nPM Fuel Gauge Board Hardware

v1.0.0

User Guide

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NORDIC® SEMICONDUCTOR

Contents

Revision history

Date	Description
2024-03-13	First release

Environmental and safety notices

Environmental and safety notices for the nPM Fuel Gauge Board.

Note: The nPM Fuel Gauge Board must be powered by a PS1 class (IEC 62368-1) power supply with maximum power of 15 W.

Skilled persons

The nPM Fuel Gauge Board 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 nPM Fuel Gauge Board 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.

Hot surface

Warning: Do not touch the nPM Fuel Gauge Board and its heat sink during active use as the heat sink can become hot during battery profiling. Allow the device to cool down before handling it post-profiling.

When the nPM Fuel Gauge Board is connected to the nPM1300 *Evaluation Kit (EK)*, pay attention to the polarity of the battery connectors on the EK. Connecting the polarity the wrong way causes the EK to become very hot.

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 nPM Fuel Gauge Board is a plug-and-play extension board for the nPM1300 *EK*. The board is designed for the battery discharge and data collection needed for battery modeling without the need for expensive measurement equipment or specialized expertise. When used with the nPM1300 EK, the board facilitates the profiling and generation of battery models for Li-ion, Lithium-polymer (Li-Poly), and Lithium iron phosphate ($LiFePO_4$) batteries in the nPM PowerUP computer application.

The nPM Fuel Gauge Board supports batteries with capacities ranging from 100 mAh to 3000 mAh across the battery's operating voltage and temperature range.

Key features

- Constant-current sink circuit for battery profiling
- Status indicator LEDs
- Connection headers compatible with the nPM1300 EK

For access to firmware source code, hardware schematics, and layout files, see www.nordicsemi.com.

2 Kit content

The nPM Fuel Gauge Board includes hardware, access to software components, hardware design files, and documentation.

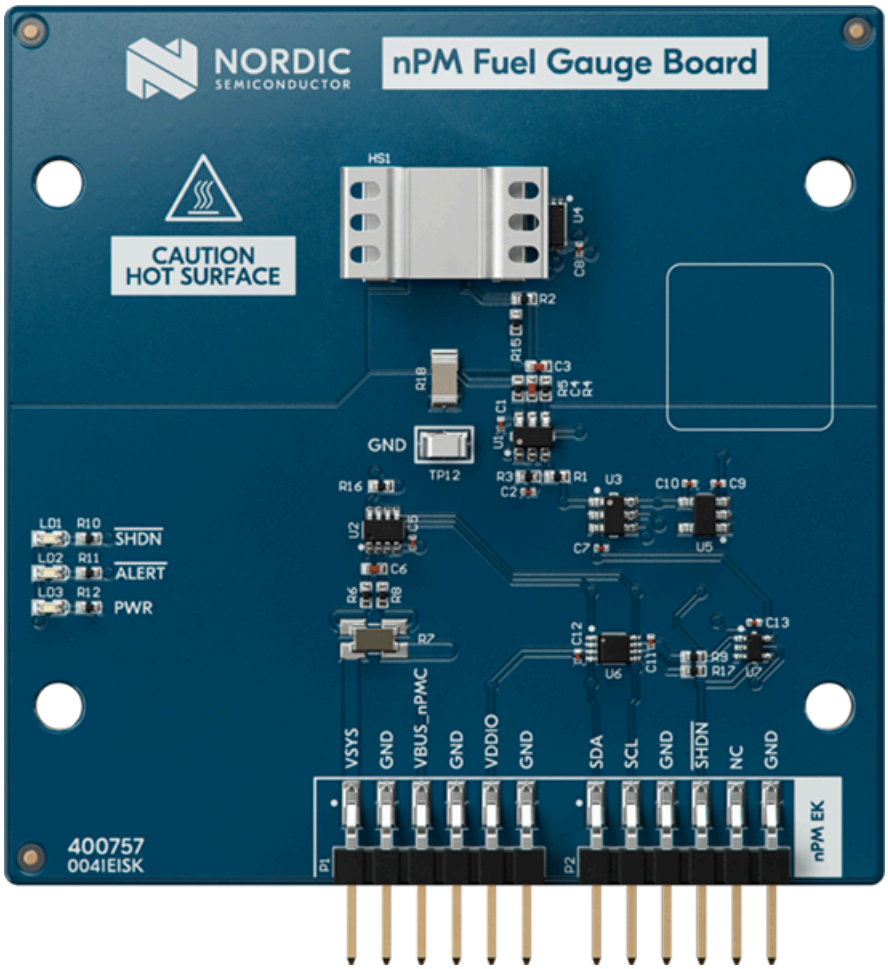


Figure 1: nPM Fuel Gauge Board, front view

Note: There is a typing error on the *Printed Circuit Board (PCB)* overlay for edge connector **P2**, pin 4. The correct label for pin 4 on **P2** is **FLAG**, not **SHDN**.

Hardware files

The hardware design files including schematics, *PCB* layout files, bill of materials, and Gerber files are available on the nPM Fuel Gauge Board product page.

3 Hardware description

The nPM Fuel Gauge Board enables battery profiling and fuel gauging with the nPM1300 *EK* using the nPM PowerUP app, which is accessible through nRF Connect for Desktop.

The following figures show the front and back of the nPM Fuel Gauge Board.

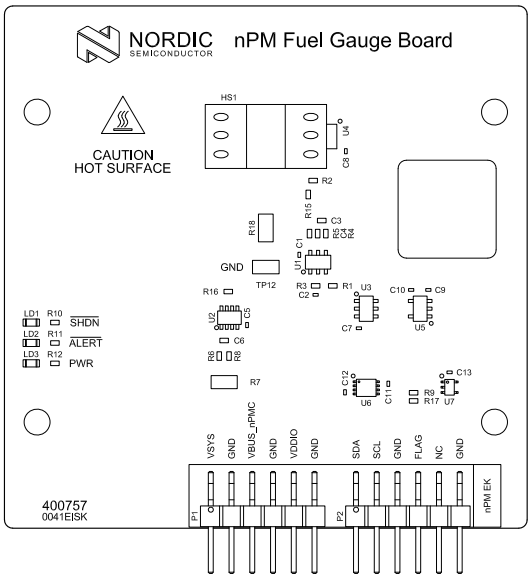


Figure 2: nPM Fuel Gauge Board (PCA63563), front view

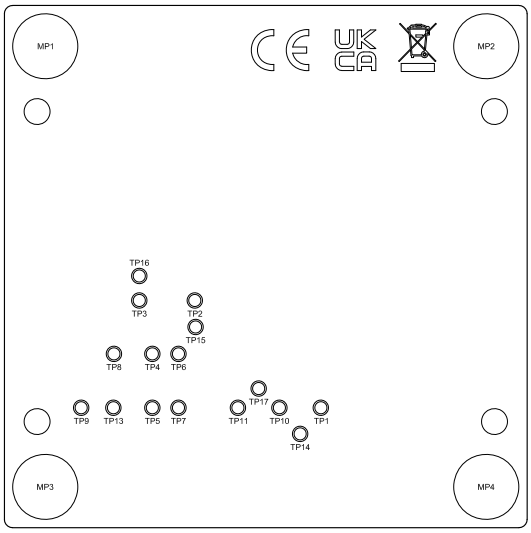


Figure 3: nPM Fuel Gauge Board (PCA63563), back view

3.1 Block diagram

The block diagram illustrates the functional architecture of the nPM Fuel Gauge Board.

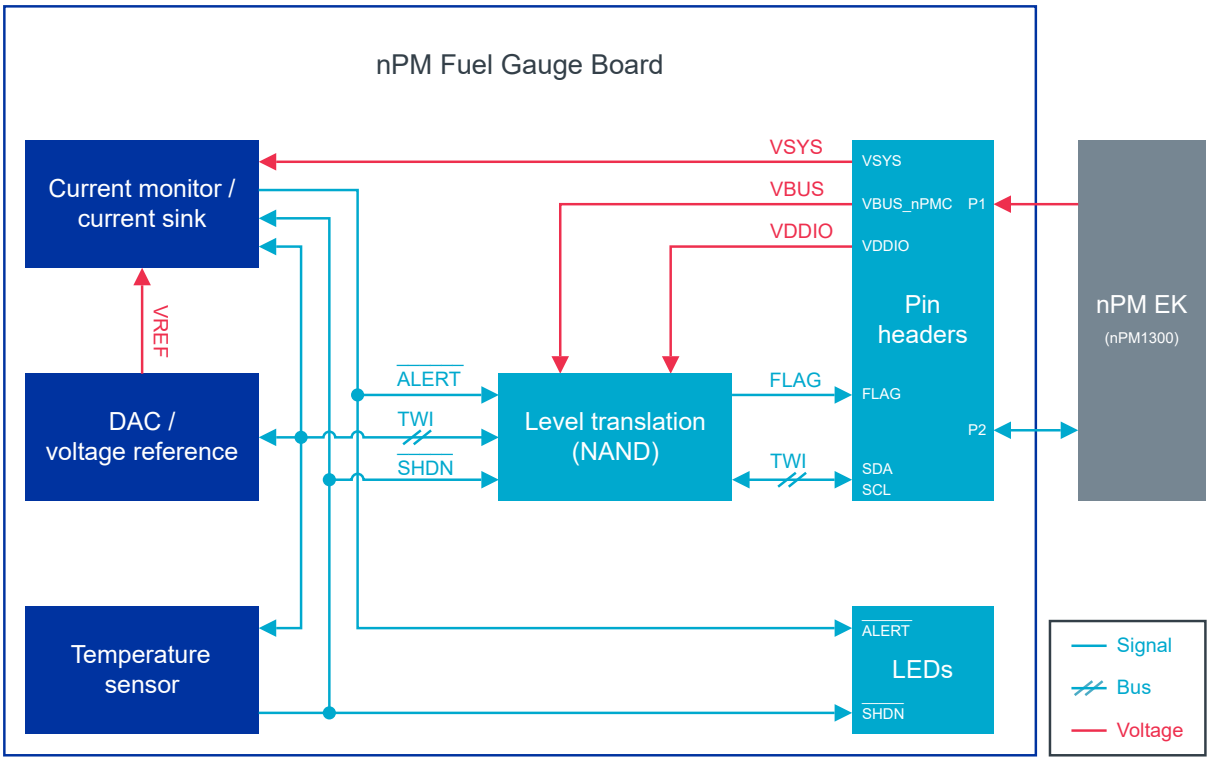


Figure 4: nPM Fuel Gauge Board block diagram

3.2 Connector interface

Use edge connectors **P1** and **P2** to connect the nPM Fuel Gauge Board to the nPM1300 *EK*.

The following figure shows the nPM Fuel Gauge Board connection headers that are labeled **nPM EK**.

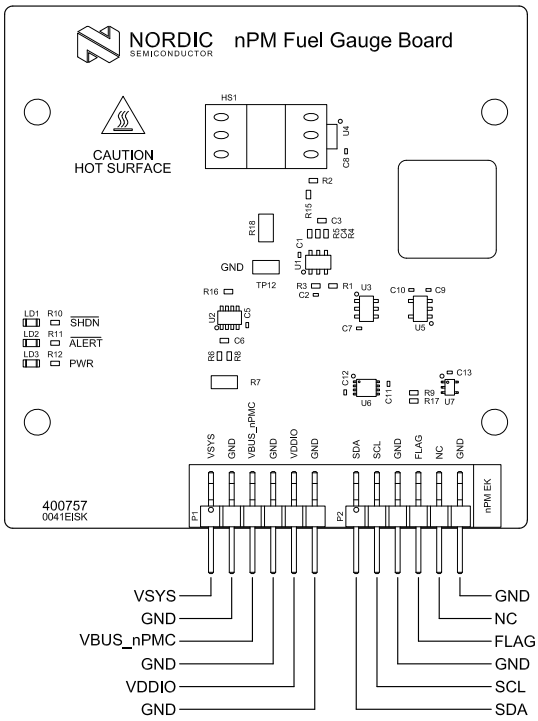


Figure 5: nPM Fuel Gauge Board connector interface (nPM EK)

Note: There is a typing error on the *PCB* overlay for edge connector **P2**, pin 4. The correct label for pin 4 on **P2** is **FLAG**, not **SHDN**.

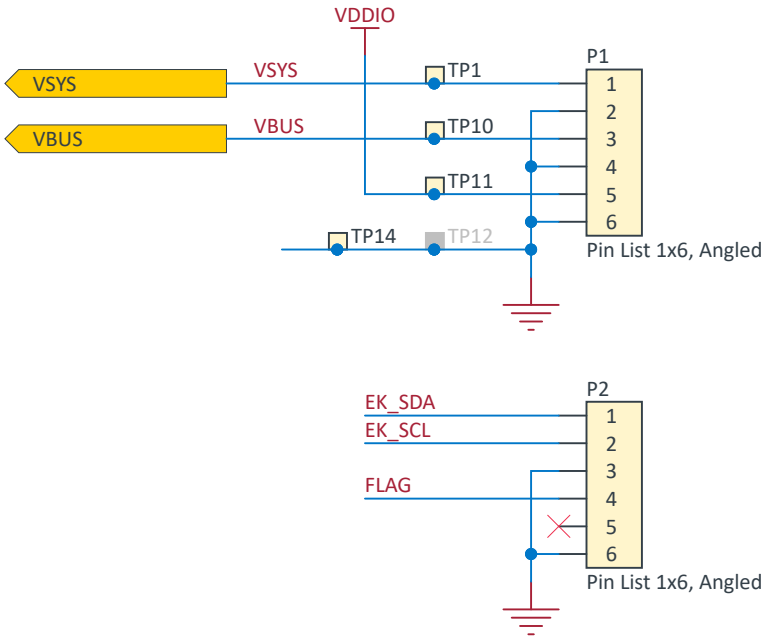


Figure 6: nPM Fuel Gauge Board edge connectors P1 and P2

The following table shows the connected nets on the edge connectors **P1** and **P2** (denoted **nPM EK**) on the nPM Fuel Gauge Board.

Pin	nPM EK edge connectors	
	P1	**P2**
1	VSYS	SDA
2	GND	SCL
3	VBUS_nPMC (nPM Controller)	GND
4	GND	FLAG (printed SHDN on PCB)
5	VDDIO	N.C.
6	GND	GND

Table 1: Connected nets on the nPM EK edge connectors

3.2.1 TWI

The *Inter-integrated Circuit (I^2C)* compatible *Two-wire Interface (TWI)* connects the nPM Fuel Gauge Board to the nPM Controller on the nPM1300 *EK*.

On the nPM Fuel Gauge Board, the TWI is connected to the current monitor (**U2**), the digital-to-analog converter (DAC) (**U3**), and the temperature sensor (**U4**).

3.2.2 FLAG status

The **FLAG** pin (pin 4) on edge connector **P2** is a status pin used to communicate a warning to the nPM Controller on the nPM1300 *EK*.

The **FLAG** pin outputs the result of a NAND operation between the **SHDN** (active low) and **ALERT** (active low) pins, which originate from the temperature sensor (**U7**) and the current monitor (**U2**) respectively. It becomes active high if the **SHDN** pin or **ALERT** pin or both are set to active low.

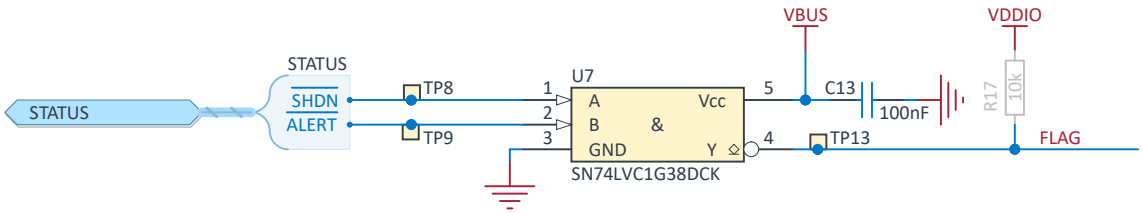


Figure 7: NAND operation between SHDN and ALERT

Note: There is a typing error on the *PCB* overlay for edge connector **P2**, pin 4. The correct label for pin 4 on **P2** is **FLAG**, not **SHDN**.

SHDN (active low)	ALERT (active low)	FLAG pin output from NAND
HIGH	HIGH	LOW
LOW	HIGH	HIGH
HIGH	LOW	HIGH
LOW	LOW	HIGH

Table 2: FLAG pin output from the NAND operation

3.3 Power supply

The nPM Fuel Gauge Board is powered by the nPM1300 *EK* though the edge connector **P1**.

The following table shows the voltage supply ranges for **VSYS**, **VBUS_nPMC**, and **VDDIO**.

Supply domain	Voltage supply range	Function
VSYS	2.3 V to 5.5 V	nPM1300 EK system voltage, used for battery characterization
VBUS_nPMC	4.35 V to 5.5 V	nPM Controller VBUS, powers the nPM Fuel Gauge Board
VDDIO	1.7 V to 3.3 V	TWI voltage reference level

Table 3: Voltage supply ranges

For more information on powering the EK, see nPM1300 EK Hardware.

3.4 LEDs

The nPM Fuel Gauge Board has three LEDs for visualizing the status of the board.

- **LD1** lights up when the **SHDN** pin on the temperature sensor (**U7**) becomes active low, signaling a shutdown warning caused by a high circuit temperature.

- **LD2** lights up when the **ALERT** pin on the current monitor (**U2**) becomes active low, indicating a warning for current levels outside the specified range.
- **LD3** lights up when **VBUS_nPMC** is supplied from the connected *EK*, showing the power status of the system.

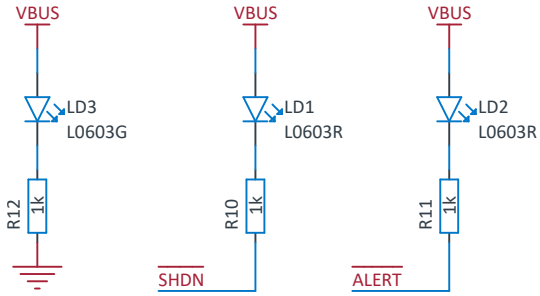


Figure 8: LEDs on the nPM Fuel Gauge Board

Part	Function	Color	Description
LD1	**SHDN** (active low)	Red	Temperature shutdown warning
LD2	**ALERT** (active low)	Red	High current alert
LD3	**PWR**	Green	System power status

Table 4: LED functionality on the nPM Fuel Gauge Board

4 Use the nPM Fuel Gauge Board with nPM1300 EK

The nPM Fuel Gauge Board is compatible with the nPM1300 *EK* for profiling batteries used in fuel gauge applications. For easy and convenient battery profiling, begin by connecting the nPM1300 EK with the nPM PowerUP app. Next, connect the EK with the nPM Fuel Gauge Board and use the Profile Battery wizard in the nPM PowerUP app to guide you through the profiling steps.

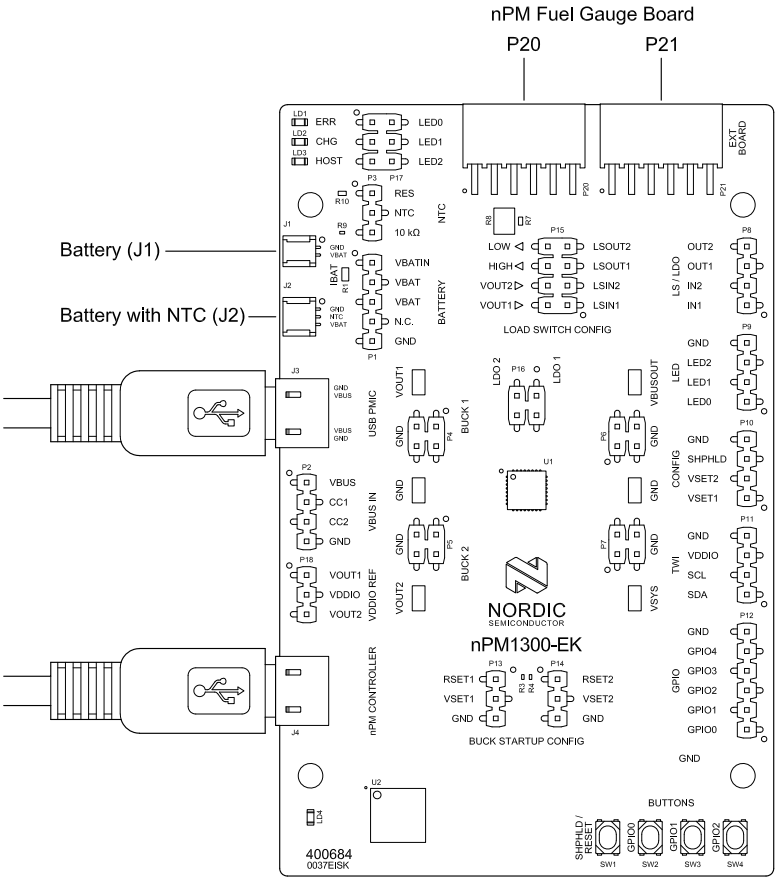
4.1 Connect the nPM1300 EK with nPM PowerUP

Set up the nPM1300 *EK* to start using the nPM PowerUP app.

1. To power the nPM1300 *Power Management Integrated Circuit (PMIC)*, connect a USB-C cable with 1.5 A current capability to **USB PMIC** on **J3**.
2. Insert the battery ensuring the correct polarity as shown on the EK. Depending on your battery, use one of the following alternatives:
   a) For a battery with an integrated *Negative Temperature Coefficient (NTC)* thermistor, use the battery connector on **J2**.
   b) For a battery without an integrated NTC thermistor, use the battery connector on **J1**. Connect a jumper between **NTC** (pin 2) and **10 kΩ** (pin 3) on pin header **P3** to use the integrated 10 kΩ resistor.
3. Use a USB-C cable with USB 2.0 High Speed compatibility to connect from your computer to **nPM CONTROLLER** on **J4**.

   Use a ferrite bead around the USB cable to reduce electromagnetic interference.

   A green LED light (**LD4**) indicates a successful connection with the nPM Controller.



4. Download and install nRF Connect for Desktop.
5. Open **nRF Connect for Desktop** and install the nPM PowerUP app.
6. Open **nPM PowerUP**.
7. Click **Select Device** on the left-side panel.
8. Select the **nPM1300 Evaluation Kit**.
9. Set the termination voltage and current limit in the **Charger** panel on the **DASHBOARD**.

You can now see status of your battery and use the built-in battery models in nPM PowerUP.

Note: To establish a successful connection with the nPM1300 PMIC, make sure to power the PMIC first or perform a power cycle on the nPM Controller.

4.2 Connect the nPM1300 EK with the nPM Fuel Gauge Board

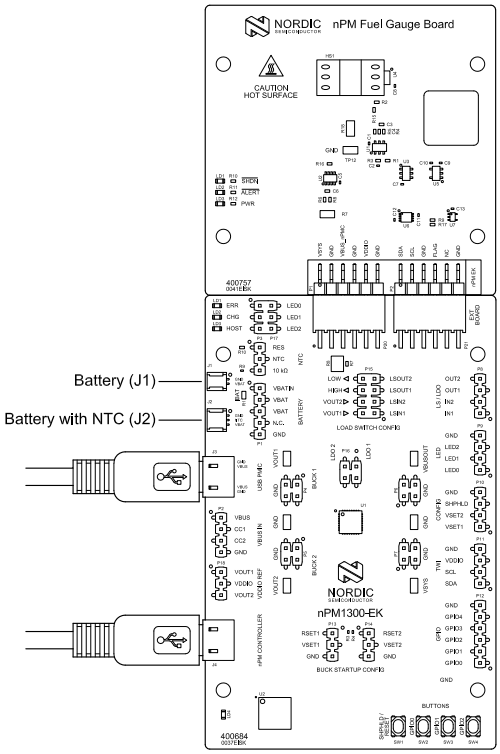
Connect the nPM1300 *EK* with the nPM Fuel Gauge Board and use the nPM PowerUP app to profile the battery and generate a battery model.

Before you begin, connect the nPM1300 EK with nPM PowerUP and install nRF Connect for Desktop.

1. Power off the nPM Controller on the nPM1300 EK by disconnecting the *Universal Serial Bus (USB)* cable on **J4**.
2. Connect the **nPM EK** pin header on the nPM Fuel Gauge Board to the to the **EXT BOARD** socket on the EK.

Note: To ensure correct operation and prevent malfunction, make sure edge connectors **P1** and **P2** on the nPM Fuel Gauge Board align correctly with their respective sockets **P20** and **P21** on the EK.

3. Power on the nPM Controller on the EK by reconnecting the USB cable on **J4**.



4. Select **nPM1300 Evaluation Kit** on the left-side panel in the nPM PowerUP app.
5. Select **Profile Battery** to profile your battery and generate a battery model.
6. Follow the instructions provided in the Profile Battery wizard and refer to Using the nPM1300 Fuel Gauge for further guidelines on battery profiling.

Warning: The heat sink on the Fuel Gauge Board can become hot during battery profiling. Allow the device to cool down before handling it post-profiling.

Drivers and sample applications for nPM1300 can be found in nPM1300 Fuel gauge sample.

Glossary

Electrostatic Discharge (ESD)

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

Evaluation Kit (EK)

A platform used to evaluate different development platforms.

Inter-integrated Circuit (I^2C)

A multi-master, multi-slave, packet-switched, single-ended, serial computer bus.

Negative Temperature Coefficient (NTC)

A negative temperature coefficient refers to materials where there is a decrease in electrical resistance when their temperature is raised.

Power Management Integrated Circuit (PMIC)

A chip used for various functions related to power management.

Printed Circuit Board (PCB)

A board that connects electronic components.

Two-wire Interface (TWI)

An I^2C compatible serial communication protocol that enables devices to exchange data by using a two-wire bus system, allowing multiple devices to be connected and controlled by a master device.

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

- Using the nPM1300 Fuel Gauge
- nPM1300 EK Hardware
- nPM1300 EK product page
- nPM Fuel Gauge Board product page

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