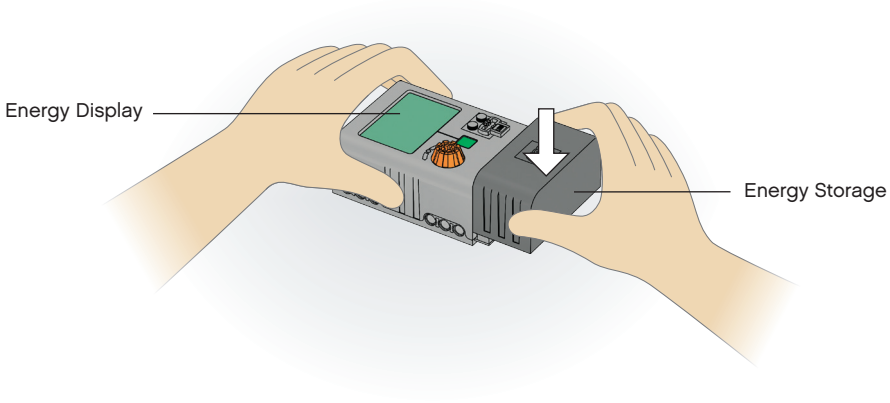
LEGO® Energy Meter

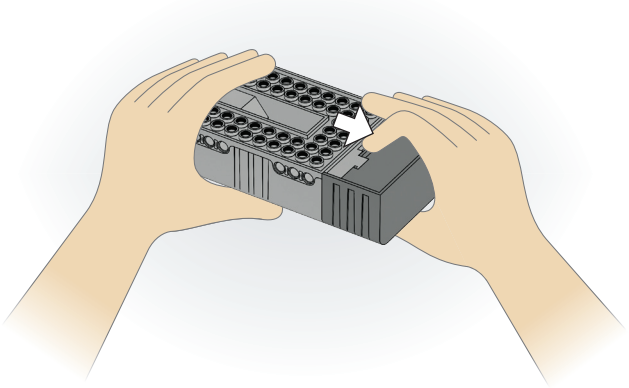
How to get started

The Energy Meter consists of two parts: the LEGO® Energy Display and LEGO Energy Storage. The Energy Storage fits onto the bottom of the Energy Display.

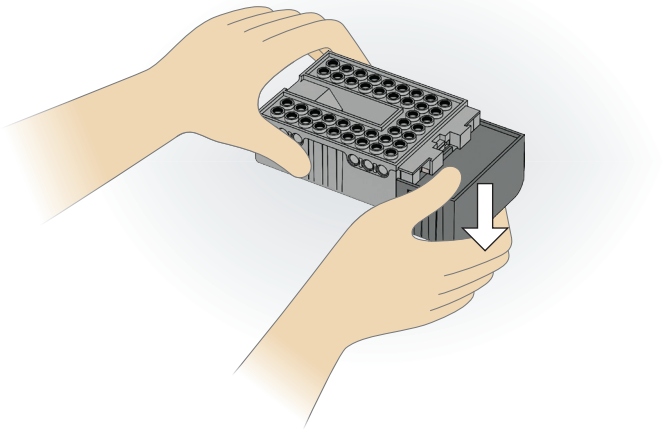
To install the Energy Storage, simply slide it down onto the Energy Display.



To remove the Energy Storage, press the plastic tab on the back and...



press the Energy Storage down to slide it off.

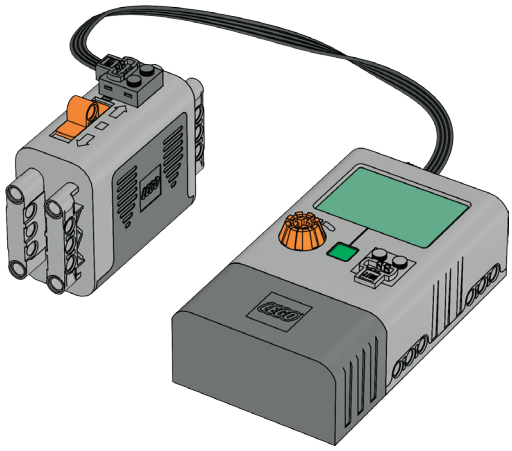


How to charge and discharge the Energy Meter

In order to achieve full capacity on your Energy Storage we recommend that you charge and discharge the Energy Meter three times upon initial use, but also after every 6 months of use or after a long storage period.
To keep full capacity of the Energy Meter and to ensure a long lifetime of the Energy Storage, please follow the charge and discharge procedure as described here.

To charge the Energy Meter:

- Connect the Energy Meter either to the LEGO® Power Functions Battery Box supplied with six new batteries or the LEGO Power Functions Rechargeable Battery Box in order to charge the Energy Storage
- Turn on the Energy Meter by pressing the green On/Off button, check that the display is on
- Let the LEGO Power Functions Battery Box or the LEGO Power Functions Rechargeable Battery Box charge the Energy Meter by leaving them connected for three hours or until the display turns off. After this the Energy Storage and thereby the Energy Meter is fully charged



Charging the Energy Meter using the LEGO MINDSTORMS NXT:

You need to use two different converter cables to connect the LEGO Energy Meter with the LEGO MINDSTORMS NXT, Port A.

When charging the LEGO Energy Meter through the LEGO MINDSTORMS NXT remember to connect a LEGO transformer to the LEGO MINDSTORMS NXT.

Build the following program within the LEGO MINDSTORMS NXT Software.

- The first block is a Move block configured for motor A, Duration set to unlimited and power set to 100.
- The second block is a Loop block configured to run forever.
- Within the loop block a Keep Alive block is inserted to make sure the MINDSTORMS NXT to not power down.

Then download and run the program.

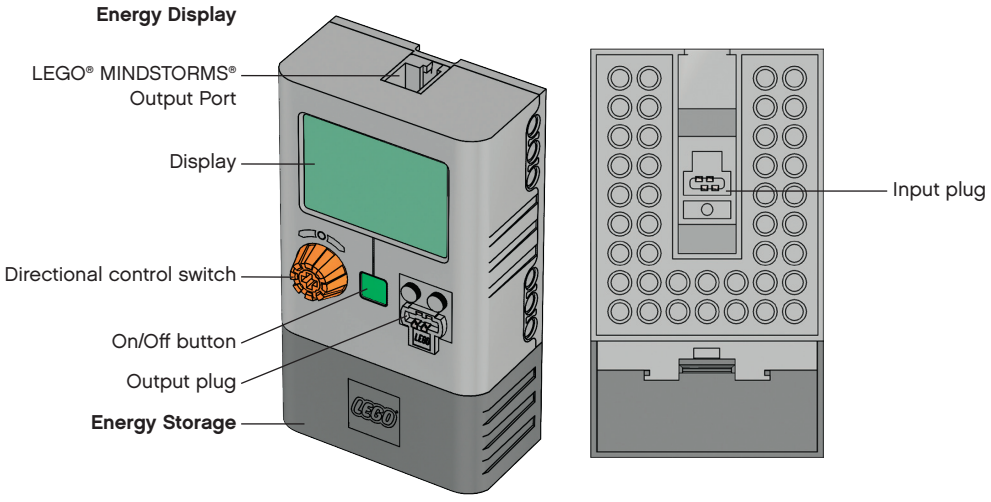
To discharge the Energy Meter:
- Disconnect all wires and other devices from the Energy Meter
- Press the green On/Off button for 10 seconds until a triangle with an exclamation mark appears blinking with one second intervals on the display
- Let the Energy Meter remain like this for approximately 1½ hours or until the display turns off. After this the Energy Storage and thereby the Energy Meter is fully discharged

If you wish to cancel the discharge, simply press the On/Off button to turn off the Energy Meter. To return to normal mode, turn on the Energy Meter again.

For more information see www.legoeducation.com

How it works
The Energy Meter can measure, store and release generated energy.

Functionality



Energy Display

MINDSTORMS Output Port
For more on how to use the Energy Meter together with LEGO MINDSTORMS, see www.MINDSTORMSeducation.com

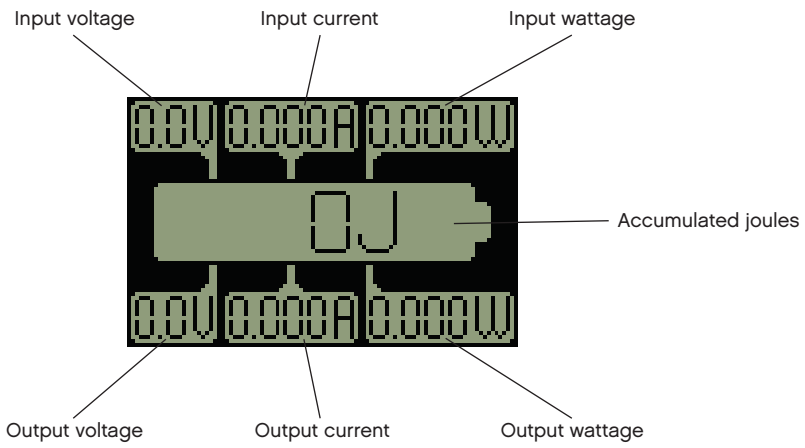
Directional control switch
Use the directional control switch to operate the output function. By turning the switch in either direction with power on you can control the output function. In the middle position, the output function is off.

On/Off button
Press the On/Off button down once to turn the Energy Meter on and once more to turn it off. Pressing down and holding the On/Off button down for two seconds will reset joules measurement to 0 J.

Output plug
Connect the E-Motor to the output plug and read the Energy Meter's power output. A minimum of 1 J must be stored before an output can be drawn from the Energy Meter.

Input plug
Connect the Solar Panel or E-Motor, used as a generator to the input plug and read the Energy Meter measurements.

Display Measurements



Accumulated joules

The maximum amount of accumulated joules that can be stored is 100 J. The reading of 100 J will start blinking on the display with one second intervals when this maximum is reached. Input voltage will remain measured in the display, but input current and input wattage will go to zero. The output measurements will depend on the load applied. Pressing down and holding the On/Off button for two seconds will reset the joules measurement to 0 J. Please notice that this is not an indication of the charged status of the Energy Storage.

Blinking lightning symbol

A lightning symbol appears blinking with one second intervals on the display, when one of two possible situations have occurred:

- If the number of joules remains the same, then you should be able to continue your activity, but the Energy Storage power level is low and you should soon charge the Energy Meter.
  The Energy Storage should be charged before each lesson.
- If the number of joules reset to 0 J and output voltage goes to zero, then the Energy Meter has been overloaded and must be recharged.
  Do not overload the Energy Meter.

Constant lightning symbol

A constant lightning symbol appears on the Energy Meter display when the Energy Storage needs to be charged.

Error

A triangle with an exclamation mark appears on the display when there is an error on the Energy Storage. Measurements are not valid. Remove the Energy Storage, check the connecting parts and see if they need cleaning. Reconnect the Energy Storage to the Energy Display and charge the Energy Meter. If the error triangle reappears, replace with a new Energy Storage.

Energy Storage
The Energy Storage stores the energy you have generated. Measurements on the Energy Display are not valid when disconnected from the Energy Storage. The lifespan of the Energy Storage depends heavily on the way it is used, maintained and stored. Store the Energy Storage at room temperature in a clean, dry place away from heat. Heat, frost and long discharge periods can significantly shorten the expected lifespan of the Energy Storage. Disconnect the Energy Storage after use. It is necessary to recharge the Energy Storage after a long storage period.

Technical Specifications
The Energy Meter will display measurements in the range of:
- 0.0 V to 9.9 V, input voltage
- 0.000 A to 0.200 A, input current
- P = V x I, P = input wattage
- 0 J to 100 J, accumulated joules
- 0.0 V to 9.9 V, output voltage
- 0.000 A to 0.450 A, output current
- P = V x I, P = output wattage

Refresh Rate and Averaging Measurements
Display measurements are refreshed every 0.5 seconds; they are calculated by averaging the measurements at equal intervals of 100 per 0.5 second. Depending on the input, this should give fairly constant and easily identifiable measurements.

Take good care of your Energy Meter
- Do not bend or push hard on it or elements connected to it
- Do not step on or otherwise place heavy weights on it
- Do not drop it
- Do not short circuit it
- Do not exceed the maximum 10 V supply voltage
- Do not overload the Energy Meter as this will cause it to discharge
- It is not waterproof
- Store at room temperature in a clean, dry place away from heat and frost
- The Energy Storage should be charged before each lesson