Work in progress

1. EEZ PSU H24005 Building Instructions

1.1. PCB assembly

The PSU has four PCBs where SMT parts are used to the greatest extent. Only connectors and few specialized parts (e.g. power resistor, PCB mounted AC/DC adapter, post-regulator's power mosfet, etc.) are THT.
SMT parts are selected to be easily mounted with hand soldering and assistance of magnifying glass with light or low magnification microscope. In general, a magnification of x8 to x10 should be more then appropriate for this task. Almost all passive components are of 0805 size and never smaller then 0603. Selected IC packages are SOIC, TSOP, TSSOP and similar that have exposed pins (i.e. no QFN or BGA package are selected).
Only two ICs (IC4, IC16) that has exposed power tab cannot be simply mounted with soldering iron and need hot air soldering station. That requires different skills but one can find many useful videos on the Internet with instructions how to do that efficiently at home without use of e.g. stencil and reflow owen.

1.1.1. Required tools

- Soldering iron with conical sloped tip example
- Hot air soldering station example
- Solder wire 0.25 mm example, and 0.7 mm example (optionally solder paste, for ICs with exposed power tabs but take into account that its shelf life is very limited even when refrigerated, therefore use small package, example)
- Solder wick / desoldering braid example
- Flux example
- Magnifying glass with light (desktop magnifier with backlight) example or microscope example
- Self-locking tweezers example
- Set of tweezers example1, example2
- Isopropyl alcohol example and paper wipes example for cleaning
- PCB holder example

1.1.2. Where to start?

The total number of parts that have to be soldered is almost 800. On the first sight that can easily discourage many, but it's not so bad. First, two most demanding PCBs for power boards are identical and you can try to assemble it side by side following steps mentioned below. The AUX PS is the simplest one but also has AC mains section that require additional care when operating. Finally, physically the biggest one – Arduino Shield is modestly populated but also carry extra parts such as TFT touch-screen display, Arduino board, binding posts, etc. that dictate some other set of assembling rules.

A good start could be to check that all parts from the consolidated BOM are available and sorted by type and values and can be easily accessible. As you have probably already learned, simple SMT parts with 2-3 terminals (passives, diode, transistors) can be easily lost even if you have well arranged and clean benchtop. Therefore instead of crying for lost one, simply order few parts more and take another one when previously selected was just gone. That issue is present with both self-locking and regular tweezers.

There is a few methods of storing and sorting SMT parts like small part snapboxes, envelopes etc. Each of them is valuable as far as it can reduce possibility of replacing one part mistakenly with another. That is especially important for ceramic capacitors (MLCCs) that do not carry value marks.

A discipline of selecting a single value at the time (even in larger quantity) and placing them on proper places is of a paramount importance to ensure that PCBs are assembled correctly and will work properly.

When needed tools, bare PCBs and SMT parts are on disposal, one important task still remain before we can start with PCB assembling – it's how to identify part value since PCB's silkscreens (top and bottom) only carry reference designators (i.e. R..., C..., IC..., etc.).
If you are using Eagle then open **.brd** file and when populating top layer make sure that among other

layers 21, 25, and 27 are visible (see *Top assembly selected layers.png*). For assembling bottom layer set layers 22, 26, and 28 as visible (see *Bottom assembly selected layers.png*).
The freeware edition of Eagle also allows you to open .brd file and switch layers on and off.
When installation of the Eagle is not an option, you can use the following images:

- *AUX PS r5B9 assembly (top layer).png*
- *AUX PS r5B9 assembly (bottom layer).png*
- *Arduino shield r3B4 assembly (top layer).png*
- *Arduino shield r3B4 assembly (bottom layer).png*
- *Power board r5B9 assembly (top layer).png*
- *Power board r5B9 assembly (bottom layer).png*

Above mentioned order of PCBs is not mandatory for assembling process but represents a logical sequence since AUX PS is required for powering Arduino shield and Arduino shield is required for controlling Power boards. Suggested order is also sorted by PCB complexity starting with the simplest one.
If not otherwise specified, we'd like to recommend that parts are soldered in the following order on the *same* layer:

- Small SMT parts (e.g. passives, diodes, transistors, etc.)
- SMT ICs
- Bulk SMT parts (elco capacitors, power inductors, mosfets and diodes) and
- THT parts (connectors, switches, chokes, etc.)

1.1.3. AUX PS r5B9 assembling

Schematic for this board is shown on sheets 6/12 and 7/12. We'd like to recommend the following steps for assembling this board:

- +5 V power supply built around IC16
- Fan control (Q22, X6)
- AC input terminal and protection
- Soft start/stand-by (Q20, Q21, OK1, OK2)
- AC/DC module (TR2) and
- Ethernet and USB terminals (X7, X11)

The IC16 is one of the few parts that require hot air soldering because of exposed power tab placed beneath its plastic body. It has to be mounted in that way to establish a solid electrical and thermal bond with exposed copper on the PCB's top layer. Otherwise, a permanent damage may occur or erratic operation. Due to that this part should be mounted first. When that is done we can proceed with completion of +5 V power supply section. The X5 connector has to be mounted *after* surrounding SMT parts (D21, R130, R131) otherwise it could be difficult to mount them without damaging X5 by touching it unintentionally with soldering iron body or tip.
When this section is finished and ready for testing do *not* solder TR2 since it's huge and could make mounting of surrounding parts afterwards almost impossible. Instead, use external regulated 12 V supply and connect it properly on its terminal 9- and +7. If everything is soldered correctly, a regulated +5 V will appear on X5 pin 10 (+) and 9 (-).
Now we can proceed with fan control. Keep in mind to mount THT part at the end (X6). Testing of this section has to be postponed until Arduino Shield is assembled. Also, it will require preparation of fan cable which comes without connector.
AC input terminal and protection section contains only THT parts that can be carefully soldered on the bottom layer.
Soft start/stand-by triacs Q20 and Q21 are sharing the same heatsink KK1 mounted on its opposite sides using single screw and nut. They can be mounted on before soldering. Another possibility is to solder heatsink first and then mount on each side a triac and then solder their terminals. Take care that power resistor R107 is of proper type (wirewound) and power rating.
Finally, place TR2 as the latest part on the top PCB layer. Now it's possible to test once again +5 V power supply by carefully applied AC mains on the X4 pin 1, 2 and 5.
On the bottom layer only two parts have to be mounted – Ethernet (X7) and USB (X11) terminals. If you got customized enclosure with pre-drilled holes on its rear panel, we recommend to mount the PCB on the rear panel first (using 14 mm spacers) and then solder that terminals. That will insure that everything fits perfectly.

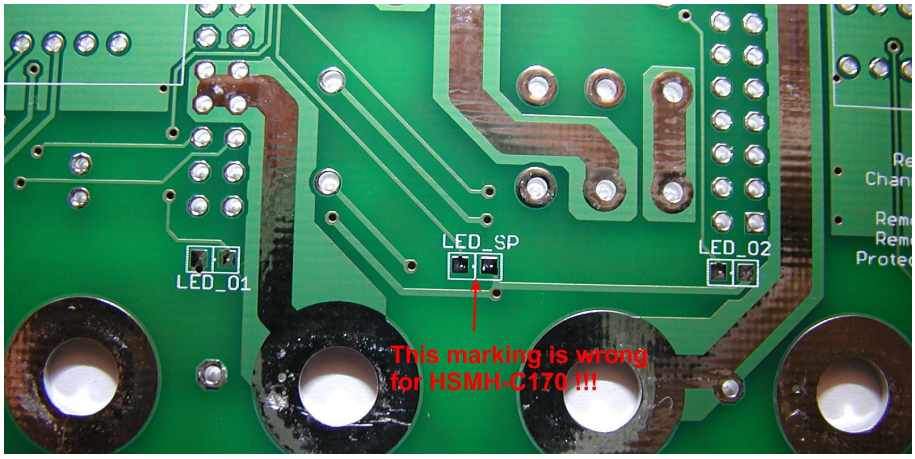
1.1.4. Arduino Shield r3B4 assembling

There is no recommended order in which sections on this PCB should be soldered. One possibility is to simply follow the order of sheets in consolidated schematics related to this board (sheet 8 to 12) and to leave the following parts for the end:

- Power relays (K_SER, K_PAR) due to their dimensions
- Super capacitor (C127) for RTC backup
- Push-in connectors (X12, X14) especially if you'd like to follow suggestion to adjust its distance from the front panel as described below
- 40-pin connector (LCD1) for the TFT touch-screen display
- Front panel power switch (SW1)

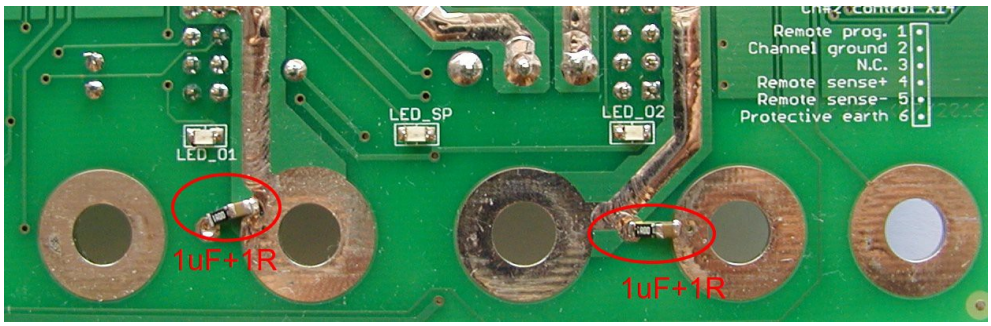
The revision r3B4 has few issues that we didn't spot before it went into manufacturing but fortunately all of them can be easily fixed.

Red LED polarity
Let's starts with the simplest one which is related to chosen red color LEDs that are located on the PCB's bottom layer. Polarity marking on the PCB is not in line with HSMH-C170 specification. Therefore you simply need to rotate it while soldering.



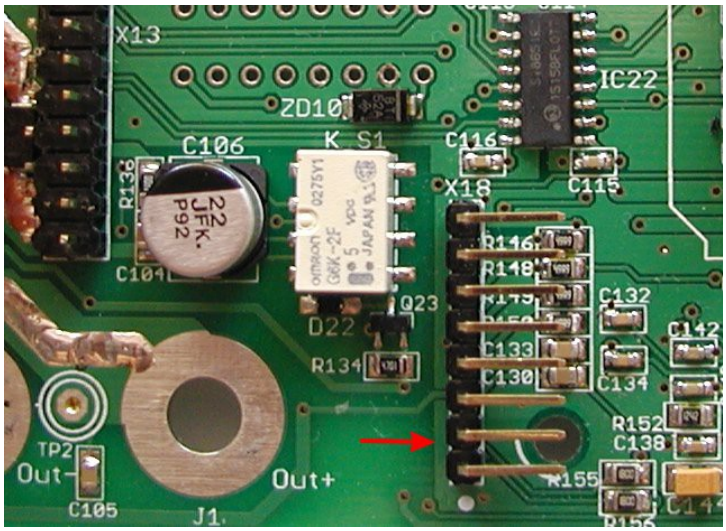
Output capacitors mounting
We are using SMT EEEFK1J220P (22 µF) as output capacitors (C106, C111) that are wider in diameter than THT UPW1J150MED (15 µF) initially specified. The SMT pads provided on that positions are also for SMT capacitors smaller in diameters. Regardless of that, mentioned type can be easily mounted by simply bending its terminals when it becomes a THT. Now, holes for a THT part can be used for soldering.

Additional output capacitors
An additional capacitor is recommended on the power output. A ceramic 1 µF, 50 V capacitor is used and damped with 1 Ω resistor. They should be placed as close as possible to the output binding post holes but there is no predicted place for that on this PCB revision. Nevertheless it's simple to add them like this:

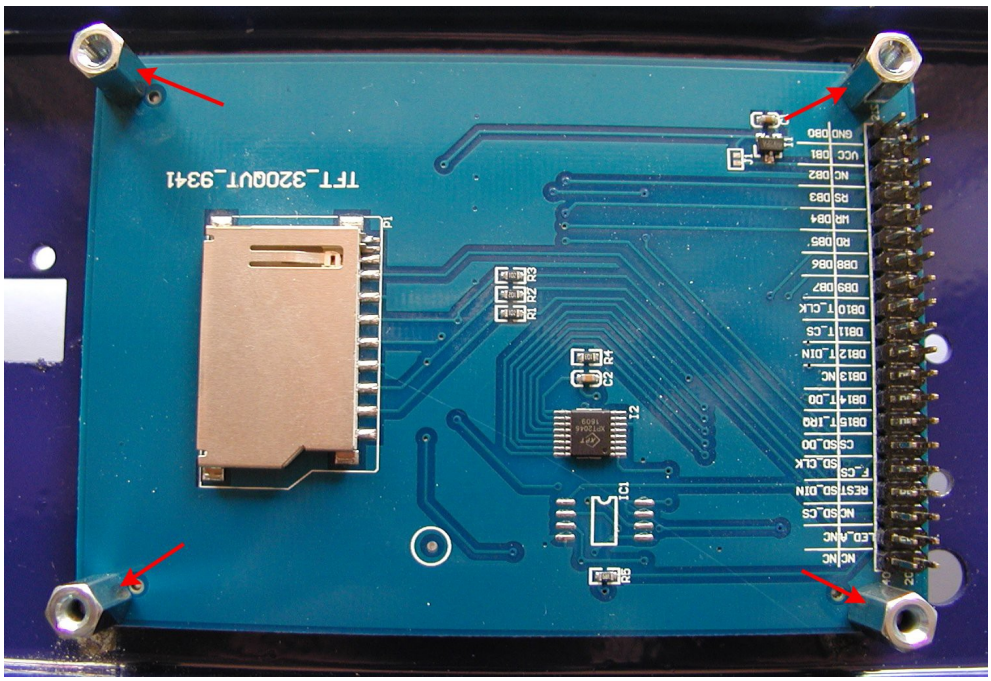


Ethernet connector position

The Ethernet connector (X18) is not properly positioned – it is too close to the CH1's heatsink. Due to that it is not possible to insert Ethernet cable that connect output terminal on the rear panel (via X8 on the AUX PS board).
A right angle connector has to be used as specified in the BOM. But, when such connector type is used (see picture below), there is no possibility to put a screw to fix TFT touch-screen display on the lower left corner viewed from the display's back (or lower right corner viewed from the display's front).



Fortunately that is not a big issue since display still can be fixed on all four corners with 11 mm spacers and that will provide enough mechanical strength required to withstand finger pressure on that part of the display:

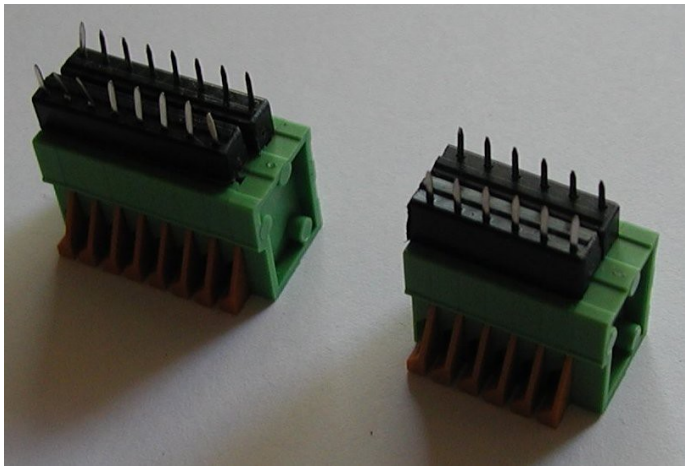


Push-in connectors distance adjustments
Distance between rear side of the front panel and the Arduino Shield PCB is defined by TFT display that is 18 mm:

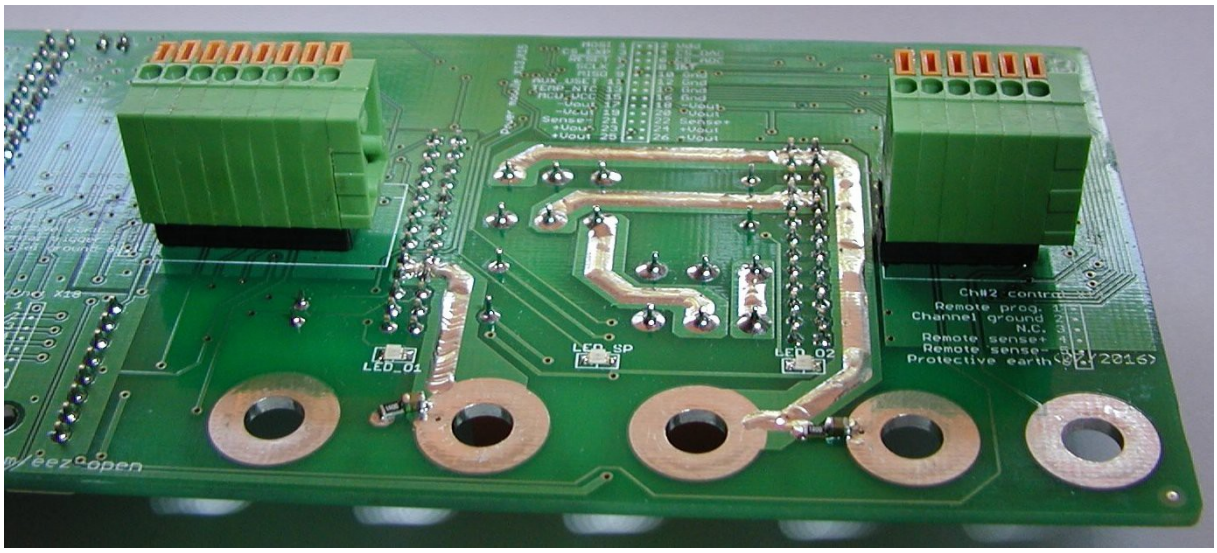
- 5 mm display thickness
- 1.5 mm display PCB thickness
- 11 mm spacer between display and plastic washer (defined by LCD1 connector height) and
- 0.5 mm plastic washer between 11 mm spacer and Arduino Shield PCB

Height of the push-in connectors (X12, X14) is 14 mm and when they are soldered directly on the PCB they will be 4 mm apart from the front panel surface. That does not mean that their pins are not accessi-

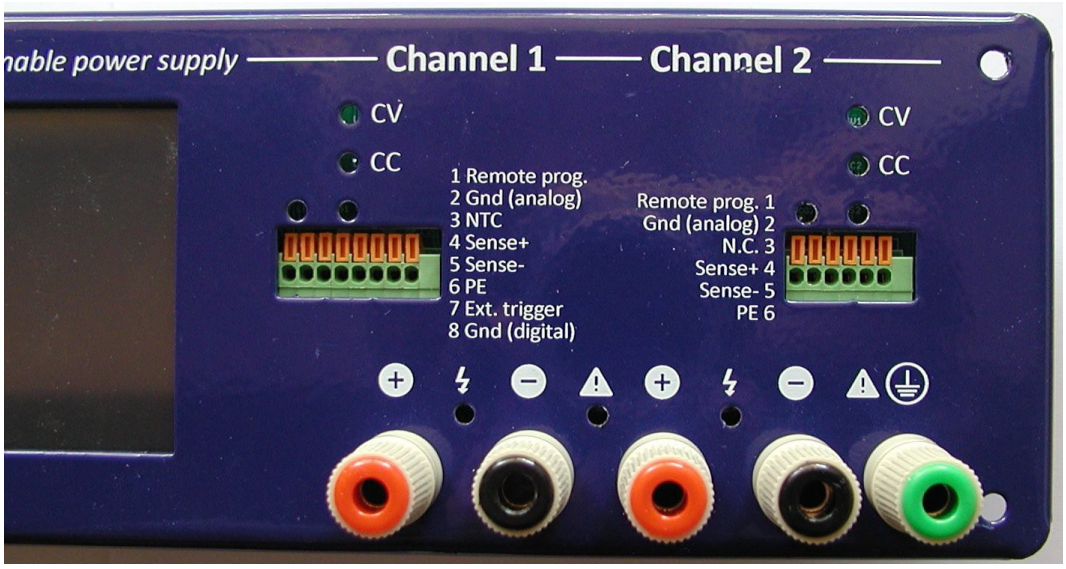
ble. It's more a question of visual appearance and you can fix that with modified cheap DIL16 sockets. You need to cut them horizontally and insert each half separately since distance between push-in connector's rows is different. You also need to adjust their height to 4 mm (usually that is about 5 mm). That can be done in a matter of minute using a piece of sandpaper.
Insert push-in connectors into modified sockets before soldering. To improve mechanical strength you can also apply e.g. hot glue.



Keep in mind that X12 and X14 have to be mounted on the bottom side of the PCB:



The end result looks like this:



When all SMT parts are mounted, followed by THT parts, we can solder few parts mentioned on the beginning:

- The power relay now should not interfere with mounting of any surrounding parts.
- The super capacitor is polarized as elco capacitors or battery cell. Check its terminals polarity twice before mounting!
- If push-in connectors X12 and X14 is not inserted into sockets, as it's suggested above, then we can now proceed with their soldering on the bottom side of the PCB.
- TFT touch-screen display connector (LCD1) has to be soldered on the bottom side too. If we want to be completely sure that it's aligned with display, we can mount display on the customized enclosure first, then insert 40-pin connector on display's header, and finally place the PCB on top of display. Use plastic washer between 11 mm spacers and PCB and another one between PCB and M3 mounting screw. We have to check alignment of the PCB with output binding posts holes and when everything is in place 40-pin connector can be soldered.
- Finally, we can mount power switch. Once again, it's recommended to see how it's aligned with the corresponding hole on the enclosure's front panel first, then adjust its position and start with soldering.

When all parts are mounted and PCB is properly cleaned, an Arduino Due board can be installed. It has to be loaded with appropriate firmware (M2 pre-release or newer) that is configured to work with this board revision. Use its USB named *Programming port* for firmware upload.

1.1.5. Power board r5B9 assembling

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