Linear Audio Auto-ranging Attenuator MK II
V3.19

Assembly Guide

V1

Version 1.0 December 2020

Introduction

The Linear Audio Auto-ranging Attenuator MK II V3.19 (AR) is an automatic signal level adjustment unit intended for use with audio soundcards and similar equipment where the input signal should be at a specific level for best performance. The AR attenuates or amplifies the signal to be measured to the level expected by the soundcard. This assembly guide covers the MK II V3.19 version of the AR.

The AR is available as a 'quarter-kit'. This concept makes it possible to keep the cost affordable, yet provide the specific PCBs, programmed controller, custom painted and lettered enclosure, and a fully assembled SilentSwitcher power supply for a successful assembly. The remaining common parts can be obtained from any of the usual parts sellers. A full BOM with Mouser part-numbers is provided. The construction does require soldering of through-hole parts, a few relatively large SMD ceramic capacitors, mechanical assembly and wiring between sub-assemblies. The RMS to DC converter is a tiny MSOP SMD package, and this chip comes pre-installed on the attenuator board. Construction also requires the assembly of a short flat cable with connectors to interconnect the switching- and control PCB. This Guide discusses this assembly process and, when followed, will virtually guarantee a unit performing as in the spec sheet.

1. Parts of the kit

1. Enclosure. The enclosure is a 2-part steel shell, painted and lettered. It has threaded (metric M3) studs for mounting the individual PCBs. The front panel has cutouts for the display and the controls and connectors, while the back panel has a single cutout for the USB-B type input power connector; the cut-out and mounting studs at the back accept a Linear Audio SilentSwitcher for power, which is included in the kit. Suitable metric bolts are included.

2. Power supply. As mentioned, this is based on the Linear Audio SilentSwitcher. The SS takes nominal 5VDC from a USB charger or a PowerBank as input and provided very low noise and clean +/- 15VDC for the analog circuits and +5VDC for the other parts of the unit.

3. Display and Control PCB. This PCB is mounted on the back side of the front panel and contains the microprocessor, the LCD display,

control push-buttons and power On/Off switch. This PCB has through-hole components only.

4. The attenuator PCB contains the input/output connectors and all the relay switching and attenuation circuits. This board has to be completed with the through-hole parts and a few SMD decoupling caps as noted in the BOM.

2. Adjustment

After completing the unit, it can be used as-is. No adjustments are required.

3. Attenuation board

The BOM table lists the Mouser parts numbers as a guide only; it does not imply that you can't get them elsewhere. It is convenient to buy everything in one go but you can use any equivalent part you already have, and the Mouser listing will provide the pertinent part parameters like pin pitch, tolerance and type of part (e.g. COG/NPO ceramic types or metal film resistor types). Note that for the specified performance you must keep to the tolerance specification for the precision resistors as shown. The opamps have a combined footprint of a DIP08 and a SOIC08, so you have a choice between an SMD opamp or a DIL opamp. Unless you are interested in testing various opamps, my recommendation for the signal chain opamps is as shown in the BOM, the OPA1656.

Following the BOM and the Stuffing Guide, solder all parts, starting with the SMD parts, the resistors and progressing to the taller parts like relays. Save the large input capacitors for last as they may hinder access to other close-by parts. Your board should look like (but not identical) to **Figure 1**. Do a visual inspection of correct parts location, diode orientation, that sort of thing. Check that all pins have been soldered and there are no obvious short. Also check that there are no parts missing on the board, except as indicated in the BOM. Set the board aside, and then repeat the whole visual inspection a day later ;-).

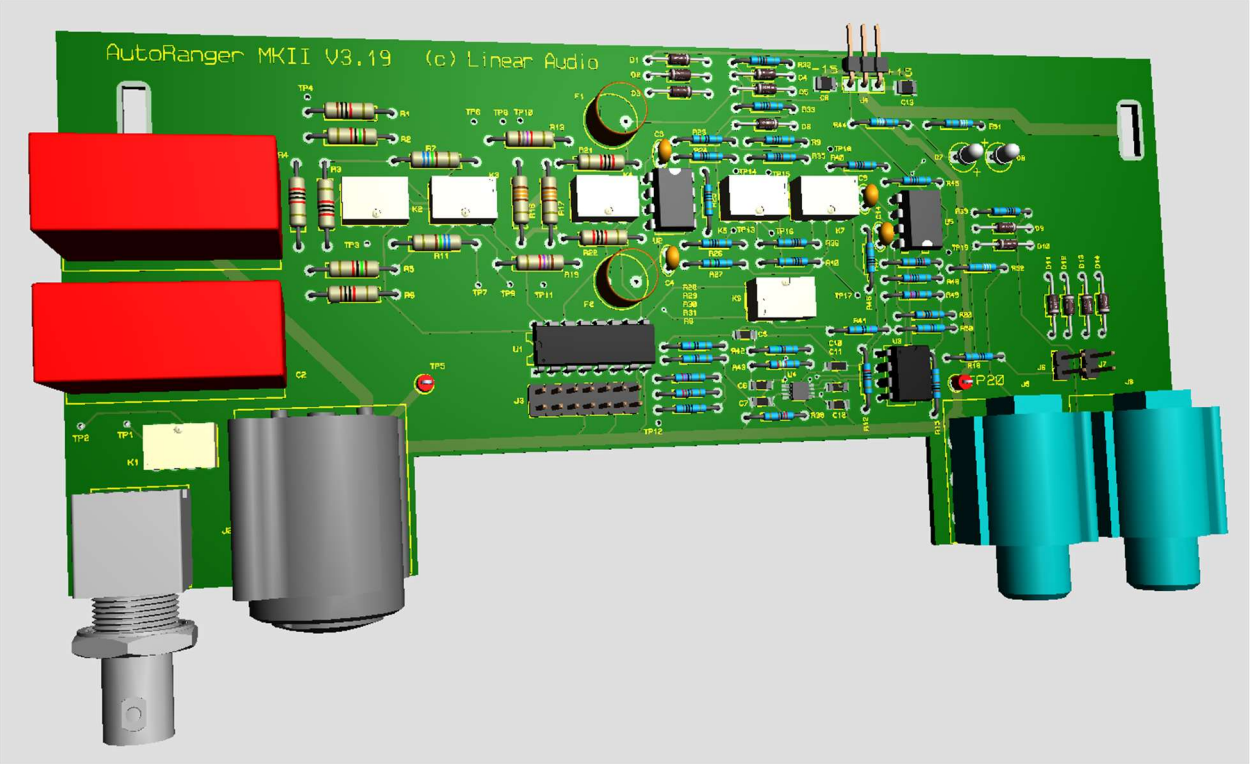

Figure 1 – completed attenuator board

This may also be a good time to construct the flat cable that will connect the attenuator board to the display & control board. Study **figure 2** for the connector orientation. Basically, the two cable ends are inserted in a 2*14 pin header connector in the same orientation. Cable length is not critical but you need some leeway to avoid stresses; 10 cm or 4 inch works fine.

Keep to the orientation as shown; the space for the connector on the attenuator board is a bit tight, and the flat side of the flat cable connector should face U1.

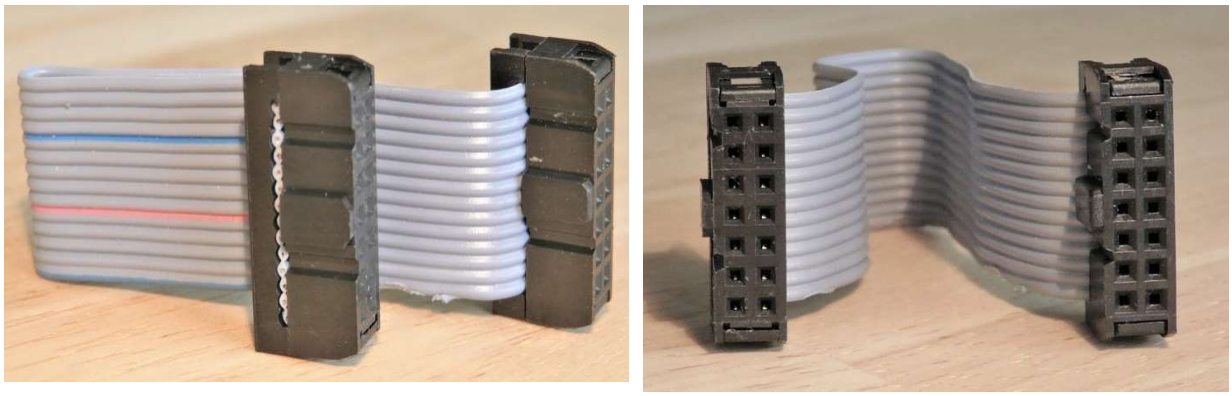

Figure 2 – interconnection flat-cable construction

4. Front panel control board

This board needs some attention to the mechanical build-up. Most of the parts are mounted on the back side that points to the inside of the enclosure. However, the push-buttons, the power switch, the LEDs and the LCD display must be mounted on the front side as they will protrude through the front panel.

Rear side parts.

The best way is to start with soldering in place the parts located at the back side, including the 28-pin DIL socket for the micro-controller and the flat cable header. The parts list is shown in the BoM with the same comments to the Mouser part numbers as mentioned before. **Do not yet solder the LEDs (D1, D2), the LCD (DP1), the power switch (S1) and the three push-buttons (SW2, SW3, SW4).** Leave those for last.

After completion it should look like **figure 3**, again, do a thorough visual inspection as described before, and then again!

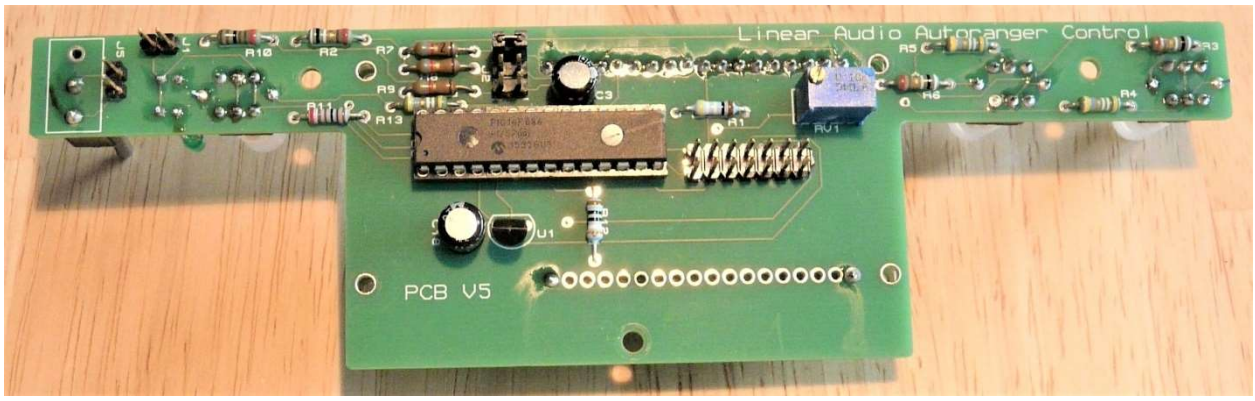

Figure 3 – Completed display & control board rear side

Front side parts. We will now proceed to mount the LCD display to the front side of the control board as follows. We will do the mechanical assembly first and then solder the pins. The mechanical assembly needs some care to make sure that after final assembly the display sits nicely in the center of the enclosure window, flat against the front panel. The steps are as follows:

a. Insert a SIL header pin strip in the top row on the board as shown in **fig. 4**. Insert two single pins in the bottom row as shown. Place the LCD on the pins – this requires some wiggling but take your time. The easiest (for me) was first to slip the LCD across the top pin row and then onto the two bottom pins. **Do not solder anything yet**!

b. Using 2.5mm metric or imperial screws, nuts and 5 mm (0.2 inch) standoffs (4 each) hardware, carefully *temporary* mount the LCD at 5mm above the board. **Figure 4** shows this step. This is to keep the LCD at the correct position while soldering the pins. Do this carefully; there is no way you can correct this after soldering short of taking everything apart and starting over, which will be hard without breaking anything (*the pictures are from the prototype and show the pins already soldered*).

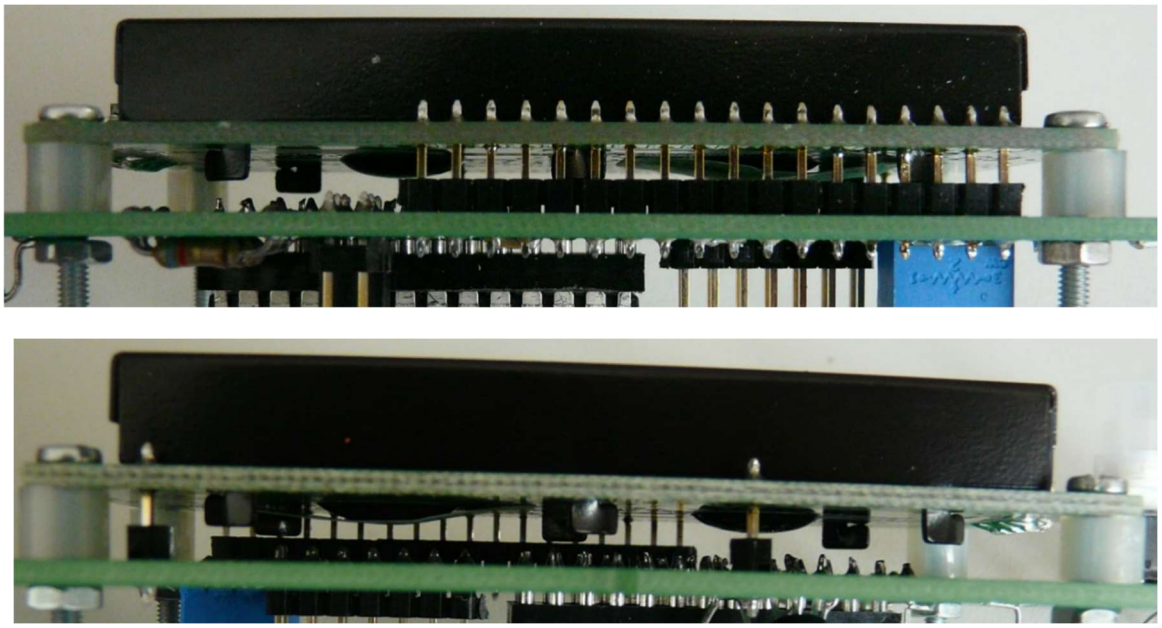

Figure 4 – temporarily mount the LCD to the control PCB with 5mm (0.2inch) standoffs as shown. Top shows the view with the top row pins inserted but not soldered. Bottom view shows the two fixing pins at bottom row 1st and last hole.

c. Next, solder all the LCD pins and remove the temporary mounting hardware.

d. Finalize this PCB by mounting the three push-button switches, the LEDs and the On/Off toggle switch. Observe the polarity for the LEDs, normally the longer pin of the LED goes to +. **Important**: there is a colored dot on one of the corners of each push-button and this dot **must** be lined up with the small square edge mark on the PCB! **Figure 5** shows the completed front side.

Figure 5 – completed front side display & control board

5. Power supply

The power supply board consists of one of my SilentSwitchers, which can be powered through a B-type USB connector on the back side.

Mount the provided USB connector, **at the component side!** Refer to **figure 6**. Mount the small board with the included M3x6mm hardware; the USB connector should be flush with the back-panel on the outside.

Make sure that the low voltage select jumper is in the 5V position! Check at https://linearaudio.nl/silentswitcher if necessary.

Normally the AR should be run off a standard 5V USB charger. For extremely sensitive measurements, the AR can be run off a standard 5V PowerBank for full mains isolation.

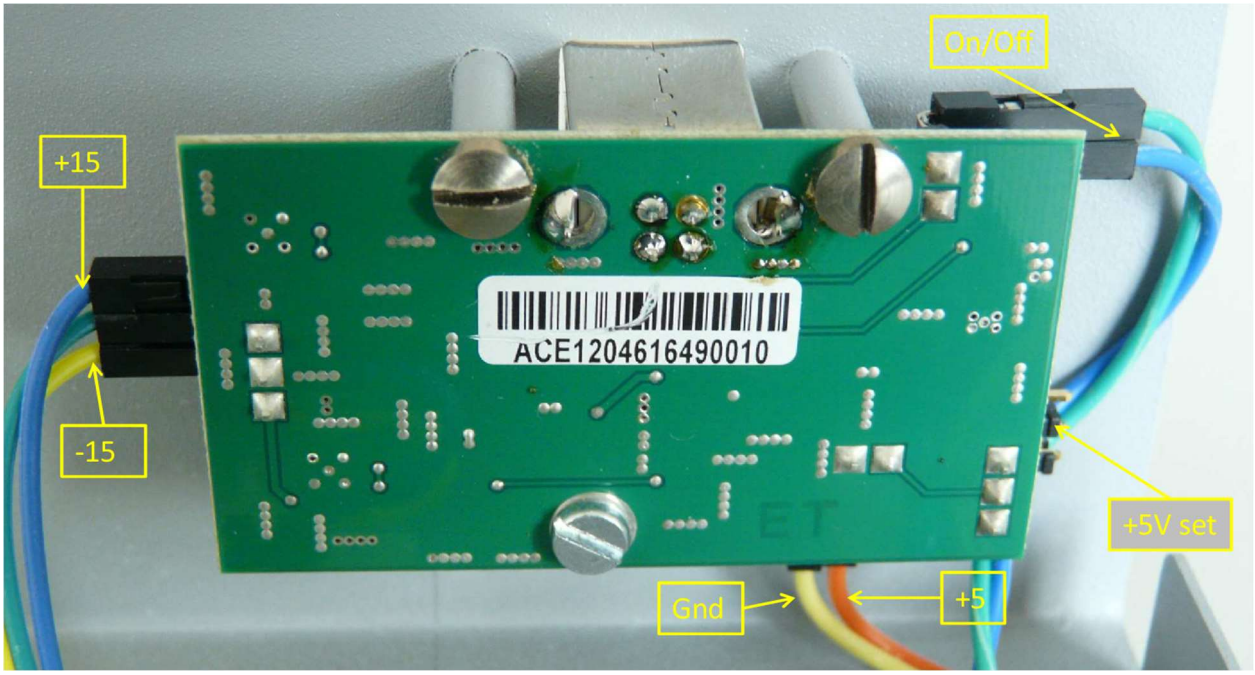

Figure 6 – Mounting and connecting power supply

6. Final assembly

After all boards and cabling has been prepared, you need to put it all together in the enclosure. Mount the power supply first, then the display & control board. Use the supplied (metric) mounting hardware.

Put the flat cable on the display board before fixing it to the front panel because it is a tight fit. Next mount the attenuator board. Partly insert the connectors through the front panel to line up the board. Then connect the flat cable, and push the board fully forward, and mount the connector outside nuts. Use two small self-tapping screws to fix the balanced input connector. Then fix the board with two screws in the slot holes at the back of the attenuator board. Connect and double check the power supply wiring as shown in pictures 6, 7 and 8.

When all is said and done, it should look like **figure 7**. Congratulate yourself and take a break ;-)

7. Initial switch-on

If you are sure all parts have been mounted, all cables connected, every pin soldered etc., it will be time to switch the unit on for the first time in its long and useful life!

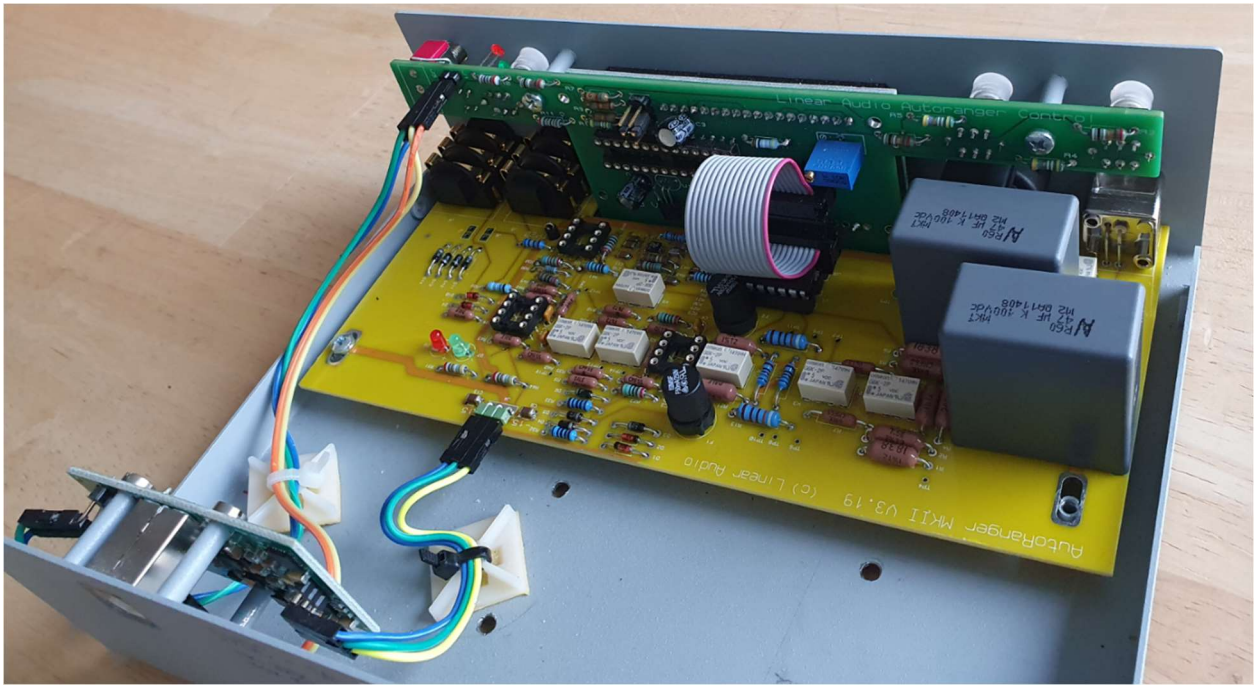

Figure 7 – final assembled unit

Just to be doubly sure, verify the connection polarities of the +/- 15V and +5V from supply to the main- and display board. Review **figures 6, 7 and 8**. The wire colors on the boards correspond to those on the power supply picture.

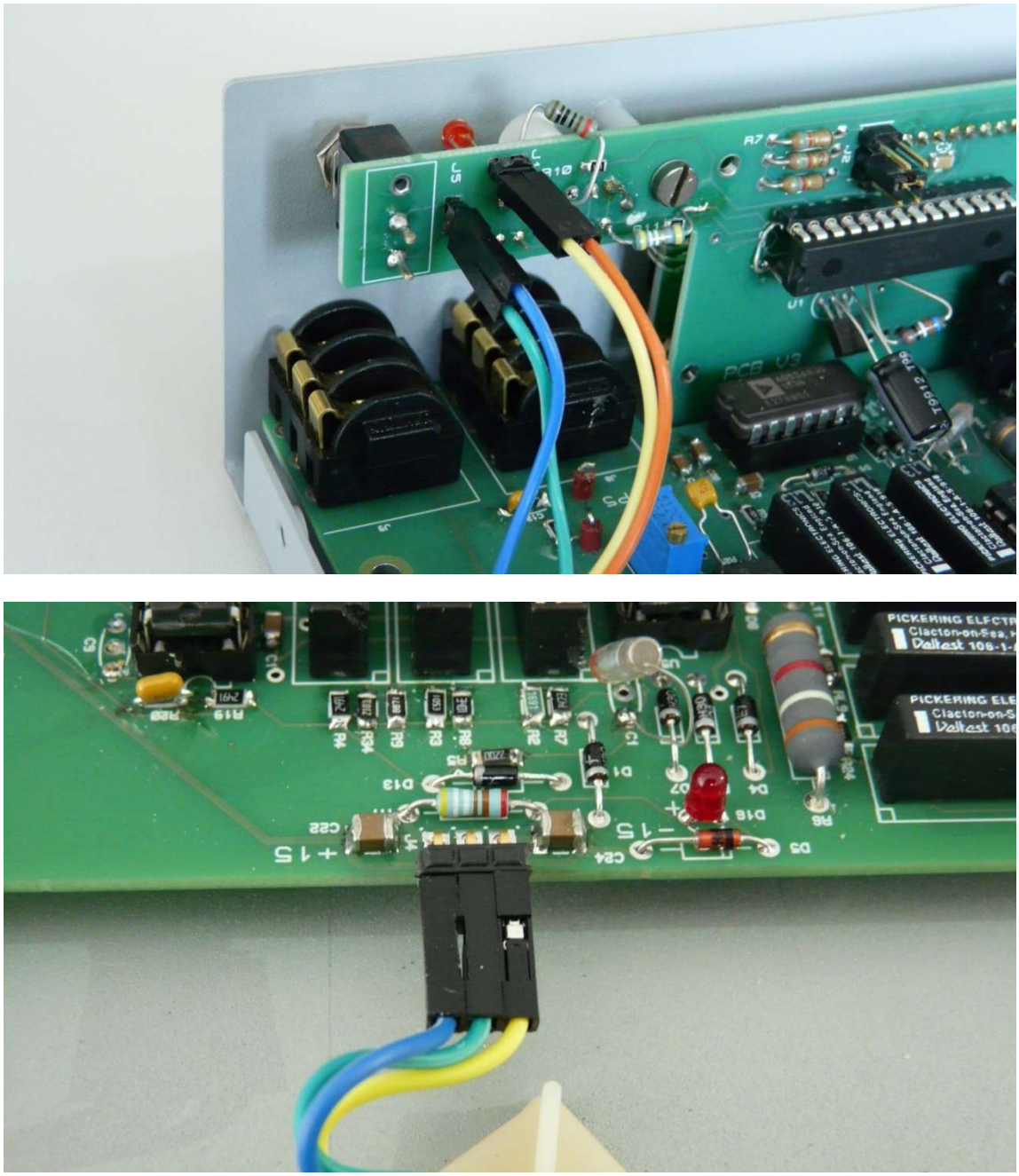

Figure 8 – Power connections to attenuator and display/control board

Display color and contrast

The display has three different color LEDs for backlighting and any one (or several at the same time) can be selected with jumpers. There is also a trim pot to adjust the contrast setting; the optimum setting may be different for different colors. **Figure 9** shows the location of the jumpers and the trimpot at the back of the front panel PCB.

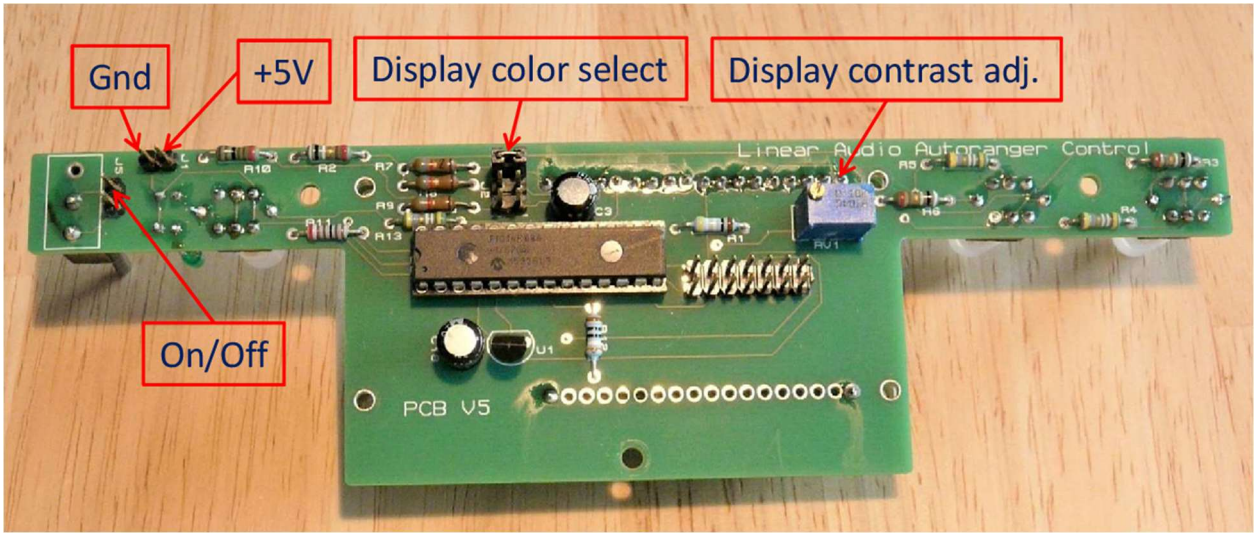

Figure 9 - Display color and contrast setting on front panel PCB

At the first switch-on you will see a short log-on message showing the nominal output level (1.5V). But chances are you see – nothing! That is because the display contrast trimmer has not been set at the correct value; turn it from one end to the other and select a setting that gives crisp and clear text on the display.

With no input signal, the AR will range to the +18dB setting. At this point, connect a signal generator and play with the input levels to get a feel for the device.

You can now check the User Guide for operation of the AR.

At any rate, have fun and I hope the AR will make your measurements just that much easier and more efficient.

Finally, check https://linearaudio.nl/la-autoranger occasionally for additional info and updates.

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