# DIY: 2 € NiMH batteries charger

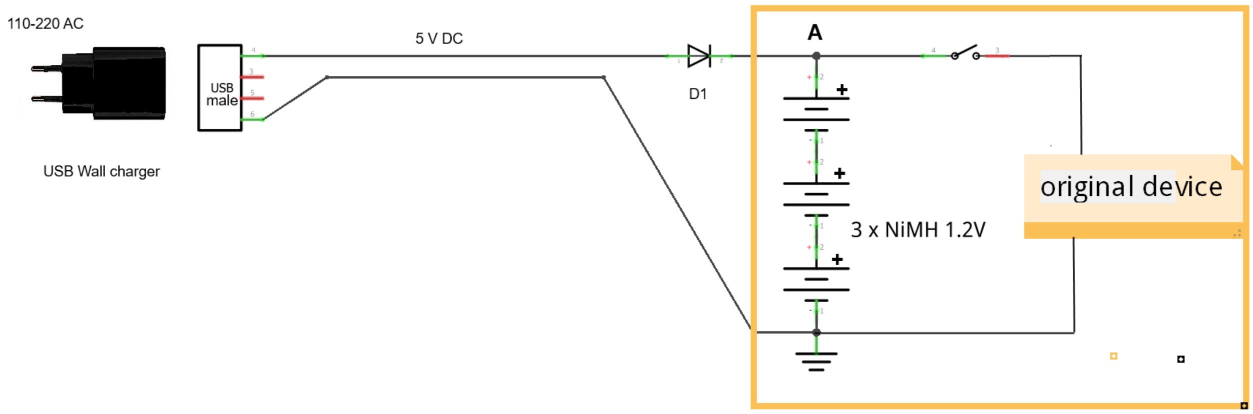
The Livarno mod z3199 garden spotlight is marketed by **Lidl**, and uses 3 AA NiMH 600 mA batteries recharged by a solar panel. It uses 10 LEDs and has two operating modes: continuous light, low intensity (15 mA) and more intense timed light (150 mA), controlled by a motion sensor (PIR) at night.

After two years of perfect functioning in my garden, the solar cell, exposed to the elements, has become unusable.
So I decided to add a 5 V 'slow charge' circuit to recharge the batteries. In this way I have the maximum freedom of choice between energy sources: with this circuit, in fact, any USB source at 5V can be used. Furthermore, as soon as the tidy solar cell (1.1 W) arrives, I can restore the original operation.

The complete analysis of the circuit used and of the possible applications are in ***e3DHW-Power Management System, an introduction*** (https://github.com/msillano/e3DHW-PMS/blob/master/e3dhw-pms-intro_en.pdf )

## The most universal NiMH battery charger

The ***slow charge*** circuit for 3 NiMH rechargeable batteries, using a 5V source is really simple, it only requires a silicon diode!
The diode has a dual purpose: it lowers the voltage of the power supply from 5V to 4.4V and excludes the power supply when it is not powered in AC.



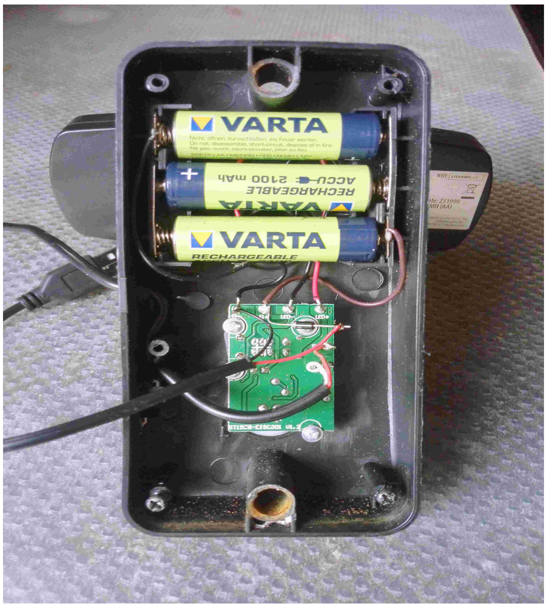

The charging current has an exponential trend: when the voltage to the batteries reaches 4.4 V the absorbed current is practically zero, guaranteeing the complete charge. NiMH rechargeable batteries can be used as buffer batteries and therefore can remain under slow charge for an indefinite time.

The 5V source (in the figure, '*USB wall charger*') can be any 5 V USB device capable of charging a smartphone: mains power supplies, power banks ... or solar cells as in origin ..

## Required material

- **A short USB power cable,** of which we will only use the male A plug with a length of cable.
- **A silicon diode,** 50 + V, 1A (e.g. IN4001).

# Mounting




1) Desolder and eliminate the original wire for the solar cell (**S+** and **S-**)
2) Prepare the power supply wire, cutting off the part that is not needed.
3) Strip 5 - 6 cm of the wire: only the red wire (+) and the black wire (ground) are needed.
4) Insert the wire into the fairlead used for the solar cell.
5) Solder the black wire to the **B-** contact of the printed circuit (battery negative)
6) Solder the red wire to the diode and then to the **B+** contact of the printed circuit (positive). Pay attention to the polarity of the diode: the white band goes towards the battery.
7) Block the cables with hot glue.

# Measurements

| Condizioni(*) | USB [V] | USB [mA] | A node [V] |
|---|---|---|---|
| Without batteries, light off, PIR on | 5,03 | 0,06 | 4,38 |
| Without batteries, steady light on | 5,01 | 15 | 4,28 |
| Without batteries, PIR, light on | 4,11 | 160 | 3,38 |
| Batteries charged, PIR, light on | 4,95 | 10 | 4,26 |
| Low batteries, PIR, light on | 4,18 | 70 | 3,50 |
| Low batteries, off | 4,80 | 40 | 4,11 |

*(*) with a mains power supply, nominally 5V 1A*

*From the measurements it can be seen that the power supply is relatively stable: it supplies 5.03 V without load, and the voltage drops to 4.11 V with a current of 160 mA (max absorption in PIR mode): in these conditions the voltage at the node A is 3.38V.*
*With the batteries charged, the current required for the lamp (160 mA) is supplied in part by the power supply (10 - 70 mA) and partly by the batteries that discharge slowly.*
*When the battery voltage reaches 3.38 V, the power supply provides all the necessary current (160 mA) and the batteries do not discharge any further.*
*This guarantees that, with a continuous 5V supply, the lamp never goes off and the batteries are protected against the risks of both overcharge and overdischarge.*
*When the light turns off, the power supply recharges (slowly) the batteries (40 mA @ 4.11V) with an exponential trend up to the final value, nominally 4.4 V.*
*Without the external 5 V supply, the batteries will discharge more quickly.*
*When the battery voltage reaches 2.50 V the LED light is very weak, but we are already in the overdischarge area. The voltage should never fall below 2.7 V! With an intermittent energy source (solar e.g.) you must promptly intervene when the LED lights begin to fade, immediately recharging the NiMH batteries.*
*But this is a rare event.*
*Consider the PIR standby current, rounded to 0.1 mA and the duration of the time delay, 2 minutes: assuming 10 starts in 24 hours: the daily consumption is equal to 0.1 x 24 + 10 x 160 x 2/60 = 55.7 mAh . So the charged batteries (600 mAh) last a full 10 days.*