



# UM90020

## NEH2000BY PMIC evaluation boards user guide

Rev. 1.1 — 11 July 2023

user manual

### Document information

Information	Content
Keywords	NEH2000BY, energy harvesting, evaluation board
Abstract	This user manual presents the NEVB-NEH2000BY-3V5 and NEVB-NEH2000BY-4V2 evaluation boards. It shows in detail the required components and set-up to evaluate the performance of NEH2000BY PMIC.

# 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: NEVB-NEH2000BY-3V5 for use with Lithium Iron Phosphate (LiFe) rechargeable batteries and NEVB-NEH2000BY-4V2 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.

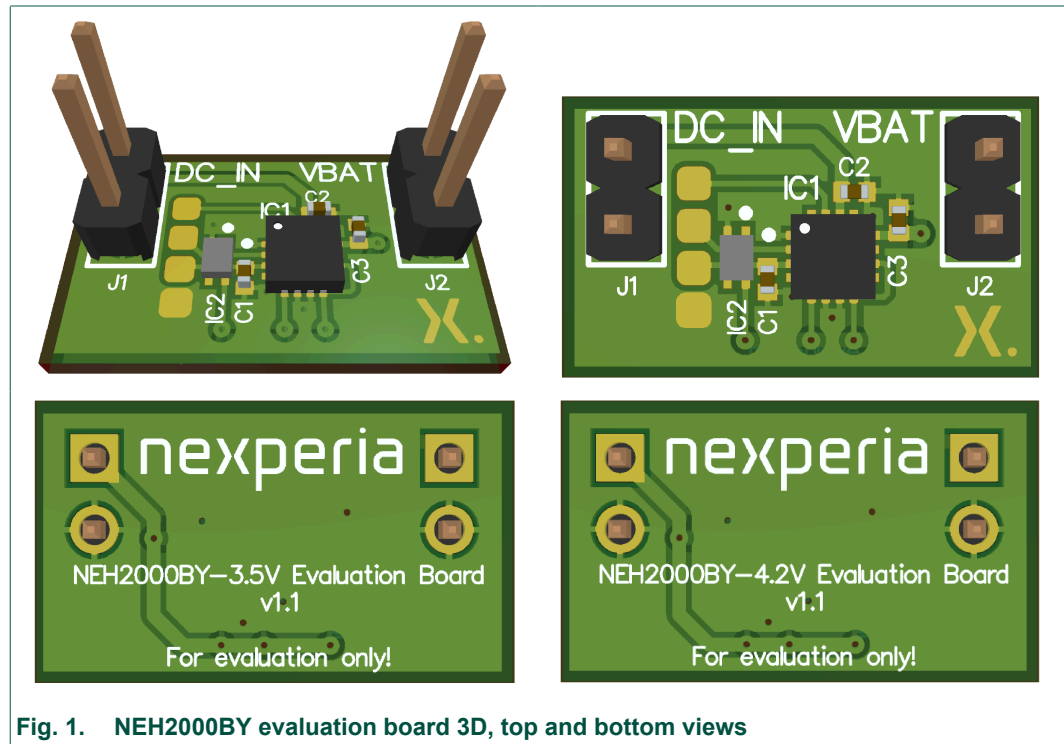


Fig. 1. NEH2000BY evaluation board 3D, top and bottom views

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.

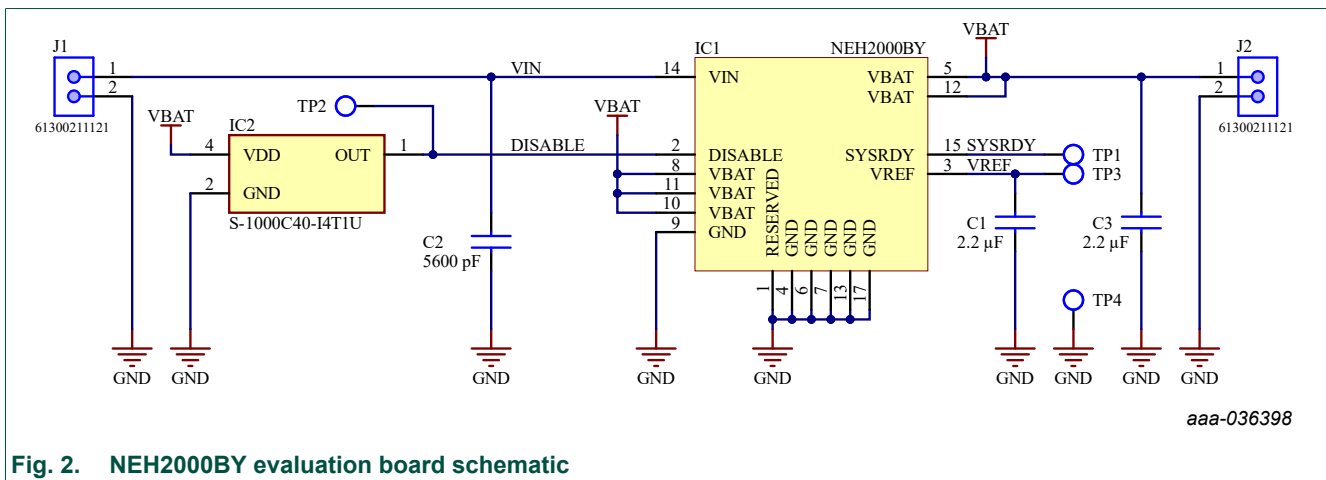


Fig. 2. NEH2000BY evaluation board schematic

Table 1. NEH2000BY evaluation board Orderable Part Numbers

Product type	Orderable Part Number
NEVB-NEH2000BY-3V5	NEVB-NEH2000BY-3UL
NEVB-NEH2000BY-4V2	NEVB-NEH2000BY-4UL

## 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.

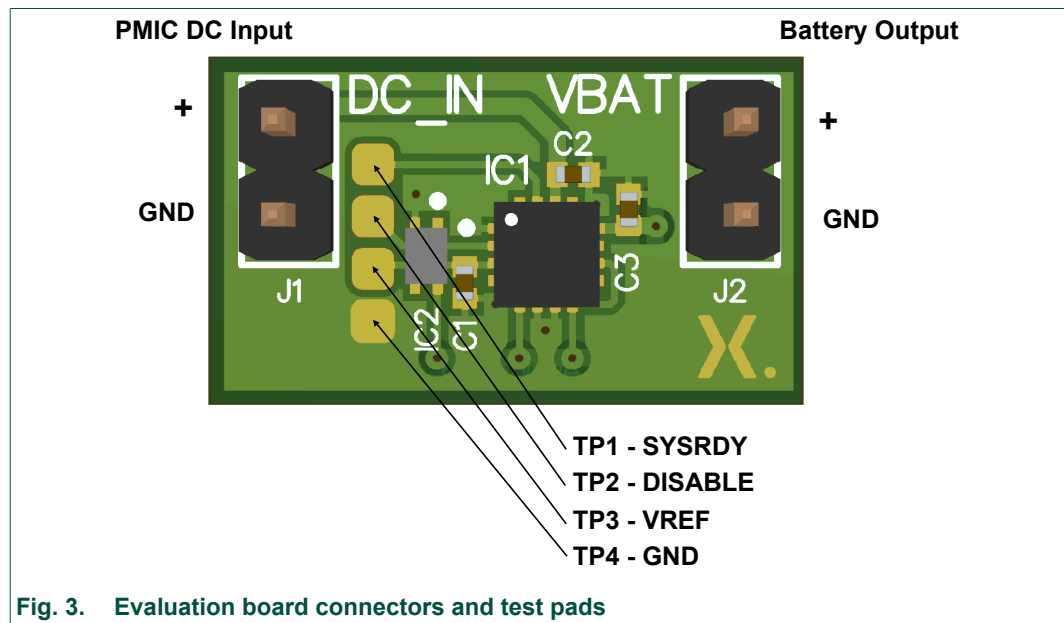
The actual state of the overcharge protection can be observed on TP1 test pad. Its location can be seen in Fig. 3. The appropriate NEH2000BY evaluation board variant should be selected to match the required battery.

The following battery types are supported:

- **Lithium Iron Phosphate (LiFe) rechargeable battery**  
NEVB-NEH2000BY-3V5 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**  
NEVB-NEH2000BY-4V2 evaluation board sets the maximal charging voltage to 4.2 Volts<sup>1</sup> 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 2 describes the functionalities of each header pin or test pad while Fig. 3 shows their polarity and location.



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

Table 2. 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 <a href="#">Fig. 3</a> .
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 <a href="#">Fig. 3</a> .
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. <b>Do not force any voltage or connect any load to this pad.</b>
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. <b>Do not force any voltage or connect any load to this pad.</b>
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. <b>Do not load or connect any circuit to this pin.</b>
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](#).

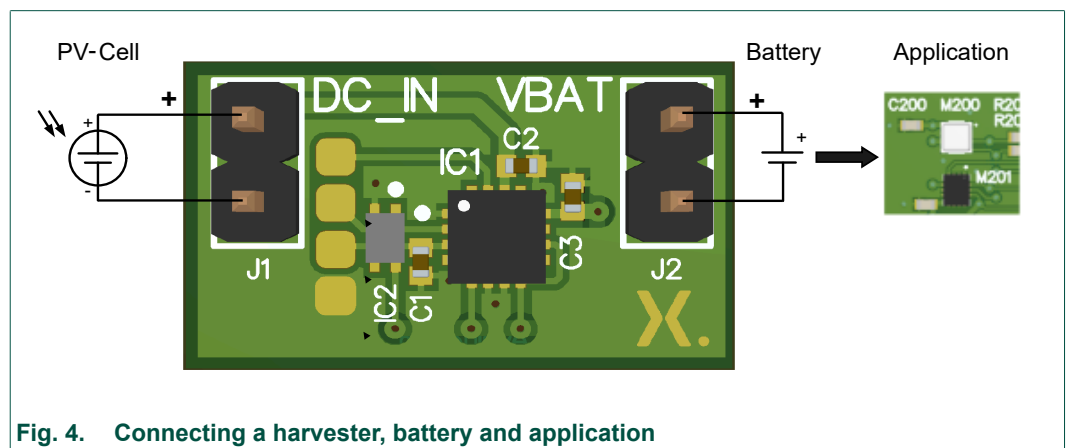


Fig. 4. Connecting a harvester, battery and application

## 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.

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

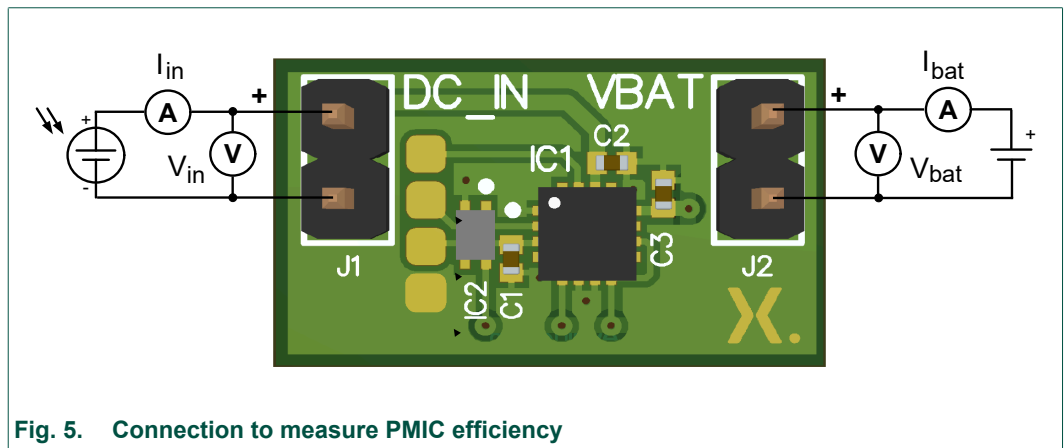


Fig. 5. Connection to measure PMIC efficiency

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 3](#) and [Table 4](#) show the bill of materials for the NEH2000BY evaluation board variants.

**Table 3. Bill of Materials for NEVB-NEH2000BY-3V5 evaluation board**

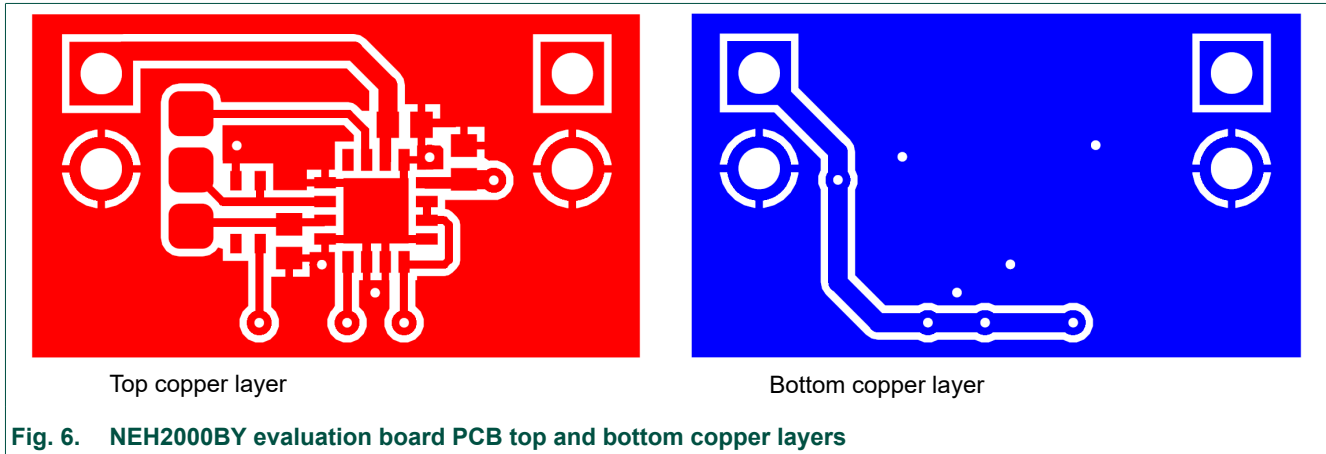
Designator	Qty	Value	Manufacturer Part Number	Manufacturer
C1, C3	2	2.2 $\mu$ F $\pm$ 10% 10V X7R	GRM155Z71A225KE44D	Murata
C2	1	5600 pF $\pm$ 10% 50V X7R	GRM155R71H562KA88D	Murata
IC1	1	Energy harvesting PMIC	NEH2000BY	Nexperia
IC2	1	Battery protection IC	S-1000C34-I4T1U	ABLIC U.S.A.
J1, J2	2	Header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

**Table 4. Bill of Materials for NEVB-NEH2000BY-4V2 evaluation board**

Designator	Qty	Value	Manufacturer Part Number	Manufacturer
C1, C3	2	2.2 $\mu$ F $\pm$ 10% 10V X7R	GRM155Z71A225KE44D	Murata
C2	1	5600 pF $\pm$ 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.



## 8. Revision history

Table 5. Revision history

Revision number	Date	Description
1.1	2023-07-11	PCB orderable part numbers updated; <a href="#">Table 1</a> added, <a href="#">Fig. 1</a> updated.
1.0	2023-03-28	Initial version.

## 9. Legal information

### Definitions

**Draft** — The document is a draft version only. The content is still under internal review and subject to formal approval, which may result in modifications or additions. Nexperia does not give any representations or warranties as to the accuracy or completeness of information included herein and shall have no liability for the consequences of use of such information.

### Disclaimers

**Limited warranty and liability** — Information in this document is believed to be accurate and reliable. However, Nexperia 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. Nexperia takes no responsibility for the content in this document if provided by an information source outside of Nexperia.

In no event shall Nexperia be liable for any indirect, incidental, punitive, special or consequential damages (including - without limitation - lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort (including negligence), warranty, breach of contract or any other legal theory.

Notwithstanding any damages that customer might incur for any reason whatsoever, Nexperia's aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the Terms and conditions of commercial sale of Nexperia.

**Right to make changes** — Nexperia reserves the right to make changes to information published in this document, including without limitation specifications and product descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof.

**Suitability for use** — Nexperia products are not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical systems or equipment, nor in applications where failure or malfunction of an Nexperia product can reasonably be expected to result in personal injury, death or severe property or environmental damage. Nexperia and its suppliers accept no liability for inclusion and/or use of Nexperia products in such equipment or applications and therefore such inclusion and/or use is at the customer's own risk.

**Applications** — Applications that are described herein for any of these products are for illustrative purposes only. Nexperia makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

Customers are responsible for the design and operation of their applications and products using Nexperia products, and Nexperia accepts no liability for any assistance with applications or customer product design. It is customer's sole responsibility to determine whether the Nexperia product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customer(s). Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products.

Nexperia does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customer(s). Customer is responsible for doing all necessary testing for the customer's applications and products using Nexperia products in order to avoid a default of the applications and the products or of the application or use by customer's third party customer(s). Nexperia does not accept any liability in this respect.

**Export control** — This document as well as the item(s) described herein may be subject to export control regulations. Export might require a prior authorization from competent authorities.

**Translations** — A non-English (translated) version of a document is for reference only. The English version shall prevail in case of any discrepancy between the translated and English versions.

### Trademarks

Notice: All referenced brands, product names, service names and trademarks are the property of their respective owners.



## List of Tables

---

Table 1. NEH2000BY evaluation board Orderable Part Numbers.....	3
Table 2. Evaluation board connectors and test pads.....	4
Table 3. Bill of Materials for NEVB-NEH2000BY-3V5 evaluation board.....	6
Table 4. Bill of Materials for NEVB-NEH2000BY-4V2 evaluation board.....	6
Table 5. Revision history.....	7

## List of Figures

---

Fig. 1. NEH2000BY evaluation board 3D, top and bottom views.....	2
Fig. 2. NEH2000BY evaluation board schematic.....	2
Fig. 3. Evaluation board connectors and test pads.....	3
Fig. 4. Connecting a harvester, battery and application.....	4
Fig. 5. Connection to measure PMIC efficiency.....	5
Fig. 6. NEH2000BY evaluation board PCB top and bottom copper layers.....	6