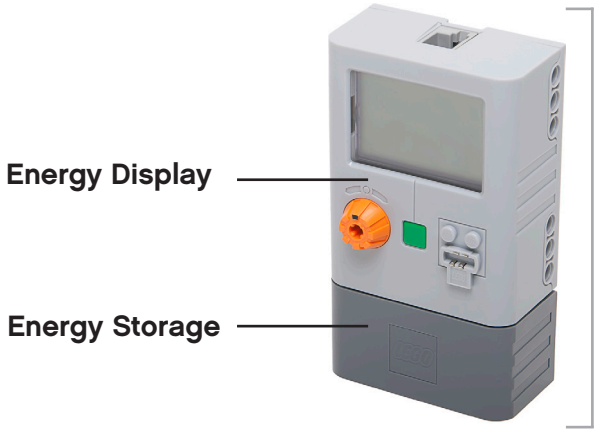
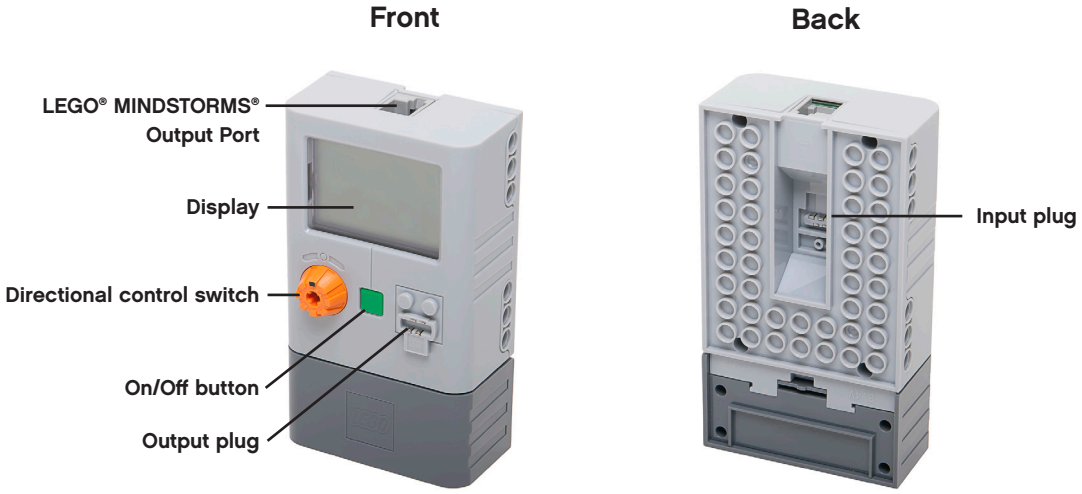
Renewable Energy

Getting Started With the LEGO® Energy Meter

Table of Contents

Energy Meter Overview





Attaching the Energy Storage

To attach the Energy Storage, slide it onto the bottom of the Energy Display as shown.

Charging and discharging the Energy Meter

Before using the Energy Meter for the first time, you must charge the Energy Meter three times in quick succession in order to achieve the full capacity it was designed to provide.

The Energy Meter measures, stores and releases generated energy. The Energy Storage powers the Energy Meter and stores energy generated during the course of your experiments.

To fully charge and power the Energy Meter, the following three energy sources can be used:

Power Functions Battery Box

Power Functions Rechargeable Battery Box

LEGO® MINDSTORMS® NXT

IMPORTANT!

To maximise the life of your Energy Meter, it is essential that you read the following information thoroughly:

Using the Energy Meter for the first time

Before using the Energy Meter for the first time, you must charge the Energy Storage **three times in quick succession** in order to achieve the full capacity the Energy Storage was designed to provide. The remainder of this section provides full instructions on charging and discharging the Energy Storage using one of the devices listed above.

After long periods of inactivity

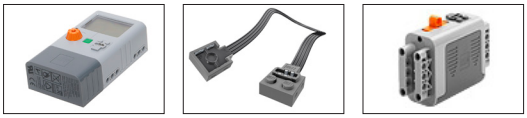
To prolong the life of your Energy Storage and ensure that it performs as designed, we highly recommend that you charge it three times in quick succession either **every six months** or following a longer period of inactivity, whichever occurs first.

Regular use

When used on a regular basis, the Energy Storage **only needs a single charge**, as and when required. Do not manually discharge the Energy Storage unless you are using it for the first time or charging it after long periods of inactivity. Remember to always disconnect the Energy Storage after use.

Charging and discharging with the LEGO® Power Functions Battery Box

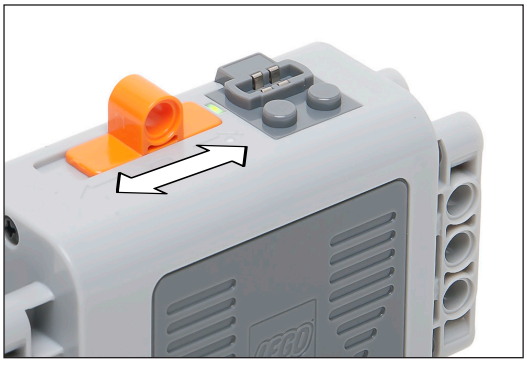
Charging the Energy Meter



Step 1
Make sure that the Power Functions Battery Box is fitted with six new batteries before beginning. Rechargeable batteries can be used.

Step 2
Connect the Power Functions Battery Box to the Input plug at the back of the Energy Meter with the Power Functions Extension Wire.

Step 3
Turn on the Power Functions Battery Box by moving the orange slider button to the right or left. The Battery Box is on when the green light is on.



Step 4
Make sure the Energy Meter is on. Turn on the Energy Meter by pressing the green On/Off button. Charging will now begin.

Charging is complete when the display turns off. Even though the display may show 100 J, the Energy Meter is not fully charged until the display turns off.

INFO
Remember that charging and discharging the Energy Meter must always be done under adult supervision.

INFO
A full charge normally takes approximately one to three hours.

Discharging the Energy Meter

Follow steps 5 to 9 only if this is the first time you are using the Energy Meter.

Step 5
To completely discharge the Energy Meter, first disconnect all wires and devices.

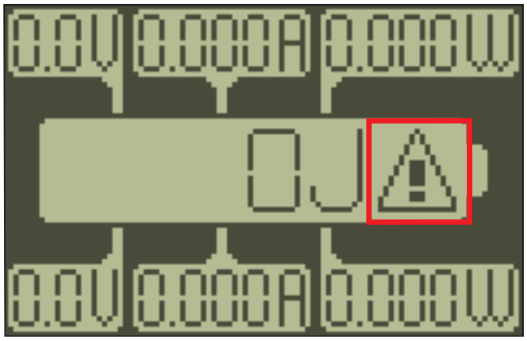
Step 6
Turn on the Energy Meter by pressing the green On/Off button.

Step 7
Press and hold the green On/Off button for 10 seconds until a blinking warning symbol appears on the display (shown below right).

Discharging will now begin.

Discharging is complete when the display turns off.

You can cancel the discharge at any time by pressing the green On/Off button. Press the button again to turn the Energy Meter on and use as normal.



INFO
A full discharge normally takes approximately 30-90 minutes.

Step 8
Charge and discharge the Energy Meter a second time by repeating steps 2 to 7.

Step 9
Finally, charge the Energy Meter for the third and last time by repeating steps 2 to 4.

You are now ready to start using your fully charged Energy Storage.

Always remove the Energy Storage from the Energy Display when not in use (see 'Removing the Energy Storage').

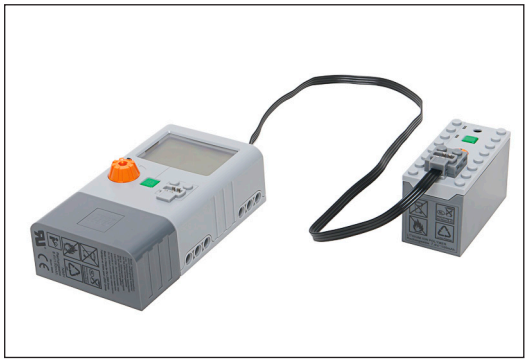
INFO
Always store the Energy Storage at room temperature in a clean, dry place.

Charging and discharging with the LEGO® Power Functions Rechargeable Battery Box

Charging the Energy Meter

Step 1
Make sure that the Power Functions Rechargeable Battery Box is fully charged before beginning.

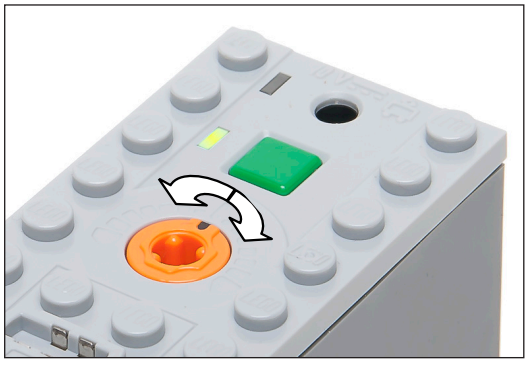
Step 2
Connect the Power Functions Rechargeable Battery Box to the Input plug at the back of the Energy Meter with the Power Functions Extension Wire.



Step 3
Connect the Rechargeable Battery Box to a power source using the LEGO transformer as shown.

Step 4
Turn on the Power Functions Rechargeable Battery Box by pressing the green On/Off button. The Rechargeable Battery Box is on when the green light is on.

Turn on the output power by turning the orange dial all the way to the right or left.



Step 5
Make sure the Energy Meter is on. Turn on the Energy Meter by pressing the green On/Off button. Charging will now begin.

Charging is complete when the display turns off. Even though the display may show 100 J, the Energy Meter is not fully charged until the display turns off.

INFO
Remember that charging and discharging the Energy Meter must always be done under adult supervision.

TIP
When fully charged, the Power Functions Rechargeable Battery Box can charge up to three Energy Meters at a same time.

TIP
A full charge normally takes approximately one to three hours.

Discharging the Energy Meter

Follow steps 6 to 10 only if this is the first time you are using the Energy Meter.

Step 6
To completely discharge the Energy Meter, first disconnect all wires and devices.

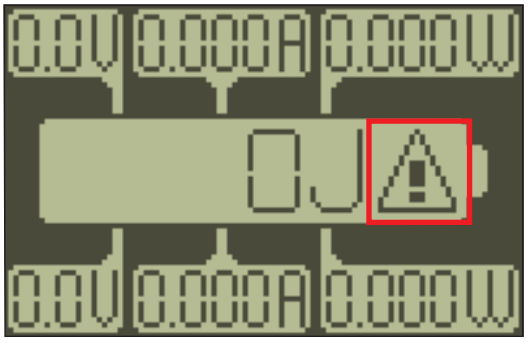
Step 7
Turn on the Energy Meter by pressing the green On/Off button.

Step 8
Press and hold the green On/Off button for 10 seconds until a blinking warning symbol appears on the display (shown below right).

Discharging will now begin.

Discharging is complete when the display turns off.

You can cancel the discharge at any time by pressing the green On/Off button. Press the button again to turn the Energy Meter on and use as normal.



INFO
A full discharge normally takes approximately 30-90 minutes.

Step 9
Charge and discharge the Energy Meter a second time by repeating steps 2 to 8.

Step 10
Finally, charge the Energy Meter for the third and last time by repeating steps 2 to 5.

You are now ready to start using your fully charged Energy Storage.

Always remove the Energy Storage from the Energy Display when not in use (see 'Removing the Energy Storage').

INFO
Always store the Energy Storage at room temperature in a clean, dry place.

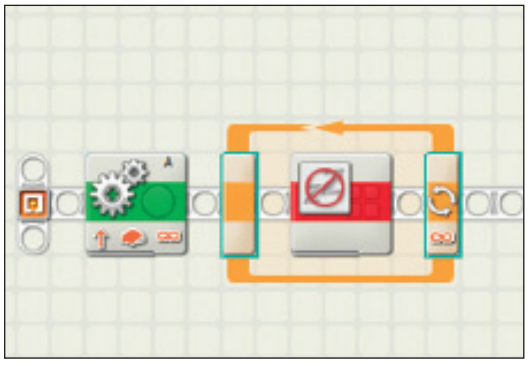
Charging and discharging with the LEGO® MINDSTORMS® NXT

Charging the Energy Meter

Step 1
Make sure that you have the LEGO Converter Cable, Power Functions Extension Wire, LEGO transformer, Energy Meter and MINDSTORMS NXT as shown.

Step 2
Connect the LEGO Converter Cable to Port A of the MINDSTORMS NXT and then connect the LEGO Converter Cable to the light grey end of the Power Functions Extension Wire. Now, connect the dark end of the Power Functions Extension Wire to the input plug at the back of the Energy Meter. Finally, connect the MINDSTORMS NXT to a power source using the LEGO transformer as shown.

Step 3
Build the following program in the MINDSTORMS NXT Software:
- Configure a Move block for motor A with the duration set to unlimited and power to 100
- Configure a Loop block to run forever
- Place a Keep Alive block inside the Loop block so the MINDSTORMS NXT does not power down during charging



Step 4
The MINDSTORMS NXT must be on. Turn on the MINDSTORMS NXT by pressing the orange On/ Enter button.

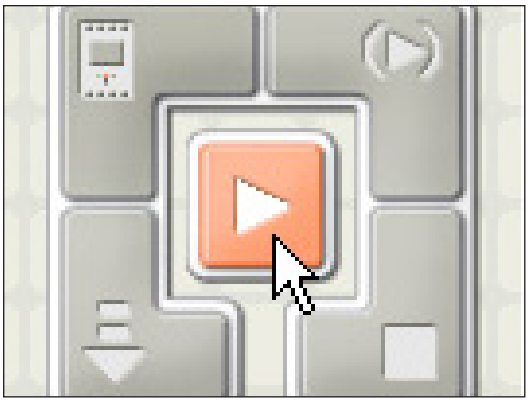
Step 5
Attach the MINDSTORMS NXT to a computer using either a USB cable or Bluetooth connection.

INFO
Remember that charging and discharging the Energy Meter must always be done under adult supervision.

TIP
When fully charged, the MINDSTORMS NXT can charge up to three Energy Meters at the same time.

TIP
Show the complete palette to locate the Keep Alive block.

Step 6
Open the program you created in the MINDSTORMS NXT Software and press Download and run.



Step 7
Make sure the Energy Meter is on. Turn on the Energy Meter by pressing the green On/Off button. Charging will now begin.

Charging is complete when the display turns off. Even though the display may show 100 J, the Energy Meter is not fully charged until the display turns off.

INFO
A full charge normally takes approximately one to three hours.

Discharging the Energy Meter

Follow steps 8 to 12 only if this is the first time you are using the Energy Meter.

Step 8
To completely discharge the Energy Meter, first disconnect all wires and devices.

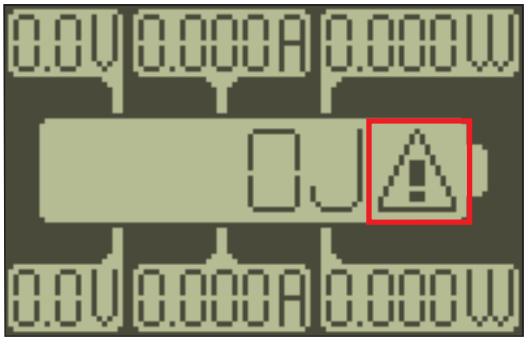
Step 9
Turn on the Energy Meter by pressing the green On/Off button.

Step 10
Press and hold the green On/Off button for 10 seconds until a blinking warning symbol appears on the display (shown below right).

Discharging will now begin.

Discharging is complete when the display turns off.

You can cancel the discharge at any time by pressing the green On/Off button. Press the button again to turn the Energy Meter on and use as normal.



INFO
A full discharge normally takes approximately 30-90 minutes.

Step 11
Charge and discharge the Energy Meter a second time by repeating steps 2 to 10.

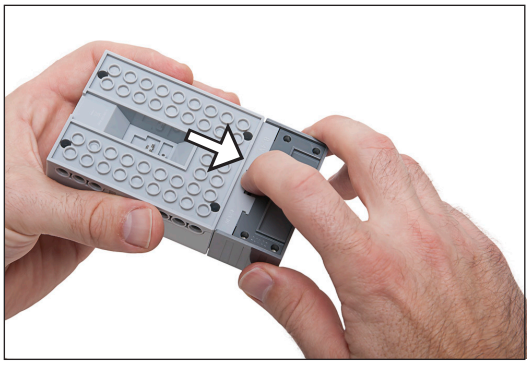
Step 12
Finally, charge the Energy Meter for the third and last time by repeating steps 2 to 7.

You are now ready to start using your fully charged Energy Storage.

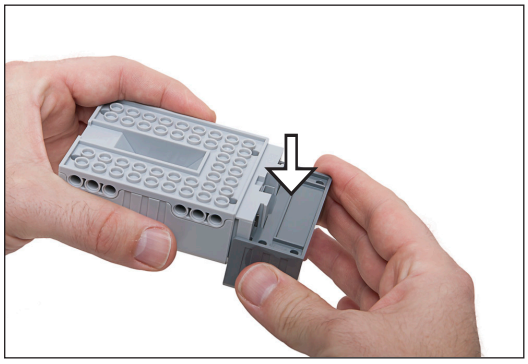
Always remove the Energy Storage from the Energy Display when not in use (see 'Removing the Energy Storage').

Removing the Energy Storage

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



... press the Energy Storage down to slide it off.

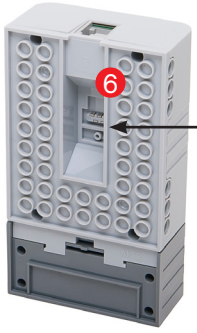


INFO
Always remove the Energy Storage from the Energy Display when not in use.

Using the Energy Meter

Energy Display
This component houses the display, controls and connectors. See below for a more detailed description of these features.

Energy Storage
This component provides power to the Energy Meter and stores energy generated during the course of your experiments.

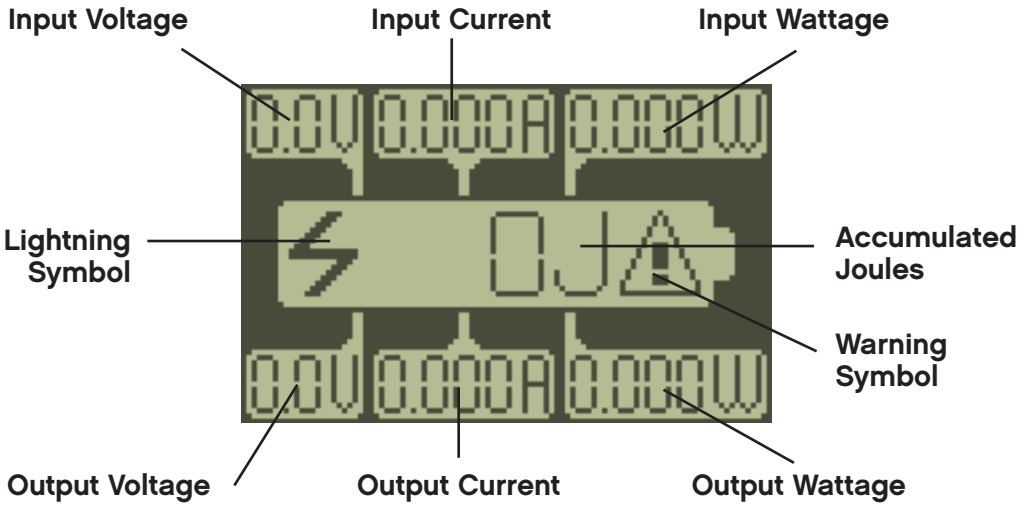


Input plug
Connect various power sources here to charge the Energy Meter.

1. LEGO® MINDSTORMS® Output Port – Allows the Energy Meter to be used with LEGO MINDSTORMS. Visit www.MINDSTORMSeducation.com for more information
2. Display – Shows input and output measurements, as well as power status and error information
3. Directional control switch – Selects the output function. Set to the middle position to turn the output function off
4. On/Off button – Turns the Energy Meter on and off. Press and hold for two seconds to reset the joule counter
5. Output plug – Connect components, such as E-Motor and LED Lights, to use the stored energy and measure the energy needed to power them
6. Input plug – Connect various power sources here to charge the Energy Meter or Connect the Solar Panel or E-Motor, used as a generator and read the Energy Meter measurements.

INFO
At least 1 J of energy must be stored before power can be drawn from the Energy Meter.

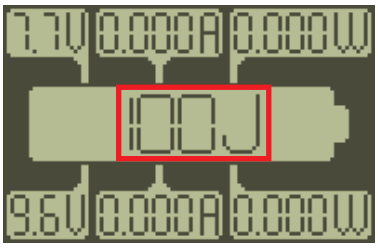
The Display



Accumulated joules

When experimenting and measuring energy input, the Energy Meter can store up to 100 joules. The following will occur when this figure is reached:

- The Accumulated joules symbol blinks at one-second intervals
- Input voltage continues to be measured and displayed
- Input current and Input wattage display 0



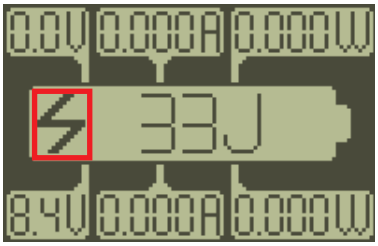
INFO
Accumulated joules is not an indication of the charge status of the Energy Storage.

TIP
Press and hold the On/Off button for two seconds to reset the accumulated joules.

Energy Storage power level is low

After a period of usage, the lightning symbol on the display will start blinking at one-second intervals to indicate that the Energy Storage needs to be recharged. You can continue to use the Energy meter until the lightning symbol stops blinking and remains on constantly (see 'Energy Storage power is empty' below). We recommend that you charge the Energy Meter when you have completed your experiments.

After recharging once, you can continue using the Energy Meter.



Energy Storage power is empty

The lightning symbol remains on constantly to indicate that the Energy Storage is empty. You cannot continue using the Energy Meter until it is fully charged.

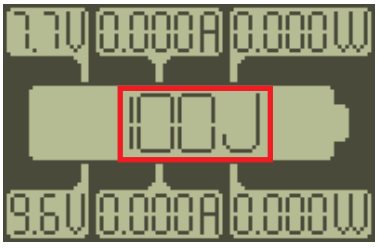
Energy Storage charging

The Energy Meter has to be turned on. The input voltage is then measured and shown in the display as the Energy Meter charges.

INFO
A full charge normally takes approximately one to three hours.

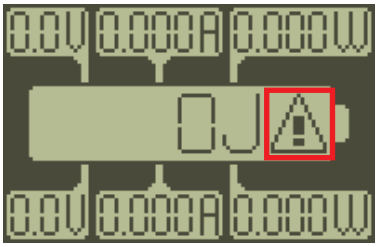
100 J not fully charged

100 joules on the display does NOT indicate that the Energy Meter is fully charged and that charging has stopped. The Energy Meter will automatically turn off when fully charged.



Energy Storage discharging

The triangular warning symbol blinks at one-second intervals to indicate that the Energy Storage is discharging.



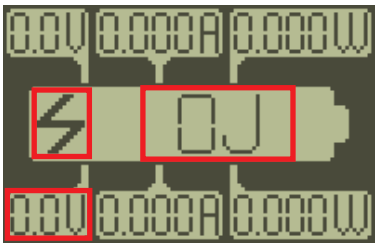
INFO
A full discharge normally takes approximately 30-90 minutes.

Charging has finished

The display turns off.

Output overloaded

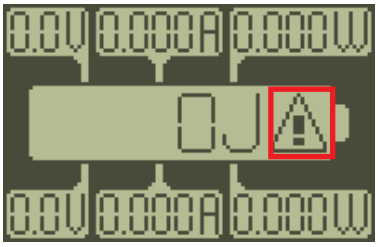
Joules and Output Voltage reset to zero and the lightning symbol blinks at one-second intervals to indicate that the output has been overloaded. We recommend charging the Energy Storage.



Energy Storage error

The triangular warning symbol remains on constantly to indicate that there is an error on the Energy Storage.

Remove the Energy Storage and check that the connections are clean. Reconnect the Energy Storage and charge. If the warning symbol reappears, replace the Energy Storage.



Troubleshooting

The display goes blank
The Energy Meter is designed to turn itself off after 15 minutes of inactivity. If the display remains blank after turning the Energy Meter back on, ensure the Energy Storage is connected correctly and is fully charged.

The Energy Meter will not charge
Check that the power source is connected correctly to the Energy Meter via the Input plug. If it is, connect a different Energy Storage to determine if the Energy Meter is faulty.

The Energy Meter will not start up
Remove the Energy Storage from the Energy Display, wait 5 minutes, reinstall the Energy Storage and then charge the Energy Meter.

Connected elements are not being powered
Check that the element is connected correctly to the Energy Meter via the Output plug. Ensure that the directional control switch is not set to off. Ensure the Energy Storage has sufficient charge.

INFO
At least 1 J of energy must be stored before power can be drawn from the Energy Meter

Caring for your Energy Meter

The life of your Energy Meter is affected by how it is used, maintained and stored. Follow the guidelines below to ensure that you get the most out of your Energy Meter:

Do...
- Store the Energy Meter at room temperature in a clean, dry environment
- Recharge the Energy Storage before every use
- Disconnect it after use

Do not...
- Use excessive force when operating the Energy Meter or when connecting elements to it
- Mishandle or drop the Energy Meter or submerge it in water
- Exceed the maximum 10 V supply voltage
- Overload the Energy Storage
- Short circuit the Energy Storage

Technical Specifications

Input voltage	0.0 - 9.9 V
Input current	0.000 - 0.200 A
Input wattage	P = V x I
Output voltage	0.0 - 9.9 V
Output current	0.000 - 0.450 A
Output wattage	P = V x I
Accumulated joules	0 - 100 J
Energy Storage	150mAh