
Van Er Vento - Electronics

This paper covers the design criteria for the solar system for Robertas Van.

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Requirements and Specification for the electrics of the van.
Will travel to remote places. In search of the wind!

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Introduction

The idea is to have a simple and nice solar system for Robertas van.

Solar panels

The idea is to use tape to mount flexible panels on the roof

KISS - the most simple way.

The amount of panels should be low, big panels > small panels.

Though, bigger panels are more expensive, so most likely we go with ~ 100 W Panels.

Table 1: Deciding which kind of solar panel

CIGS	Flex	Glass
bigger	smaller	smaller but thicker
less efficient	efficient	efficient
hotter	cooler	cooler
lightweight	heavier	very heavy
easy to mount	easy to mount	difficult to mount

Specification of the Solar panels

The Specs should be:

- High efficiency (because of limited space)
- operating voltage above battery voltage
- Power => Surface area

Electrically, we assume that the System batter is around 24 Vdc, means 20 V to 30 V.

Flex Panels are recommended for their robustness and efficiency, even though they are more expensive than the other options.

Solar module	mean Voltage	min Voltage	max Voltage	Power
Flex	30 V	24 V	100 V	min. 400 W

Example Proposition

Price should be ideally around 50 € / 100 W.

For the price to be that low, we cant use big panels, but several smaller ones.

520W Flexibel Solarmodul 4*130W Solarpanel Mono Camper Wohnmobil Balkonkraftwerk



Figure 1: 4x 140 W Flex Panels

Roof Mounting Proposal

Goal is to keep the Van watertight and using inexpensive materials with no high effort. That said, it is possible to create watertight long-life bolt-through connections, but that can be quite hard, and can be avoided.

Table 3: Solving the mounting challenge

Problem	Fix/ Workaround
Uneven Surface	
Heat	Gap between Roof and Module

Usage of sticky tape and plastic sheet base

As shown in Tutorial RV-Mounting Panels

1) Avoiding the need to drill holes for the panels -> use sticky tape

The tape should be around the modules to keep them fixed - the tape to be used is for roof application.

- EternaBond RSB-6x50 Dachdichtungsband für Dach Wohnmobil wasserdicht
Abdichtband für Kunststoffdach 10cm breit

- 3M VHB Tape Montage Klebeband

The cables should be taped down with single-sided tape, the panels and the plastic sheets with double-sided tape.



Figure 2: single-sided roof sealing tape and double-sided tape

2) Uneven surface and heat & water buildup -> use plastic base

To place the Solar modules on a spacer prevents heat and water buildup under the panel. This is to keep an air gap for cooling and to create an even surface.

- Corrugated Plastic Sheets
Kunststoffplatte
colorful plastic sheets:

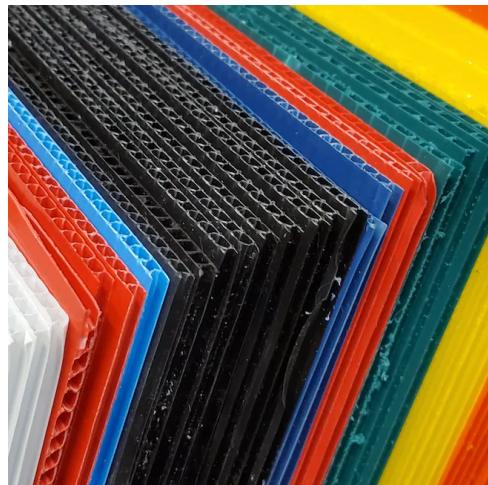


Figure 3: corrugated plastic-sheets

Cable duct through the roof

One hole is required to guide the cables into the van. A professional cable through is proposed:

As shown in Tutorial installing a roof-cable-duct

- Scanstrut DS-HD6 Dachdurchführung Kabeldurchführung



Figure 4: cable duct

Battery considerations

Recommendation: 24 V LiFePo4 Block

Type

Regarding the Type or Chemistry of the battery: I would recommend getting a LiFePo4 (Lithium Iron Phosphate) Battery. The main reason is:

- Safety (no thermal runaway possible)
- Many charge and discharge cycles, so that it doesn't have to be thrown away in a few years, reducing trash
- It's more lightweight than lead batteries (ist a bus - need to not exceed max. road legal overall weight)

Comparison LiFePo4 - Li-Io - Lead:

- LiFePo4 is more expensive than lead batteries but higher charge-discharge cycles
- LiFePo4 less expensive but heavier than Li-Io

Table 4: List of Types of Batteries

Type	Pros	Cons
Lead-Acid	cheap	low cycle n, heavy, big, need maintenance
AGM	cheap	low cycle n, heavy, big
Li-Io	small	expensive low cycle n, dangerous
Li-FePo4	medium weight	high cycle n

Voltage

Because the electronic devices running on 24 V are the least expensive for power usage of around 200 W usually, and rarely at a maximum of 2 kW. So that's my recommendation for the voltage level.

Personally I would use 48 V for higher power transfer efficiency, but here, as lights, fridge and laptop is the power consumption, I would propose to use 24 V.

A 12 V System would mean that very high current is necessary to run at the peak power consumption, which is not good.

Type related safety system: integrated BMS

So, to make it easy and least expensive, a 24 V Battery with integrated BMS (Battery Management System) is proposed.

The BMS will shut down the Battery in case of a fault:

* Overcurrent * Overtemperature * Overdischarge * Overcharge

The BMS is the last safety barrier, so the external electronic modules are taking care that the limits are not reached.

Specification for the battery:

- Type/ Chemistry: LiFePo4
- Voltage: 24 V
- Capacity: 100 Ah
- Stored Energy: 2,4 kW

Buy or DIY

Table 5: Buy Batteries

Name	Voltage	Capacity	Price	Price per kW
Pylontech US5000	48 V	4,8 kWh	940 €	195,8 €/kWh
Langzeit LiFePO4	12 V	1,200 kWh	169 €	140,8 €/kWh
Langzeit AGM	12 V	1,200 kWh	123 €	102,5 €/kWh
Power Queen	24 V	2,4 kWh	428 €	178 €/ kWh

Table 6: Buy/ build from kit w/ cells

Name	Spannung	Kapazität	Preis	Preis pro kW
Basen Green Sheila	48 V	14,6 kWh	3500 €	240 €/kWh

Example diy kit:

Basen Green Sheila EU US Stock Lifepo4 Batterie kästen und Racks 51,2 V 48V 14 kWh 15kWh Gehäuse Leere DIY Metall batterie Zubehör

Buy recommendation

Get any 24 V 100 A Battery w/ BMS for the least amount of money:

2,4 kWh Battery: 24 V 100 Ah for 290 € on ebay

**Figure 5:** battery

Electronics, several discrete modules

Solar input

For charging the battery from the solar panels.

- MPPT (maximum power tracker) To regulate the solar input to the battery. This is DC, depending on the choice of module probable 20 Vdc to 100 Vdc.

Device Name	Input Voltage	Output Voltage	Notes
Solar Panels to Battery - MPPT DC-DC Converter	40 V	30 V	-

Recommendation: EPEVER VS6048AU

I have good experiences with that one, its quite reliable and survived several festivals since i bought it.

EPEVER® PWM Solar Laderegler manual



Figure 6: EPEVER_MPPT.png

Technical specifications

- Model of manufacturer VS6048AU
- Related Charge current 60A
- Max. PV open circuit voltage 96V
- USB output 5VDC/2.4A
- Nominal voltage 12/24/36/48V DC Auto
- Grounding Positiv
- Temperature -20°C bis +55°C
- Dimension 214 * 128,7 * 72,2mm

- Weight 1040g
- Enclosure IP30

Car generator input

The battery should be charged while driving:

- DC Charging Car engine generator DC converter For charging the system battery with the car engine/ generator. The input is around 14 Vdc.

We have to take care that below 14 Vdc, the car engine/ generator is off, and we would use energy from the car battery, which we do not want to do. So the DC-DC Converter needs to be switched on only when the input Voltage is above 14 Vdc.

Device Name	Input Voltage	Output Voltage	Notes
Car to MPPT DC-DC Converter	12 V	30 V	off below 14 V input Voltage

There is a high power DC-DC converter:

- Product name: High-power non-isolated DC boost module power supply.
- Product model: 100A2000W.
- Input voltage: DC12V-60V.
- Input current: 100A (maximum).
- Input power: 2000W (maximum).
- No-load power consumption: less than 2W.
- Output voltage: DC15V-80V.
- Output current: 50A (maximum).
- Output power: 1850W (maximum).
- Conversion efficiency: 92-96% (efficiency is related to input and output voltage and current).
- Working temperature: -20~50°C.
- Price: around 100 €

DC-DC Converter, 100 A input, 2 kW, 100 on ebay



Figure 7: DC-DC 24V Geni to Bat

Utility (fridge) and lights output

To regulate the charging and discharging, some electronic functions, in discrete/ separate modules or integrated in one module, have to be implemented:

- Load output - battery discharge protection The lights and the fridge should run on DC power from the battery. To run them on 230 V means one conversion step that can be omitted. More conversion steps is less efficient than running the fridge an the lights on the battery directly.

The MPPT Tracker has such an Output, this will be used.

MPPT Tracker with Load output



Figure 8: example MPPT Load Output

See Specs VS6048AU - 60 A Output.

eBike charger, using another MPPT

For efficient charging of the ebike, i would recommend to use a DC-DC charger instead of connecting it via the 230 Vac outlet.

Basically the same system consideration as with the lights and the fridge - less conversion steps means higher efficiency.

Instead of DC to AC to DC, we can use a DC-DC converter.

To save some money, we can go for another MPPT here, which meets our requiements of being a battery charger foir the eBike.

The ebike has a charging voltage of 36 Vdc (i think?). It should be charged from the battery which has 24 Vdc.

So the suggestion is, to use a MPPT tracker for this situation, because it is pretty cheap, and i have good experiance with it:

MPT-7210A Manual



Figure 9: second MPTT Solar Charge controller as eBike charger

Specs:

- Input voltage: DC12-60V
- Output voltage: DC24V-72V adjustable
- Output Current: 0-10A key adjustable
- Output Power: 600W max

230 Vac Inverter

For all devices that use a regular houshould plug, there should be a socket available.

I do recommend a pure sine wave inverter to not destroy sensible loads. For Motors, sine wave is required anyway.

For example:

12V/24V/48V to 230v 800W/1500W/2000W/2500W/3000W wechselrichter reiner sinus



Figure 10: Inverter 254 Vdc to 230 Vac

Electronics, integrated MPTT and Inverter module

To save money and space, we can use one module which integrates the main electric components.

Main Specs would be:

- Battery voltage: 24 V
- Solar input: Anything above 24 V
- DC Load output
- 230 V Inverter

Recommendation: Easun 3200W Solar Off Grid Wechselrichter 24V 80A MPPT Ladegerät 230V mit WiFi

Price on Ebay is 190 €.

Device

Model: ISolar-SMG-II-3.2KW

Rated Power: 3.5KW

Input

Voltage: 230Vac

Selectable Voltage Range: 170Vac~280Vac) ±2% ; (90Vac~280Vac)±2%

Frequency Range: 50Hz/ 60Hz (Auto detection)

Output

AC Voltage Regulation (Batt.Mode): 230VAC ±5%

Wave Form: Pure Sine Wave

Battery & Solar Charger

Nominal Battery Voltage: 24VDC

Floating Charge Voltage: 27VDC

Overcharge Protection: 33VDC

Maximum Charge Current: 60A

Solar Charger

MAX.PV Array Power: 4000W

MPPT Range @ Operating Voltage: 55-450VDC

Maximum PV Array Open Circuit Voltage: 450VDC

Maximum Charging Current: 100A

Maximum Efficiency: 98%

Physical

Dimension (DWH mm): 330x278x98mm

Net Weight (kgs): 4.5kg

Communication Interface: RS232/RS485(Standard) / GPRS/WIFI(Optional)

Environment

Humidity: 5% to 95% Relative Humidity (Non-condensing)

Operating Temperature: 10°C to 55°C

Storage Temperature: -15°C to 60°C



Figure 11: MPTT & Inverter integrated module

Beispiel 2: POW-HVM2H-12V-N, pow-hvm3.2h-24v-n

Beispiel 3: VEVOR 2-in-1-Hybrid-Solar-Wechselrichter 3500W Solar Inverter Reiner Sinus MPPT

Beispiel 4: BlueWalker Inverter 3000 PWM, Wechselrichter

Housing and Cables

All electronics shall be in a nice case.

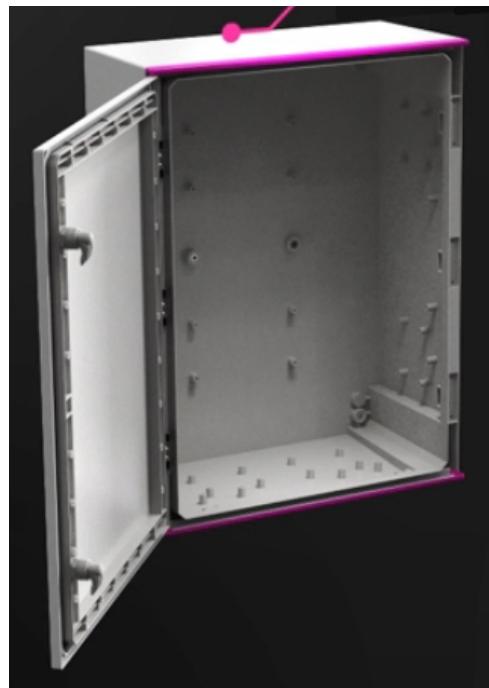


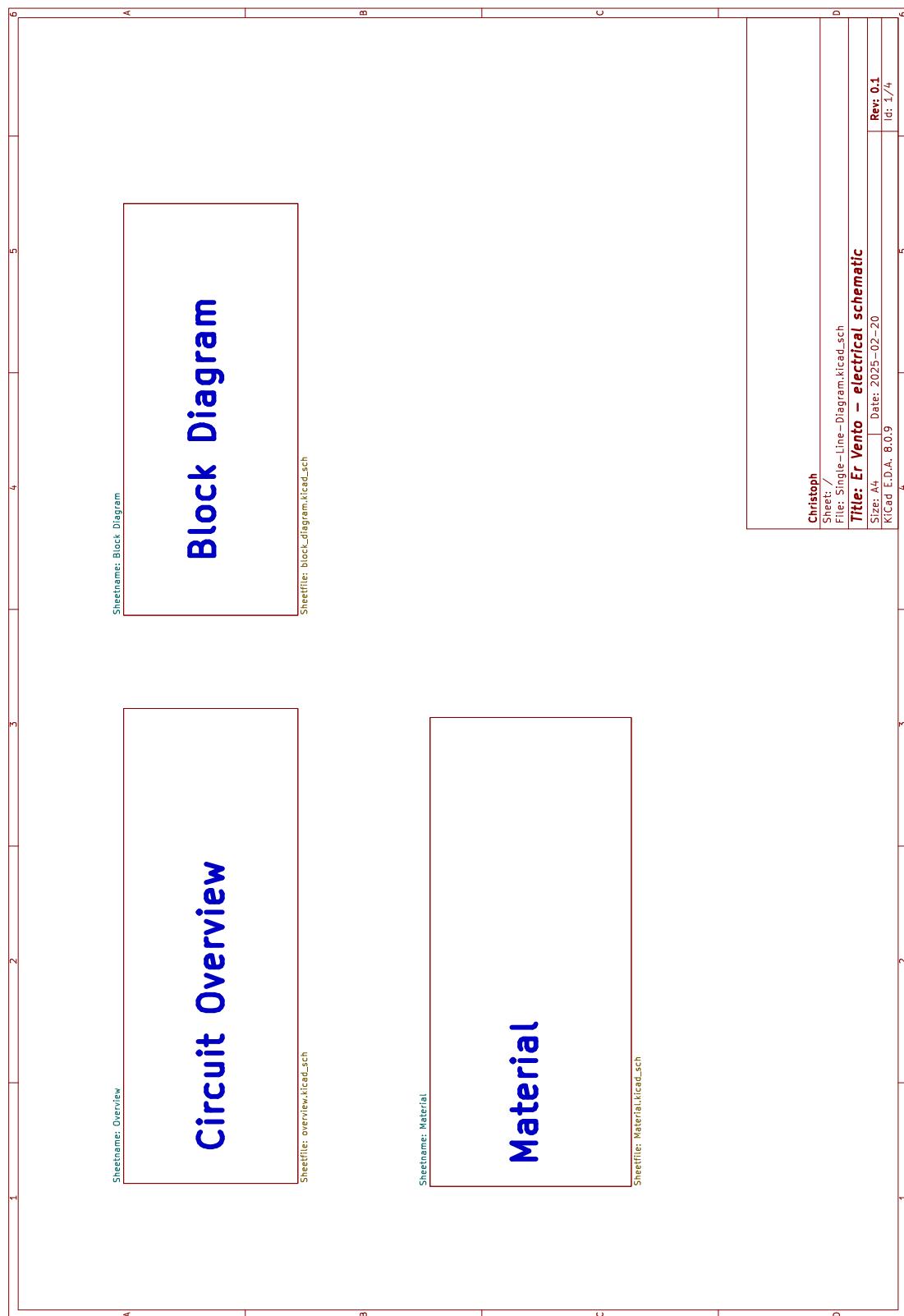
Figure 12: Example: Schaltschrank-AX-Kunststoff-250x350x150mm-IP66-Outdoor

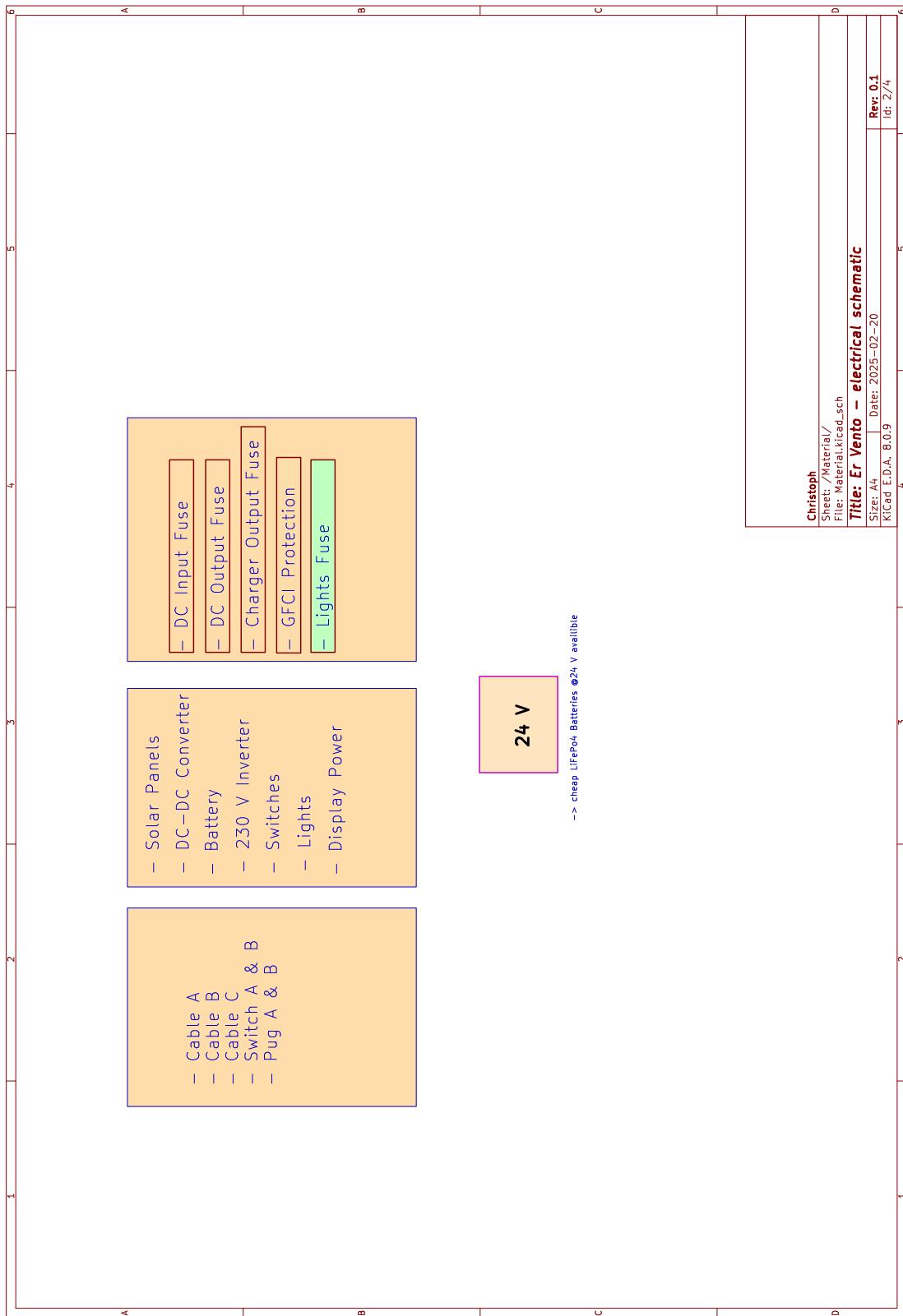
Cables

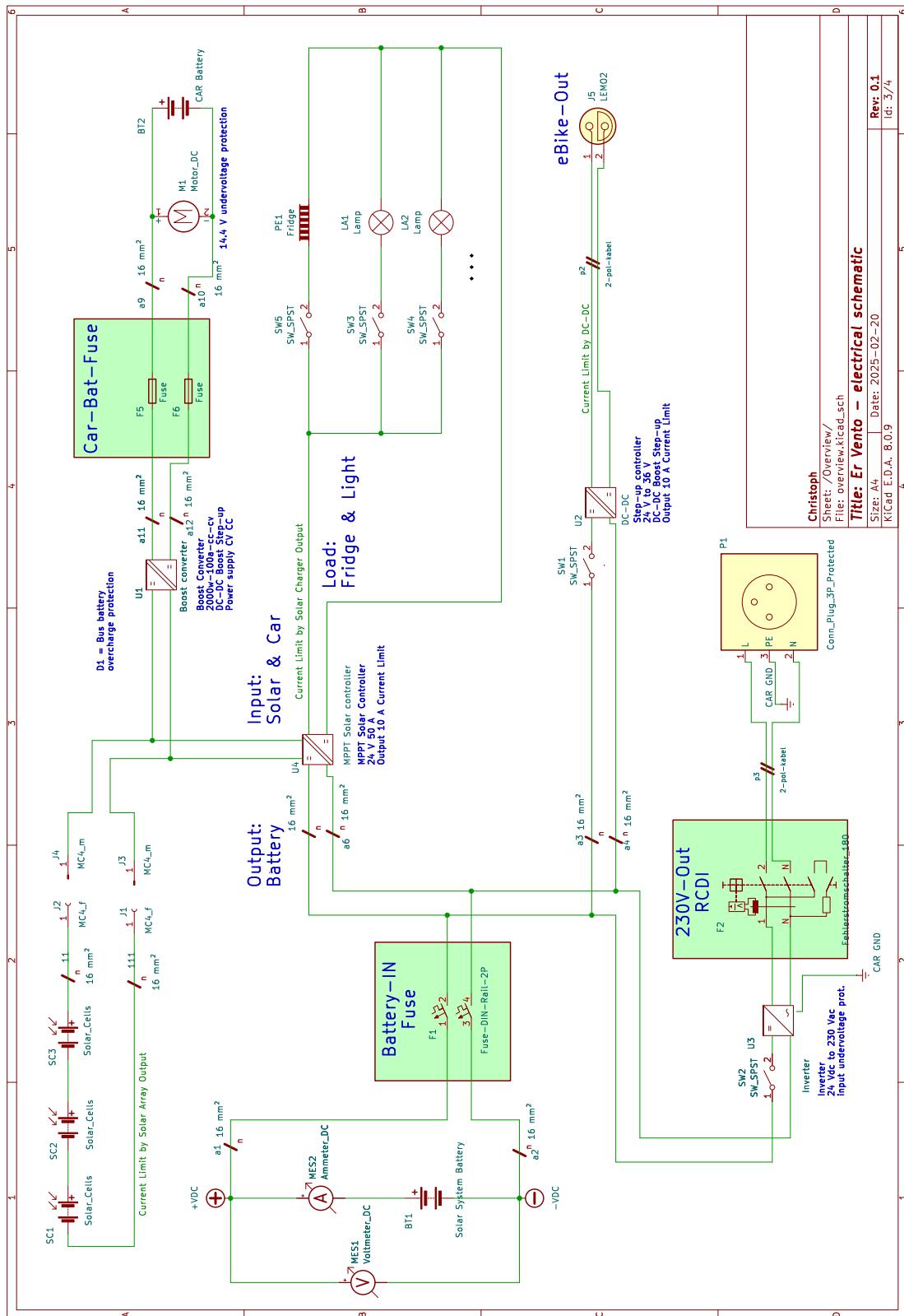
Yes, we should specify them.

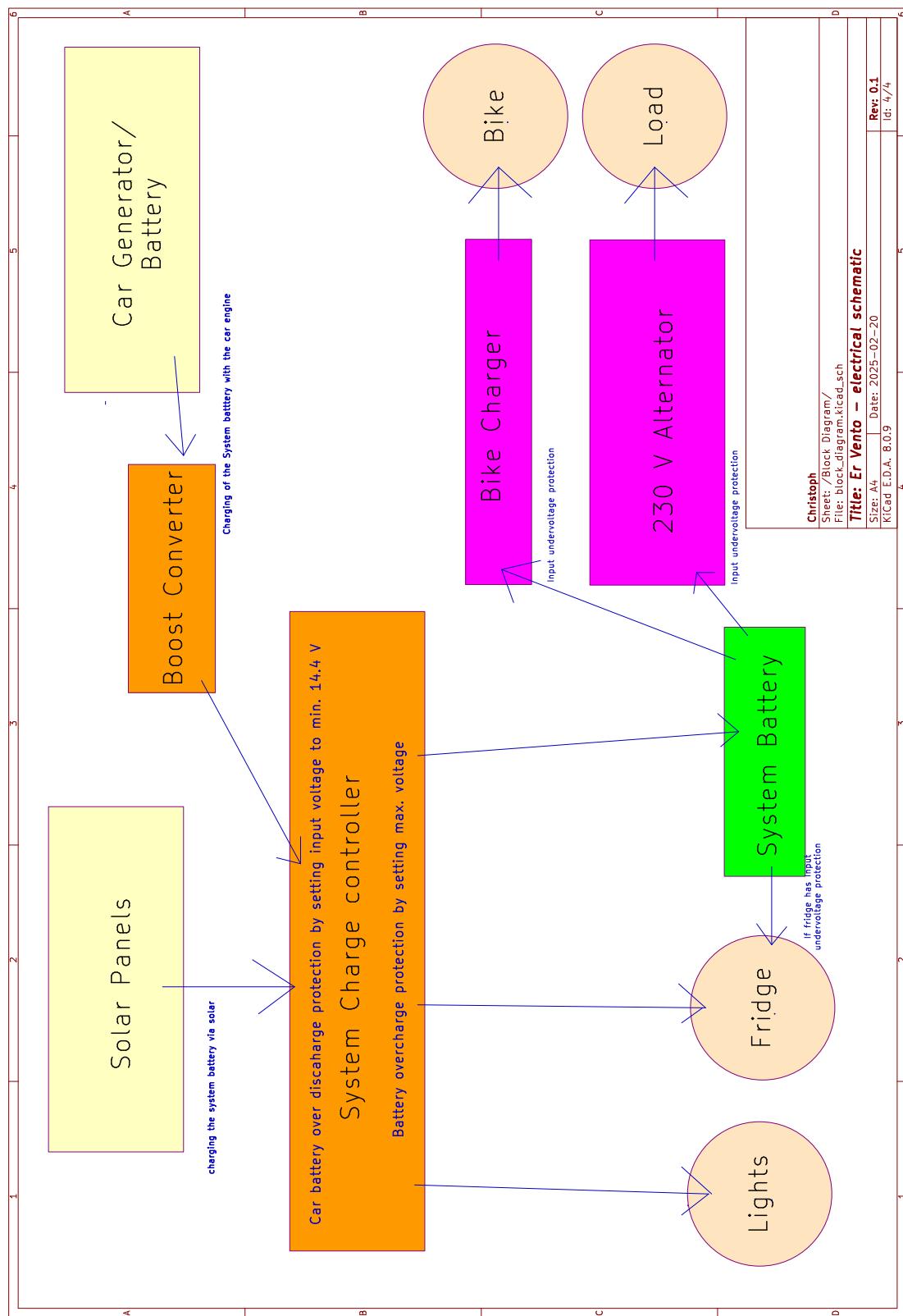
Schematic and system layout

The Drawing is created with KiCAD [1]









Thanks

Thanks to Roberta for letting me participate in building something unique.

Citations and Quotes

- [1] <https://www.kicad.org/about/kicad/s>, *Created with KiCad*. Available: <https://www.kicad.org/>