GlassWare
AUDIO DESIGN
www.glass-ware.com · sales@glass-ware.com

Dear Aikido-Ardent Audiophile,

Thank you for your purchase of the TCJ Aikido octal stereo printed circuit board. This FR-4 PCB is extra thick, 0.094 inches (inserting and pulling tubes from their sockets won't bend or break this board), double-sided, with plated-through 2oz copper traces, and the boards are made in the USA. Each PCB holds two Aikido line-stage amplifiers; thus, one board is all that is needed for stereo unbalanced use or one board for one channel of balanced amplification. The boards are four inches by ten inches, with eight mounting holes, which help to prevent excessive PCB bending while inserting and pulling tubes from their sockets.

Warning

The PCB is for use with a high-voltage power supply, so be cautious at all times once the power supply is attached, as a real shock hazard exists. Assume that capacitors will have retained their charge even after the power supply is disconnected or shut down. If you are not an experienced electrical practitioner, have someone who is review your work, before applying the B+ voltage. There are too few tube-loving solder slingers left; we cannot afford to lose any more.

Solder Pads

The board holds two sets of differently spaced solder pads for each resistor, so that radial and axial resistors can be easily used (bulk-foil resistors and carbon-film resistors, for example). In addition, each low-valued capacitor location finds many redundant solder pads, so wildly differing sized coupling capacitors can neatly be placed on the board, without excessively bending its lead. (Each tube's heater is shunted by its own 10-100μF, 10-16V electrolytic capacitor; be sure to observe the correct polarity.)

Dual Coupling Capacitors

The boards hold two coupling capacitors, each finding its own 1M resistor to ground. Why? The idea here is that you can select (via a rotary switch) between C1 or C2 or both capacitors in parallel. Why again? One coupling capacitor can be Teflon and the other oil or polypropylene or wax or wet-slug tantalum.... As they used to sing in a candy bar commercial: "Sometimes you feel like a nut; sometimes you don't." Each type of capacitor has its virtues and failings. So use the one that best suits the music; for example, one type of coupling capacitors for old Frank Sinatra recordings and the other for Beethoven string quartets. Or the same flavor capacitor can fill both spots: one lower-valued capacitor would set a low-frequency cutoff of 80Hz for background or late night listening; the other higher-valued capacitor, 5Hz for full range listening. Or if you have found the perfect type of coupling capacitor, the two capacitors could be hardwired together on the PCB, one smaller one acting as a bypass capacitor for the lager coupling capacitor.

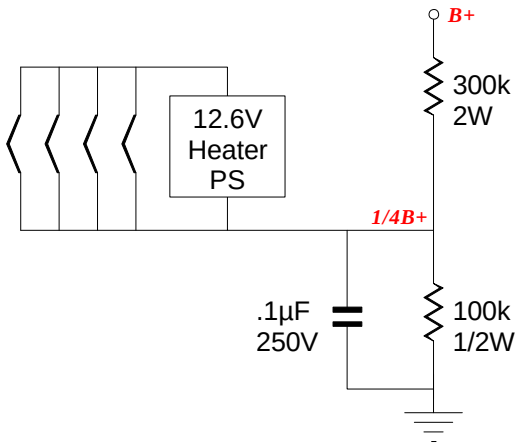
Heater Issues

The board assumes that a DC 12V power supply will be used for the heaters, so that 6.3V heater tubes (like the 6SN7 and 6BL7) or 12.6V tubes (like the 12SN7 or 12SX7) can be used. Both types can be used exclusively, or simultaneously; for example 6SL7 for the input tube and a 12SX7 for the output tube. For example, if the input tube (V2 and V3) is a 12SX7 and the output tube is a 6BX7 (V1 and V4), then use jumpers J1, J5 and J6. In other words, think series vs. parallel for the two sets of tubes.

Although designed for a 12V power supply, a 6V heater power supply can be used with the PCB, as long as all the tubes used have 6.3V heaters (or 8V or 18V power supply can be used, if all the tubes share the same 8V or 18V heater voltage). Just use jumpers J1 and J4 only.

A 25V heater power supply can be used, if only 12.6V and/or 25.2V tubes are used. Just use the jumper settings that are listed on the PCB for 6V and 12V use. For example, if the input tube (V2 and V3) is a 12SL7 and the output tube is a 25SN7 (V1 and V4), then use jumpers J2 and J3 and J4. [Note: Perfectly good tubes with uncommon heater voltages can often be found at swap meets, eBay, and surplus stores for a few dollars each. Think outside 6.3V box.] An AC heater power supply (6V or 12V) can be used, if the heater shunting capacitors C7, C8, C9, C10 are left off the board, or are replaced by 0.01µF ceramic capacitors.

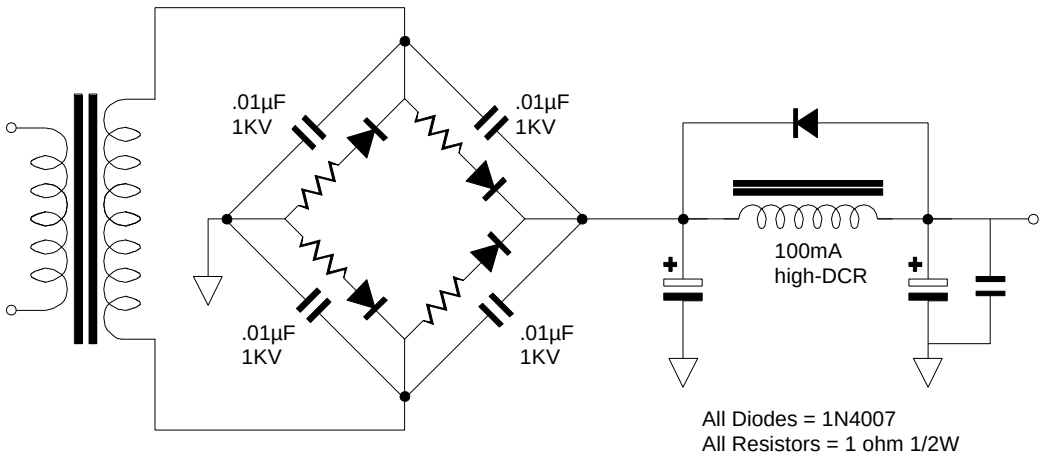
Since one triode stands atop another, the heater-to-cathode voltage experienced differs between triodes. The safest path is to reference the heater power supply to a voltage equal to one fourth the B+ voltage; for example, 75V, when using a 300V power supply. The ¼ B+ voltage ensures that both top and bottom triodes see the same magnitude of heater-to-cathode voltage. The easiest way to set this voltage relationship up is the following circuit:



Alternatively, you might experiment with a floating heater power supply, by "grounding" the heater power supply via a 0.1µF film or ceramic capacitor. The capacitor will charge up through the leakage current between heater and cathodes. Not only is this method cheap, it is often quite effective in reducing hum.

Power Supply

The power supply is external to the PCB and can be mounted in or outside the chassis that houses the Aikido PCB. The power supply voltage depends on the tubes used. For example, 12SX7s can be used with a low 80V power supply, while 6SN7s work better with a 220-300V B+ voltage. The sky is not the limit here, as the heater-to-cathode voltage sets an upward limit of about 400V. The genius of the Aikido circuit is found in both its low distortion and great PSRR figure. Nonetheless, a good power supply helps. I recommend at least a solid, choke-filtered, tube or fast-diode rectified power supply be used. If you insist on going the cheap route, try the circuit below, as it yields a lot of performance for little money.



Jumper J7 connects the PCB's ground to the chassis through the top centermost mounting hole. If you wish to float the chassis or capacitor couple the chassis to ground, then either leave jumper J7 out or replace it with a small-valued capacitor (0.01 to 0.1μF).

Tube Selection

The Aikido amplifier defines a new topology without fixed part choices, not an old topology with specified part choices. In other words, an Aikido amplifier can be built in a nearly infinite number of ways. For example, a 6SL7 input tube (V2 & V3) will yield a gain close to 35 (mu/2), which would be suitable for a phono preamp or a SE input stage; a 6SN7 (5692) or 12SN7 input tube will yield a gain near 10, which would be excellent for a line stage amplifier; the 6BL7 or 6BX7 in the output stage (V1 & V4) would deliver a low output impedance that could drive capacitance-laden cables or even high-impedance headphones. The list of possible tubes is not overly long: 2C50, 6BL7, 6BX7, 6SL7, 6SN7, 6SU7, 12SL7, 12SN7, 12SX7, 5691, 5692, 6080, ECC32. The only stipulations are that the two triodes within the envelope be similar and that the tube conforms to the 8BD base pin-out. Additionally, both input tube must match each other as should both output tubes. In other words, don't use a 5691 as the input tube in one channel while using a 6SL7 in the other (their heaters draw differing currents).

Cathode Resistor Values

The cathode resistor sets the idle current for the triode: the larger the value of the resistor, the less current. In general, high-mu triodes require high-value cathode resistors (1-2K) and low-mu triodes require low-valued cathode resistors (100-1k). I recommend running the output tubes hotter than the input tubes. For example, 1k cathode resistors for the input tube (V2 and V3) and 300-ohm resistors for the output tubes (V1 and V4), when using 6SN7s throughout. Thus, the output tubes will age more quickly than the input tubes, so rotating output for input tubes can extend the useful life of the tubes.

Assembly

Before soldering, be sure to clean both sides the PCB with 99% isopropyl alcohol. All the parts sit on the side of the PCB with the white lettering.

First solder the resistors in place, then the next tallest, and then the next tallest... If any of the parts have gold-plated leads, remove the gold flash before soldering the part, as only a few molecules of gold will poison a solder joint. Use sandpaper or a solder pot. NASA forbids any gold-contaminated solder joints; you should as well. (Yes, there are many quality parts with gold-flashed leads, but the use of gold is a marketing device, not sound electrical engineering practice.)

If you wish to have the tubes protrude from holes on the top of the chassis (and place the PCB within 1" of the panel), then all the other parts other than the sockets can be placed on the PCB's backside; it is a double-sided board after all (be sure to observe the electrolytic capacitors' polarity and hot glue heavy coupling capacitors to the PCB).

Let us know what you think

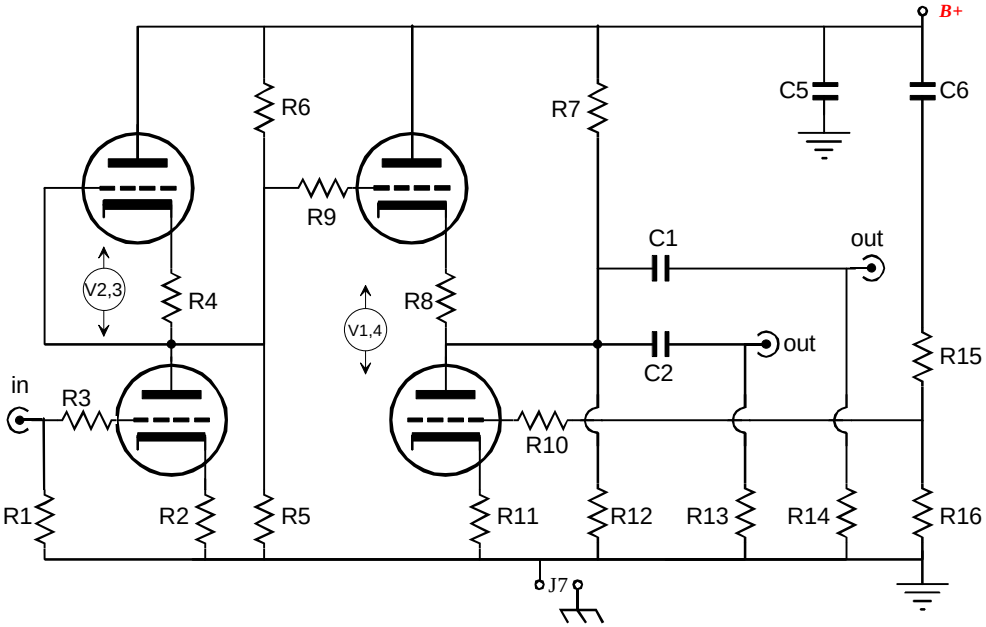
If you would like to see some new audio PCB or kit or recommend a change to an existing product or if you need help figuring out the heater jumper settings or cathode resistor values, drop me a line by e-mail to the address above (begin the subject line with either "Aikido" or "tube").

John Broskie

P.S.

Since the Aikido circuit came out in the *Tube CAD Journal*, people have been building it and marveling at its sound. A prediction: just as the 1980s were the cascode decade and the 1990s, the SRPP decade, this decade will be known as the Aikido decade. Spread the word.

Aikido stereo octal [Rev-A] schematic of recommended line amplifiers



Typical Part Values () Parentheses denote recommended values

	[6/12]SN7 & [6/12]SN7	[6/12]SL7 & [6/12]SN7	[6/12]SN7 & 6BX7
B+ Voltage =	170V - 300V (300V)	200V - 300V (300V)	200V - 300V (200V)
Heater Voltage =	6.3V/12.6V	6.3V/12.6V	6.3V
R1,5,6,7,12,13 =	1M	Same	Same
R2,4 =	270 - 1k (470)*	470 - 2k (1k)*	270 - 1k (330)*
R3,9,10 =	100 - 1k (300)*	Same	Same
R8, R11 =	240* [Iq = 10mA]	390* [Iq = 17mA]	158* [Iq = 30mA]
R15 =	83.3k	Same	66.1k
R16 =	100k	"	"
R17 =	0, Jumper	"	"

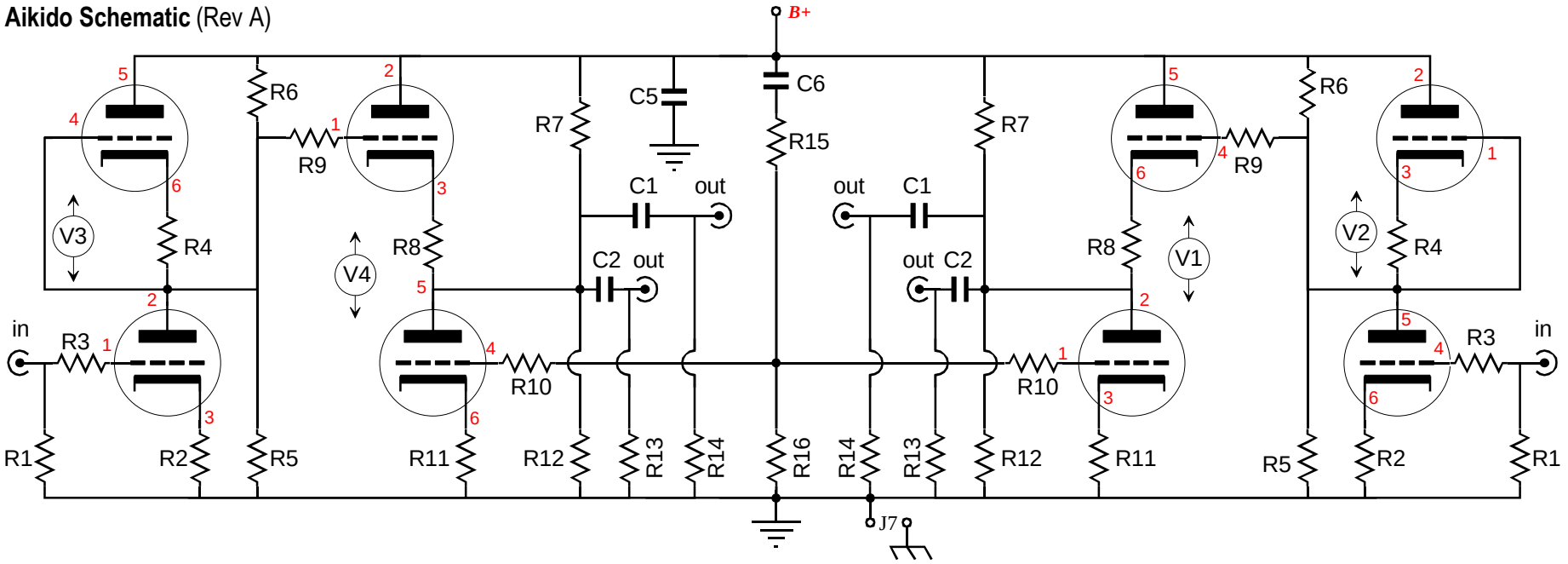
*High-quality resistors essential in this position
All resistors 1/2W or higher

C1 =	0.1 - 10µF* Film or oil	Same	Same
C2 =	0.1 - 10µF* Film or oil	"	"
C5 =	0.1 - 10µF*	"	"
C6 =	0.047µF - 0.22µF* Film or oil	"	"
C5 =	100 - 1kµF, 16V Electrolytic	"	"

*voltage rating must equal or exceed B+ voltage

(input) V1 =	6SN7, 12SN7, 12SX7, 5692, B65, ECC32, ECC33	6SL7, 6SU7, 12SL7, 5691	6SN7, 12SN7, 12SX7, 5692, B65, ECC32, ECC33
(output) V2=	6SN7, 12SN7, 12SX7, 5692, B65, ECC32, ECC33	Same	6BL7, 6BX7

Octal Aikido Schematic (Rev A)



Part Values

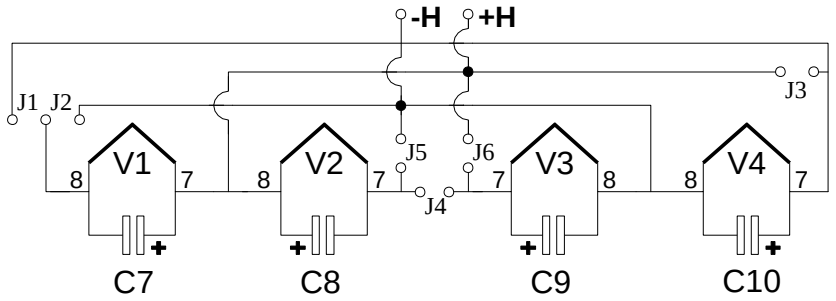
R1, R6, R5, R7, R12, R13, R14 =	1M
R3, R9, R10 =	100 - 470 ohm*
R2, R4 =	200 - 2k (depends on tube)*
R8,R11 =	100 - 1k (depends on tube)*
R15 =	R16 x (mu - 2) / (mu + 2) eg 82k for 6SN7
R16 =	100k

*High-quality resistors

All resistors 1/2W or higher

C1 =	0.1 - 4µF (voltage rating must exceed B+ voltage)
C2 =	0.1 - 4µF (voltage rating must exceed B+ voltage)
C5 =	1 - 10µF (voltage rating must exceed B+ voltage)
C6 =	0.1µF (voltage rating must exceed B+ voltage)
C7, C8, C9, C10 =	10-100µF (Use only with DC power supply; heater-shunting capacitors, from pins 7 to 8; voltage rating must exceed heater power-supply voltage)
(inputs) V2, V3 =	6SL7, 6SN7, 12SL7, 12SN7, 12SX7, 5691, 5692, B65, ECC32, ECC33
(outputs) V1, V4 =	6AS7, 6BL7, 6BX7, 6SN7, 8SN7, 12SN7, 12SX7, 5692, 6080, B65, ECC32, ECC33

Filament Jumper Wire Schedule



With a 6.3V heater PS

Use J2, J3, J5, and J6 only.

All tubes must be 6.3V heater types, such as 6BL7, 6SN7.

With a 12.6V heater PS

Output Tubes V1 and V4:
If tubes are 6.3V, use J1 only.
If tubes are 12.6V, use J2 and J3 only.

Input Tubes V2 and V3:
If tubes are 6.3V, use J4 only.
If tubes are 12.6V, use J5 and J6 only.

Tube	mu	Rp Ohms	Rk Ohms	Ik (mA)	B+ Volts	R15 Ohms	R16 Ohms	Input Gain	Input Gain dBs	Output Gain	Output in dBs	Zo Ohms
6AS7	2.23	234	55	100.0	100	5437	100k	1.1	0.9	0.60	-4.47	95
6AS7	2.0	310	205	75.0	150	0	100k	1.0	0.0	0.61	-4.28	220
6AS7	1.87	441	530	50.0	200	0	100k	0.9	-0.6	0.61	-4.24	456
6BL7	14.80	3140	196	10.0	150	76190	100k	7.4	17.3	0.91	-0.83	343
6BL7	15.40	2470	94	20.0	200	77011	100k	7.7	17.7	0.91	-0.86	219
6BL7	15.40	2540	165	20.0	250	77011	100k	7.7	17.7	0.91	-0.79	283
6BL7	15.90	2200	114	30.0	300	77654	100k	7.9	18.0	0.91	-0.79	219
6BX7	8.96	1760	267	10.0	100	63504	100k	4.5	13.0	0.87	-1.24	370
6BX7	9.44	1420	182	20.0	150	65035	100k	4.7	13.5	0.87	-1.21	273
6BX7	9.80	1270	158	30.0	200	66102	100k	4.9	13.8	0.87	-1.16	239
6BX7	10.10	1170	147	40.0	250	66942	100k	5.0	14.0	0.88	-1.13	220
6BX7	9.52	1730	542	20.0	300	65278	100k	4.7	13.5	0.89	-1.04	565
6SL7	70.00	43000	1000	1.3	300	94444	100k	31.4	29.9	0.98	-0.17	1174
6SN7	20.50	10200	583	3.0	150	82222	100k	10.0	20.0	0.93	-0.59	827
6SN7	21.10	8960	397	5.0	200	82684	100k	10.4	20.3	0.93	-0.59	657
6SN7	21.00	9250	626	5.0	250	82609	100k	10.3	20.2	0.94	-0.56	820
6SN7	21.90	7530	243	10.0	300	83264	100k	10.8	20.7	0.93	-0.60	489
6SN7	21.10	9000	680	5.8	300	82684	100k	10.3	20.3	0.94	-0.54	846
6SN7	21.40	8360	470	7.2	300	82906	100k	10.5	20.4	0.94	-0.56	685
6SN7	20.80	9840	1000	4.5	300	82456	100k	10.1	20.1	0.94	-0.53	1063
12SL7	See **6SL7**											
12SN7	See **6SN7**											
12SX7*	21.20	8750	218	5.0	80	82759	100k	10.5	20.4	0.93	-0.64	519
5691	See **6SL7**											
5692	See **6SN7**											
6080	See **6AS7**											
6082	See **6AS7**											
B65	See **6SN7**											
ECC32	See **6SN7**											
ECC33	35.00	9700				89189	100k	17.3	24.8	0.95	-0.48	248

*12SX7 can also use 6SN7's data.

The table above lists many triodes suitable for the octal-based Aikido amplifier PCB. The table lists the same tube under different B+ voltages and with different cathode resistor values. Two gains are listed: the first is the gain the tube realizes in the input position in the Aikido; the second is the gain of the same tube in the output stage. To calculate the final gain multiply the two voltage gains together (or add the gain in dBs together). For example, given an Aikido line amplifier with a B+ voltage of 300V, and a 6SN7 input tube with cathode resistors of 680, and a 6BX7 output tube with cathode resistors of 542 ohms, the final voltage gain equals 10.3 from the 6SN7 against the 0.89 gain of the 6BX7, with a product of 9.17. or, working with dBs instead, 20.3dB plus -.1.04dB, for a total of 19.26dB. (Aren't decibels great?)

If you have additional data, send it in and I'll add to the list.