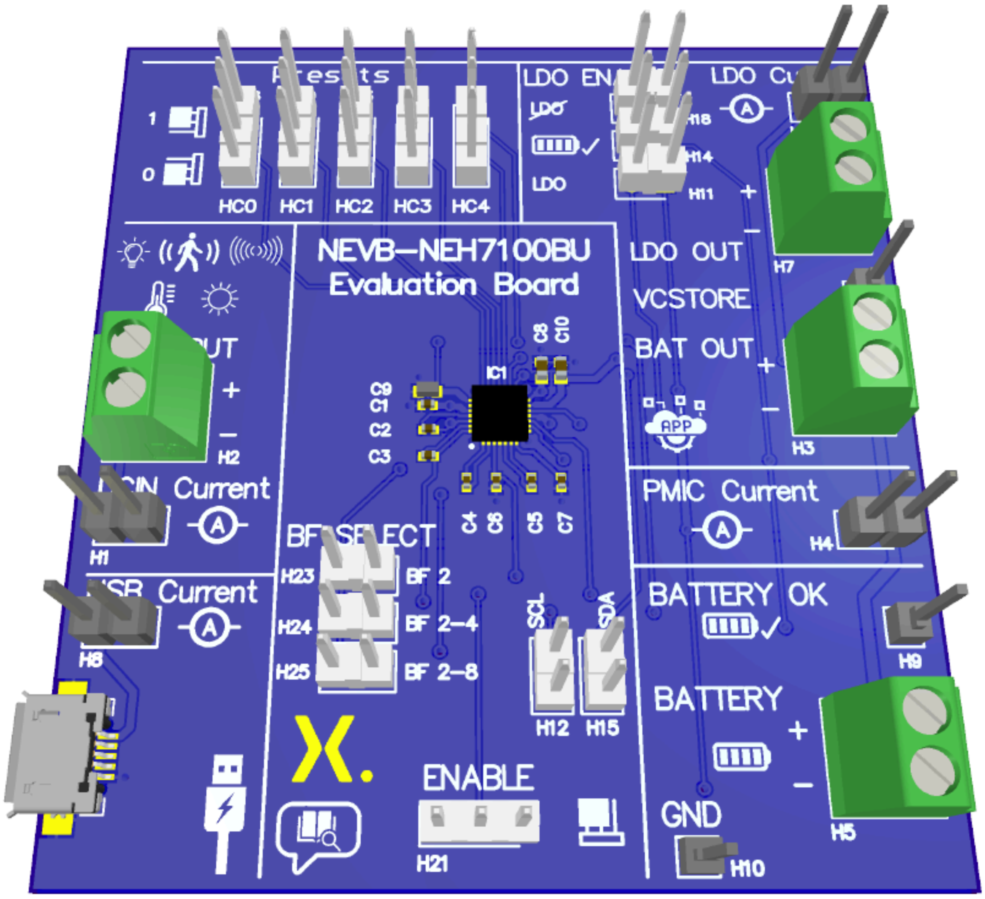
UM90025

Rev. 2.0 — 13 June 2024

User manual

NEVB-NEH7100BU PMIC evaluation board user guide



Abstract: This user manual presents the NEVB-NEH7100BU evaluation board. It shows in detail the required components and set-up to evaluate the performance of NEH7100BU PMIC.

Keywords: NEVB-NEH7100BU, PMIC, evaluation board

1. Overview

Fig. 1 shows the NEVB-NEH7100BU evaluation board. This evaluation board has been designed to evaluate and test the NEH7100BU PMIC performance and features. To evaluate the performance and features of the NEH7100BU, an energy harvester, a rechargeable battery (or super-capacitor), and multimeters are necessary.

When using an energy harvester with an AC output, such as piezoelectric harvesters, AC-to-DC rectification is necessary before connecting it to the evaluation board.

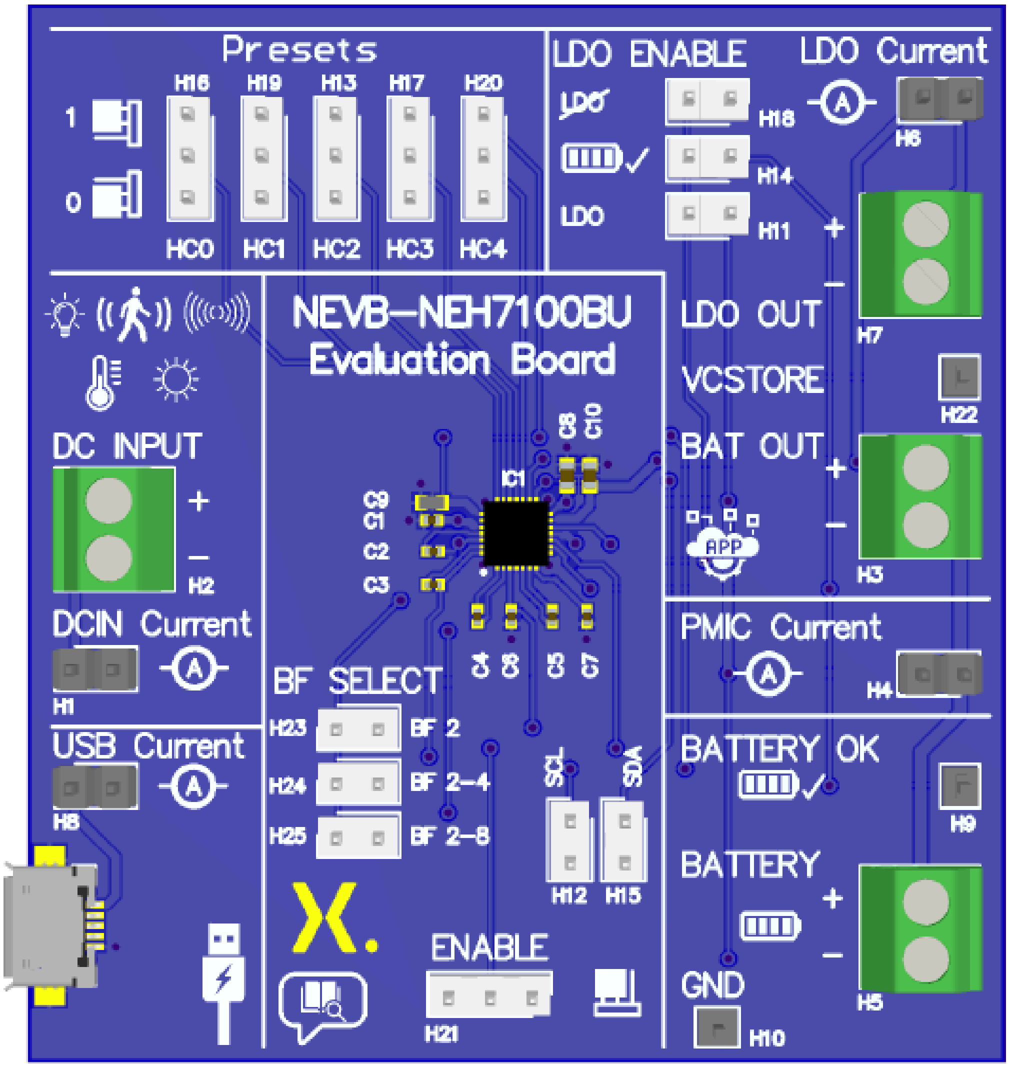


Fig. 1. NEVB-NEH7100BU evaluation board

2. Connectors

The NEVB-NEH7100BU evaluation board includes several connectors for the harvester, the external storage element, the measurement equipment and for PMIC set up. Voltages and currents can be measured through the current test headers. Fig. 2 shows the location and Table 1 describes the functionality of each connector.

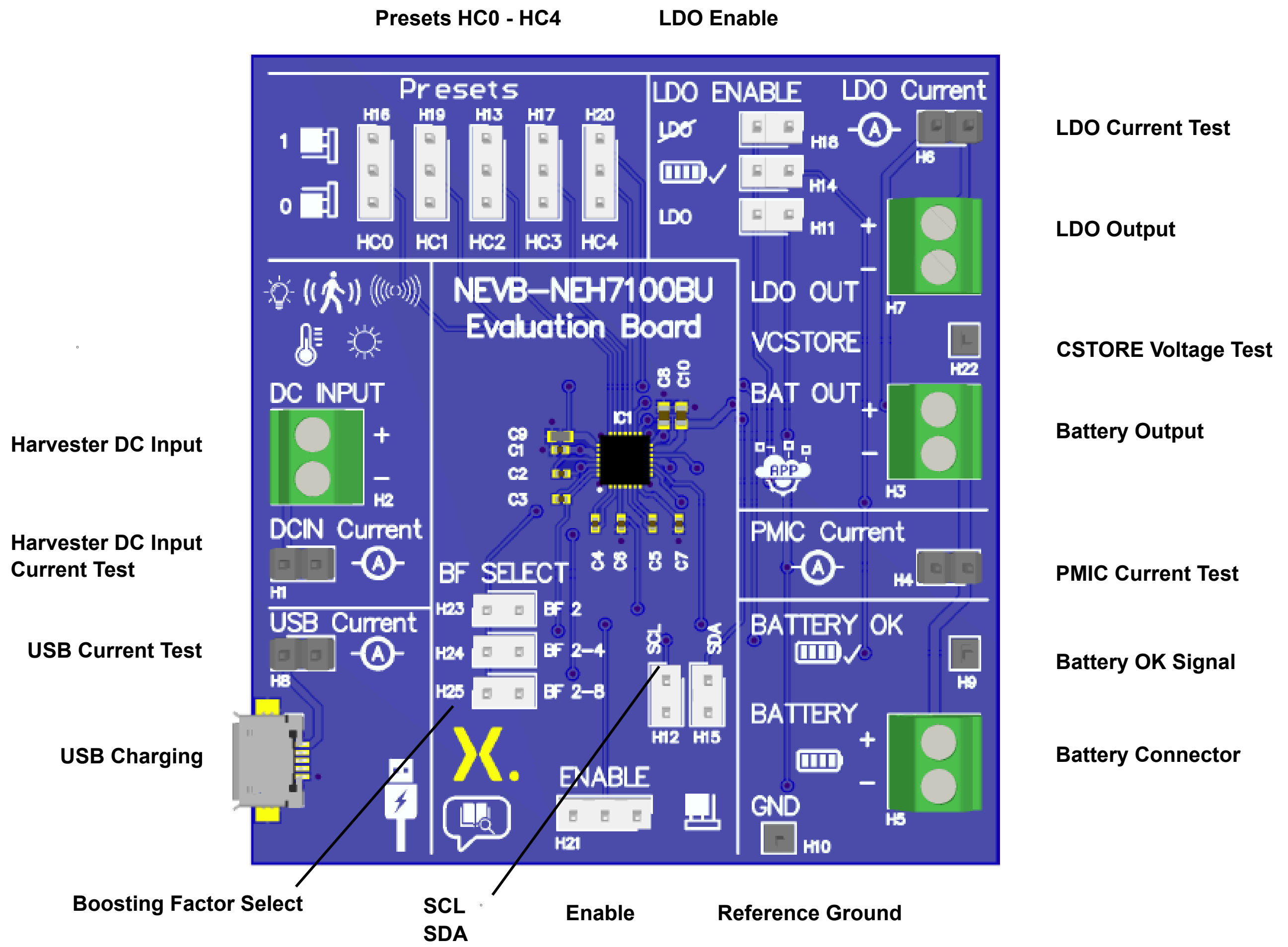


Fig. 2. NEVB-NEH7100BU evaluation board connectors

Table 1. Connector descriptions

Connector	Description
HC0 - HC4	Preset pins can be connected either to ”0” or ”1” based on the actual jumper position on the header. For more details, please consult the NEH7100 data sheet.
Harvester DC Input	DC power input for the PMIC. Connect the DC output of the harvester to the terminal.
Harvester DC Input Current Test	Harvester’s DC input current can be measured through the header. Connect the DC current meter between the two pins. If current measurement is not needed, pins should be shorted with a jumper.
USB Current Test	USB current can be measured through the header. Connect the DC current meter between the two pins. If current measurement is not needed, pins should be shorted with a jumper.

Connector	Description
USB Charging	USB micro-B socket enables USB charging. Use a USB cable and attach it to a USB charger or computer. **Note:** the USB header is only for charging purposes, it can't be used for communication.
Boosting Factor Select	Selecting boosting factors available to the PMIC. Note, that only one of H23, H24 or H25 or none can be jumpered at the same time: • No jumpers on H23, H24 and H25 enables using all available boosting factors as of 2, 4, 8 and 16 • H23 is jumpered enables using only boosting factor 2 • H24 is jumpered enables using boosting factors 2 and 4 • H25 is jumpered enables using boosting factors 2, 4 and 8 One or more capacitors can be removed if boosting factor range is reduced. Detailed description can be seen in Section 3.
LDO Enable	These headers are controlling the on-chip LDO. The following options are available. • LDO is always enabled if H11 is shorted with a jumper. • LDO is controlled by “Battery OK” signal if H14 is shorted with a jumper. • LDO is disabled if H18 is shorted with a jumper. **Warning:** To avoid board damage, only one of the three jumpers is allowed to attach at the same time. Adding more than one jumper to the headers of H11, H14, H18 can cause short circuit of the battery. This must be avoided. It is also needed to consider that LDOEN pin, pin 12, of the PMIC must not be left floating. At least one jumper must be presented on one of the headers. For better understanding, please consult the NEVB-NEH7100BU evaluation board schematic.
LDO Current Test	LDO load current can be measured through the header. Connect the DC current meter between the pins. If current measurement is not needed, pins should be shorted with a jumper.
LDO Output	The LDO output is available through the terminal. Output setting is based on device settings detailed in the actual data sheet.
CSTORE Voltage Test	The voltage on the CSTORE pin, pin 22, can be measured on this terminal.
Battery Output	Unregulated battery voltage is accessible through the terminal. Connect the application to this terminal if unregulated battery voltage is sufficient to power it (i.e. no regulated LDO voltage is required).
Battery OK Signal	“Battery OK” signal shows if the battery voltage level is sufficiently high. The level is set by the hardcode settings or through I²C. It can also enable LDO functionalities based on the battery level if selected.
PMIC Current Test	PMIC’s charging current can be measured through the header. Connect the DC current meter between the pins. If current measurement is not needed, pins should be shorted with a jumper.
Battery Connector	The external rechargeable battery, or super-capacitor, can be connected to the terminal block.
SCL	I²C SCL line of the PMIC. Connect this line to the external I²C master. If I²C communication is not used this pin must be shorted to GND by attaching a jumper to the pins.
SDA	I²C SDA line of the PMIC. Connect this line to the external I²C master. If I²C communication is not used this pin must be shorted to GND by attaching a jumper to the pins.
Enable	Shorted with a jumper in ”Enable” position activates the internal circuits of the PMIC and enables its functionalities.

3. Boosting Factor select

The NEVB-NEH7100BU evaluation board enables selecting the boosting factors used by the PMIC. If one or several higher boosting factors are not used by the PMIC, the components required to these boosting factors should be removed from the board to save BOM cost and have better efficiency. Lower boosting factors can be disabled via I²C register GMIN. **Note**: in this case all the external capacitors are still needed because the higher boosting factors still use them. For better understanding please consult with the device data sheet. For example, if the selected harvester is a 4-cell amorphous PV, the boosting factors of 16, 8 and 4 can be bypassed, allowing the final design to save the costs of 3 capacitors.

Table 2 summarizes the options available to select boosting factors, while Fig. 3 shows the position of the components related to the selected options.

Table 2. Boosting factor selection

Jumper on header	Boosting factors available	Components to remove
H23	2	C2, C3, C4, C6
H24	2, 4	C2, C3
H25	2, 4, 8	C2
None	2, 4, 8, 16	none

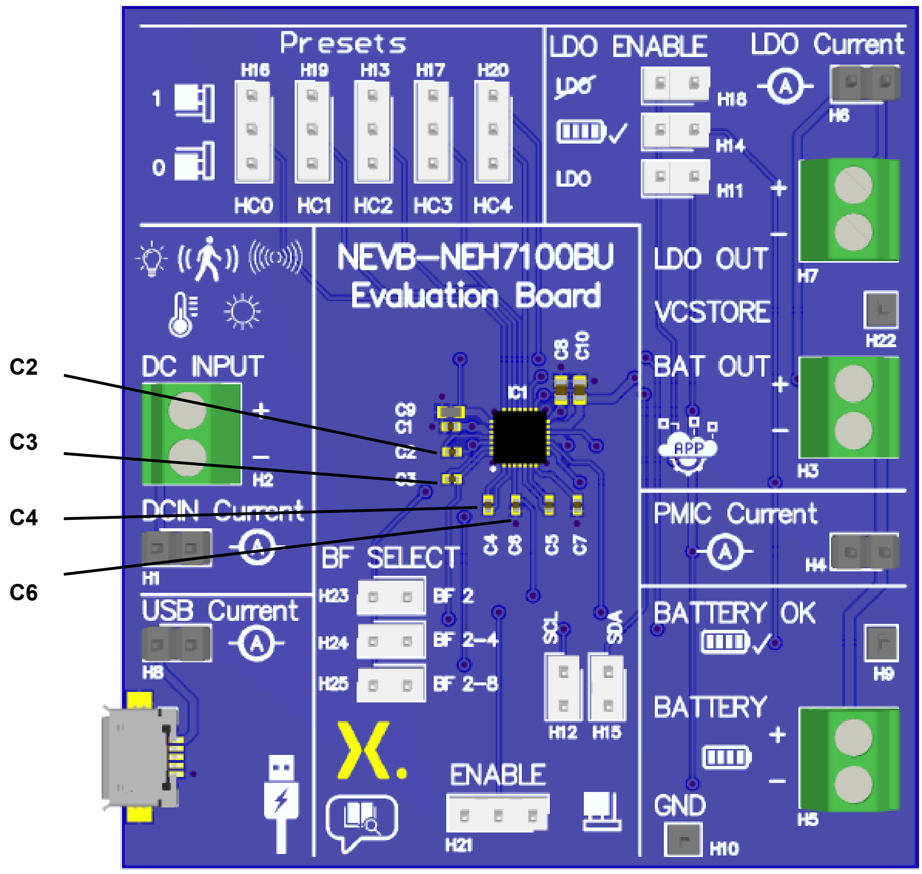


Fig. 3. Capacitor positions

4. Presets

The Evaluation Board consists of **HC0** to **HC4** preset headers. Shorting pins with a jumper either to ”0” or ”1” enables supporting different battery types and LDO voltages.

For a detailed description, please consult NEH7100 data sheet.

5. Harvesters

The NEH7100BU PMIC can be used with different types of external harvesters. External harvesters need to provide DC voltage. When using an energy harvester with an AC output, such as piezoelectric harvesters, AC-to-DC rectification is necessary before connecting it to the evaluation board.

In case the absolute maximum ratings of the PMIC are expected to be violated for any time by the harvester, a clamping circuit must be implemented to avoid device damage. For the absolute maximum ratings of the NEH7100BU PMIC please consult NEH7100 data sheet. External harvester can be attached to **Harvester DC Input** terminal and harvester current can be monitored through the **Harvester DC Input Current Test** header.

6. On-chip LDO

The NEH7100BU PMIC on-chip LDO can be controlled by **H11**, **H14** and **H18** headers. These set the following behavior:

- LDO is *enabled* if **H11** is shorted by a jumper.
- LDO is enabled if only *Battery OK* signal is active when **H14** is shorted by a jumper.
- LDO is *disabled* if **H18** is shorted by a jumper.
  Warning: To avoid board damage, only one of the three jumpers is allowed to attach at the same time. Adding more than one jumper to the headers of H11, H14, H18 can cause short circuit of the battery. This must be avoided. It is also needed to consider that LDOEN pin, pin 12, of the PMIC must not be left floating. At least one jumper must be presented on one of the headers.

For a detailed description consult the NEH7100 data sheet and the NEVBNEH7100BU evaluation board schematic diagram.

LDO output can be accessed through **LDO Output** terminal and the actual LDO voltage is determined by **HC0 to HC4** preset values. LDO load current can be measured through **LDO Current Test** header.

7. Storage element

The NEVB-NEH7100BU evaluation board requires an external storage element, such as a rechargeable battery or super-capacitor to be connected to the **Battery Connector** terminals. Unregulated battery power can be accessed through **Battery Output** terminal. This terminal can also be used to power the application circuit. Battery current can be monitored through **Battery Current Test** header. Note: the application circuit can be powered from either from the LDO output or directly from the battery voltage through the **Battery Output** terminal, and, if required by the application, both can be used.

The NEH7100BU PMIC continuously monitors the status of the battery. When the battery voltage is greater than the predefined LVD threshold, the “Battery OK” signal is asserted. This signal is accessible on **Battery OK** signal pin and can also be used to enable the on-chip LDO.

8. USB charging

USB Charging micro-B socket enables charging the storage element via USB. Use a regular USB cable and attach it to a USB charger or computer. USB current can be monitored through **USB Current Test** pin.

9. I²C connection

The PMIC's internal registers can be accessed by the I²C interface. Fig. 4 shows the connections of an external I²C master, such as an application microcontroller.

To use I²C interface application's, I²C lines should be connected to pin 1 of **SCL** and **SDA** headers, respectively. Note that the board is not providing the necessary pull-up resistors to the I²C interface lines. This is the application circuit's responsibility. For the suggested pull-up resistor values, consult NEH7100 data sheet. **Note:** the I²C pull-up resistors also can be connected to VBAT in case of the application being directly powered from VBAT.

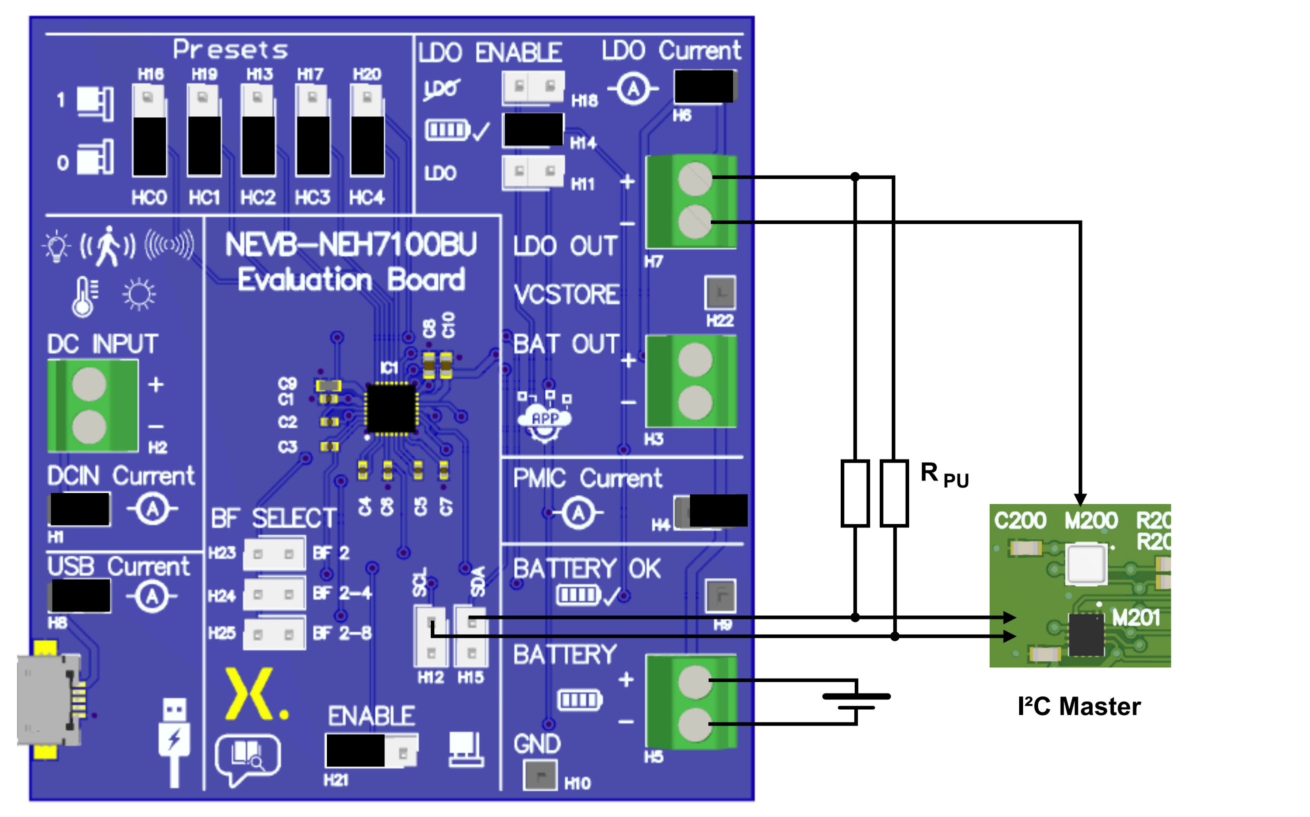


Fig. 4. Connecting the I²C interface lines to a master

10. Connecting the harvester and the application circuit

To use the Evaluation Board, connect the harvester to the **Harvester DC Input**, the rechargeable battery, or a super capacitor, to the **Battery Connector** and (optionally) the application circuit to the **LDO Output** as shown in Fig. 5. If currents are not measured, current test headers must be shorted by a jumper.

Caution should be taken when making connections for the battery, the harvester and application circuit. The positive terminals should be connected to the appropriate terminal pin marked with a "+" symbol.

To use a harvester with an AC output like piezoelectric harvesters or inductive harvesters, rectify the signal before connecting to the Evaluation Board. For the absolute maximum ratings of the PMIC, please consult with the appropriate data sheet.

The **HC0 to HC4** preset headers should be set with the jumpers to support the type of the attached battery and the selected LDO voltage required by the application. **LDO Enable** also should be set according to the application needs. In most cases "Battery OK" signal is selected to control the LDO operation to make sure that LDO voltage will always be in the recommended range.

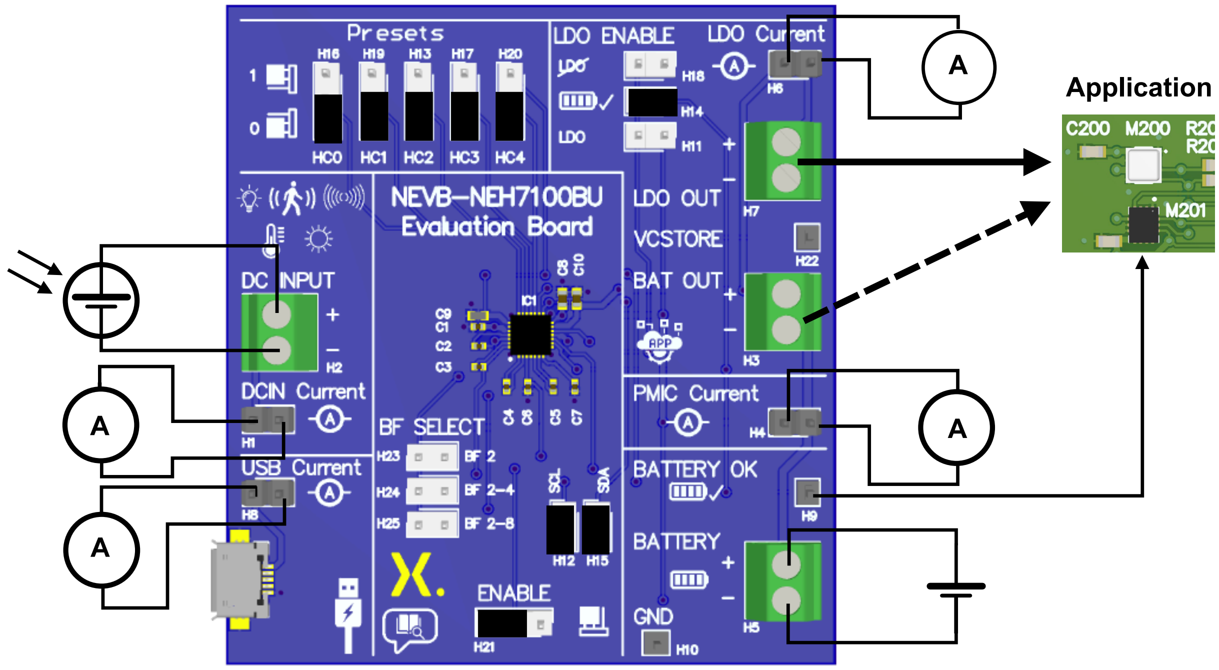


Fig. 5. Connecting measurement equipment, energy harvester and application circuit

11. Measuring currents

Pin Headers labeled **Harvester DC Input Current Test**, **USB Current Test**, **LDO Current Test** and **Battery Current Test** are provided to monitor the input and output currents of the PMIC. To measure currents, remove the bridging jumper from the header pins and replace them with a current meter as shown in Fig. 5.

12. Measuring PMIC efficiency

To determine PMIC's efficiency, it is required to calculate the input and output power of the PMIC. This can be measured using two current meters and two voltage meters as shown in Fig. 6.

To determine the input power, one voltmeter should be connected to the input of the PMIC between **Harvester DC Input** "+" and "-" pins and a current meter should also be connected to **Harvester DC Input Current Test** pins.

Multiplying the voltage and the current values the input power P_{in} can be determined:

$$P_{in} = V_{in} \times I_{in} \tag{1}$$

To determine the output power one voltmeter should be connected to the output of the PMIC between **Battery Output** "+" and "-" pins and a current meter should also be connected to **Battery Current Test** pins.

Multiplying the voltage and the current values the output power P_{out} can be determined.

$$P_{out} = V_{bat} \times I_{bat} \tag{2}$$

The values of P_{in} and P_{out} can be used to calculate the efficiency of the PMIC using the formula:

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

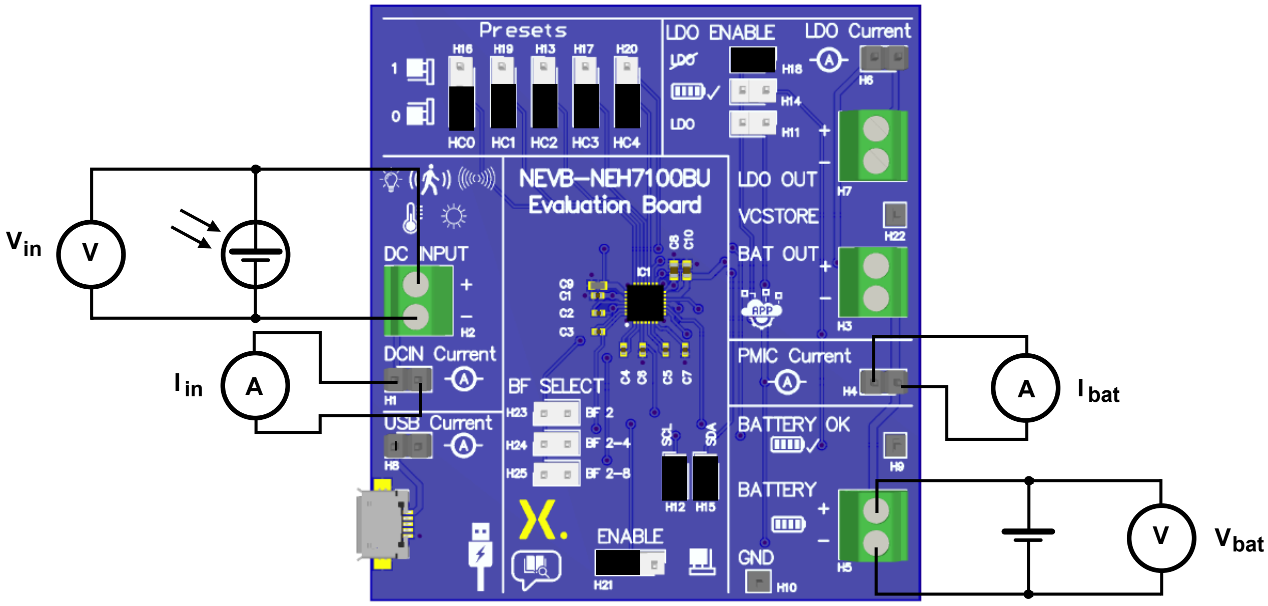
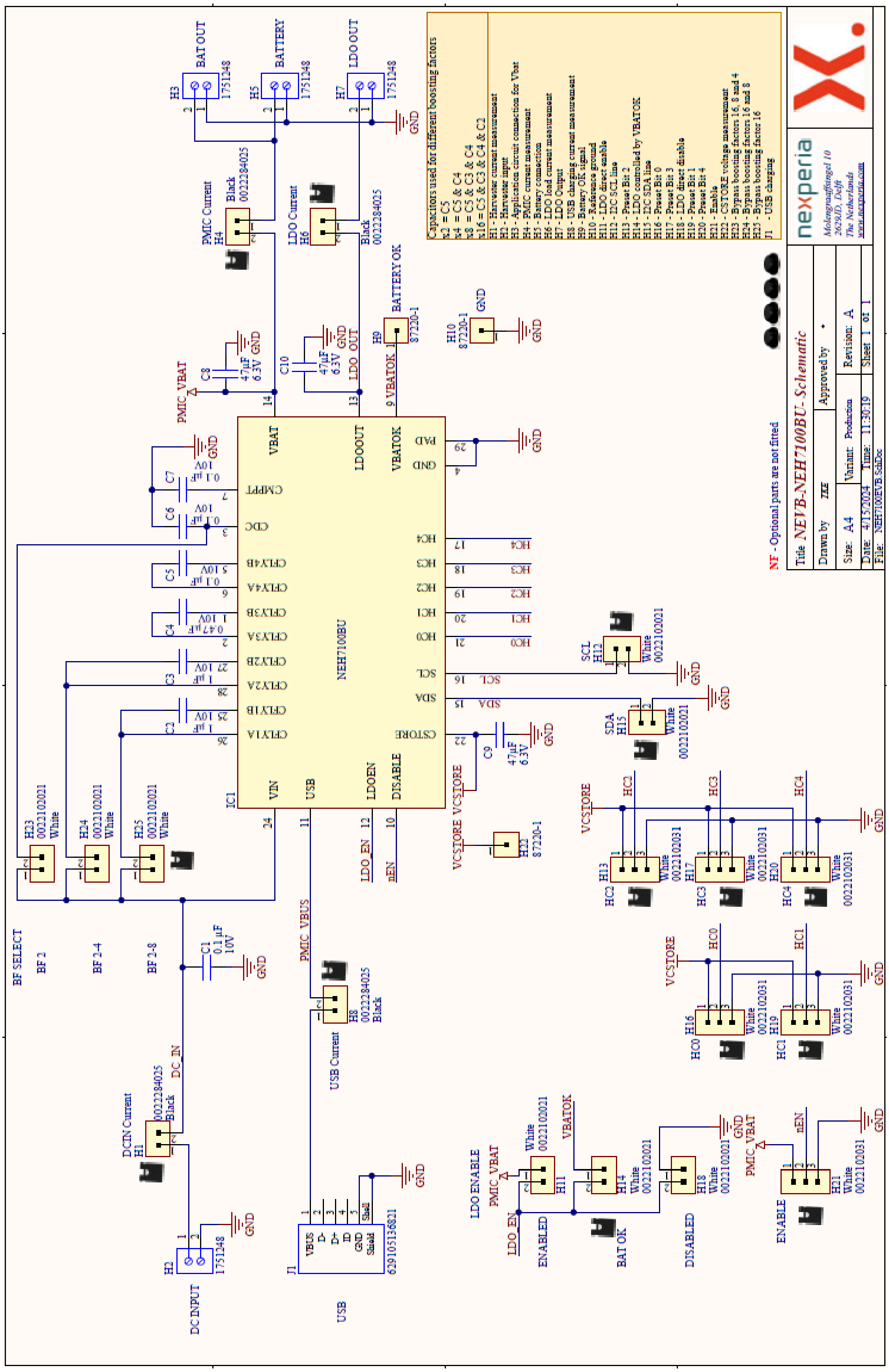


Fig. 6. Measuring PMIC efficiency

13. NEVB-NEH7100BU evaluation board schematic



14. NEVB-NEH7100BU evaluation board PCB

The NEVB-NEH7100BU evaluation board features a double-sided PCB. Fig. 7 to Fig. 12 show the PCB design details.

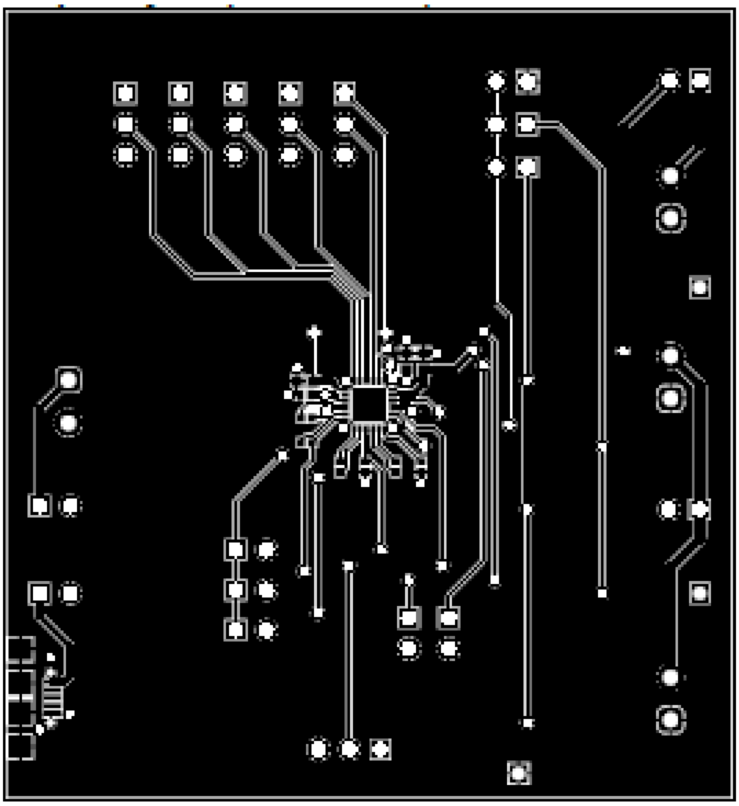


Fig. 7. NEVB-NEH7100BU evaluation board PCB top layer copper

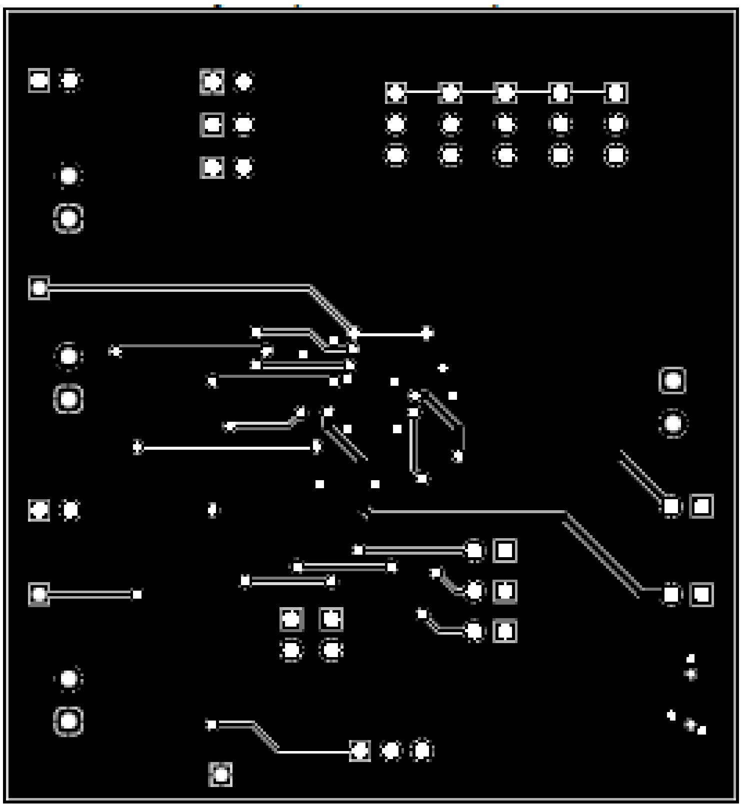


Fig. 8. NEVB-NEH7100BU evaluation board PCB bottom layer copper

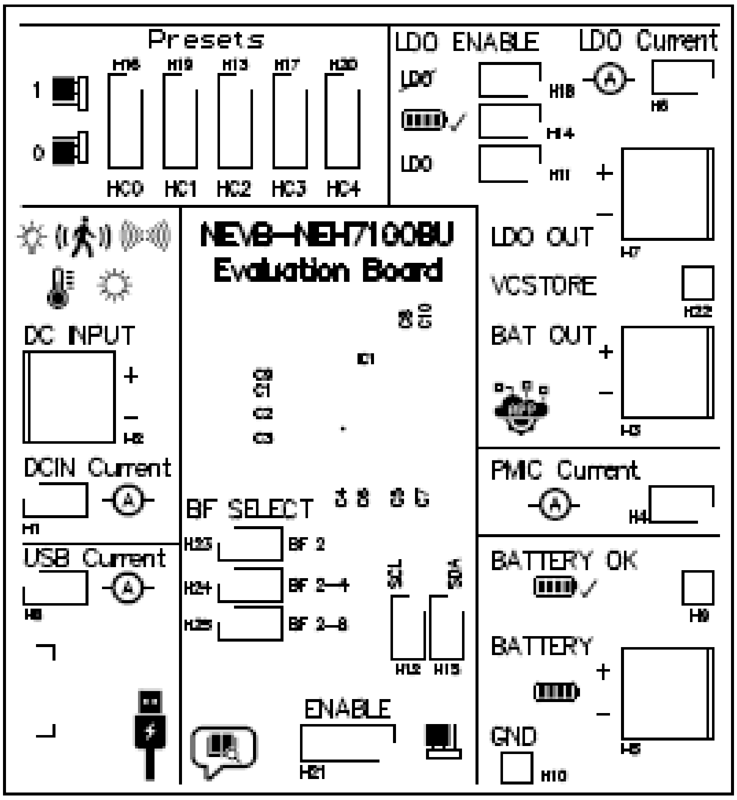


Fig. 9. NEVB-NEH7100BU evaluation board PCB top layer silkscreen

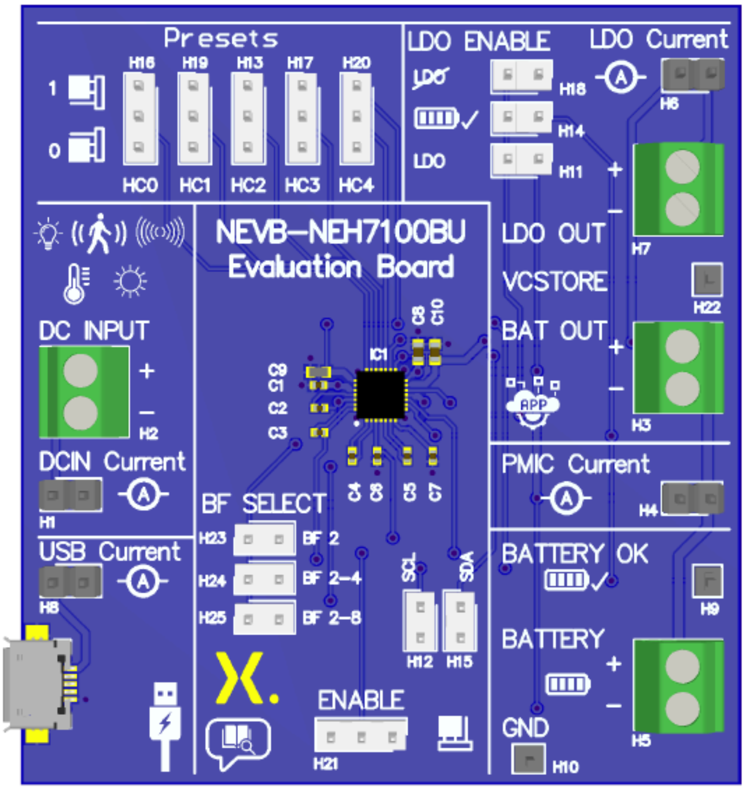


Fig. 10. NEVB-NEH7100BU evaluation board PCB top view

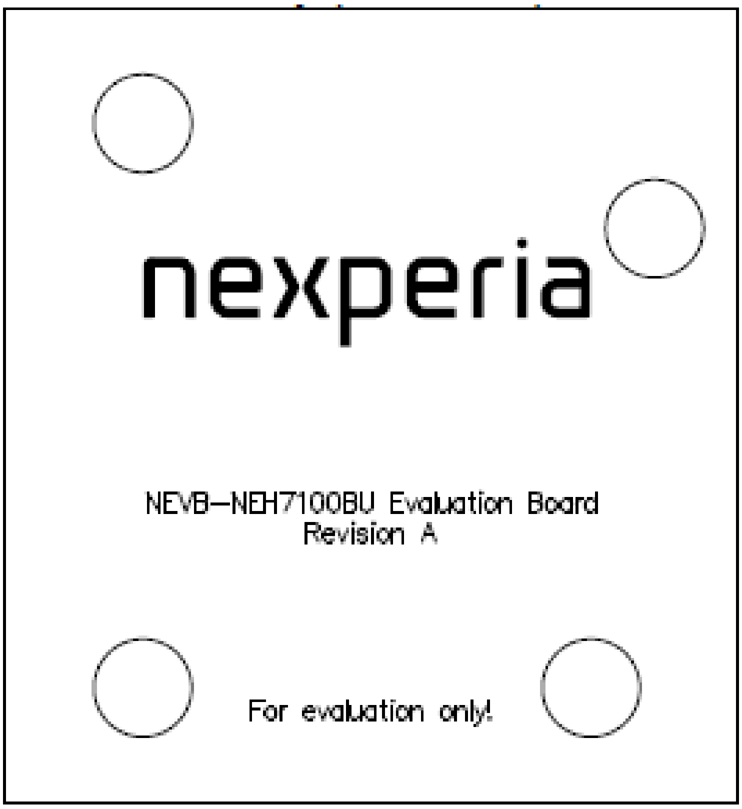


Fig. 11. NEVB-NEH7100BU evaluation board PCB bottom layer silkscreen

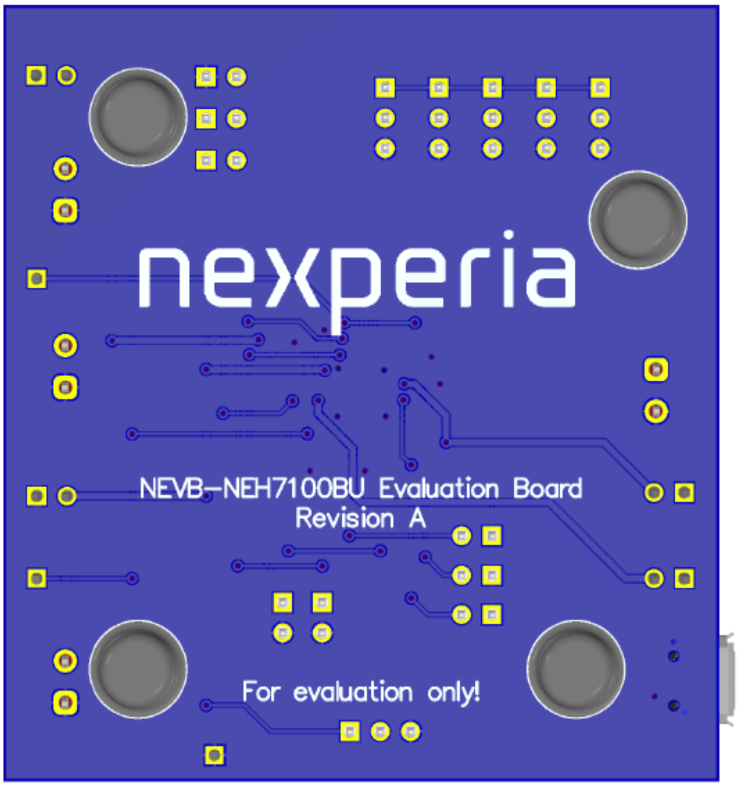


Fig. 12. NEVB-NEH7100BU evaluation board PCB bottom view

15. NEVB-NEH7100BU evaluation board Bill of Materials (BOM)

Table 3. Bill of Materials (BOM)

Quantity	Designator	Value	Description	Manufacturer	Manufacturer Part Number	Digi-Key Part Number
4	B1, B2, B3, B4		Bumper Cylindrical, Flat Top 0.315" Dia (8.00mm) Polyurethane Black	3M	SJ5076	3M156065-ND
4	C1, C5, C6, C7	0.1 µF	0.1 µF ±10% 10V Ceramic Capacitor X5R 0402 (1005 Metric)	Murata Electronics	GRM155R61A 104KA01J	490-6297-1-ND
2	C2, C3	1 µF	1 µF ±20% 10V Ceramic Capacitor X5R 0402 (1005 Metric)	Murata Electronics	GRM153R61A 105ME95D	490-14577-1-ND
1	C4	0.47 µF	0.47 µF ±10% 10V Ceramic Capacitor X5R 0402 (1005 Metric)	Murata Electronics	GRM155R61A 474KE15D	490-3264-1-ND
3	C8, C9, C10	47µF	47 µF ±20% 6,3V Keramische condensators X5R 0603 (1608 metrisch)	Murata Electronics	GRM188R60J 476ME15D	490-13247-1-ND
4	H1, H4, H6, H8		Connector Header Through Hole 2 position 0.100" (2.54mm)	Molex	0022284025	23-0022284025-ND
4	H2, H3, H5, H7		2 Position Wire to Board Terminal Block Horizontal with Board 0.138" (3.50mm) Through Hole	Phoenix Contact	1751248	277-5719-ND
3	H9, H10, H22		Connector Header Through Hole 1 position	TE Connectivity AMP Connectors	87220-1	A26540-ND
8	H11, H12, H14, H15, H18, H23, H24, H25		Connector Header Through Hole 2 position 0.100" (2.54mm) White	Molex	0022102021	WM2722-ND
6	H13, H16, H17, H19, H20, H21		Connector Header Through Hole 3 position 0.100" (2.54mm) White	Molex	0022102031	WM2723-ND
1	IC1		NEH7100BU QFN28	Nexperia	NEH7100BU	
1	J1		USB - Micro B USB 2.0 Receptacle Connector 5 Position Surface Mount, Right Angle	Wurth Elektronik	629105136821	732-3155-1-ND
14	JMP1, JMP2, JMP3, JMP4, JMP5, JMP6, JMP7, JMP8, JMP9, JMP10, JMP11, JMP12, JMP13, JMP14		2 (1 x 2) Position Shunt Connector Black Open Top 0.100" (2.54mm) Gold	Sullins Connector Solutions	QPC02SXGN-RC	S9337-ND

16. Revision history

Table 4. Revision history

Revision number	Date	Description
2.0	2024-06-13	Document updated to the latest Nexperia format. Content modified to refer to Revision A of the evaluation board.
1.0	2023-11-08	Initial version.

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List of Tables

List of Figures

Contents