you have not ticked the **Auto read memory** option under the **Device** menu and wish to visually see the memory layout before you program, click **Read** in the menu. If you have ticked it, the memory layout will update automatically.
6. Click **Add HEX file** in the **File** pane on the right and select **Browse**.
7. Navigate to the `images_full` subfolder of the folder where you extracted the nRF9160 DK firmware and select the `nrf9160dk_asset_tracker_ltem_*.hex`, `nrf9160dk_asset_tracker_nbiot_*.hex`, or `nrf9160dk_asset_tracker_nbiot_legacy_pco_*.hex` file.

See [iBasis IoT network coverage](#) for information on which mode (*LTE-M* or *NB-IoT*) is suitable for your location. For *NB-IoT*, two variants of the firmware with different *Protocol Configuration Options (PCO)* handling are available. The main *NB-IoT* variant is suitable in most cases. Only use the legacy *PCO* variant if your network does not support ePCO.

8. Click **Erase & write** in the **Device** pane to program the device.

If you experience any problems while updating the firmware, restart nRF Connect Programmer by pressing **CTRL+R** (**CMD+R** on Mac).



### 4.2.3 Updating the modem firmware

The nRF9160 DK contains a multimode modem that supports *LTE-M* and *NB-IoT*. After downloading the *DK* firmware, use nRF Connect Programmer to update the modem firmware.

Complete the following steps to update the modem firmware:

1. Open nRF Connect for Desktop and launch [nRF Connect Programmer](#).
2. Make sure that the **PROG/DEBUG (SW5)** switch on the nRF9160 DK is set to **nRF91**.
3. Connect the nRF9160 DK to the computer with a micro-USB cable, and turn it on.  
In the navigation bar, **No devices available** changes to **Select device**.
4. Click **Select device** and select the device from the drop-down list.

You can identify the nRF9160 DK by the fact that it has three COM ports. If the three COM ports are not visible, it could be because of the following reasons:

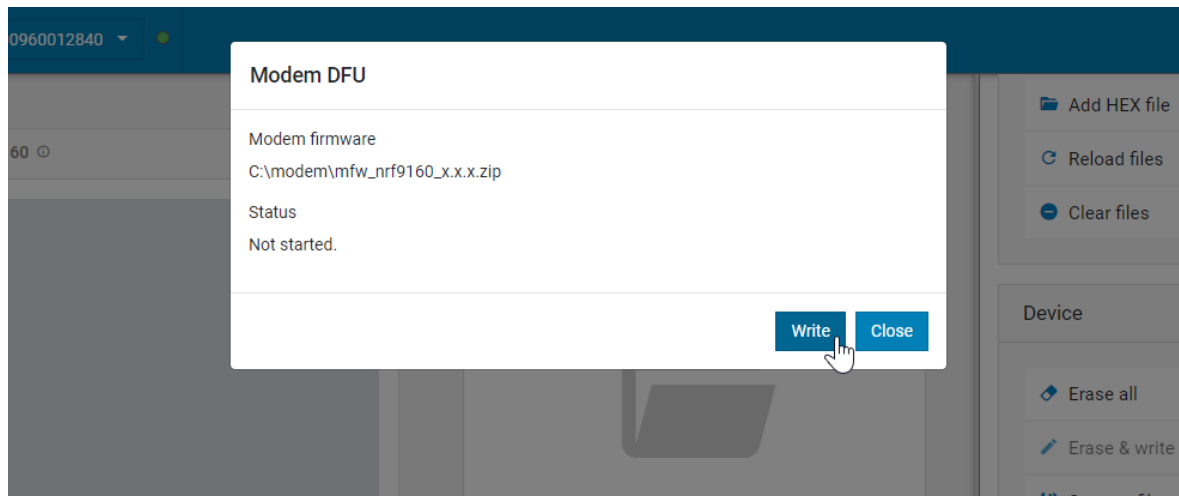
- When the nRF9160 DK is reset while it is still connected to the Programmer app. Press **Ctrl+R** in Windows and **command+R** in macOS to restart Programmer and to correctly view the COM ports.
- Other errors.

The button text changes to the SEGGER ID of the selected device, and the **Device Memory Layout** section indicates that the device is connected.

5. Click **Update modem** in the **Cellular Modem** pane on the right and choose the `mfwnrf9160*.zip` file from the folder where you extracted the nRF9160 DK firmware.

**Note:** Make sure to select the zip file. Do not unzip it.

The **Modem DFU** dialog box appears as shown in the following figure.



6. Click **Write** in the **Modem DFU** dialog box to update the firmware.  
Do not unplug or turn off the device during this process.

**Note:** If you have issues updating modem firmware, click **Erase all** before trying to update the modem again. In this case, the contents of the flash memory are deleted and the applications must be reprogrammed.

When the update is complete, you see a success message.

If you experience any problems while updating the firmware, restart nRF Connect Programmer by pressing **CTRL+R** (**CMD+R** on Mac).

## 4.3 Creating an nRF Connect for Cloud account

You must sign up with nRF Connect for Cloud before you can start using the service.

[nRF Connect for Cloud \(nrfcloud.com\)](https://nrfcloud.com) is Nordic Semiconductor's platform for connecting your IoT devices to the cloud, viewing and analyzing device message data, prototyping ideas that use Nordic Semiconductor chips, and more. It even includes a public REST *Application Programming Interface (API)* that can be used for building your own IoT solutions.

Complete the following steps to create an nRF Connect for Cloud account:

1. Navigate to [nRF Connect for Cloud \(nrfcloud.com\)](https://nrfcloud.com) and click **Create Account**.
2. Enter your email address and choose a password. Then click **Create Account**.  
nRF Connect for Cloud will send you a verification email.
3. Check your email for a message sent by `no-reply@verificationemail.com`. Copy the 6-digit verification code and paste it into the prompt on the [nRF Connect for Cloud \(nrfcloud.com\)](https://nrfcloud.com) website.

You can now sign in on [nRF Connect for Cloud \(nrfcloud.com\)](https://nrfcloud.com) with your email address and password. After signing in, you will be directed to the dashboard, which displays the number of gateways and devices that are connected to your nRF Connect for Cloud account.

## 4.4 Updating the nRF Connect for Cloud certificate

To establish a connection with *nRF Connect for Cloud*, you might need to update the security certificate that is stored in the nRF9160 DK.

The prebuilt [nRF9160: Asset Tracker](#) application transmits data to *nRF Connect for Cloud* for visualization. Therefore, it requires a valid security certificate.

**Note:** The following steps are required for nRF9160 DK versions up to v0.9.0. Newer versions of the nRF9160 DK contain a valid *nRF Connect for Cloud* certificate, and you can therefore skip the steps in this section.

### 4.4.1 Downloading the nRF Connect for Cloud certificate

You can download the *nRF Connect for Cloud* certificate for your nRF9160 DK from *nRF Connect for Cloud*.

Complete the following steps to download the certificate:

1. Go to [nRF Connect for Cloud \(nrfcloud.com\)](https://nrfcloud.com) and sign in.
2. Click the menu icon in the top-right corner and select **Account**.
3. In the **Device Certificates** section, enter your device ID and ownership code.

#### Device ID

The device ID is composed of `nrf-` and the 15-digit *International Mobile (Station) Equipment Identity (IMEI)* number that is printed on the label of your nRF9160 DK. For example:

```
nrf-123456789012345
```

#### Ownership code

The ownership code is the PIN or the hardware ID of your DK. You can find it on the label of your nRF9160 DK. If the label contains a PIN in addition to the *IMEI* number, enter this PIN.

If it does not contain a PIN, enter the HWID HEX code, with or without colons. For example:

```
AA:BB:CC:DD:EE:FF or AABBCCDDEEFF
```

You need to enter this information several times while setting up your nRF9160 DK. Therefore, it can be helpful to note it down somewhere on your PC.

**Note:** The ownership code serves as a password and proves that you own the specific nRF9160 DK. Therefore, you should not share it with anyone.

4. Click **Download Certificate** and save the \*.cert.json file to a folder of your choice.

**Note:** The certificate contains all information that is needed to connect your nRF9160 DK to *nRF Connect for Cloud*. Therefore, you should not share the certificate with anyone.

## 4.4.2 Provisioning the nRF Connect for Cloud certificate

After retrieving the certificate from *nRF Connect for Cloud*, you must provision it to your nRF9160 DK.

**Note:** The application firmware on the nRF9160 DK must support long AT commands up to 3 kB to provision the certificate. If you [updated the application firmware](#) as described, this requirement is fulfilled.

Complete the following steps to provision the certificate:

1. Open nRF Connect for Desktop and launch [nRF Connect LTE Link Monitor](#).
2. In the **Settings** pane on the right, deselect the check box for **Automatic requests**.
3. If you have already inserted the *SIM* card into your *DK*, remove it before you continue.
4. Connect the nRF9160 DK to the computer with a micro-USB cable, and turn it on. In the navigation bar, **No devices available** changes to **Select device**.
5. Click **Terminal** in the navigation bar to switch to the terminal view.
6. Enter `AT+CFUN=4` in the AT command text field and click **Send**. This AT command puts the modem to offline state.
7. Enter `AT+CFUN?` in the AT command text field and click **Send**. This AT command returns the state of the modem. The command should return `+CFUN: 4`, which indicates that the modem is in offline state. If it returns a different value, repeat the previous step.
8. Click **Certificate manager** in the navigation bar to switch to the certificate manager view.
9. Click **Load from JSON** and select the \*.cert.json file that you downloaded from *nRF Connect for Cloud*. You can also drag and drop the file onto the GUI.
10. Ensure that the **Security tag** is set to 16842753, which is the security tag for *nRF Connect for Cloud* credentials.
11. Click **Update certificates**. The log message "Certificate update completed" indicates that the certificate was provisioned successfully. If you encounter any errors, switch to the terminal view and check the output of the AT commands that were sent to the nRF9160 DK modem.

**Note:** If you had connected your nRF9160 DK to *nRF Connect for Cloud* before, you must delete the device there after provisioning the certificate. To do so, open the entry for your device from the **Devices** view, click **Configure**, and select **Delete Device**. Then, add the nRF9160 DK again as described in [Connecting the DK to nRF Connect for Cloud](#) on page 12.

## 4.5 Connecting the DK to nRF Connect for Cloud

To be able to transmit data from your nRF9160 DK to *nRF Connect for Cloud*, you must activate your *SIM* card and add the nRF9160 DK to your *nRF Connect for Cloud* account.

Complete the following steps to connect your nRF9160 DK to *nRF Connect for Cloud*:

1. Go to [nRF Connect for Cloud \(nrfcloud.com\)](https://nrfcloud.com) and sign in.
2. Click the + icon in the top left corner.
3. Click **LTE Device**.
4. Activate your iBasis *SIM* card by entering the 18-digit *Integrated Circuit Card Identifier (ICCID)* and the *Personal Unblocking Key (PUK)*, accepting the terms and the privacy policy, and clicking **Activate SIM**.  
The *ICCID* and the *PUK* are printed on the *SIM* card.

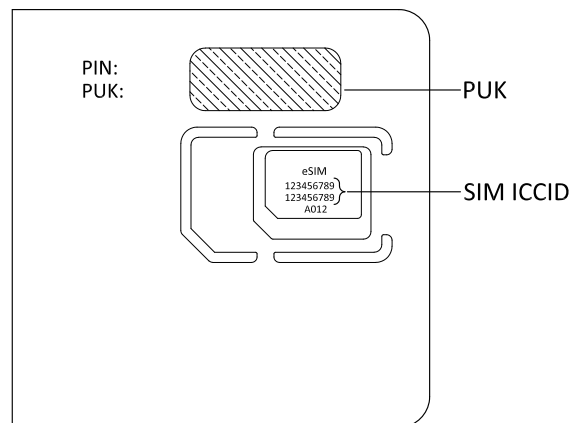


Figure 1: Placement of PUK and SIM ICCID on the SIM card

**Note:** If you activated your iBasis *SIM* card before, click **Skip this step**.

If you are using a *SIM* card from another provider, make sure to activate it via your network operator. Then click **Skip this step**.

- After the *SIM* card is activated, you are redirected to the **Add LTE Device** screen. Leave the browser window open and continue with the next step before you enter the information on that screen.
5. Punch out the nano-SIM from the *SIM* card and plug it into the *SIM* card holder on the nRF9160 DK.
  6. Optional: If you want to test the optional *Global Positioning System (GPS)* functionality and you have received an external *GPS* patch antenna with your nRF9160 DK, attach it to the **GPS** SWF connector (**P29**) to the left of the LTE antenna.  
See [nRF9160 DK GPS](#) for more information.
  7. Connect the nRF9160 DK to the computer with a USB cable and turn it on, or reset the device if it is already turned on.
  8. Wait up to three minutes for the device to find the cellular network and the cloud server.  
The LEDs indicate the current state as described in [Asset Tracker user interface](#). When **LED3** and **LED4** blink simultaneously, the connection to *nRF Connect for Cloud* has been established. The device is now provisioned on *nRF Connect for Cloud*, but it is not yet associated with your account.
  9. When both LEDs blink, return to the *nRF Connect for Cloud* browser window from the [earlier step](#) to associate the device with your account.
  10. In the **Add LTE Device** screen, enter your device ID and ownership code.

**Device ID**

The device ID is composed of `nrf-` and the 15-digit *IMEI* number that is printed on the label of your nRF9160 DK. For example: `nrf-123456789012345`

**Ownership code**

The ownership code is the PIN or the hardware ID of your *DK*. You can find it on the label of your nRF9160 DK. If the label contains a PIN in addition to the *IMEI* number, enter this PIN. If it does not contain a PIN, enter the HWID HEX code, with or without colons. For example: `AA:BB:CC:DD:EE:FF` or `AABBCCDDEEFF`

You need to enter this information several times while setting up your nRF9160 DK. Therefore, it can be helpful to note it down somewhere on your PC.

**Note:** The ownership code serves as a password and proves that you own the specific nRF9160 DK. Therefore, you should not share it with anyone.

**11. Click Add Device.**

**LED3** stops blinking and **LED4** turns on, indicating that the device is now associated with your *nRF Connect for Cloud* account.

The nRF9160 DK is now added to your *nRF Connect for Cloud* account. You can access it by clicking **Devices** in the navigation pane on the left.

## 4.6 Testing the application

After successfully associating your nRF9160 DK with your *nRF Connect for Cloud* account, you can start testing it.

The application that is programmed is the [nRF9160: Asset Tracker](#) from the [nRF Connect SDK](#).

Complete the following steps to test the application:

1. Turn on or reset your nRF9160 DK and wait until **LED3** is off and **LED4** is on, indicating that the connection to *nRF Connect for Cloud* has been established.
2. Go to [nRF Connect for Cloud \(nrcloud.com\)](#) and sign in.
3. Click **Devices** in the navigation pane on the left and open the entry for your device.
4. Toggle **Switch 1** on the nRF9160 DK to simulate orientation change. Observe that the **Terminal** card in *nRF Connect for Cloud* displays a FLIP event, and the orientation change is logged in the **Asset Orientation** card.

If you experience problems and need to check the log messages, open *nRF Connect for Desktop* and launch [nRF Connect LTE Link Monitor](#). After connecting to your *DK*, you can see the log messages in the terminal view.

### 4.6.1 Testing the GPS functionality

If supported by the LTE network, the [nRF9160: Asset Tracker](#) retrieves GPS data and transmits it to *nRF Connect for Cloud*.

There are several conditions that must be satisfied so that the nRF9160 DK can retrieve GPS data:

- The *SIM* card that you are using must be able to establish a connection. You can confirm this by checking whether the status of your nRF9160 DK is displayed correctly in *nRF Connect for Cloud*.
- Your network operator must support *Power Saving Mode (PSM)* or *Extended Discontinuous Reception (eDRX)* with the *SIM* card that you are using.

If you are using an iBasis *SIM* card, check [iBasis eSIM national coverage update](#) on the Nordic DevZone to see the supported features for different countries and different network operators.

If you are using a different *SIM* card or if you want to confirm the supported features, check whether *PSM* is activated by following the instructions in [Testing the cellular connection with the AT Client sample](#) on page 16.

- To retrieve GPS data, the nRF9160 DK must be outside or close to a window, with good visibility.

Complete the following steps to test the GPS functionality:

1. If you have received an external *GPS* patch antenna with your nRF9160 DK, attach it to the **GPS SWF** connector (**P29**) to the left of the LTE antenna.

See [nRF9160 DK GPS](#) for more information.

2. Turn on or reset your nRF9160 DK and wait until **LED3** is off and **LED4** is on, indicating that the connection to *nRF Connect for Cloud* has been established.
3. Go to [nRF Connect for Cloud \(nrfcloud.com\)](#) and sign in.
4. Click **Devices** in the navigation pane on the left and open the entry for your device.
5. Press **Button 1** on your nRF9160 DK for a minimum of 10 seconds to enable *GPS* tracking.

Observe that after a while, the *GPS* data is displayed on the map in the **GPS Data** card in *nRF Connect for Cloud*.

# 5

## Building and testing a sample application

After testing a prebuilt application, you should build one of the sample applications provided by the [nRF Connect SDK](#).

The nRF Connect SDK provides several samples for the nRF9160 DK. See [Samples and applications](#) for a list of all available samples.

The following sections guide you through installing the nRF Connect SDK, programming a sample application, building and testing the basic [nRF9160: AT Client](#) sample, and building the [nRF9160: Asset Tracker](#) application from scratch.

### 5.1 Installing the nRF Connect SDK

The recommended way to install the nRF Connect SDK is through an app in nRF Connect for Desktop.

[nRF Connect for Desktop](#) provides different apps to simplify installing the nRF Connect SDK, depending on the operating system that you are using.

**Note:** If you prefer to install the nRF Connect SDK manually, see [Installing the nRF Connect SDK manually](#) for instructions.

Complete the following steps to install the nRF Connect SDK using an nRF Connect for Desktop app:

1. Download and install [nRF Connect for Desktop](#).
2. Install and run one of the following apps:
  - On Windows or macOS, use the Toolchain manager. This app installs the full sandboxed toolchain that you need, including *SEGGER Embedded Studio (SES) Nordic Edition* and the nRF Connect SDK source code.
  - On Linux, use the Getting Started Assistant. This app assists you in setting up the toolchain, the nRF Connect SDK source code, and *SES Nordic Edition*.

See [nRF Connect for Desktop](#) for information about how to install and open apps.

3. Follow the instructions in the app to install the nRF Connect SDK.
4. Make sure that you have the correct version of the nRF Connect SDK source code. Unless instructed otherwise, you should work with the last tagged release of the nRF Connect SDK.
  - If you used the Toolchain manager app, you installed a specific version and no further action is required.
  - If you used the Getting Started Assistant app, make sure that you checked out the correct version and ran `west update`.

If you want to switch to a different tagged release or to the latest version on the master branch, see [Updating the repositories](#) for instructions.

### 5.2 Programming a sample

Use the Nordic Edition of the *SES Integrated Development Environment (IDE)* to build and program an nRF Connect SDK sample. See [Building and programming a sample application](#) for detailed instructions.

If you prefer to build and program your application from the command line, see [Building on the command line](#) for instructions. You can also use [nRF Connect Programmer](#) to program your application.

The following user guides in the [nRF Connect SDK documentation](#) explain the concepts that you need to know to work with the nRF9160 DK in the nRF Connect SDK:

- [Working with nRF9160](#)
- [Modifying a sample application](#)
- [Application Development](#)

When building samples for the nRF9160 DK, you can choose between two different build targets:

- `nrf9160dk_nrf9160` for firmware in the secure domain
- `nrf9160dk_nrf9160ns` for firmware in the non-secure domain

When in doubt, use `nrf9160dk_nrf9160ns`. All samples in the nRF Connect SDK are configured to run in the non-secure domain. They automatically include the [nRF9160: Secure Partition Manager](#) for the secure domain.

You can find documentation for all available samples under [Samples and applications](#).

## 5.3 Testing the cellular connection with the AT Client sample

A good starting point for experimenting with the nRF9160 DK is to program and test the [nRF9160: AT Client](#) sample. You can also use it to troubleshoot and debug any connection issues.

The AT Client sample enables you to send AT commands to the *LTE-M/NB-IoT* modem of your nRF9160 DK to test and monitor the cellular connection.

Complete the following steps to build and test the AT Client sample:

1. Build and program the sample application as described in [Building and programming a sample application](#).

Use the following information when opening the nRF Connect SDK Project, where *NCS\_folder* is the folder where you installed the nRF Connect SDK (for example, `C:\NCS`):

- **CMakeLists.txt:** `NCS_folder\nrf\samples\nrf9160\at_client\CMakeLists.txt`
- **Board Directory:** `NCS_folder\zephyr\boards\arm\nrf9160dk_nrf9160`
- **Board Name:** `nrf9160dk_nrf9160ns`
- **Build Directory:** accept the default

**Note:** The AT Client sample is also provided as a prebuilt firmware image. If you do not want to build the sample yourself but program it to troubleshoot connection issues, follow the steps in [Updating the application firmware](#) on page 8 to program the `nrf9160dk_at_client_*.hex` file from the nRF9160 DK application and modem firmware package that you can download from the [nRF9160 DK Downloads](#) page.

2. Test the AT client sample as described in [Testing the AT Client sample](#).
3. Optional: If you are experiencing problems when [testing the GPS functionality](#), check if the network operator supports *PSM* or *eDRX* with the *SIM* card that you are using. *PSM* or *eDRX* are required to retrieve *GPS* data.

Complete the following steps to check if *PSM* is activated:

- a) In [nRF Connect LTE Link Monitor](#), deselect the check box for **Automatic requests**.
- b) In the terminal view, enter `AT+CFUN=4` in the AT command text field and click **Send** to put the modem in offline state.



- c) Enter `AT+CFUN?`.  
The command should return `+CFUN: 4`, which indicates that the modem is in offline state. If it returns a different value, repeat the previous step.
- d) Enter one of the following AT commands to set the **system mode**:
- For *LTE-M*: `AT%XSYSTEMMODE=1,0,1,0`
  - For *NB-IoT*: `AT%XSYSTEMMODE=0,1,1,0`
- e) Enter `AT+CFUN=0` to set the parameter to non-volatile memory.
- f) Power-cycle the nRF9160 DK.
- g) In LTE Link Monitor, select the check box for **Automatic requests** and connect to the device again.
- h) Enter `AT+CFUN=1` to turn on the modem.
- i) Enter `AT+CFUN?`.  
The command should return `+CFUN: 1`, which indicates that the modem is in normal mode.
- j) Enter `AT+CEREG=4` to enable receiving Active Time and periodic *Tracking Area Update (TAU)* values.  
See [Network registration status +CEREG](#) for more information.
- k) Use `AT+CPSMS` to activate *PSM*.  
For example, enter `AT+CPSMS=1,"","","10101010","00100001"` to set the periodic *TAU* timer to 10 minutes and Active Time to 1 minute.  
You can use different values for periodic *TAU* and Active Time. See [Power saving mode setting +CPSMS](#) for more information.
- l) Enter `AT+CEREG?` to display the received values.

**Note:** It can take several minutes until the periodic *TAU* and Active Time values are updated.

The returned values should be similar to the following example:

```
+CEREG: 4,1,"7789","01042504",7,,,"00100001","10101010"
```

If the first three digits of the eighth and ninth position of the returned comma-separated string are non-empty and not 111, *PSM* is activated and your nRF9160 DK connected to the base station successfully.

See the [nRF91 AT Commands Reference Guide](#) for a list of supported AT commands.

## 5.4 Building and testing the Asset Tracker

The **nRF9160: Asset Tracker** is not only provided as prebuilt application, but also as source code in the **nRF Connect SDK**.

Complete the following steps to build and test the Asset Tracker application from scratch:

1. Build and program the sample application as described in [Building and programming a sample application](#).

Use the following information when opening the nRF Connect SDK Project, where *NCS\_folder* is the folder where you installed the nRF Connect SDK (for example, `C:\NCS`):

- CMakeLists.txt: `NCS_folder\nrf\applications\asset_tracker\CMakeLists.txt`
- Board Directory: `NCS_folder\zephyr\boards\arm\nrf9160dk_nrf9160`
- Board Name: `nrf9160dk_nrf9160ns`
- Build Directory: accept the default

2. Test the Asset Tracker application as described in [Testing the application](#) on page 13.

# 6 Developing your own application

After testing the provided samples, you are ready to develop your own application with the [nRF Connect SDK](#).

The following documentation helps you understand how to work with the [nRF Connect SDK](#):

- [nRF Connect SDK documentation](#), especially:
  - [Getting started](#)
  - [Working with nRF9160](#)
  - [Application Development](#)
  - [Zephyr Application Development](#)
- [nRF Connect SDK tutorial on DevZone](#)

# Glossary

## **Application Programming Interface (API)**

A language and message format used by an application program to communicate with an operating system, application, or other service.

## **Cat-M1**

LTE-M User Equipment (UE) category with a single RX antenna, specified in 3GPP Release 13.

## **Cat-NB1**

Narrowband Internet of Things (NB-IoT) User Equipment (UE) category with 200 kHz UE bandwidth and a single RX antenna, specified in 3GPP Release 13.

## **Development Kit (DK)**

A development platform used for application development.

## **Device Firmware Update (DFU)**

A mechanism for upgrading the firmware of a device.

## **Extended Discontinuous Reception (eDRX)**

A method to conserve the battery of an IoT (Internet of Things) device by allowing it to remain inactive for extended periods.

## **Global Positioning System (GPS)**

A satellite-based radio navigation system that provides its users with accurate location and time information over the globe.

## **Integrated Circuit Card Identifier (ICCID)**

A unique serial number of a SIM card.

## **Integrated Development Environment (IDE)**

A software application that provides facilities for software development.

## **International Mobile (Station) Equipment Identity (IMEI)**

A unique code consisting of 14 digits and a check digit for identifying 3GPP-based mobile devices.

## **LTE-M**

An open standard that is most suitable for medium throughput applications requiring low power, low latency, and/or mobility, like asset tracking, wearables, medical, POS, and home security applications. Also known as Cat-M1.

## **Narrowband Internet of Things (NB-IoT)**

A narrowband technology standard with longer range, lower throughput, and better penetration in, for example, cellars and parking garages compared to LTE-M. NB-IoT is most suitable for static, low throughput applications like smart metering, smart agriculture, and smart city applications. Also known as Cat-NB1.

## **Non-access Stratum (NAS)**

In telecom protocol stacks, the highest stratum of the control plane between the core network and *User Equipment (UE)*. The layer is used to manage the establishment of communication sessions and for maintaining communications with the UE as it moves.

#### **nRF Connect for Cloud**

Nordic Semiconductor's platform for connecting IoT devices to the cloud, viewing and analyzing device message data, prototyping ideas that use Nordic Semiconductor chips, and more. It includes a public REST API that can be used for building IoT solutions. See [nRF Connect for Cloud \(nrfcloud.com\)](https://nrfcloud.com).

#### **Personal Unblocking Key (PUK)**

A digit sequence required in 3GPP mobile phones to unlock a *SIM* that has disabled itself after an incorrect personal identification number has been entered multiple times.

#### **Power Saving Mode (PSM)**

A feature introduced in 3GPP Release 12 to improve battery life of IoT (Internet of Things) devices by minimizing energy consumption. The device stays dormant during the PSM window.

#### **Protocol Configuration Options (PCO)**

An element of *Non-access Stratum (NAS)* message used for transferring parameters between the *UE* and the P-GW (Packet Data Network Gateway).

#### **SEGGER Embedded Studio (SES)**

A cross-platform *IDE* for embedded C/C++ programming with support for Nordic Semiconductor devices, produced by SEGGER Microcontroller.

#### **Subscriber Identity Module (SIM)**

A card used in *UE* containing data for subscriber identification.

#### **System in Package (SiP)**

A number of integrated circuits, often from different technologies, enclosed in a single module that performs as a system or subsystem.

#### **Tracking Area Update (TAU)**

A procedure initiated by the *UE* when moving to a new tracking area in the LTE (Long-term Evolution) system.

#### **User Equipment (UE)**

Any device used by an end-user to communicate. The UE consists of the Mobile Equipment (ME) and the Universal Integrated Circuit Card (UICC).

# Acronyms and abbreviations

These acronyms and abbreviations are used in this document.

**API**

Application Programming Interface

**DFU**

Device Firmware Update

**DK**

Development Kit

**eDRX**

Extended Discontinuous Reception

**GPS**

Global Positioning System

**ICCID**

Integrated Circuit Card Identifier

**IDE**

Integrated Development Environment

**IMEI**

International Mobile (Station) Equipment Identity

**LTE**

Long Term Evolution

**NAS**

Non-access Stratum

**NB-IoT**

Narrowband Internet of Things

**PCO**

Protocol Configuration Options

**PSM**

Power Saving Mode

**PUK**

Personal Unblocking Key

**SES**

SEGGER Embedded Studio

**SIM**

Subscriber Identity Module

**SiP**

System in Package

**TAU**

Tracking Area Update

**UE**

User Equipment

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