Power Profiler Kit

v1.1.0

User Guide

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NORDIC® SEMICONDUCTOR

Contents

Revision history

Date	Description
2021-02-26	• Updated Using the Power Profiler app on page 23 • Updated Figure 4: Block diagram on page 9 • Added Views on page 23 • Editorial changes
September 2019	Updated Installing the Power Profiler app on page 22
May 2019	Updated Installing the Power Profiler app on page 22
March 2019	Changed content to reflect support for external SEGGER J-Link debuggers
June 2018	Updated the content to clarify that when using a standalone SEGGER J-Link debugger, v1.1 of the Python-based PPK software must be used
March 2018	The following content was corrected: • Quick start on page 8 • Troubleshooting on page 27
March 2018	Updated due to new software
July 2017	Updated to match PPK v1.1.0 Settings window updated: • A new tab added, see Using the Power Profiler app on page 23 • Logging feature added, see File menu options Updated: • Installing Power Profiler Kit software package • Troubleshooting on page 27
October 2016	First release

Previous versions

Power Profiler Kit User Guide v1.1 (application software not supported)

1 Introduction

The Power Profiler Kit (PPK) is an affordable, flexible tool that measures the real-time power consumption of your designs.

The PPK measures power consumption for a connected nRF5 DK or any external board. It measures current from 1 µA to 70 mA and gives a detailed picture of the current profile for the user application.

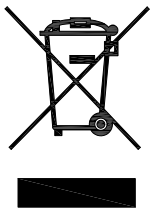
The PPK can be used in conjunction with the nRF5 DK to measure current on the nRF5 DK or on an external board. The hardware is delivered with an application that is installed using nRF Connect for Desktop. There are several measurement configurations, which are described in this user guide.

Key features

- Variable power supply voltage ranging from 1.8 V to 3.6 V (software configurable)
- Maximum 70 mA current measurement
- Resolution down to 0.2 µA
- Automatic switching between three current measurement ranges ensuring optimal resolution
- Measurement accuracy better than ±20 % (average currents measurement)
- Desktop application for measurement analysis
- Real-time current measurement display
- Recording display up to two minutes
- Real-time display with a resolution down to 13 µs
- Internal/external trigger

Applications

- Quick power consumption measurements on a firmware running on an nRF5 DK or an external board
- Accumulative measurements, such as average, peak, maximum
- Instantaneous measurements presented as waveform plots



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.

2 Minimum requirements

Before you start setting up the PPK, check that you have the required hardware and software.

Hardware requirements

- Micro-USB cable
- nRF5 DK or a standalone SEGGER J-Link debugger

Software requirements

- One of the following operating systems:
  - Microsoft Windows 8 or 10
  - macOS
  - Linux
- nRF Connect for Desktop

3 Kit content

The PPK includes hardware and access to software components, reference design files, and documentation.

3.1 Hardware content

The PPK hardware content consists of the PPK board PCA63511.

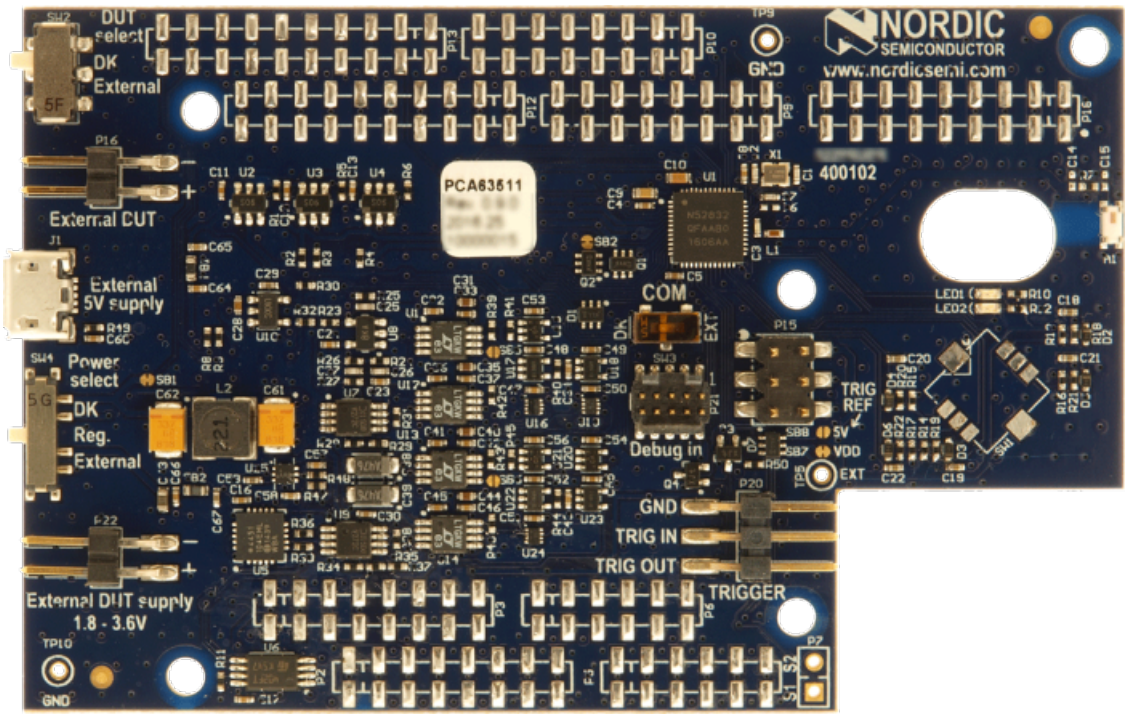


Figure 1: PPK board (PCA63511)

3.2 Downloadable content

The downloadable content for PPK consists of hardware files and this user guide.

You can download the hardware files from the Power Profiler Kit product page.

The hardware zip file contains the following files for the PCA63511 board:

- Altium Designer files
- Production files (bill of materials and assembly, drill, Gerber, and pick-and-place files)
- PCB layout files and schematics in PDF format

You also need nRF Connect for Desktop.

4 Quick start

Complete a few steps to set up your PPK. The PPK is connected to an nRF5 DK (not included in the package).

In this quick start, the PPK measures current on the nRF5 DK, which also acts as a power supply and sends data to the Power Profiler app.

1. Prepare the nRF5 DK for current measurements. See the following user guides for more information:
   - *Preparing the development kit board* in the nRF51 DK User Guide
   - Preparing the nRF52 DK
   - Preparing the nRF52840 DK
2. Connect the PPK to the *Development Kit (DK)*.

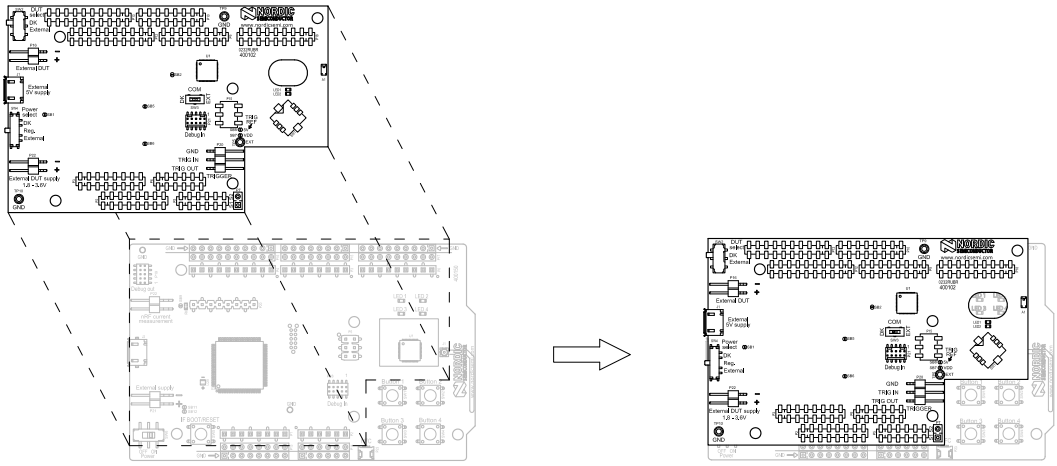


Figure 2: Connecting the PPK to the DK

3. Connect the *DK* to a computer using a micro-USB cable.

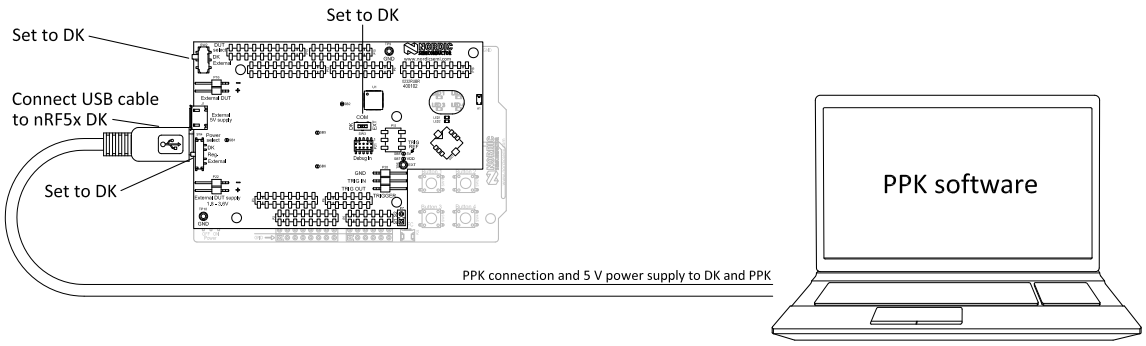


Figure 3: Typical configuration for measuring current on the DK

4. Set the switches on the PPK as shown in the figure above.
5. Install the Power Profiler app from nRF Connect for Desktop as described in Installing the Power Profiler app on page 22.
6. Start the Power Profiler app as described in Using the Power Profiler app on page 23.

The PPK is now ready to use.

5 Hardware description

The PPK contains connectors and measurement components.

5.1 Measurement system

The PPK is driven by the nRF52832 *System on Chip (SoC)*, which uses its analog-to-digital converter (ADC) to measure a voltage drop over a series of measurement resistors. Resistor values are used to calculate the power consumption. The PPK has three different measurement ranges, which are managed by an automatic switch circuitry.

To send the data to the desktop application, the nRF52832 *SoC* on the PPK uses the SEGGER RTT (Real-Time Transfer). By connecting the PPK to an nRF5 DK, the SEGGER J-Link debug probe available on the nRF5 DK can be used for the computer connection. Alternatively, an external SEGGER J-Link debugger can be used.

5.1.1 Block diagram

The PPK block diagram illustrates the overall system and connections between the various blocks.

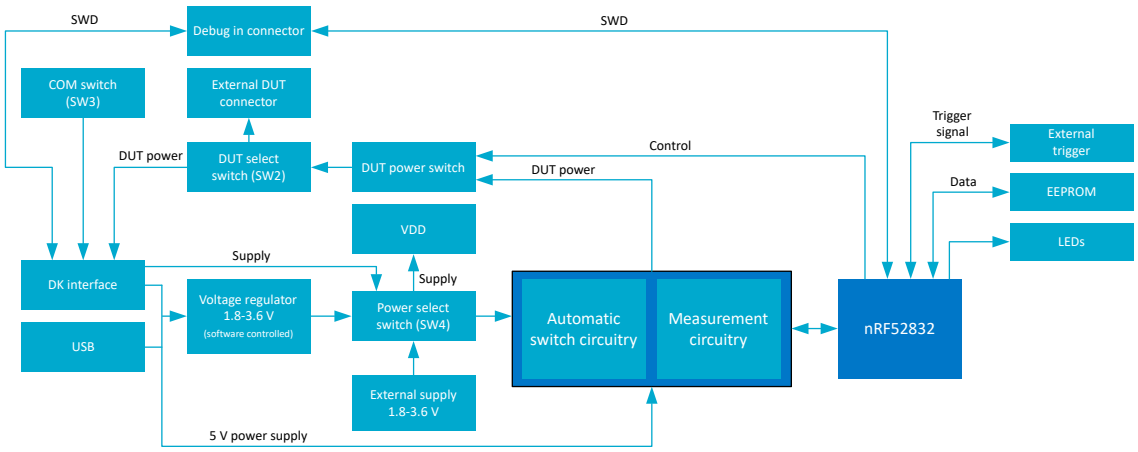


Figure 4: Block diagram

5.1.2 Power supply

There are three power supply options for the PPK digital logic and for the *Device Under Test (DUT)*.

The power supply options are:

- DK interface
- PPK onboard voltage regulator
- External supply

The power supply is selected using the power select switch (**SW4**).

The PPK onboard voltage regulator is supplied by the 5 V USB power supply. Its output can be adjusted between 1.8 – 3.6 V through the Power Profiler app.

If an external power supply is used, the voltage is applied directly to the circuits without regulation. This voltage must be limited to the 1.8 – 3.6 V range.

When the DK is selected as the power supply, the DK supplies the PPK circuitry.

The analog part of the automatic switch circuitry requires a 5 V power supply. When the PPK is connected to an nRF5 DK, the 5 V is supplied by the DK. When the PPK is used standalone, a USB cable has to be connected to supply the 5 V required by the circuitry.

5.1.3 Measurement ranges and switch levels

To achieve a high measurement dynamic range, the PPK features three calibrated parallel measurement means realizing the three measurement ranges simultaneously. An automatic range switching mechanism always selects the correct measurement range depending on the instantaneous current drawn by the *DUT*.

If your *DUT* has a power consumption that is close to an automatic switching level, it can cause rapid switching between the ranges, creating measurement errors and distorted plots. A hysteresis is applied at the switching point in order to avoid distorted measurements as shown in the following figure.

There are four switch levels:

Switch up LOW
Switches up from low to medium range

Switch up HIGH
Switches up from medium to high range

Switch down HIGH
Switches down from high to medium range

Switch down LOW
Switches down from medium to low range

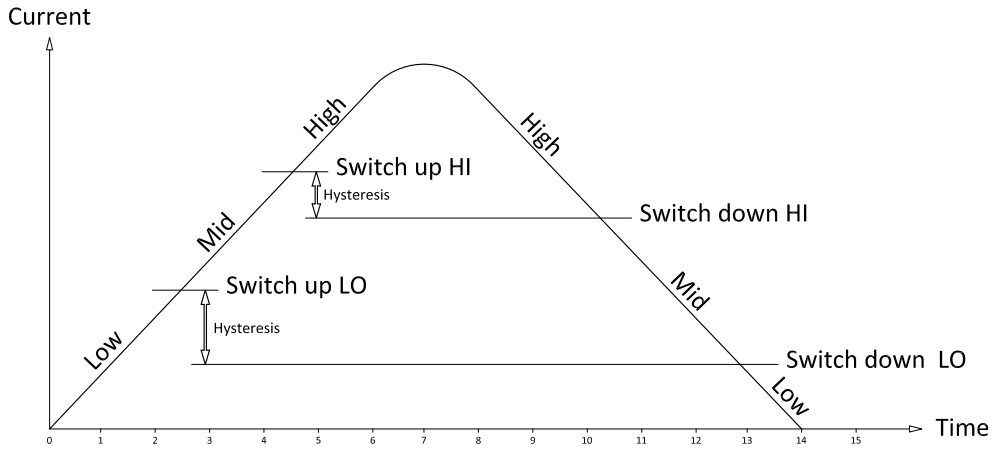


Figure 5: Measurement ranges and switch levels

5.1.4 DUT output

For *DUT* output, the PPK supports two modes of operation that are selected using the DUT select switch (**SW2**).

The two modes of operation are:

- Measuring current on the nRF5 DK device
- Supplying power and measuring current on an external board

The *DUT* can be turned on and off using the **Enable power output** toggle in the Power Profiler app.

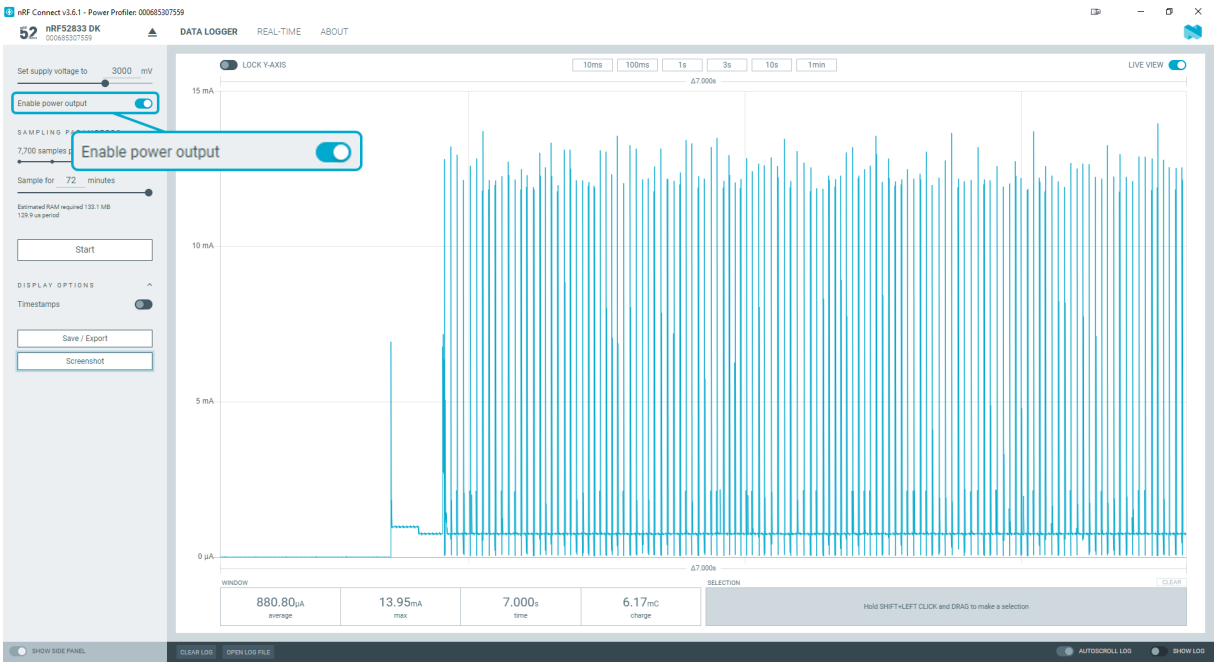


Figure 6: Enable power output in the Power Profiler app v3.1.0

5.1.5 EEPROM

On the PPK, there is an EEPROM memory connected to the nRF52832 *SoC*. The EEPROM is used to store calibration data.

5.2 Connectors

Access to the PPK is available from a set of connectors.

The PPK has five connectors on the top side:

- Two connectors for the power supply:
  - **P16** to connect an external device under test (DUT)
  - **J1** for the USB
- **P22** for connecting the custom/external hardware
- **P20** for connecting an external trigger
- **P21** connector for connecting an external SEGGER J-Link

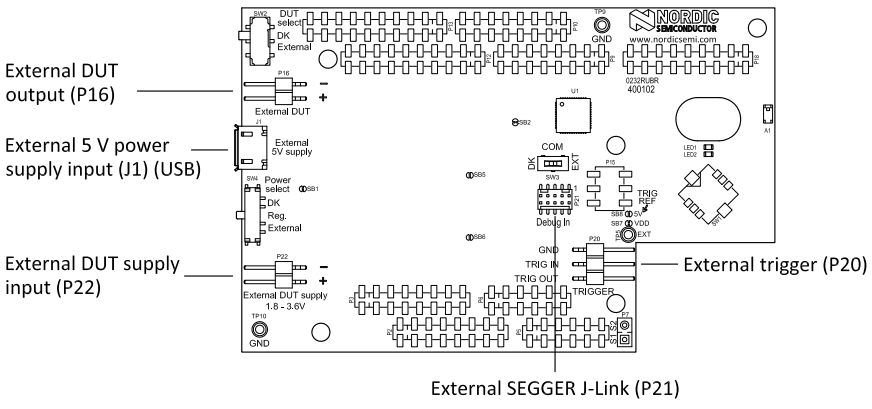


Figure 7: PPK connectors

The connectors on the bottom side are for connecting the PPK to an nRF5 DK , which supplies both data interface and power to the PPK.

Connector	Description
External 5 V power supply input (USB; **J1**)	This USB connector on the PPK supplies the onboard analog measurement circuitry and the onboard regulator with 5 V provided by a USB host. This connector is used when the PPK is used standalone or any time the USB on the nRF5 DK is not connected. **Note:** When used with an nRF5 DK with USB connection, this connector must not be used.
External DUT output (**P16**)	The **External DUT** connector provides power to the DUT.
External DUT supply input (**P22**)	A lab power supply from 1.8 to 3.6 V can be connected here to provide precise control of the voltage.
External trigger (**P20**)	This connector allows you to: • Feed an external trigger to the PPK (15 V max) • Have the PPK send a trigger signal to external instruments The voltage of the **TRIG OUT** pin can be configured by the **TRIG REF** on the PPK board which has the following options: • VDD: default • 5 V: cut **SB7** and solder **SB8** • External voltage: cut **SB7** and **SB8** (if shorted) and connect to **TP5** (EXT)
External SEGGER J-Link (**P21**)	Used to connect an external SEGGER J-Link for communicating with the desktop application when: • The PPK is used standalone • The SEGGER J-Link on the nRF5 DK is used for debugging of the nRF5 chip on the *DK* If this connector is in use and the PPK is connected to an nRF5 DK, the COM switch (**SW3**) must be in the **EXT** position to disconnect the PPK from the SEGGER J-Link on the *DK*. How to connect and use is described in Table 2: PPK switches on page 13.

Table 1: PPK connectors

5.3 Switches

Use the switches on the PPK to select either the *DUT* on which current is measured, the power supply, or the SEGGER J-Link connection.

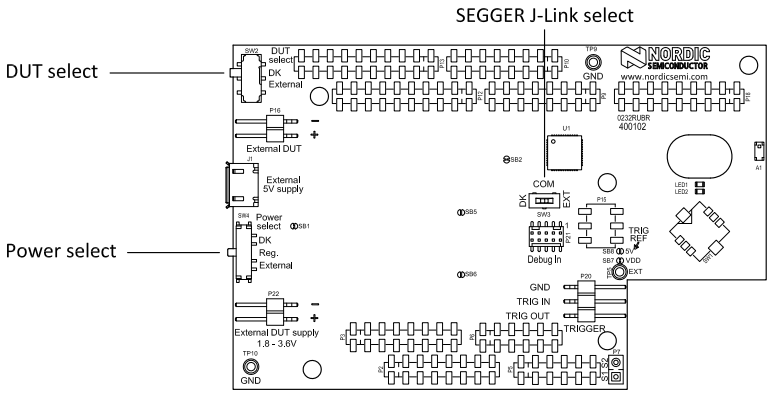


Figure 8: PPK switches

Switch	Description
DUT select (**SW2**)	Selects if the measurements are performed on the nRF5 DK or on an external/ custom hardware. Options: • **DK**: The measurements are performed on the nRF5 DK. • **External**: The measurements are performed on the external/custom hardware connected to the External DUT (**P16**) connector.
Power select (**SW4**)	Selects the power source for the PPK and *DUT*. Options: • **DK**: The power source is the nRF5 DK. Used when measuring current on the nRF5 DK (that is, when the DUT select switch is in the **DK** position). • **Reg.**: The power source is the onboard regulator powering the PPK and the external *DUT*. Used when measuring current on the external/custom hardware (that is, when the DUT select (**SW2**) switch is in the **External** position). • **External**: An external power supply is the power source connected to the External DUT supply (**P22**) connector of the PPK. **Note:** • The Power Profiler app can be used to adjust the power supply voltage only when the Power select (**SW4**) switch is in the **Reg.** position, that is, when the power is supplied by the PPK onboard regulator. • It is not recommended to use the PPK onboard regulator (**SW4** in the **Reg.** position) when measuring current on the nRF5 DK unless the PPK onboard regulator voltage exactly matches the nRF5 DK voltage. Otherwise, current leakage may occur and lead to erroneous current readings. The voltage is usually somewhere between 2.9 V and 3 V. To be sure, it is recommended to measure the *DK* voltage. This configuration, although possible, is not recommended.

Switch	Description
COM (**SW3**)	This switch selects the SEGGER J-Link connection. Options: • **DK**: The SEGGER J-Link on the nRF5 DK is used. • **EXT**: An external SEGGER J-Link is used and connected to the **Debug in** (**P21**) connector. This will disconnect the PPK from the SEGGER J-Link on the nRF5 DK. **Note:** • To program the *DUT* on the *DK*, the switch must be in the **EXT** position. When programming with the switch in the *DK* position, the PPK will be programmed. • When the PPK uses the nRF5 DK SEGGER J-Link, it cannot be used to debug the nRF5 *SoC* on the *DK* at the same time. To debug the nRF5 DK *SoC* on the *DK*, set the **COM** (**SW3**) switch to the **EXT** position.

Table 2: PPK switches

6 Configuring the PPK

Different configuration setups and methods for measuring current can be used for the PPK.

To configure the PPK, complete the following steps:

1. Adjust measurement accuracy as described in Optimizing measurement accuracy on page 15.
2. Choose a use case and implement a configuration for the PPK. The options are presented in the following table.

Use case	Configuration setup/measurement method
Design phase, no custom hardware	Measuring current on an nRF5 DK on page 16.
Design and optimization phase, no custom hardware, with debugging	Measuring current on an nRF5 DK while debugging on page 17.
Design phase, using external/ custom hardware	Measuring current on custom hardware with an nRF5 DK on page 18.
	Measuring current on custom hardware without an nRF5 DK on page 19.

Table 3: PPK use cases

6.1 Optimizing measurement accuracy

When measuring current with the PPK, some adjustments are needed to optimize the measurement accuracy. The nRF5 DK must be prepared for the measurement.

6.1.1 Power Profiler Kit use with nRF5 DK

When the PPK is used with an nRF5 DK, it is recommended to use the Power select (**SW4**) switch in the **DK** position.

It is not recommended to use the PPK onboard regulator as the power source (the Power select switch (**SW4**) in the **Reg.** position) as this may lead to erroneous current readings.

Note: If you want to improve the USB noise filtering, you need to use the PPK onboard regulator as the power source. Make sure that the PPK regulator voltage exactly matches the nRF5 DK voltage. Otherwise, current leakage may occur and lead to erroneous current readings.

6.1.2 Current measurement on external DUTs

When measuring current on external devices, it is important to keep in mind that large filtering capacitors, which may be present on the *DUT* circuit, will smooth out the variations in power consumption.

This yields a good result for the average power consumption, but the short current bursts will be filtered out and the plot might differ from what you see on the measurements done on the nRF5 DK during development.

You must include decoupling capacitors to ensure correct operation of the devices. However, as a good practice, keep extra decoupling capacitors to a minimum when measuring detailed current draw.

6.2 Connecting the Power Profiler Kit to an nRF5 DK

For all of the PPK configurations, except when the PPK is running standalone, the PPK needs to be connected to the nRF5 DK.

Connect your PPK to the nRF5 DK as shown in the following figure.

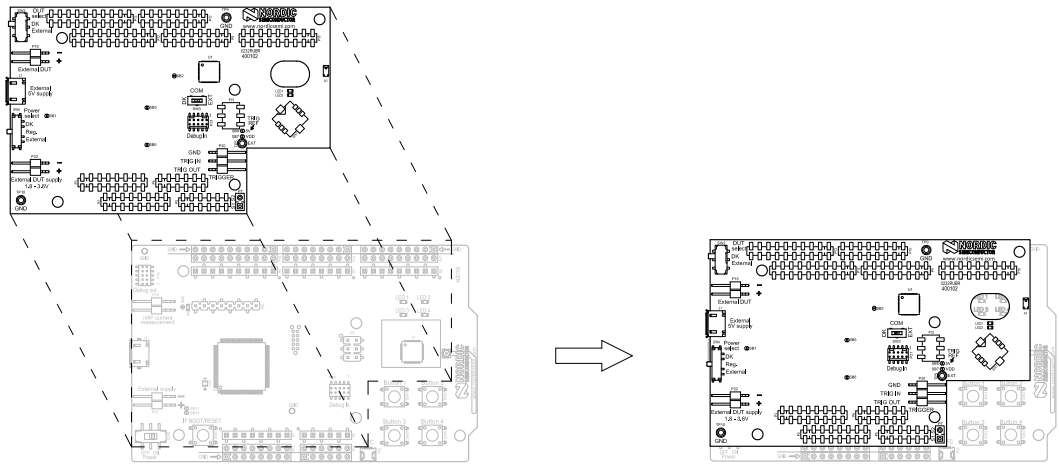


Figure 9: Connecting the PPK to the nRF5 DK

6.3 Measuring current on an nRF5 DK

You can use this setup during the design phase when custom hardware is not yet available.

For the PPK, this is a typical configuration that allows quick setup and current measurements in reference applications from the SDK or in custom applications.

In this case, the connection to the Power Profiler app is provided by the SEGGER J-Link on the nRF5 DK with a power supply applied on the *DK*. The configuration for this use case is shown in the following figure.

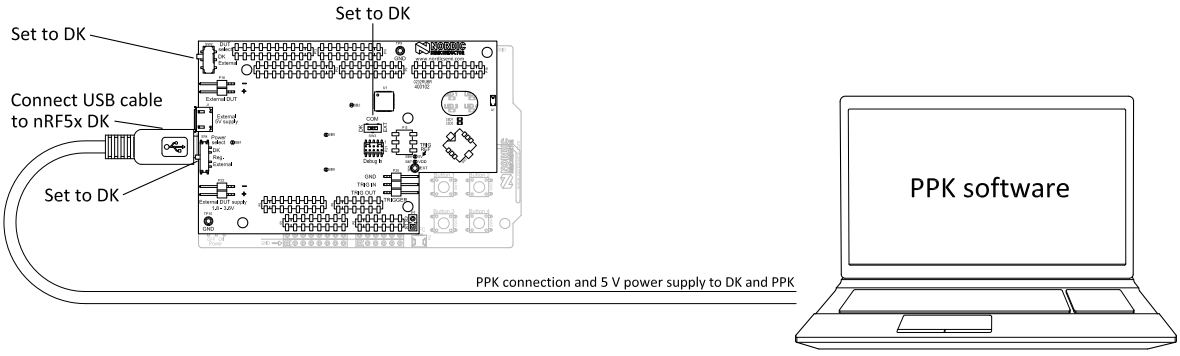


Figure 10: Measuring current on the nRF5 DK

Make sure that the following are configured:

- The PPK is connected to the nRF5 DK as described in Connecting the Power Profiler Kit to an nRF5 DK on page 16.
- The DUT select switch (**SW2**) is in the **DK** position.

- The Power select switch (**SW4**) is in the **DK** position.
- The COM switch (**SW3**) is in the **DK** position.
- The USB cable is plugged into the USB connector on the nRF5 DK and connected to a computer with the Power Profiler app.

6.4 Measuring current on an nRF5 DK while debugging

This setup is to be used during the design and optimization phase when no custom hardware is available yet. The SEGGER J-Link debugger on the nRF5 DK is used for debugging.

Because the SEGGER J-Link of the nRF5 DK is used for debugging, an additional SEGGER J-Link is needed to connect the PPK to your computer. This could be either another nRF5 DK with an onboard SEGGER J-Link or a standalone SEGGER J-Link which can be purchased separately from SEGGER J-Link Software.

The configuration for this use case is shown in the following figure.

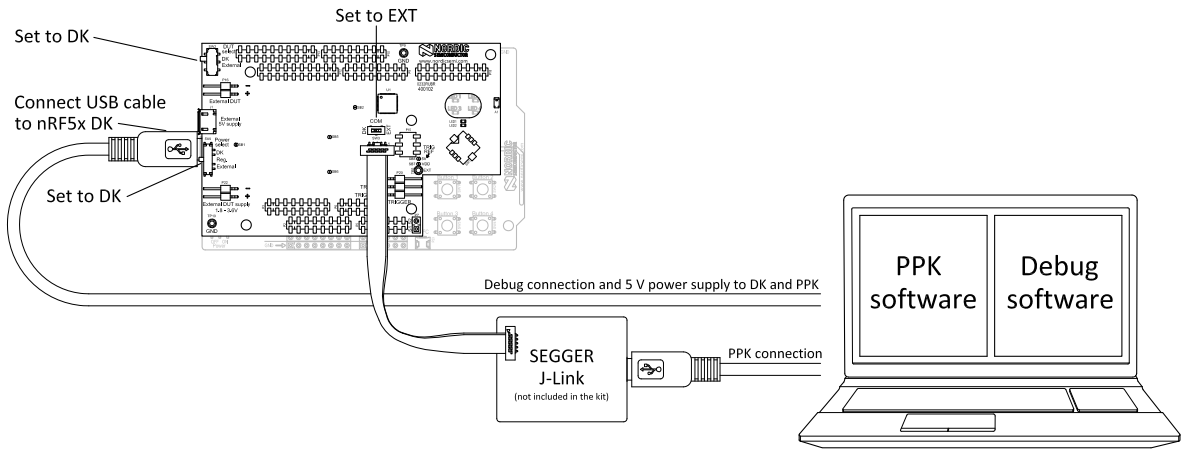


Figure 11: Measuring current on the nRF5 DK with debugging

Make sure that the following are configured:

- The PPK is connected to the nRF5 DK board as described in Connecting the Power Profiler Kit to an nRF5 DK on page 16.
- The DUT select switch (**SW2**) is in the **DK** position.
- The Power select switch (**SW4**) is in the **DK** position.
- The USB cable is plugged into the USB connector on the nRF5 DK and connected to a computer running the debugging software.
- The additional SEGGER J-Link is connected to the Debug in connector (**P21**) on the PPK, using the 10-pin flat cable. The USB cable is plugged into the SEGGER J-Link and connected to a computer running the Power Profiler app.
- The COM switch (**SW3**) is in the **EXT** position.

Note: Power consumption may be higher for devices during debugging than in normal operation. The difference depends on what is active at any given time. This is caused by the clocking of the debug interface and constantly powering sections of the device that are independent of the operation of the part. When debugging, accurate power consumption cannot be measured, but software issues can be detected.

6.5 Measuring current on custom hardware with an nRF5 DK

This setup is to be used during the design phase on custom hardware acting as the device under test (DUT) with the nRF5 DK.

In this use case, the PPK measures the current on the external *DUT*. The PPK is connected to the nRF5 DK which is used as a SEGGER J-Link interface to the computer running the Power Profiler app.

The power supply is provided either by the PPK onboard regulator, or an external power source (see the following figures).

The power supply is applied to the nRF5 DK, which in turn powers the PPK board. This is used to supply power to the onboard analog measurement circuitry and the onboard regulator with 5 V. This will supply the external *DUT* when using the onboard regulator. If an external power source is used to supply the custom hardware, the USB connection will still be needed to supply the measurement circuitry of the PPK.

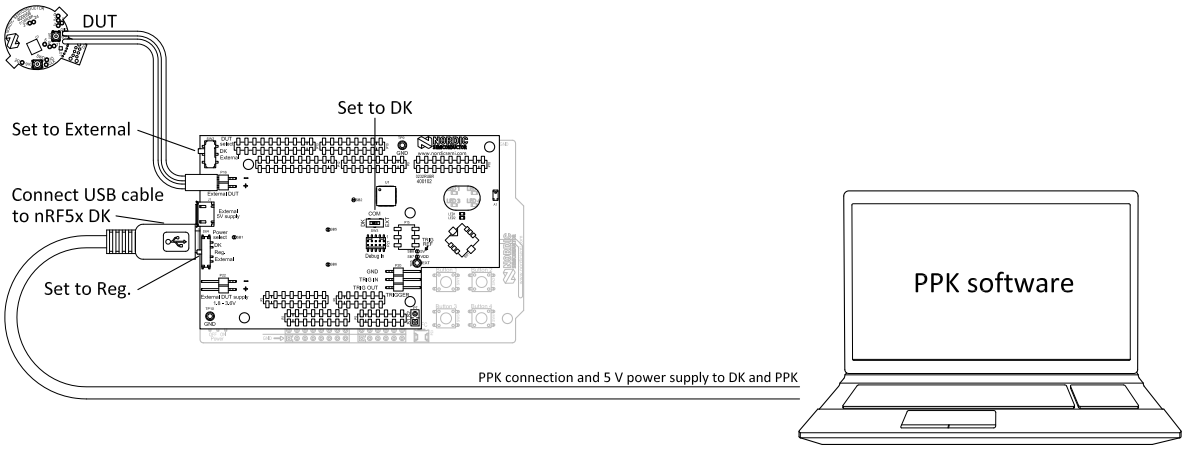


Figure 12: Measuring current on custom hardware with the onboard regulator as the power source and the nRF5 DK

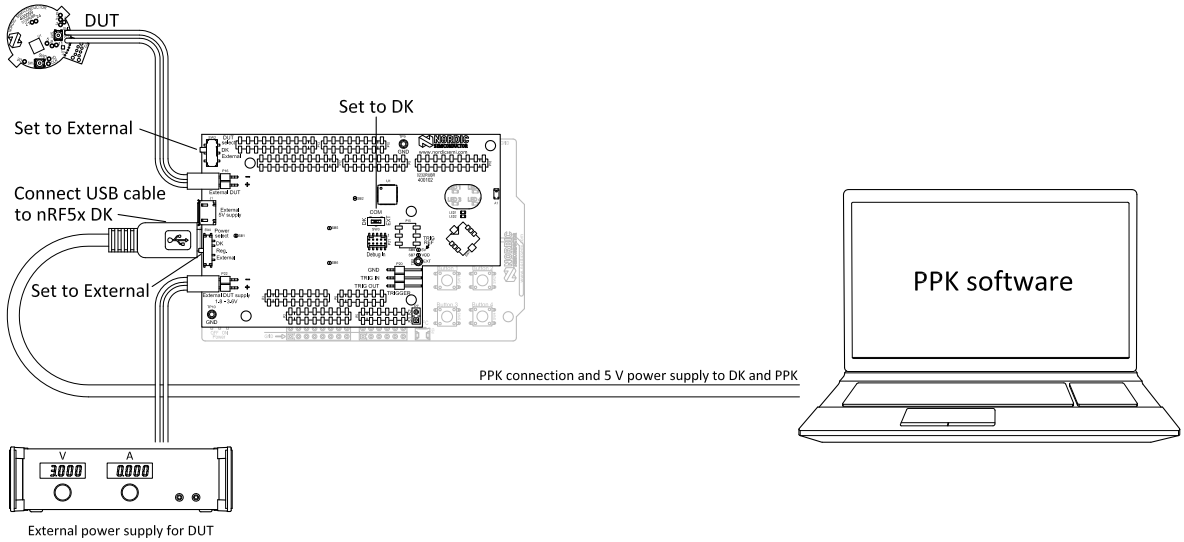


Figure 13: Measuring current on custom hardware with an external power source and the nRF5 DK

Make sure that the following are configured:

- The PPK is connected to the nRF5 DK board as described in Connecting the Power Profiler Kit to an nRF5 DK on page 16.
- The USB cable is plugged into the USB connector on the nRF5 DK and connected to a computer running the Power Profiler app.
- The DUT select switch (**SW2**) is in the **External** position.
- The custom hardware is connected to the External DUT connector (**P16**) of the PPK.
- The power source is one of the following:
  - The PPK onboard regulator: Set the Power select switch (**SW4**) in the **Reg.** position.
  - External power supply: In addition to the USB cable plugged into the nRF5 DK, make sure that the external power is connected to the External DUT supply connector (**P22**) of the PPK (voltage range from 1.8 V to 3.6 V). Set the Power select switch (**SW4**) in the **External** position.
- The COM switch (**SW3**) is in the **DK** position.

6.6 Measuring current on custom hardware without an nRF5 DK

This setup is to be used during the design phase on custom hardware without using the nRF5 DK.

The power supply is provided either by the PPK onboard regulator or an external power source (see the following figures).

The External 5V supply USB connector (**J1**) of the PPK is used to supply power to the onboard analog measurement circuitry and the onboard regulator with 5 V. This will supply the custom hardware (DUT). If an external power source is used to supply the custom hardware, the USB connection will still be needed to supply the measurement circuitry of the PPK.

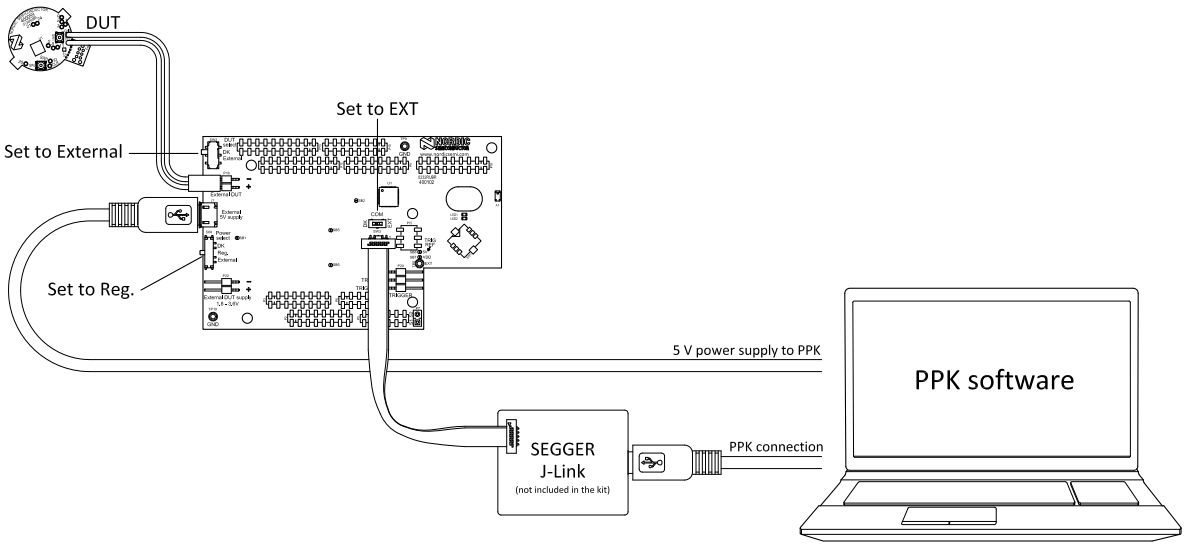


Figure 14: Measuring current with the onboard regulator as the power source without an nRF5 DK

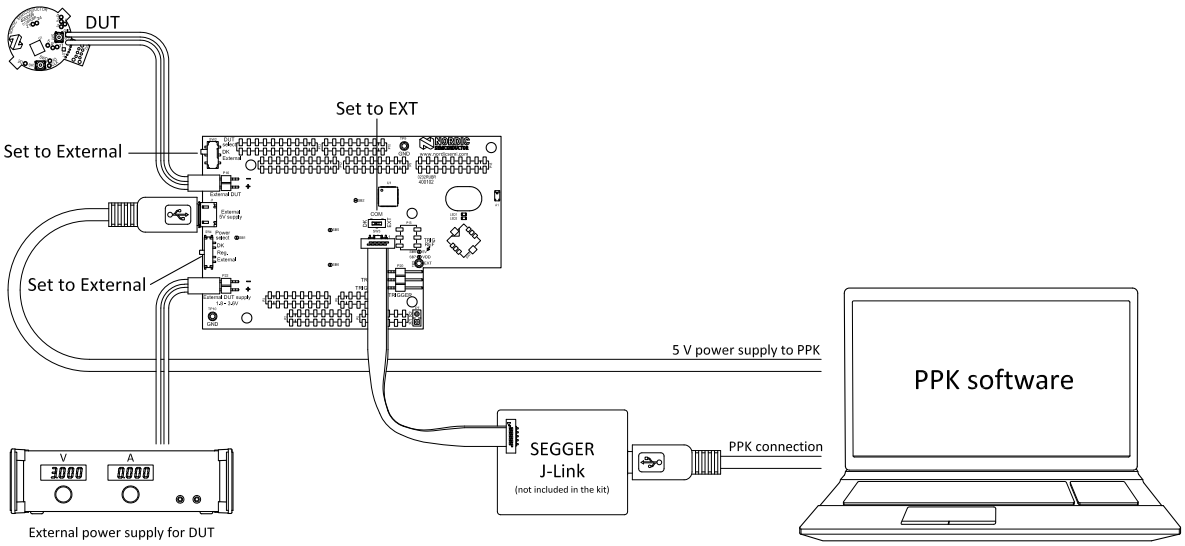


Figure 15: Measuring current with an external power source without an nRF5 DK

Make sure that the following are configured:

- The DUT select switch (**SW2**) is in the **External** position.
- The custom hardware (DUT) is connected to the External DUT connector (**P16**) of the PPK.
- The power source is one of the following:
  - The PPK onboard regulator: Make sure that a USB cable with power is plugged into the External 5V supply USB connector (**J1**) of the PPK. Set the Power select switch (**SW4**) in the **Reg.** position.
  - External power supply: In addition to the USB cable plugged into the External 5V supply USB connector (**J1**), make sure that the external power is connected to the External DUT supply connector (**P22**) of the PPK (voltage range from 1.8 V to 3.6 V). Set the Power select switch (**SW4**) in the **External** position.
- The additional SEGGER J-Link is connected to the Debug in connector (**P21**) on the PPK using the 10-pin flat cable. The USB cable is plugged into the SEGGER J-Link and connected to a computer running the Power Profiler app.
- The COM switch (**SW3**) is in the **EXT** position.

7 Connecting the PPK to a computer

You need to connect the PPK to a computer with a USB cable in order to use it.

1. Connect the PPK to your computer using a USB cable.
   - If the PPK is connected to an nRF5 DK, connect the USB cable to the nRF5 DK.
   - If the PPK is running standalone, connect the USB cable to the PPK (**J1**). See Figure 7: PPK connectors on page 11.
2. If you are using an external SEGGER J-Link in your configuration, use a USB cable to connect it to your computer.
3. If you are using an nRF5 DK, slide the power switch to **ON**.

   If Windows driver installation starts for the inserted *DK*, wait until it finishes before continuing.
4. Verify that the **LED2** is lit on the PPK.

Your PPK is now connected to the computer. You are ready to start the Power Profiler app.

8 Installing the Power Profiler app

Power Profiler is installed as an app for nRF Connect for Desktop.

Before you can install the app, you must download and install nRF Connect for Desktop.

To install the app:

1. Open nRF Connect for Desktop.
2. Find the Power Profiler app in the list 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**.

9 Using the Power Profiler app

The PPK must be configured correctly, connected to your computer, and powered before the Power Profiler app can be started.

1. Open the Power Profiler app using nRF Connect.

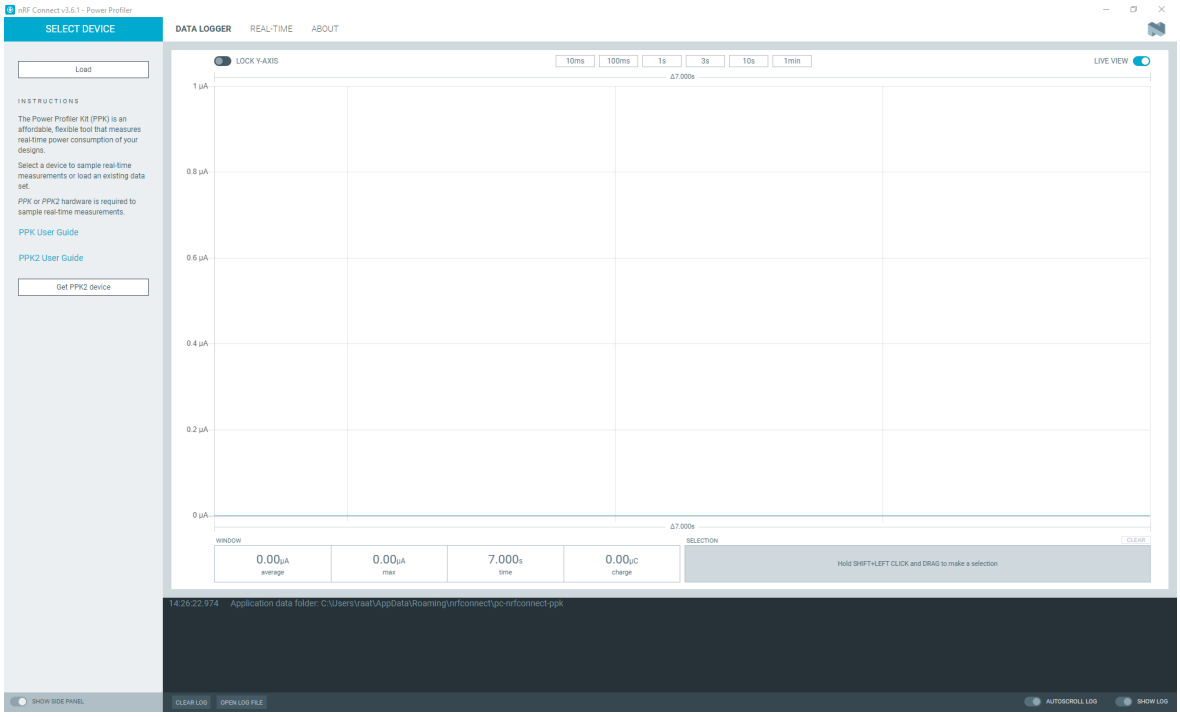


Figure 16: Settings and Plots view in the Power Profiler app v3.1.0

2. Click **Select Device** (in the top left corner) and select from the list the *DK* or the SEGGER J-Link debugger connected to the PPK.
3. Click **Start**.
4. Toggle **Enable power output** to enable power to the *DUT* if not enabled.

You can start measuring current when connection is established.

The Power Profiler app checks if the PPK has the required firmware and shows a firmware upgrade dialog if needed.

To show advanced controls for switch levels and resistor calibration, press **CTRL+ALT+SHIFT+A**.

9.1 Views

The Power Profiler app has two views that provide detailed power consumption information.

9.1.1 Data logger view

The data logger view lets you examine the power continuously over a period of time.

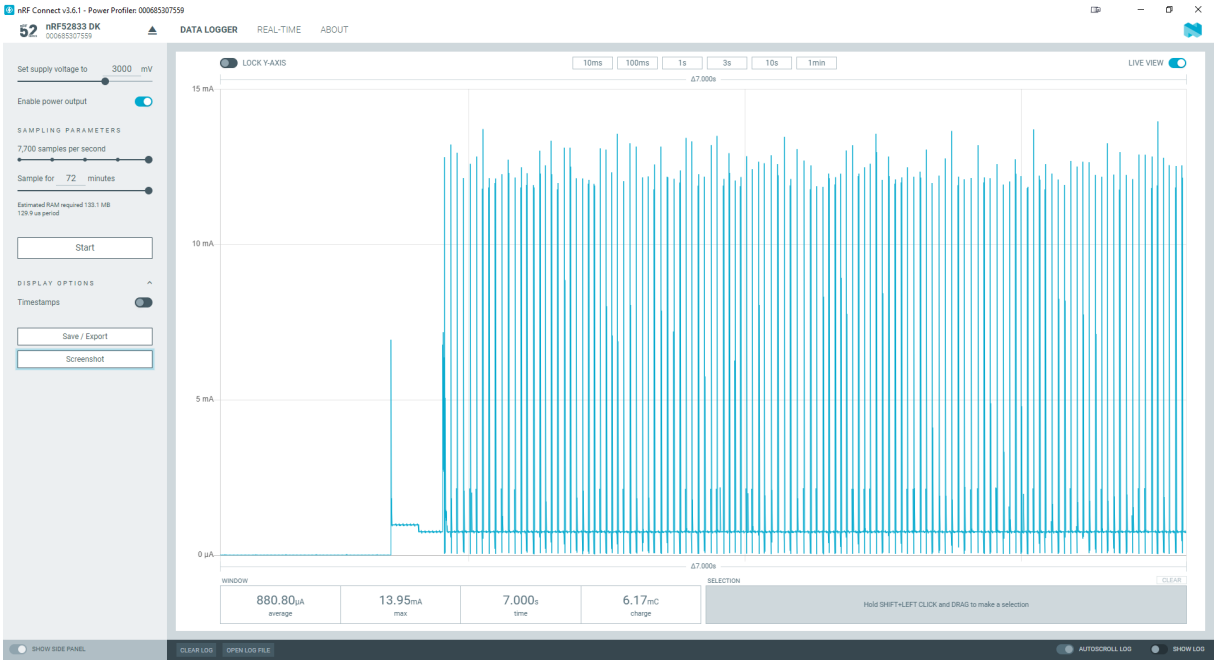


Figure 17: Data logger view in the Power Profiler app v3.1.0

9.1.2 Real-time view

The real-time view, which functions similar to an oscilloscope, plots a set amount of time whenever the consumed power reaches a specified trigger level.

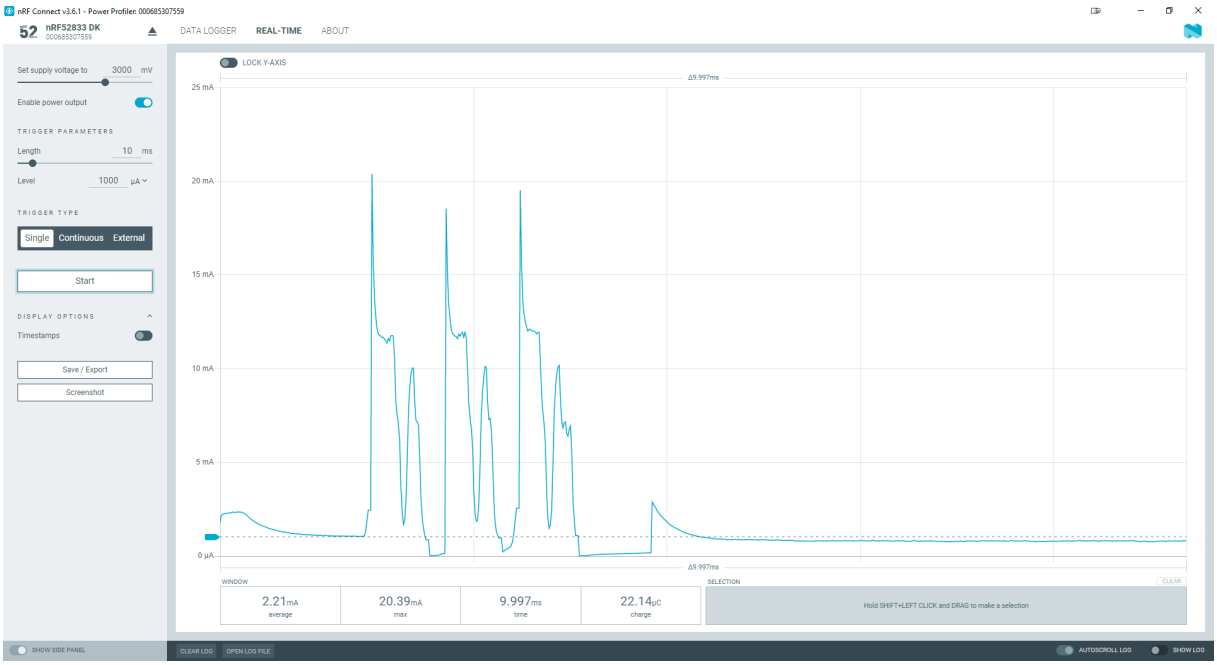


Figure 18: Real-time view in the Power Profiler app v3.1.0

10 Electrical specifications

These specifications contain the property values that are essential for using the PPK.

10.1 Environmental specifications

These environmental specifications contain the values that are essential for using the PPK.

Item	Name	Min	Typ	Max	Unit	Description
Operating temperature	Op_Temp	15		30	°C	

Table 4: Environmental specifications

10.2 Power supply specifications

These power supply values are essential for using the PPK.

Item	Name	Min	Typ	Max	Unit	Description
DUT voltage	VDD_DUT	1.8		3.6	V	
External supply voltage	VDD_EXT	1.8		3.6	V	
Micro-USB supply voltage	V5V	4.5		5.5	V	USB voltage tolerances

Table 5: Power supply specifications

10.3 Measurement specifications

These measurement specifications contain the property values that are essential for using the PPK.

10.3.1 Maximum DUT admissible current

The maximum *DUT* admissible current specification contains the value that is essential for using the PPK.

Item	Name	Min	Typ	Max	Unit	Description
Maximum DUT admissible current	Max_I			70	mA	

Table 6: Maximum DUT admissible current

10.3.2 Measurement resolution

These measurement resolution values are essential for using the PPK.

Item	Name	Min	Typ	Max	Unit	Description
1–70 µA range	R1_Resol		0.2		µA	
70 µA–1 mA range	R2_Resol		3		µA	
1–70 mA range	R3_Resol		50		µA	

Table 7: Measurement resolution

10.3.3 Measurement accuracy

These measurement accuracy values are essential for using the PPK.

Item	Name	Min	Typ	Max	Unit	Description
1–70 µA range	R1_Accuracy		+/- 20		%	Readout on Average value
1–70 µA range	R1_Offset		±2		R1_Resol	
70 µA–1 mA range	R2_Accuracy		+/- 15		%	Readout on Average value
70 µA–1 mA range	R2_Offset		±2		R2_Resol	
1–70 mA range	R3_Accuracy		+/- 15		%	Readout on Average value
1–70 mA range	R3_Offset		±2		R3_Resol	
Sampling rate	Meas_Frequency		77		kHz	Fixed value

Table 8: Measurement accuracy

11 Troubleshooting

Here are some basic troubleshooting steps to help you fix issues you may encounter when using the PPK.

PPK only measuring noise

Make sure you have prepared the nRF5 DK for current measurements by cutting the nRF current measurement solder bridge as described in:

- *Preparing the development kit board* in the nRF51 DK User Guide
- Preparing the nRF52 DK
- Preparing the nRF52840 DK

Measurements fluctuate when there should be a steady current draw

Your *DUT* may have a power consumption that is close to a switching point causing rapid switching between the ranges and creating measurement errors/distorted plots. Try adjusting the switching points.

Graph response is very slow

Avoid using *Universal Serial Bus (USB)* hubs and docking stations. Also, if the trigger window is receiving a lot of updates, consider stopping this plot to have better throughput for the **Average** plot.

For more information, visit Nordic DevZone.

For personalized support from our technical support team, sign up for or sign in to Nordic Developer Zone and enter a private ticket.

Glossary

Development Kit (DK)

A hardware development platform used for application development.

Device Under Test (DUT)

A manufactured product undergoing testing.

System on Chip (SoC)

A microchip that integrates all the necessary electronic circuits and components of a computer or other electronic systems on a single integrated circuit.

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

- nRF51 DK
- nRF52 DK
- nRF52833 DK

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