ILN // Module 1 : Renewables energies // Practical exercises

Theory Part // Electrical engineering

- Learning the concepts: Voltage, Current & Wattage

To use the Energy meter sensor, it is necessary to learn some electrical concepts about the Voltage, Current & Wattage.
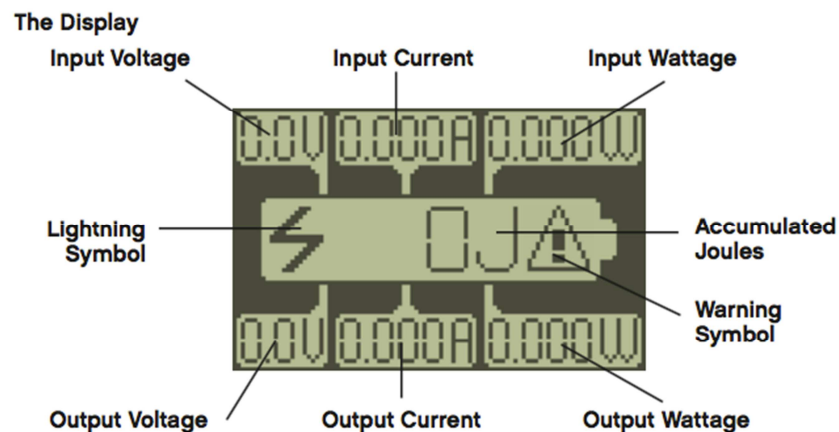

Illustration 1: The display

Voltage

Voltage, electric potential difference, electric pressure or electric tension (denoted ΔV or ΔU) is the difference in electric potential energy between two points per unit electric charge. The voltage between two points is equal to the work done per unit of charge against a static electric field to move the charge between two points and is measured in units of volts (a joule per coulomb).
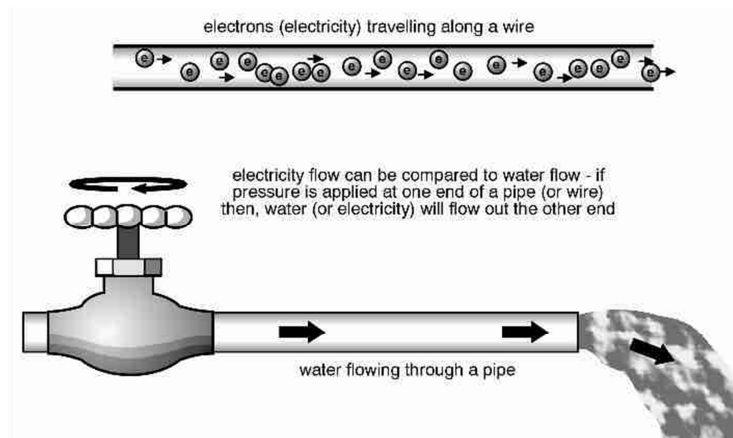
Illustration 2: Electrical analogy with the water

Volt, formally, is defined as the potential difference across a conductor when a current of one ampere dissipates one watt of power. This definition is not very helpful to consumers. Using a water-in-pipes analogy, volts is analogous to water "pressure" in the electrical system. Having higher "pressure" in a pipe (or electrical conductor) means that conductor is capable of delivering more energy to the user.

Just as a 10 gpm flow rate of water through a pipe provides half the amount of water as a 20 gpm flow rate, 10 amps of current in a conductor provides half the energy as 20 amps of current.

Current
Amps, as we discussed above, is a measure total current flow (or "gallons per minute" or "gpm" using the popular water analogy) available from an electrical service.

Wattage
Watts is a measure of the amount of electricity being used - a rate of electrical power consumption. Most people use a very simple mathematical formula to determine how many watts an electrical circuit can carry or how many watts an electrical device will require:

- Watts = Volts x Amps

This formula shows how Watts relates to Volts and Amps. You can rearrange this equation using simple algebra or you can re-write it using Ohm's law. (Ohms is a measure of electrical resistance, which also measures the heat that will be generated in a wire carrying a given current.)

- Amps = Volts / Ohms

Given those two equations just cited, we can also write:

- Watts = Volts x (Volts / Ohms)

Exercise 1 // Electrical engineering

- Learn to use Energy meter sensor

Introduction

The Energy Meter is part of the Renewable Energy Add-On Set. If you connect the Energy Meter to a sensor port on the EV3 Brick, the meter can provide data about the electrical energy storage, input, and consumption of the electrical components connected to it.

Illustration 3: Energy meter sensor

The display

Energy meter show the following information in the LCD display:

The Display
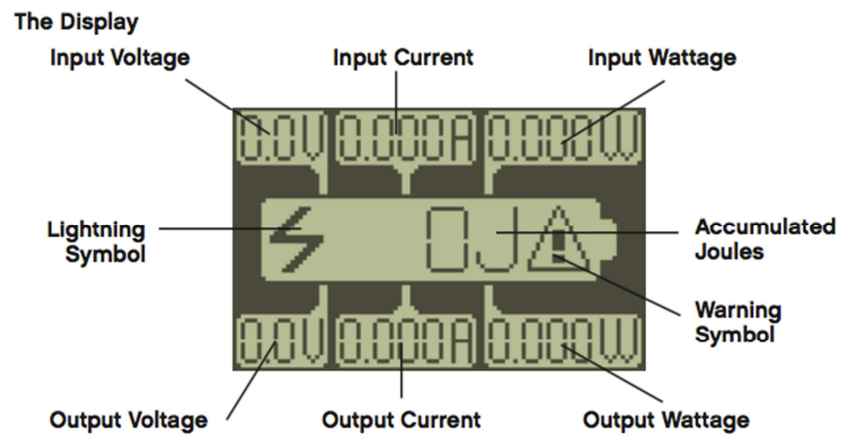
| Input Voltage | Input Current | Input Wattage |

Lightning Symbol

Accumulated Joules

Warning Symbol

| Output Voltage | Output Current | Output Wattage |

Illustration 4: The display

The Energy Meter provides seven kinds of Numeric data:

Data	Type	Range	Units	Notes
In Voltage (V)	Numeric	0.0 to 10.0	Volts (V)	Input voltage
In Current (A)	Numeric	0.0 to 0.3	Amps (A)	Input current
In Wattage (W)	Numeric	0.0 to 3.0	Watts (W)	Input power
Out Voltage (V)	Numeric	0.0 to 10.0	Volts (V)	Output voltage
Out Current (A)	Numeric	0.0 to 0.5	Amps (A)	Output current
Out Wattage (W)	Numeric	0.0 to 5.0	Watts (W)	Output power
Joule (J)	Numeric	0 to 100	Joules (J)	Stored energy

Illustration 5: Information provided by the Energy Meter

Technical Specifications

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

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

Where to use the sensor

Block	Mode	Use
Wait	Energy Meter - Compare	Wait for a data reading to reach a certain value.
Wait	Energy Meter - Change	Wait for a data reading to change by a certain amount.
Loop	Energy Meter	Repeat a sequence of blocks until a data reading reaches a certain value.
Switch	Energy Meter	Choose between two sequences of blocks based on a data reading.
Energy Meter	Measure	Get a data reading on a Numeric data wire.
Energy Meter	Compare	Compare a data reading to a threshold and get the result on a Logic data wire.
Data Logging		See Data Logging

Illustration 6: Available blocks to use this sensor

- Practice: 1: Connect the Energy Meter with a Motor

Connect to the energy meter a Lego E-Motor to generate an amount of energy. Learn to read the display.

Illustration 7: Lego E-motor

Practice: 2: Connect the Energy Meter with EV3

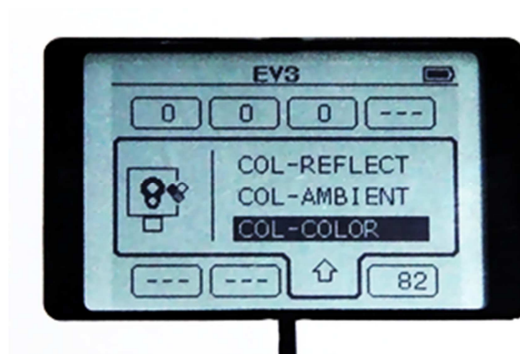Use the port view to read values from the sensor Energy meter

Illustration 8: EV3 Port view

Class 3

- Practice: 3: Show the amount of energy stored in the Energy meter
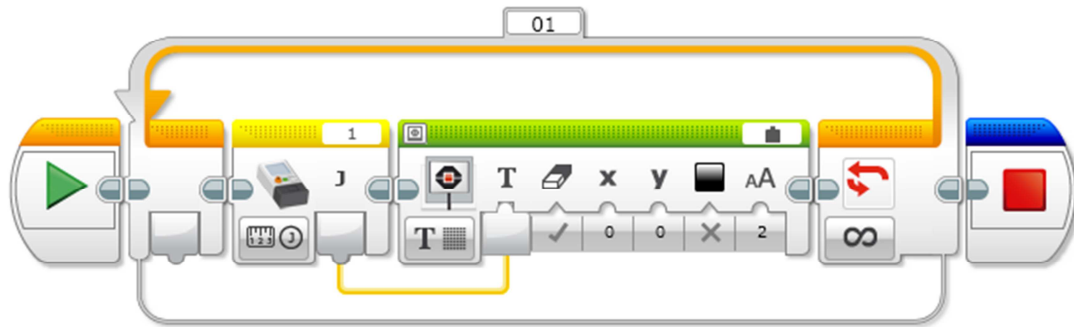

Illustration 9: EV3 Program example

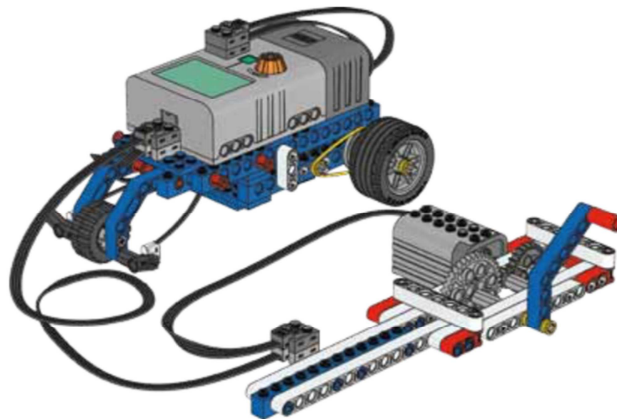- Practice: 4: Play an alert sound when the Energy meter stores 50J

Extra // Homework

- What batteries do you have at home?

Check Voltage and capacity.

- Homework1: Create a Hand Generator

Ideas:

http://www.mocpages.com/moc.php/285654
https://www.youtube.com/watch?v=XCoVoF3sgo0
https://en.wikipedia.org/wiki/AA_battery

Class 3