

Using the NCS / West to Program the DTM example into the nRF52840-DK

Background:

There is a need to enable a Nordic Semiconductors System on a Chip / transceiver with the Direct Test Mode (DTM) firmware. This is in order that the physical layer and RF characteristics may be ascertained as set in the Bluetooth Sig Specification. The DTM example is used to put the nRF52840 into various operational modes in order to exercise the device for Bluetooth low energy testing. Although not as robust as the Radio_Test example, it can nevertheless be used to test a DUT towards FCC, ETSI, and other regulatory agencies. This may also be used to bring up prototypes to ensure they are operational. The purpose of this document is to show how DTM utility maybe built and programmed into the nRF52840-DK (development kit). The procedures shown in this short document are directed at the nRF52840 but are also applicable to any of the other nRF52 devices that are supported in the application. A brief study on how to determine if the device is programmed and operational is included.

The sample uses Direct Test Mode (DTM) to test the operation of the following features of the radio:

- Transmission power and receiver sensitivity
- Frequency offset and drift
- Modulation characteristics
- Packet error rate
- Intermodulation performance

Hardware used:

nRF52840-DK

USB to micro USB cable

Windows PC

Optional: nRF52-DK or nRF52840-dongle. Used for testing

Software / Utilities:

nRF Connect for Desktop, newest version

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

The most current NCS as well as older revisions may be installed by the Toolchain Manager.

Note that if a different version is used then work must be done in the subsequent subdirectories.

nRF Command Line tools:

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

Segger Embedded Studio – Free Nordic Edition -for NCS

https://developer.nordicsemi.com/nRF_Connect_SDK/doc/latest/nrf/gs_installing.html#install-the-ses-nordic-edition.

Preparation procedure:

Using the USB to micro USB cable, connect nRF52840-dk to an available USB port on the PC.

(The use of a USB hub is not suggested.)

Download and install the nRF Connect for Desktop program from the Nordic semiconductor website.

Start nRFconnect for desktop

Check for any and all updates. Install as needed

Start nRFconnect for desktop and move to Toolchain Manager

Open Toolchain Manager. Be sure to use the most recent Toolchain Manager.

Toolchain Manager
Install and manage tools to develop with the nRF Connect SDK (NCS)
official, v0.10.3

Open

Find v1.9.1 and click on install the IDE in the directory of your choice. It is suggested installing this into an NCS subdirectory off the root directory. Note that at the time this document was written, v1.9.1 was the most current SDK version. Always use the most current version of the NCS SDK.

Programming the development board:

Use the NRFconnect for Desktop to move to a “sand box” first. This is where the programming of the nRF52840 will take place.

Click on open in the Toolchain manager

Note that there may be newer version then what is shown below.

Toolchain Manager
Install and manage tools to develop with the nRF Connect SDK (NCS)
official, v0.10.3

Open

Click on the down arrow to the right of Open IDE and then “Open Command prompt”.

Note that running a command prompt (CMD) from the start menu will not work.

nRF Connect SDK v1.9.1 First steps Open VS Code Open Segger Embedded Studio

- Open bash
- Open command prompt**
- Open SDK directory
- Open toolchain directory
- Update SDK
- Update toolchain
- Remove

nRF Connect SDK v1.9.0 First steps Open VS Code C

nRF Connect SDK v1.8.0

Compiling and programming the DTM example into the nRF52840’s memory.

Go to `\nrf\samples\bluetooth\direct_test_mode`.

Type `west build -b nrf52840dk_nrf52840 -p`

This will build (compile) the project.

At the end of a successful build the utility will show the following at the end:

```
[165/165] Linking C executable zephyr\zephyr.elf
Memory region      Used Size  Region Size  %age Used
FLASH:             35616 B    1 MB        3.40%
SRAM:              8640 B    256 KB      3.30%
IDT_LIST:          0 GB     2 KB        0.00%

C:\NCS\v1.9.1\nrf\samples\bluetooth\direct_test_mode>
```

To program the device, type “west flash”
After a successful programming operation, the following will be shown.

```
Enabling pin reset.
Applying pin reset.
-- runners.nrfjprog: Board with serial number 68314 flashed successfully.
```

If you have more than one board running it will show a list of Segger serial numbers. They are located on the white label on the Dev Kit. Chose the one you wish to use for programming.

The nRF52840-DK is now programmed.

*Note to reprogram or program additional boards the only action needed is to type “west flash” again.

Device recovery option:

If for some reason, there is any difficulty with programming. The device can be “recovered” using the nrfjprog --recover command.

nrfjprog must be installed on the computer. This is included when the Command Line Tools are installed.

Type nrfjprog --recover and hit enter. (Double hyphen before recover)

The following should be observed:

```
C:\NCS\v1.9.1\nrf>nrfjprog --recover
Recovering device. This operation might take 30s.
Erasing user code and UICR flash areas.

C:\NCS\v1.9.1\nrf>
```

If an error is reported, it may be that the path is not set to the location where nrfjprog is located. Configure the path and run again.

Return to the earlier steps and reflash the application as described in the steps above.

Using the DTM example:

The instructions for running the DTM example may be found here:

https://developer.nordicsemi.com/nRF_Connect_SDK/doc/1.9.1/nrf/samples/bluetooth/direct_test_mode/README.html

Other information on this can be found in the readme.rst file in the radio_test Subdirectory.

C:\NCS\v1.9.1\nrf\samples\bluetooth\direct_test_mode

The source code is here: Drive:\nrf\samples\bluetooth\direct_test_mode\src

Instructions on how to run the tests are included in this link:

https://developer.nordicsemi.com/nRF_Connect_SDK/doc/latest/nrf/samples/bluetooth/direct_test_mode/README.html#

Note that to do full DTM testing for Bluetooth certification, a dedicated tester such as a Litepoint, Anritsu, Rohde & Schwarz would be used.

Quick test:

The operation of the programmed device may be seen by using the Direct Test Mode utility found in nRFconnect for Desktop program.

Observation of the nRF52840 transmitting in DTM mode may be accomplished by using a nRF52 based development Kit or a nRF52840-Dongle as a RF sniffer and the RSSI utility in the nRFConnect for desktop. Plug in the USB dongle, go to nRFconnect for desktop RSSI utility. Select the dongle under the Select button, if asked, allow the utility to program the dongle. The RSSI utility will now show all the 2.4Ghz devices in the nearby proximity regardless of the protocol being used.

Program the DTM program into the nRF52840-DK using the method outlined in the procedure above. Open the nRFconnect for desktop and click on the DTM utility. Click on select device and choose the nRF52840-DK. Do not accept the invitation to program the device as it will write over the firmware previously installed.

Click on transmitter button. Now click on packet type and then on constant carrier. pick the channel you wish to transmit on. Click on start test. A blue bar will appear on the BLE channel map indicating that it is transmitting. Go back to the RSSI utility. The chart should now show a strong signal at the transmitted frequency. Changing the distance between the development kit and dongle should result in the signal level increasing or decreasing.

