Project Documentation

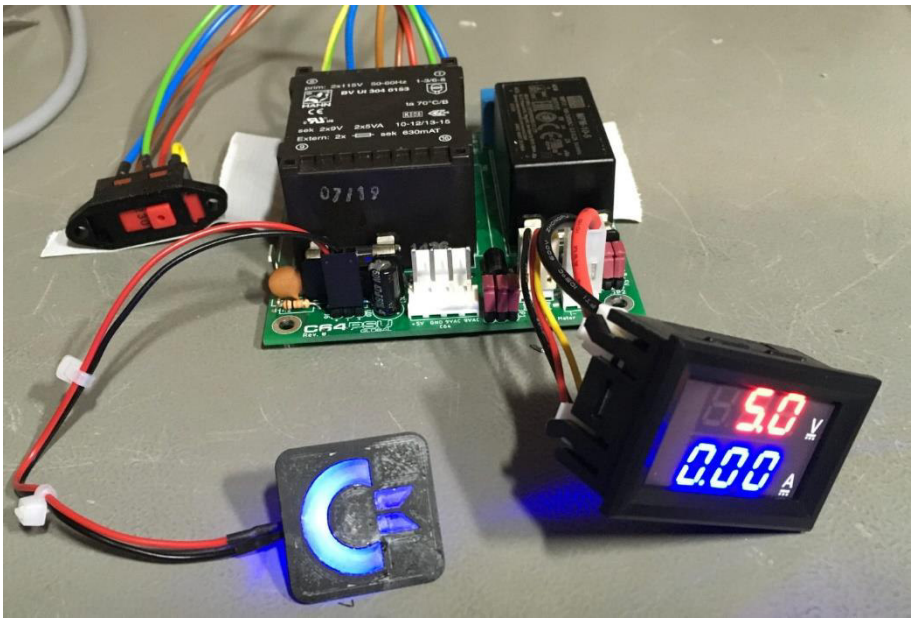
C64 PSU GLOBAL

C64 PSU global

Project number: 133

Revision: 0

Date: 15.08.2019



Disclaimer

Working with mains voltages can be harmful and cause death. Do not connect this PCB to mains (230VAC) unless you are trained in doing so and know the required safety regulations.

This PSU is a prototype, it is not certified in any way and might only be used as a prototype under laboratory conditions. Usage is at own risk.

The PSU is designed to be installed in a plastic case. In case a metal case is used, a 3 prong mains connector is required and the case has to be connected to PE in a suitable way.

The documentation is drafted to the best of my knowledge. The creator is not liable for the accuracy and completeness.

C64 PSU Global Rev. 0

Module Description

Introduction

The C64 PSU Global is a replacement power supply for the Commodore C64, which is suitable to power the Commodore computer from 115V and 230V.

There are two options for transformers for the 9VAC, one is capable of being switch between 115V and 230V.

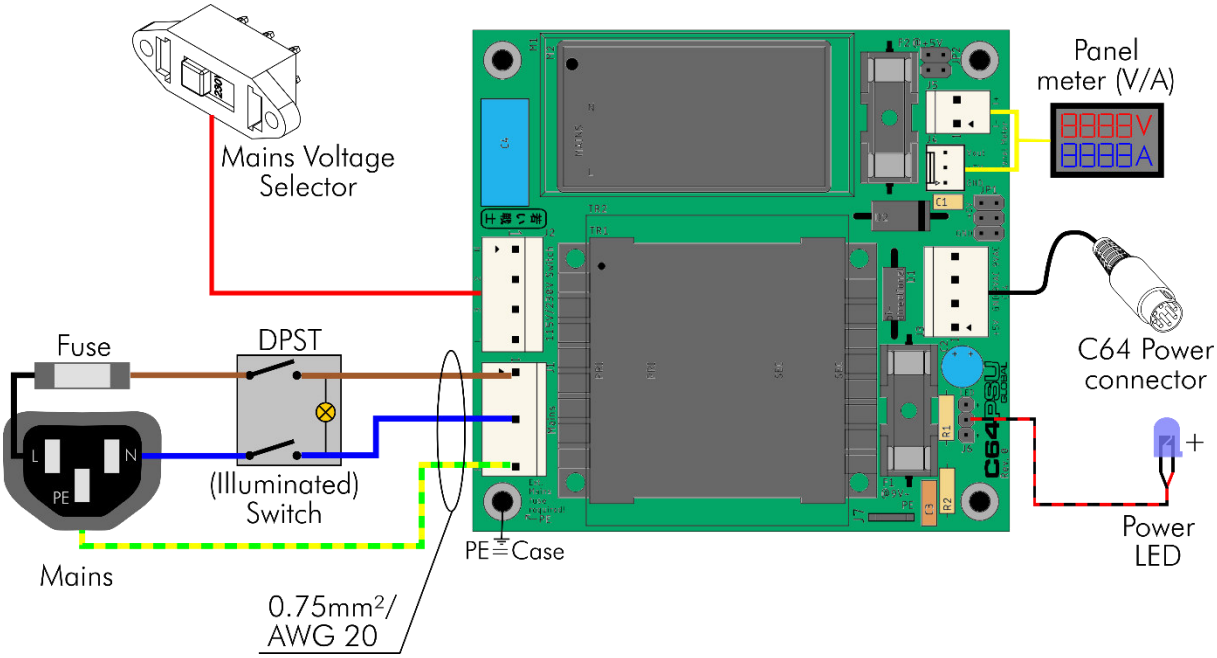


Figure 1: Block diagram

The 5VDC are generated by an AC/DC converter. There are two options that can be placed on the PCB, both have a wide range input (85VAC-264VAC) and are suitable for both main voltages without switching. The technical data of the power supply vary, depending on the chosen options:

Option	Type	Mains	Output
Transformer TR1	Hahn BV UI 304 0153	115VAC/230VAC	9VAC/1.1A
Transformer TR2	BREVE TUFVASSONS TEZ10/D230/9V	230VAC	9VAC/1.1A
AC/DC M1	RECOM RAC10-05SK/277	85VAC-305VAC	5VDC/2A
AC/DC M2	Mean Well MPM-10-5	80VAC-264VAC	5VDC/2A

The mains voltage selector switch is only required for the option Transformer TR1. A fuse for the mains is external and mandatory. It is recommended to use a combination of mains with an integrated fuse and maybe a switch. The switch should switch off both, the hot and the neutral mains. In Figure 1, an illuminated mains switch is shown. Its lamp is located at the switched side.

A power LED can be connected. At least one signal should allow the use to notice, whether the PSU is switched on or off, the Power LED or the illuminated mains switch.

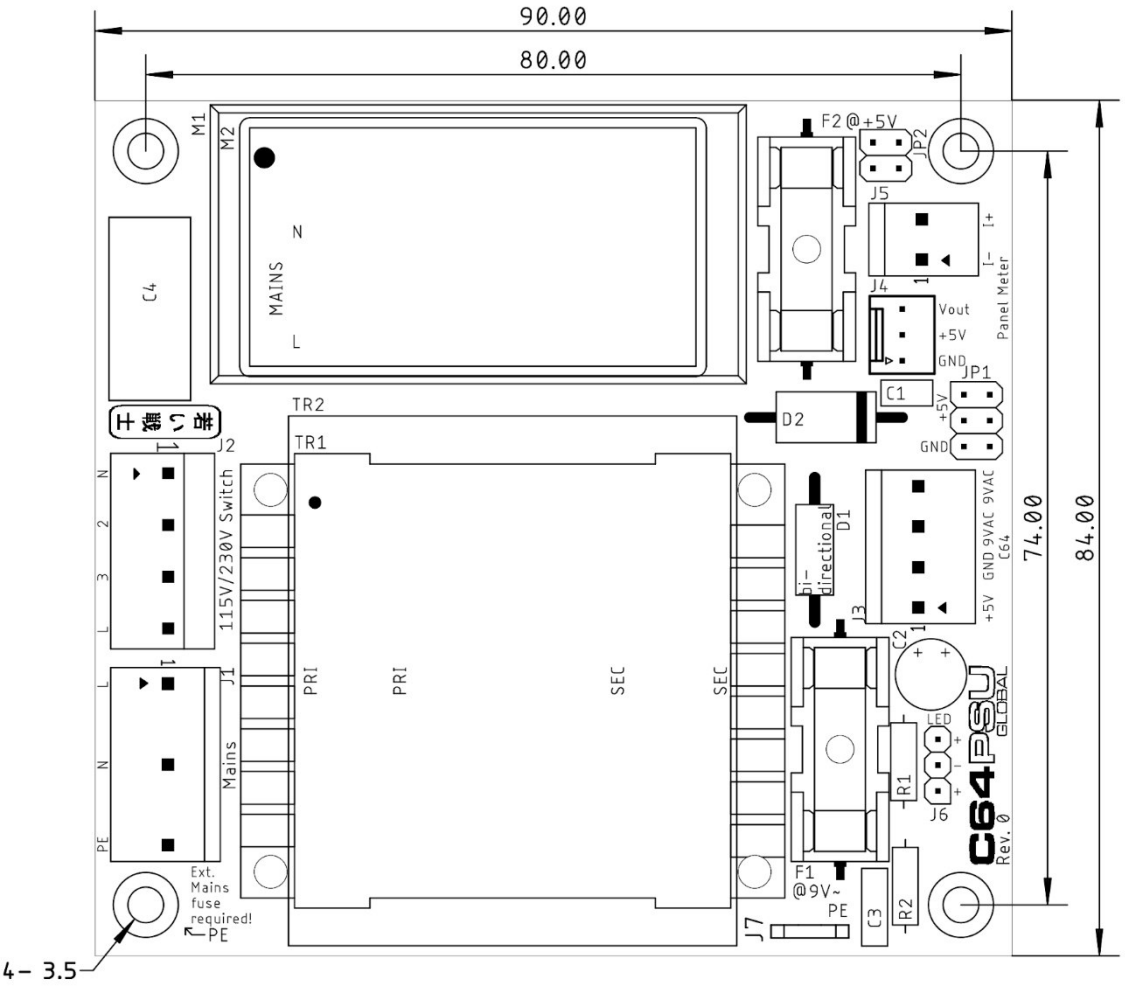


Figure 2: Dimensions

A panel meter can be connected. The common panel meter measures the current in the negative (ground) lead. The panel meters might be very inaccurate and the current and voltage should be adjusted with a load resistor and a multimeter. Sometimes, it is not even possible to adjust the current properly, so the panel meter is not really recommended. In case the panel meter is not installed, JP2 has to be bridged with jumpers.

A not yet developed over voltage protector (aka C64 saver) can be connected to JP1. In case this is not installed, JP1 has to be bridged with jumpers.

An R/C combination (R2/C3) between GND and PE serves for creating System Ground, which is tied to protective earth (PE). Some further power supplies for the monitor or the S-Video/HDMI converters might inject (a weak) mains voltage into the system. This happens due to a capacitive coupling to mains within those PSUs and could be felt when touching the C64 ports.

Connectors

J1 – Mains connectors

- Molex KK 396 Header, Vertical, Friction Lock, 5 Circuits, Tin (Sn) Plating (Pin 2 and pin 4 removed): P/N 0026604050
- KK 3.96mm Crimp Terminal Housing, Friction Ramp, 5 Circuits, Natural: P/N 09503051
- KK 396 Crimp Terminal 2478, 18-24 AWG, Bag, Brass Tin (Sn): P/N 08500106.

Pin	Signal
1	L (hot)
3	N (neutral)
5	PE (protective earth)

J2 – Mains Voltage Selector

This is an option and only required, if the TR1 (the 115V/230V type) is used.

- Molex 5.08mm Pitch SPOX Wire-to-Board Header, Vertical, with Friction Lock, 4 Circuits, P/N 10321041
- Molex 5.08mm Pitch SPOX Crimp Terminal Housing, 4 Circuits, P/N 10013046
- Molex SPOX Crimp Terminal, 18-24 AWG, Brass, P/N 08701031

As a switch, the type Bulgin T22205B436B is suggested.

J3 – C64 Power Connector

- Molex KK 396 Header, Vertical, Friction Lock, 4 Circuits, Tin (Sn) Plating: P/N 0026604040
- KK 3.96mm Crimp Terminal Housing, Friction Ramp, 4 Circuits, Natural: P/N 09503041
- KK 396 Crimp Terminal 2478, 18-24 AWG, Bag, Brass Tin (Sn): P/N 08500106.

Pin	Signal
1	+5V
2	GND
3	9VAC2
4	9VAC1

J4, J5 – Panel Meter

J5 – Current path

- Molex KK 396 Header, Vertical, Friction Lock, 2 Circuits, Tin (Sn) Plating: P/N 0026604020
- KK 3.96mm Crimp Terminal Housing, Friction Ramp, 2 Circuits, Natural: P/N 09503021
- KK 396 Crimp Terminal 2478, 18-24 AWG, Bag, Brass Tin (Sn): P/N 08500106.

Pin	Signal
1	GND PSU (I-)
2	GND OUT (I+)

J4 – Voltage connection

- Molex KK 254 Wire-to-Board Header, Vertical, with Friction Lock, 3 Circuits, Tin (Sn) Plating: P/N 22272031
- KK 254 Crimp Housing, 3 Circuits, Natural: P/N 22-01-3037

- KK 254 Crimp Terminal, 22-30 AWG, Bag, Hot Tin (Sn) Dip Plating: P/N 08500114

Pin	Signal
1	GND
2	+5V (supply)
3	+5V (measurement)

Power LED – J6

- Pin header, 1x3 circuits, 2.54mm (0.1") pitch
- Crimp housing: Dupont crimp housing
- Dupont crimp terminals

It is possible to use a widely available (Ebay, AliExpress etc.) Dupont cable, which can be cut and soldered to the LED.

Pin	Signal
1	LED +
2	LED -
3	LED +

J7 – PE Connection

The PE connection to the chassis is accomplished via the mounting hole marked with "← PE". This is directly connected to the mains connector J1, Pin 5. In case other metal parts have to be grounded, a 6.3 x 0.8 FastOn (spade) connector can be installed in J7.

Jumpers

JP1 – Over-Voltage Protection

In case an over-voltage protection is not installed, the pin header JP1 should be bridged. The jumpers should be rated 1A or more.

Signal	Pin	Pin	Signal
Input 5V	1	2	Output 5V
Input 5V	3	4	Output 5V
GND	5	6	GND

JP2 – Current Path of the Panel Meter

The panel meter measures the current between GND and the negative output lead of J3 (power output). In case the panel meter is not connected, JP3 has to be bridged, otherwise the GND will be open and the 5V are not supplied to the C64.

Signal	Pin	Pin	Signal
GND	1	2	GNDOUT (J3)
GND	3	4	GNDOUT (J3)

The jumpers should be rated 1A or more.

Wiring

This device is connected to mains. Mains voltage is potentially lethal. High currents, that can occur in this device can cause fire hazards. Do not carry out this work, if you are not trained!

Up to four sorts of crimp contacts are required for installing this device:

- FastOn Flat connectors 6.3 x 0.8 (isolated, red) for mains connector/switch
- Molex SPOX/KK 3.96 (J1, J3, J5)
- Molex SPOX/5.08 (J2, option)
- Molex KK2.54 (option)
- Dupont 2.54mm

The crimp tool for the flat connector (FastOn) are cheap. A tool capable of isolated crimps is required. While crimping is the suggested method, the mains connector/fuse/switch can be soldered (do not forget the shrinkable sleeve) as well.

A crimp tool for the other types of connector is the Engineer PA-20. A cheaper, but less good tool is the IWISS IWS-2820M.

The mains should be wired with 0.75mm²/AWG20 cables.

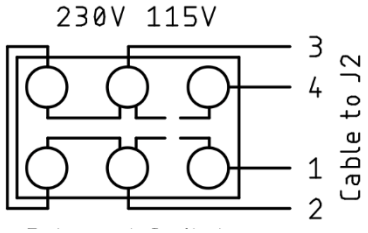


Figure 3: Wiring of the mains voltage selector switch

The Mains Voltage Selector is optional and has to be wired like shown in Figure 3. The wiring should be checked with a multimeter before the PSU Global is powered up.

Position	Connected	Open
230V	Pin 2 – 3	Pin 4 – 3, Pin 1 – 2, Pin 1 – 4
115V	Pin 3 – 4, Pin 2 – 1	Pin 2 – 3, Pin 1 – 4

Table 1: Mains Voltage Selector checks

The installation of the PSU in a metal enclosure requires connection to PE of all metal parts of this enclosure. These connections need to be proved (at least with a multimeter) after finishing the assembly. One mounting hole of the PCB is connected to the PE of the installation. This is marked "← PE". Chopper disks are recommended to attain a good connection.

In case, the power cables should stay connected to this PSU, strain reliefs are required. An alternative way is a DIN-jack on the back panel of the power supply and extra cables to have as few cables in the installation as possible.

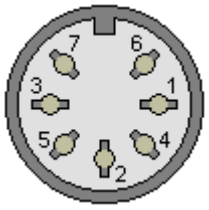
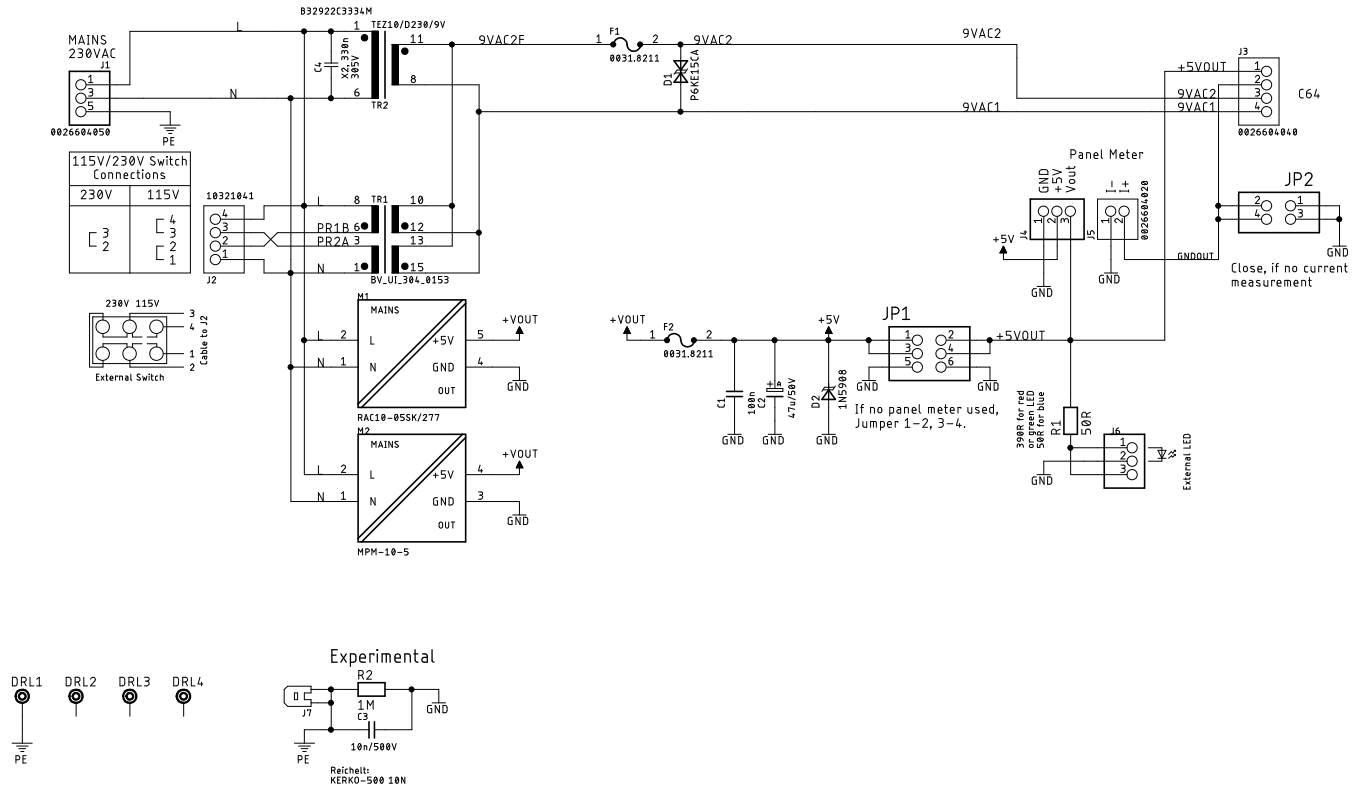
C64 Power Jack	Pin	Voltage
	1	-
	2	GND
	3	-
	4	-
	5	+5V
	6	9VAC(1)
	7	9VAC(2)

Table 2: Power jack of the C64

Table 2 shows the power jack of the C64. The view is on the particular contact side. This is identical with the view on the solder side of the respective DIN plugs. The cables soldered to the din plugs should be 0.5mm²/AWG21. It is possible to use 0.75mm²/AWG20 wires, but this might require to clip off some of the wire strands, since the solder cups of the DIN plugs are usually not capable of accepting a wire of this diameter.

After finishing the wiring, it is required to test the complete device. Swapping the voltages by confusing the pins or the wiring will usually damage the connected devices. The +5V should measure between +4.9V and +5.2V. The 9VAC are not regulated and might be quite a bit higher without load. 11VAC is still an acceptable reading.



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		Draft.:	Sven Petersen
Date:	30.08.2019 10:43	Rev.: 0	Page 1/1
File:	C64_PSU_230_115		
			A3

Sven Petersen 2019	Doc.-No.: 133-1-01-00	
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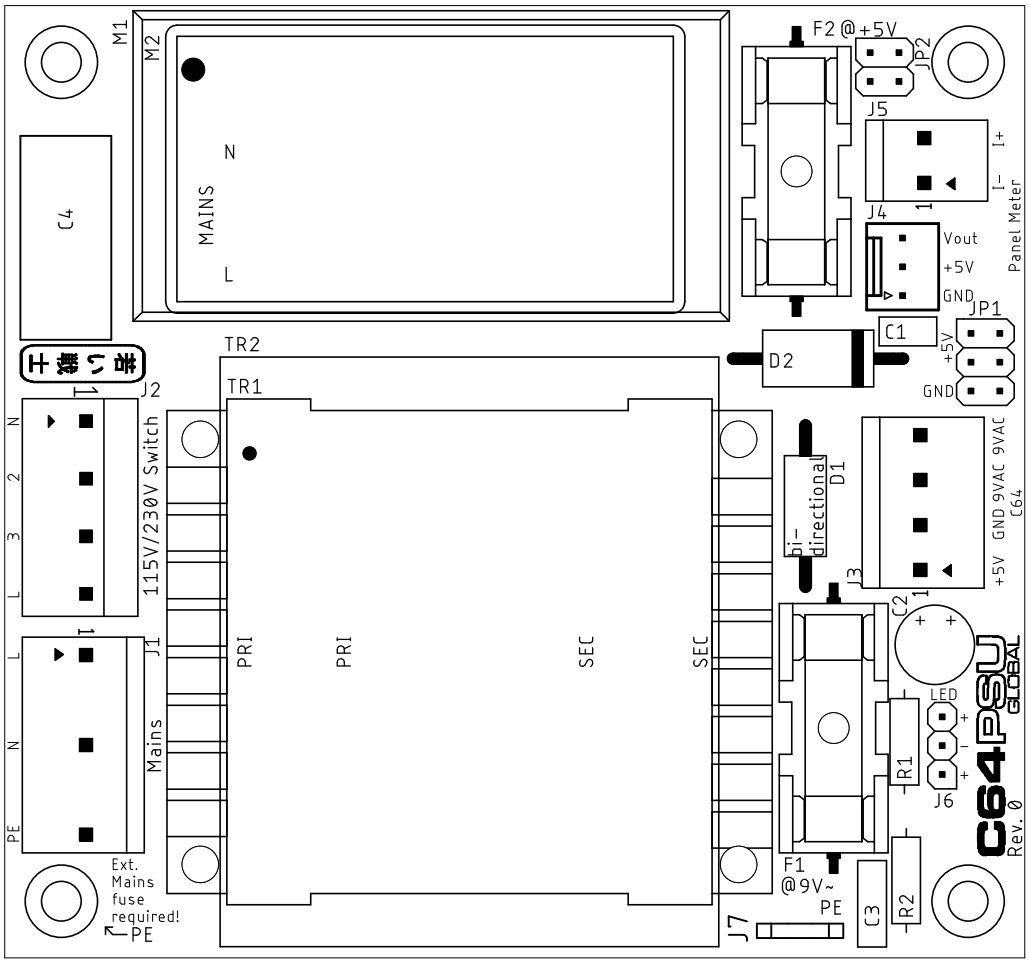
C64_PSU_230_115		
30.08.2019 10:44	Rev.: 0	
placement component side		



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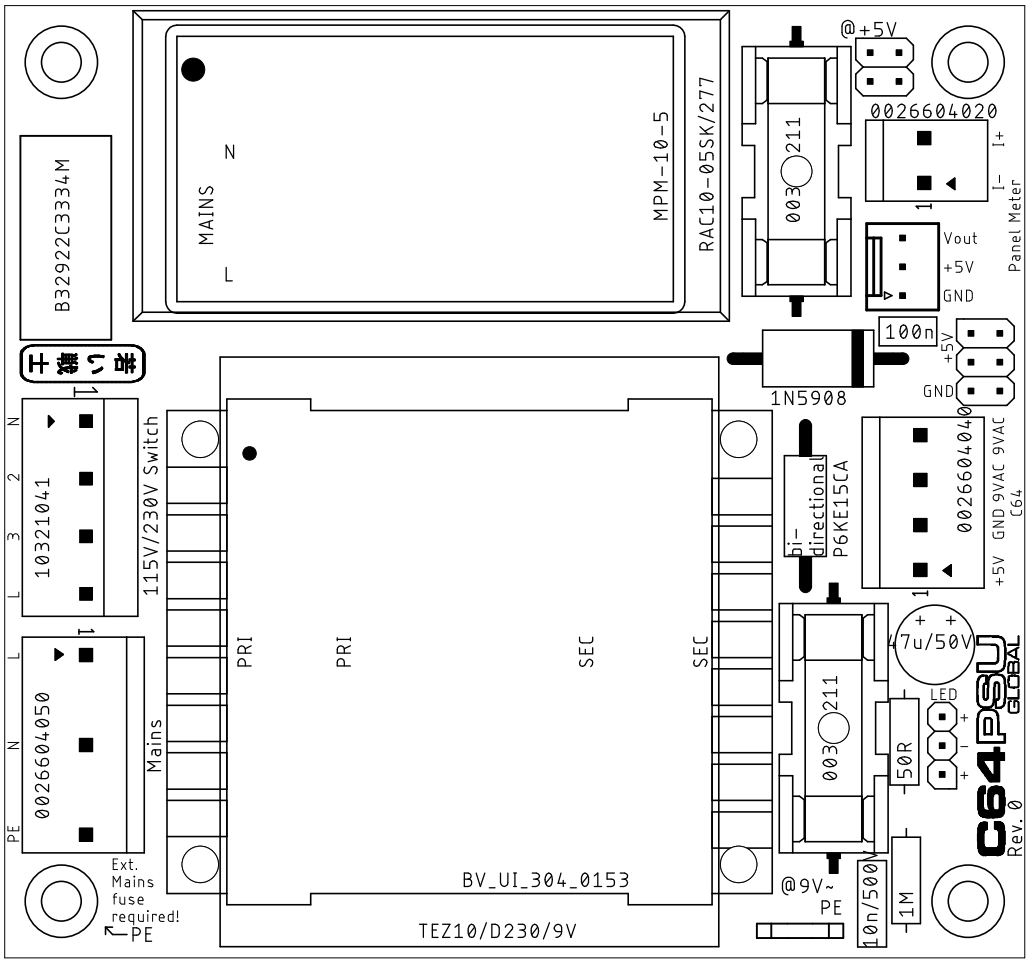

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placement solder side		

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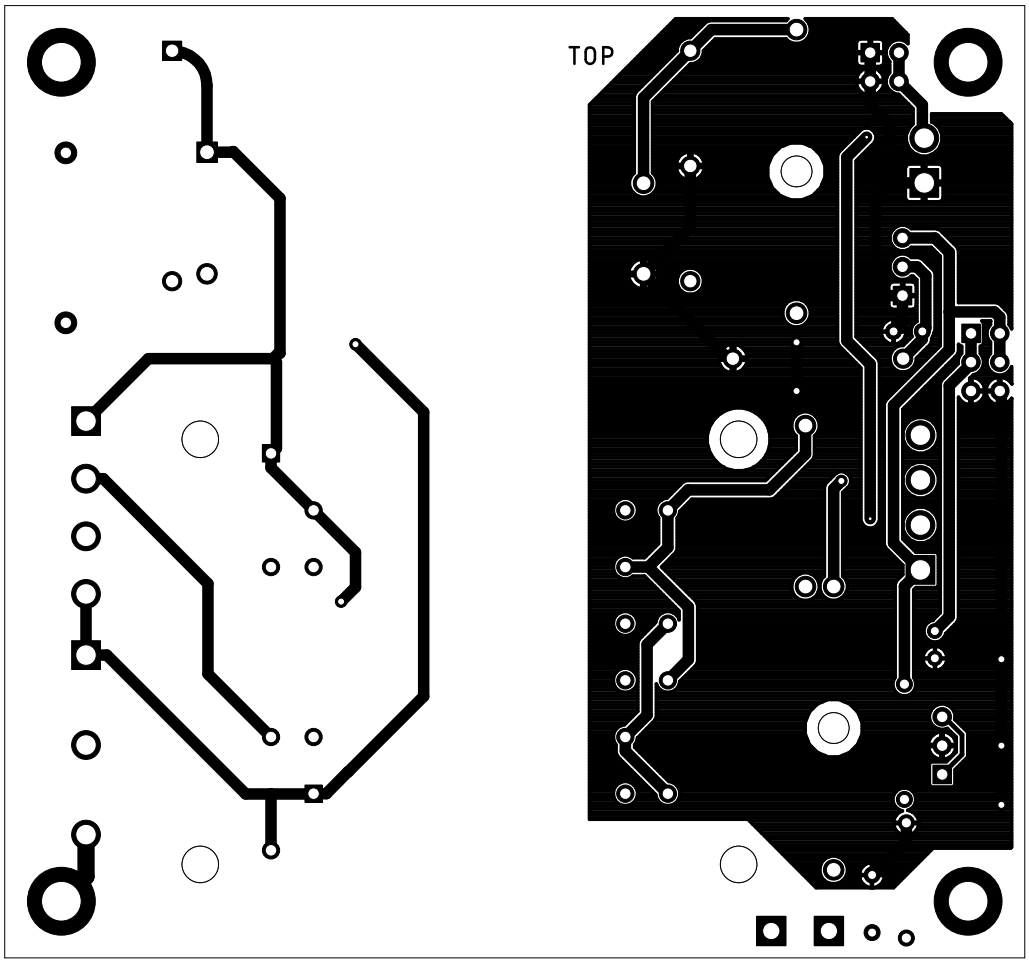

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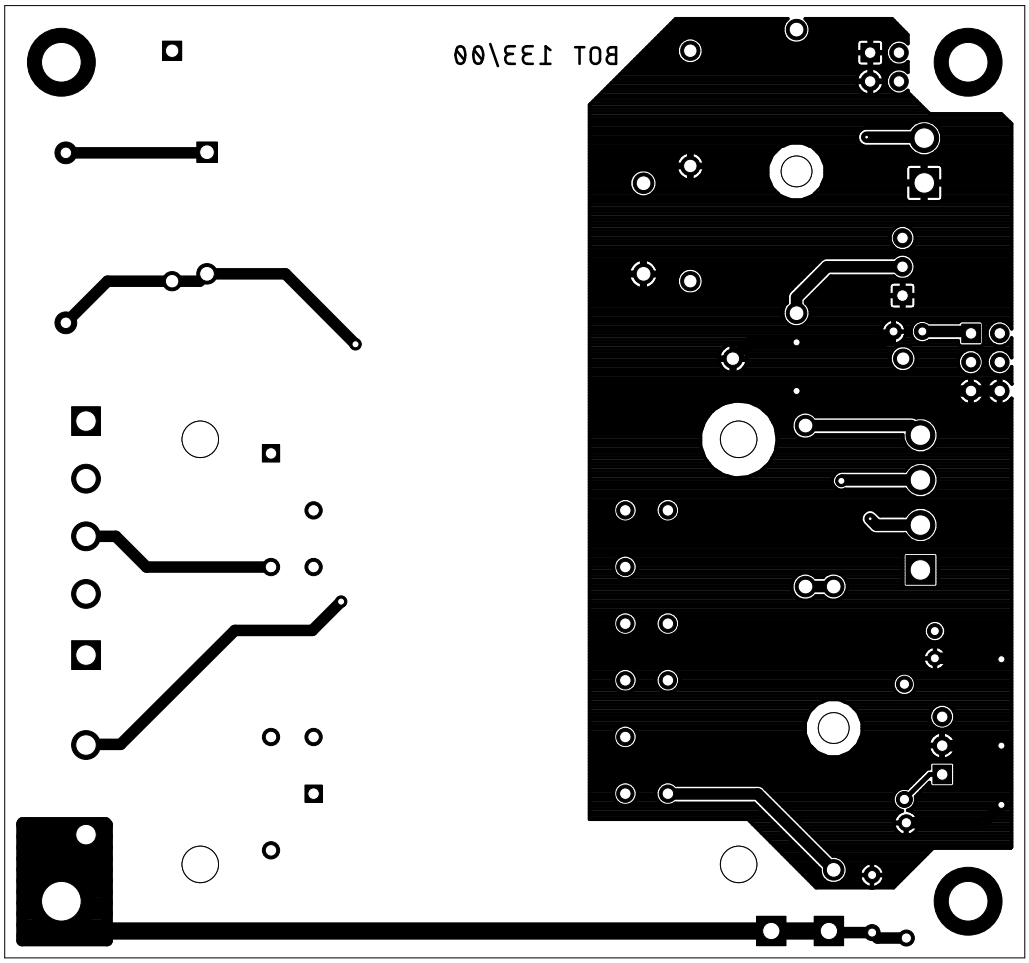
bottom		



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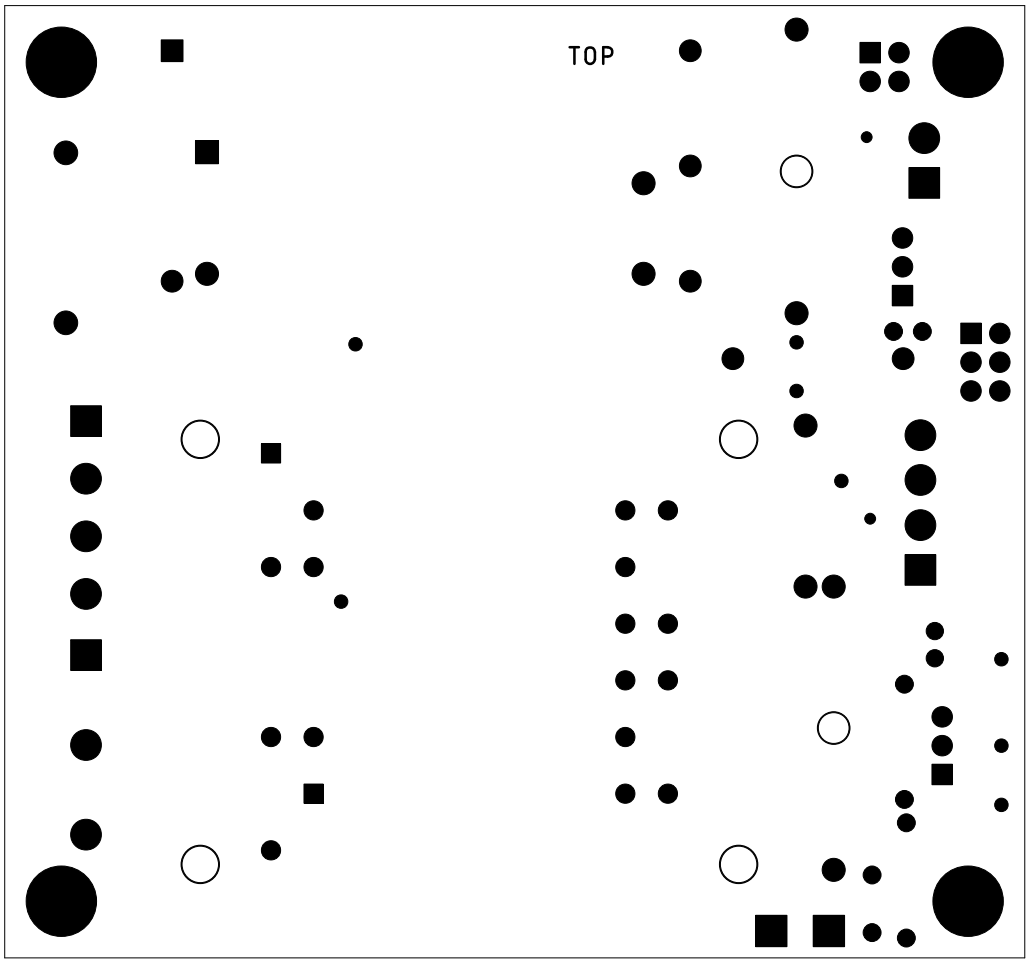
stopmask component side		



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C64_PSU_230_115		
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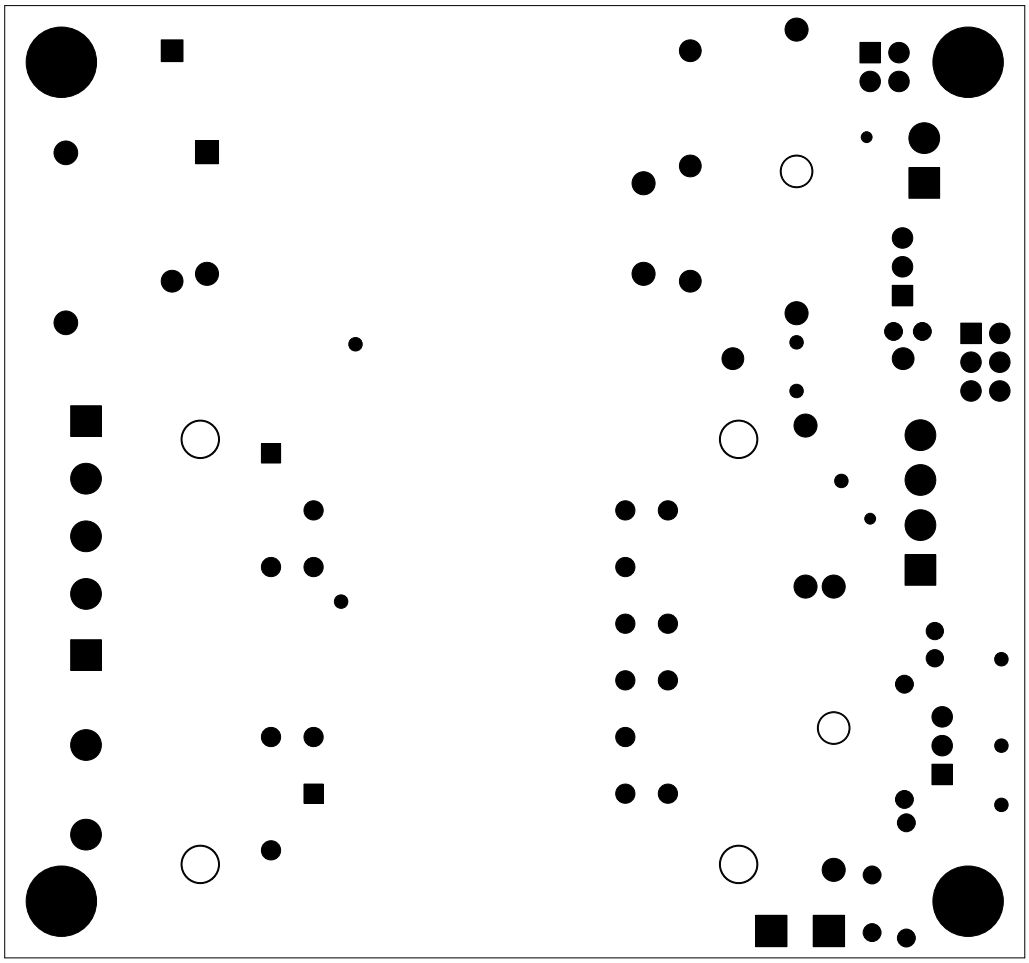
stopmask solder side		



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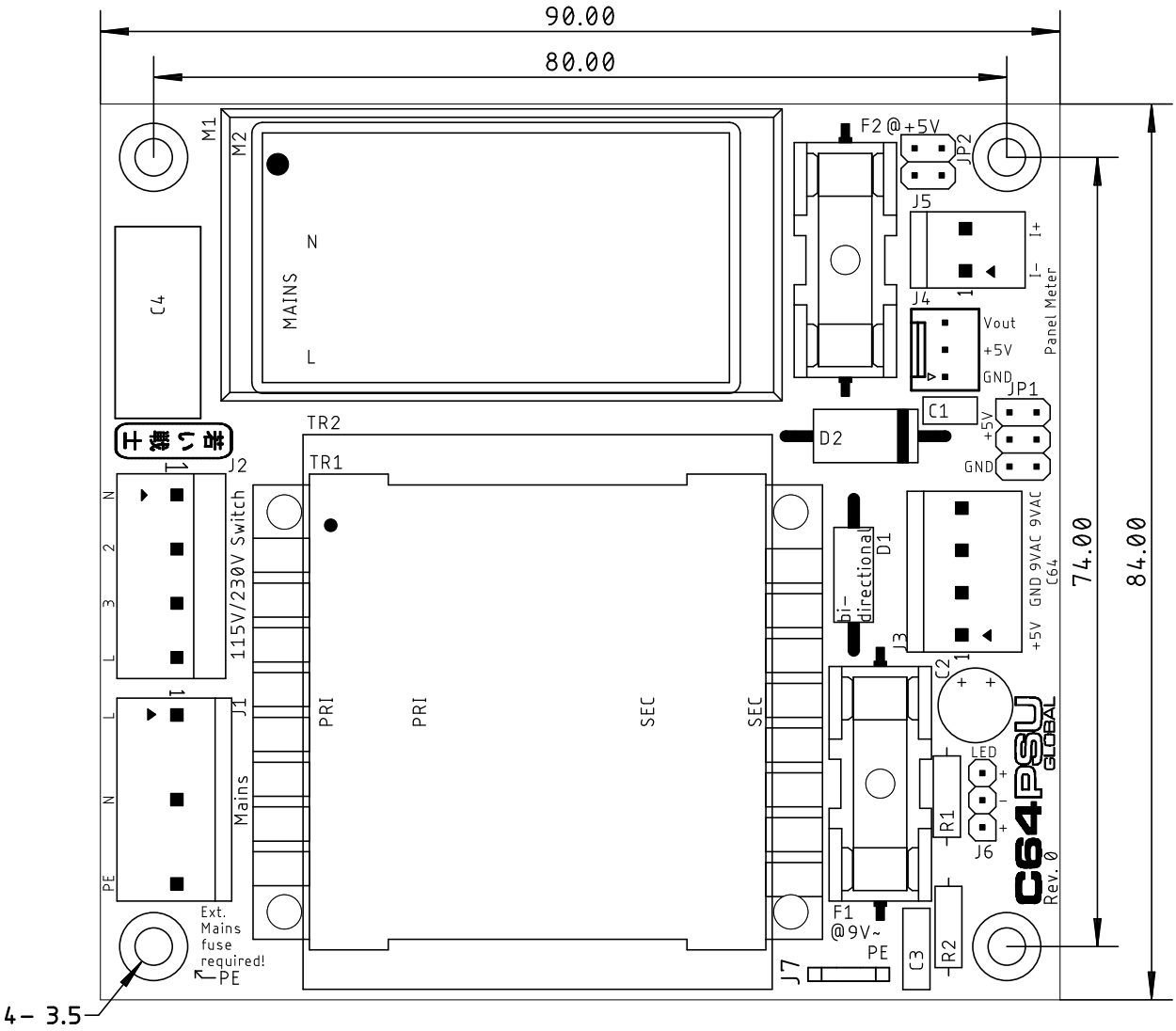
C64_PSU_230_115		
30.08.2019 10:44	Rev.: 0	
placement component side measures		



C64 PSU Global Rev. 0

Functional Description

J1 is the mains connector of the board. Up to 240V can be connected. Two types of transformers fit alternatively. TR2 is for 230V only, TR1 can be switched between 230V and 115V. In this case J2 has to be populated. The wiring and connections are shown in the schematics.

M1 and M2 are AC/DC modules, which provide +5V. Both modules can be populated alternatively. The criteria for choosing one of these is availability and price. The function is identical in this case.

F1 is the fuse for the 9VAC. D1 serves as an over-voltage protection.

F2 is the fuse for +5V. C1 and C2 are for smoothing the voltage, D2 is a **minimal** over-voltage protection. It is equivalent to the TVS diodes, which are sometimes retrofitted in the C64.

JP1 is for connecting an external (and hopefully more precise) over-voltage protection (aka "Saver"). This saver is not yet developed. In case no saver is installed, JP1 should be bridged.

J4 and J5 are for connecting a panel meter. In case this is not connected, the output ground (GNDOUT) has to be bridged on JP2.

J6 is for connecting a power LED. The value of R1 is calculated for installing a blue LED. For a red or green LED, 330R or 390R are recommended.

C64 PSU Global Rev. 0

Testing

The testing is still preliminary.

The testing was performed with a prototype configured for the 230V/115V option at 230V mains voltage. The output voltage was observed while being connected to load resistors for one hour. A C64 was powered (ASSY250469).

A test with 115V was not yet performed.

The 230V only transformer (TR2) fits the footprint on the PCB. This option has not been built, yet and not been tested.

C64 PSU GLOBAL Rev. 0
Bill of Material Rev. 0.0

Pos.	Qty	Value	Footprint	Ref.-No.	Comment
1	1	133-2-01-00	2 Layer	PCB Rev. 0	2 layer, Cu 35µ, HASL, 90.0 x 84.0, 1.6mm FR4
2	1	22-27-2031	6410-3P	J4	optional (for **panel meter**): Molex 6410/22-27-2031 (KK, 2.54mm, 3p), e.g. Reichelt: MOLEX 22272031, tme.eu: MX-6410-03A
3	1	22-01-3037		(J4)	crimp housing, optional (for **panel meter**), Molex. E.g. Reichelt: MOLEX 22013037, tme.eu: MX-22-01-3037
4	3	08-50-0114		(J4)	crimp terminal, optional (for **panel meter**), Molex. E.g. Reichelt: MOLEX 8500114, tme.eu: MX-0850-0114
5	1	6.3 x 0.8	FLA6,3	J7	optional PE connector, PCB mount spade connectors
6	1	1x3p, 2.54mm	1X03	J6	standard pin header, 2.54mm pitch
7	1	dupont housing, 3p		(J6)	ebay, AliExpress or other
8	2	dupont terminals, female		(J6)	ebay, AliExpress or other
9	1	LED, blue		(J6)	Power LED, blue (R1 is calculated for blue)
10	1	2x2p, 2.54mm	2X02	JP2	standard pin header, 2.54mm pitch
11	1	2x3p, 2.54mm	2X03	JP1	standard pin header, 2.54mm pitch
12	5	jumper, 2.54mm		(JP1), (JP2)	standard jumper (rated 1A or more). E.G. Reichelt: JUMPER 2,54 SW, tme.eu: 63429-202LF
13	1	26604020	SPOX_3.96_2P	J5	optional (for **panel meter**): Molex SPOX, e.G. Reichelt: MOLEX 26604020, tme.eu: MX-26-60-4020
14	1	09503021		(J5)	crimp housing, optional (for **panel meter**): Molex. E.g. Reichelt: MOLEX 9503021, tme.eu: MX-2139-2A
15	2	08500106		(J5)	crimp terminal, optional (for **panel meter**), Molex. E.g. Reichelt: MOLEX 08500106, tme.eu: MX-2478-1-P913L (= 10 pack)
16	1	26604040	SPOX_3.96_4P	J3	Molex SPOX, e.G. Reichelt: MOLEX 26604040, tme.eu: MX-26-60-4040
17	1	09503041		(J3)	crimp housing: Molex. E.g. Reichelt: MOLEX 9503041, tme.eu: MX-2139-4A
18	4	08500106		(J3)	crimp terminal, Molex. E.g. Reichelt: MOLEX 08500106, tme.eu: MX-2478-1-P913L (= 10 pack)

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Bill of Material Rev. 0.0

Pos.	Qty	Value	Footprint	Ref.-No.	Comment
19	1	26604050	SPOX_3.96_5P3	J1	Modification: Remove Pin 2 and Pin 4. Molex SPOX, e.G. Reichelt: MOLEX 26604050, tme.eu: MX-26-60-4050
20	1	09503051		(J1)	crimp housing: Molex. E.g. Reichelt: MOLEX 9503051, tme.eu: MX-2139-5A
21	3	08500106		(J1)	crimp terminal, Molex. E.g. Reichelt: MOLEX 08500106, tme.eu: MX-2478-1-P913L (= 10 pack)
22	2	0031.8211	318211	F1, F2	Schurter fuse holder (5x20mm). E.g. Reichelt: PL OGN-25, tme.eu: 0031.8211
23	1	5x20mm, 1.6A		(F1)	Fuse for 9VAC
24	1	5x20mm, 2A		(F2)	Fuse for 5VDC
25	1	100n	C-2,5	C1	Ceramic Cap, 50V, pitch 2.5mm
26	1	10321041	SPOX_5.08_4P	J2	MOLEX, option: 115V/230V switch, tme.eu: MX-5281-04A
27	1	10013046		(J2)	MOLEX, option: 115V/230V switch., tme.eu: MX-5197-04, Farnell: 2612656 , Mouser: 538-10-01-3046 , Digikey: WM9124-ND
28	4	08701031		(J2)	Molex Crimp terminal, option 115V/230V, Farnell: 2060658, rs-online.com: 670-6265, Mouser 538-08-70-1031-CT, Digikey: WM18820CT-ND
29	1	T22205B436B		(J2)	Bulgin, option 115/230V (switch), tme.eu: AE-T22205B
30	1	10n/500V	C-5	C3	Ceramic Cap, 500V, pitch 5mm, Reichelt: KERKO-500 10N, tme.eu: CCH-10K (=10 pack)
31	1	1M	R-10	R2	Resistor, metal film, 5% or better, 0,6W
32	1	1N5908	CB429	D2	5V TVS diode. ST Micro. E.g. Reichelt: 1N 5908, tme.eu: 1N5908
33	1	47u/50V	C07/2,5	C2	el. Cap, 105°C, diameter 7mm, pitch 2.5mm
34	1	50R	R-10	R1	Resistor, metal film, 5% or better, 0,6W, calculated for blue led. For red, green, yellow: 330R
35	1	B32922C3334M	C-18X8-RM15	C4	X2-capacitor, 330n, 305V, EPCOS. E.g. Reichelt EPCO B32922C3334, tme.eu: B32922C3334M

C64 PSU GLOBAL Rev. 0
Bill of Material Rev. 0.0

Pos.	Qty	Value	Footprint	Ref.-No.	Comment
36	1	BV UI 304 0153	UI30	TR1	Hahn transformer, **option 115V/230V**, tme.eu: BVUI3040153
37	1	MPM-10-5	MPM10	M2	Mean Well, +5V@10W AC/DC module. tme.eu: MPM-10-5, Digikey: 1866-3459-ND, Farnell: 3002904, Mouser: 709-MPM10-5. Alternative for M1.
38	1	P6KE15CA	CB417NP	D1	15V bi-dir TVS diode, ST Micro, e.G. Reichelt: P6KE 15CA, tme.eu: P6KE15CA
39	1	RAC10-05SK/277	RAC10-K/277	M1	RECOM, +5V@10W AC/DC module. Tme.eu: RAC10-05SK/277, Digikey: 945-3121-5-ND, Farnell: 2822839, Mouser: 919-RAC10-05SK/277. Alternative for M2.
40	1	TEZ10/D230/9V	TEZ10	TR2	BREVE TUFVASSONS transformer, **option 230V only**, tme.eu: TEZ10/D/9V
41	1	6200.2300			Schurter, tme.eu: 6200.2300. Example for main connector with fuse.
42	1	1835.3118			Marquardt, tme.eu: 1835.3118. Example for an illuminated mains switch
43	7	2-520184-2			TE connectivity, tme.eu: 2-520184-2 or Reichelt RND 465-00067. Example for 6.3 x 0.8 spade terminals, red, fully isolated. Required to connect to teh mains connector and switch.
44	1	MAS 70S			Hirschmann DIN plug 7pin, 262°. Reichelt: MAS 70S, tme.eu: MAS70SGR. Example for C64 power plug
45	1.5m	$4x0.5mm^2$			Cable for output voltages. 4xAWG21
46					wires for mains and the LED