UM90020

NEH2000BY PMIC evaluation boards user guide

Rev. 1.0 — 28 March 2023 user manual

Document information

Information	Content
Keywords	NEH2000BY, energy harvesting, evaluation board
Abstract	This user manual presents the NEH2000BY-3.5V and NEH2000BY-4.2V evaluation boards. It shows in detail the required components and set-up to evaluate the performance of NEH2000BY PMIC.

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1. Overview

Nexperia has designed an evaluation board to allow convenient evaluation of the NEH2000BY energy harvesting PMIC. Fig. 1 shows a 3D and top view of the NEH2000BY evaluation board. This board is designed to evaluate and test the NEH2000BY PMIC performance and features. Its small form factor enables easy integration into prototype applications.

The evaluation board is available in 2 variants: NEH2000BY-3.5V for use with Lithium Iron Phosphate (LiFe) rechargeable batteries and NEH2000BY-4.2V for use with Lithium Ion and Lithium-Ion Polymer (LiPo) rechargeable batteries.

To evaluate the NEH2000BY PMIC performance and features, a PV-cell, rechargeable battery and multimeter are necessary.

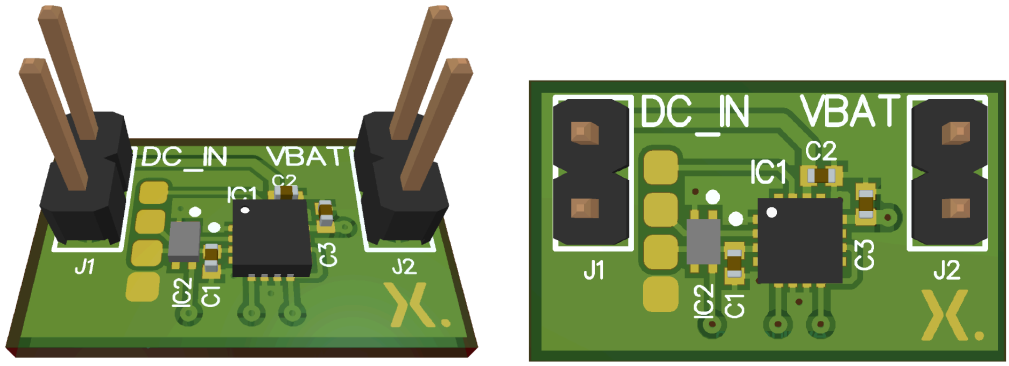


Fig. 1. NEH2000BY evaluation board 3D and top views

Fig. 2 shows the schematic of the NEH2000BY evaluation board. Note that the part number for IC2 depends on the evaluation board variants. More description about the available variants can be found in Section 2.

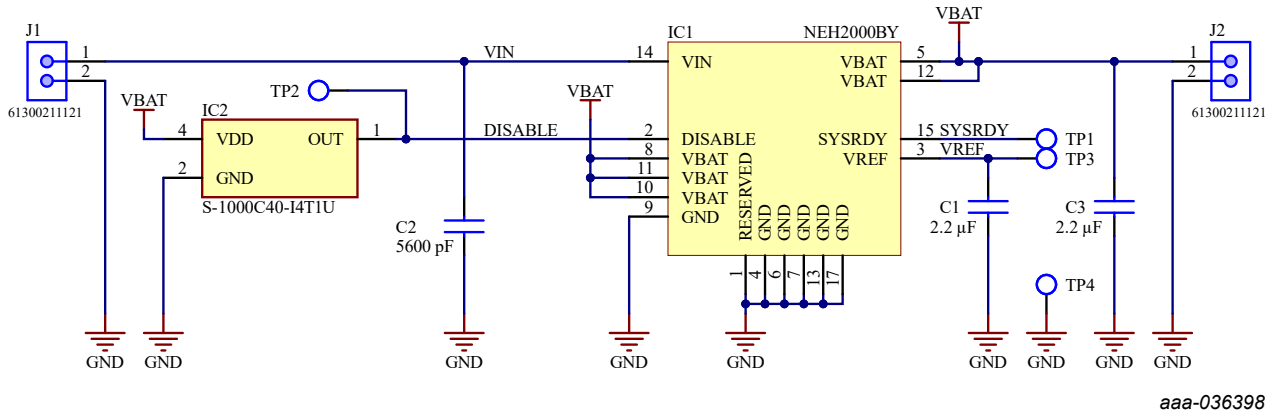


Fig. 2. NEH2000BY evaluation board schematic

2. Battery Protection

The NEH2000BY evaluation board is designed with overcharging protection for the attached battery. The required overcharge protection voltage depends on the type of attached battery. IC2, (see Fig. 2), is responsible for the overcharge protection for the battery. As the maximal battery voltage is reached IC2 stops charging by pulling the DISABLE pin of NEH2000BY (pin 2) to VBAT. As the battery voltage is decreased, charging is enabled again by pulling the same pin to GND.

The actual state of the overcharge protection can be observed on TP1 test pad. Its location can be seen in Fig. 3. The appropriate NEH2000BY evaluation board variant should be selected to match the required battery.

The following battery types are supported:

- **Lithium Iron Phosphate (LiFe) rechargeable battery**
  NEH2000BY-3.5V evaluation board sets the maximal charging voltage to 3.5 Volts for Lithium Iron Phosphate rechargeable batteries.
- **Lithium Ion and Lithium-Ion Polymer (LiPo) rechargeable batteries**
  NEH2000BY-4.2V evaluation board sets the maximal charging voltage to 4.2 Volts[1] for Lithium Ion and Lithium-Ion Polymer rechargeable batteries.

3. Connectors and test pads

The evaluation board provides two pin headers to attach the PV-cell and the battery. The most important signals of the PMIC are also available through the test pads. Table 1 describes the functionalities of each header pin or test pad while Fig. 3 shows their polarity and location.

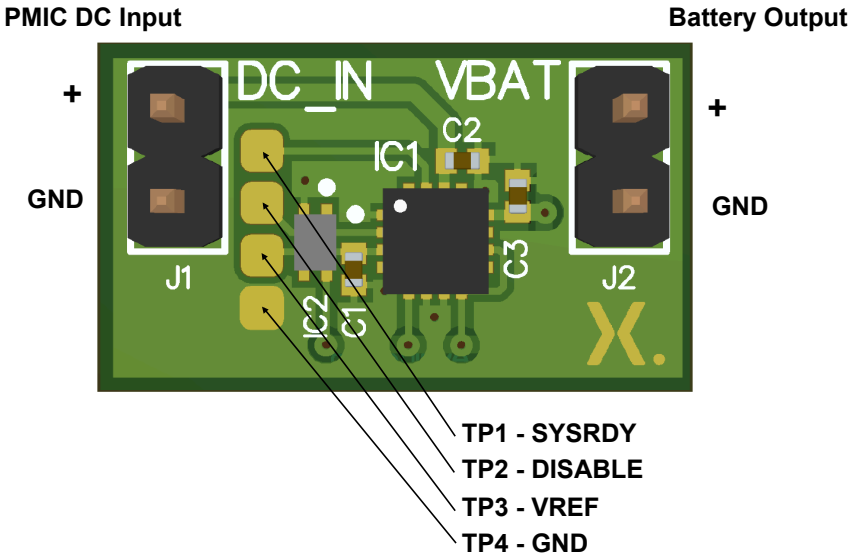


Fig. 3. Evaluation board connectors and test pads

1 Because of component shortage, the actual maximum charging voltage of IC2 might be 0.1 V higher.

Table 1. Evaluation board connectors and test pads

Reference	Name	Type	Description
J1	PMIC DC input	Pin header	Connect the positive terminal of the harvester to the VIN pin and the negative terminal to the GND pin. For the correct polarity see Fig. 3.
J2	Battery output	Pin header	Connect the positive terminal of the storage element to the VBAT pin and the negative terminal to the GND pin. For the correct polarity see Fig. 3.
TP1	System ready	Test pad	This pad is connected to the SYSRDY pin, pin 15 of the PMIC. Measured voltage between TP1 and GND shows if the PMIC is ready to convert. If the voltage on TP1 is equal to VBAT the PMIC is ready to convert, if it is equal to GND the PMIC is not ready for conversion yet. **Do not force any voltage or connect any load to this pad.**
TP2	Overcharge protection	Test pad	TP2 is to determine if overcharge protection is active or not. Logical low level on this pad indicates that overcharge protection is inactive and battery charging is enabled. IC2 is connected to this pad and actively driving the pad and the DISABLE pin, pin 2 of the PMIC. **Do not force any voltage or connect any load to this pad.**
TP3	Reference voltage	Test pad	This pad is connected to VREF pin, pin 3 of the PMIC. If PMIC is powered up by the attached battery 1.8 Volts is measured on this pin. **Do not load or connect any circuit to this pin.**
TP4	Reference ground	Test pad	Reference ground pad

4. Connecting a harvester, battery and application

To use the evaluation board, connect the PV-cell to J1 and a rechargeable battery to J2 as shown in Fig. 4. Application can be connected parallel to the battery. Caution should be taken when making connections. The positive terminal of the PV-cell should be connected to DC_IN pin and the negative terminal to GND pin. The positive terminal of the battery should be connected to VBAT pin and the negative terminal to GND pin. The type of the connected battery should always match to the overcharge protection voltage set by the Evaluation Board. The application can be connected parallel to the rechargeable battery as shown in Fig. 4.

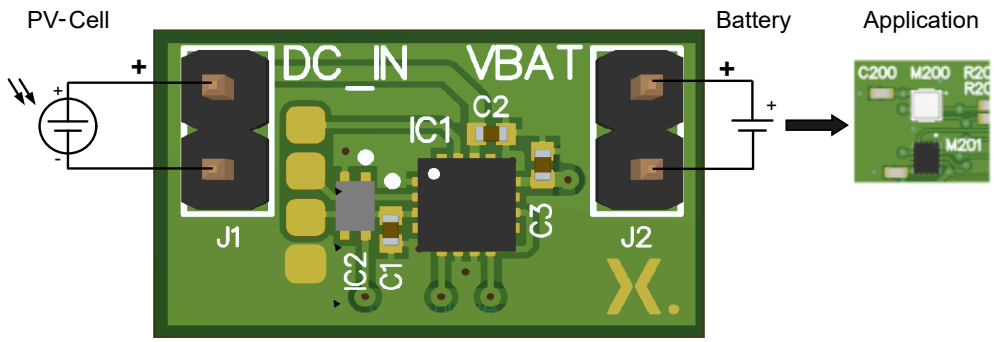


Fig. 4. Connecting a harvester, battery and application

5. Measuring PMIC efficiency

To determine PMIC efficiency, the input and output power of the PMIC should be measured. This can be done by using two current meters and two voltage meters as shown in Fig. 5. To determine the input power level, one voltmeter should be connected to the input of the PMIC between DC_IN and GND at J1 and a current meter should be connected in series to the harvester.

By multiplying the measured voltage and current the input power can be determined:

$$P_{in} = V_{in} \times I_{in} \quad (1)$$

To determine the output power, one voltmeter should be connected to the output of the PMIC between VBAT and GND at J2 and a current meter should be connected in series with the battery. By multiplying the measured voltage and the current the output power can be determined.

$$P_{out} = V_{bat} \times I_{bat} \quad (2)$$

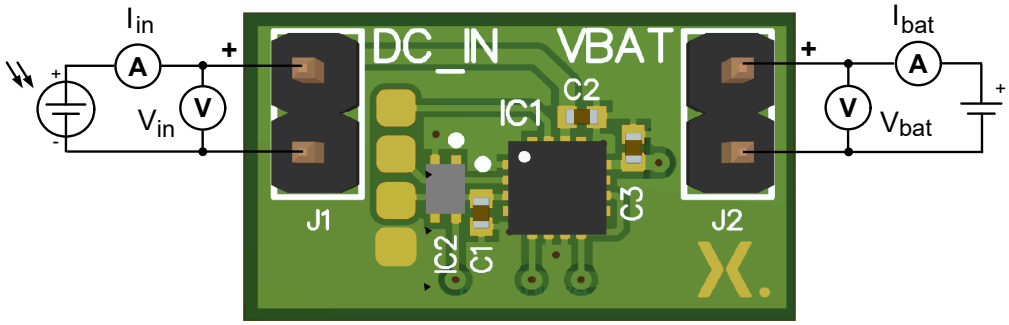


Fig. 5. Connection to measure PMIC efficiency

The efficiency of the PMIC can be calculated using the formula below:

$$\text{Efficiency} = \frac{P_{out}}{P_{in}} \times 100\% \quad (3)$$

6. Bill of Materials

Table 2 and Table 3 show the bill of materials for the NEH2000BY evaluation board variants.

Table 2. Bill of Materials for NEH2000BY-3.5V evaluation board

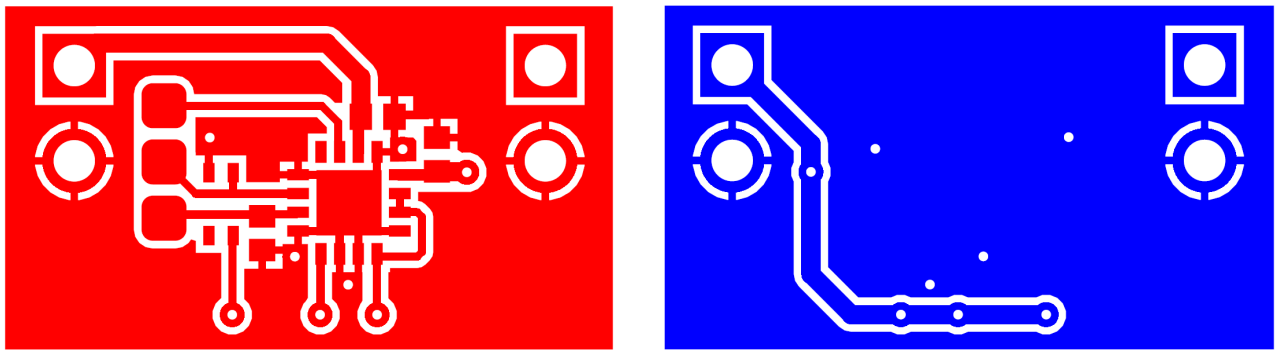
Designator	Qty	Value	Manufacturer Part Number	Manufacturer
C1, C3	2	2.2 µF ±10% 10V X7R	GRM155Z71A225KE44D	Murata
C2	1	5600 pF ±10% 50V X7R	GRM155R71H562KA88D	Murata
IC1	1	Energy harvesting PMIC	NEH2000BY	Nexperia
IC2	1	Battery protection IC	S-1000C34-I4T1U	ABLIC U.S.A.
J1, J2	2	Header pins	61300211121	Würth Elektronik

Table 3. Bill of Materials for NEH2000BY-4.2V evaluation board

Designator	Qty	Value	Manufacturer Part Number	Manufacturer
C1, C3	2	2.2 µF ±10% 10V X7R	GRM155Z71A225KE44D	Murata
C2	1	5600 pF ±10% 50V X7R	GRM155R71H562KA88D	Murata
IC1	1	Energy harvesting PMIC	NEH2000BY	Nexperia
IC2	1	Battery protection IC	S-1000C40-I4T1U	ABLIC U.S.A.
J1, J2	2	Header pins	61300211121	Würth Elektronik

7. PCB layouts

Fig. 6 show the layout of the evaluation board PCB. Both evaluation board variants share the same PCB layout.



Top copper layer

Bottom copper layer

Fig. 6. NEH2000BY evaluation board PCB top and bottom copper layers

8. Revision history

Table 4. Revision history

Revision number	Date	Description
1.0	2023-03-28	Initial version.

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Date of release: 28 March 2023