PAS-AIKIDO Line Preamp Upgrade Kit

assembly and installation instructions

02-2023 v1

Overview

The circuit board is the same size as the original PC5 board, 5.6×3.6 inches, and mounts identical to the original board.

The AIKIDO circuit delivers the sonic goods. It offers low distortion, low output impedance, a great PSRR figure, and feedback-free amplification. The secret to its superb performance which lies in its internal symmetry, which balances imperfections with imperfections. As a result, the circuit works at least a magnitude better than the equivalent grounded-cathode amplifier, and much better than the 50 year old Dynaco design.

Low Distortion

The AIKIDO circuit produces far less distortion than comparable circuits by using complementary, balancing load design. By loading a triode with the same triode, under the same cathode-to-plate voltage and idle current and with the same cathode resistor works well to flatten the transfer curve out of that triode.

PSRR

The circuit self-corrects power supply noise by incorporating the noise into its normal operation. The improved PSRR advantage greatly unburdens the power-supply, and results in a better than -30dB PSRR figure.
A conventional grounded-cathode amplifier with the same tubes and current draw yields only a -6dB PSRR).
In a conventional circuit, critical voltages will vary as the power line voltage falls and climbs with normal variations in utility power, but with this design the amplifier will tracks and correct these voltage changes symmetrically.
This circuit eliminates power-supply noise from its output, by injecting the same amount of PS noise at the inputs of the top and bottom tubes in the two-tube cathode-follower circuit.
Since both of these signals are equal in amplitude and phase, they cancel each other out, as each triode sees an identical increase in plate current.

Age Tolerant

Tube characteristics change with age and wear out. In other words, a fresh 12AX7 is not the same as that same 12AX7 after 2,000 hours of use. But as long as the two Triode's within the 12AX7 age in the same way—which they are inclined to do—the amplifier will always bias up correctly, splitting the B+ voltage between the Triode's.
NOTE: tubes require 24VDC for the filaments, NOT 6.3V or 12.6VDC!

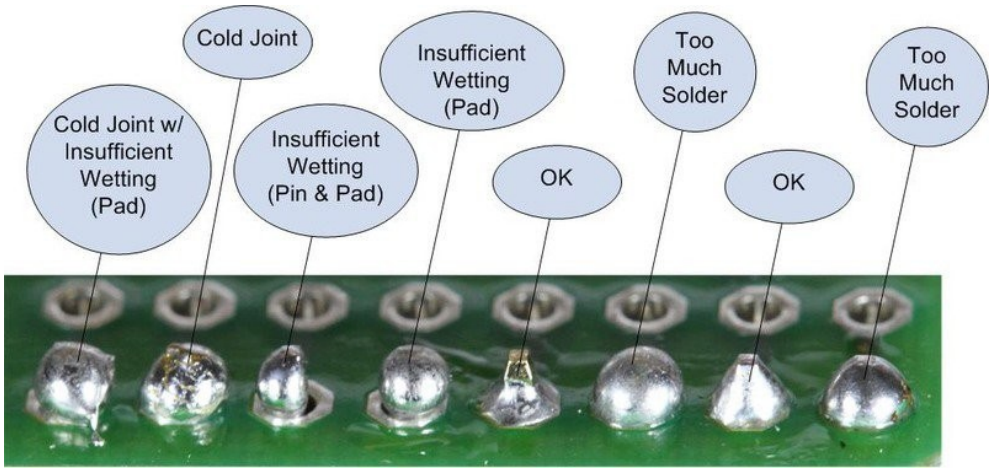
Low Output Impedance

This circuit uses a modified cathode follower circuit as the output stage. Cathode follower s are famous for providing low distortion and low output impedance’s, but no voltage gain. This modified cathode follower scrubs away the power-supply noise from its output and provides a complementary non-linear load for the top Triode's cathode. The top Triode's capacitor resistor is in series with the output, so its resistance must be added to the cathode follower output impedance.
Had the output connection been taken from the top Triode's cathode, then the output impedance would be slightly lower, but the symmetry would be broken and the PSRR enhancement would be lost.

Gain

The gain from this circuit is around 12dB with the 12AX7 type tube.
There may be some instances where this gain of 12dB may be too high for your setup, with other words, your amp seems to max out in volume with less that 50% turn on the volume control.
The gain can be reduced to 6dB, by changing the values of the following components.
Change C1 from 0.22uF to 0.47uF. Change R15 from 1M to 470K. Make sure you make these changes for BOTH channels!

Assembly
First, solder all the resistors in place, and then the tube sockets. Finally solder the capacitors.
Be consistent in orienting the resistors; keep all the parts labels the same so they can all be read from the same side when the PCB is finished. This will pay dividends later, if you need to locate a soldered a resistor or capacitor in the wrong location. Because the board is double sided, with traces and pads on each side, it is easier to solder the resistors from their top side.
Be sure to confirm all the electrolytic capacitor orientations, as a reversed polarized capacitor can easily vent (or even explode) when presented with high-voltage.
Confirm twice, solder once.



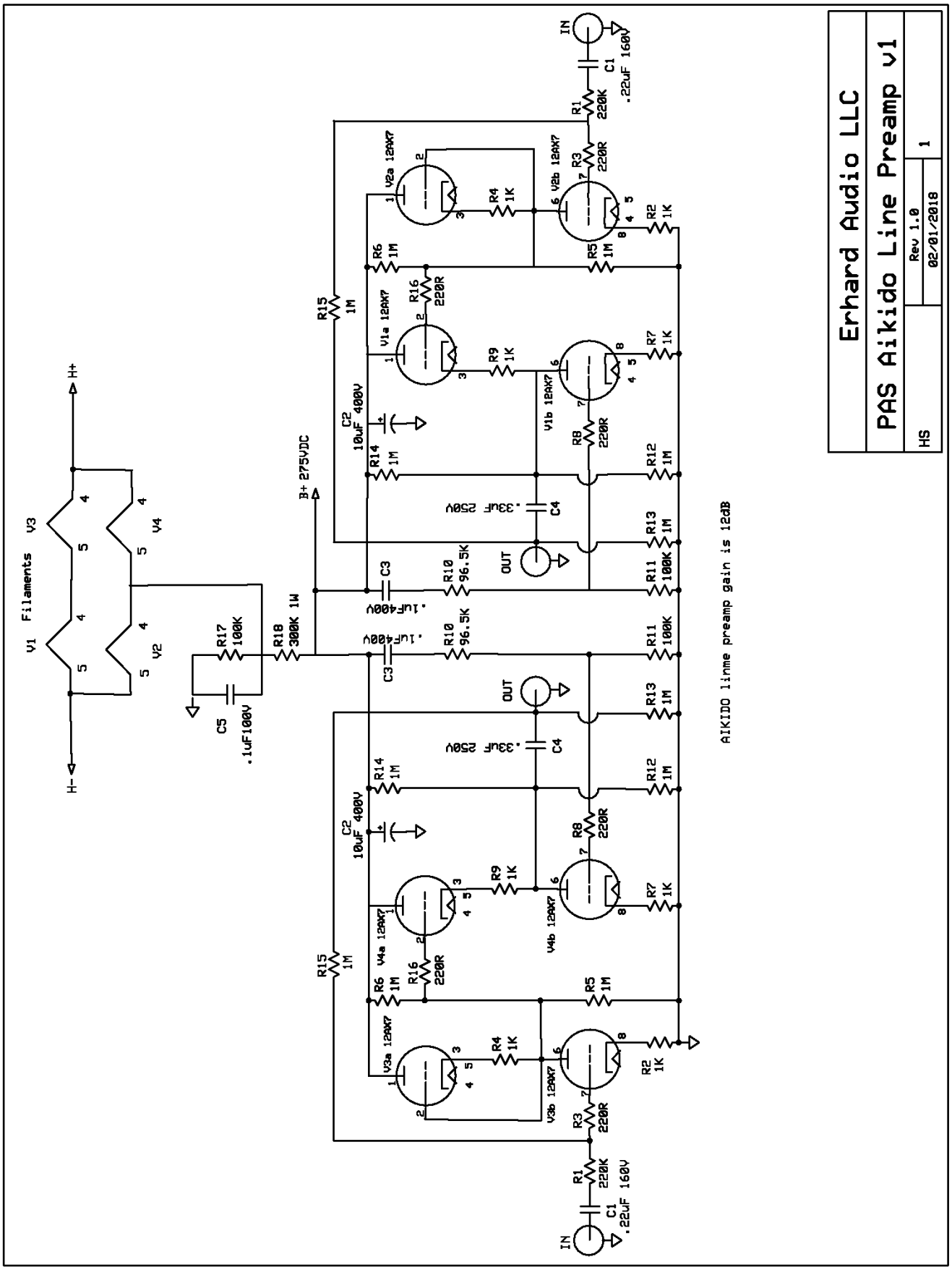
Signal Wiring
This Aikido circuit has been designed where optimum performance is achieved by placing the volume/balance controls at the OUTPUT of the Preamp, instead of the more conventional input of the Preamp.
However, Spice simulations, as well as real world tests have shown, that the volume/balance control scan also be placed at the Preamp input without any audible differences.
So, our recommendation is that if you are installing this Aikido into an existing PAS where the volume and balance controls are already prewired, place them at the input of the Aikido.
If you are however carrying out a complete new rewiring of your PAS, place the controls at the output of the Aikido.
See diagrams in the following pages for wiring details.

Testing
Make a habit of using only one hand, with the other hand behind your back, while attaching probes or handling high-voltage gear, as a current flow through your body can result in death. In addition, wear rubber-soled shoes and work in a dry environment.
Remember, safety first, second, and last.

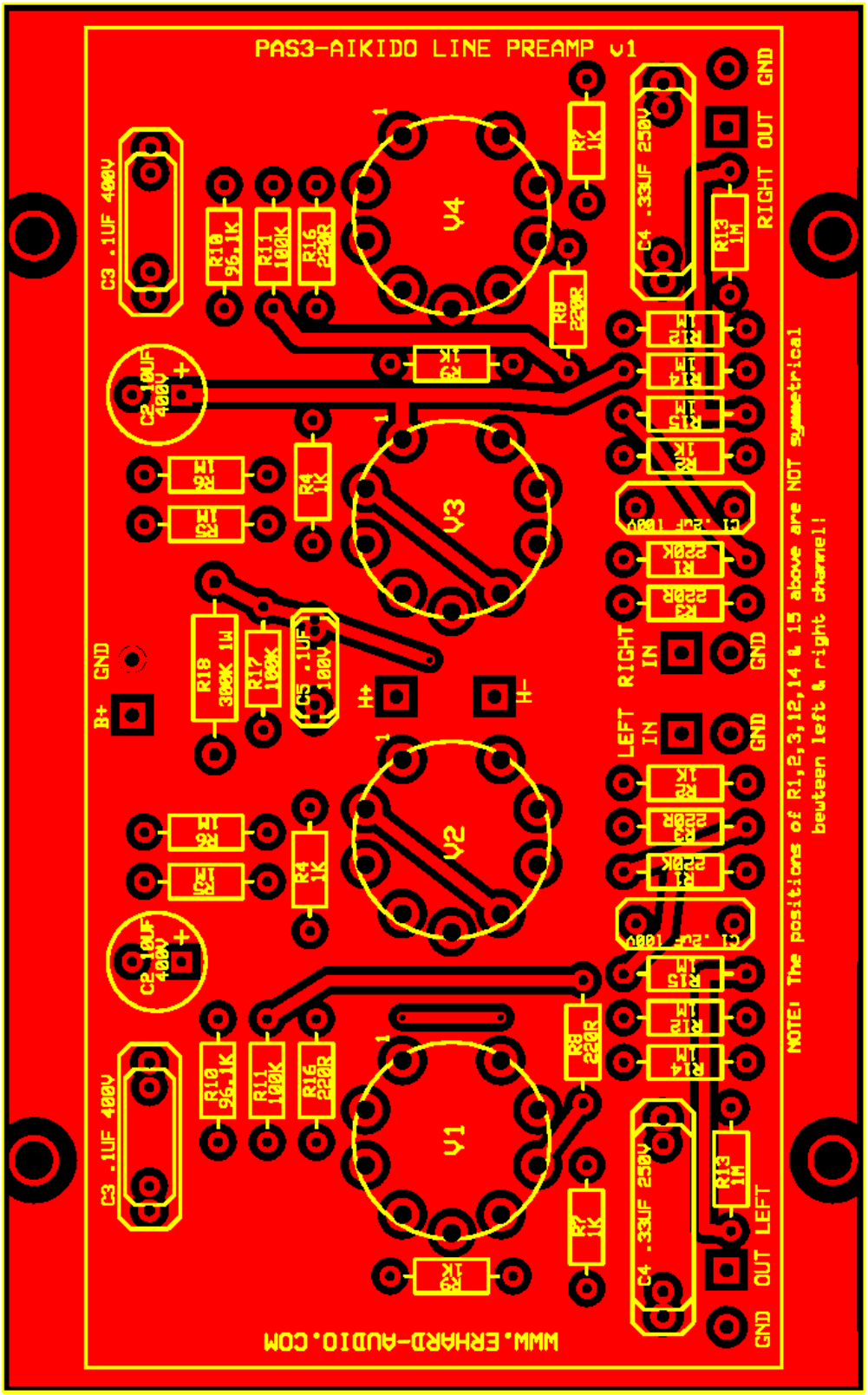
Grounding

Ground loops in a tube Preamplifier are extremely easy to introduce. For example, if the RCA jacks are not isolated from the chassis, then the twisted pair of wires that connect the PCB to the jacks will each define a ground loop.
The solution is either to isolate the jacks or use only a single hot wire from jack to PCB (the wire can be shielded, as long as the shield only attaches at one end).

Schematic Diagram



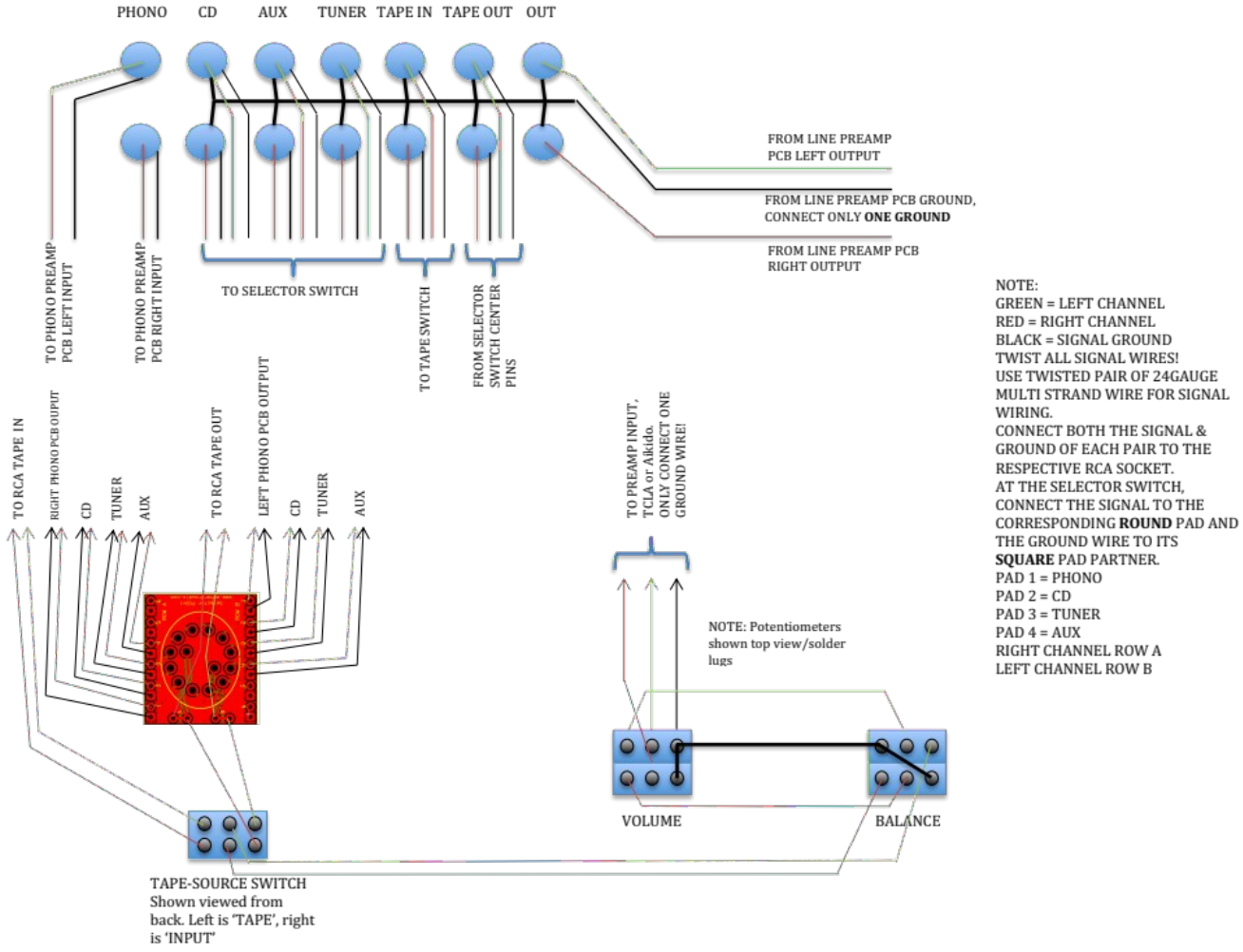
PCB layout diagram & parts list



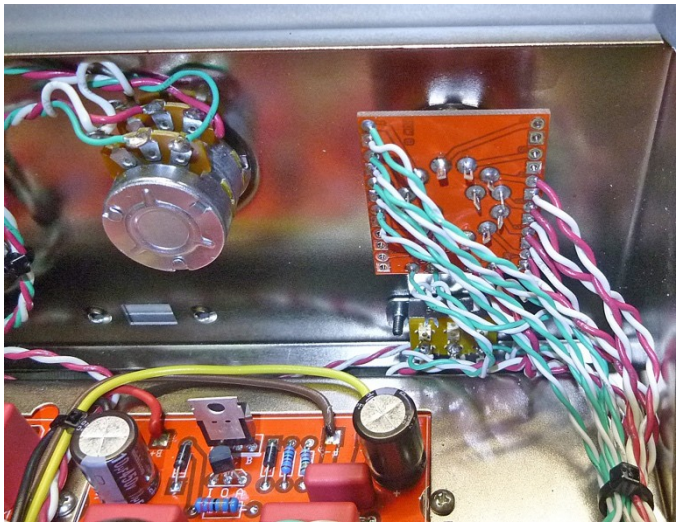
NOTE: On the pcb, R10 is shown as 96.1K, it is in fact 96.5K. C1 is shown as 0.2uF, it is in fact 0.22uF.

Aikido v1 parts list					
Resistors		Type	Qty		
R5,6,12,13,14,15	1M	1/2W	12		
R11,17	100K	1/2W	3		
R10	96.5K	1/2W	2		
R3,8,16	220R	1/2W	6		
R1	220K	1/2W	2		
R2,4,7,9	1K	1/2W	8		
R18	300K	1W	1		
Capacitors		Type			
C4	0.33uF 250V	Film 15/20mm	2		
C3,5	0.10uF 400V	Film 10mm	3		
C1	0.22uF 160V	Film 10mm	2		
C5	10uF 400/450V	Electro	2		
	PCB				
	PAS3 Aikido		1		
	Tube socket				
	9 pin		4		

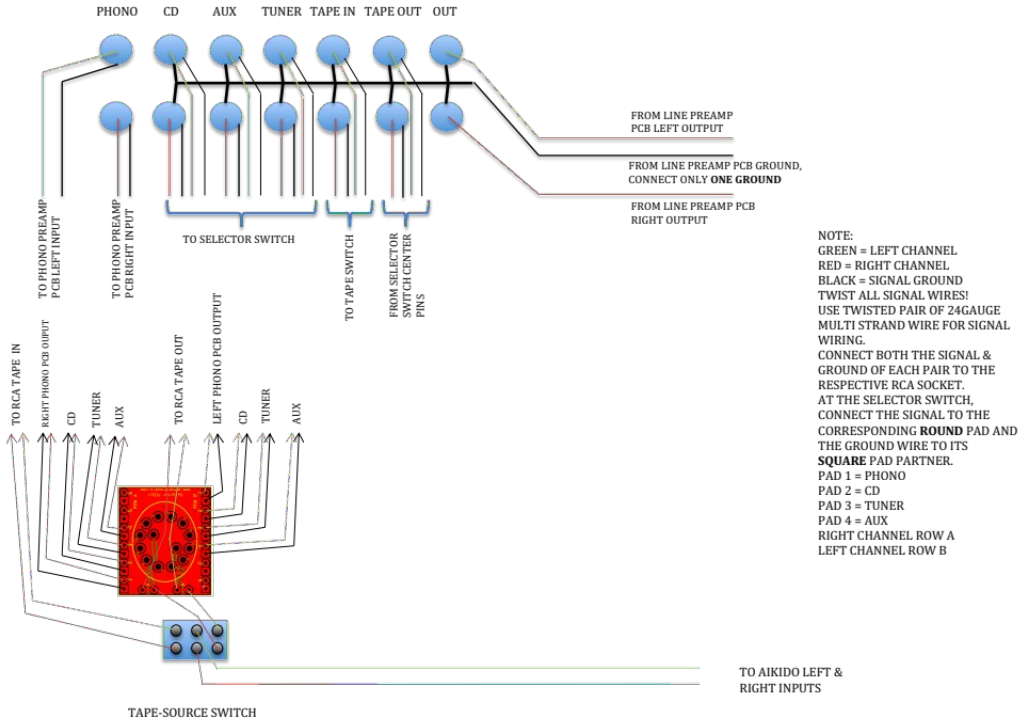
SIGNAL WIRING – Placing the volume/balance controls at the Preamp input

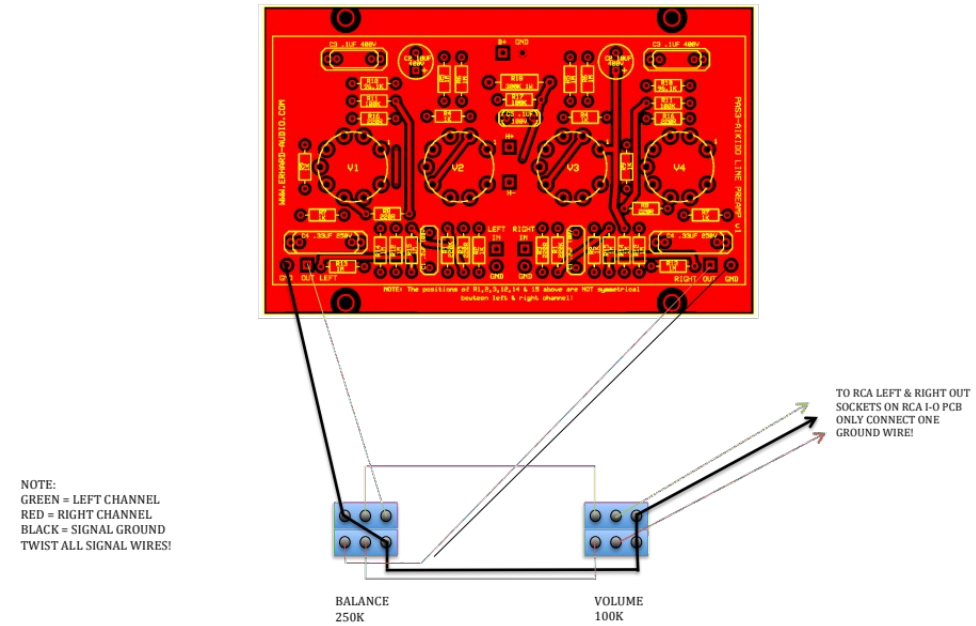


NOTE:
GREEN = LEFT CHANNEL
RED = RIGHT CHANNEL
BLACK = SIGNAL GROUND
TWIST ALL SIGNAL WIRES!
USE TWISTED PAIR OF 24GAUGE MULTI STRAND WIRE FOR SIGNAL WIRING.
CONNECT BOTH THE SIGNAL & GROUND OF EACH PAIR TO THE RESPECTIVE RCA SOCKET.
AT THE SELECTOR SWITCH, CONNECT THE SIGNAL TO THE CORRESPONDING **ROUND** PAD AND THE GROUND WIRE TO ITS **SQUARE** PAD PARTNER.
PAD 1 = PHONO
PAD 2 = CD
PAD 3 = TUNER
PAD 4 = AUX
RIGHT CHANNEL ROW A
LEFT CHANNEL ROW B

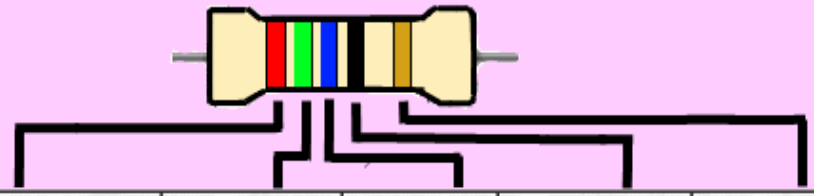


SIGNAL WIRING – Placing the volume/balance controls at the Preamp output





5 Band Resistor Color Coding



COLOR	1ST BAND	2ND BAND	3RD BAND	MULTIPLIER	TOLERANCE
BLACK	0	0	0	x1Ω	
BROWN	1	1	1	x10Ω	±1%
RED	2	2	2	x100Ω	±2%
ORANGE	3	3	3	x1000Ω	
YELLOW	4	4	4	x10000Ω	
GREEN	5	5	5	x100000Ω	±0.5%
BLUE	6	6	6	x1000000Ω	±0.25
VIOLET	7	7	7	x10000000Ω	±0.10
GREY	8	8	8		±0.05
WHITE	9	9	9		
GOLD					±5%
SILVER					±10%

How to read Capacitor Codes

Large capacitor have the value printed plainly on them, such as 10.uF (Ten Micro Farads) but smaller disk types along with plastic film types often have just 2 or three numbers on them?

First, most will have three numbers, but sometimes there are just two numbers. These are read as Pico-Farads. An example: 47 printed on a small disk can be assumed to be 47 Pico-Farads (or 47 puff as some like to say)

Now, what about the three numbers? It is somewhat similar to the resistor code. The first two are the 1^{st} and 2^{nd} significant digits and the third is a multiplier code. Most of the time the last digit tells you how many zeros to write after the first two digits, but the standard (EIA standard RS-198) has a couple of curves that you probably will never see. But just to be complete here it is in a table.

Third digit	Multiplier (this times the first two digits gives you the value in Pico-Farads)
0	1
1	10
2	100
3	1,000
4	10,000
5	100,000
6 not used	
7 not used	
8	.01
9	.1

Now for an example: A capacitor marked 104 is 10 with 4 more zeros or 100,000pF which is otherwise referred to as a .1 uF capacitor.

Most kit builders don't need to go further, but I know you want to learn more. Anyway, Just to confuse you some more there is sometimes a tolerance code given by a single letter. I don't know why there were picked in the order they are, except that it kind of follows the middle row of keys on a typewriter.

So a 103J is a 10,000 pF with +/-5% tolerance

	Tolerance of capacitor
D	+/- 0.5 pF
F	+/- 1%
G	+/- 2%
H	+/- 3%
J	+/- 5%
K	+/- 10%
M	+/- 20%
P	+100% ,-0%
Z	+80%, -20%

Picofarad (pF)	Nanofarad (nF)	Microfarad (uF)	Code	Picofarad (pF)	Nanofarad (nF)	Microfarad (uF)	Code
10	0.01	0.00001	100	4700	4.7	0.0047	472
15	0.015	0.000015	150	5000	5.0	0.005	502
22	0.022	0.000022	220	5600	5.6	0.0056	562
33	0.033	0.000033	330	6800	6.8	0.0068	682
47	0.047	0.000047	470	10000	10	0.01	103
100	0.1	0.0001	101	15000	15	0.015	153
120	0.12	0.00012	121	22000	22	0.022	223
130	0.13	0.00013	131	33000	33	0.033	333
150	0.15	0.00015	151	47000	47	0.047	473
180	0.18	0.00018	181	68000	68	0.068	683
220	0.22	0.00022	221	100000	100	0.1	104
330	0.33	0.00033	331	150000	150	0.15	154
470	0.47	0.00047	471	200000	200	0.2	254
560	0.56	0.00056	561	220000	220	0.22	224
680	0.68	0.00068	681	330000	330	0.33	334
750	0.75	0.00075	751	470000	470	0.47	474
820	0.82	0.00082	821	680000	680	0.68	684
1000	1.0	0.001	102	1000000	1000	1.0	105
1500	1.5	0.0015	152	1500000	1500	1.5	155
2000	2.0	0.002	202	2000000	2000	2.0	205
2200	2.2	0.0022	222	2200000	2200	2.2	225
3300	3.3	0.0033	332	3300000	3300	3.3	335

We cannot take ANY responsibility for mains, and for that matter, ALL high voltage AC and DC wiring you carry out. We have described in this, and all of our other manuals, as best as we can, on how to wire up these high voltage connections.
You MUST take EXTREME care, that no wires are shorted together, or to the chassis, or any other part of the assembly and pcb's.
All these high voltages can be life threatening, and can hurt you or others if carried out incorrectly.
Use your meter in the continuity setting to make sure no high voltage wires are shorted together or to chassis ground.
Apart from bodily harm, incorrect high voltage wiring can and will damage components!
You are totally and solely responsible for all high voltage wiring and the general assembly of this kit!
We have wired our prototype amp exactly as described in this and all of our other manuals, so we know that the amp will work as designed and intended!

If you are unsure of how to carry out some of our instructions, PLEASE contact us via e-mail, we provide, as part of our service, full support for this and all of our kits!

No question is stupid. The ONLY stupid question is the one you do not ask!