Documentation

Commodore C64 Power Supply

(Replacement)

Project number: 107

Revision: 2

Date: 25.02.2019

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.

Commodore C64 Power Supply (Replacement) Rev. 2

Module Description

This module is a power supply unit for the Commodore C64. It is dimensioned for an input voltage of 230VAC and provides 9VAC@2A as well as +5VDC@2A, which is sufficient to power the C64. The output voltages are isolated against each other.

The dimensions of the PCB are suitable for fitting it into an RND 455-00220 plastic enclosure (reichelt.de).

The PE connector is not connected to the mounting holes. In case a metal case is used, a 3 prong mains connector is mandatory and the case has to be connected to PE.

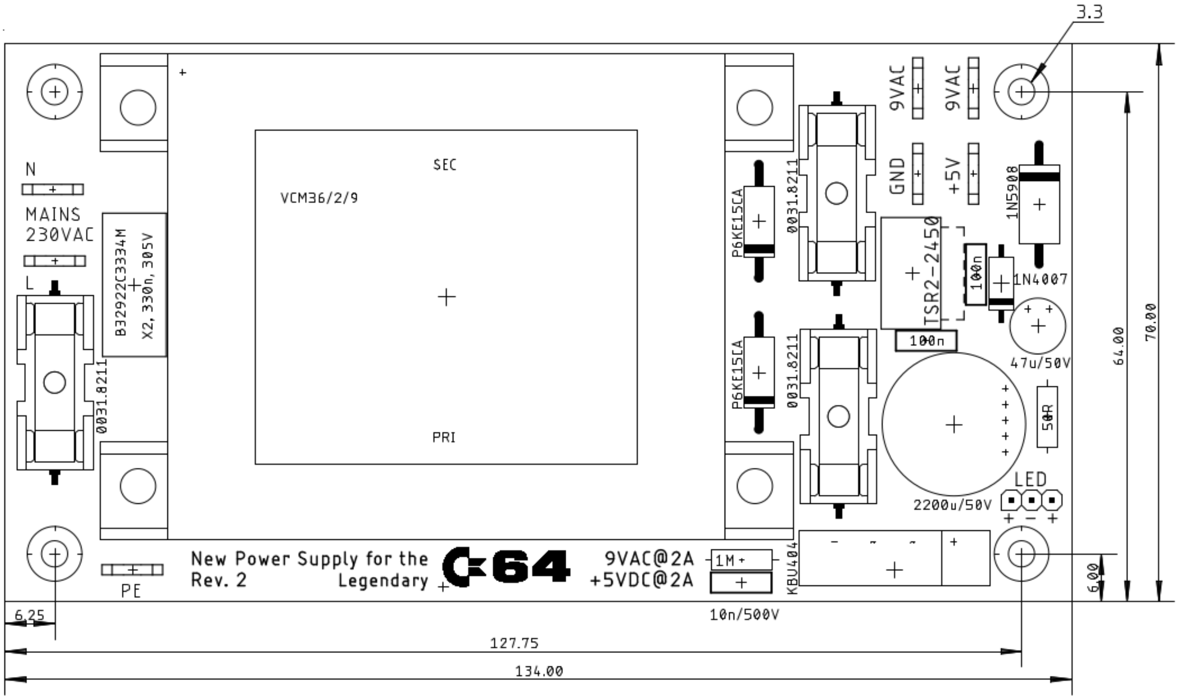


Figure 1: Dimensions of the PCB

Pinning

Spade connectors

6,3 x 0,8

Spade connector	Voltage
J1	Mains (L)
J2	Mains (N)
J8	PE (not assembled)
J4	9VAC (1)
J5	9VAV (2)
J6	+5V
J7	GND (reference for +5V)

LED

A blue LED (V_f=4,0V @ 20mA) is connected to J3. J3: Pinheader, RM2,54mm.

Pin	Signal
1	LED+
2	LED-
3	LED+

For a red, green or yellow LED, the value of R1 should be 330Ω.

Fuses

Fuse	Voltage	Value
F1	9VAC	2AT
F2	+5VAC	2AT
F3	Mains (230VAC)	0,16AT

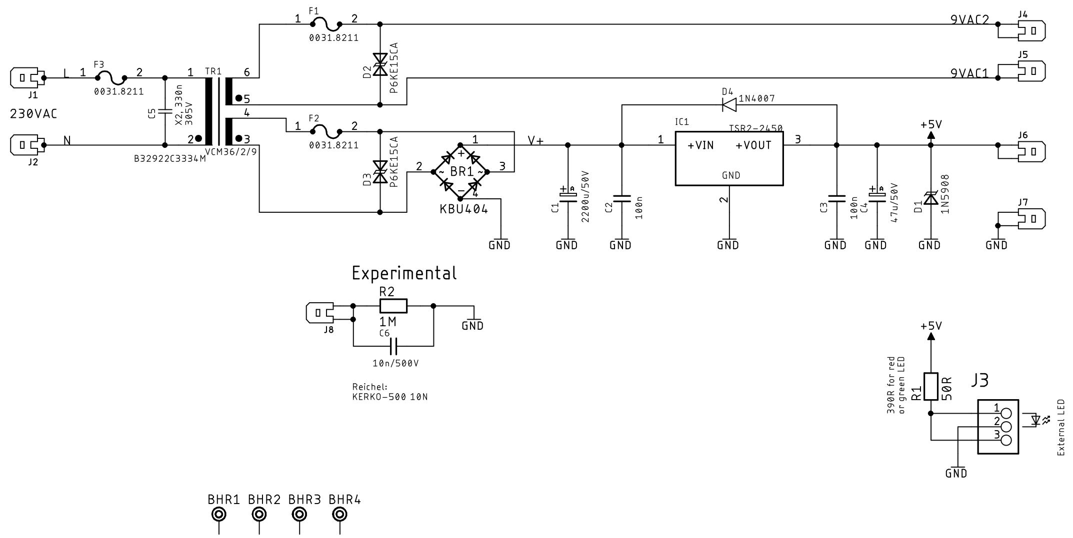
Revision History

Rev. 0 → Rev. 1

- PCB revision
- C5: footprint corrected
- D4: diode added

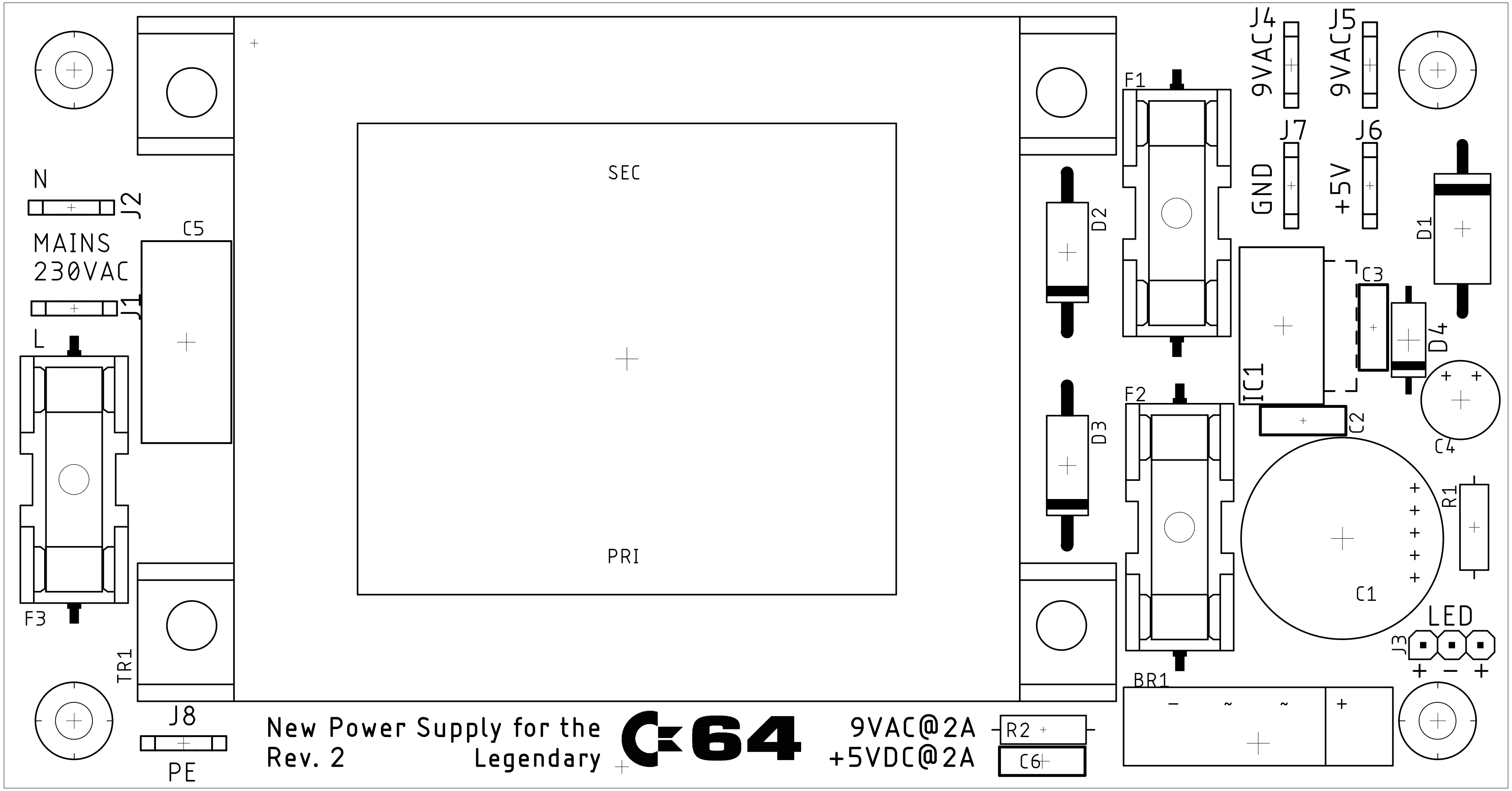
Rev. 1 → Rev. 2

- PCB revision
- IC1: TRACO 2A version (it is still possible to place the RECOM 1.5A dc/dc converter).
- D1: different type
- J8, R2, C6: Experimental connection of GND and PE



Title:	Commodore C64 Power Supply (Replacement)	Doc.-No.: 107-1-01-02	
		Draft.: Petersen	
Date:	25.02.2019 19:00	Rev.: 2	Page 1/1
File:	C64_PS		
			A3

Sven Petersen 2019	Doc.-No.: 107-2-01-02	
	Cu: 35µm	Cu-Layers: 2
C64_PS		
25.02.2019 19:03		Rev.: 2
placement component side		



Sven Petersen 2019	Doc.-No.: 107-2-01-02	
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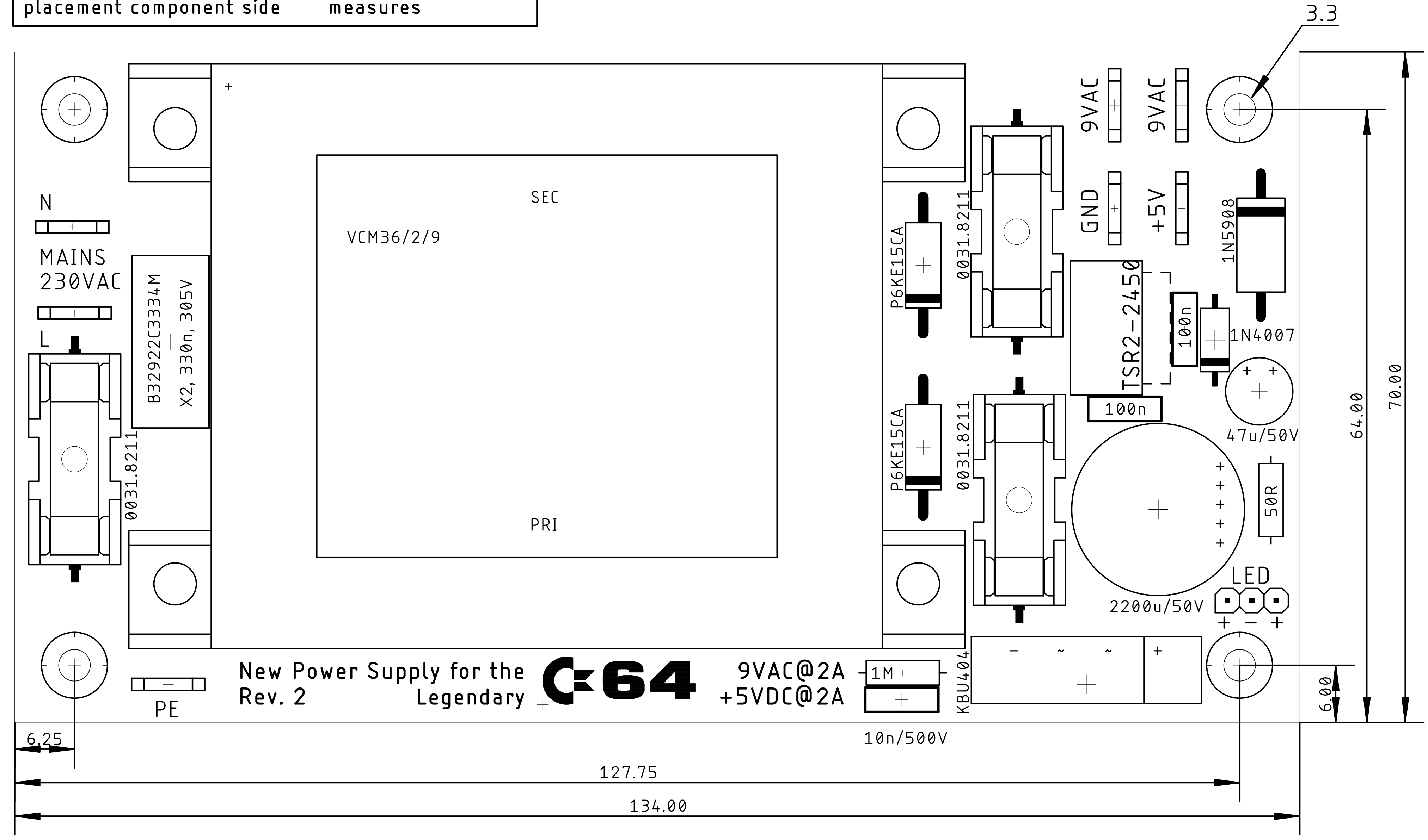
25.02.2019 19:04	Rev.: 2	
placement component side measures		



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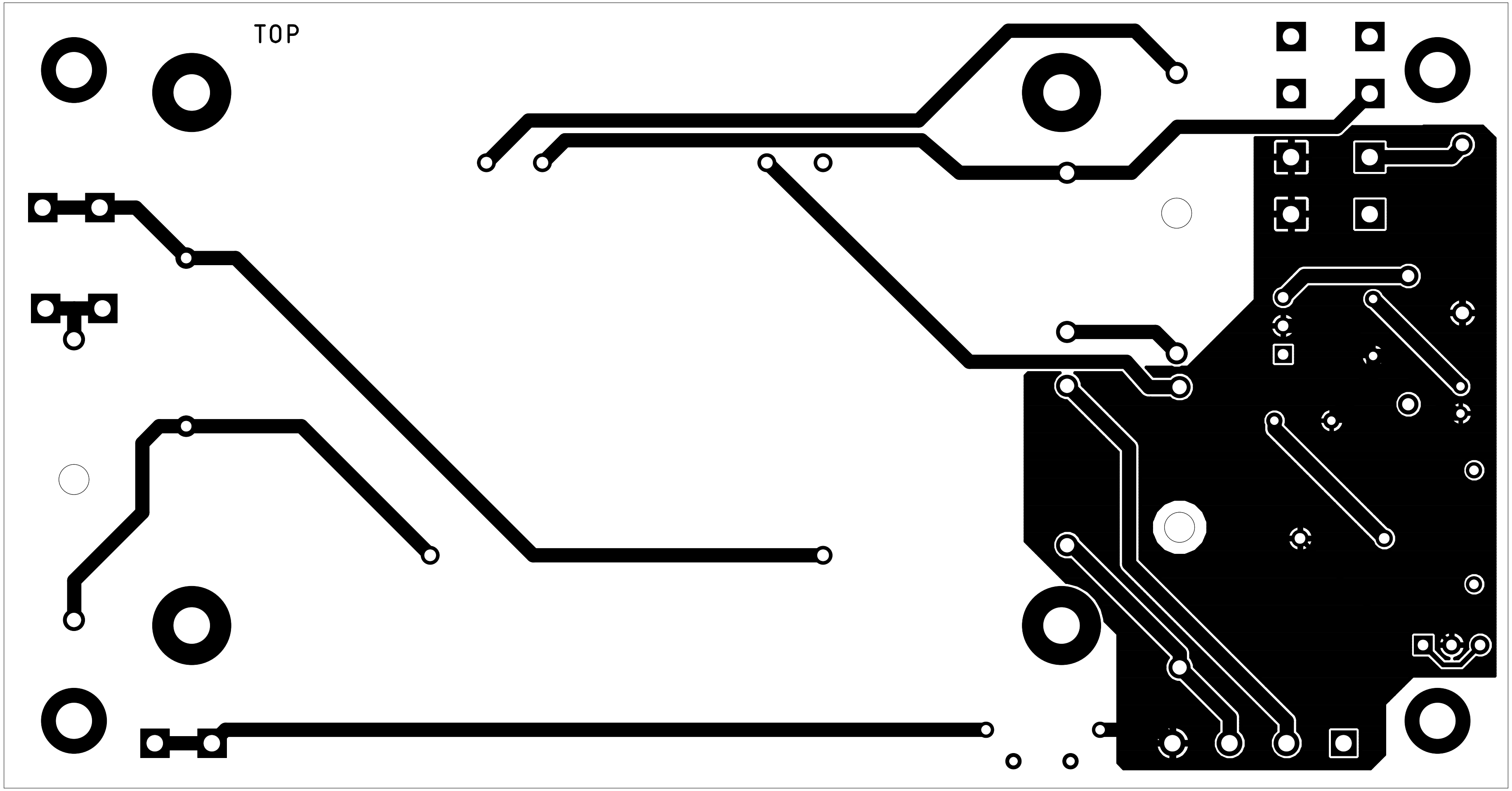

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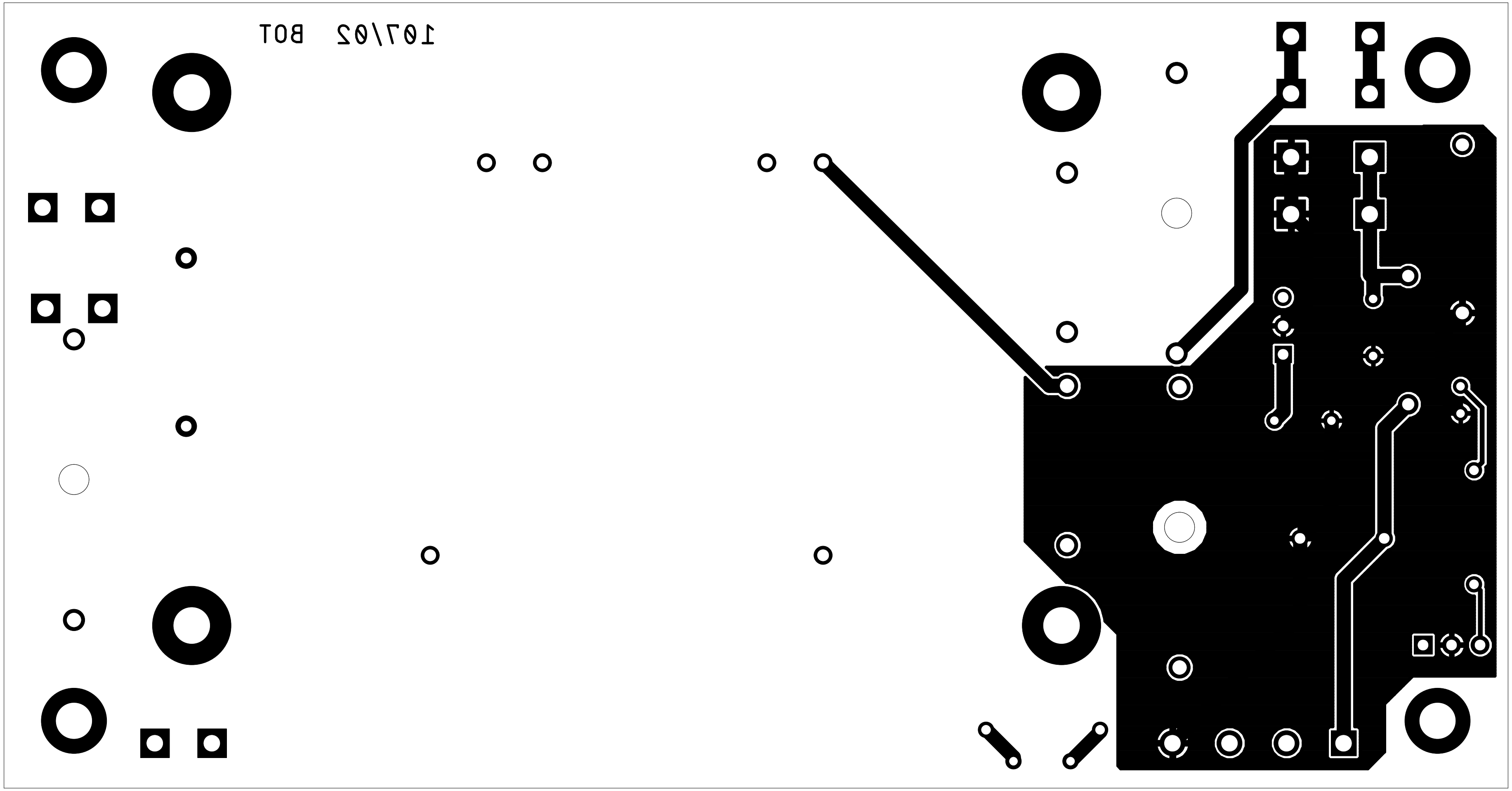

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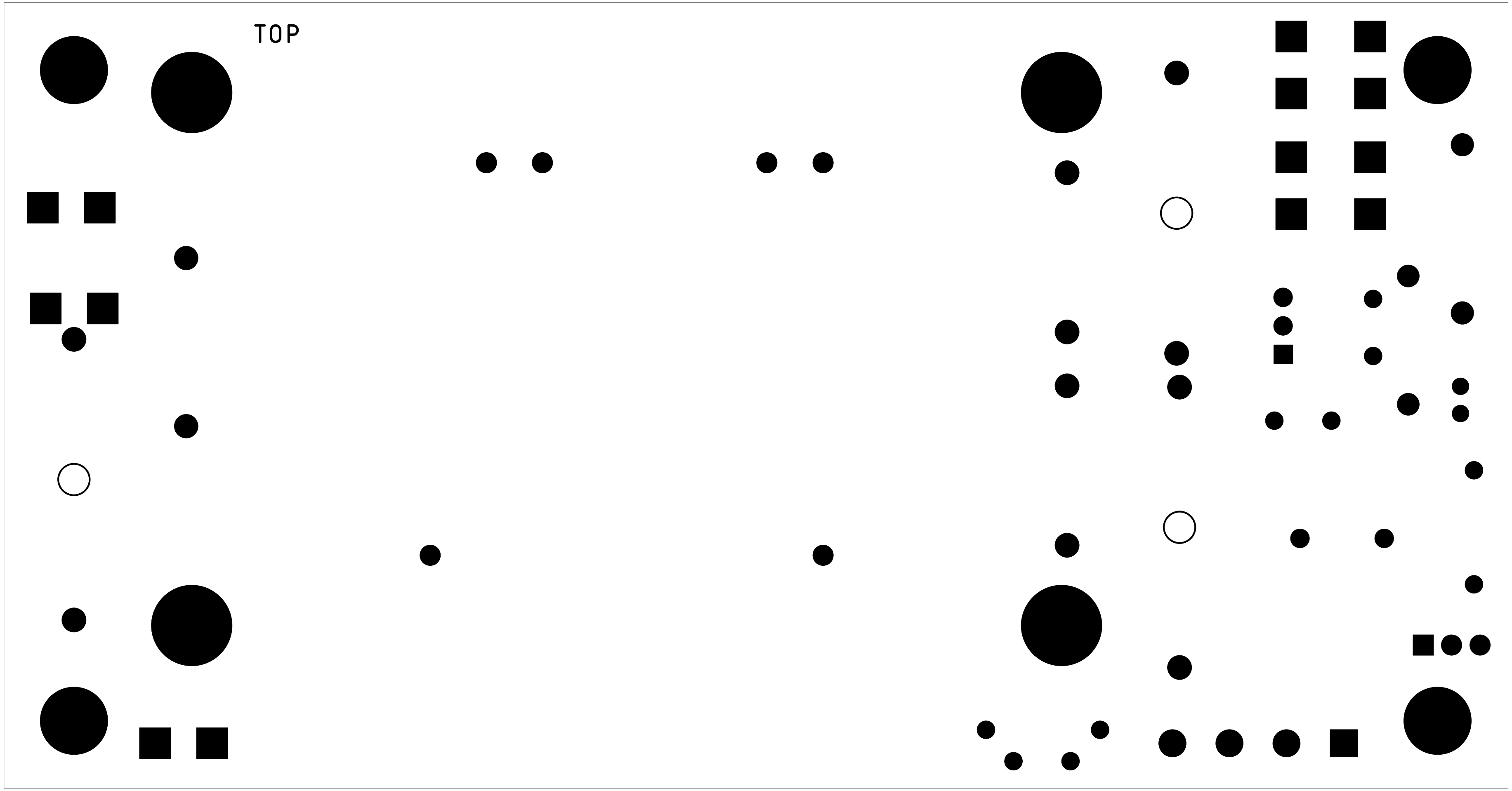

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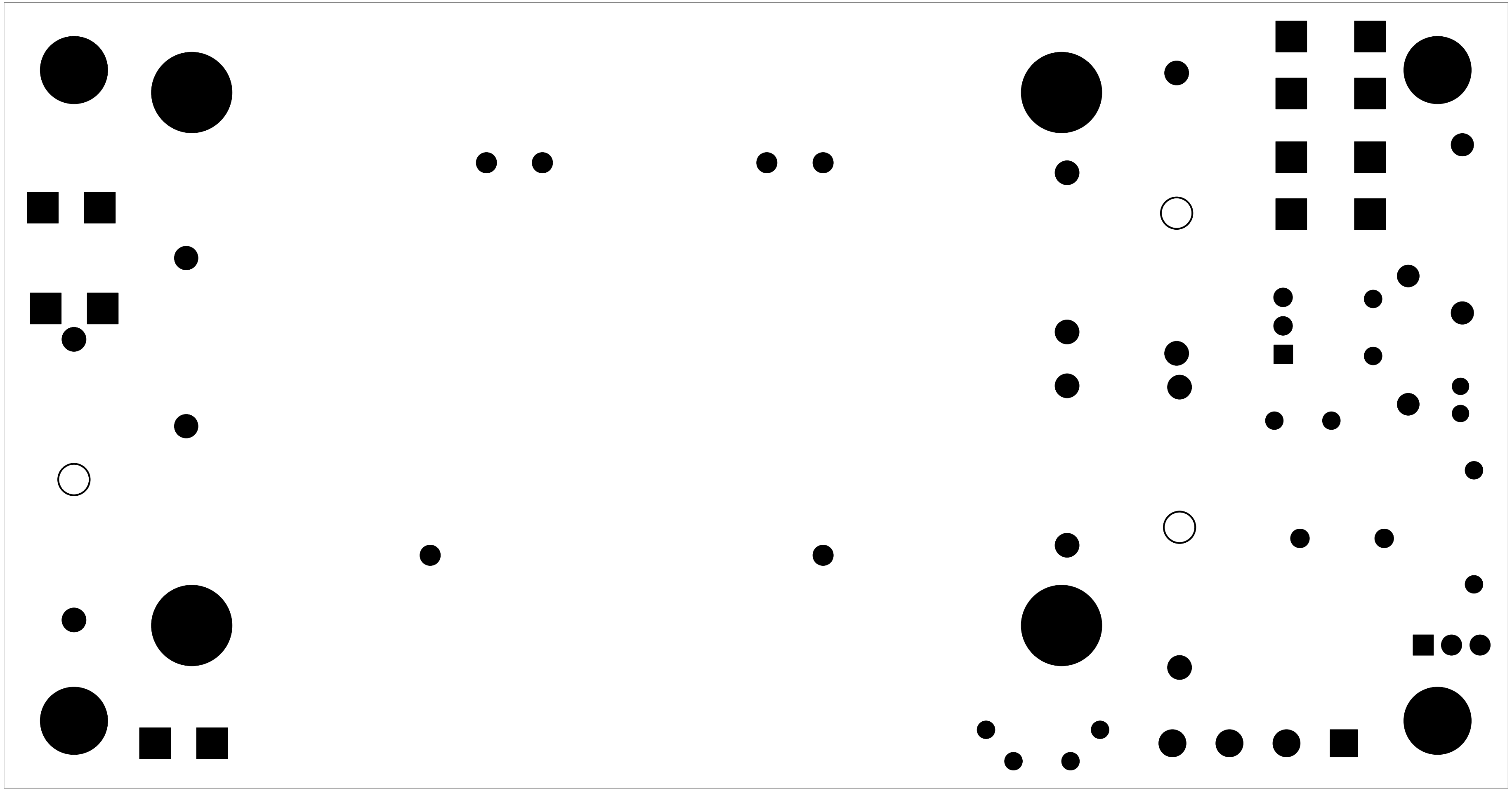
stopmask solder side		



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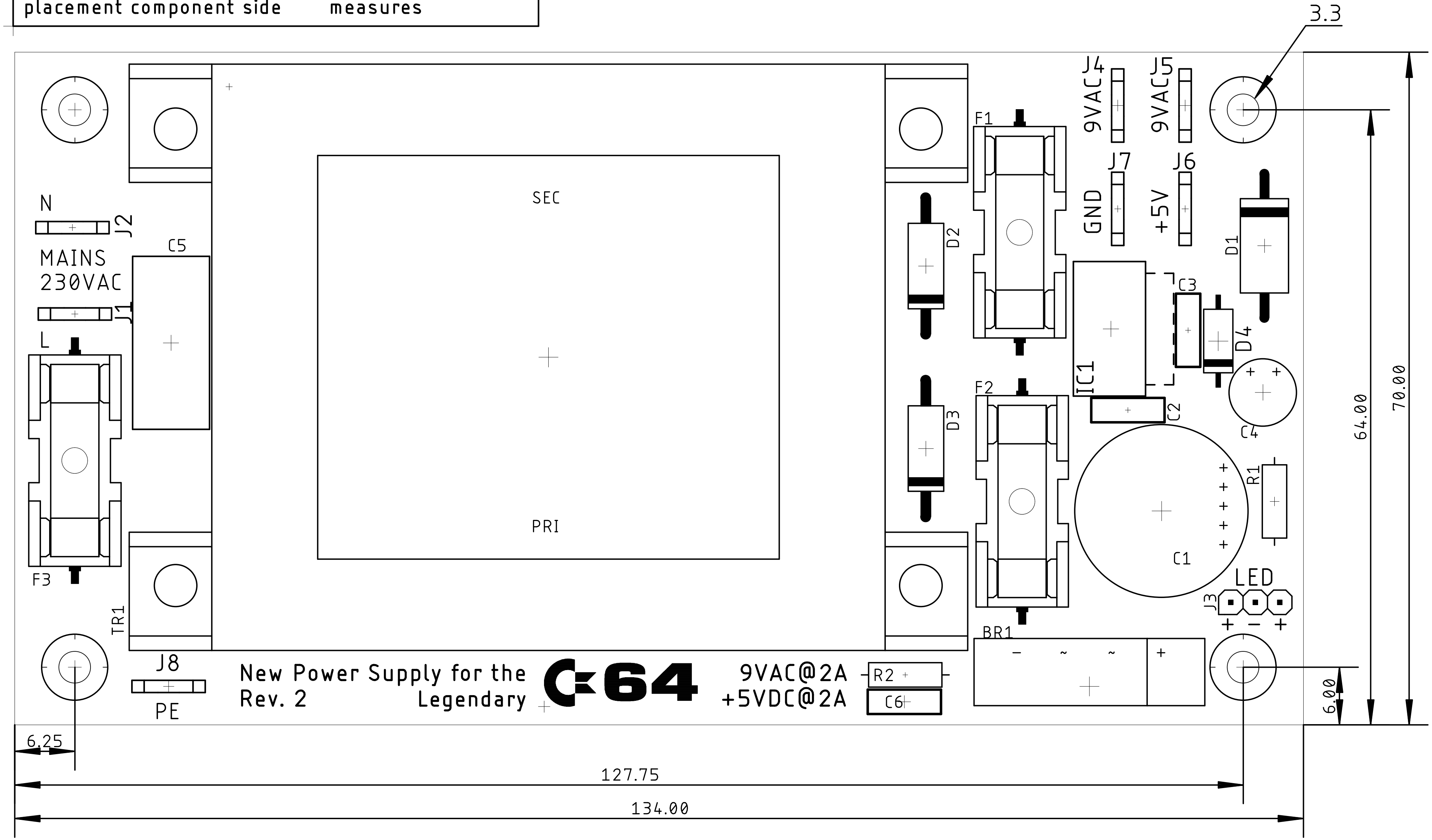
25.02.2019 19:03	Rev.: 2	
placement component side measures		



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Functional description

The mains 230VAC are connected to the spade connectors J1 and J2. The primary coil of the transformer TR1 is protected by the fuse F3. C5 is the X2 capacitor for attenuation of interferences/transients.

TR1 is powered by 230VAC, the secondary coils provide 9VAC (nominal) @ 2A. One output is protected by F1. It provides the 9VAC for the C64. D2 acts as an overvoltage protection. It is bidirectional and suitable for AC.

The second output of the transformer is protected by F2. The bi-directional TVS diode D3 is placed for blocking transients. BR1 is a bridge rectifier. Its output voltage is smoothed by C1. IC1 is a dc/dc converter, which generates the+5VDC (max 2A) from its input voltage. C2, C3 and C4 are suppressing interferences. D4 is a reverse protection diode for the dc/dc converter.

The TVS diode D1 is protecting the output against over voltages and transients.

The output voltages are connected to the spade connectors (J4-J7).

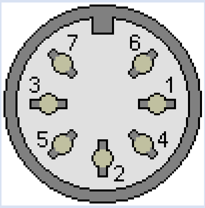
The purpose of R2 and C6 is to provide a connection of the GND to PE, which could be connected to J8. This might be helpful in case some peripherals connected to the C64 (such as composite video/HDMI converter) are powered by poorly isolated PSUs. This is still in an experimental stage and not proved.

Commodore C64 Power Supply (Replacement) Rev. 2

Cables

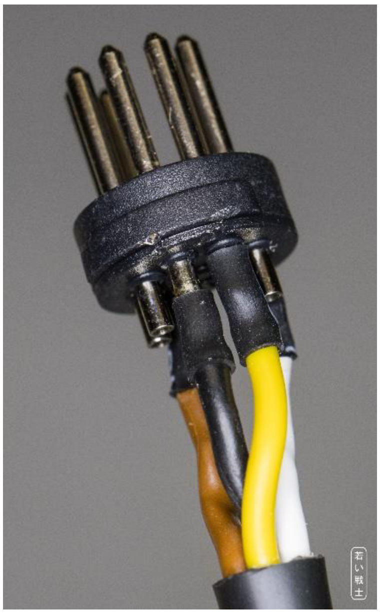
DIN-Cable to Power the C64

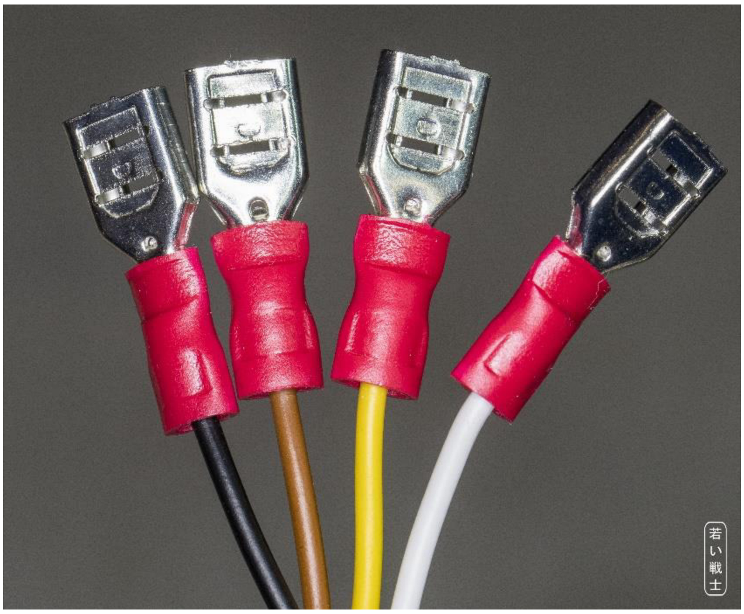
Pinning of the power jack

Jack	Pin	Signal	Color
	1	n/c	-
	2	GND	black
	3	n/c	-
	4	n/c	-
	5	+5VDC	yellow
	6	9VAC (1)	brown
	7	9VAC (2)	white

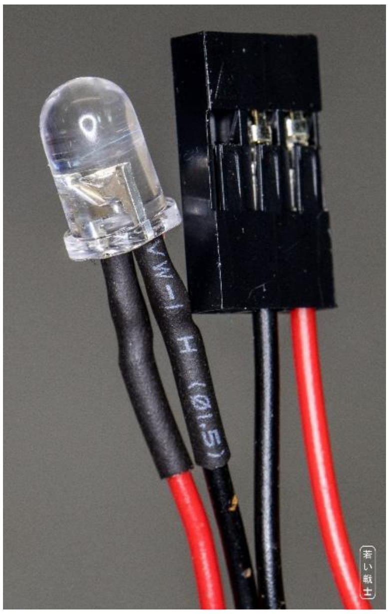
The jack is shown here. It resembles the pinning of the plug seen from the solder side.

Old C64 models have the +5VDC connected to pin 4. This is no problem, since it is connected to pin 5 on the C64 mainboard.





LED-Cable



The cathode of the LED is connected to the black wire, the anode is connected to the red wire. The pinning of the Dupont connector is +/-/+, so the orientation of the connector does not matter. The black wire is connected to the middle terminal, the red is connected to Pin 3.

The pin header has a pin distance of 2.54mm (1/10"), any receptable, that is suitable can be soldered to the wires instead.

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Prototype Test

Measurements

Voltage	No load	C64	*Full load*	*Testing*
+5VDC	+5.034V	+4.841V	+4.800V	Within -5% margin: ok
9VAC	10.62V~	10.43V~	10.13V~	Above nominal: ok

The voltages of "no load" are measured on the DIN plug of the PSU. The other measurements were done on the User Port. The C64 is a model C (ASSY 250469).

"Full load" means, that a C64 with an Ultimate II+ and a Commodore C2N Datasette are connected. The motor of the Datassette is running.

The measurements were conducted with a Fluke 89 IV multimeter.

Oscilloscope view of the +5VDC

The +5VDC were measured at the User Port (Pin 2 and Pin1). The time division was set to 1.0µs/cm, which seems to be sufficient with a clock frequency of approximately 1MHz. The trigger was set to 4.76V (+5V – 5%).

No failure was detected. The wave form shown in Figure 1 was recorded in auto trigger mode, since the scope was never triggered.

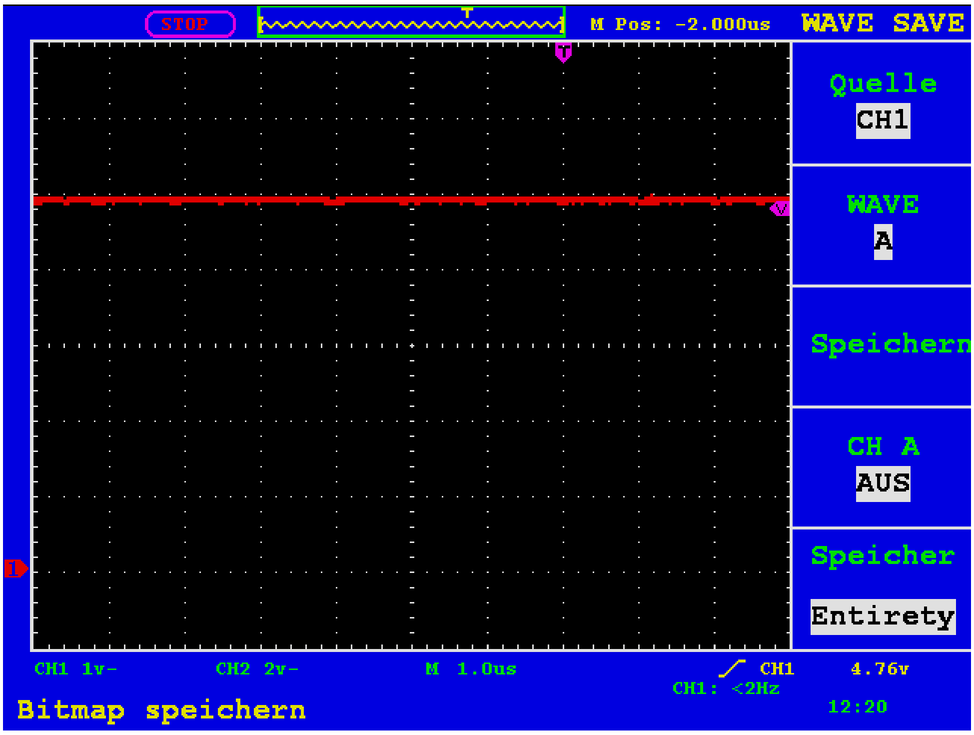

Figure 1: +5VDC, DC-Coupling (1V/cm)

Figure 2 shows the AC coupled signal. The vertical setting was 20.0mV/cm. The interferences are little ($82mV_{peak-peak}$).

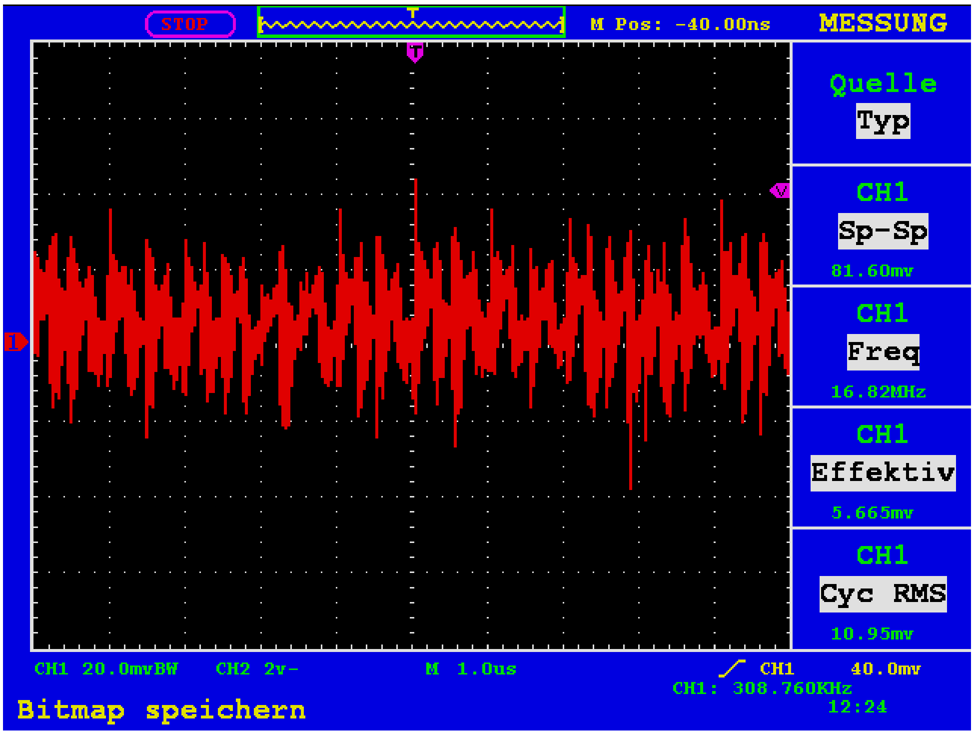

Figure 2: +5VDC, AC-Coupling (20mV/cm)

Testing: ok

The measurements were conducted with a Peak-Tech 1190 oscilloscope. The condition was a "full load" condition, the C64 was running and the Ultimate II+ was active.

Long time testing

A long-time test over 5 hours was conducted by running the Diagnostic Rev. 586220. No failure was detected.

Testing: ok

Thermal testing

The thermal testing was conducted under a full load condition (C64, Ultimate II+, Datassette). The components were initially at room temperature condition (25°C). A thermo couple was attached to the transformer, the case was closed except the mounting hole for the LED. It was occupied by the thermo couple. The test arrangement was running until the temperature of the transformer stabilized. This was after about four hours at 44.2°C.

Subsequently, the thermo couple was attached to the bridge rectifier. It was waited until the temperature stabilized. The reading was 45.4°C.

Finally, the thermo couple was attached to the DC/DC converter. Again, it was waited until the temperature stabilized. The reading was 47.8°C. AT this point, the elapsed thermal testing time was 7 hours. After switching off, the temperature sunk 35°C within 12 minutes.

The testing was conducted with a Fluke 89 IV multimeter and a corresponding thermo couple.

Figure 3: Thermal testing - Initial condition

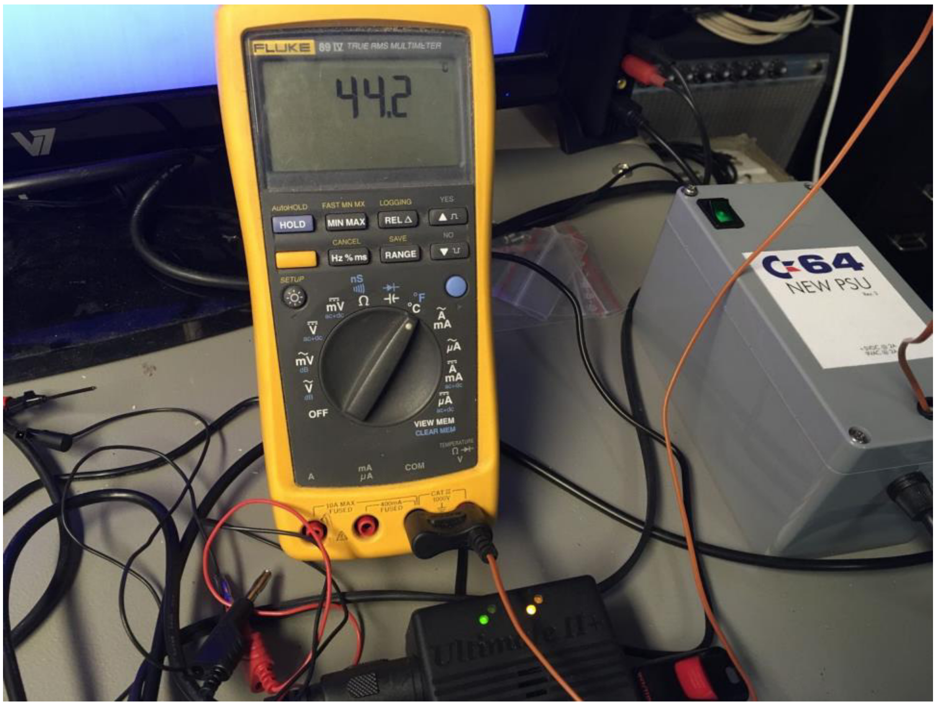

Figure 4: Thermal Testing – Transformer

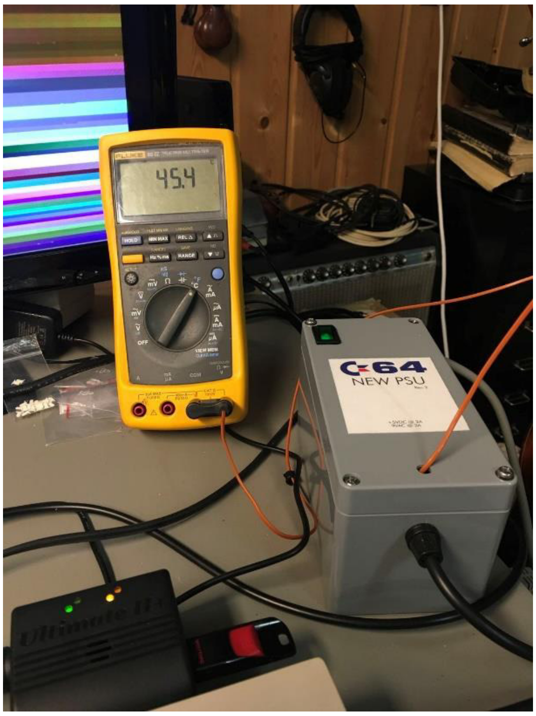

Figure 5: Thermal Testing – Rectifier

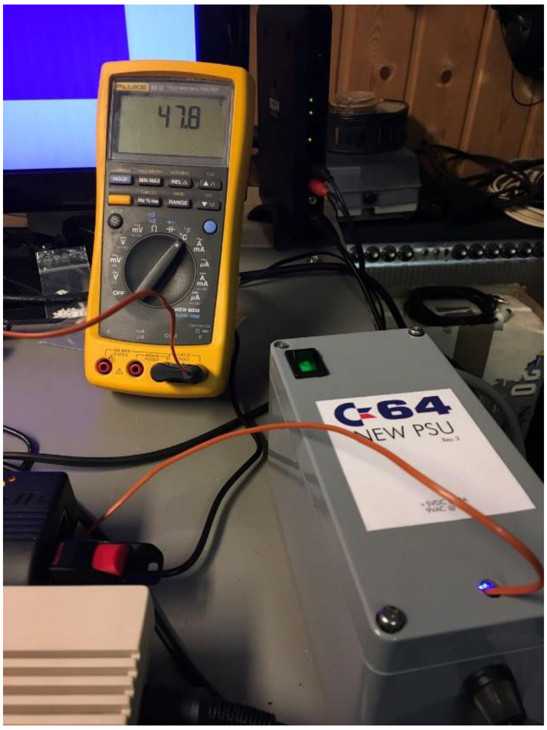

Figure 6: Thermal Testing: DC/DC converter

Component	Measured (surface)	Rated (data sheet)	Testing
Transformer TR1	44.2°C	$T_{ambient}$ = 40°C	Note 1
Bridge Rectifier BR1	45.4°C	125°C	ok
DC/DC-Converter IC1	47.8°C	85°C	ok

Note 1: The surface temperature is usually higher than the ambient temperature. The temperature might not be a problem, but it is close to the temperature ratings of the transformer. **Ventilation openings in the enclosure are recommended.**

The thermal testing was not conducted under best conditions. Instead of a defined load (maximum rating) from an electronic load, an estimated practical maximum load was used. A cassette motor permanently running for hours with an inserted tape for challenging the 9VAC does not have a practical use. The power consumption of the Ultimate II+ is not constant and it might not always reach its maximum.

The ambient temperature outside the PSU was 24°C. Testing in an environmental chamber was not conducted.