User Guide
Energy Autonomous Thingy:91 Plug-In

Abstract:

The energy autonomous Thingy:91 plug-in board enables the user to develop for any energy autonomous LTE-M or NB-IoT sensor application based on Nordic Semiconductors Thingy:91 prototyping platform. The plug-in uses Nowi's NH2 Energy Harvesting PMIC with an onboard voltage supervisor for over voltage protection. The plug-in is specifically designed in order to easily add energy harvesting to any application running on the Thingy:91. It includes current measurement capabilities, pin-to-pin compatible with Nordics Power Profiler Kit II, to power profile, and optimize the power consumption of your application.

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1. Introduction

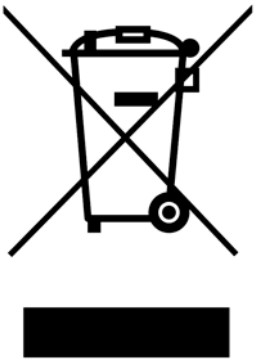
Nowi Energy Autonomous Thingy:91 Plug-In is a hardware accessory to be used with Nordic Semiconductors Thingy:91 prototyping platform. It can be used for the design and development of energy autonomous sensor applications that require LTE Cat-M1 or LTE CAT-NB1 connectivity.

The board includes all necessary circuitry to safely charge the internal battery of the Thingy:91 using solar energy harvesting.

The key features of this accessory board are:

- NH2D0245 energy harvesting PMIC
- Plug-in PV panel expansion board
- Interface for the NH2 output current measurements
- Compatible with Nordic Semiconductors PPKII, Power Profiler Kit II
- Voltage supervisor to protect the battery of the Thingy:91

Be cautious when handling the printed circuit board and take any electrostatic discharge precautions where necessary. Waste electronic products should not be disposed of with household waste. Please recycle if the facilities exist. Check with your local authority for recycling advice and policies.



2. Kit Content

The Nowi Energy Autonomous Thingy:91 Plug-In accessory includes hardware, documentation, schematics, PCB layout files, and PCB manufacturing files.

2.1. Hardware Content

The Nowi Energy Autonomous Thingy:91 Plug-In accessory contains the Plug-In board and three plastic PCB spacers to attach the Plug-In board to the Thingy:91. A PV panel expansion board can be used to attach a solar harvester, or the solar harvester can be attached directly to the designated connectors on the Plug-In. Guidelines for the dimensions of the PV panel expansion board are given in Figure A.1 in Appendix A, these dimensions can be used or modified based on the solar harvester used with the plug-in board. The PV expansion board is symmetrical both of the orientations will work, and has the same shape and dimensions as the PCB of the Thingy:91. The polarity of the pins are given in Figure A.1.

Figure 1: *Plugged into the Thingy:91*

Hardware Files
The hardware design files including schematics, PCB layout files, bill of materials, and Gerber files for the Nowi Energy Autonomous Thingy:91 Plug-In accessory are available on the product page.

2.2. Related Documentation

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

Additional Documentation

- NH2D0245 Datasheet
- Power Profiler Kit II User Guide

3. Hardware Description

The Nowi Energy Autonomous Thingy:91 Plug-In accessory can be used as a development platform for the NH2D0245. An onboard connector provides access to the current measurement pins and is pin-to-pin compatible with the Power Profiler Kit II.

3.1. Block Diagram

the Nowi Energy Autonomous Thingy:91 Plug-In board consists of only two blocks. The energy harvesting block using NH2D0245 and the voltage supervisor block for overcharge protection. The connections between the different blocks and sub-blocks are shown in figure 2.

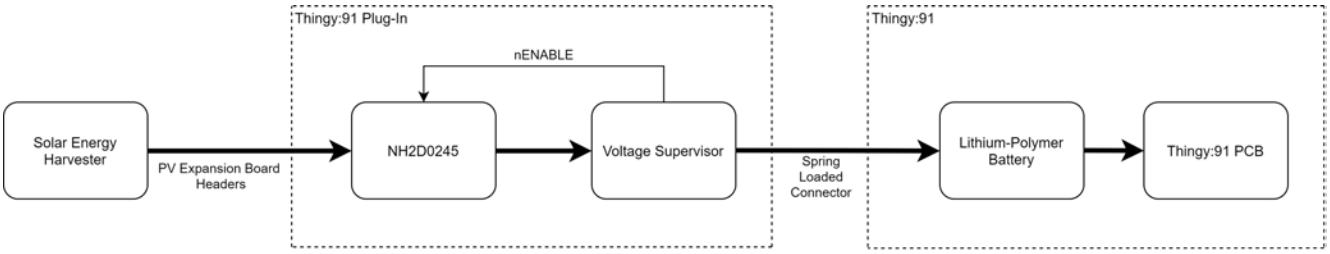


Figure 2: *Thingy:91 Plug-In Board Block Diagram*

3.2. NH2D0245

The energy harvesting section of the Plug-In board consists of the NH2D0245. There is a spring loaded connector at designator **J4**, which when assembled makes electrical contact with the battery inside the Thingy:91. This spring loaded connector is used to charge the battery in the Thingy:91 with energy harvesting. There are two female connectors provided on the top side of the board at **J2** and **J3**, which provide connection to a PV harvester extension board. At **J1** there are current measurement pins exposed to measure the output current of the NH2D0245 energy harvesting PMIC and how much current flows into the Thingy:91. These current measurement pins are pin-to-pin compatible with Nordics Power Profiler Kit II (PPKII). In addition to all this there is a switch available on the top side at **SW1**. This switch can be used to set the NH2D0245 to higher power mode or lower power mode, according to how large the PV panel size is on the PV panel expansion board. To configure the plugin for higher power set the switch to the top position, and for lower power set the switch to the bottom position. Typically for outdoor solar harvesting application it is recommended to set this switch to high power mode. Table 1 gives a brief overview of the designators of the connectors and switch with the corresponding functionality.

Figure 3: *Thingy:91 Plug-In Board Top View*

The NH2D0245 has an $\overline{\text{ENABLE}}$ pin that enables or disables conversion. When this pin is logic high it will disable the conversion, and when the pin is logic low it will enable the conversion of the PMIC. It can be used as a means of protecting the battery from overcharging by disabling conversion when the battery voltage crosses a set threshold. A voltage supervisor is used to control this pin to prevent any overvoltage or overcharge from happening inside the Thingy:91.

Table 1: *Designators of switch and connectors*

Designator	Functionality	Note
J1	Current measurement interface	Pin-to-pin compatible with the Power Profiler Kit II
J2	PV Expansion board connector	Photovoltaic harvester
J3	PV Expansion board connector	Photovoltaic harvester
J4	Spring loaded battery connector	Electrically connected to the Li-Po battery of the Thingy:91
SW1	Power range selection switch	Switch between higher power and lower power ranges

3.3. Voltage Supervisor

The voltage supervisor section of the Plug-In board consists of the BD46421G by ROHM Semiconductor. This voltage supervisor keeps track if the batteryvoltage is larger or smaller than 4.2 V. If the batteryvoltage is larger than 4.2 V the voltage supervisor will disable the NH2D0245, if the batteryvoltage is smaller than 4.2 V the voltage supervisor will keep the NH2D0245 turned on.

3.4. PCB Layout

Figures 4 and 5 show the top and bottom layout of the Thingy:91 Plug-In.

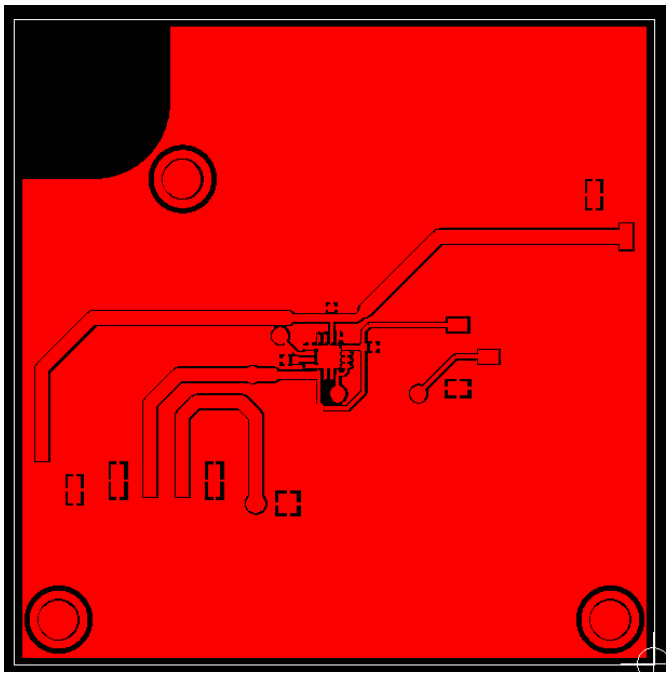


Figure 4: *Top Layer PCB Layout*

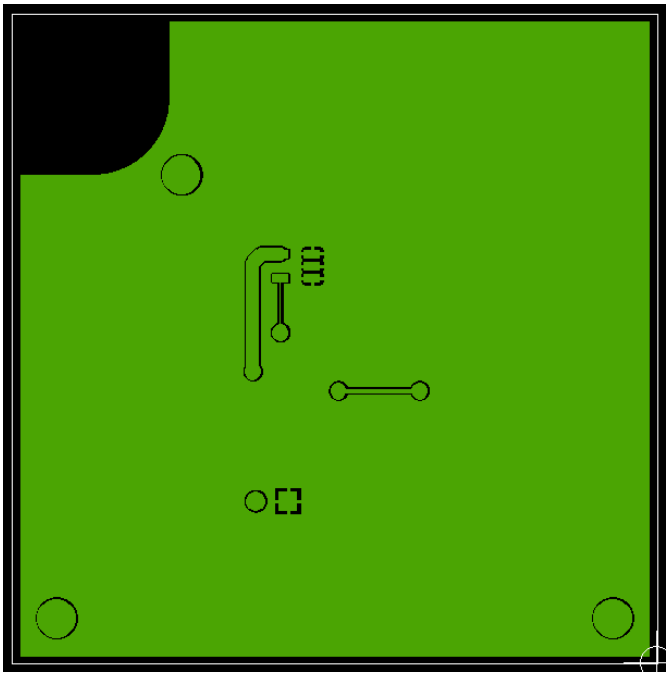


Figure 5: *Bottom Layer PCB Layout*

4. Measuring Current

There is a current measurement connector present on the Plug-In board at connector **J1**. Using this connector, the output current of the PMIC, which also corresponds to the current flowing into the Thingy:91, can be measured. This connector is pin-to-pin compatible with the pinout of the Power Profiler Kit II and can also be used with other energy analyzer or current measurement tools. Table 2 shows the pinout of the PPKII compatible current measurement connector. When measuring with the PPKII connect both Grounds to the designated Grounds on the PPKII (Pin 1 and 4), connect the output of the NH2 (Pin 2) to the input of the PPKII, and connect the output of the PPKII to the input to the Thingy:91 (Pin 3). When measuring with a regular current meter, connect the positive terminal of the meter to pin 2 and the negative terminal of the meter to pin 3.

Table 2: *Pinout Connector J1*

1	2	3	4
GND	Output of the NH2	Input to the Thingy:91	GND

5. Assembling the Plug-In

Assembling the Thingy:91 Energy Harvesting Plug-In is very straightforward, all that is required is a Thingy:91, the NH2 Plug-In, and the three plastic PCB spacers delivered with the NH2 Plug-In. The steps to assemble the Plug-in are all shown in the figures B.1 to B.5 in the Appendix.

Take the Thingy:91, NH2 Plug-In board, PV Board, and the PPKII as shown in figure B.1. Remove the silicon cover of the Thingy:91 and attach the three plastic PCB spacers in the mounting holes of the PCB of the Thingy:91 as shown in figure B.2. Attach the NH2 Plug-In board as shown in figure B.3 in to the plastic PCB spacers. After attaching the energy harvesting plug-in board to the Thingy:91 using the plastic PCB spacers, a measurement tool of choice can be attached to measure the battery charging current. Figure B.4 shows the PPKII connected to the energy harvesting plug-in board, connected as described in section 4. After attaching the PPKII, the PV add-on board can be plugged into the energy harvesting plug-in, or a PV harvester can be connected directly to either connector J2 or J3. After completing all the steps, the battery inside the Thingy:91 will be charged using solar energy harvesting, and the battery charging current can be measured using the PPKII or different measurement tool.

6. Glossary

LTE Cat-M1
Long Term Evolution, category M1. This technology is for Internet of Things devices to connect directly to a 4G network, without a gateway, and on batteries.

Cat-NB1
Narrowband Internet of Things, a Low Power Wide Area technology used to connect devices to the internet using existing mobile networks.

7. Acronyms and Abbreviations

These acronyms and abbreviations are used in this document.

LTE-M
Long Term Evolution for Machines

NB-IoT
Narrowband Internet of Things

PMIC
Power Management Integrated Circuit

Li-Po
Lithium-Polymer

SiP
System in Package

PCB
Printed Circuit Board

8. Legal Notices

Any information in this document is preliminary and subject to changes without prior notice. Any information in this document is Nowi B.V. proprietary property and is protected by copyright and trademark laws and other intellectual property rights.

Nowi B.V. is willing to supply limited numbers of Plug-In boards and associated documents to the Customer. It is agreed that parts and documentation will be supplied under Nowi B.V Terms of Supply. Parts and documents will be supplied "as is". Nowi B.V does not warrant to the Customer that either is free from faults or defects or is of satisfactory quality or fit for any particular purpose.

Appendix A: PV Panel Expansion board Dimensions

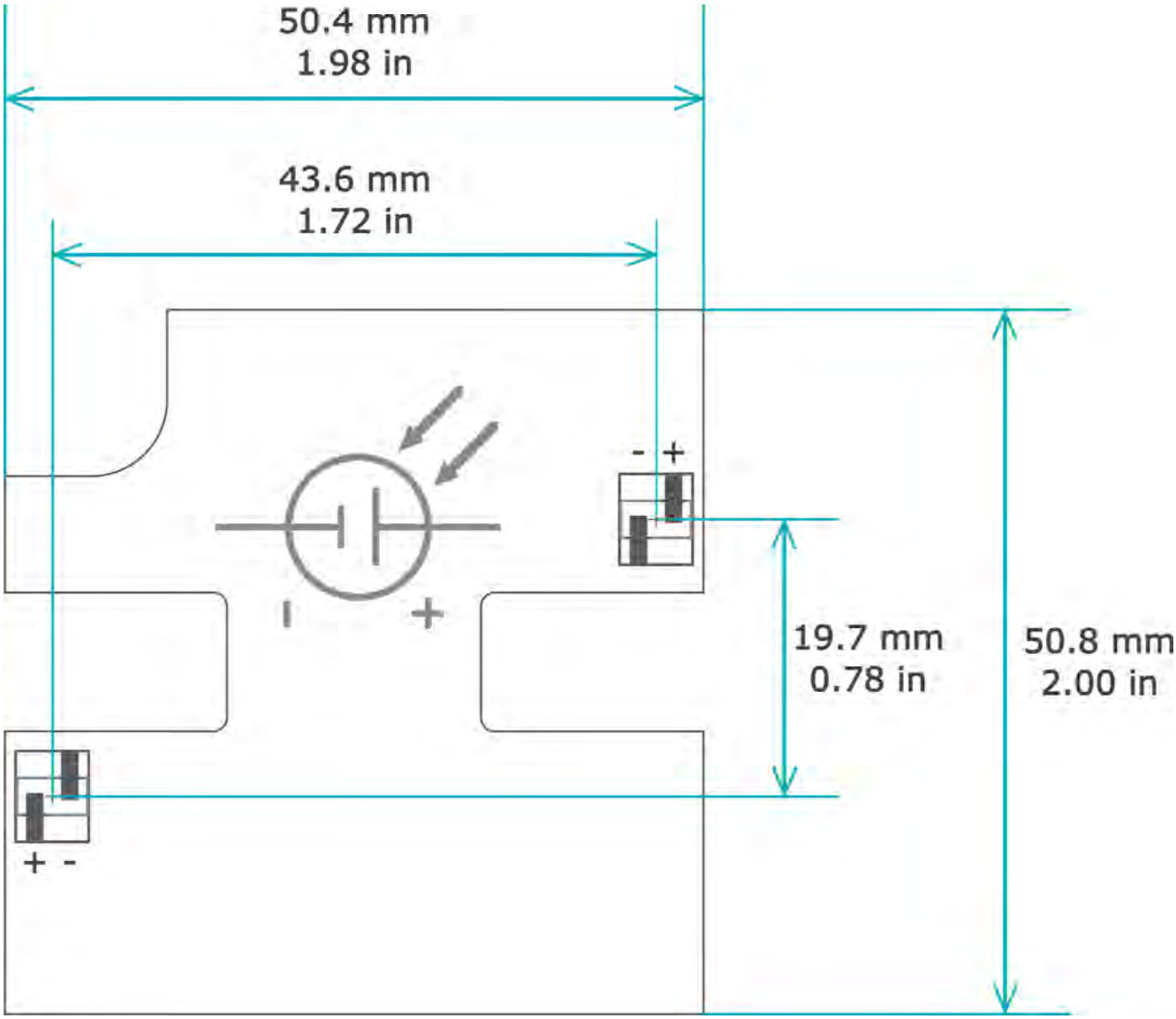


Figure A.1: *PV Add On Board Dimensions*

Appendix B: Assembling the NH2 Plug-In

B1. Step 1

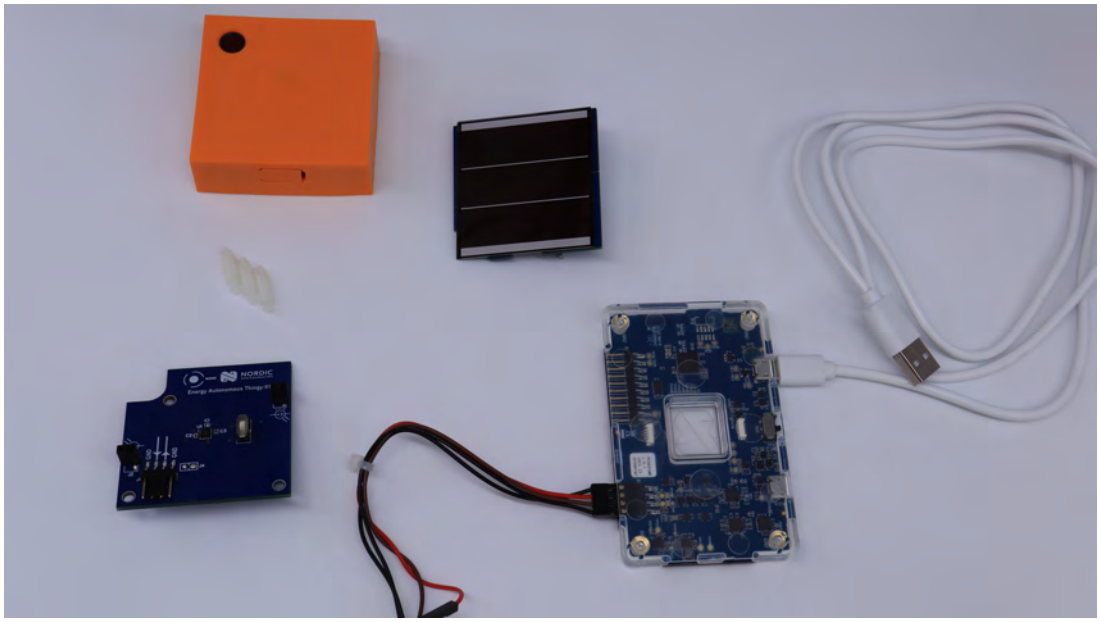


Figure B.1: *Assembling the Thingy:91 Plug-In = Step 1*

B2. Step 2

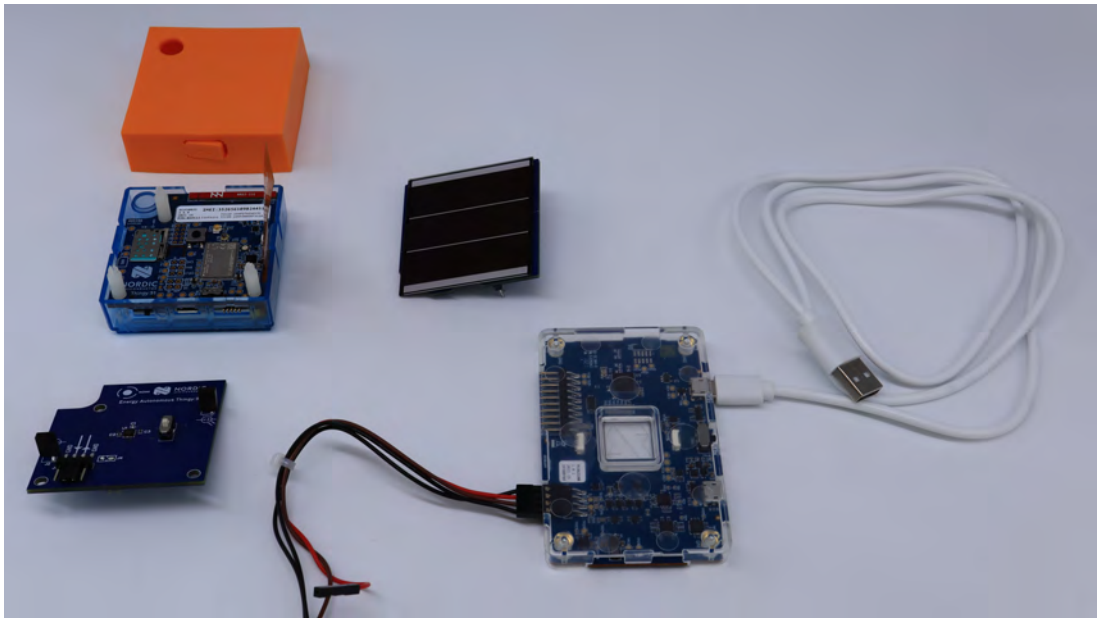


Figure B.2: *Assembling the Thingy:91 Plug-In = Step 2*

B3. Step 3

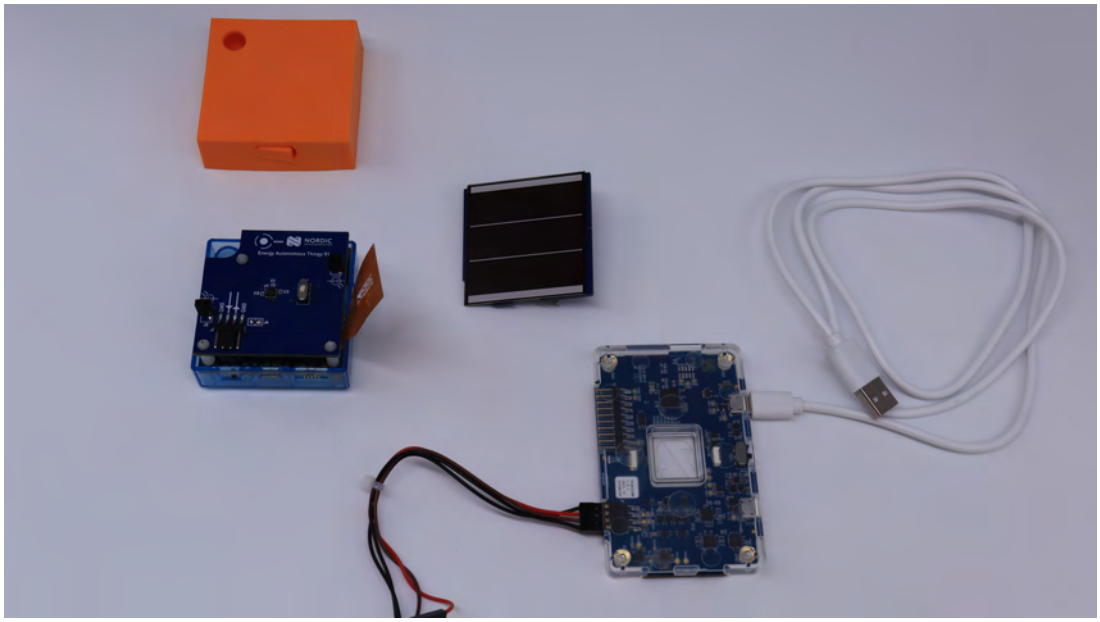


Figure B.3: *Assembling the Thingy:91 Plug-In = Step 3*

B4. Step 4

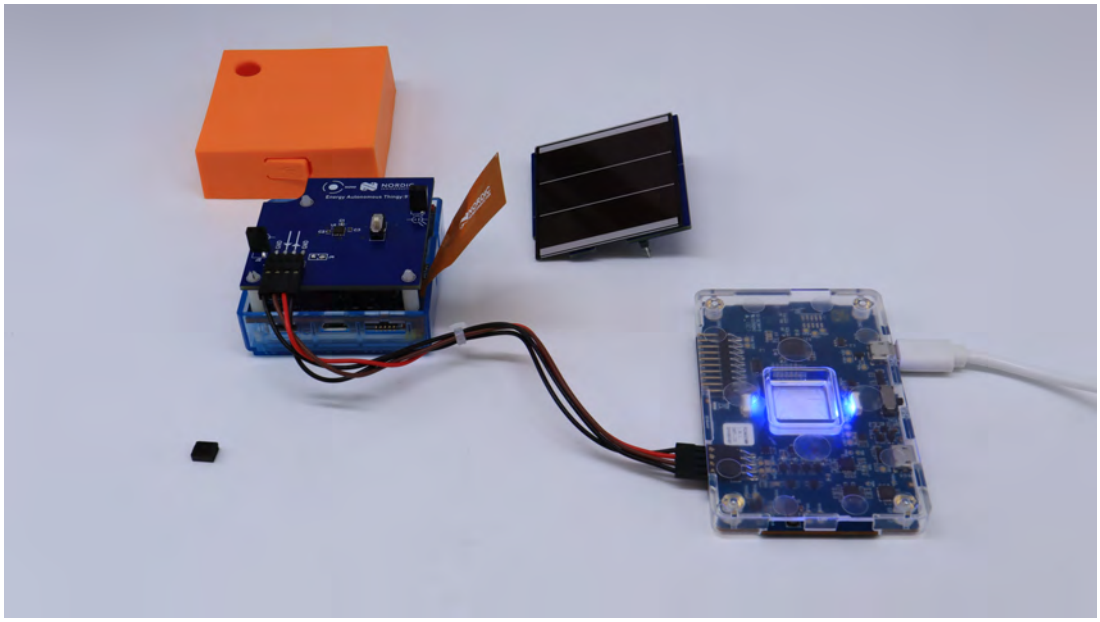


Figure B.4: *Assembling the Thingy:91 Plug-In = Step 4*

B5. Step 5

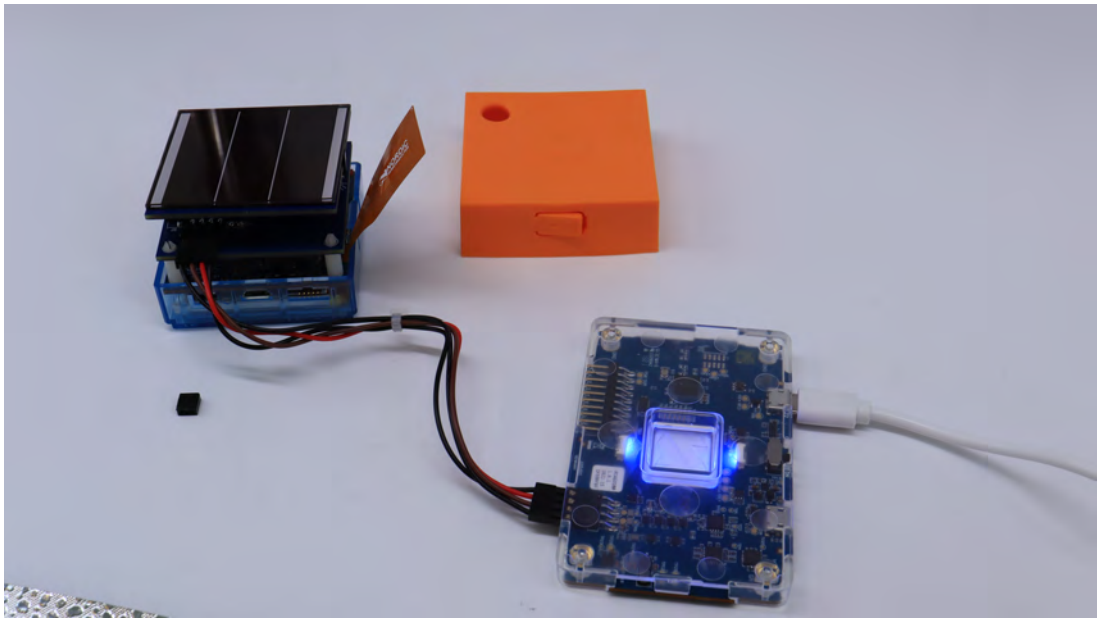


Figure B.5: *Assembling the Thingy:91 Plug-In = Step 5*