nPM6001 EK Hardware

v0.7.0

User Guide

4444_261 / 2022-09-26

Contents

Revision history

Date	Description
2022-09-26	Updated Power supply on page 8
2022-09-15	First release

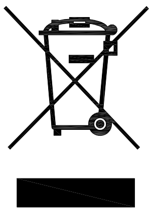
1 Introduction

The nPM6001 EK is a hardware platform used to evaluate the nPM6001 *Power Management Integrated Circuit (PMIC)*.

Key features

- Multiple options to connect a power source
- Exposed DC/DC and *Low-Dropout Regulator (LDO)*s with multiple connection options
- Options to connect to the *Inter-integrated Circuit (I^2C)* bus of the host device:
  - Exposed pin headers
  - SparkFun Qwiic Connect System
  - Adafruit STEMMA connectors
  - Level shifter, for hosts with system voltage higher than 1.8 V
- Exposed jumper pins to:
  - Enable/disable chip outputs
  - Change the operation mode of the buck regulators
  - Configure alternative application options
  - Connect to *General-Purpose Input/Output (GPIO)*s

For access to hardware schematics and layout files, see the nPM6001 product page.



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, check that you have the required hardware.

Hardware requirements

- Appropriate wires for your host system such as female header wires to connect to nRF5340 *Development Kit (DK)*
- Power source such as a battery or bench power supply
- Host device for programming (optional)

3 Kit content

The nPM6001 EK consists of hardware, reference design files, and documentation.

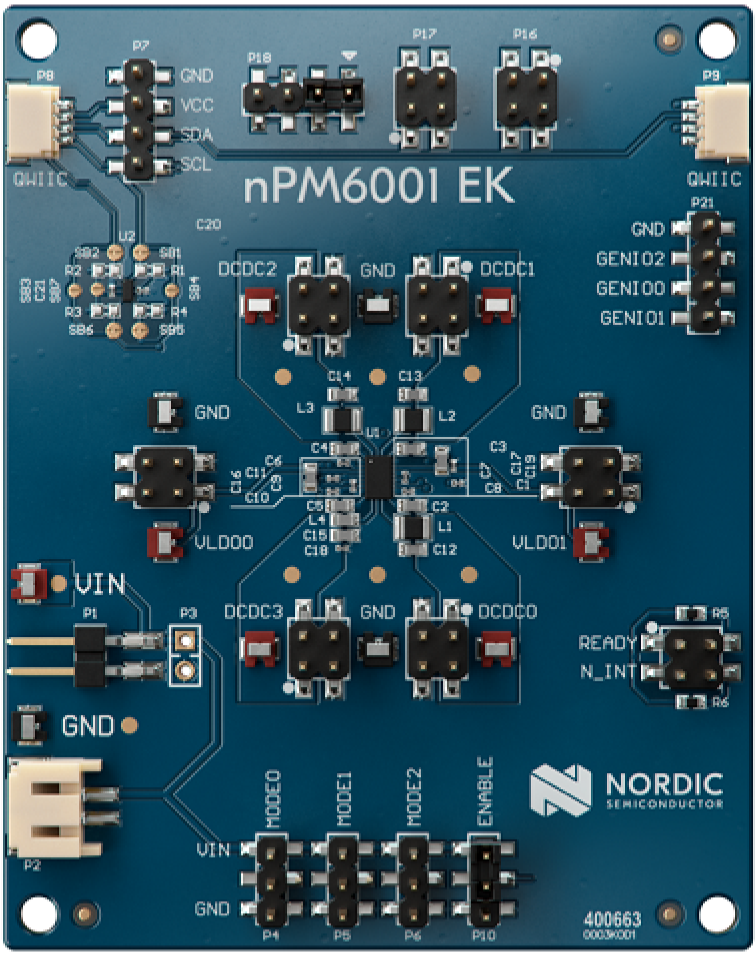


Figure 1: nPM6001 EK

Hardware files

The hardware design files including schematics, *Printed Circuit Board (PCB)* layout files, bill of materials, and Gerber files for the nPM6001 EK are available on the nPM6001 product page.

4 Hardware description

The nPM6001 EK lets you test different functions and features of the nPM6001 *PMIC* without extra programming.

You can control the output state of the PMIC, operation mode of the DC/DC regulators, and disable parts of the *Evaluation Kit (EK)* without software control. You can change the output voltages of the regulators and open the full potential of the PMIC using the provided library and sample code.

The following figure is a hardware drawing of the nPM6001 EK.

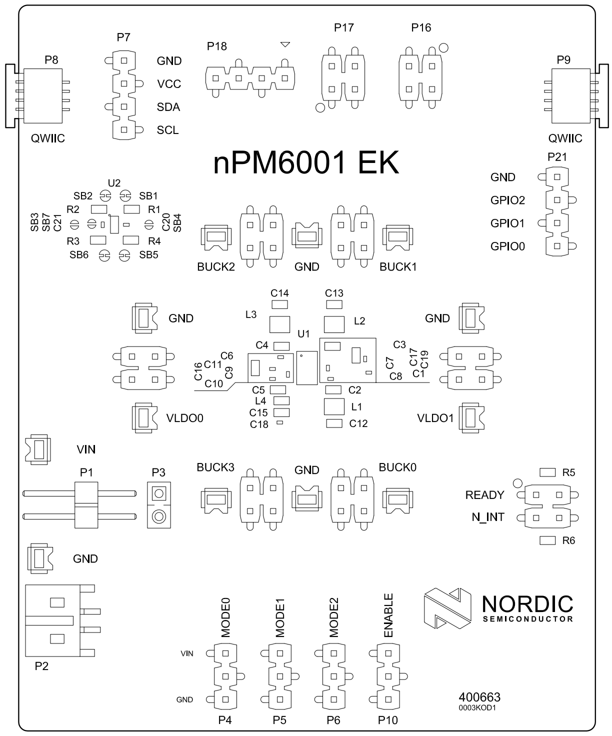


Figure 2: nPM6001 EK hardware drawing

4.1 Block diagram

The block diagram illustrates the nPM6001 EK functional architecture.

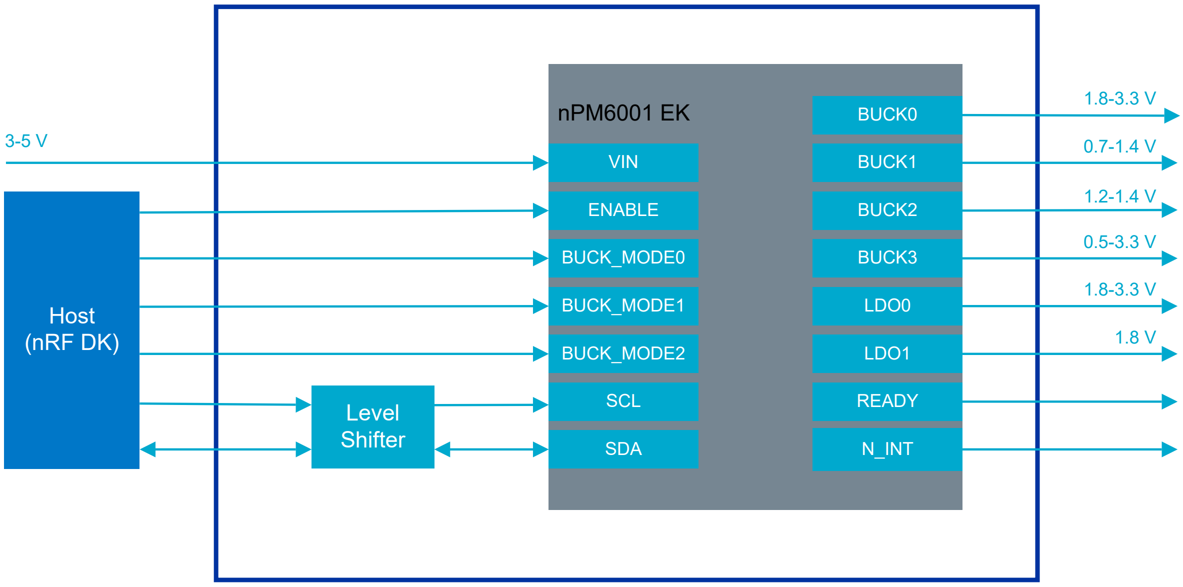


Figure 3: nPM6001 EK block diagram

4.2 Power supply

The nPM6001 EK has a flexible and configurable power supply system to allow testing with different power sources and to facilitate accurate power measurements.

There are three primary connections to power input:

- Pin headers — connect to another device like the nPM1100 EK to see how both *PMIC*s can be used in a design with battery management and multiple power rails.
- Test points — use with test probes of a lab PSU or another power source.
- Standard JST battery connector — test scenarios of a battery-driven design.

The nPM6001 EK accepts input voltage ranging from 3 V to 5.5 V. The input voltage of the PMIC should be higher than the expected voltage on any of the outputs.

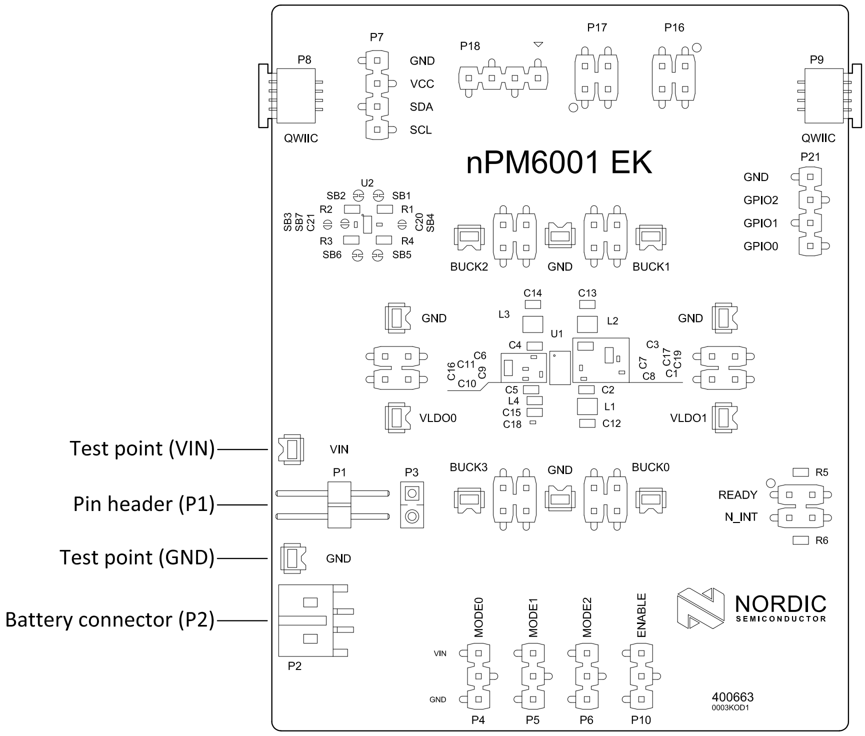


Figure 4: Power supply options

Note:

- The maximum allowed input current is 1 A.
- The power supply adapter must meet PS1 requirements (15 W maximum).
- Pay attention to the polarity when connecting the power supply. Connecting the polarity the wrong way will cause the device to become very hot.

4.3 Output connections

The nPM6001 EK exposes all available regulators inside the *PMIC*.

The connection options are:

- Test points — use this option to test the performance of PMICs using lab equipment like electronic load, SMU, or PPK2.
- Pin headers — use this option to power other devices like the nRF5340 DK, nRF5340 Audio DK, or different parts of the design.

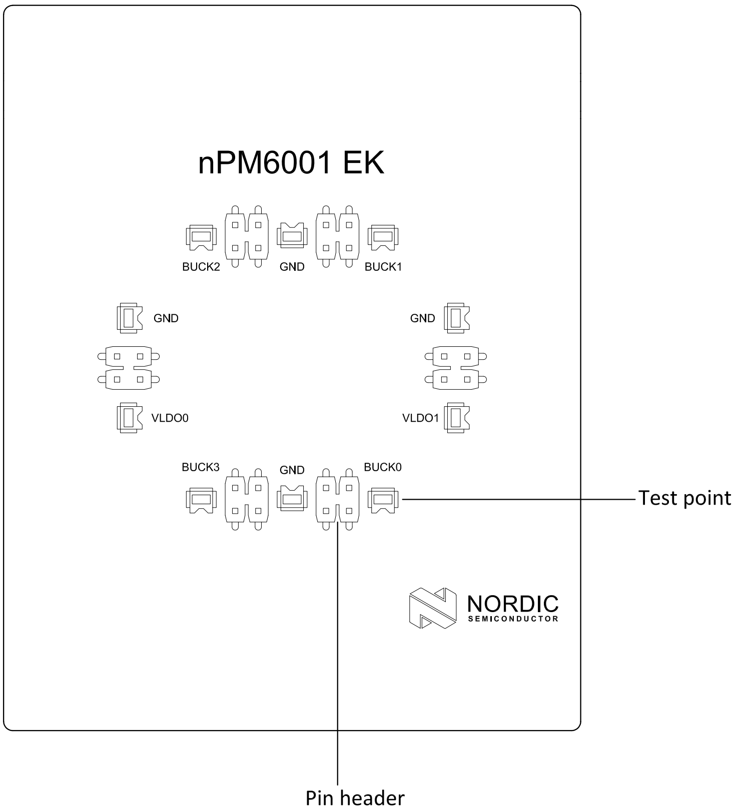


Figure 5: Output connections

Note: In nPM6001 EK v0.2.1, the connections are named DCDC instead of BUCK.

4.4 Software control

The nPM6001 EK provides connections for software control of the *PMIC*.

4.4.1 Level shifter

The nPM6001 EK provides connections to a level shifter for hosts with a system voltage higher than 1.8 V. The maximum host side voltage should not be greater than 5.0 V.

Connection options

There are two connectors that expose the *I2C* bus on the *EK*:

- Standard pin header
- Qwiic/STEMMA connector for supported configurations

Power options

The EK bus is supplied from the **BUCK0** by default. For instances where the buck regulator has a different voltage level, it is necessary to supply the bus pin with 1.8 V from another source.

Bypass option

If the host system runs at 1.8 V, you can bypass the level shifter and have the bus directly connected to the *PMIC*. You can power the host from **BUCK0**. To do this, cut **SB1** and **SB2** and connect **SB3**, **SB4**, and **SB7**.

4.4.2 Software library and sample

Use the nRF Connect SDK to configure the nPM6001 EK with the Two-Wire Interface (TWI), *GPIO*s, and a sample driver.

4.5 I/O pins

The nPM6001 EK provides connections to status and control pins of the *PMIC* including three *GPIO*s available for custom workflows.

4.5.1 READY

The logic high state on READY output indicates that the nPM6001 EK has started successfully and is ready for use. This is an open-drain type pin.

4.5.2 N_INT

The N_INT signal is an active low, open drain pin that provides interrupt signals to the host. It is configured, read, and cleared through the Two-Wire Interface (TWI). See the nPM6001 Product Specification for more information.

4.5.3 GPIOs

GPIO0, **GPIO1**, and **GPIO2** are *GPIO*s available for use by the host.

After nPM6001 EK startup, the GPIO pins are disabled and set to high-impedance mode by default. The GPIO pins can be individually enabled, configured, read, and set using Two-Wire Interface (TWI).

> **Note:** In nPM6001 EK v0.2.1, GPIOs are named GENIO. For GENIO0 and GENIO2, the silk text is incorrect. GENIO0 is GENIO2 and GENIO2 is GENIO0.

4.5.4 Enable (EN)

This pin controls the output state of the *PMIC* (ON/OFF). In a static configuration, the EN pin can be connected to **VIN** (ON) or **GND** (OFF) with a jumper. Alternatively, it can be connected to a host device or a **PGOOD** pin of a PMIC higher in the chain for power sequencing or another controlling circuit.

4.5.5 BUCK mode selection

BUCK_MODE0, **BUCK_MODE1**, and **BUCK_MODE2** input pins are a fast control method to toggle the power mode of the buck regulators.

These pins are functional only when register SWREADY has been reconfigured through Two-wire Interface (TWI). Like the **EN** pin, these pins can be shorted with a jumper or controlled by the host or another circuit.

4.6 Jumpers

The nPM6001 EK has several configuration and control options.

4.6.1 BUCK1 not used

Use **P17** to configure the nPM6001 EK if **BUCK1** is not used. In this configuration, **BUCK1** output must be connected to **VIN**.

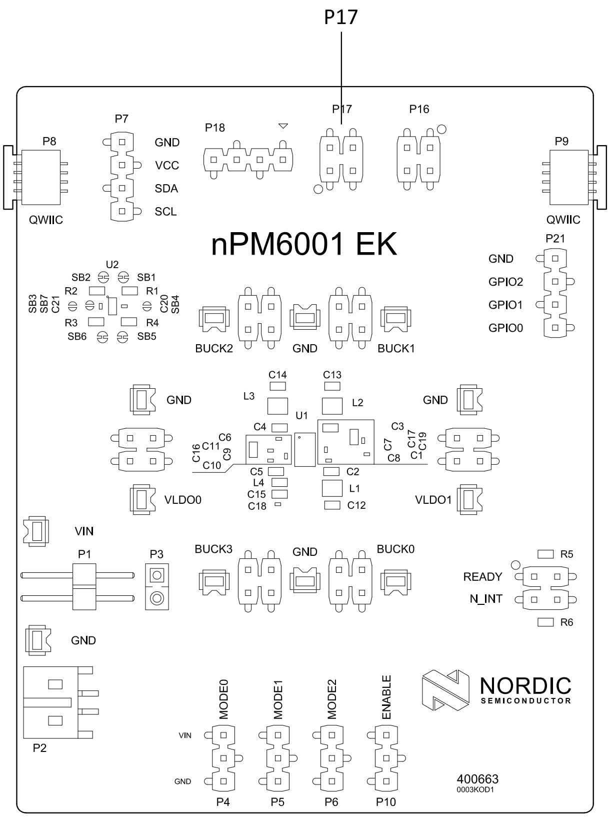


Figure 6: BUCK1 configuration

4.6.2 BUCK2 not used

Use **`P16`** to configure the nPM6001 EK if **BUCK2** is not used.

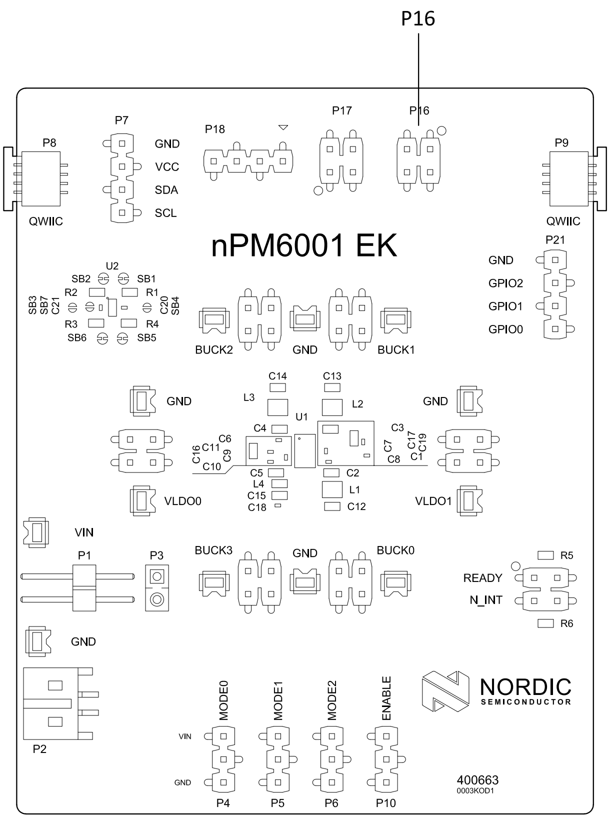


Figure 7: BUCK2 configuration

4.7 Configuration options

The nPM6001 EK can be configured in various ways.

The following table shows the components required for different configurations.

Option	L1, C12	L2, C13	L3, C14	L4, C15, C18
All regulators used	Populated	Populated	Populated	Populated
VO3 not used	Populated	Populated	Populated	Do not fit
VO3 and VO2 not used	Populated	Populated	Do not fit, connect VO2 to VO0[1]	Do not fit
Only VO0 used	Populated	Do not fit, connect VO1 to VIN[1]	Do not connect, connect VO2 to VO0[1]	Do not fit

Table 1: Configuration options

4.8 Evaluation measurements

The nPM6001 *PMIC* is a powerful and flexible power management solution that can be used in many different applications.

It is good practice to check which power solution fits your application and if it can handle the necessary loads and input voltages, as well as the potential transient events that can happen in the system.

Three main parameters can help you understand if the power solution fits the application:

- Power-on behavior
- Steady state
- Transient response

The following sections describe how to perform simple measurements of the three parameters using lab tools.

4.8.1 Preparing for measurements

Ensure that you have the instruments to perform measurements.

The following instruments are required:

- Power source. Connect to a DC power supply with 3–5.5 V voltage range.
- Electronic load to simulate different load scenarios in the system.
- Oscilloscope to capture waveforms of the input and output voltages.

For higher precision results, we recommend the use of a *Source Measure Unit (SMU)* on both input and output. The Power Profiler Kit II can be used as an affordable alternative to an SMU because it captures traces of both voltage and current changes.

Prepare the test bench as shown in the following figure.

[1] Use the jumpers on the nPM6001 EK. See Jumpers on page 11 for more information.

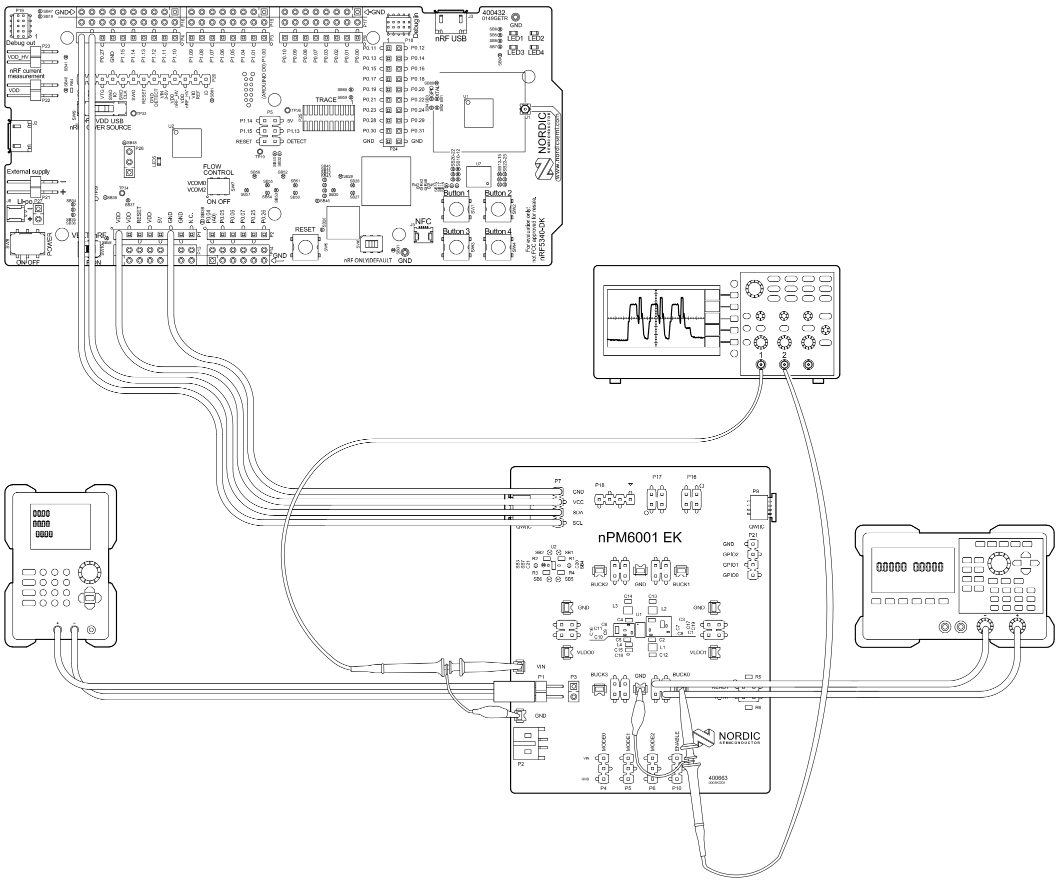


Figure 8: Test bench

For all measurements, **VIN** is set to 3.8 V. **BUCK0** is used to demonstrate the measurements. For other outputs, limits should be adjusted accordingly.

4.8.2 Power-on behavior

This measurement shows the behavior of the nPM6001 *PMIC* during startup.

The DC load should be set to the normal load of the system (for example, the average consumption). To get the power-on value, use a CH1 probe to trigger when voltage is applied. Monitoring input and output voltages, and input and output current provides primary information to confirm the correct power-on behavior.

If using an *SMU* or the Power Profiler Kit II, scope captures are not necessary.

4.8.3 Measuring static parameters (steady state)

This measurement shows the behavior of the *PMIC* when the system reaches the steady state.

Maximum load is usually used in this test. Monitoring both input and output values shows the performance of the system. It is a good idea to run the same test with the maximum load current of the application for some time, to see if the PMIC fits the application.

> **Note:** Do not load the power rails of the nPM6001 PMIC with a higher current than rated by the Product Specification.

To capture the ripple, set both probes of the oscilloscope to AC coupling and adjust Trigger. Capture waveforms on both CH1 and CH2. Measuring peak-to-peak voltage values on both shows the PMIC voltage ripple.

To get correct measurements, the GND lead of the probe should be as short as possible. It is also common to limit the scope bandwidth to 20 MHz. In real applications, it is recommended to perform these measurements at all values of input and output voltages and real loads to check that the voltage regulator does not introduce unexpected noise to the system.

4.8.4 Measuring load transient

This measurement shows the behavior of *PMIC* with changing load current.

To perform this measurement, you need an external trigger to capture data when load is changing. The Trigger output of the DC load is one of the options.

Set DC load to normal level (for example, 10% of maximum load). Set scope to capture once at the external trigger. The resulting figure on CH2 shows how the regulator handles sudden loads.

> **Note:** In real applications, load changes may happen faster than electronic loads can simulate. In these cases, alternative test setups should be used.

Glossary

Development Kit (DK)
A hardware development platform used for application development.

Evaluation Kit (EK)
A platform used to evaluate different development platforms.

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.

Inter-integrated Circuit (I^2C)
A multi-master, multi-slave, packet-switched, single-ended, serial computer bus.

Low-Dropout Regulator (LDO)
A linear voltage regulator that can operate even when the supply voltage is very close to the desired output voltage.

Printed Circuit Board (PCB)
A board that connects electronic components.

Power Management Integrated Circuit (PMIC)
A chip used for various functions related to power management.

Source Measure Unit (SMU)
An electronic instrument that is capable of both sourcing and measuring at the same time.

Recommended reading

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

Nordic documentation

- nPM6001 Product Specification
- nPM6001 product page

Legal notices

By using this documentation you agree to our terms and conditions of use. Nordic Semiconductor may change these terms and conditions at any time without notice.

Liability disclaimer

Nordic Semiconductor ASA reserves the right to make changes without further notice to the product to improve reliability, function, or design. Nordic Semiconductor ASA does not assume any liability arising out of the application or use of any product or circuits described herein.

Nordic Semiconductor ASA does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information. If there are any discrepancies, ambiguities or conflicts in Nordic Semiconductor's documentation, the Product Specification prevails.

Nordic Semiconductor ASA reserves the right to make corrections, enhancements, and other changes to this document without notice.

Life support applications

Nordic Semiconductor products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury.

Nordic Semiconductor ASA customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Nordic Semiconductor ASA for any damages resulting from such improper use or sale.

RoHS and REACH statement

Complete hazardous substance reports, material composition reports and latest version of Nordic's REACH statement can be found on our website www.nordicsemi.com.

Trademarks

All trademarks, service marks, trade names, product names, and logos appearing in this documentation are the property of their respective owners.

Copyright notice