

Power Profiler Kit II

v1.0.1

User Guide



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Revision history

Date	Description
2024-02-08	Moved content about Using the Power Profiler app to the separate nRF Connect Power Profiler documentation set
2022-08-16	Updated the following topics based on nRF9160 DK v0.9.0 or later: <ul style="list-style-type: none">• Quick start on page 7• Measuring current in Source Meter mode on page 10• Measuring current in Ampere Meter mode on page 11
2021-11-01	<ul style="list-style-type: none">• Updated Measuring current in Ampere Meter mode on page 11• Editorial changes
2021-06-08	Updated Table 3: Pin connections in Ampere Meter mode on page 11
2021-02-26	<ul style="list-style-type: none">• Updated Using the Power Profiler app on page 13• Updated Measuring current in Source Meter mode on page 10• Updated Measuring current in Ampere Meter mode on page 11• Added Views• Editorial changes
2020-12-01	First release

1 Introduction

The Power Profiler Kit II (PPK2) is an affordable, flexible tool that measures the real-time power consumption of your designs.

The PPK2 measures power consumption by either providing power to the external board or acting as an ampere meter. It measures current from 500 nA to 1 A and gives a detailed picture of the current profile for the user application.

The PPK2 can measure current on any external board (e.g. nRF5 Series or nRF91 Series DKs). 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 0.8 V to 5.0 V (software configurable)
- Maximum 1 A current measurement
- Accurate measurement down to approximately 200 nA
- Resolution down to 0.2 μ A
- 100 kS/s sampling speed
- Automatic switching between five current measurement ranges ensuring optimal resolution
- Measurement accuracy better than $\pm 20\%$ (average currents measurement)
- 8 pin digital port for digital tracing
- *Universal Serial Bus (USB)* communication, enabling simple porting to other applications
- Desktop application for measurement analysis
- Real-time current measurement display

Applications

- Quick power consumption measurements on a firmware running on any nRF *Development Kit (DK)*
- Accumulative measurements, such as average, maximum, and charge
- Instantaneous measurements presented as waveform plots

The PPK2 is manufactured by Nordic Semiconductor ASA, Otto Nielsens veg 12, 7052 Trondheim, Norway.

Note: If the PPK2 is used in a manner not specified by Nordic Semiconductor, the protection provided by the equipment may be impaired.



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 PPK2, check that you have the required hardware and software.

Hardware requirements

- Micro-USB cable

Software requirements

- One of the following operating systems:
 - Microsoft Windows 8 or 10
 - macOS
 - Linux
- [nRF Connect for Desktop](#)

3 Kit content

The PPK2 includes hardware and access to software components, reference design files, and documentation.

3.1 Hardware content

The PPK2 hardware content consists of the PPK2 board, 4-pin current measurement cable, and 10-pin logic port cable.

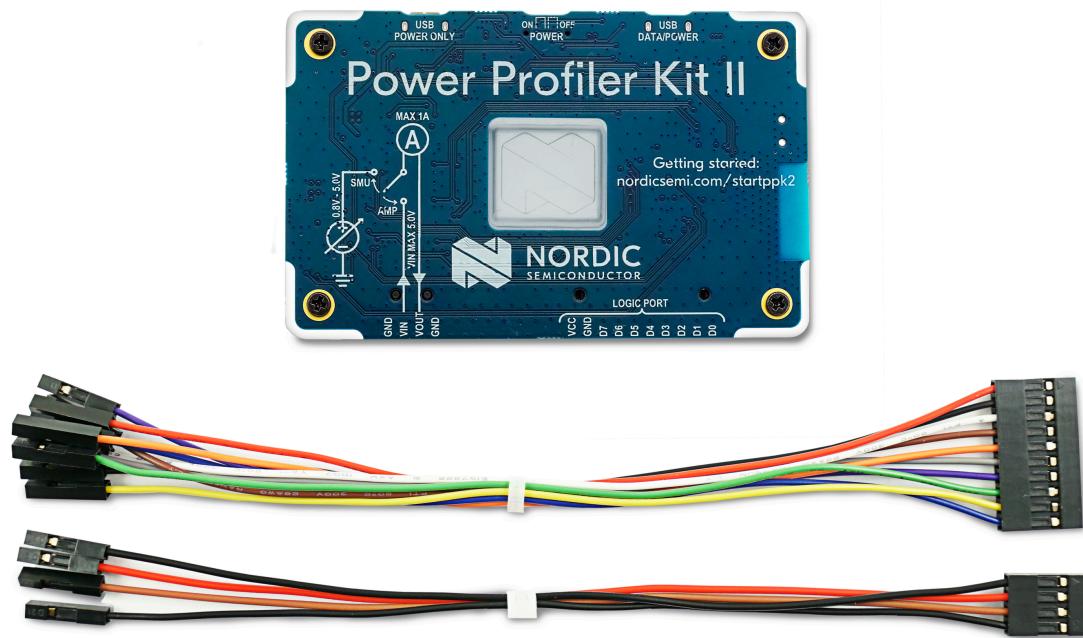


Figure 1: PPK2 board and cables

3.2 Downloadable content

The downloadable content for PPK2 consists of hardware files and this user guide.

You can download the hardware files from the [Power Profiler Kit II](#) product page.

The hardware zip file contains the following files:

- 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

In this quick start, the PPK2 measures current on the nRF9160 DK v0.9.0 or later.

1. Prepare the nRF9160 DK for current measurements by doing some modifications to the *DK*. See the [nRF9160 DK User Guide](#) for instructions on how to do this.

Note: If you are using a different *DK*, see [Preparing a DK for current measurement](#) on page 10 for more information.

2. Connect the PPK2 to the *DK* with a 4-pin measurement cable using the following pins:
 - PPK2 **VIN** to **P22 VDD_nRF'**
 - PPK2 **VOUT** to **P22 VDD_nRF**
 - PPK2 **GND** to **P21**
3. Connect the *DK* to a computer using a micro-USB cable.

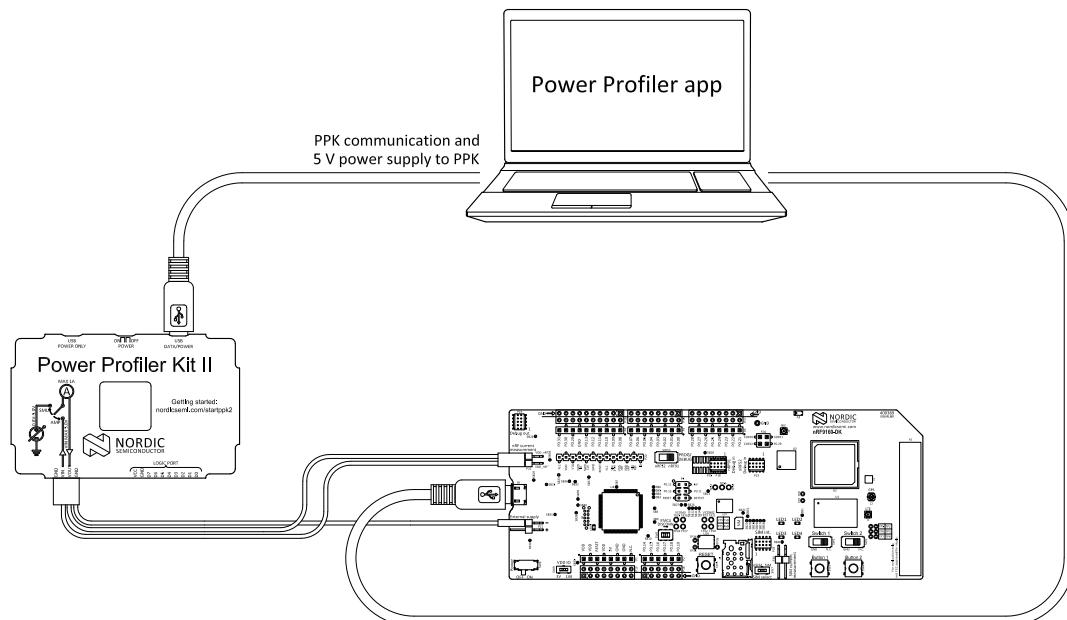


Figure 2: Typical configuration for measuring current on the DK

4. Install the Power Profiler app from nRF Connect for Desktop as described in [Installing nRF Connect for Desktop apps](#).
5. Start the Power Profiler app as described in [Using the Power Profiler app](#) in the [nRF Connect Power Profiler](#) documentation.
6. Select **Ampere meter** as the mode.

The PPK2 is now ready to use.

5 Hardware description

The PPK2 contains connectors and measurement components.

5.1 Measurement system

The PPK2 is driven by the nRF52840 *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 PPK2 has five different measurement ranges, which are managed by an automatic switch circuitry.

To send the data to the desktop application, the nRF52840 *SoC* uses *USB Communication Device Class (CDC) Abstract Control Model (ACM)* which all major operating systems support without the need for extra driver installations.

5.1.1 Block diagram

The PPK2 block diagram illustrates the overall system and connections between the various blocks.

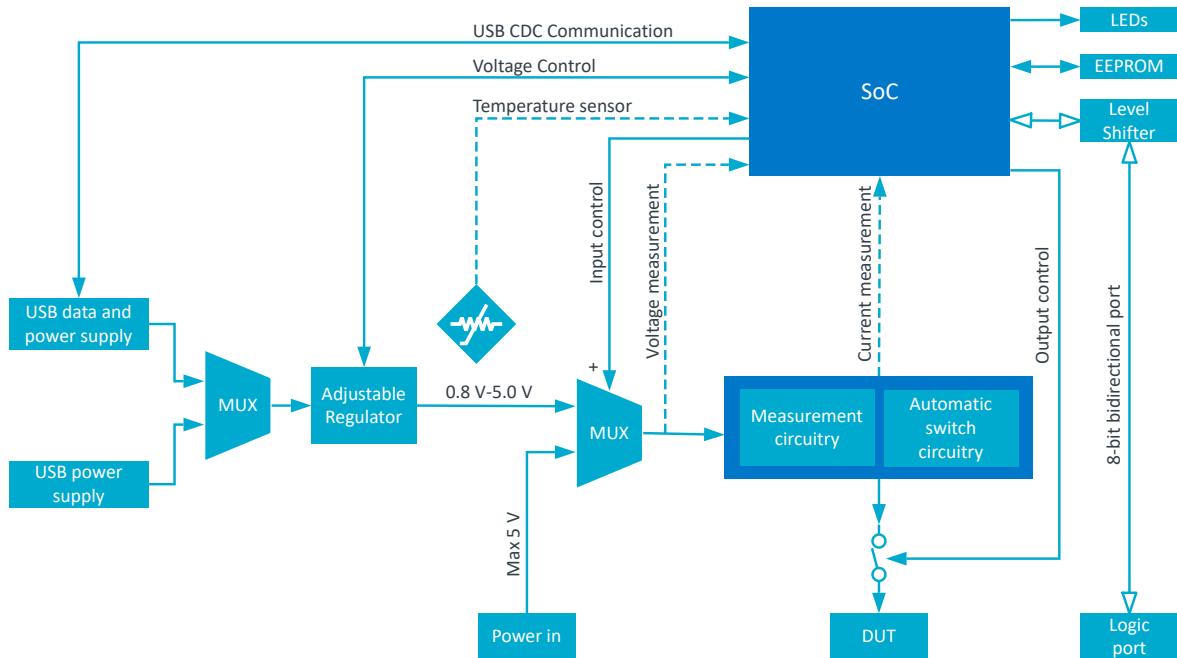


Figure 3: Block diagram

5.1.2 Power supply

There are two different modes of measurement for the PPK2.

The measurement modes are:

- Source Meter
- Ampere Meter

The modes are selected in the Power Profiler app.

When the PPK2 is used in Source Meter mode, its output can be adjusted between 0.8 - 5.0 V through the Power Profiler app.

When the PPK2 is used in Ampere Meter mode, an external power supply is used for the *Device Under Test (DUT)*. The external voltage is applied directly to the circuits without regulation. This voltage must be limited to the 0.8 - 5.0 V range.

The data/power *USB* connection must always be connected when using the PPK2. If the PPK2 is operating in Source Meter mode and the *DUT* can draw more than 400 mA, an extra external *USB* power supply that can deliver 1 A or more is recommended.

5.1.3 EEPROM

On the PPK2, there is an EEPROM memory connected to the nRF52840 SoC. The EEPROM is used to store calibration data.

5.2 Connectors

Access to the PPK2 is available from a set of connectors.

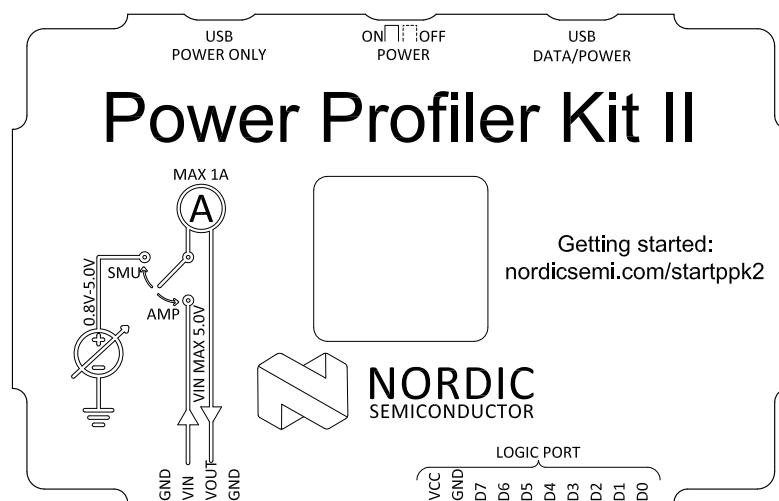


Figure 4: PPK2 connectors

Connector	Description
GND	Ground connection to <i>DUT</i> .
VOUT	Positive voltage output to <i>DUT</i> .
VIN	External power input. Only used for Ampere meter mode.
GND	Ground connection to <i>DUT</i> .
USB DATA/POWER	USB connection for power and communication with the PPK2.
USB POWER ONLY	USB connection for supplying extra power to the PPK2. Only needed in Source Meter mode (> 400 mA).
LOGIC PORT	
VCC	VCC of <i>DUT</i>
GND	GND of <i>DUT</i>
D0-D7	Digital input pins

Table 1: PPK2 connectors

6 Setting up the PPK2

The following sections help you set up the PPK2.

6.1 Preparing a DK for current measurement

When measuring current with the PPK2, some adjustments are needed to measure current on the *DK*.

See the following links for more information on your relevant *DK*:

- *Preparing the development kit board* in the [nRF51 DK User Guide](#)
- [Preparing the nRF52 DK](#)
- [Preparing the nRF52840 DK](#)
- [Preparing the nRF52833 DK](#)
- [Preparing the nRF9160 DK](#)
- [Preparing the nRF5340 DK](#)

6.2 Measuring current in Source Meter mode

When the PPK2 is used in Source Meter mode, the *DUT* is supplied power by the PPK2.

The voltage output to the *DUT* is adjusted with the Power Profiler app (see [Using the Power Profiler app](#) on page 13).

The following figure shows a typical measurement configuration using an nRF9160 DK v0.9.0 or later.

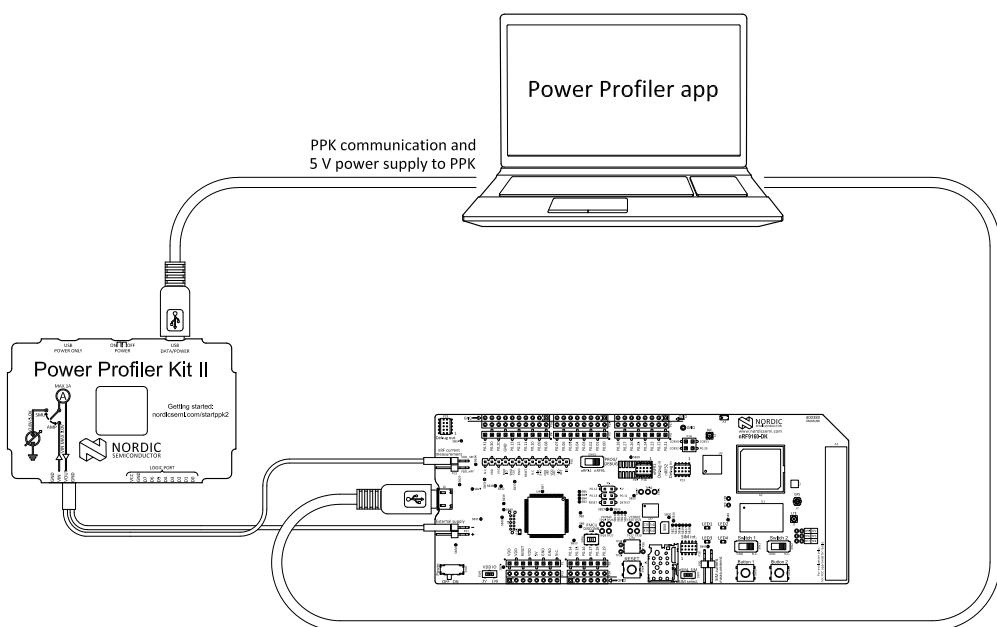


Figure 5: Measuring current in Source Meter mode

PPK2	DK
VOUT	P22 VDD_nRF
GND	P21

Table 2: Pin connections in Source Meter mode

When you have connected the PPK2 to the *DUT*, see [Connecting the PPK2 to a computer on page 12](#).

6.3 Measuring current in Ampere Meter mode

When the PPK2 is used in Ampere Meter mode, the *DUT* must be supplied power from an external source (for example, *USB*).

Note: Although using *USB* to power the *DUT* is sufficient, Nordic recommends a lab power supply to ensure better accuracy.

The following figure shows a typical measurement configuration using an nRF9160 DK v0.9.0 or later.

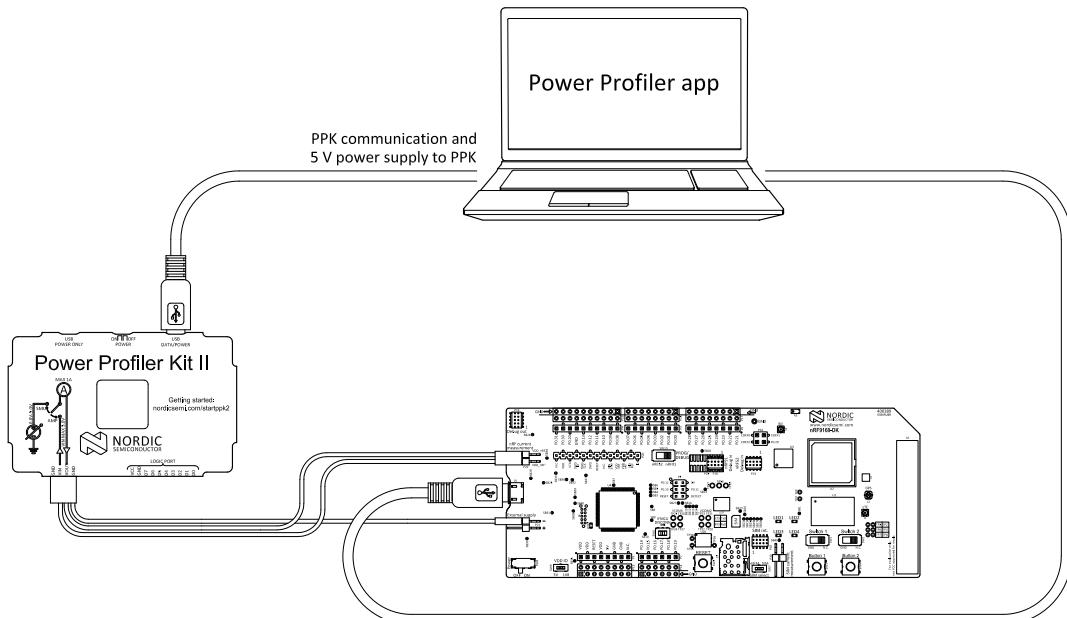


Figure 6: Measuring current in Ampere Meter mode

PPK2	DK
VIN	P22 VDD_nRF'
VOUT	P22 VDD_nRF
GND	P21

Table 3: Pin connections in Ampere Meter mode

When you have connected the PPK2 to the *DUT*, see [Connecting the PPK2 to a computer on page 12](#).

6.4 Logic port

The PPK2 supports reading digital inputs on up to 8 channels simultaneously.

To use the logic port, connect the following:

- *DUT*'s VCC to the PPK2 logic port VCC pin
- *DUT*'s GND to the PPK2 logic port GND pin
- *DUT*'s digital signal to any logic port Dx pin

6.5 Connecting the PPK2 to a computer

Connect the PPK2 to your computer using a micro-USB cable.

Once connected, you can start the Power Profiler app.

Note: In Source Meter mode, the *USB* power source has to support the maximum current consumption for the *DUT*, in addition to approximately 50 mA for the PPK2 circuitry.

6.6 Installing 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 application, follow the steps on [Installing nRF Connect for Desktop apps](#).

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**.

7 Using the Power Profiler app

The PPK2 must be connected to your computer and powered on before the Power Profiler app is started.

See the [nRF Connect Power Profiler](#) documentation for information about the application features and how to use them.

8 Electrical specifications

These specifications contain the property values that are essential for using the PPK2.

8.1 Environmental specifications

These environmental specifications and conditions contain the values that are essential for using the PPK2.

Item	Name	Min	Typ	Max	Unit	Description
Operating temperature	Op_Temp	5		40	°C	

Table 4: Environmental specifications

Item	Description
Indoor or outdoor use	Indoor use
Altitude	Up to 2000 m
Temperature	5–40 °C
Relative humidity	Maximum relative humidity 80% for temperatures up to 31 °C decreasing linearly to 50% relative humidity at 40 °C
Mains supply voltage fluctuations	Not applicable (equipment not connected to mains)
Oversupply category	Category 0 based on EN 61010-1-2-030
Wet location	Not applicable
Pollution degree	2

Table 5: Normal environmental conditions

Note: Do not use the PPK2 for measurements within Measurement categories II, III, or IV, or for measurements on MAINS circuits or on circuits derived from Ovovoltage Category II, III, or IV which may have transient voltages where they can cause a hazard. An analysis of the working voltages, loop impedances, temporary overvoltages, and transient overvoltages in the system must be conducted to making measurements.

8.2 Power supply specifications

These power supply values are essential for using the PPK2.

Item	Name	Min	Typ	Max	Unit	Description
DUT voltage	VDD_DUT	0.8		5.0	V	
External supply voltage	VDD_EXT	0.8		5.0	V	
Micro-USB supply voltage	V5V	4.5		5.5	V	USB voltage tolerances
Logic port VCC	VCC	1.65		5.5	V	
Rated Power				5	W	

Table 6: Power supply specifications

8.3 Measurement specifications

These measurement specifications contain the property values that are essential for using the PPK2.

8.3.1 Maximum DUT admissible current

The maximum *DUT* admissible current specification contains values essential for using the PPK2.

Item	Name	Min	Typ	Max	Unit	Description
Maximum DUT admissible current	Max_I			1	A	Ampere meter mode (continuous)
				600	mA	Source Meter mode

Table 7: Maximum *DUT* admissible current

8.3.2 Measurement resolution

These measurement resolution values are essential for using the PPK2.

Range	Name	Typ	Unit
200 nA–50 µA	R1_Resol	0.2	µA
50 µA–500 µA	R2_Resol	0.5	µA
500 µA–5 mA	R3_Resol	5	µA
5 mA–50 mA	R4_Resol	50	µA
50 mA–1000 mA	R5_Resol	1000	µA

Table 8: Measurement resolution

8.3.3 Measurement accuracy

These measurement accuracy values are essential for using the PPK2.

Name	Range	Typ	Description
R1_Accuracy	100 nA–50 µA	± 10%	Readout on average value
R1_Offset		± 2%	
R2_Accuracy	50 µA–500 µA	± 10%	Readout on average value
R2_Offset		± 2%	
R3_Accuracy	500 µA–5 mA	± 10%	Readout on average value
R3_Offset		± 2%	
R4_Accuracy	5 mA–50 mA	± 10%	Readout on average value
R4_Offset		± 2%	
R5_Accuracy	50 mA–1000 mA	± 15%	Readout on average value
R5_Offset		± 5%	

Table 9: Measurement accuracy

8.3.4 Digital input resolution

Digital input pins **D0–D7** are sampled with 100 kHz frequency with a typical bandwidth of 50 kHz.

9 Troubleshooting

Here are some basic troubleshooting steps to help you fix issues you may encounter when using the PPK2.

PPK2 only measuring noise

Make sure you have connected the PPK2 to the *DUT* as described in [Setting up the PPK2](#) on page 10.

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.

Graph response is very slow

Avoid using *USB* hubs and docking stations. Data plotting may consume a lot of CPU resources after some time, so ensure that sufficient resources are available.

PPK2 not measuring anything

Confirm that the measurement cables are connected correctly because the PPK2 cannot measure negative currents.

Grounding

Ensure that the *DUT* ground is connected to the PPK2 even in ampere meter mode.

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](#)
- [nRF52840 DK](#)
- [nRF9160 DK Hardware](#)
- [nRF5340 DK](#)

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