



Measuring the Dynamic Current of nRF8001

nAN-27

Application Note v1.0

This document describes how you measure the dynamic current of nRF8001 using a series resistor and oscilloscope while running a heart rate sensor demo.

Understanding the peak current and average current of a device is necessary for maximizing battery lifetime. Battery size and lifetime are important factors in battery driven applications. Smaller batteries allow for smaller applications, while low average current helps maximize battery lifetime. Their limited peak current capabilities are an important factor when avoiding large reservoir capacitors.

When nRF8001 is in active mode the peak current draw can be significantly higher than the average current draw. Depending on the operation it is performing, the current draw of the nRF8001 varies between a few μA in idle mode to several mA in active mode.

1 Test setup

The following tools are needed in order for you to perform the test:

- nRF8001 Development Kit (DK)
- nRF8001 Software Development Kit (SDK)
- nRFgo Starter Kit
- nRFgo Studio
- Oscilloscope

1.1 Hardware setup

To measure the dynamic current follow these steps:

1. Remove the **nRF Current Measurement** jumper (P4) on the nRF2735 board and wire a $10\ \Omega$ resistor across it. It is important the series resistor is placed close to the VDD connection of the nRF8001 module.
2. Use two channels on a digital storage oscilloscope to measure the voltage drop over the resistor.

Note: Make sure there are no large capacitors between the series resistor and the nRF8001 module. A large capacitor will smooth the current waveform, making it difficult to see the different states.

For more information regarding the test setup, please refer to our White Paper, *nRF Performance Test Guidelines* at www.nordicsemi.com.

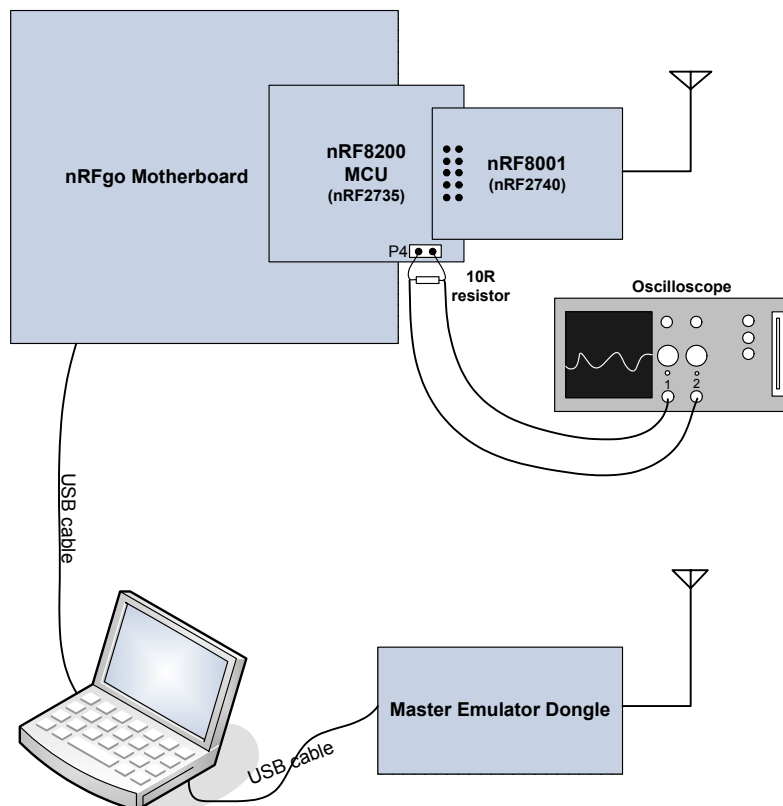


Figure 1 Test setup

1.2 Firmware setup

The necessary firmware is included in the nRF8001 SDK. It is available on your computer after you install nRFgo Studio and the nRF8001 SDK.

1.2.1 Programming the nRF8200

Program the nRF8200 in nRFgo Studio with the precompiled HEX file for the heart rate sensor demo.

1. Connect the nRFgo Motherboard and open nRFgo Studio.
2. Click the **Browse** button next to the File to program field.

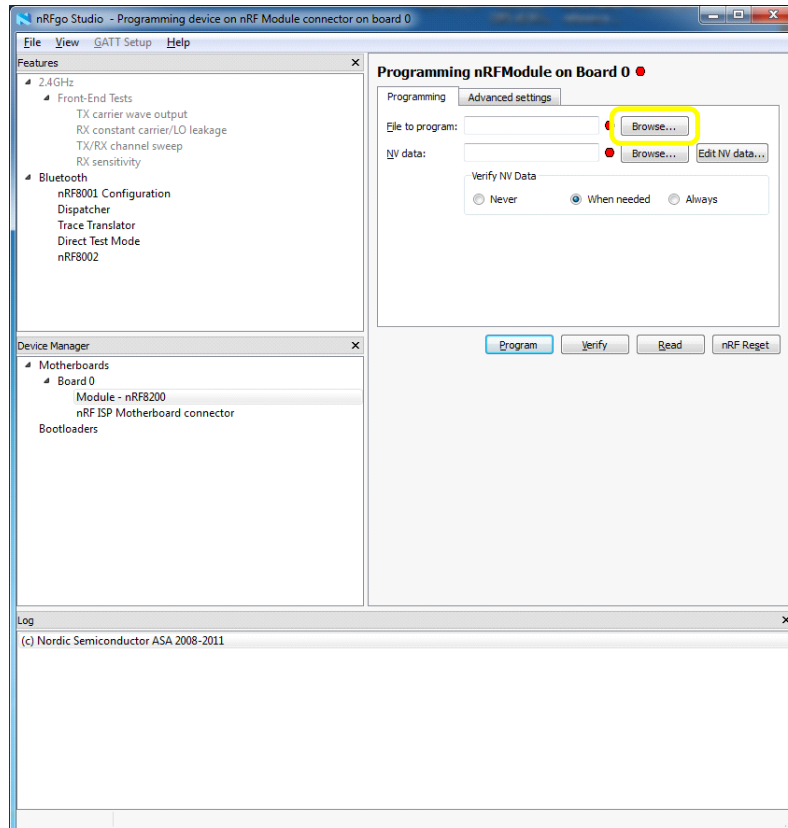


Figure 2 nRFgo Studio start up

3. Select **heart_rate_sensor_nrf8200.hex** which is found in `\\NordicSemiconductor\nRF8001SDK vN.N\Precompiled_hex\` and click **Open**.

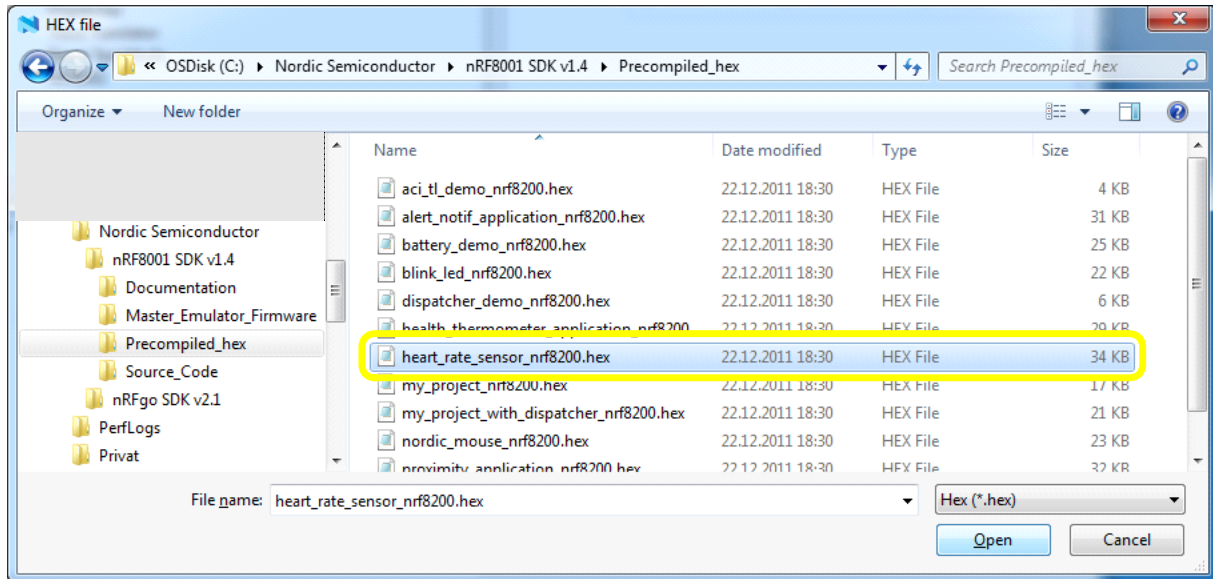


Figure 3 HEX file location

4. Click **Program** once the file appears in the File to program field.

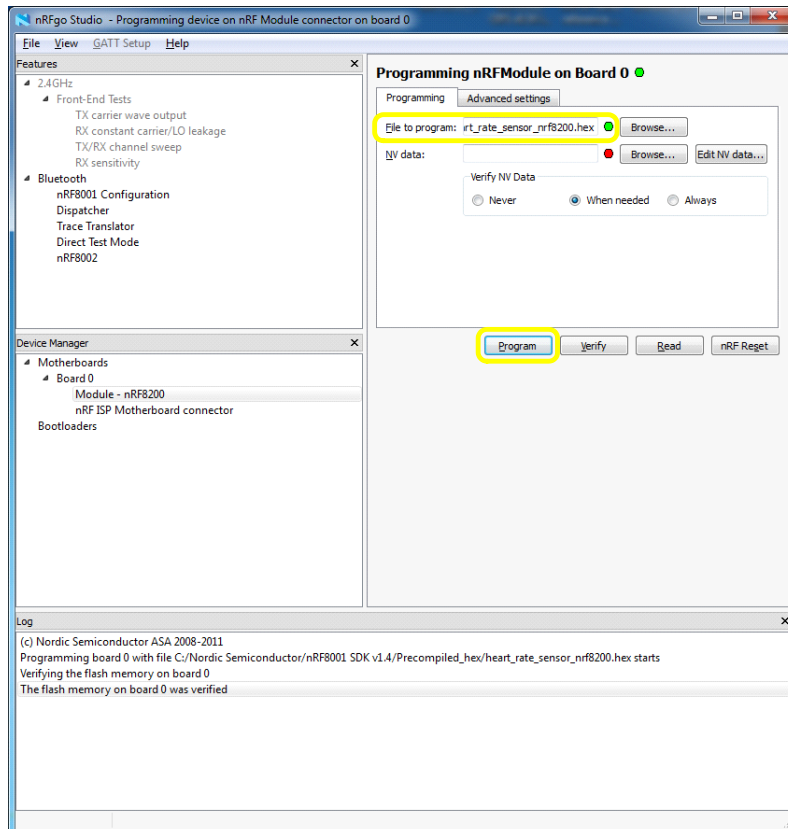


Figure 4 Programming the nRF8200 with the HEX file

1.2.2 Master Control Panel setup

The Master Control Panel is part of the nRF8001 SDK and is used to initiate the Master Emulator dongle. If the destination folder was not changed upon installation, the Master Control Panel can be found in the Start Menu. When started, a device discovery is performed as seen in *Figure 5*.

1. Select the **Nordic HRM V1.0** device and click **Select device**.

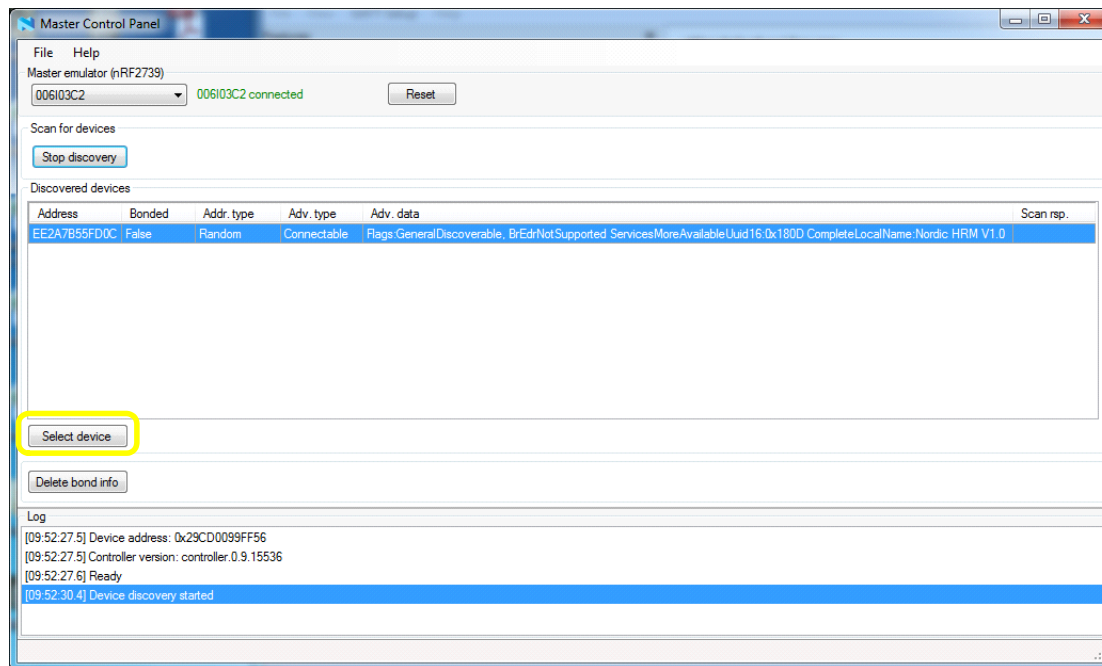


Figure 5 Master control panel device discovery

2. Click **Service discovery** and then click **Enable Services**.
3. A list of available services on nRF8001 are shown in the Service Discovery window. The heart rate dummy data is updated every second as shown in the Log window.

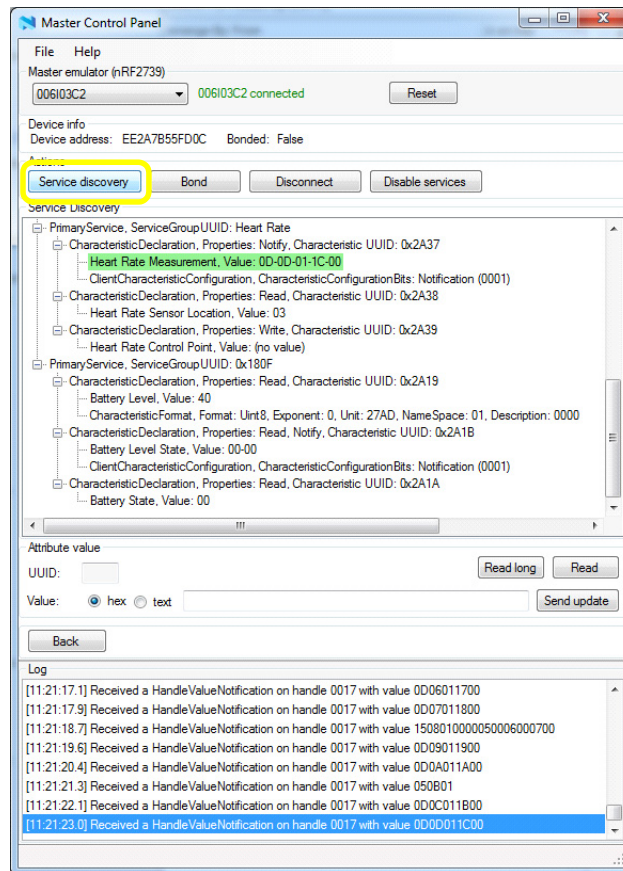


Figure 6 Master Control Panel - Service Discovery

4. To adjust the default connection interval, select **File** and then **Options**. Change the interval from 20 ms to 1000 ms.
5. Connection supervision timeout should be changed to a minimum of six times the connection interval.
6. Enable the new settings by disconnecting and then reconnecting the device.

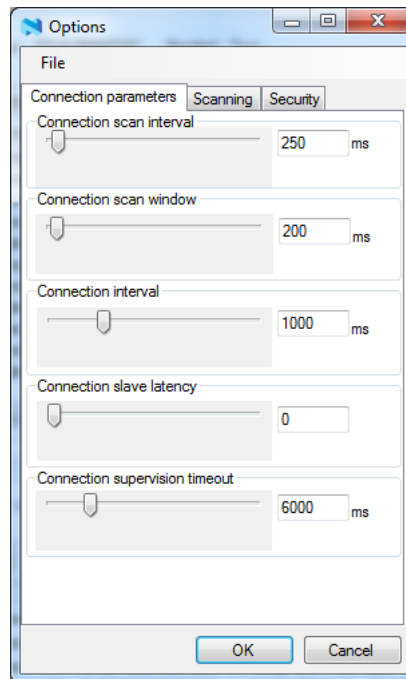


Figure 7 Setting connection interval

2 Measurement analysis

The top line on the graph from the oscilloscope shows the current and the bottom line shows VDD_PA as a reference. VDD_PA goes high when the TX is on. The x axis is divided into 1ms intervals and the y axis is divided into 5 mA intervals.

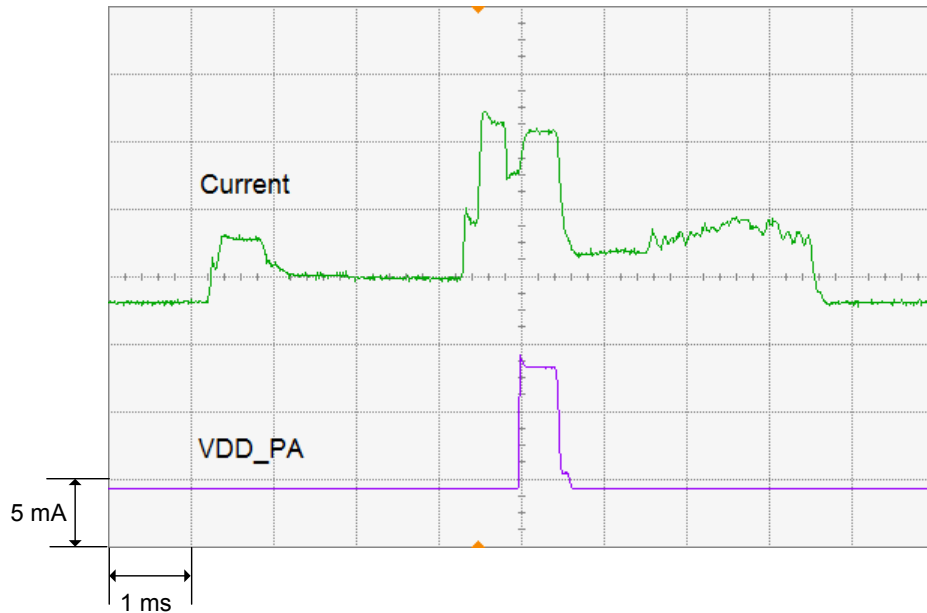


Figure 8 Current waveform

Note: An analysis of the current waveform and detailed analysis of the dynamic current consumption can be found in the *nRF8001 Product Specification*.

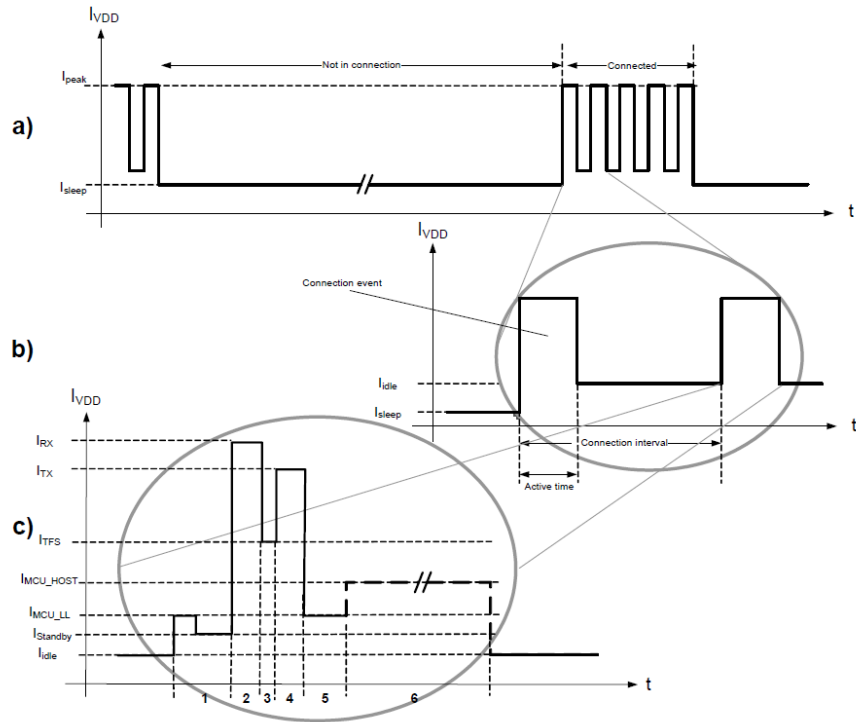


Figure 9 Current consumption over time

A breakdown of the different states in a single connection event can be seen in **Figure 9** as referred to in the *nRF8001 Product Specification*.

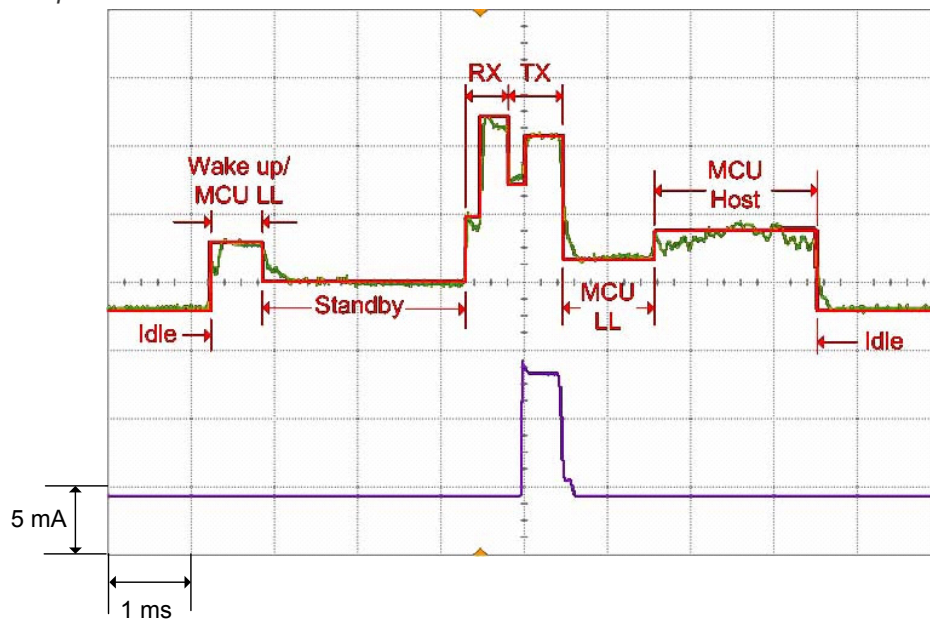


Figure 10 Current consumption

Figure 10 shows that the two correspond well when the curve in segment C from **Figure 9** is overlaid with the curve in **Figure 8** on page 8.

Using the markers on the oscilloscope, you can read the following currents:

Markers	Current
$I_{\text{Wake up, MCU LL}}$	3.8mA
I_{Standby}	0.9mA
I_{RX}	13.5mA
I_{TX}	12.5mA
$I_{\text{MCU LL}}$	3.5mA
$I_{\text{MCU host}}$	5.0mA

Table 1 Current measurement

Note: I_{Idle} and I_{Sleep} cannot be measured using this method because the voltage drop over the resistor will be too small for an exact reading. An ampere meter must be inserted instead of the 10 Ω resistor.

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Revision History

Date	Version	Description
November 2012	1.0	First release