nRF7002 EK Hardware

v1.0.0

User Guide

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NORDIC® SEMICONDUCTOR

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Revision history

Date	Description
2023-11-13	First release

Environmental and safety notices

Skilled persons

The nRF7002 EK is intended for use only by skilled persons.

A skilled person is someone with relevant education or experience that enables them to identify potential hazards and takes appropriate action to reduce the risk of injury to themselves and others.

Electrostatic discharge

The nRF7002 EK is susceptible to *Electrostatic Discharge (ESD)*.

To avoid damage to your device, it should be used in an electrostatic free environment, such as a laboratory.

Environmental Protection

Waste electrical products should not be disposed of with household waste.

Please recycle where facilities exist. Check with your local authority or retailer for recycling advice.

1 Introduction

The nRF7002 *Evaluation Kit (EK)* (PCA63556) is a hardware platform used to evaluate the nRF7002 companion IC. It can be plugged onto and used with the nRF52840, nRF5340, or nRF91 Series *Development Kit (DK)*s.

Key features

- nRF7002 Wi-Fi® companion IC
  - Dual-band 2.4 GHz and 5 GHz Wi-Fi 6
  - Compatible with IEEE 802.11ax (also known as Wi-Fi 6) and earlier standards IEEE 802.11a/b/g/n/ac
  - 20 MHz wide channels, 1x1 (*Single-Input Single-Output (SISO)*) operation, and up to 86 MHz 802.11 PHY rate
  - Open-source Wi-Fi driver
  - 3-wire or 4-wire coexistence interface configurations
  - Secure 64-word *One Time Programmable (OTP) memory* with logical and voltage-level based protection mechanisms
- Onboard 2.4/5 GHz antenna
- Default *Serial Peripheral Interface (SPI)* to DK
- Possibility to strap EK to DK using *Quad Serial Peripheral Interface (QSPI)*
- *Microwave coaxial connector with switch (SWF)* RF connector for direct RF measurements
- Footprint for header pins to measure power consumption
- 3.6 V power supply from the **V5V** on the Arduino header to the **VBAT** of the nRF7002 companion IC
- 1.62 V to 3.6 V supply voltage range from VIO on the Arduino header to IOVDD

For access to firmware source code, hardware schematics, and layout files, see nRF7002 EK Downloads.

To get started, plug the nRF7002 EK onto a host DK as shown in the following image.

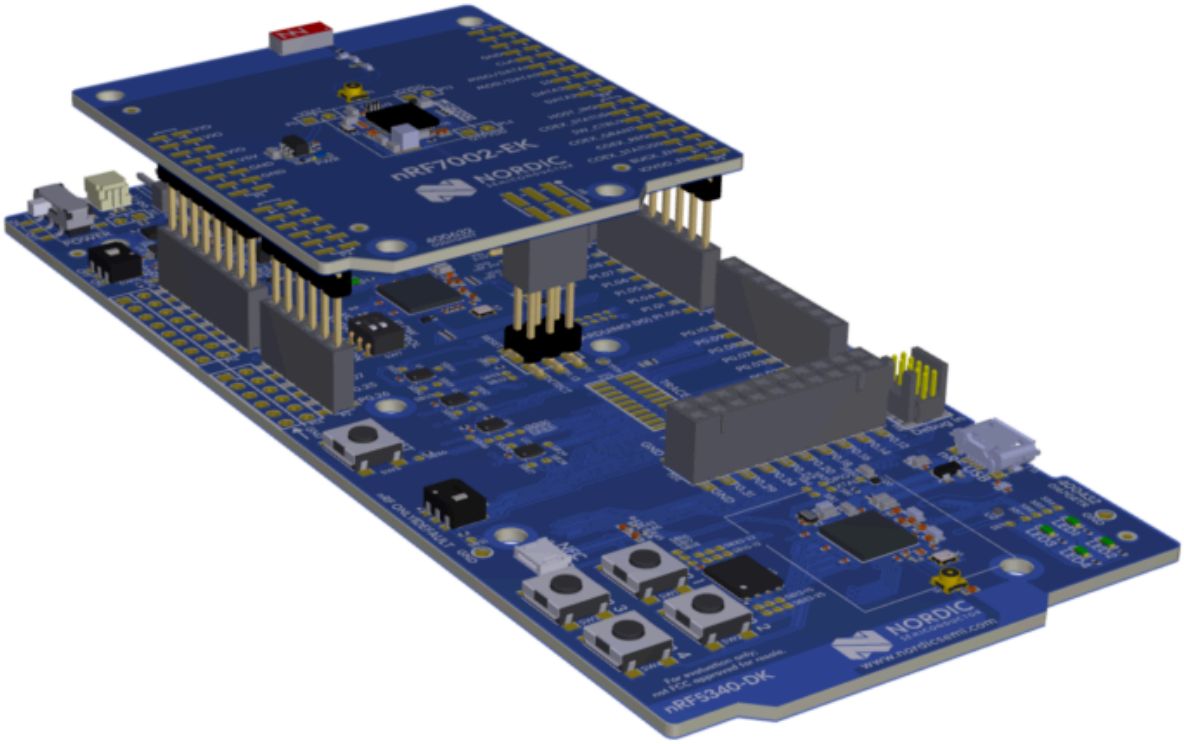

Figure 1: nRF7002 EK connected to a host DK SPI

2 Kit content

The nRF7002 EK includes hardware, documentation, hardware schematics, and layout files.

Figure 2: nRF7002 EK front view

Hardware files

The hardware design files are available on nRF7002 EK Downloads and include the following.

- Schematics
- *Printed Circuit Board (PCB)* layout files
- Bill of materials
- Gerber files

3 Hardware description

The nRF7002 EK drawings show both sides of the PCA63556.

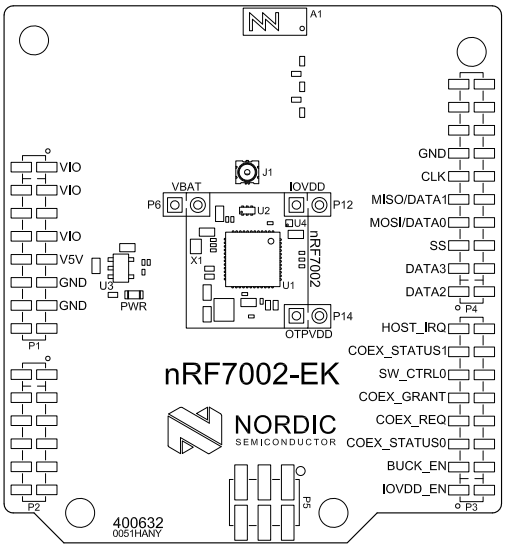

Figure 3: nRF7002 EK front view

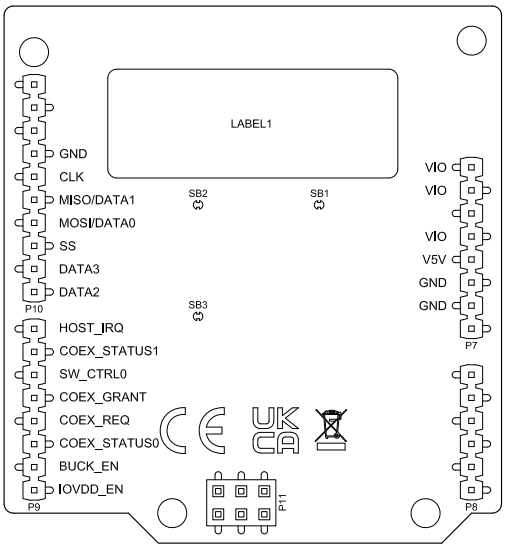

Figure 4: nRF7002 EK back view

3.1 nRF7002 companion IC

The nRF7002 EK uses the Arduino shield form factor and interface to enable evaluation of the nRF7002 companion IC in combination with Arduino compatible boards.

The Arduino interface connectors are described in the following table. See also Figure 7: Arduino signals routing on the nRF7002 EK on page 11.

Arduino pin name	nRF7002	Default use
D0	**IOVDD_EN**	Enable power to I/O interface
D1	**BUCK_EN**	Enable power to nRF7002
D2	**COEX_STATUS0**	Coexistence status 0
D3	**COEX_REQ**	Coexistence request from host
D4	**COEX_GRANT**	Coexistence grant to host
D5	**SW_CTRL0**	Switch control 0
D6	**COEX_STATUS1**	Coexistence status 1
D7	**HOST_IRQ**	Interrupt request to host
D8	**DATA2**	QSPI Data line 2
D9	**DATA3**	QSPI Data line 3
D10	**SS**	Slave select
D11	**MISO/DATA1**	QSPI/SPI Data line 1/Slave Out
D12	**MOSI/DATA0**	QSPI/SPI Data line 0/Slave In
D13	**CLK**	QSPI/SPI Clock
GND	**GND**	Ground
AREF	N.C.	Not used
SDA	N.C.	Not used
SCL	N.C.	Not used

Table 1: Arduino and nRF7002 companion IC interface connectors

3.2 Strapping a QSPI connection to the nRF5340 DK

If your application does not require external flash memory, you can use the nRF7002 EK *QSPI* connection with an nRF5340 *DK*.

The following steps describe how to strap the QSPI connection. See the following image and table for more information.

1. Disconnect the QSPI signals from the nRF5340 DK onboard memory *Integrated Circuit (IC)* and route the signals to the **P24** header on the DK.
2. Disconnect the **P10** header on the back of the *EK* from the nRF5340 DK if possible.

   Otherwise, to avoid interference, configure the nRF5340 DK's firmware to tri-state the I/O lines.
3. Use cables to strap the **P4** connector on the front of the EK to the **P24** header on the nRF5340 DK as shown in the following image. See Table 2: nRF7002 companion IC QSPI interface on page 10 for more information.
4. Cut **SB10-SB15** on the nRF5340 DK.
5. Solder **SB20-SB25** on the nRF5340 DK.

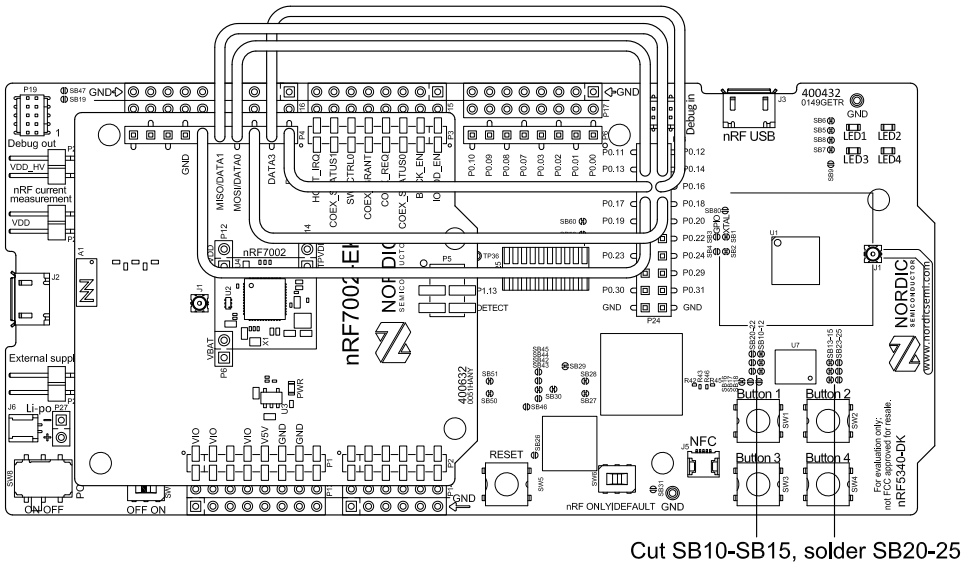

Figure 5: nRF7002 EK strapped to an nRF5340 DK QSPI

nRF7002 companion IC QSPI pin	QSPI signal
P0.13	QSPI I/O 0
P0.14	QSPI I/O 1
P0.15	QSPI I/O 2
P0.16	QSPI I/O 3
P0.17	QSPI CLK
P0.18	QSPI CS

Table 2: nRF7002 companion IC QSPI interface

3.3 Power supply

The nRF7002 EK is powered through the Arduino header **P1**/**P7** from the VIO and V5V power nets.

The following power sources are supported:

- **VIO** powers the IOVDD net on the nRF7002 companion IC.
- **V5V** is regulated down to 3.6 V and powers the VBAT net on the nRF7002 companion IC.

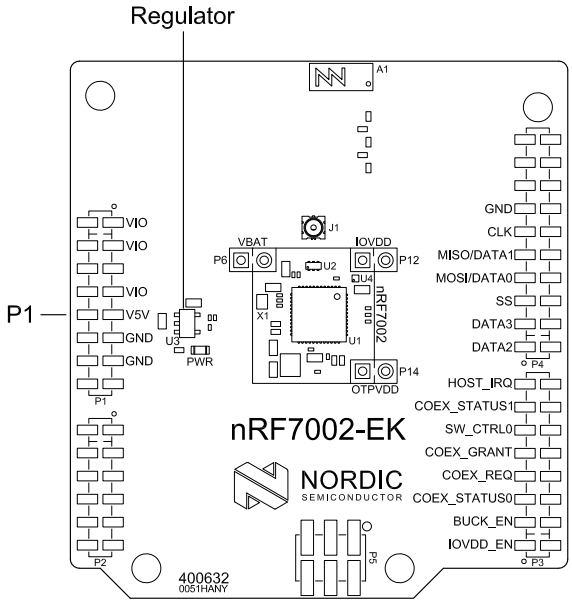

Figure 6: Power supply options and regulator

3.4 Connector interface

Access to the nRF7002 EK *General-Purpose Input/Output (GPIO)*s is available from headers of the connectors **P7** - **P10** on the back of the board.

The following is an overview of the *EK* connector functions.

- The **P1** and **P7** connectors provide access to ground and power on the nRF7002 EK.
- The **P2** and **P8** connectors provide access to the analog signals of the DK. These signals are not used on the EK.
- The **P3** and **P9** connectors provide access to the digital signals of the DK. These are used on the EK as control signals for the nRF7002 companion IC.
- The **P4** and **P10** connectors provide access to the digital signals of the DK. These are used for QSPI/SPI communication to the nRF7002 companion IC.

The following figure shows the Arduino signals routing on the nRF7002 EK.

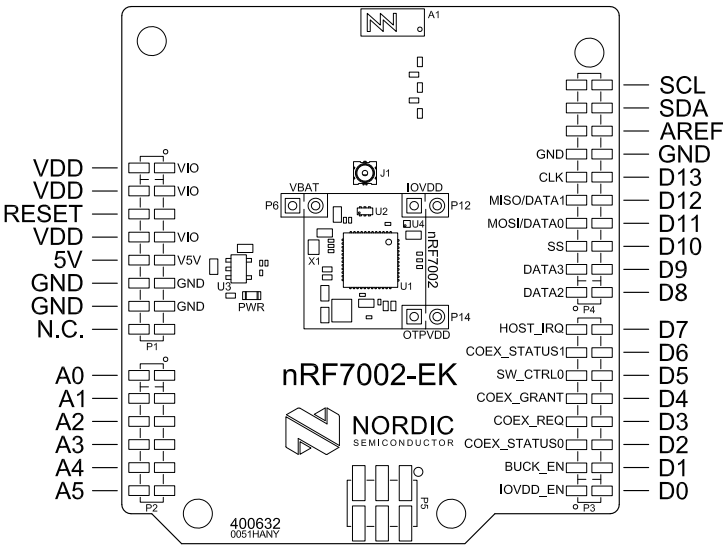

Figure 7: Arduino signals routing on the nRF7002 EK

Note: The nRF7002 EK runs at an IO voltage range of 1.62 V to 3.6 V. Ensure that the base or motherboard has the correct voltage level.

3.5 Power LED

To indicate the power state of the shield, the nRF7002 EK has a power LED directly connected to **V5V**.

3.6 Antenna

The nRF7002 EK has an onboard dual-band 2.4 GHz/5 GHz antenna.

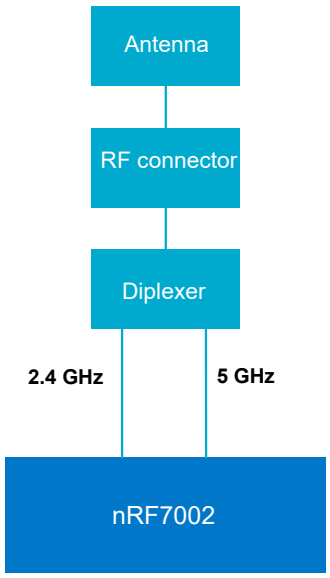

Figure 8: nRF7002 EK antenna configuration

3.7 Solder bridge configuration

The nRF7002 EK has three solder bridges, one for each power net. You must cut the corresponding solder bridge when measuring current.

The following section includes a solder bridge overview table and an image of the solder bridges on the back of the nRF7002 EK.

Solder bridge	Default	Function
SB1	Closed	Cut to disconnect VBAT
SB2	Closed	Cut to disconnect IOVDD
SB3	Closed	Cut to disconnect OTPVDD

Table 3: Solder bridge configuration

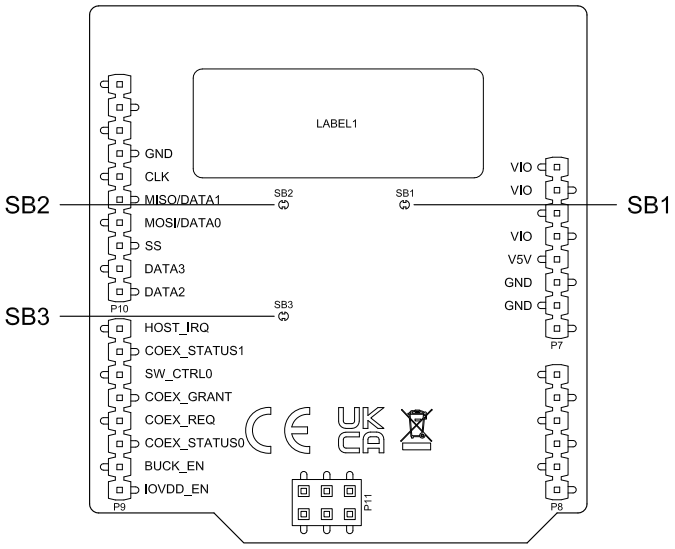

Figure 9: nRF7002 EK solder bridges

4 Measuring current

The current drawn by the nRF7002 companion IC can be monitored using the nRF7002 EK.

Current can be measured using any of the following test instruments.

- Power analyzer
- Oscilloscope
- Ampere meter
- Power Profiler Kit II

For measurement instructions, see the following chapters. Power analyzer measurements are not described in this document.

The nRF7002 companion IC has two available power supplies, IOVDD (1.62 V to 3.6 V) and VBAT (2.9 V to 4.5 V). The nRF7002 EK is prepared for measuring current on both domains. Only the VBAT domain current measurement is described here, but the approach is the same with the IOVDD supply. See the following table for the corresponding components.

Component	Measurement connector
VBAT	**P6**
IOVDD	**P12**
OTPVDD	**P14**

Table 4: Components for current measurement on VDD and VBAT

For more information on current measurement, see the tutorial Current measurement guide: Introduction.

4.1 Preparing the nRF7002 EK

To measure current, you must first prepare the *EK*.

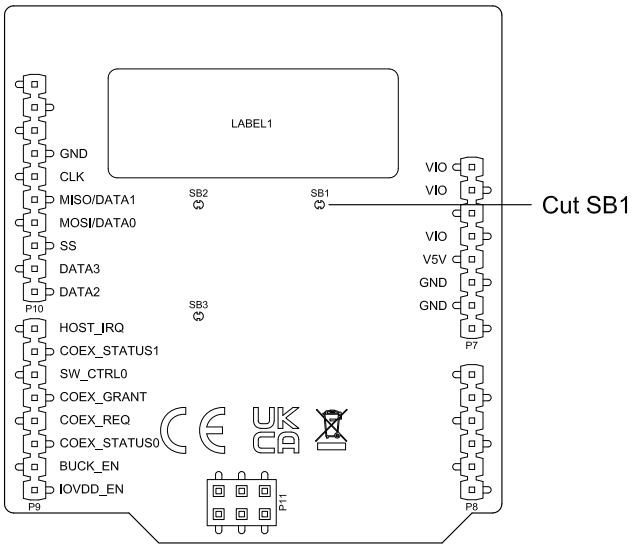

Figure 10: Preparing the EK for current measurements

To measure current in the VBAT domain, put **P6** in series with the load and cut solder bridge **SB1**. To restore normal EK function after measurement, apply a jumper on **P6** or short solder bridge **SB1**.

Note: If you want to measure current in the VDD domain, you must change the connector and solder bridge used, see Table 4: Components for current measurement on VDD and VBAT on page 14 and Table 3: Solder bridge configuration on page 12.

4.2 Using an oscilloscope for current profile measurement

An oscilloscope can be used to measure both the average current over a given time interval and capture the current profile.

Make sure you have followed the instructions in Preparing the nRF7002 EK on page 14.

1. Mount a 10 Ω resistor between the pins on **P6**.
2. Connect an oscilloscope in differential mode or similar with two probes on the pins of the **P6** connector as shown in Figure 11: Current measurement with an oscilloscope on page 15.
3. Calculate or plot the instantaneous current from the voltage drop across the 10 Ω resistor by taking the difference of the voltages measured on the two probes. The voltage drop is proportional to the current. The 10 Ω resistor causes a 10 mV drop for each 1 mA drawn by the circuit being measured.

The plotted voltage drop can be used to calculate the current at a given point in time. The current can then be averaged or integrated to analyze current and energy consumption over a period.

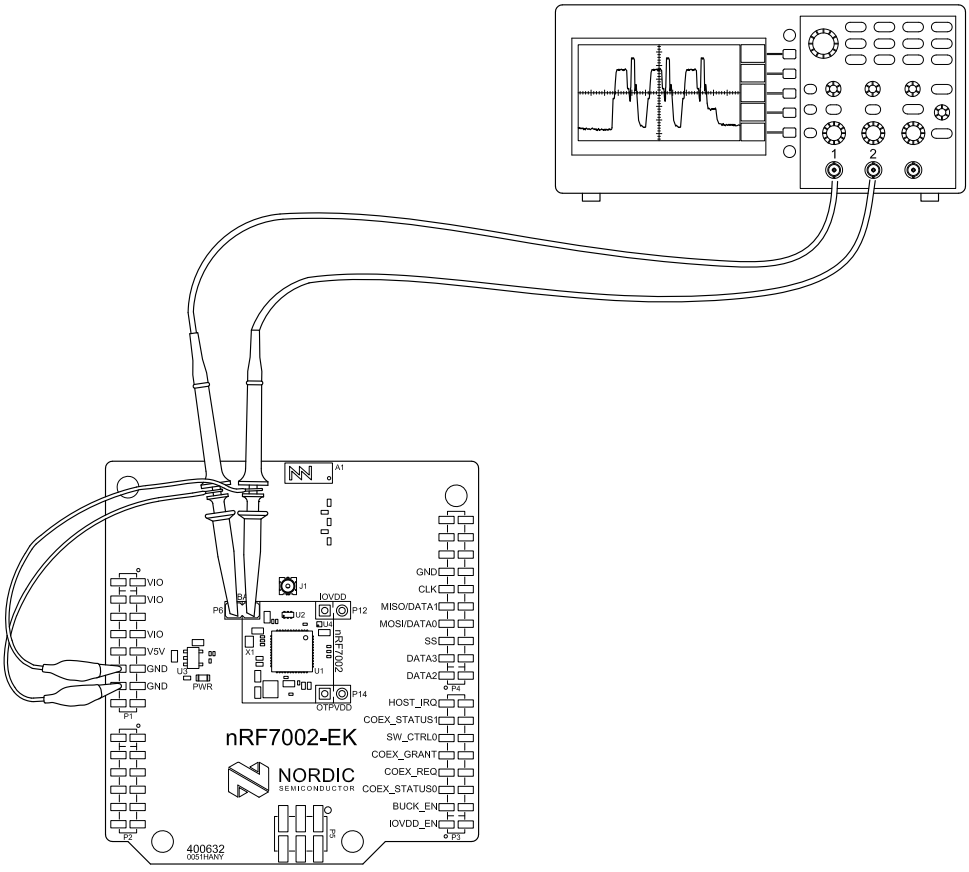

Figure 11: Current measurement with an oscilloscope

To reduce noise, you can do the following:

- Use probes with 1x attenuation.
- Enable averaging mode to reduce random noise.
- Enable high resolution function if available.

A minimum of one sample every 5 µs is needed to accurately measure the average current.

4.3 Using an ampere meter for current measurement

The average current drawn by the nRF7002 EK can be measured using an ampere meter. This method monitors the current in series with the nRF device.

Make sure you have prepared the *EK* as described in Preparing the nRF7002 EK on page 14.

Connect an ampere meter between the pins of connector **P6** as shown in the following figure.

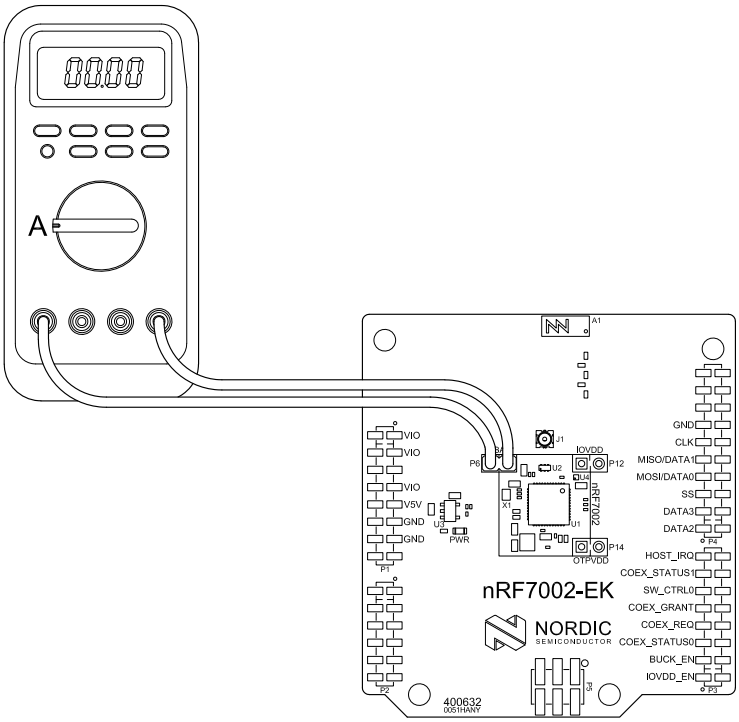

Figure 12: Current measurement with an ampere meter

For the following conditions, an ampere meter measures the average current drawn by the nRF7002 EK.

- The EK is in a state where it draws a constant current for the activity on the device changing load current, like Wi-Fi connection events, the activity is repeated continuously, and has a short cycle time (less than 100 ms) so that the ampere meter averages whole load cycles and not parts of the cycle.
- The dynamic range of the ampere meter is wide enough to give accurate measurements from 1 µA to 15 mA.

For best results, use a true *Root Mean Square (RMS)* ampere meter.

4.4 Using a Power Profiler Kit II (PPK2) in ampere meter mode for current measurement

The average current drawn by the nRF7002 EK can be measured using a PPK2. This method monitors the current in series with the nRF device. See the Power Profiler Kit II User Guide for more information.

Make sure you have prepared the *EK* as described in Preparing the nRF7002 EK on page 14.

1. Connect the PPK2 between the pins of connector **P6**.
2. Connect GND on the PPK2 kit to GND on the nRF7002 EK.
   You can use **GND** on EK connector **P1** or **P4** for ground.

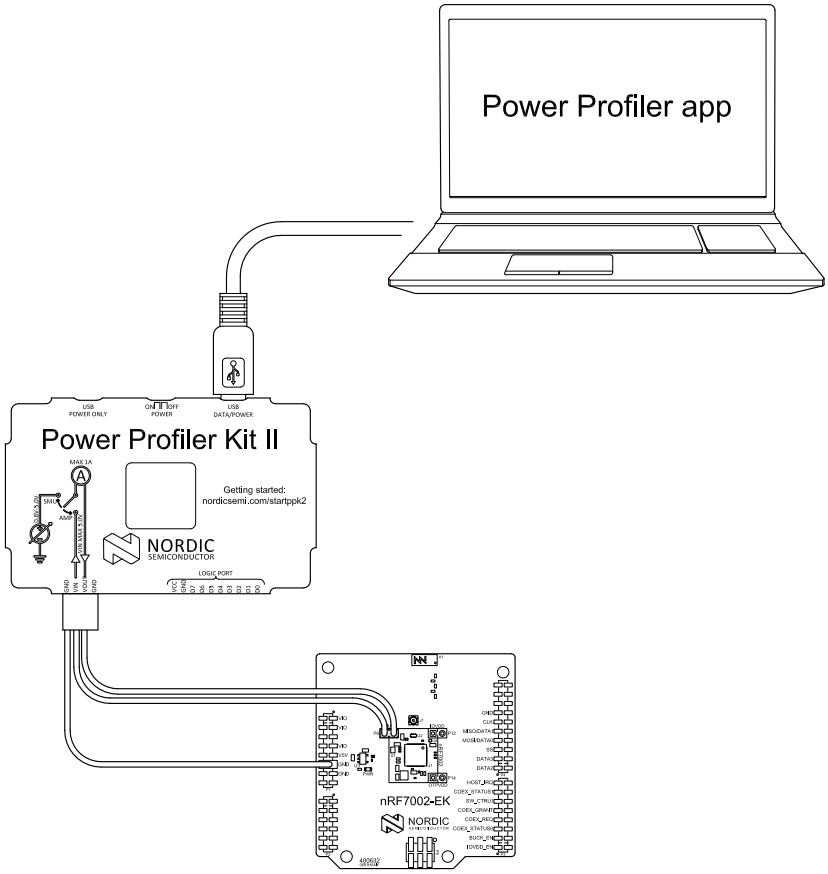

Figure 13: Current measurement with a PPK2

5 RF measurements

The nRF7002 EK has a small coaxial connector to measure RF signals from the nRF7002 companion IC connector **J1** using a spectrum analyzer.

The connector is an *SWF* type (Murata part no. MM8130-2600) with an internal switch. By default, when no cable is attached, the RF signal is routed to the onboard chip antenna.

In this example, a test probe (Murata part no. MXHS83QE3000) is used with a standard *SubMiniature Version A (SMA)* connection for instruments (the test probe is not included with the kit). When connecting the test probe, the internal switch in the SWF connector disconnects the onboard antenna and connects the RF signal from the nRF7002 companion IC to the test probe.

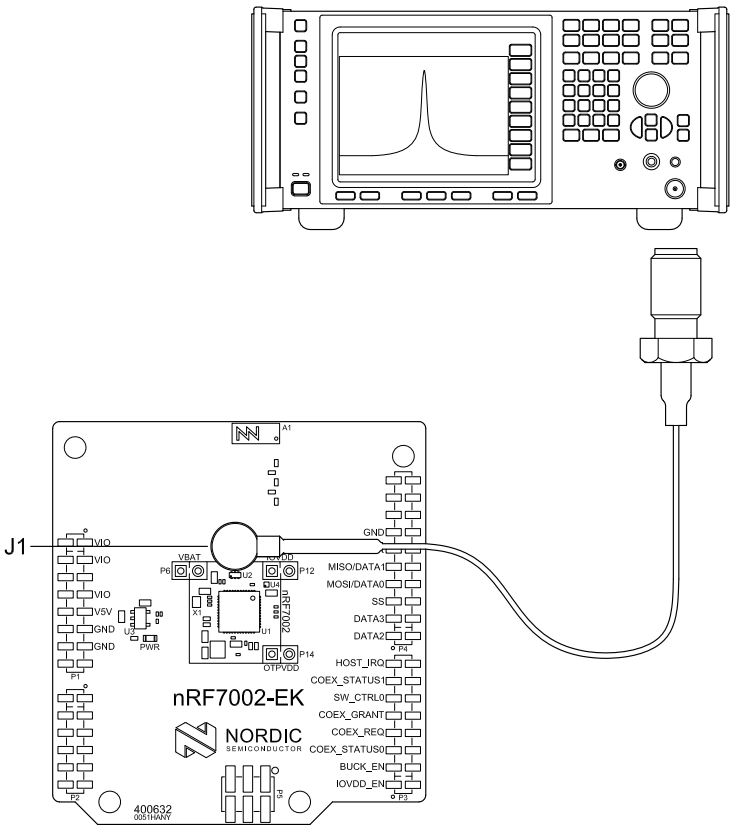

*Figure 14: Connecting a spectrum analyzer to **J1** on the nRF7002 EK*

The connector and test probe add loss to the RF signal, which should be taken into account when measuring. See the following table for more information or consult the test probe user guide if you are using another model.

Frequency (MHz)	Loss (dB)
2440	1.0
4880	1.7
7320	2.6

Table 5: Typical loss in connector and test probe (Murata part no. MXHS83QE3000)

Glossary

Development Kit (DK)

A hardware development platform used for application development.

Evaluation Kit (EK)

A platform used to evaluate different development platforms.

Electrostatic Discharge (ESD)

A sudden discharge of electric current between two electrically charged objects.

General-Purpose Input/Output (GPIO)

A digital signal pin that can be used as input, output, or both. It is uncommitted and can be controlled by the user at runtime.

Integrated Circuit (IC)

A semiconductor chip consisting of fabricated transistors, resistors, and capacitors.

One Time Programmable (OTP) memory

A type of non-volatile memory that permits data to be written to memory only once.

Printed Circuit Board (PCB)

A board that connects electronic components.

Quad Serial Peripheral Interface (QSPI)

A Serial Peripheral Interface (SPI) controller that allows the use of multiple data lines.

Root Mean Square (RMS)

An RMS meter calculates the equivalent Direct Current (DC) value of an Alternating Current (AC) waveform. A true RMS meter can accurately measure both pure waves and the more complex nonsinusoidal waves.

Single-Input Single-Output (SISO)

The use of only one antenna for transmission and reception.

SubMiniature Version A (SMA)

A semi-precision coaxial RF connector for coaxial cables with a screw-type coupling mechanism.

Serial Peripheral Interface (SPI)

Synchronous serial communication interface specification used for short-distance communication.

Microwave coaxial connector with switch (SWF)

A small, RF surface-mount switch connector series for wireless applications.

Universal Serial Bus (USB)

An industry standard that establishes specifications for cables and connectors and protocols for connection, communication, and power supply between computers, peripheral devices, and other computers.

Recommended reading

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

Nordic documentation

- nRF7002 Product Specification
- nRF Connect SDK

FCC regulatory notice

The following regulatory notices apply to the nRF7002 EK.

This *EK* has not been authorized under the rules of the FCC and is designed to allow:

- Product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product.
- Software developers to write software applications for use with the end product.

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