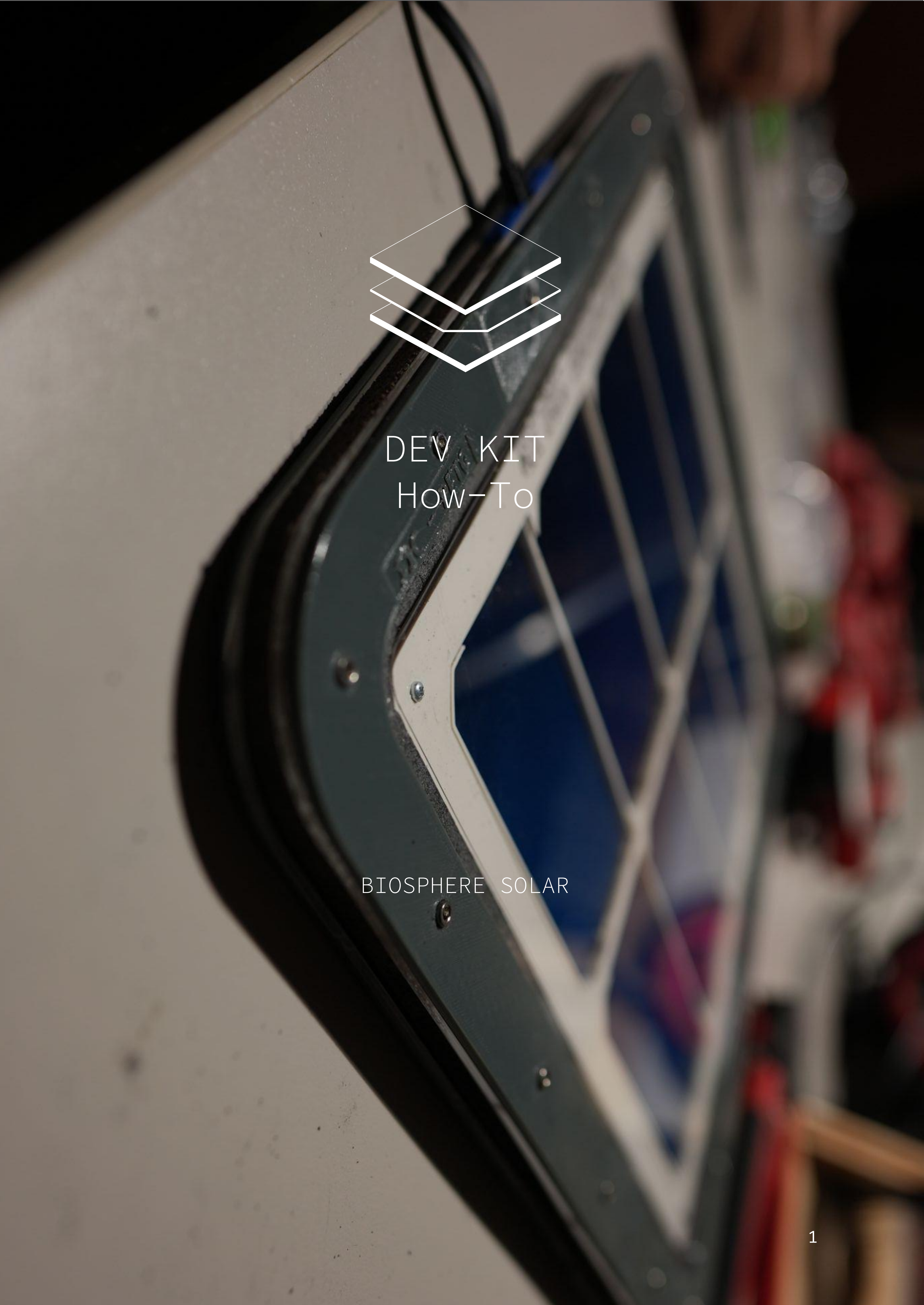


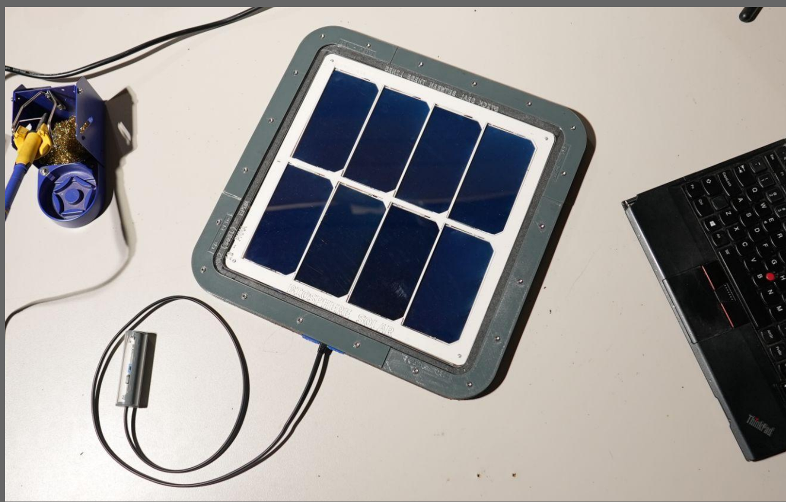
DEV KIT How-To

BIOSPHERE SOLAR

Table of Contents

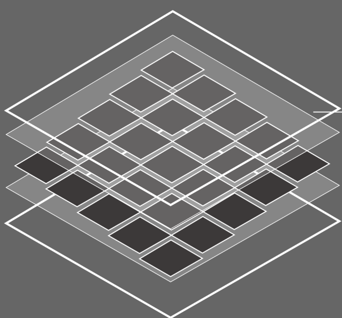
INTRODUCTION

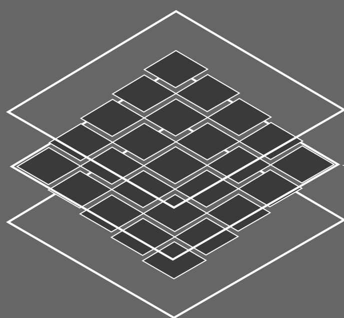
Dear readers, welcome to our How-To document for the DEV KIT, our first DIY small solar panel. Here you will receive detailed instructions on how to assemble your first small circular solar panel! At Biosphere Solar with our team with your help, part of our global community, we are bringing fair and circular solar to the solar industry and market. Some of our projects can be found on our Wikifactory page. With the DEV KIT, we aim to create an open source hardware community for circular solar development. By integrating the feedback for the DEV KIT design and knowledge of the solar module designers, engineers, researchers, hackers and enthusiasts. We would like to improve the design of our larger module through the feedback and iteration of this DEV KIT design. In addition, we aim to demonstrate to the wider audience how accessible and relatively straightforward it is to build your own circular solar panel at home without needing specialized tools.



BACKGROUND

Conventional solar panels (bottom left) consist of two layers of glass with solar cells (arranged in series) in between and two layers of EVA lamination between the cells and the glass. While the EVA lamination provides internal structural support for the panel, it makes the disassembly of solar modules virtually impossible. So the design of Biosphere Solar DEV KIT (bottom right) utilizes edge seals and cellbeds for better circularity and repairability. It utilizes interdigitated back contact cells to increase efficiency and ease of soldering. The end of the cell arrangement is connected to the wire for power output and optionally a USB plug.



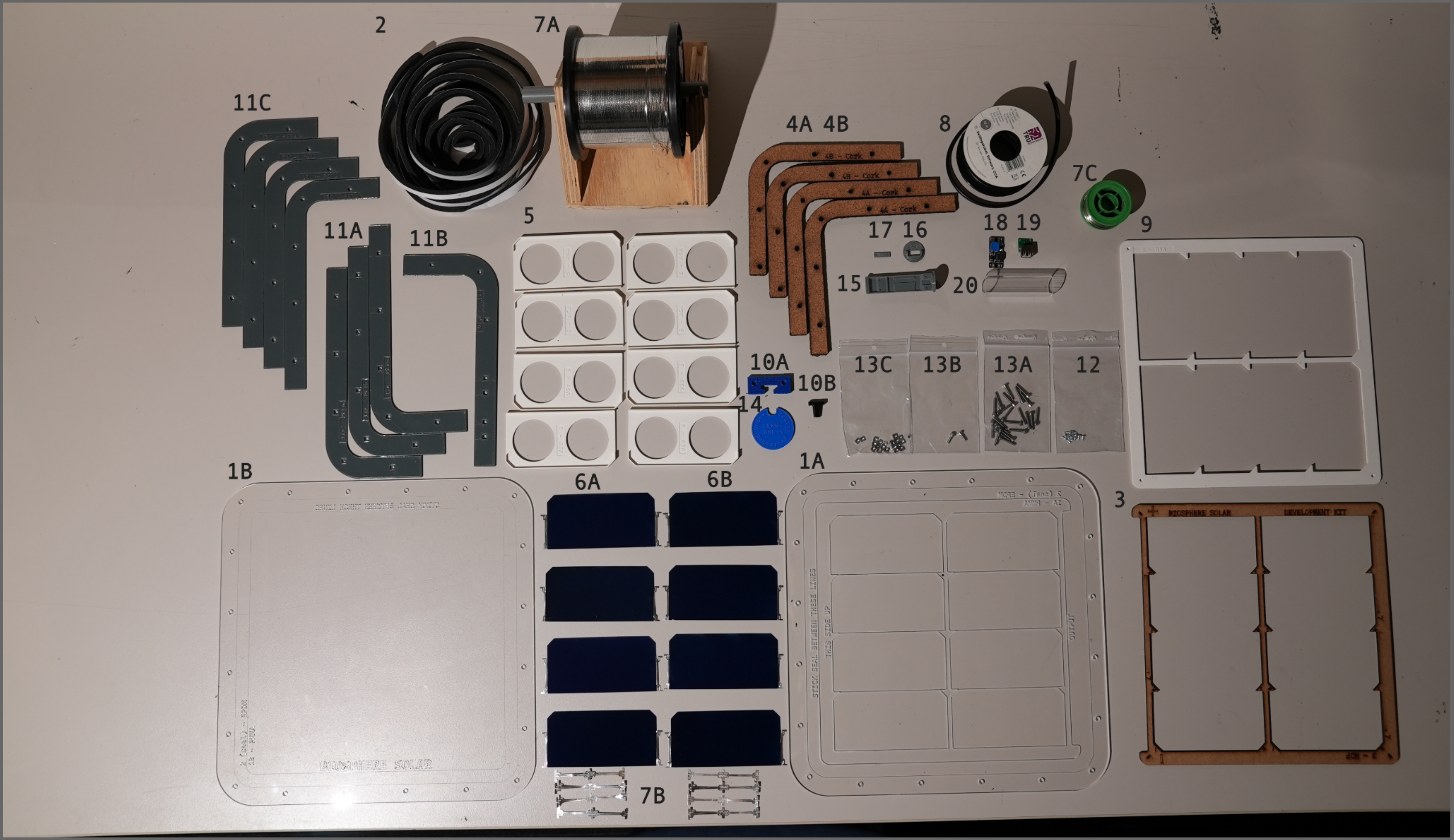


PARTS

Part number	Part name	Amount	Material	Size
1A 1B	Bottom sheet Top sheet	1 1	PMMA	3 mm
2	Seal strip	1	EPDM	6 mm
3	Cell template	1	MDF	3 mm
4A 4B	Edge spacer A Edge spacer B	2 2	Cork	7 mm
5	Cellbed	8	ASA	
6	Half cut +- cell Half cut -+ cell	4 4	Si, Sn, Cu	62.5 x 125 mm
7A 7B 7C	Tabbing wire Dogbone Soldering wire	1 8 1	Sn, Cu Sn, Cu Sn, Cu	
8	Cable	1	Al, Cu, PVC	2 x 0.75 mm^2
9	Cell holder sheet	1	ASA	
10A 10B	Cable-through piece Cable insert	1 1	PETG TPU	
11A 11B 11C	Edge distribution bottom Edge distribution bottom Edge distribution top	3 1 4	PETG	
12	Small screws	9	Fe, C, Zn	
13A 13B 13C	M3 X 18 bolts M3 X 10 bolts (optional) M3 nuts	20 2 22	Fe, C, Cu	
14	Branding	1	ASA	
15	Dongle core	1	PETG	
16	Dongle output	1	PETG	
17	Dongle cable clamp	1	PETG	

18	Dongle converter	1	PCB mix	
19	Dongle USB port	1	PCB mix	
20	Dongle transparent tube	1	PMMA	Inner Ø 25 mm x 80 mm

Parts 1, 3, 4 are laser cutted; parts 5, 9-11, 14-17 are 3D printed; and the rest are ordered online (some contains like). We chose the materials based on heat and UV resistance but feel free to experiment with different filaments. The files for 3D printing and laser cutting are in Wikifactory. The file names follow this format: DEV_KIT_componentname_partnumber. The next page has a detailed image of all the parts for the DEV KIT.


2
7A
11C
4A 4B
8
7C
5
11A
11B
17 16
18 19
9
15
20
10A
13C
13B
13A
12
10B
14
1B
6A
6B
1A
3
BIOSPHERE SOLAR
DEVELOPMENT KIT
7B

TOOLS AND MATERIALS

Tools	Critical?	Notes
Soldering station	Critical	To solder cells to dogbones and tabbing wires
Latex gloves	Critical	Ensure the cells are not never touched with bare hands
Wire clippers	Critical	To cut the tabbing wires to the right length
Multimeter	Critical	To ensure the current flows through the solar cells and the proper connection of the cells
3M mask	Critical	Often times soldering wire contains lead and other toxic metals
Allen wrench 2.5	Critical	Used to tighten the bolts
Slot head screwdriver	Critical	Used to configure the booster to the right output voltage
Scissors	Interchangeable	Used to cut the seal and or cable
Fume extractor	Interchangeable	The fumes released from soldering are toxic so they need to be extracted or filtered
Pliers	Interchangeable	Used to stretch the tabbing wire before it being cut to the right length
Philips head 1 (PH1/PZ1)	Interchangeable	Used to tighten the screws
Wire stripper	Interchangeable	To strip the wires for soldering
Stanley knife	Interchangeable	To cut the wire for soldering and to cut the seal
Hammer	Optional	To fit the nuts to the edge distribution strips
Flat soldering tip	Optional	Enables an easier soldering process because the components are mostly flat
Tweezer	Optional	Used to press down the electrical components for soldering
Glass cleaner	Optional	For cleaning the transparent sheet
Glass cleaning cloth	Optional	For cleaning the transparent sheet

Saw	Optional	For cutting the tube of the booster to the right length

DEV KIT

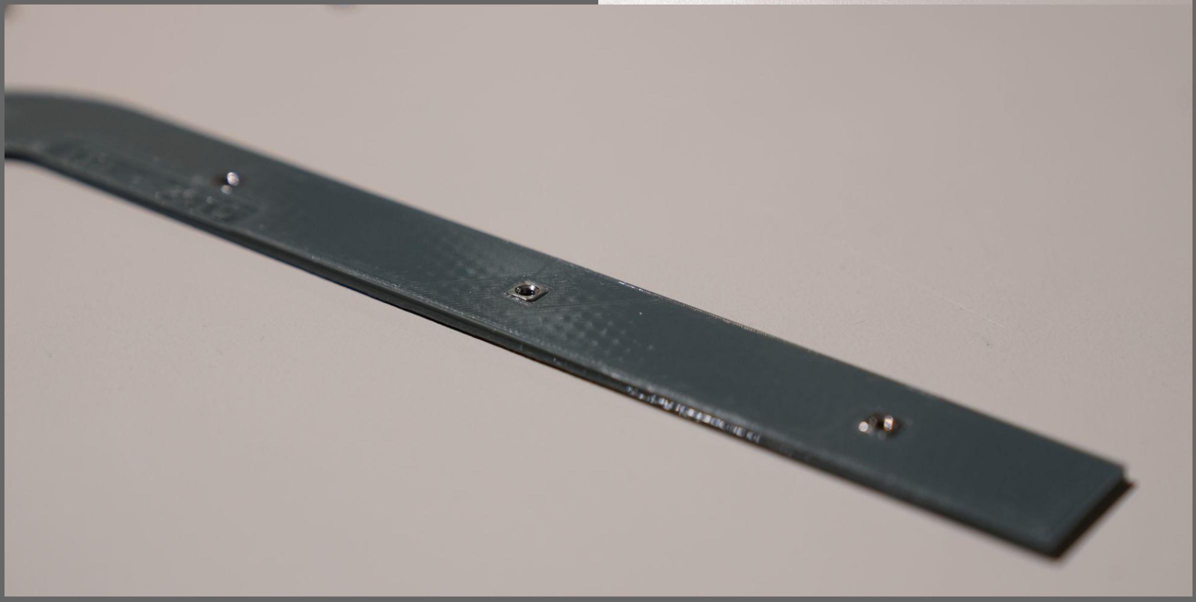
Step 0

Clean your workspace, check the parts and ensure you have everything. Remove the foil from the top (1A) and bottom (1B) transparent sheets. Wear latex gloves when handling the cells. **Be careful with the cells, since they are extremely fragile and one crack ruins the cell.**

Step 1

Parts: 11A, 11B, 13C

Press the nuts (13C) firmly into the square cutouts of the distribution strip (11A & 11B) and place the strip with the nuts facing down on a flat working surface. Or if the holes are too small from 3D printing, you can either use a hammer to fit.



Step 2

Parts: 1A, 2

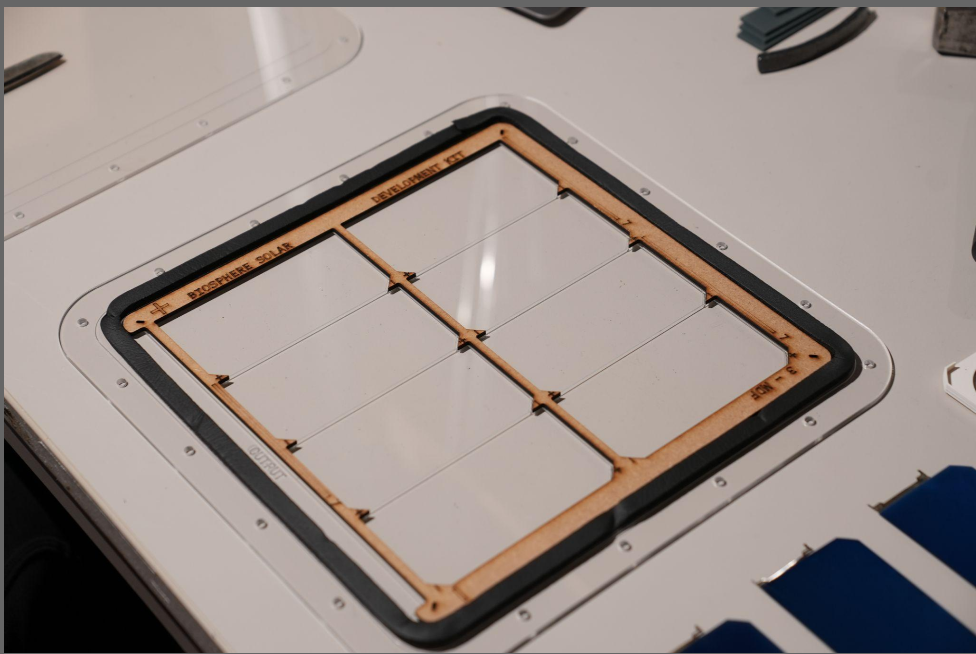
Tools: Scissors

Place the transparent bottom PMMA sheet (1A) on top of 11A & 11B, with ‘stick seal between these lines’ facing upwards and the text on the 11A & 11B facing down. Begin sticking the seal (2). Cut the seal on both ends in a 45° angle on the vertical side, overlapping slightly where the ends meet.

Step 3

Parts: 3

Place the cell template (3) on the bottom sheet (1A) according to the engraved lines on the bottom sheet (1A). ‘OUTPUT’ should be lined up with the cutout on one of the sides of the cell template (3).

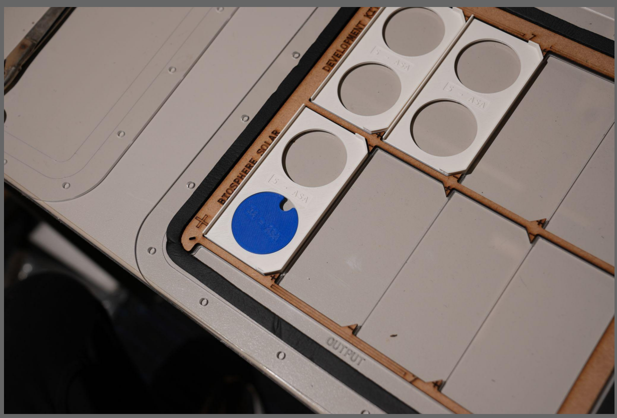


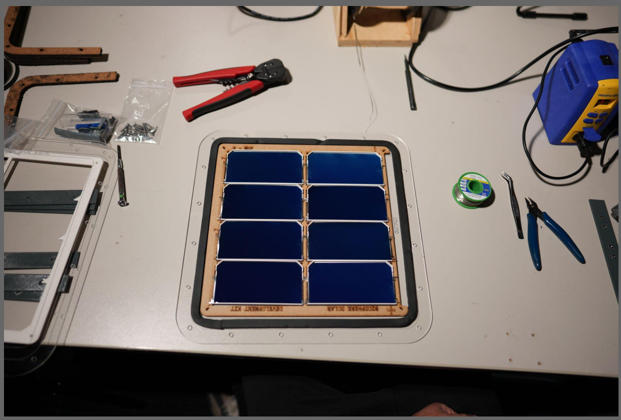
Step 4

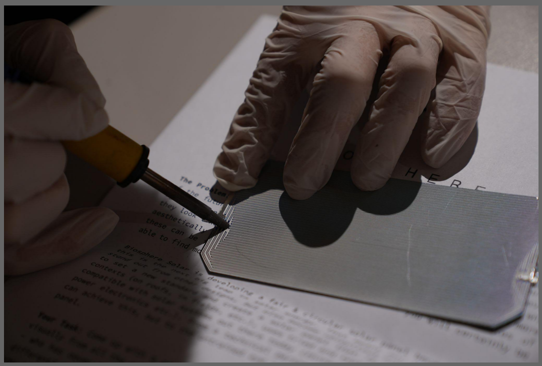
Parts: 5, 6A, 6B, 7B, 7C, 14

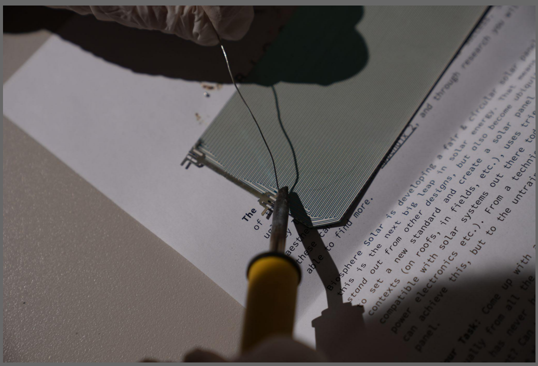
Tools: Latex gloves, multimeter, soldering station, soldering wire

Now onto the most important steps of the DEV KIT assembly! The cellbeds (5) can be placed in the cell template (3) accordingly. This is also the moment to insert the branding part (14) or any other customization parts. The cells should be aligned in series. But before that, put a pair of latex gloves on and start soldering the dogbones and cells. Use soldering wire if needed. The dogbones need to be cut in half and soldered onto each cell. Soldering wire (7C) is recommended to ease the process. And a tweezer can be used to press down A multimeter is used to check the voltage and polarity of the cells. The voltage of each cell should be between 0.2 V and 0.6 V. Make sure the readings are positive to ensure the polarity of each side for the cells to be aligned in series. To do so, the poles of the cells should align with the + and – markings on the cell template (3). And lastly check the cells carefully for microcracks.







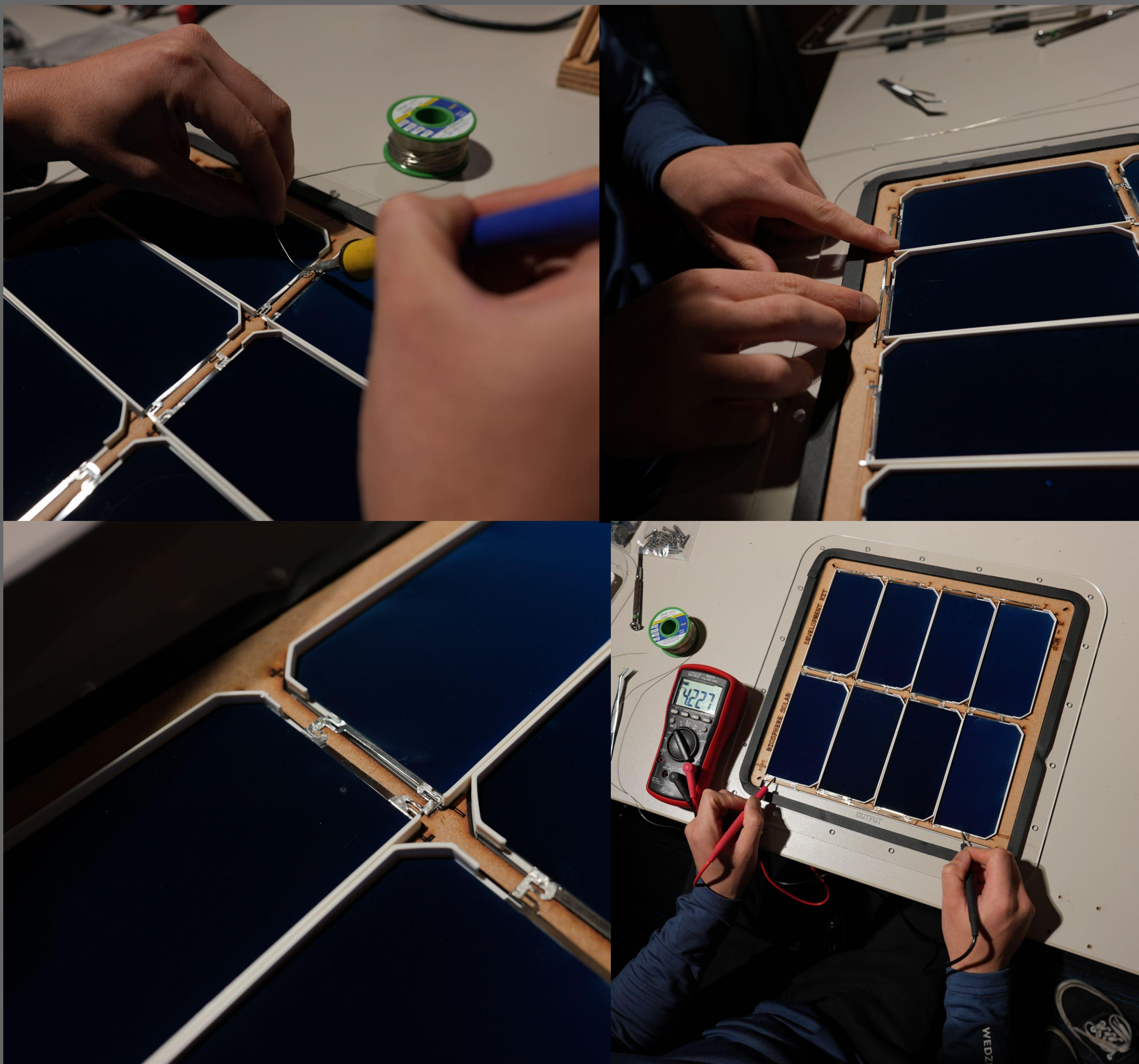


Step 5

Parts: 7A, 7B, 7C

Tools: Multimeter, soldering station, soldering wire, wire clipper

The overlapping ‘dogbones’ (7B) in the middle can be soldered directly together. <u>Don’t press down too hard</u>, because the dogbones can come loose from the cells. Using a bit of soldering wire (7C) helps with the process. Patience is key, don’t rush since the cells are very fragile. Markings on the cell template (3) indicate which cells need to be connected using tabbing wire (7A) to realise the flow of current. Place the tabbing wires to the indicated markings and solder them to the dogbones outside. When measuring the voltage of all the cells in series, the voltage should be around 4 V.

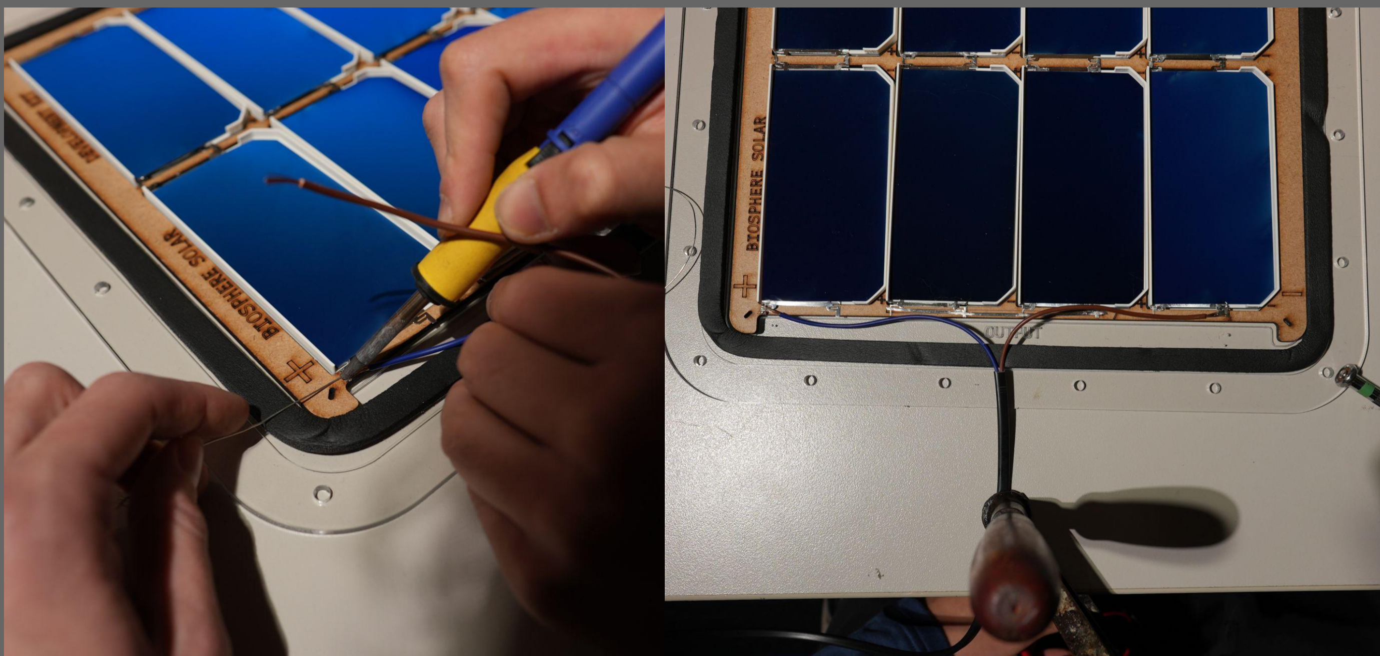


Step 6

Parts: 8

Tools: Wire stripper, stanley knife, soldering station, soldering wire

Cut the cable (8) to the desired length (0.5-1 m is suitable for most applications) and strip the end so that the blue and brown cables are exposed (around 10 cm with no more than 1 cm of exposed copper wire). The end poles of the cellbed assembly can be soldered to the cable (8). The blue cable should be connected to the + pole, and brown to the - pole. A clamp can be used to prevent the wires from moving. The cellholder sheet (9) can be aligned with the cell template (3). The countersinking of the screws in the corner of the cellholder sheet (9) should face upwards. Use the small screws in the corners to attach the cellholder sheet (9) to the cell template (3).



Step 7

Parts: 9, 12

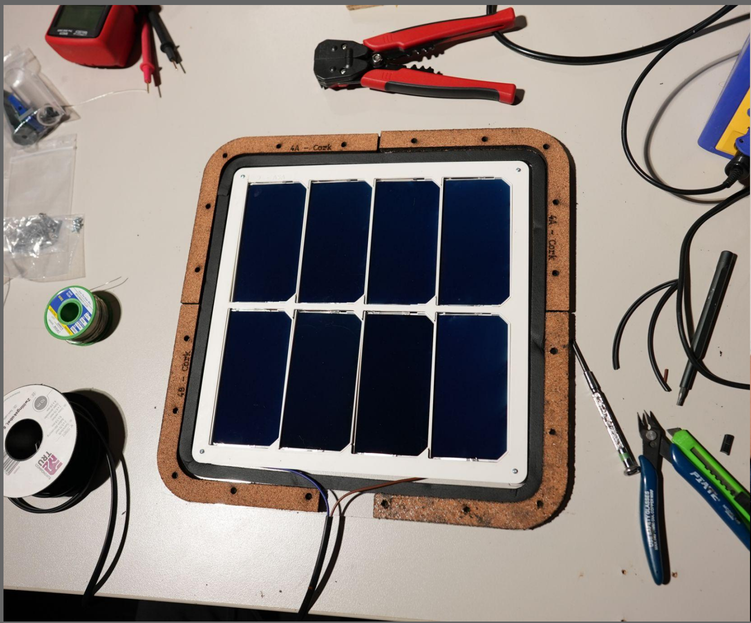
Tools: Philips head 1 (PH1 / PZ1)

The cellholder sheet (9) can be aligned with the cell template (3). The countersinking of the screws in the corner of the cellholder sheet (9) should face upwards. Use the small screws in the corners to attach the cellholder sheet (9) to the cell template (3).

Step 8

Parts: 4A, 4B, 10A, 10B

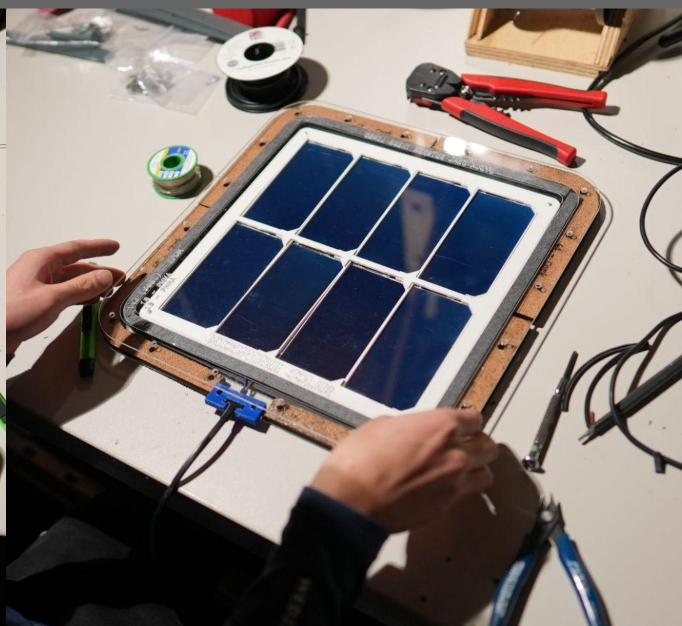
With the cells secured, align the cork space holders (4A, 4B) with the screw holes on the bottom sheet (1A), leaving a small gap for the cable-through piece (10A). The cable insert (10B) should be placed in the cable-through piece (10A). The cable (8) should go through the cable through piece (10A) with the text facing upwards and holes aligned with the cork spacers.



Step 9

Parts: 1B, 2

Repeat step 2 with the top sheet (1B). Make sure the seal is placed on the side where you can read ‘stick seal between these lines. Cut the seal (2) on both ends in a 45° angle on the vertical side, overlapping slightly where the ends meet. Place the top sheet with the seal facing down on the stack of the other parts. The cable (8) should be sandwiched in between the two seals.

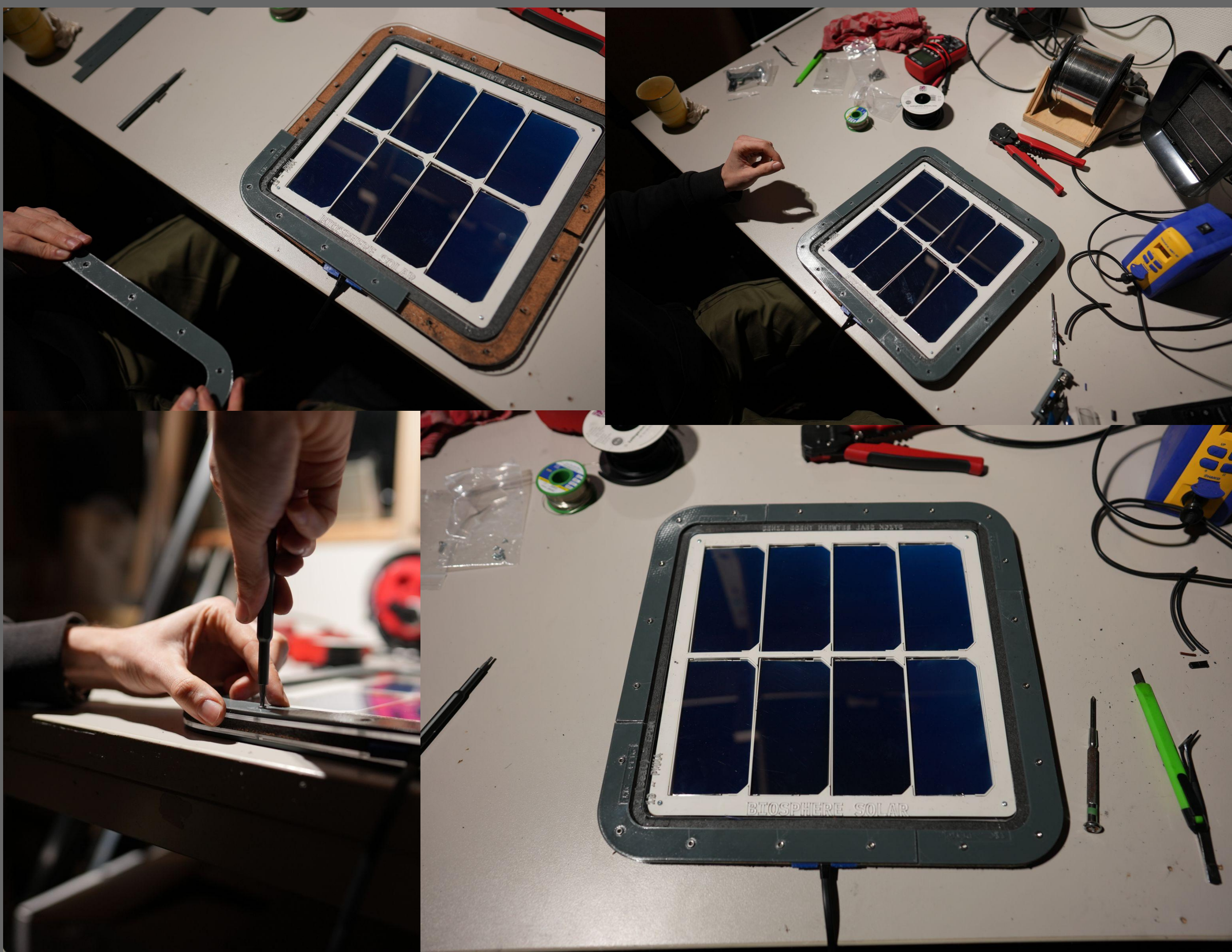


Step 10

Parts: 11C, 13A, 13B

Tools: Allen wrench 2.5

The 2 M3x10 mm bolts (13B) are inserted through the cable-through piece (10A), which aligns with the two centermost nuts on the bottom edge of 11B. The insertion of the M3X10 mm bolts are optional but they secure the cable even more. The top distribution strips (11C) can be aligned on the top sheet (1B), the countersinks should be facing upwards. Carefully align all the layers one more time. The M3X18 mm bolts (13A) can then be screwed through the holes and fastened into the nuts (13C) at the bottom. Make sure to apply some pressure when fastening the bolts since the seal can be compressed. Choose an edge or corner to start and work your way around. Congratulations! Your DEV KIT is finished!



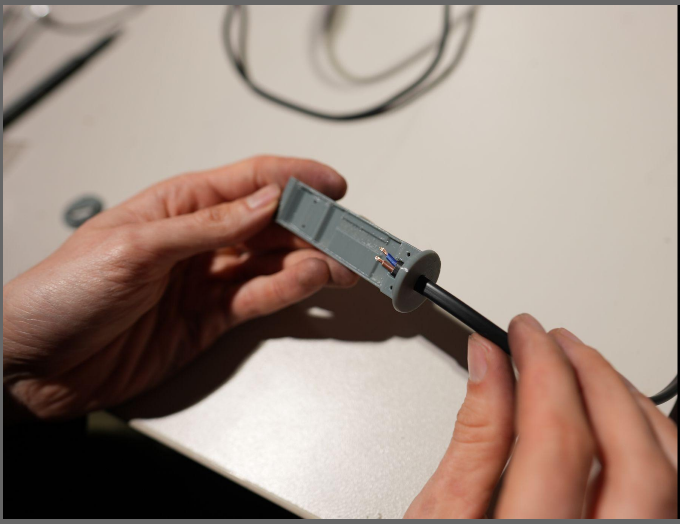
BOOSTER DONGLE

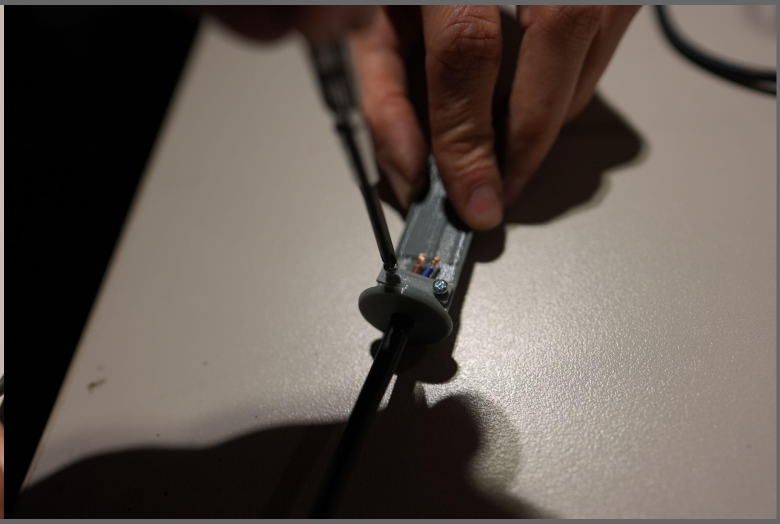
Step 1

Parts: 12, 15, 17

Tools: Philips head 1 (PH1 / PZ1)

Strip and pull the end of the cable (8) through the hole of the dongle core (15). The cable can be clamped down using the small cable clamp (17) and two screws (12).



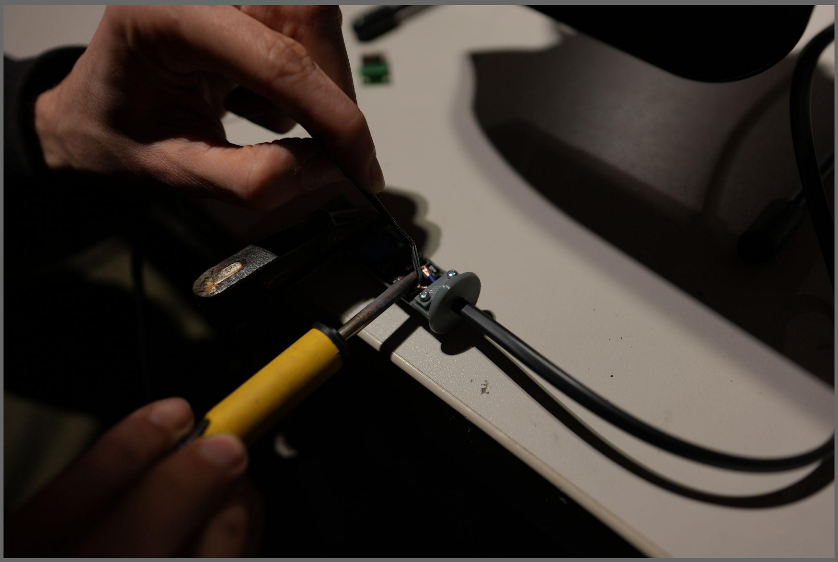


Step 2

Parts: 18

Tools: Soldering wire, Philips head 1 (PH1 / PZ1)

Solder the ends of the cable to the input side of the step up converter (18). Remember that blue should be soldered to the + side and brown to the - side. And the converter can be placed on the dongle core.

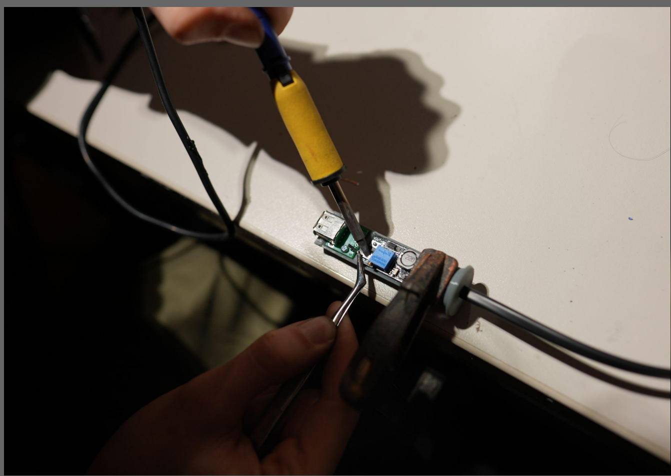


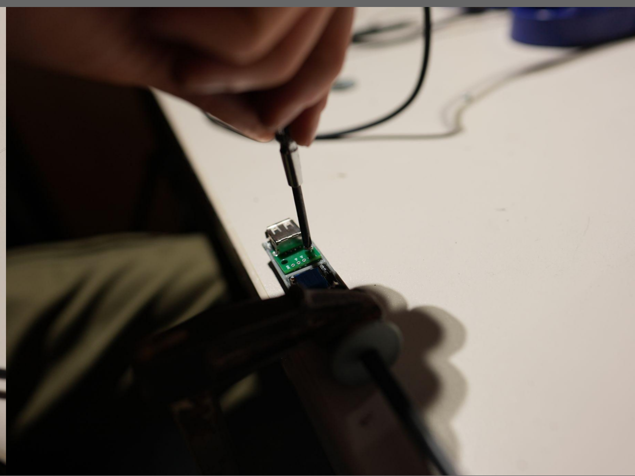
Step 3

Parts: 7A, 19

Tools: Philips head 1 (PH1 / PZ1)

The USB port (19) can be placed in the dongle core (15) and fastened using two screws (12). Using two small pieces of about 1,5 cm of tabbing wire (7A), the converter (18) can be soldered to the outer pins of the USB port (19). The two middle pins are for data and are not used in this case.





Step 4

Tools: Multimeter, small slot-head screwdriver

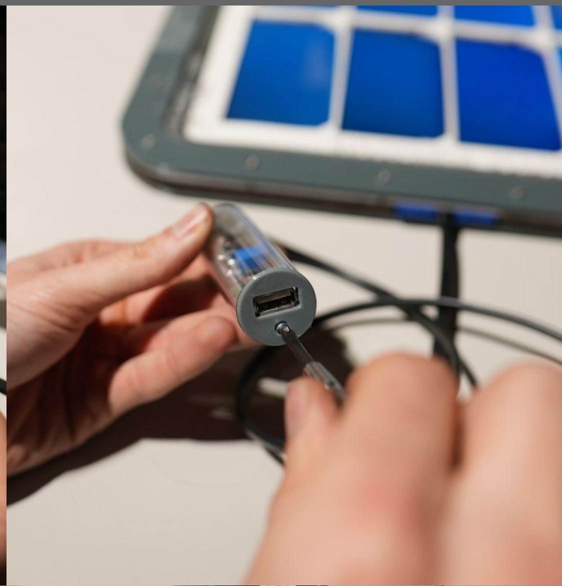
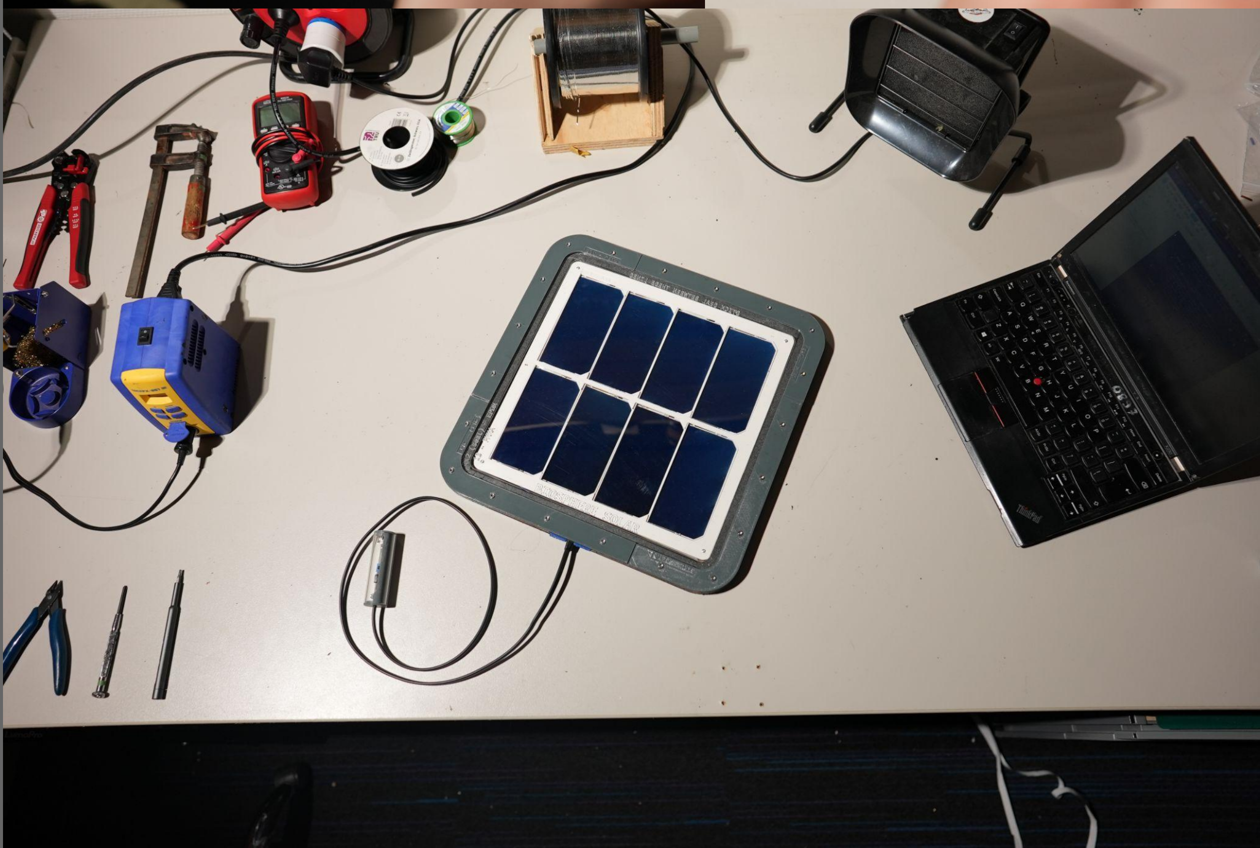
At this point, the converter (18) must be calibrated to transform the variable current of the cells into a usable 5V output. Take the DEV KIT to a sunny place and measure the output voltage on the converter. A small slot-head screwdriver can be used to adjust the square, blue variable resistor on the converter. Adjust the resistor until the output voltage measures a consistent 5V. It might take a lot of turns.

Step 5

Parts: 12, 16, 20

Tools: Philips head 1 (PH1 / PZ1)

When the output voltage is consistent, the transparent tube (20) can be slid over the core. Lastly, the output cap (16) connects on the end of the dongle using the last small screw (12).

QUESTIONS AND HACKS

Do you have any questions? Please go to our Discord and use the #general or #burning questions channel or the specific ones related to each functional design principle. Tried our design and improved it? Share any hacks and improvement on our wikifactory forum in a file called [Name of your changes]_BioSol_Dev_HOWTO

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BIOSPHERE SOLAR
2023