

# Photovoltaic solar cooking without batteries and storage

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## Part 2 : MANUALLY OPERATED COOKER : APPENDICES

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Translated with the help of [www.DeepL.com/Translator](http://www.DeepL.com/Translator) (free version)

This second part contains additional information for the neophyte. By design, this solar photovoltaic cooker is dedicated to self-construction. The experienced professional, craftsman or technician manufacturing cookers for marketing purposes, will be kind enough to be lenient with the abundance of details mentioned below...

We are talking here about a cooker working with a panel of 300 W max / 40V max / 10 A max, but all other powers of cookers are conceivable subject to respecting all the rules of the art, in particular as regards the electrical characteristics of the various components, and subject to not exceeding 40 Volt for safety reasons.

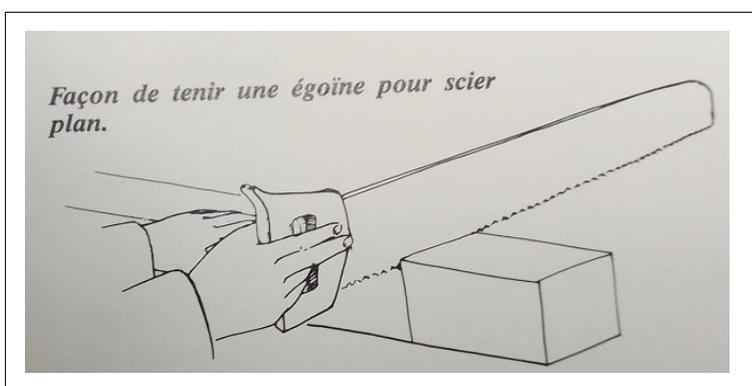
The fifth part is devoted to more general information about the electricity, the components, the photovoltaic panel...

The web links mentioned below are commercial links, whose durability is not guaranteed; however, these products are commonly used.

## 1st STEP - THE BASE OF THE COOKER

Exterior grade plywood is made with moisture resistant glue, so it is a good choice for the cooker.

The 8 mm plywood is very easy to cut with a fine tooth egine saw. It is recommended that you always draw two lines on the cutout to make it clear where it is.



And to prevent the ego-saw from stubbornly deviating from its assigned path, "Leave the index and middle fingers extended, so as to keep the blade and the forearm in the same axis" (Xavier Buhot-Launay - "Building a wooden boat"; a model of pedagogy).

Whatever the plywood, it is necessary to paint it.

If possible, use "glued and screwed" assemblies; 3x20 screws are very suitable.

To assemble a piece of plywood on a wooden cleat, it is always preferable to drill the plywood (diameter 2 or 2.5 for a 3 mm screw), and to mill the location of the screw head.

## 2nd STEP - THE CONTROL PANEL

### The PVC plate

Supply of the PVC plate: for example at Polydis.fr, white PVC plate thickness 3 mm, code PVCC3W04.

To make the cuts, you can use for example a Bahco 302 scroll saw, ref 63813414 at Leroy Merlin.

A DIY cutter can be used to make finishing touches if needed

It is possible to supply a cut plate; consult leboncoin.fr, category "others" (this is the last one), location Brest(29200), then search for "parts for manual solar cooker" .

The royal solution consists of course in machining the plate with a small numerical control machine called "table CNC", dimensions 40 x 30.

In order not to melt the PVC during machining, one can use carbide milling cutters Ø 3 or 3,175mm (1/8") with 1 tooth, for example at CNCfraises.fr, reference FC1D3012EVO ; rotation at 800 revolutions (is this a reliable measure?), feed 300, passes of 0.8 mm, machining downstream, and "levels first" in order not to heat the material.

[Here is a DXF drawing for cutting PVC on CNC](#)

The optional installation of LEDs to indicate the position of the switches requires some additional drilling, see part 5 Chapter II. This is a small complication, but it is very useful for the user.

It is preferable to supply the electrical components (switches...) before making the cut-outs, because of the possible changes in dimensions.





# La Diode

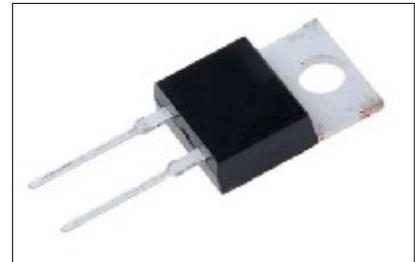
The electric current delivered by a solar collector, like the one delivered by a battery or an electric cell, is a direct current, abbreviated DC for Direct Current, which "flows" (to make it simple) from the positive pole called the +, to the negative pole called the -. The current of an electrical network is an alternating current, called AC, whose flow changes direction 50 times per second.

Some appliances that use electricity are not sensitive to the direction of the current, for example the ceramic heaters used under the hot plate of the cooker. Others are very sensitive, or even do not work at all if they are plugged in "backwards", in particular electronic devices; however, our cooker uses a Wattmeter, which is a small electronic meter, a very useful compass for the user. It is therefore important to always connect the cooker correctly: the + pole of the sensor to the + pole of the cooker (in principle: red wire, or dark red), and the - pole of the sensor to the - pole of the cooker (in principle: blue wire, or black).

But of course an error is always possible. To avoid damage to the meter, the solution is to use a small electronic component, a semiconductor, which allows the current to flow only in one direction, namely a diode. For our use, a so-called "power diode" such as the one below is very suitable:

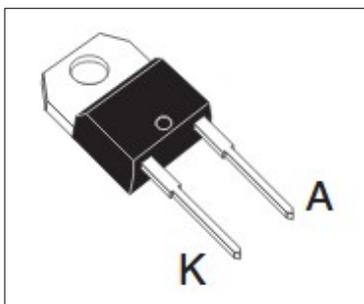
Through-going diode, 15 Ampere, 200 Volt, at [en.rs-online.com](http://en.rs-online.com), code 687-0824. See also : diode DIOTEC P2000A on a search engine.

The diode is the first component at the input of the cooker: if the user swaps the + and the -, nothing works, but there will be no damage.



One of the pins, the Anode, is connected directly to the + pole of the solar collector, then the current comes out through the Cathode and continues its way into the cooker. On the documentation of the diode, locate the Anode and Cathode.

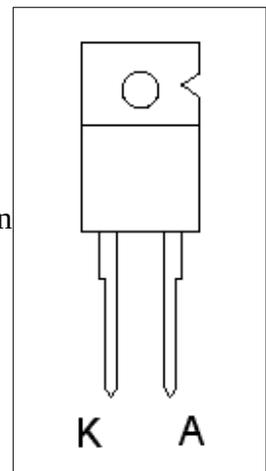
For its operation, the diode takes a little voltage, about 0.7 Volt; depending on the available amperage, about 7 to 8 Ampere in cruising mode, it results in a release of heat, about half a dozen watts, which must be evacuated; It is the role of the small tinned copper plate, which acts as a radiator; it is pierced, in order to add another metal plate, if necessary, in case of important heat release, but that should not concern us. In our case, this hole allows us to fix the diode under the control panel, using a bolt long enough to move one away from the other, and allow a good ventilation of the diode.



For a neophyte (and even for a professional) nothing is easier than to confuse Anode and Cathode when it comes to connecting them, so let's agree here to locate the Anode by making a small notch with a file on the heat sink, on the side of the Anode. For the rest, it doesn't matter in which direction the diode is represented on the assembly diagrams: the only instruction is to connect the + coming from the sensor, on the pin

which is on the side of the notch.

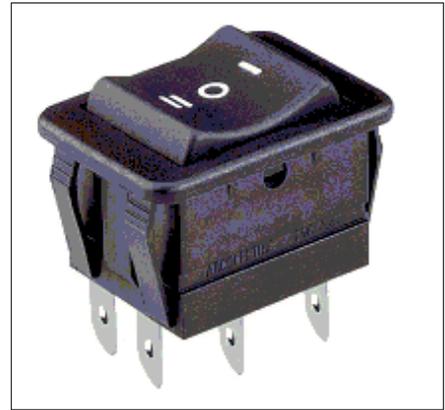
We can easily check the direction of a diode with a multimeter, see part 5 chapter II



## Les Interrupteurs à bascule

Supply of the three-position switch: e.g. [Arcoelectric](#) or Marquardt or RS PRO

Supply of two-position switches: for example [Arcoelectric](#)



It is essential to supply good quality switches for two reasons. Firstly, in the case of photovoltaic cooker, the current intensity, also called Amperage, is relatively high, up to 8 or 10 Ampere (while the voltage does not exceed 35 or 40 Volt). In order to transmit this amount of electricity, it is essential that the switches are equipped with good contacts, otherwise they heat up (which consumes electrical current!) and can be destroyed by heat, not to mention the risk of fire. Secondly, we are talking about direct current (DC) and not alternating current (AC) like the one usually available on electrical networks. One of the particularities of direct current is that it causes a flash when a circuit is broken, when the current is "cut off", resulting in premature wear and tear of the contacts. Any switch that heats up should be eliminated. Switches available on the Net at very low prices are to be rejected. N.B. there is a solution to this problem, see Part 5 Chapter II.

## The Wattmeter

DC 6.5-100V, 20A model  
PZEM-031

The PZEM 031 model (see back of the device), without shunt, up to 20 A, is very suitable for a one-panel installation, like the one proposed here; beyond that, a model with shunt should be used.

This Wattmeter is mainly available in Asia, search for the keywords "wattmetre électronique", but we start to find the same in Europe

In the case of the manually operated sensor, the driver only takes into account the power in Watt, to increase or decrease the number of ceramic resistors in operation.



### **Step 3: WIRING THE CONTROL PANEL**

Concerning the soldering of electrical cables, many tutorials are available on the Net.

Use flexible cable according to the H07V-K standard. The K specifies that it is a flexible cable, a U would specify that it is a rigid cable, unsuitable for our use.

A 1,5 mm<sup>2</sup> section is very well suited to wire the cooker. This cable is not always available in stores, but it is easily found on the Web

To connect the cooker to the photovoltaic panel, a section of 2,5 or 4 mm<sup>2</sup> will be essential

The electrical connections can be crimped or soldered.

Insulate the connections with heat-shrink tubing. After installing a small piece of tubing over the soldering, simply heat it slightly with a lighter.

### **4th step : THE HEATING PLATE**

#### **The aluminum sheet**

The thickness of 5 mm, which is a good compromise between heat transfer and rigidity, must be respected.

The sheet metal can be obtained from an industrial sheet metal shop; if the sheet metal is sheared, make sure that it is not bent very slightly, which would make it unsuitable for our use.

With a bit of luck, we can find a sheet metal of adequate dimensions at a scrap dealer on the Net, in which case a jigsaw cut is quite feasible (make sure that the saw is not subject to any vibration), the rounding of the 142 mm diameter does not need to be perfect.

A good solution is to contact a laser or waterjet cutting shop, but these shops usually do not handle such small quantities.

It is possible to buy a cut sheet on leboncoin.fr, category "others" (it's the last one), location Brest(29200), then search for "parts for manual solar cooker"; the location of the holes is drawn on the sheet.

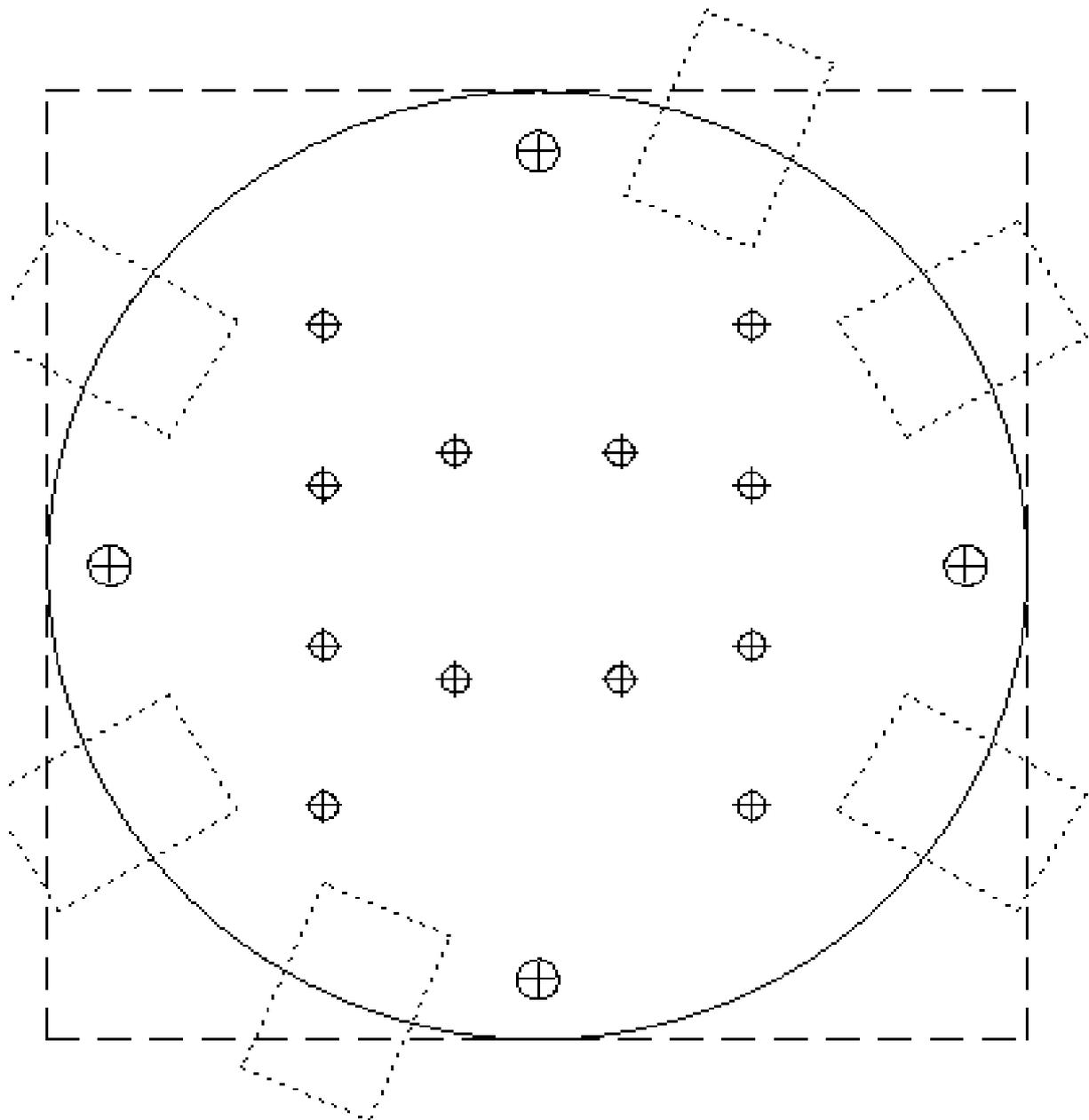
#### **the drilling template**

If you are supplying a raw sheet, you can use the drilling template below, in actual dimensions, to apply to the round aluminium sheet.

- After printing, check that the dashed square measures exactly 142 mm on each side; an error of plus or minus 2 mm is permissible. If the dimensions need to be modified slightly to obtain a square of 142 mm, you can make a screen copy to be inserted in Libre Office, and then modify the dimensions to the nearest pixel with the help of the vertical and horizontal rules.

- you can cut the small dotted windows with a cutter to position the template correctly on the sheet, and fix it with adhesive tape

- do not use a punch with a hammer to avoid deforming the sheet; you can drill directly with the drill bit to center through the paper template.



**Some thermal considerations** , about the removal of machining burrs :

The thermal conduction  $\lambda$  of aluminum, i.e. its capacity to let heat pass through the material, is 230 W/m.K. The thermal conduction  $\lambda$  of air at 100°C is 0.031 W/m.K. No matter the units here, the ratio is 230/0.031, i.e. 1/ 7420. A layer of still air of 1 millimeter thick insulates as much as ... 7.40 meters of aluminum. This shows how important the flatness, the good surface condition and the cleanliness of the heating plate are for the heat transfer between the heating plate and the cooking vessel: the slightest air gap compromises the functioning of the cooker.

(For the sake of completeness, it should be noted that air can also transmit heat, but in this case we are talking about moving air masses, convection and not conduction through the material, which is not what we are talking about here).

## 5th step : FIXING THE CERAMICS

### Belleville spring washers

Supply washers  $\varnothing$  4,2 inside, and  $\varnothing$  8 mm outside. We can find some with an external diameter of 10 or 12 mm, but it is useless for us. See for example:

otelo.com 67881793,

or screw-express.fr 3552170051 (available in quantities of 30 pieces)

About the supply of ceramics, see Part 6, Chap II.



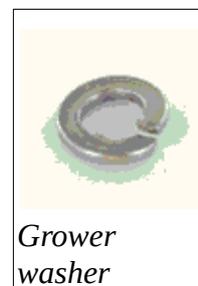
*Belleville spring washers*

## Step 7: ASSEMBLY OF THE HEATING BLOCK

Grower M6 washers; for example:

otelo.com 67881943 ,

or vis-express.fr 8751000618



*Grower washer*

The fan washers are available in the stores mentioned above, or in the DIY stores.



*fan washer*

Banana plugs: e.g. Radiospare ref. 175-8974, to be used e.g. for the connection between the cooker and the solar collector; see Part 5 Chap VII.

