Building RBSC's Tiny Power Supply into
Panasonic FS-A1 and FS-A1 MK2 MSX2 Computers
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About the project

The TinyPSU project was created by RBSC to bring back to life a batch of MSX2 computers, mostly Panasonic FS-A1. Those computers were lacking original power supply units that made them pretty much unusable. It's a known fact that original power supplies for those computers are hard to find and even if one is lucky to find one for sale, the price literally bites. Japanese sellers may easily ask for $70 for such a power supply. Overseas shipment, local and import taxes can easily bring the total cost of an original power supply to $100. But that's not the only problem.

The second problem is that these MSX2 computers have the special 3-pin power socket that was not used in many other MSX computers. So, reusing power supplies from other MSX computers was never an option. However, similar sockets were used in some old PC laptops, so it was possible to find an old laptop's power supply in order to utilize its cable to build a custom power supply for Panasonic FS-A1 or FS-A1 MK2 computers. The TinyPSU project solves this and many other problems. There's a detailed installation guide in the Docs folder of the repository with instructions on how to fit the TinyPSU into Panasonic computers.

There was at least one public project that made it possible to build the replacement power supply and use the special power cable from a old laptop's power supply. That project required purchasing 2 expensive transformers from China and also buying a relatively expensive plastic box to host the circuit board. Here's an example of such custom power supply. The total costs were about 75-80 Euro and it had to be assembled (there were no ready-made units).

That power supply worked really well, but the project was not open-source, so one had to buy the circuit board, the case and necessary components from several different sellers. And, of course, finding an old laptop's power

supply with the necessary cable was a challenge. Such power supply alone could cost up to $50. Taking all the above into account, it was decided to create a better and cheaper solution. The idea was to create a tiny power supply unit that could provide up to 3A to MSX2 computer and to have all 3 required output voltages: +5V, +12V and -12V. Using Meanwell or other Chinese-made power supply units was never an option because of a very limited amount of free space inside FS-A1 computer's case.

But the application of this power supply is not only limited to Panasonic FS-A1 and similar MSX computers. Technically, this power supply can be used with any MSX computer that requires 3 different voltages: +5V, +12V and -12V. For example, this repository contains a holder for the TinyPSU that could be used with Yamaha YIS 503II, 503III, YIS-604, CX5M, CX11 and similar MSX and MSX2 computers. There's no need to even modify the motherboard in order to fit this power supply into those computers. Moreover, after installation of this power supply the problem of incompatible mains voltage (100V or 220V) is also resolved thanks to the universal low-voltage external power supply.

Creating the PSU

The main requirements for the new power supply (PSU) were quite specific. It had to be very small, had to supply up to 3A to a motherboard, had to feed all 3 power rails: +5V, +12V and -12V. There had to be no radiators to cool voltage regulators, so the PSU had to be of switching type. At the same time all power conversion elements on the circuit board had to have sufficient cooling under maximum load. Based on these requirements a small (64x46mm) circuit board with the special thermal profile was created.

It was decided to use the 9V DC 2A external switching power supply with the barrel-shaped power connector (2.1mm, center-positive) as the primary source of power. The circuit on the new TinyPSU was designed to convert 9V DC 2A from an external source into both +12V and -12V and also to +5V. Two separate step-up and step-down converters were used. The voltage converter circuits were created based on reference designs from respective datasheets for these ICs.

To cool down voltage converters the circuit board was designed to take the heat from the bottom of each IC and to dissipate it within the board. Multiple tests showed that the cooling solution was adequate and the maximum temperature under excess load (close to 3A) was within acceptable limits (~50 degrees Celsius). The circuit was designed to protect the 5V rail from overvoltage by adding a suppressor and a fuse. Besides, the external switching power supply has its own overload protection that adds an additional level of protection.

Important notes

Please note that cheap Chinese power supply units may not be suitable to power the RBSC's TinyPSU. Such cheap power supplies usually lack proper filters and circuit protection that may result in adding interference to the video output of FS-A1 computers. The FS-A1 MK2 computer is better protected from interference because of additional capacitors on the HIC board. The recommended external power supply for the TinyPSU can be purchased from Amazon:

- Security-01 AC to DC 9V 2A Power Supply, Plug 5.5mm x 2.1mm, Plug EU, Center Positive
- https://www.amazon.de/dp/B0BZPK7MMS

This power supply showed the best results during testing. It's recommended not to buy 3A rated power supply, 2A should be more than enough. It may be also possible to power up the circuit with a 12V 2A switching power supply, though this is not recommended.

DO NOT use 12V transformer-based power supplies to power the TinyPSU! Those power supplies normally exceed the allowed input voltage and may result in the overvoltage on both 12V power rails of an MSX computer.

DO NOT use switching power supplies with lower (less than 7V) or higher (more than 12V) voltage output to power the TinyPSU! That may cause anomalies and damage your MSX computer!

Using 1A rated switching power supply as the external power source is not recommended because in most cases such power supply will trigger its internal protection when powering up the TinyPSU.

When preparing wires for connecting the TinyPSU to the motherboard it is highly recommended to use the crimping tool to put terminals onto one side of each wire. This will allow to secure these wires properly inside screw terminal block connectors. Here's an example of the crimping tool and a set of terminals for PSU's wires.

When choosing wires, please select at least 1.0-1.5mm diameter wires that are capable to hold up to 2A at 9V, otherwise your TinyPSU may not get insufficient power from the external PSU or/and the TinyPSU may not provide enough power for your motherboard.

When choosing the power connector for the external power supply, please buy one of the following connectors from AliExpress:

Square power connectors will fit perfectly into the FS-A1 computer's case. Round power connectors will require a 3D-printed holder in order to fit into the case.

All 3D models for this project could be found in the RBSC's repository on Thingiverse: https://www.thingiverse.com/thing:6987948/files

Preparation for modding

As the TinyPSU is built inside MSX2's computer case, there has to be enough space for it to fit in. So, certain electronic components must be removed from a motherboard. In addition, the massive aluminum radiator must be trimmed in order to be used with the new PSU and external power connector. Pliers and a file will be necessary for such trimming. Nothing too complicated.

To safely remove components from a motherboard it's recommended to have a desoldering station (desoldering pump) or a good manual solder sucker (manual or electric). You will also need wire cutters and a decent soldering station to complete the job. Motherboards of FS-A1 and FS-A1 MK2 are different, so modding instructions will be different too. You can find them below.

First of all, open the computer's case by removing 4 screws on the bottom of the case. Remove the top cover and carefully disconnect the keyboard. Remove all screws that hold the motherboard, lift the motherboard from the bottom of the case and desolder 2 wires that connect the motherboard to backup battery's terminals. Then completely remove the motherboard from the bottom case. Be careful not to damage the bottom side of the motherboard - it has an additional layer (green tracks) that may be damaged by sharp objects. After that you can start removing components from the motherboard.

Remove the screw that holds the power transistor against the massive aluminum radiator. Then remove the aluminum radiator from the motherboard. Please note that the radiator has twistable parts that go through the holes of the motherboard. In most cases those parts will not be twisted and will allow the radiator to be easily removed. But in some cases you will need to untwist these parts with pliers in order to be able to remove the radiator. If during untwisting one of the twistable parts breaks - this is fine: the radiator still has enough holding points. The radiator itself will need to be trimmed, the instructions are below.

The part of the radiator that secures the old power connector needs to be completely removed. It can be done with pliers. Then the edge needs to be leveled and a part of the radiator must be covered with an insulation tape to protect the wiring from the new external power connector. See the below pictures for reference. The tape must be applied to both sides of the radiator.
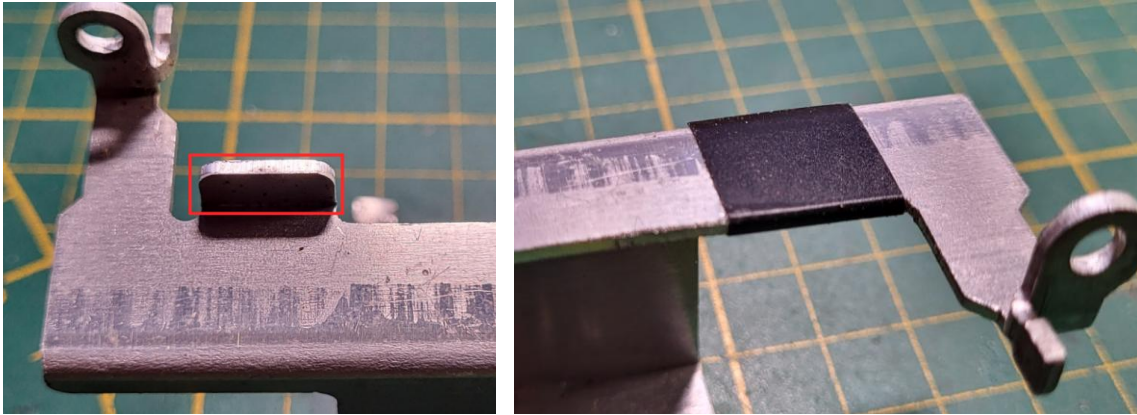
The TinyPSU should be installed into the 3D-printed holder and connected to the aluminum radiator with a screw like shown below. The connecting point is where the power transistor used to be attached to the radiator. It's recommended to remove the thermal paste from the radiator before this step.

For FS-A1 MK2's radiator an additional trimming is needed for the 5V connector to fit properly:
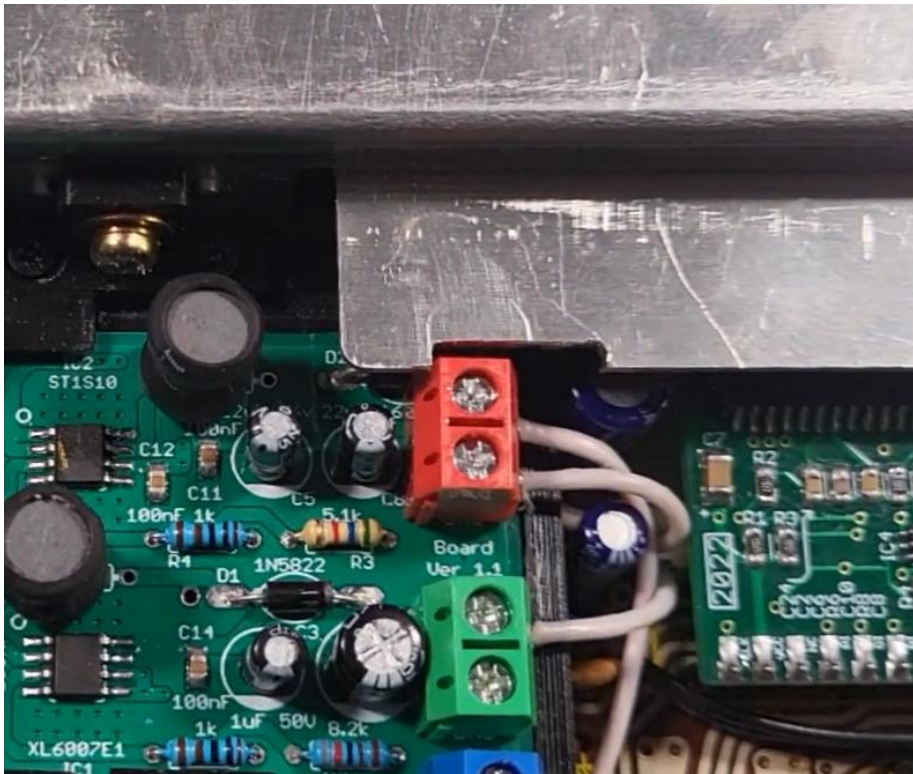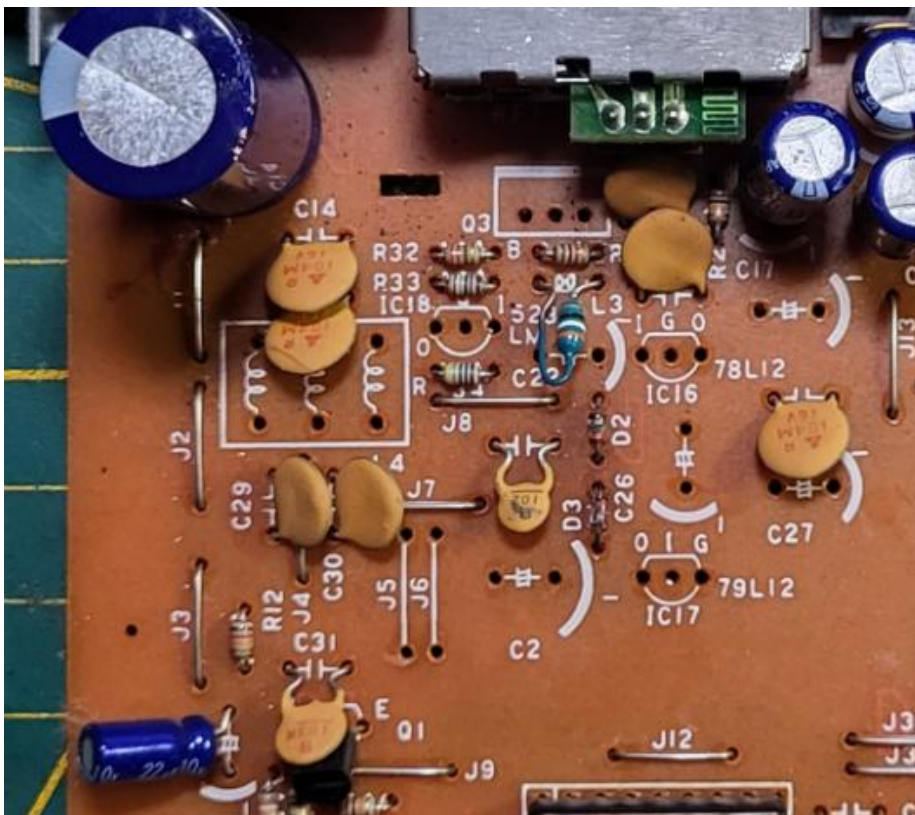
FS-A1 motherboard modding
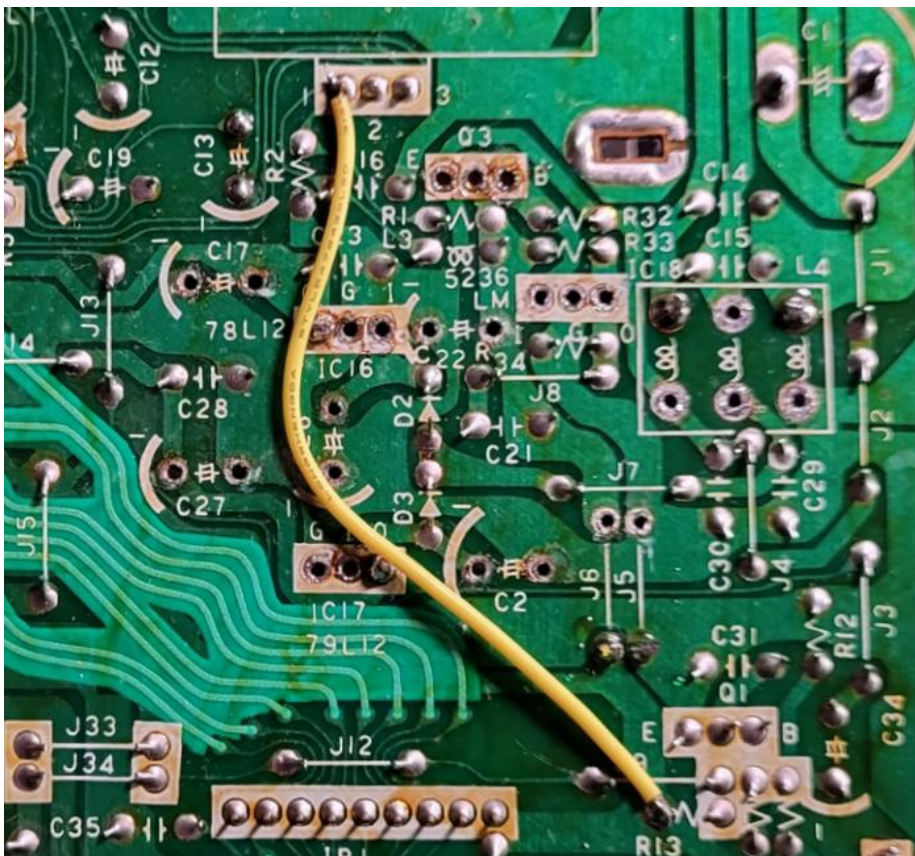
Carefully remove the following components from the motherboard:

- Power socket
- Coil assembly: L4
- Transistor: Q3
- Voltage regulators: IC16, IC17, IC18
- Jumpers: J5, J6
- Electrolytic capacitors: C2, C17, C22, C26, C27

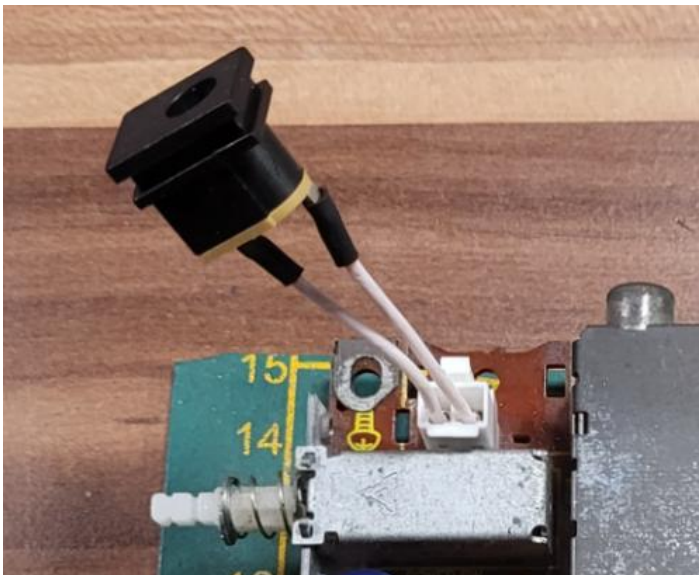Carefully bend remaining components as shown on the below picture:

If you plan to use the RF output, you need to solder a wire to its power input pin as shown below:

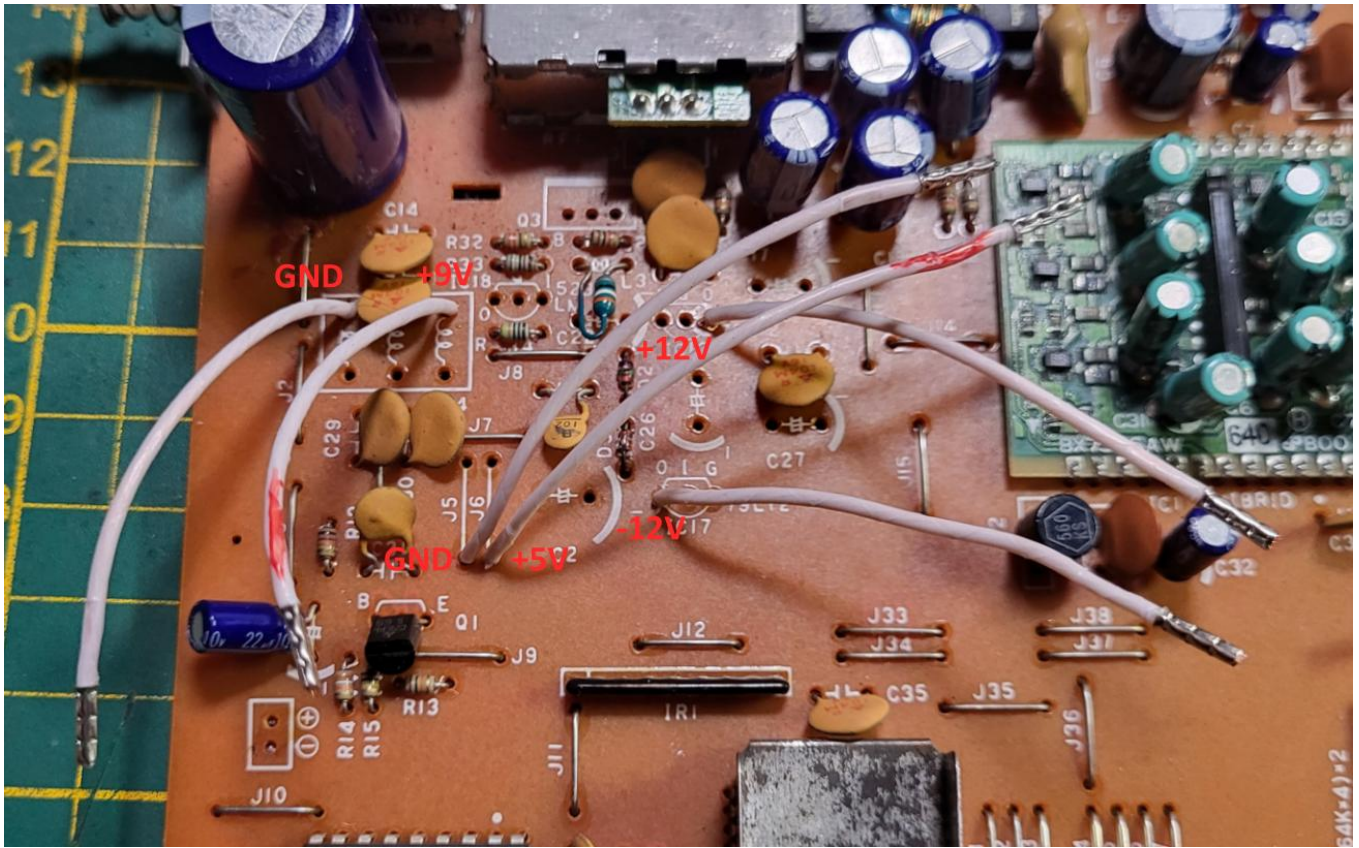Solder the 2-pin VH 3.96 male connector for the external power supply onto the motherboard as shown below:

The external power connector has to be prepared as well, use short thick wires and the VH 3.96 female connector. Wires should be crimpled into VH 3.96 terminals. The left pin is ground, the right pin is power. It should look like that when ready:
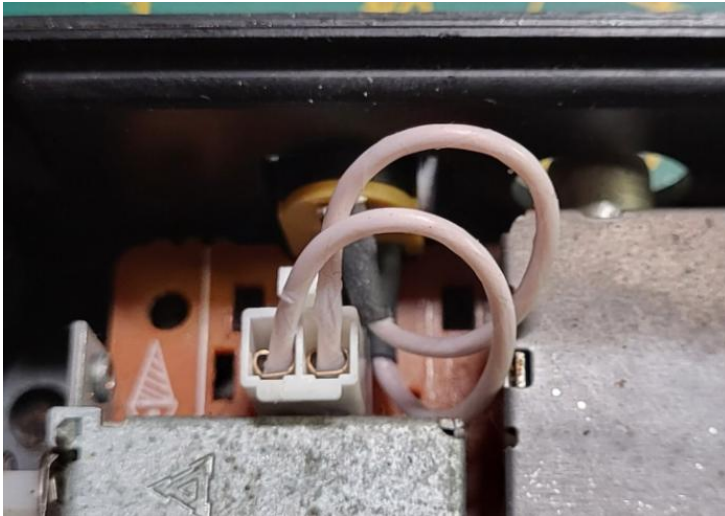

Finally, 6 wires have to be soldered for TinyPSU to be connected to the motherboard. When completed, it should look like that:
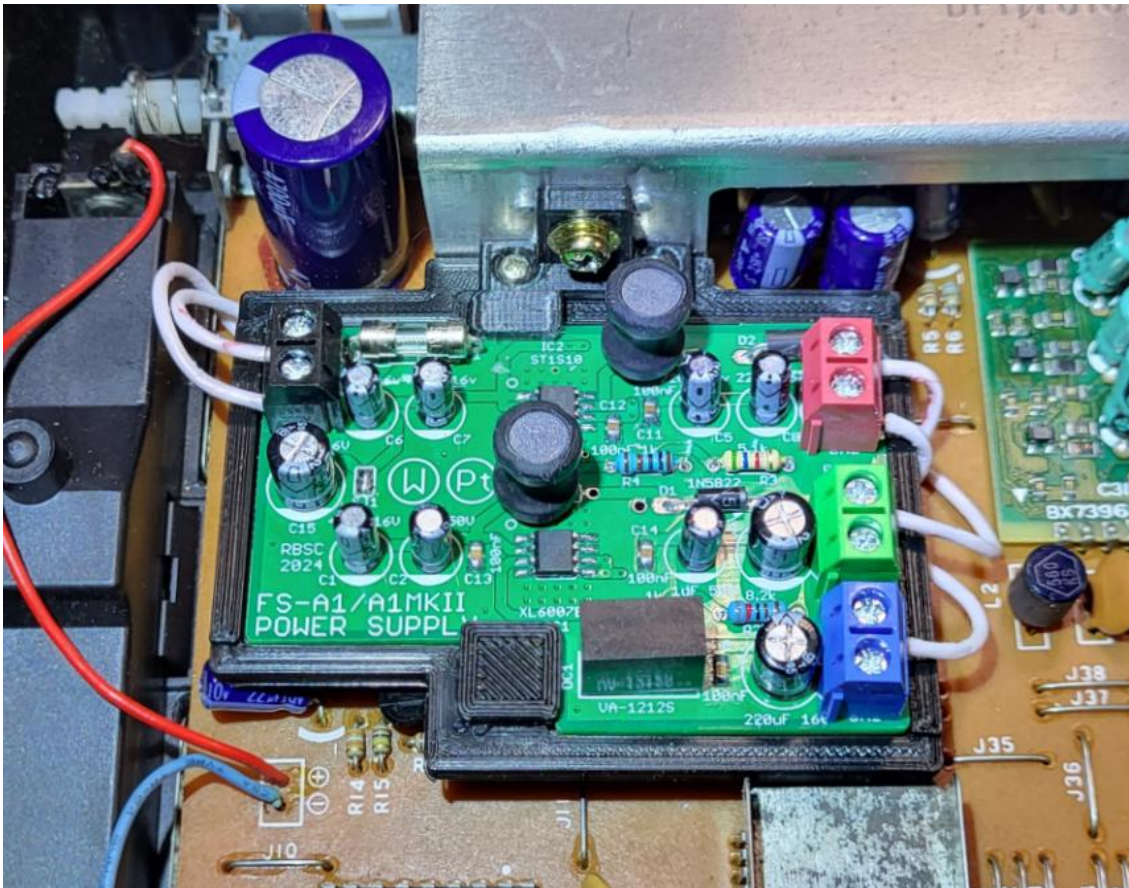
It is highly recommended to mark +9V and +5V wires with a red marker to avoid confusion with GND wires when wiring the TinyPSU.

At this point it's recommended to solder both battery terminal wires back to the motherboard (mind the polarity!) and install the motherboard back into the bottom part of the case. The wires of the external power connector must be carefully put through the power connector's hole. The external power connector or the 3D-printed holder for the round external power connector must be inserted into the square hole on the back of the case. The female connector must be connected to the male connector on the motherboard until a click is felt or heard. Finally you can install the radiator with the mounted TinyPSU, please make sure that the twistable radiator's parts get through motherboard's holes and that the radiator is firmly sitting on top of the motherboard. It's recommended to secure the radiator with at least the middle screw before connecting wires to the TinyPSU.

Now 6 wires need to be connected to screw terminal block connectors (black: +9V and GND; red: +5V and GND; green: +12V; blue: -12V). When fully installed the power supply should look like that:


Video of the installed TinyPSU: https://www.youtube.com/watch?v=BFeywwGB-1E

FS-A1 MK2 motherboard modding

Carefully remove the following components from the motherboard:

- Power socket
- Coil assembly: L6
- Transistor: Q1
- Voltage regulators: IC1, IC2, IC3
- Electrolytic capacitors: C10, C16, C18, C19, C20, C22, C23, C24, C28, C30
- Resistor: R20

Solder ceramic capacitors (size 1210) with 33-47uF capacitance onto the bottom side of the board between the pads of the previously removed C19, C20 and C24 capacitors as shown on the below image:
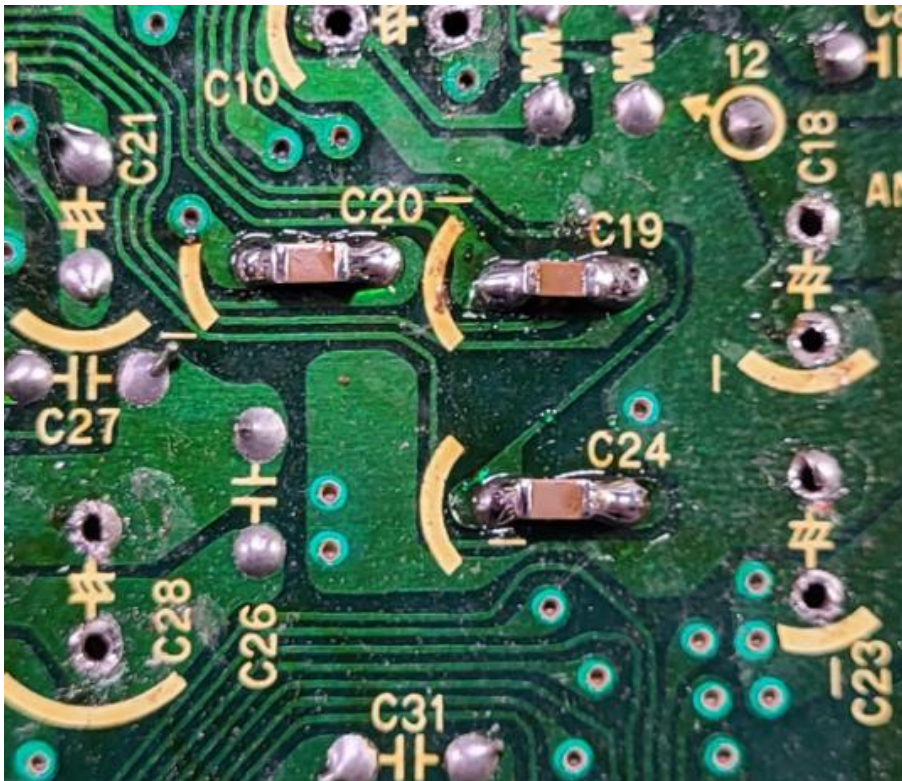
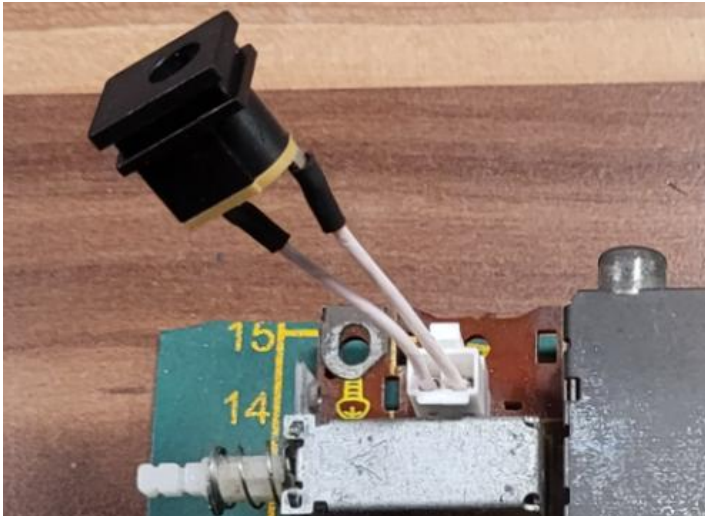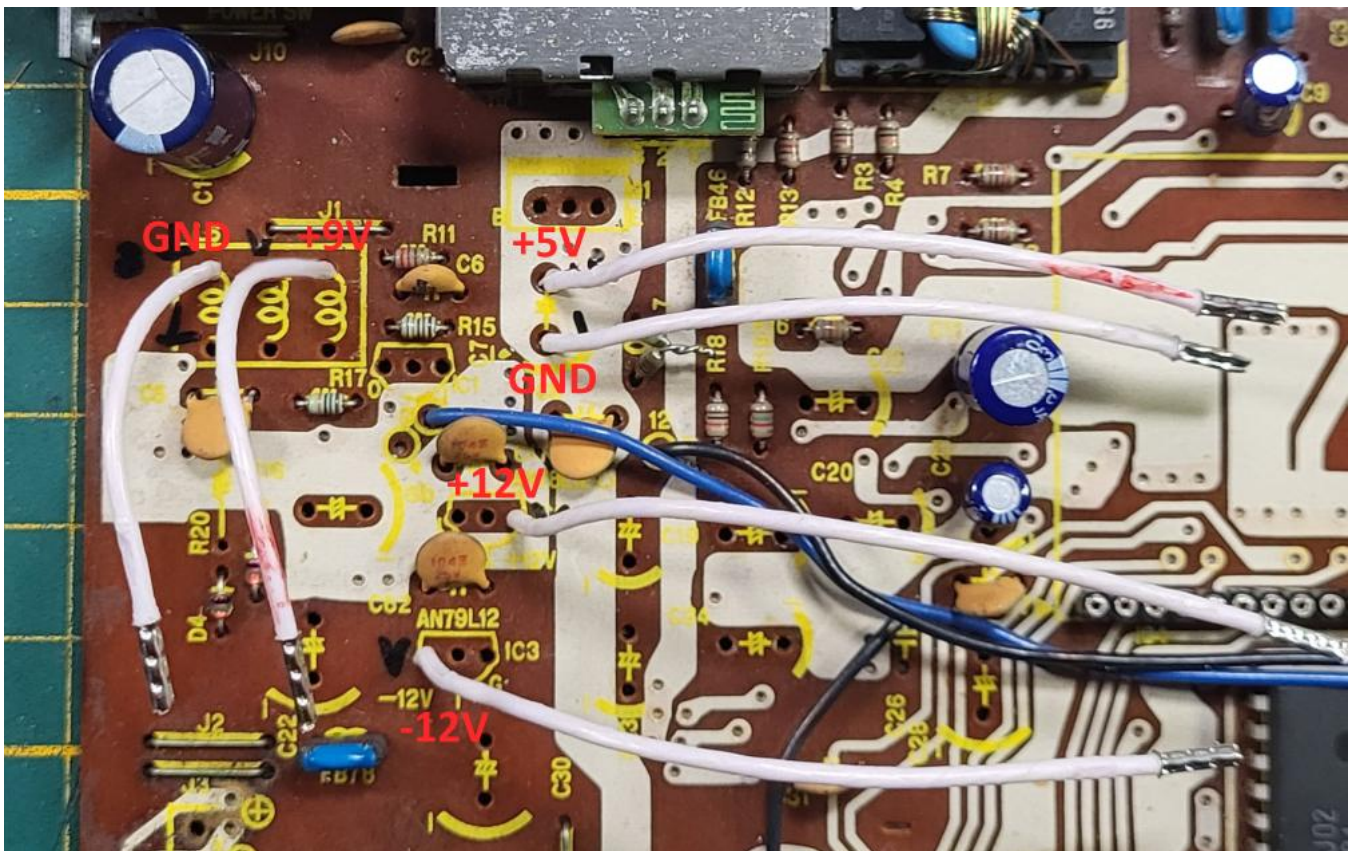Carefully bend remaining components as shown on the below picture:
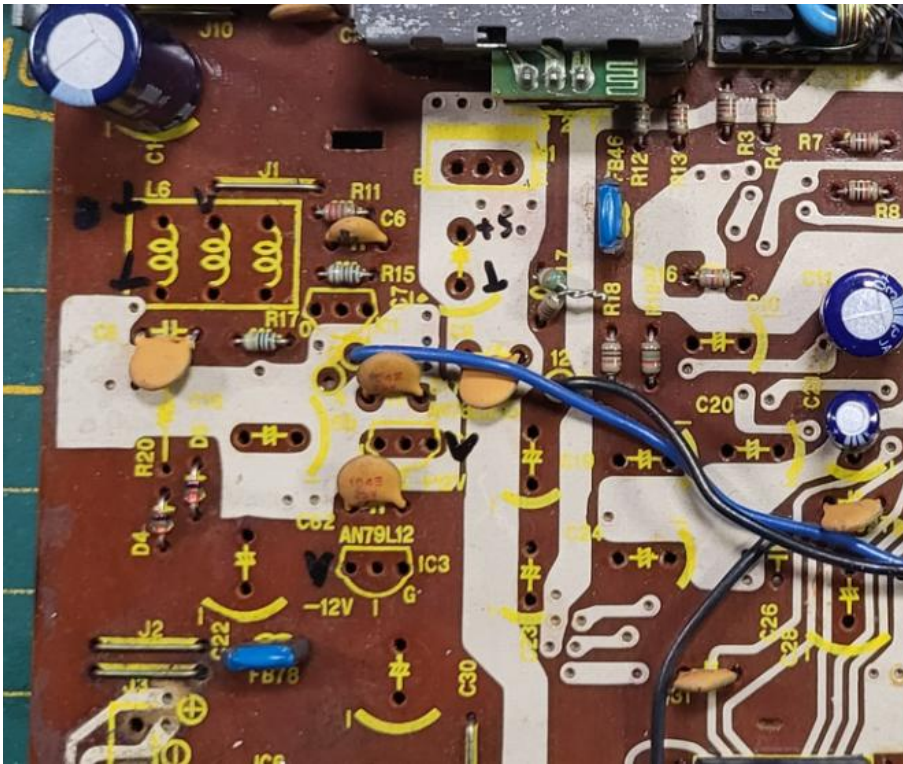
Solder the 2-pin VH 3.96 male connector for the external power supply onto the motherboard as follows:

The external power connector has to be prepared as well, use short thick wires and the VH 3.96 female connector. Wires should be crimpled into VH 3.96 terminals. The left pin is ground, the right pin is power. It should look like that when ready:
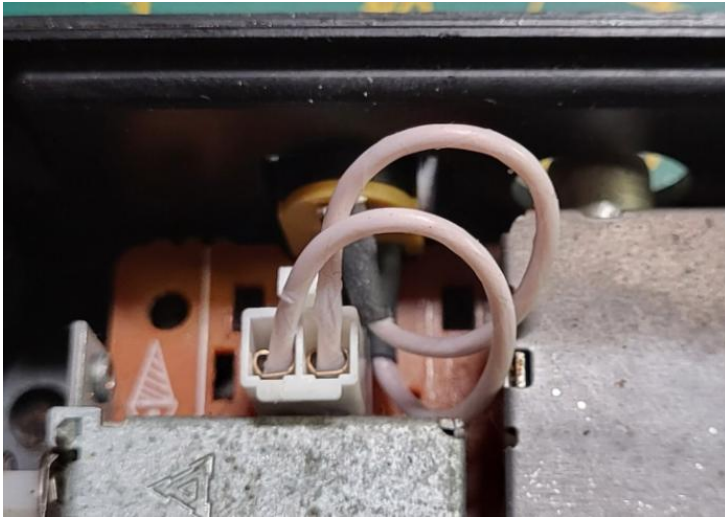
Finally, 6 wires have to be soldered for TinyPSU to be connected to the motherboard. When completed, it should look like that:

It is highly recommended to mark +9V and +5V wires with a red marker to avoid confusion with GND wires when wiring the TinyPSU.
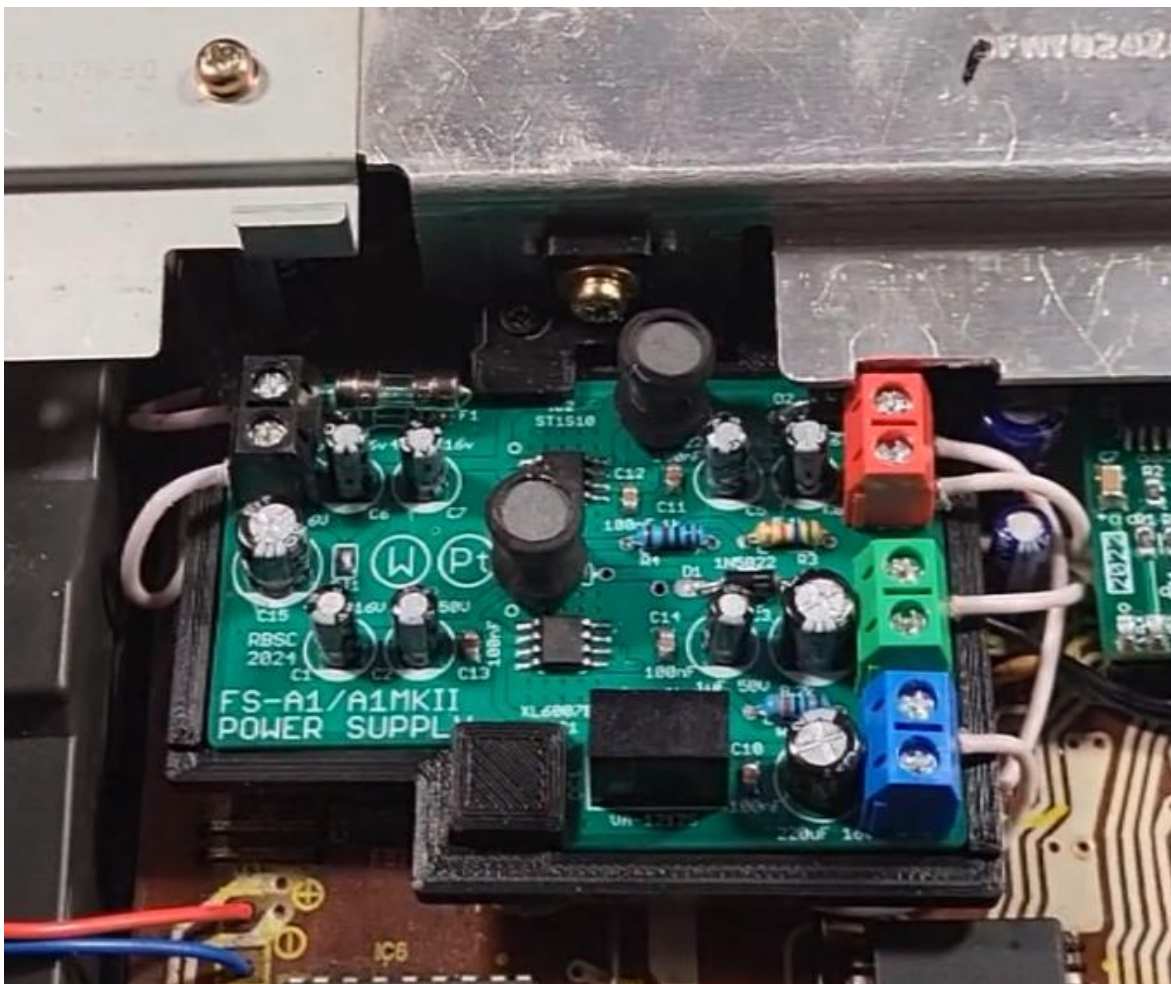
At this point it's recommended to solder both battery terminal wires back to the motherboard (mind the polarity!) and install the motherboard back into the bottom part of the case. The wires of the external power connector must be carefully put through the power connector's hole. The external power connector or the 3D-printed holder for the round external power connector must be inserted into the square hole on the back of the case. The female

connector must be connected to the male connector on the motherboard until a click is felt or heard. Finally you can install the radiator with the mounted TinyPSU, please make sure that the twistable radiator's parts get through motherboard's holes and that the radiator is firmly sitting on top of the motherboard. It's recommended to secure the radiator with at least the middle screw before connecting wires to the TinyPSU.

Now 6 wires need to be connected to screw terminal block connectors (black: +9V and GND; red: +5V and GND; green: +12V; blue: -12V). When fully installed the power supply should look like that:

Video of the installed TinyPSU: https://www.youtube.com/watch?v=ehKnjLdJIPI

Testing the installed PSU

It is recommended to test the installed PSU with a multimeter or with the iBolit or iBolit2 diagnostic cartridge that can display voltages on all 3 computer's power rails. The iBolit project could be found [[en:msx:ibolit:|here]]. Its successor, iBolit2, can be found in RBSC's repository.

Start with testing with measuring the voltage is provided by the external switching power supply. It should be 9V +/- 0.25V (or 12 +/- 0.25V if 12V external power supply is used). Make sure that the computer's power switch is off and connect the external power supply to the back of the computer. Insert the iBolit diagnostics cartridge into any MSX slot and power up the computer with the side switch. The iBolit should show 3 different voltages: +5V (top voltmeter), +12V (middle voltmeter) and -12V (bottom voltmeter). If voltages are significantly higher or lower than described above, please switch off the computer immediately and check the PSU for faults.

In case you don't have iBolit or iBolit2 diagnostics cartridge, you can use any multimeter to test the input/output voltages. To do that put your multimeter into the DC voltage measuring mode. Then you should put the black probe onto the lower screw of the black, red or green terminal block connector. The red probe should be put onto the upper screw of desired connector. On the black connector there should be around +9V, on the red connector there should be around +5V, on the green connector there should be around +12V and on the blue connector

there should be around -12V. If voltages are significantly higher or lower than described above, please switch off the computer immediately and check the PSU for faults.

Reassembling the computer

Once the TinyPSU is installed and tested, it's time to reassemble the computer. Reinstall all screws that secure the motherboard to the bottom part of the case. Then please make sure that the PSU sits firmly and doesn't pop too much from the surface of the motherboard. Connect the keyboard to the motherboard and put it on its case holders. Make sure that the PSU under the keyboard doesn't touch the bottom of the keyboard. If it does, remove the keyboard and re-adjust the position of the TinyPSU so that it fits properly under the keyboard. Once the keyboard is installed, close the case and reinstall the remaining 4 screws to secure the top cover. Your computer is now ready. Enjoy!

Troubleshooting

If you see interference in the video output signals of the FS-A1 computer after installing the TinyPSU, please make that you are using the recommended external power supply. Otherwise try to get the one that is recommended to be used with the RBSC's TinyPSU. The interference can be normally removed by installing an additional 1000uF or 1500uF electrolytic capacitor onto the 5V output of the TinyPSU, like shown below. This may look like an ugly hack, but it works.
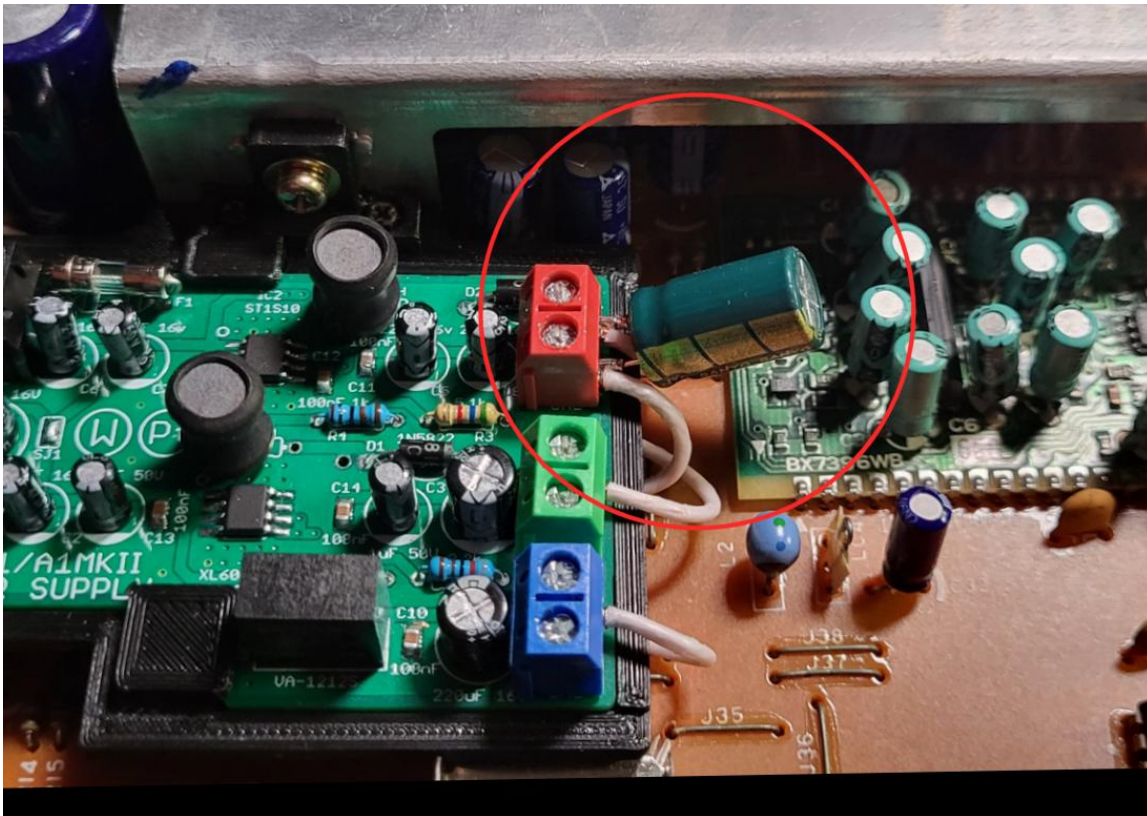
It is recommended to install the same terminals that were used on 6 wires on the outputs of the capacitor. This will help to secure the capacitor properly in the screw terminal block connectors. When installing the capacitor, please mind the polarity!

Credits and disclaimer

The RBSC provides all the files and information for free, without any liability (see the disclaimer.txt file). The provided information, software or hardware must not be used for commercial purposes unless permitted by the RBSC.

The members of RBSC group Tnt23, Wierzbowsky, Pyhesty, Ptero, GreyWolf, SuperMax, VWarlock, ALSP and DJS3000 can be contacted via the group's e-mail address:
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admin@rbsc.su

The group's website can be found here:
https://rbsc.su/
https://rbsc.su/ru

The RBSC's hardware repository can be found here:
https://github.com/rbsc

The RBSC's 3D model repository can be found here:
https://www.thingiverse.com/groups/rbsc/things

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