

Final Wiring & Assembly

Final Assembly of Board to Chassis:

1. Place 5 of the small O-rings supplied with the kit over the remaining (longer) 4-40 screws.



2. Put the screws through the board mounting holes and put the 5 remaining O-rings over the screws and up against the bottom of the board.

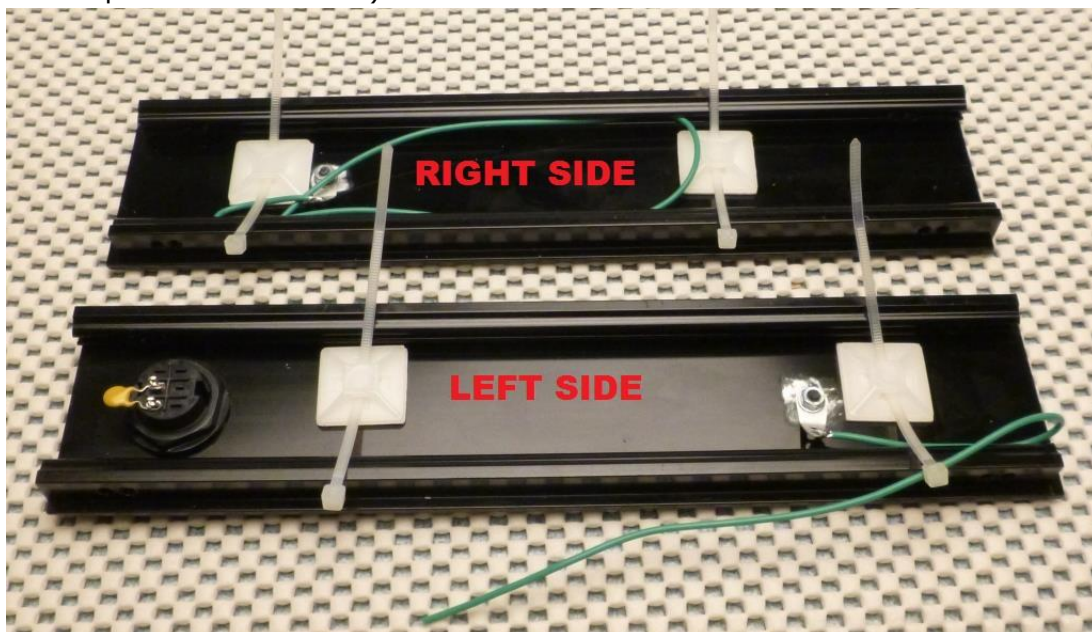


3. Apply a drop of nail polish to the threads of each screw.
4. Carefully position the board over the five standoffs on the chassis bottom.
5. Start each of the 5 screws in turn into the standoffs.

6. Once all 5 screws have started threading into the standoffs tighten each one until all of the O rings have compressed about the same amount or the screws have bottomed if you are using ¼" spacers. Don't over tighten or the top O-rings will pop over the heads of the screws.

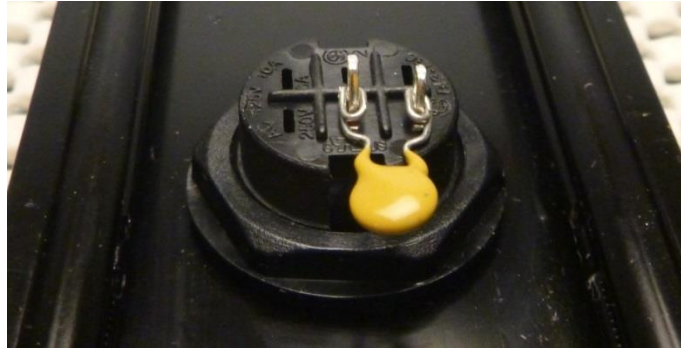
AC Switch Wiring and Grounding:

1. Assemble a grounding lug (Mouser part no. 534-7311) to the bare spot on the **right** side panel as shown below and secure with a 4-40 or M3 screw, flat washer and nut. Lock in place with a drop of nail polish across the thread of the screw and the nut.
2. Assemble a grounding lug (Mouser part no. 534-7311) to the bare spot on the **left** side panel as shown below and secure with a 4-40 or M3 screw, flat washer and nut. Lock in place with a drop of nail polish across the thread of the screw and the nut.
3. Assemble the power switch (Mouser part no. 112-R13-130A) to the **left** side. See picture below.
4. Put a drop of nail polish on the thread then start and tighten the nut.
5. Clean the inside surfaces of both sides with solvent and apply the cable tie mounts (Mouser part no. 514-08461) where shown.

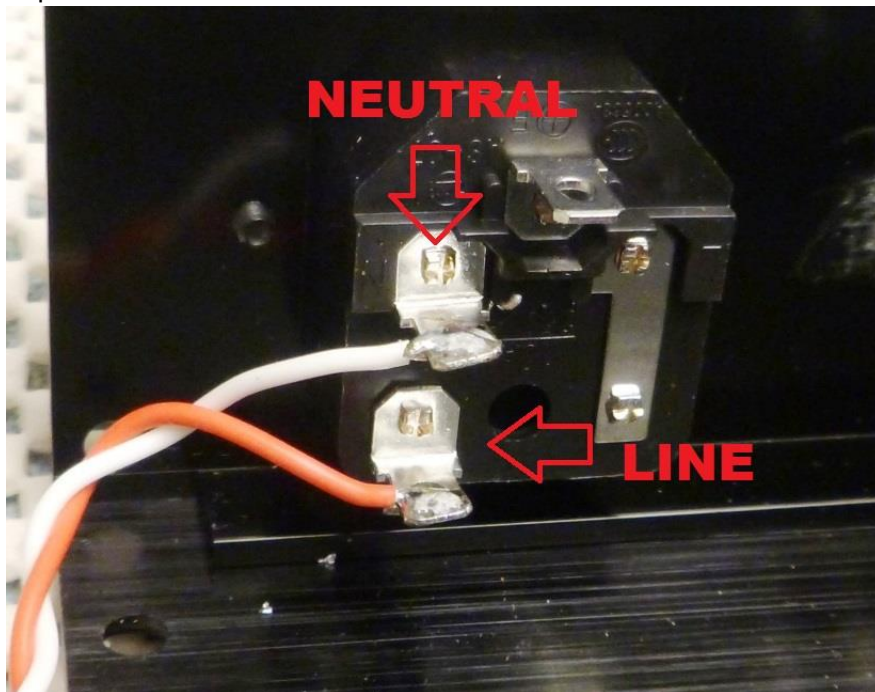


6. Slide a zip tie through each anchor.

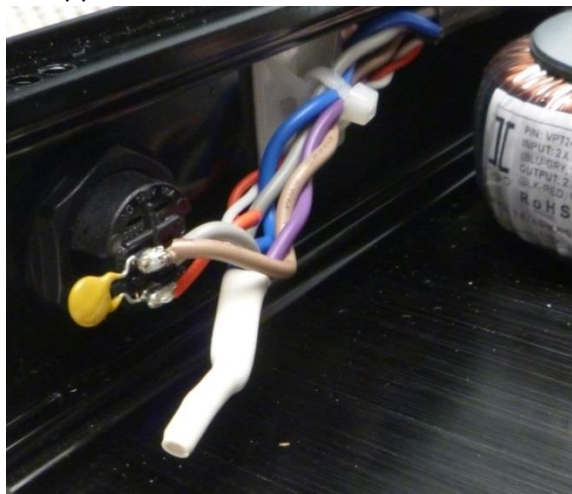
7. Cut a piece of wire **320mm** long strip one end and solder to the lug on the chassis **right** side panel.
8. Cut a piece of wire **220mm** long strip one end and solder to the lug on the chassis **left** side panel.
9. Wrap the leads of the switch protection capacitor (Mouser part no. 72-VY1102M35Y5UG63V0) around the switch terminals and trim excess. Don't solder yet.



10. Cut two wires of different colours **300mm** long and twist together.
11. Separate about **20mm** at one end and strip 6mm of insulation off.
12. Connect one to the **neutral** and one to the **line** terminal of the AC inlet and solder as shown in picture.

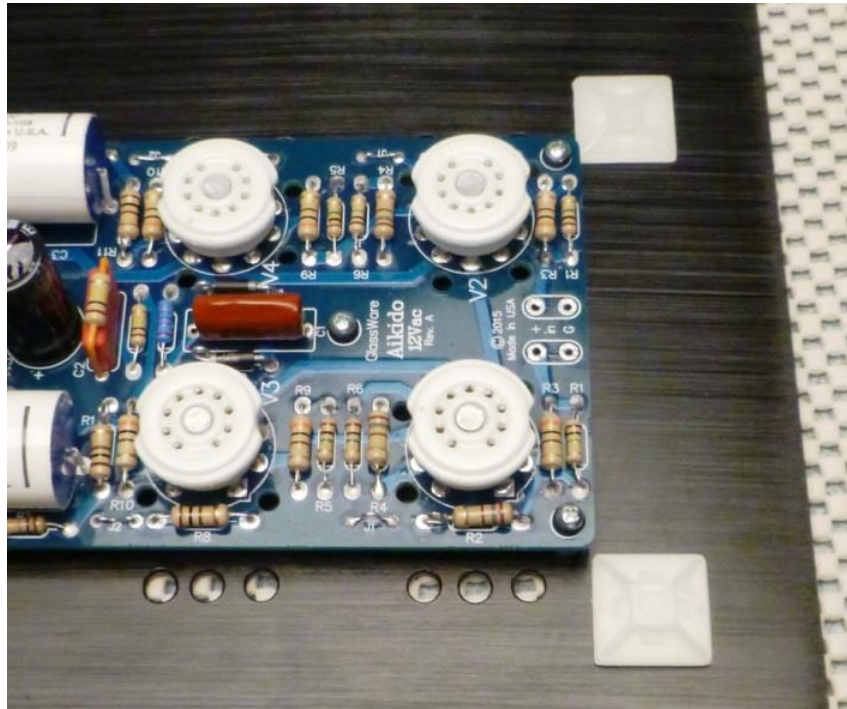


13. Assemble the **left** side panel to the chassis bottom and back. Secure with 2 screws each in the bottom and back.
14. Route the wires from the AC inlet along the **left** side and trim even with the front edge.
15. Un-twist about 35mm and strip 8mm of insulation from the ends.
16. Wrap the lead from the **line** terminal (orange in the picture) around the lower switch terminal and solder. Wrap one of the pairs from the transformer primary leads around the switch upper terminal and solder.



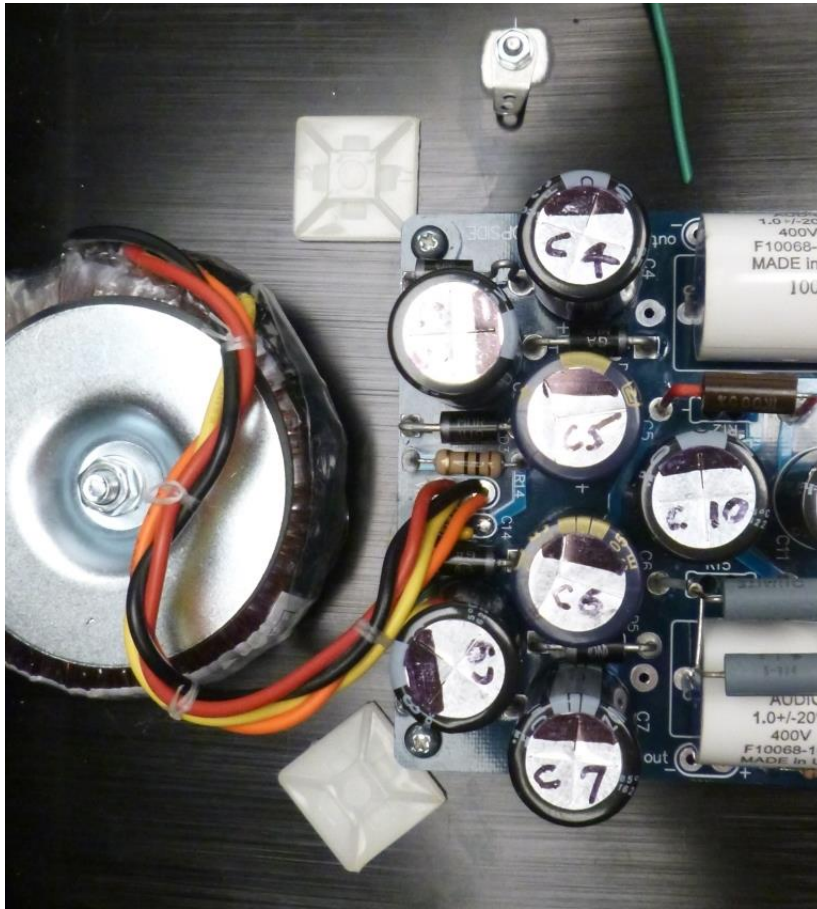
17. Twist the remaining pair of transformer primary leads together with the **neutral** wire (white in the picture), solder and cover with 2 layers of heat shrink tubing.
18. Close the zip ties around the wiring, including transformer primary wires, along the left side and trim the ends.

19. Wipe the chassis **bottom** around the right end of the circuit board with solvent and place 2 cable tie mounts (Mouser part no. 514-08461) as shown.



20. Slide a zip tie through each anchor.
21. Assemble the **right** side to the chassis bottom and back, secure with 2 screws each in the bottom and back.

22. Wipe the chassis **bottom** around the left end of the circuit board with solvent and place 2 cable tie mounts (Mouser part no. 514-08461) as shown.

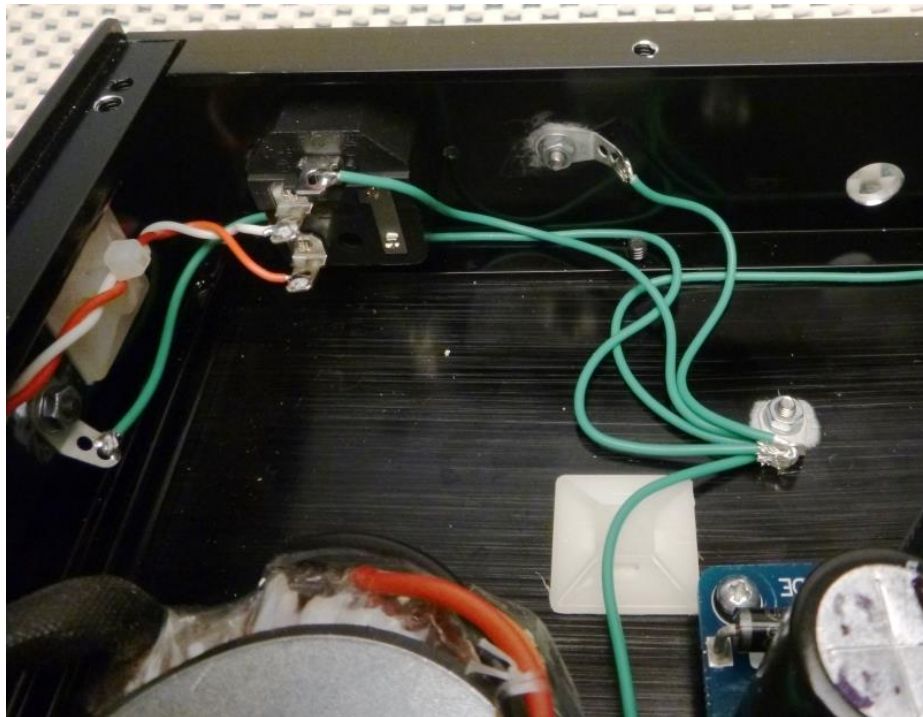


23. Cut a **320mm** long piece of wire and strip 8mm of insulation from each end.
24. Solder one end to the large terminal ring (Mouser part no. 517-1634). This is used to ground the volume pot assembled later. Securely grounding the frame of the volume pot helps eliminate hand-induced hum when adjusting the volume.



25. Lay the wire across the cable tie mounts at the left side of the circuit board and put the end through the grounding lug on the chassis bottom behind the board, don't solder yet. See picture next page.

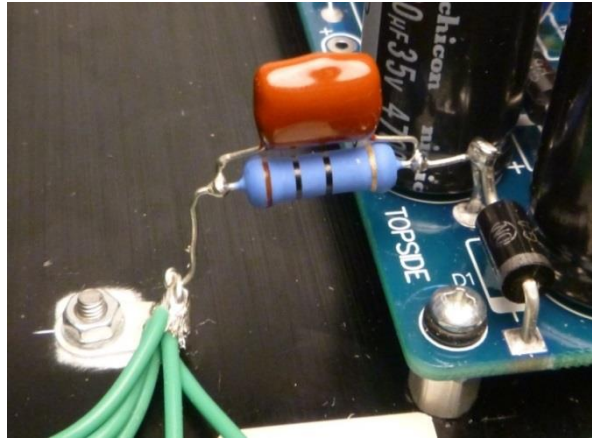
26. Strip the ends of the grounding wires from the **left** and **right** sides and thread through the grounding lug as well, don't solder yet. See below.
27. Cut a **130mm** long piece of wire and strip both ends.
28. Connect one end to the **ground** terminal of the AC inlet and solder. Place the other end through the grounding lug on the chassis bottom, don't solder yet.
29. Cut a **100mm** long piece of wire and strip both ends.
30. Connect one end to the grounding lug on the chassis **rear** and solder. Place the other end through the grounding lug behind the board, don't solder yet.



31. Prep the 10 ohm 3 watt grounding resistor (Mouser part no. 283-10-RC) and the 0.01uf film cap (Mouser part no. 667-ECQ-E2103KF) as shown.



32. Connect the grounding resistor/capacitor combo between the loop on diode D1 and the grounding lug behind the board.



33. Solder one end of the resistor/capacitor combo to the diode.
34. Solder the other end of resistor/capacitor combo to the grounding lug and solder all of the grounding wires as well.

Connecting the Board to the Output Jacks:

All jacks must have their grounds isolated from the chassis with insulators. This is to minimize ground loops which could cause hum.

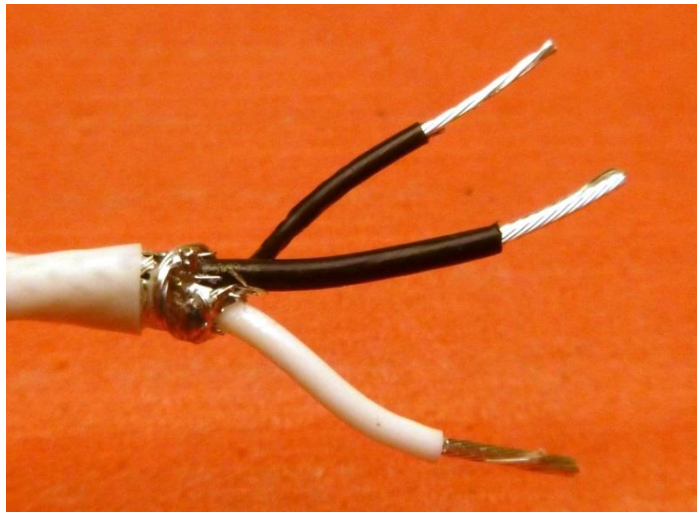
For connection to the jacks I used some generic cable that I acquired years ago. It has Teflon insulation which makes soldering easier. If you fancy building one of these line stages you can use anything from twisted pairs stripped out of Cat 5 network cable, which works quite well, twisted pairs of hook up wire, to shielded pairs of Litz wire Cardas cable or any other fancy pairs in a shield if you want to splurge.

The English author Morgan Jones in his book, *Valve Amplifiers*, makes the case for using quasi-balanced interconnects and internal wiring even for single-ended I.E. non-balanced, connections and circuits. According to Jones single conductor coax cable inside a shield just won't make the grade as it is more prone to interference from outside sources. A twisted pair inside a shield is best for both the ground (-) and hot (+) connections. The shield is connected to the ground at one end only, typically the end closest to the source, as it is the lower impedance connection and will better dissipate interference induced into the shield and twisted pair. As a result the output jack shields are tied to the ground circuit (the - indicator on the board) at the board.

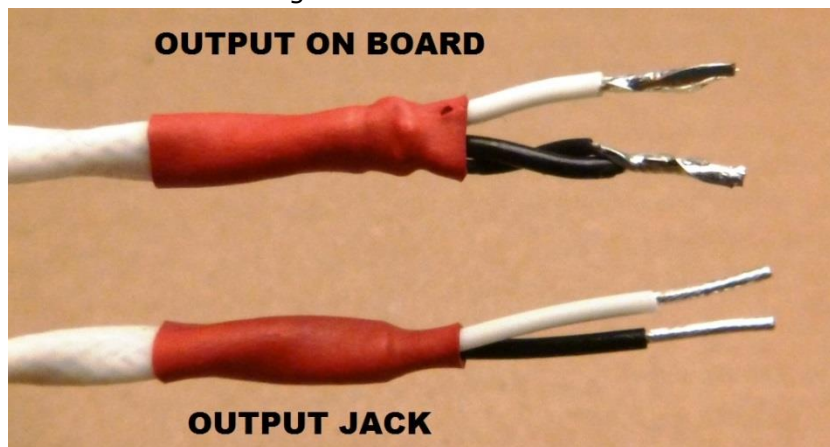
1. Cut two pieces of cable (or two twisted pairs) one **190mm** and one **260mm** long.
2. Lightly score the sheaths about **25mm** from one end on each and remove them.
3. Bunch the shield up as shown in the picture.



4. Trim the shield even with the end of the sheath.
5. Put a piece of heat shrink tubing over the end leaving about **15mm** of the pair protruding and heat.
6. Remove about **20mm** of the outer sheath on the other end of both cables.
7. Bunch the shield up and cut off leaving about **3mm** of shield exposed beyond the sheath. See picture below.
8. Strip about **12 mm** off of two small gauge wires (one for each cable), wrap around the shields and solder. This is possible with Teflon insulated cable. Otherwise the shields should be un-braided then twisted and small wires soldered to them. If you are using Cat 5 or other twisted pairs you'll avoid dealing with shields.



9. Trim the small wires soldered to the shield even with the 2 wires protruding from the shield.
10. Strip **4 to 5mm** of the insulation off of all the wires.
11. Twist the shield wire and signal negative wire (2 blacks in this case) and melt a little solder on them to keep the strands together.
12. Melt a little solder on the signal positive wire (white in this case) to keep the strands together.
13. Put a piece of heat shrink tubing over the ends as shown below.



14. Select the **190mm** long cable and insert the end with the double black wire (- conductor and shield) through the - output eyelet on the rear of the board with about **2mm** of bare wire above the board and solder. See picture below.
15. Put the white (+) conductor through the + output eyelet on the board with about **2mm** of bare wire above the board and solder.



Note 1: The following order of operations is for outside mount jacks. If you are using inside mount types simply solder the cable or twisted pair wires to the jack then assemble one insulating shoulder washer to the jack, insert jack through hole in chassis, assemble second shoulder washer (or flat washer) then nut and tighten.

Note 2: Use caution when soldering not to overheat and melt non-teflon jack insulators.

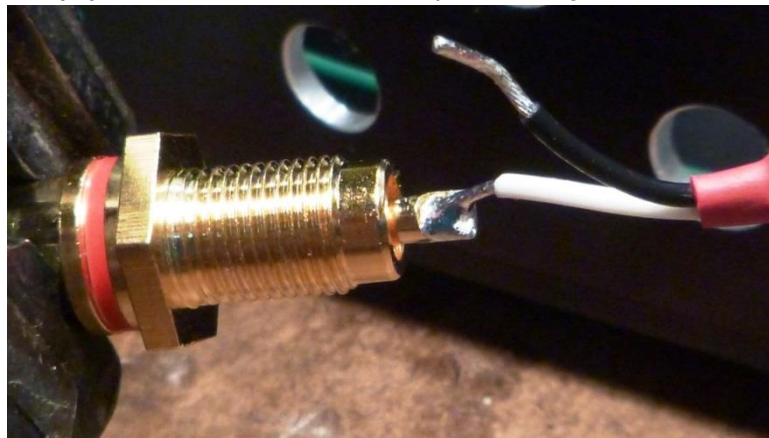
Note 3: Most plastic washers used to insulate the jacks from the chassis are heat sensitive. Therefore solder wires to the jacks first before tightening the nuts that secure the jacks to the chassis.

16. Assemble to the output cable, in order, the following jack parts: nut, ground lug and flat plastic washer.



17. Push the end of the output cable through the upper output jack hole in the back of the chassis. Put the shoulder washer over the cable with the shoulder facing the chassis.

18. Solder the white (+) conductor to the centre pin of the jack.



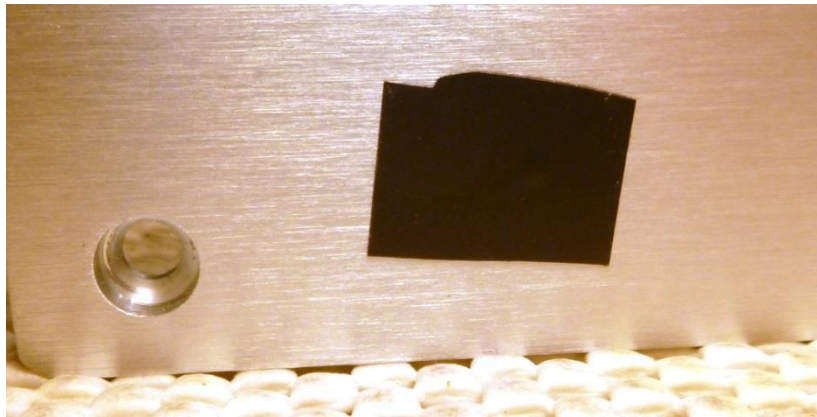
19. Slide the shoulder washer over the cable up to the back of the jack.

20. Slide the jack into the hole in the back of the chassis and assemble the flat plastic washer, ground lug and nut to the jack leaving them loose. They are left loose on purpose so that when soldering the black wire to the ground lug heat won't melt the plastic washers.
21. Put the black wire through the hole in the ground lug and solder.
22. Tighten the nut to secure the jack to the chassis.
23. Repeat with the **260mm** long cable connecting to the output on the front of the board.

LED Assembly to Front Panel and Wiring Prep:

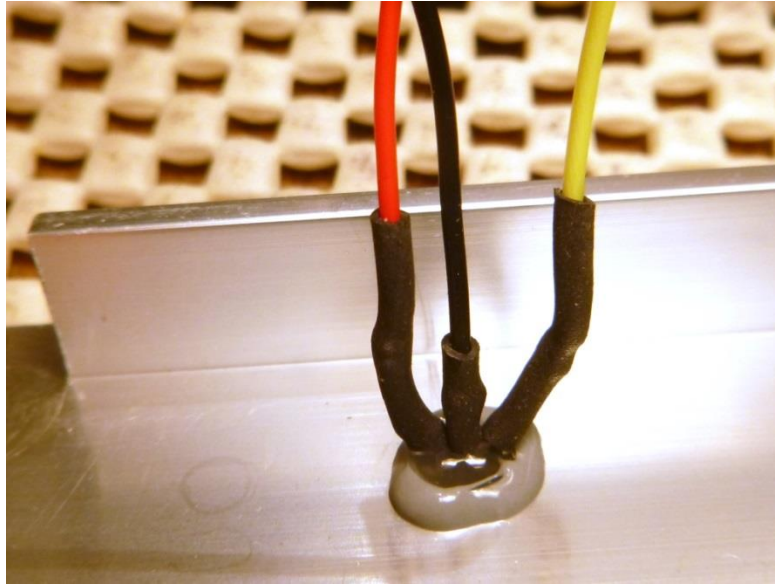
I've selected a dual red/green LED that can be made to look a nice tube-like orange glow with the right resistors and it has a flat front that is set flush to the outside of the front panel.

1. Clean the LED and the hole for the LED in the front panel with solvent.
2. Place a piece of electrical tape across the hole in the front panel. See below.



3. Mix up a small amount of five minute epoxy and spread around the outside diameter of the LED, don't get any on the face of the LED.
4. Insert the LED in the hole until the front just touches the tape. Set the panel aside for an hour or two to give the epoxy a chance to harden completely. See picture next page.
5. Once the epoxy is hard remove the tape.

6. Trim the center (negative terminal) of the LED, cut a black wire **300mm** long, strip one end and solder to the centre terminal. Cover the joint with heat shrink tubing. See picture below.
7. Choosing the longer of the two remaining LED wires, trim, cut a red wire **120mm** long, strip one end and solder to the lead. Cover the joint with heat shrink tubing.
8. Trim the remaining LED lead, attach a **120mm** long wire of a third colour to it, solder and cover the joint with heat shrink tubing.

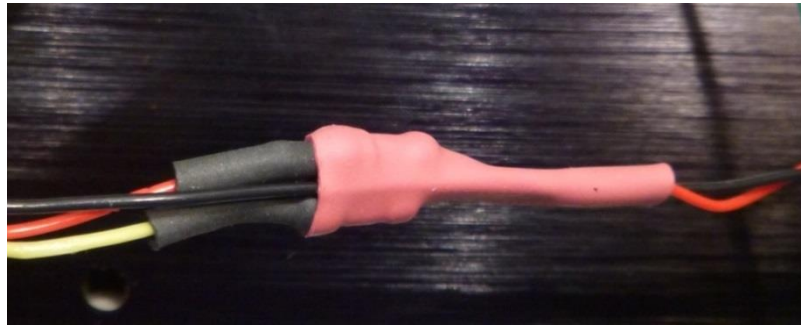


9. Strip **4mm** off of the free end of the red wire.
10. Cut both leads on the 2.2K Ω 1 watt resistor (Mouser part no. 294-2.2K-RC) to about **6mm** long. See picture next page.
11. Form a loop in the resistor lead, attach to the red wire and solder.
12. Strip **4mm** off of the remaining wire, not the black one, (yellow as shown in picture) cut both leads on the 7.5K Ω 1 watt resistor (Mouser part no. 281-7.5K-RC) to about **6mm** long.
13. Form a loop in the resistor lead, attach to the third wire and solder.

14. Cover part of each resistor and the wires soldered to them with heat shrink tubing.



15. Cut a piece of red wire about **200mm** long and strip one end, attach to the remaining ends of both resistors as shown above and solder.
16. Cover both resistors and solder joint with heat shrink tube.



17. Dress the wires from the LED to the resistors with waxed dental tape to keep them together.
18. Twist the red and black wires from the resistors. They will be connected to the board later.

Front Panel Assembly:

1. Assemble the input selector switch (Mouser part no. 105-SR2511F-43S) to the **front** panel, place a drop of nail polish on the threads, assemble the washer and nut and tighten.
2. Assemble the **front** panel to the **bottom** and **sides** of the chassis and retain with screws.

Wiring Input Jacks to Selector Switch:

I once worked with a fellow who had a very peculiar command of the English language. When a task was particularly boring he would say, "That's a monogamous job". Now we have arrived at the *monogamous* part of this job; preparing all of the cabling and connecting the input jacks to the input selector switch, the switch to the volume pot and the pot to the board.

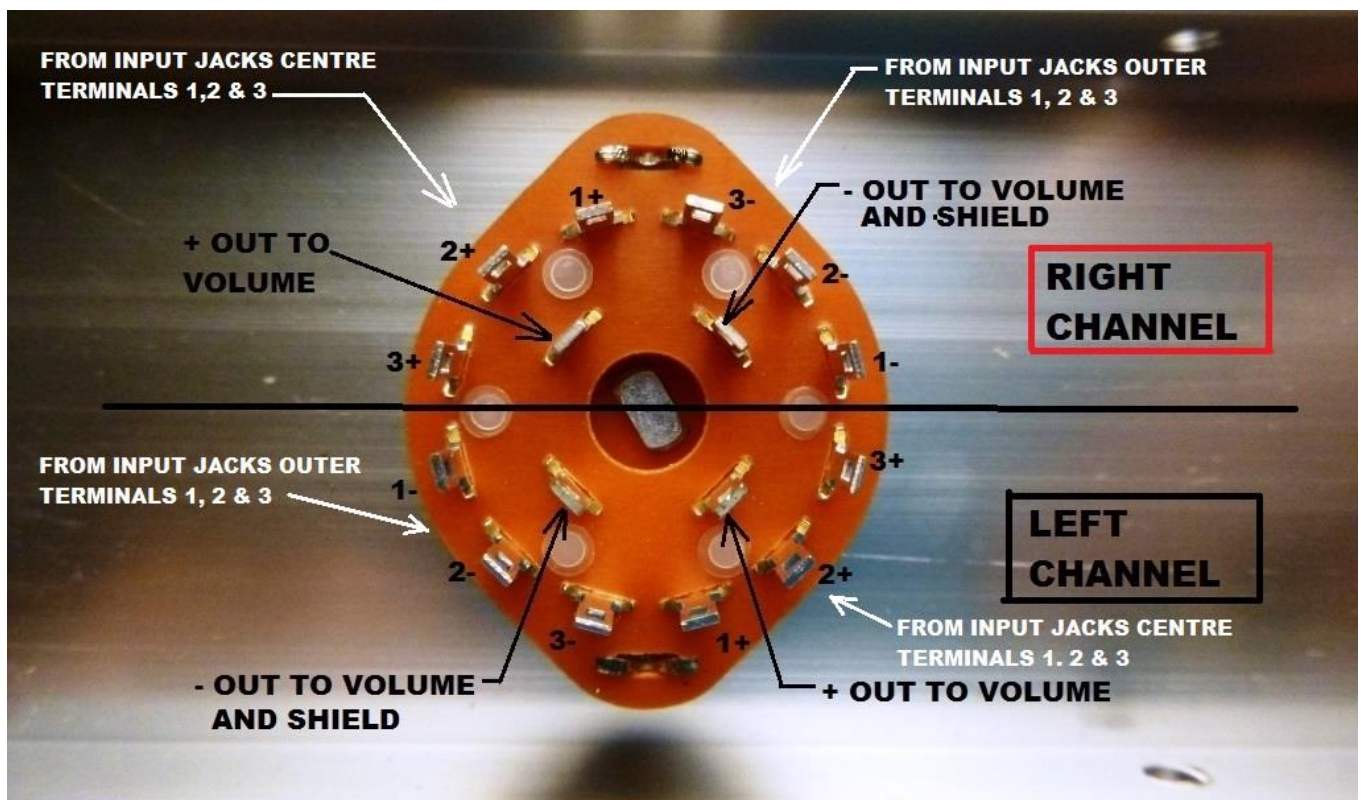
I won't get into all of the gruesome details, it's similar to the output jack wiring above, except that the shields (if you are using shielded cable) should be connected at the input jack ground lugs.

As well the cables connecting the input selector switch to the volume control should have their shields connected at the selector switch end.

The cables connecting the volume control to the board should have their shields connected at the volume pot end.

The selector switch I have chosen switches both the ground (-) and hot (+) side of the input signals. This provides better isolation between sources as well as reducing potential ground loop issues.

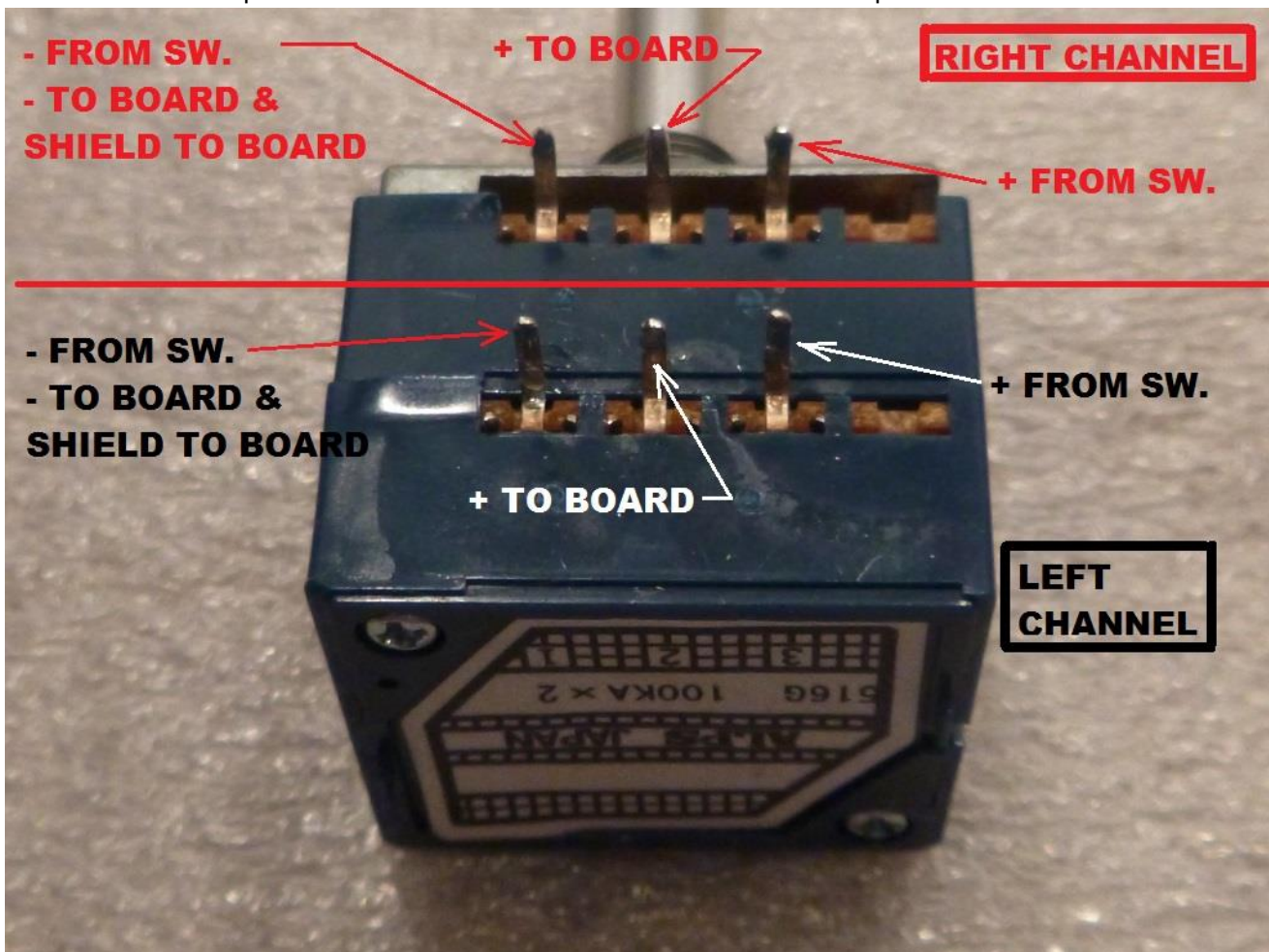
See the picture below where the input selector switch terminals are identified.



Volume Pot Wiring and Assembly:

It is easier to connect the switch wiring to the volume pot and the wiring from the pot to the board before assembling the pot to the front panel.

1. Temporarily install the volume pot (Mouser part no. 688-RK27112A00CC) on the front panel to judge the length of cabling required to connect it to the selector switch and board.
2. Cut lengths of cable or twisted pairs to the desired lengths.
3. See the picture below for the connections to the volume pot.



4. Connect and solder the cables from the selector switch to the volume pot.
5. Connect and solder the cables that will lead to the board.

6. Place the ring with grounding wire attached over the shaft of the pot.
7. Inset the shaft of the pot through the front panel.
8. Assemble the washer to the shaft and over the threads.
9. Place a drop of nail polish on the threads.
10. Assemble the nut to the thread and tighten.
11. Solder the wires from the pot to the inputs on the board, observing correct channel orientation.
12. Close the zip ties at the left end of the board around the output cable and ground wire from the pot. Trim the ends of the zip ties.
13. Close the zip ties on the right side of the board and right chassis side around the input cabling and cabling from volume pot to board and trim the ends.

The knobs I purchased are for a 6mm shaft which matches the volume pot but one will need to be drilled out to 1/4" for the input select switch.

14. Remove the set screw from the knob.
15. Clamp the knob in a vise using a piece of thin cardboard to protect from damage.



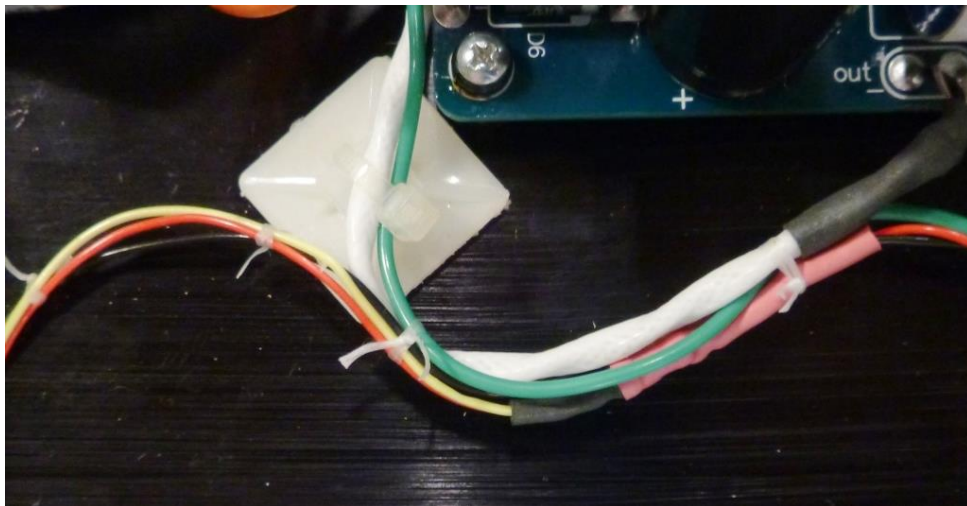
16. Using a counter sink enlarge the lead-in bevel on the hole to help the drill engage.

17. Put 4 or 5 drops of automatic transmission fluid in the hole and on the drill bit for easier cutting.
18. Using a 1/4" or 6.4mm drill enlarge the hole. It's not necessary to drill the full depth as the shaft of the selector switch is fairly short.
19. Clean out the chips and clean the hole including the set screw hole with solvent.
20. If you wish use a centre drill to put an index detent on the bevel of the knobs. Clamp it as shown below, mark the spot with a centre punch approximately opposite the set screw hole and drill at a low speed. Colour the index detent with the tip of a Sharpie marker if you wish. Re-assemble the set screw to the knob.

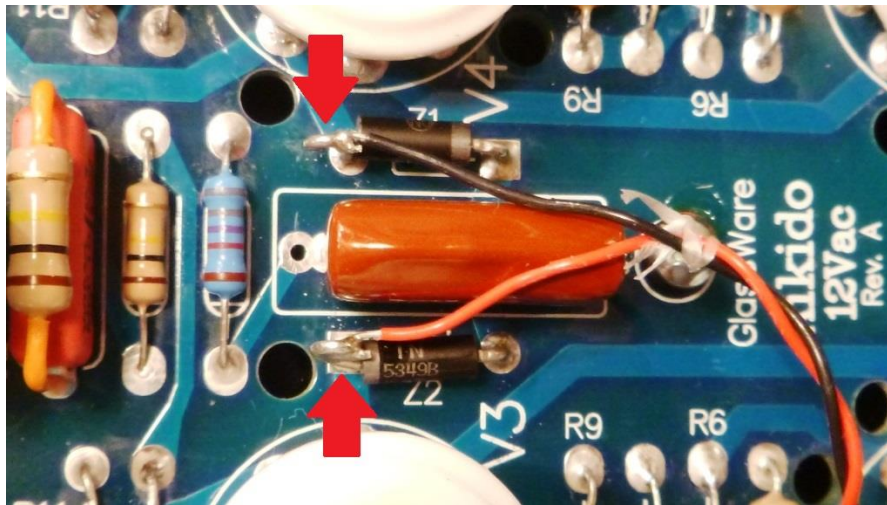


LED Connection to Board:

1. Strap the resistor bundle to the front output cable with zip ties or dental tape as shown.



2. Loop the red and black pair along the front edge of the board and up between V1 and V3 to the loops on Z1 and Z2.
3. Trim as required and strip **6mm** of insulation from the ends.
4. Connect the **red** wire to the loop on **Z2** (the one closest to V3) and solder.
5. Connect the **black** wire to the loop on **Z1** (the one closest to V4) and solder.



Final Assembly:

1. Assemble the knobs to the switch and volume pot shafts.
2. Install the tubes in their sockets. Note: Because the board is rubber mounted with O-rings and therefore not entirely rigid it is a good idea to support the board when installing or removing tubes.
3. Pop the plastic grommets (Mouser part no. 836-2240) through the holes in the chassis top.
4. Carefully place the top over the tubes onto the chassis.
Note: You may have to temporarily loosen the screws securing the front and back to the sides to get the top to drop into place.

5. Secure the top with screws and tighten the front and back screws if necessary.

Pat yourself on the back you've done a good job. Connect your line stage up and enjoy some music. Don't forget that it will sound better once you have 24 hours of running time on it and will keep improving even more through 200 hours or so of use.