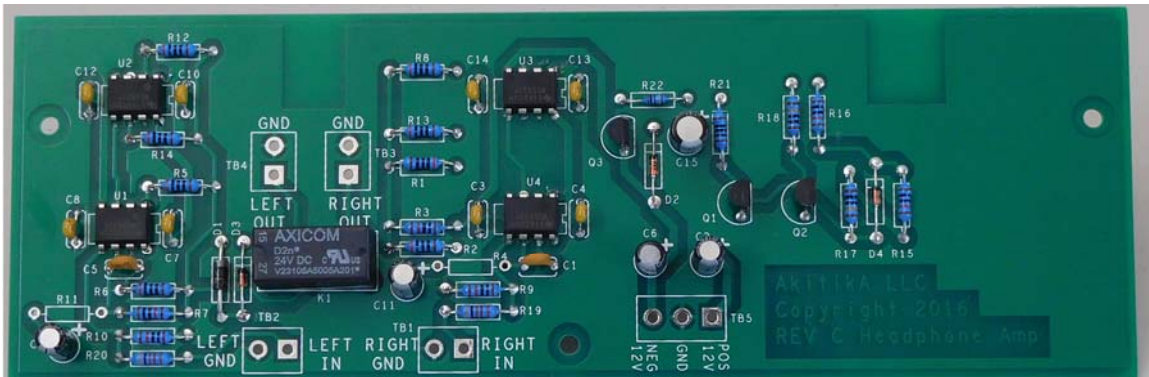


Akitika

PR-101 STEREO PREAMPLIFIER



Headphone Amp ASSEMBLY MANUAL

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Section 1: About This Manual

This manual gives the information needed to build and use the Headphone Amp for Akitika LLC's PR-101 Stereo Preamplifier.

Who Should Attempt this Project?

You can build this kit if you can:

1. Solder (using normal rosin core solder and a soldering iron).
2. Use simple hand tools like screwdrivers, wire cutters, and pliers.
3. Read and follow directions.

It helps if you:

1. know a bit about electronics, or
2. have a friend who knows a bit about electronics
3. can get to YouTube to watch a few helpful videos about the assembly process (none are posted as of this version of the manual).

Tools you'll need

You'll need the following tools:

1. Phillips screwdriver (#1 and #2)
2. Pliers or nut drivers suitable for #4 and #6 hardware
3. needle nose pliers (helpful, but not strictly necessary)
4. pencil type soldering iron of 35 to 50 Watts (no huge honking soldering guns or blowtorches)
5. wire cutters and strippers
6. multi-meter to measure power supply voltages and confirm resistor values (strongly recommended)!

Helpful Tools

These tools aren't strictly necessary, but make building the kit easier.

1. magnifying glass, if you're over 42!
2. lead bending jig to form axial component leads to the correct span for insertion in the PCB.

Project Overview

The project consists of the following steps:

1. Building the Headphone Amp circuit board.
2. Choosing a few load options based on your headphones.
3. Installing the Headphone Amp into a PR-101 preamplifier.

Important Safety Notes

By purchasing, using, or assembling this kit, you have agreed to hold Akitika LLC harmless for any injuries you may receive in its assembly and/or use. To prevent injuries:

- Wear safety glasses when soldering or clipping wires to prevent eye injuries.
- Always unplug the power before working on the amplifier.
- Large capacitors hold lots of energy for a long time. Before you put your hands into the amplifier:
 - Pull the AC plug!
 - Wait 2 full minutes for the capacitors to discharge!
- Remove jewelry and rings from your hands and wrists, or anything that might dangle into the amplifier or fall from a shirt pocket.
- If working on the equipment with the power on, keep one hand in your pocket, especially if you're near the power supply or power supply wires. This can prevent serious shocks.
- Build with a buddy nearby. If you've ignored all the previous advice, they can dial 911 or get you to the hospital.
- Read and understand the safety manuals of all the tools you use.

About Components

We reserve the right to make design/or component changes at any time without prior notification.

Recommended Solder

The kit must be assembled with 60/40 Rosin Core solder. The recommended diameter is 0.032 inches. Among many such sources of solder, I have used Radio Shack part number 64-009. It contains 8 oz. of solder, which is much more than you'll need to assemble the kit.

Warranty

With the exception of fuses, Akitika will replace for free any parts of a correctly assembled product that fails within one year of the date of purchase when the equipment has been used in home stereo applications. It is the responsibility of the kit builder to install the replacement part(s). This warranty applies to the original purchaser only. It does not apply to units that have been physically or electrically abused, modified without prior factory authorization, or assembled with other than 60/40 Rosin Core solder. Akitika LLC's liability shall in no event exceed the cost paid to Akitika LLC for the kit.

Section 2: Kit Building Hints

Yes, I know you want to ignore this section, and jump right into building the kit. However, please ***take a minute and read this advice.*** I've condensed it into bullets so that even you guys who are in a hurry can benefit.

- Stop any time you're feeling confused, tired, or anxious. Taking breaks at those strategic times will keep the build enjoyable and greatly enhance your chances of first-time success.
- A soup bowl is your friend. Before you build a board, carefully empty the parts into a broad, flat, light colored soup bowl. That makes it easy to find the parts, and keeps them from getting lost.
- A digital ohm-meter is an easy way to make sure that you've picked the right resistor. It's a great cross-check on the resistor color code. Measure twice and solder once!
- A lead-bending jig can make for quicker, neater assembly. It's certainly not necessary.
- Is something in this manual confusing? Does something look wrong? Send your questions by email to dan@akitika.com. You'll help yourself and everyone who builds the kit.

Section 3: Building the Headphone Amp

This section details the process of building the Headphone Amp circuit board. Begin by carefully emptying the contents of the parts envelope into a broad soup bowl, as shown below. In general, you'll start with the components that lay closest to the board, working your way towards the taller components.

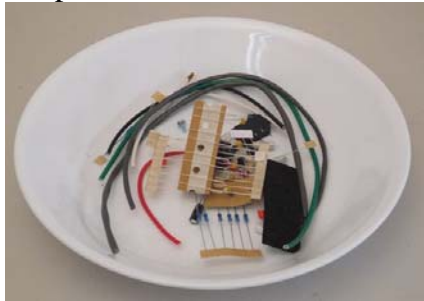


Figure 1-Empty the components into a soup bowl

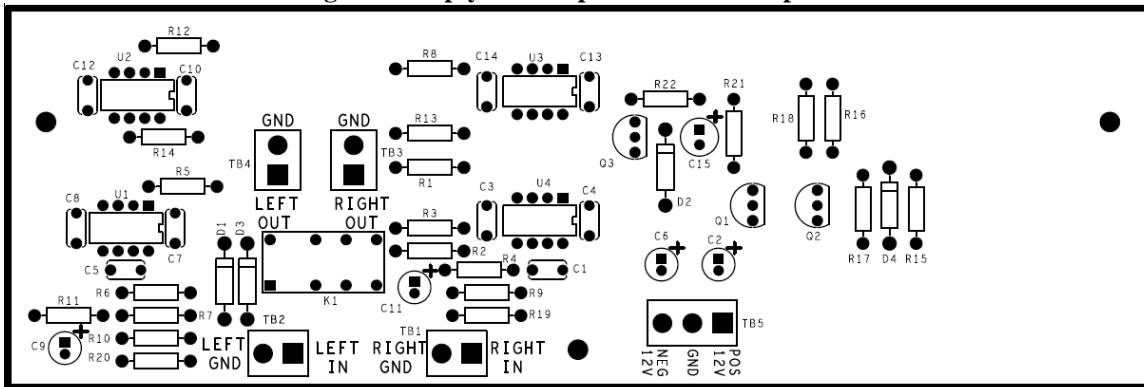


Figure 2-Silk screen shows Headphone Amp component locations

Component Order

You'll notice that the component designations in the directions don't go in order. We have grouped them so that all components with the same value appear together. This makes assembly easier. You'll find in the parts kit that similar parts, e.g. 3 1K resistors, are typically (though not always) taped together.

Install the Resistors

In general, you install axial leaded components (like the resistors) by placing the body on the silk screen side of the board, and the leads through the indicated holes. Bend the leads over on the back of the board to keep the resistors from falling out until your solder them in place. Try to bend the leads in a direction that won't lead to solder bridges between traces that should remain disconnected.

We recommend the following procedure:

1. Insert all components of the same value or type
2. Bend the leads as described above.
3. Solder the leads on the back of the board.
4. Clip the leads.

Track your progress by placing a check-mark in the done column as you install each component.

Bend resistor leads to 0.45" width			
Designation	Value	Color Code	Done ✓
R21	100	Brown, Black, Black, Black, Brown	
R1	200	Red, Black, Black, Black, Brown	
R2	200	Red, Black, Black, Black, Brown	
R5	200	Red, Black, Black, Black, Brown	
R6	200	Red, Black, Black, Black, Brown	
R8	200	Red, Black, Black, Black, Brown	
R12	200	Red, Black, Black, Black, Brown	
R13	200	Red, Black, Black, Black, Brown	
R14	200	Red, Black, Black, Black, Brown	
R3	10K0	Brown, Black, Black, Red, Brown	
R4	10K0	NO LOAD	
R7	10K0	Brown, Black, Black, Red, Brown	
R9	10K0	Brown, Black, Black, Red, Brown	
R10	10K0	Brown, Black, Black, Red, Brown	
R11	10K0	NO LOAD	
R15	10K0	Brown, Black, Black, Red, Brown	
R16	10K0	Brown, Black, Black, Red, Brown	
R17	100K	Brown, Black, Black, Orange, Brown	
R18	100K	Brown, Black, Black, Orange, Brown	
R22	1M00	Brown, Black, Black, Yellow, Brown	

Save two pieces of the clipped resistor lead. Depending upon the gain setting you choose, they may be used in the next section.

Selected Resistor Installation

Depending on the type of headphones you have, you will set the gain of the headphone amp differently. Basically, there are two types of headphones out there:

- Modern headphones have low impedance, typically 32 Ohms, but could be as low as 18 Ohms. Grado SR-60E's are typical of modern 32 Ohm headphones. They have a sensitivity of 99.8 dB SPL for 1 milliwatt, corresponding to a voltage of 179 mV RMS.
- Some older headphones have an impedance of around 600 Ohms. The Sennheiser HD420 is an example of 600 Ohm phones. They have a listed sensitivity of 94 dB SPL for 1 milliwatt, corresponding to a voltage of 0.775 Volts RMS.

Translate this to a common output level of 100 dB SPL, and we find that:

- Typical 32 Ohm phones produce 100 dB SPL with 183 mV RMS input
- Typical 600 Ohm phones produce 100 dB SPL with 1.55 Volts RMS input

This big difference is a ratio of $1.55/0.183=8.5$ to 1, or 18.5 dB. That's why we strongly recommend setting the gain of the Headphone amp to different values depending upon your headphones.

Recommended resistor values for 32 Ohm headphones (most common)			
Designation	Value	Color Code	Done ✓
R20	30K1	Orange, Black, Brown, Red, Brown	
R19	30K1	Orange, Black, Brown, Red, Brown	
R11	NA	Do not install	
R4	NA	Do not install	

If you install the resistor values for 32 Ohm headphones, you will have 2 spare 10K0 resistors that are not used.

Recommended resistor values for 600 Ohm headphones (not common)			
Designation	Value	Color Code	Done ✓
R20	jumper	Piece of saved resistor lead	
R19	jumper	Piece of saved resistor lead	
R11	10K0	Brown, Black, Black, Red, Brown	
R4	10K0	Brown, Black, Black, Red, Brown	

If you install the resistor values for 600 Ohm headphones, you will have 2 spare 30K1 resistors that are not used.

Install the diodes

Install the diodes. *The polarity is critical. Make sure that the banded end of the diode matches the banded end of the silk-screen on the PCB.*

Polarity is critical!			
Designation	Value	Rating, Marking	Done? (✓)
D1	1N4004	400V, 1 Amp Rectifier diode	
D2	TVX6V2C	6.2 V Zener	
D3	BZX79-B10	10 V Zener	
D4	BZX79-B10	10 V Zener	

Install the small non-polarized capacitors

The capacitors you'll install in this section can be installed in either orientation.

Small Value COG dielectric Capacitors			
Designation	Value	Rating, Marking, Description	Done? (✓)
C1	33 pF	NPO, 33J, disc capacitor, 5% tolerance	
C5	33 pF	NPO, 33J, disc capacitor, 5% tolerance	

Install the bypass capacitors

The 0.1 uF bypass capacitors are not polarized, and can be inserted in either orientation.

Non Polarized Bypass Capacitors (Location Hint: a pair of these surrounds each IC)			
Designation	Value	Rating, Marking	Done? (✓)
C3	0.1 uF	Bypass, 104, radial leads	
C4	0.1 uF	Bypass, 104, radial leads	
C7	0.1 uF	Bypass, 104, radial leads	
C8	0.1 uF	Bypass, 104, radial leads	
C10	0.1 uF	Bypass, 104, radial leads	
C12	0.1 uF	Bypass, 104, radial leads	
C13	0.1 uF	Bypass, 104, radial radial leads	
C14	0.1 uF	Bypass, 104, radial leads	

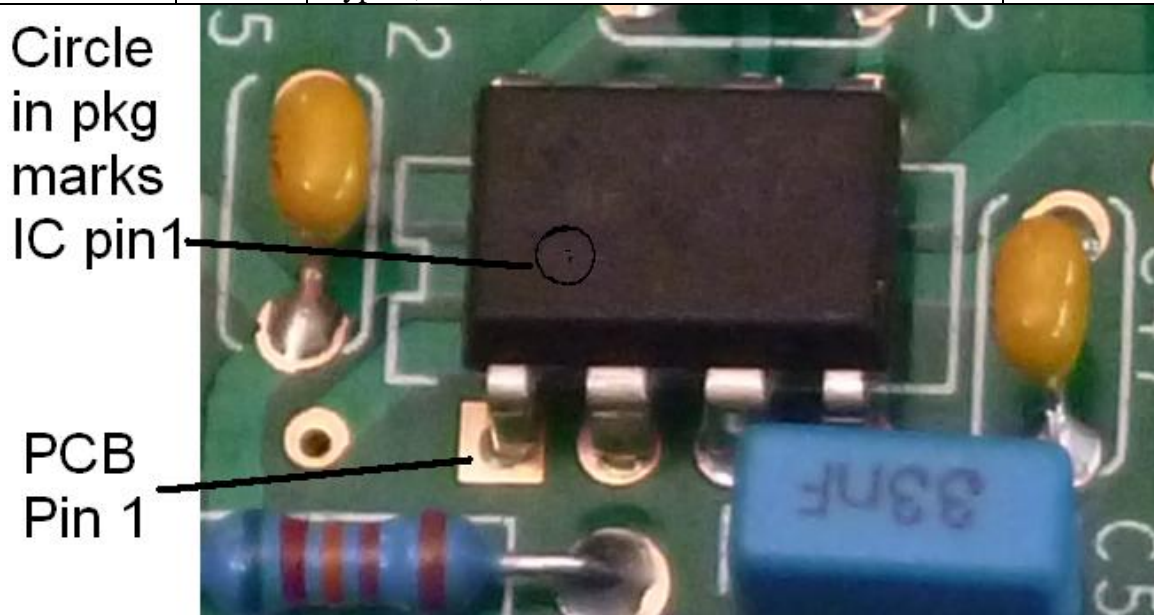


Figure 3-Locating pin 1 of the IC and pin 1 of the PCB

Install the Integrated Circuits

Integrated Circuits (watch pin 1 location)		
Designation	Description	Done? (✓)
U1	NE5532 dual opamp, 8 pin dip package	
U2	NE5532 dual opamp, 8 pin dip package	
U3	NE5532 dual opamp, 8 pin dip package	
U4	NE5532 dual opamp, 8 pin dip package	

Install the Electrolytic (polarized) Capacitors

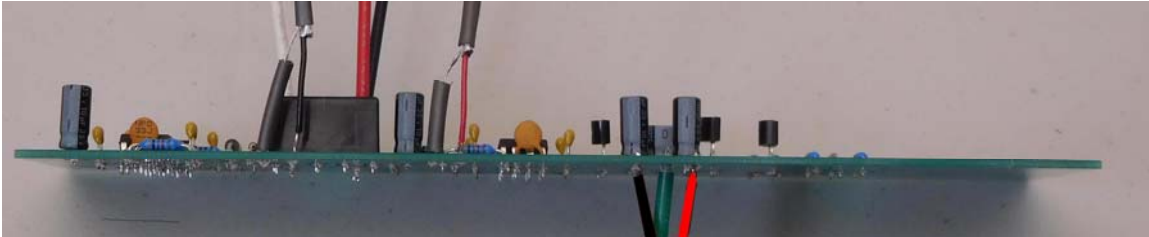
Please note that C15 has a 50 Volt rating, while the rest of these capacitors have a 35 volt rating.

Polarized Capacitors (watch polarity)			
Designation	Value	Rating, Marking	Done? (✓)
C2	10 uF	Electrolytic capacitor, 10 μF 35 V, radial leads	
C6	10 uF	Electrolytic capacitor, 10 μF 35 V, radial leads	
C9	10 uF	Electrolytic capacitor, 10 μF 35 V, radial leads	
C11	10 uF	Electrolytic capacitor, 10 μF 35 V, radial leads	
C15	10 uF	Electrolytic capacitor, 10 μF 50 V, radial leads	

Install the Relays, Transistors, and MOSFET

For Q1-Q3, make sure to match the body shape to the silk-screen shape			
Designation	Value	Description	Done? (✓)
K1	DPDT	Double pole double throw, 24 volt relay coil	
Q1	2N3904	NPN transistors	
Q2	2N3904	NPN transistor	
Q3	2N7000	MOSFET	

Section 4: Install the Wires



Power and Ground Wires

12 Volt Ground wires

Cut a 7" length of 18 AWG Green wire. Prepare, twist and tin the ends as shown here:



12V ground wire installation	Done? (✓)
Insert one end of the tinned ground wire from the bottom of the Headphone Amp PCB into the center TB5 hole, marked GND and solder it on the top side. The other side of this wire will be connected in a later step.	

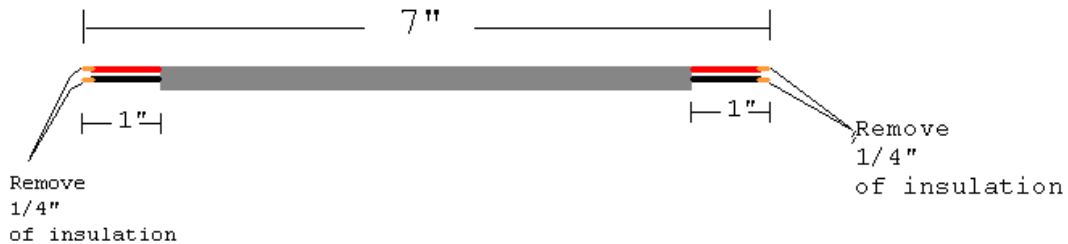
12 Volt Power wires

Locate the thicker gray jacketed cable. Note that there is also thinner gray jacketed cable. *Find both and compare them to make sure you really have the thicker gray jacketed cable.*

Now that you're sure you have the thicker gray jacketed cable, beneath the gray jacket you'll find:

- Red 18 AWG stranded wire
- Black 18 AWG stranded wire
- Foil shield
- Bare stranded 18 AWG drain wire
- Fuzzy string

Prepare a 7" length per the following diagram:



Cut the drain wire from both ends. Remove the foil shield. Pull the fuzzy string out of the plastic jacket, pulling it lengthwise in a direction parallel to the wires.

Plus and Minus 12V power wire installation	Done? (✓)
Twist and tin both bare ends of the red wire.	
Twist and tin both bare ends of the black wire.	
Insert the tinned red wire into the bottom of the Headphone Amp board into the TB5 hole marked POS12V and solder it on the top side. The other side of this wire will be connected in a later step.	
Insert the tinned black wire into the bottom of the Headphone Amp board into the TB5 hole marked NEG12V and solder it on the top side. The other side of this wire will be connected in a later step.	

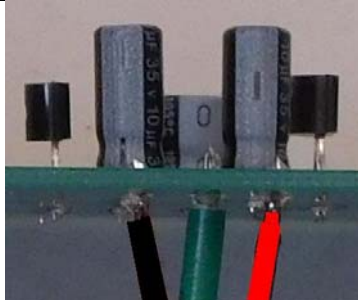
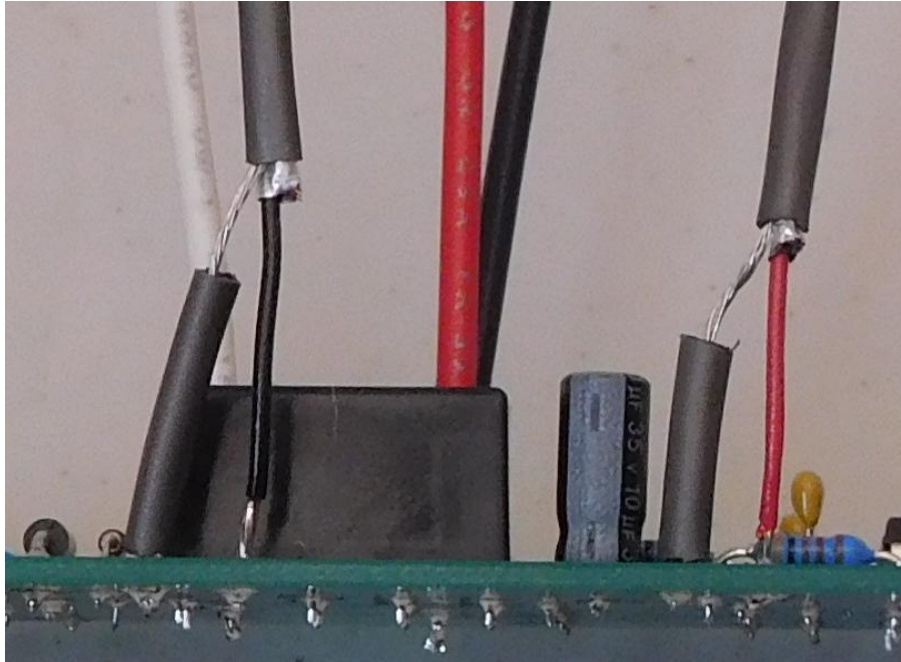


Figure 4-Close-up showing installation of -12V, GND, and +12V power wires

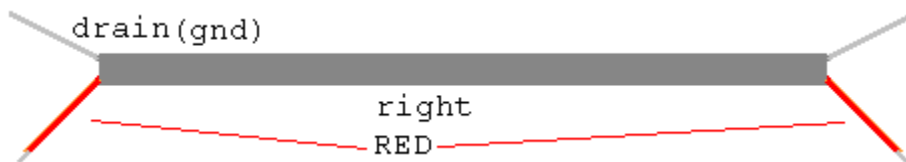
Double check your power wiring to make sure that Positive is to RED, Negative is to BLACK, and Ground is to GREEN!

Install the Signal Wires

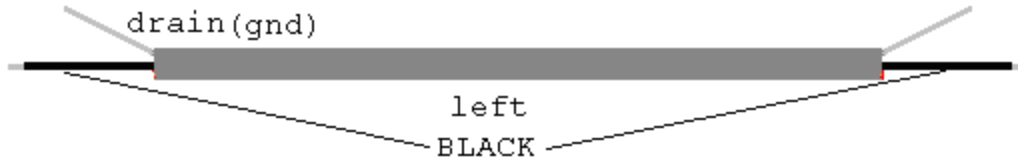


Signal Input Wires

The wires in this section will bring signal into the inputs of the headphone amp. You will use the thinner of the two types of gray jacketed wire for these steps (All but a few inches of the thicker gray jacketed wire was used in the previous power wiring steps)



Signal Wiring (Right Channel Input Connections)	
Task	Done? (✓)
Cut a 4" length of shielded cable that will be used for the right channel connections. This is the thinner, gray jacketed cable.	
Prepare the ends as shown in Appendix 1. Reserve the outer jacket removed when you exposed the ends.	
Cut the black wire at both ends of the shielded cable. It won't be used.	
Strip, twist and tin the remaining red ends (2 places)	
Twist and tin the drain wire at both ends.	
Cut a 1/2" length of the outer jacket and slip it over the drain wire.	
Insert the red wire into the component side of the PCB, into the RIGHT IN terminal of TB1. Solder it on the solder side.	
Insert the drain wire (with the outer jacket covering) into the component side of the PCB, into the RIGHT GND terminal of TB1. Solder it on the solder side.	



Signal Wiring (Left Channel Input Connections)	
Task	Done? (✓)
Cut a 4" length of shielded cable that will be used for the left channel connections. This is the thinner, gray jacketed cable.	
Prepare the ends as shown in Appendix 1. Reserve the outer jacket removed when you exposed the ends.	
Cut the red wire at both ends of the shielded cable. It won't be used.	
Strip, twist and tin the remaining black ends (2 places)	
Twist and tin the drain wire at both ends.	
Cut a 1/2" length of the outer jacket and slip it over the drain wire.	
Insert the black wire into the component side of the PCB, into the LEFT INPUT terminal of TB2. Solder it on the solder side.	
Insert the drain wire (with the outer jacket covering) into the component side of the PCB, into the Ground of TB2. Solder it on the solder side.	

Signal Output Wires

These wires will connect the output from the headphone amp to the headphone jack.

Headphone jack wires	
Task	Done? (✓)
Cut a 3" length of black 22 AWG wire. Strip 1/4" of insulation from both ends. Twist and tin the ends.	
Insert one end of the black wire into the GND terminal of TB3 from the component side. Solder it on the Solder Side.	
Cut a 3" length of red 22 AWG wire. Strip 1/4" of insulation from both ends. Twist and tin the ends.	
Insert one end of the red wire into the RIGHT OUT terminal of TB3 from the component side. Solder it on the Solder Side.	
Cut a 3" length of white 22 AWG wire. Strip 1/4" of insulation from both ends. Twist and tin the ends.	
Insert one end of the white wire into the LEFT OUT terminal of TB4 from the component side. Solder it on the Solder Side.	

Section 5 – Install the Headphone Amp into the PR-101

Make sure that the power is disconnected from the PR-101 before proceeding with the installation.



Figure 5-Tone/Volume dismantled to make room to install Headphone Amp

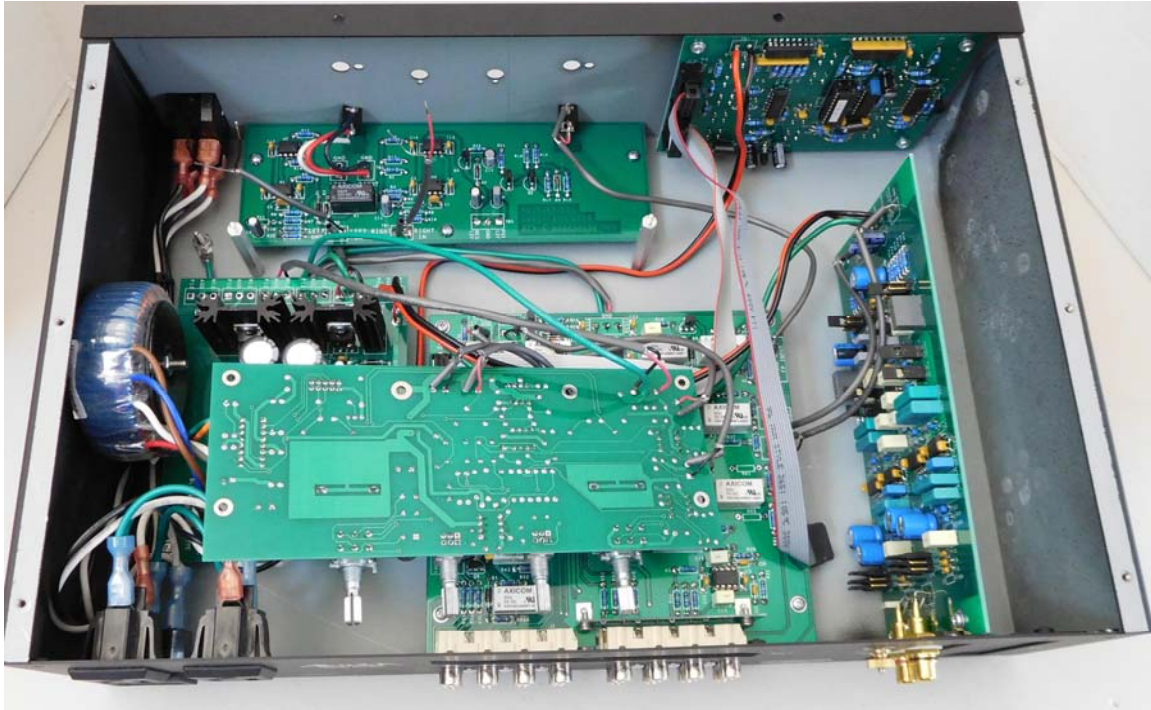
Mechanical Installation

Please protect the paint finish on your PR101. Be sure to put a towel onto your work surface prior to laying your PR101 on your work bench. The general steps are:

1. Dismount the tone/volume board.
2. Mount the Headphone Amp board.
3. Connect power and headphone jack wires.
4. Remount the tone/volume board.
5. Connect signal wires.

Dismount the tone/volume board

Task	Done? (✓)
Pull off the front panel knobs (volume, balance, bass, and treble).	
Remove and reserve the nuts and washers that hold the volume, balance, bass, and treble controls in place.	
Remove the 10 pin cable from its socket. Don't pull the cable, but rather wiggle the body of the connector until it comes loose from the socket.	
Remove and reserve the two 4-40 keps nuts at the back of the board that hold the tone/volume board onto the stand-offs.	
Lift the back of the tone/volume board off the stand-offs. It may take just a little bit of "convincing".	
Set the tone/volume board comfortably on top of the input selector board to make room to install the headphone amp.	



Mount the Headphone Amp Board

Task	Done? (✓)
Install two female/female standoffs into the chassis, onto the threaded studs next to the front of the chassis.	
Fasten the third female/female standoff onto the stand-alone hole in the Headphone Amp PCB using a 4-40x1/4" Phillips screw. The standoff goes on the solder side, and the screw installs from the component side. The standoff will just rest on the chassis floor.	
Install the Headphone Amp board into the chassis using 4-40x1/4" screws inserted through the PCB and into the standoffs installed previously.	

Wiring the Headphone Amp In

Headphone Jack Connections

Task	Done? (✓)
Identify the red, black, and white 22 AWG wires installed into the Headphone Amp board previously.	
Solder the red, white, and black wires into the front-panel 1/8" jack marked with the headphone symbol. Use Figure 6 as your guide to getting the wires in the correct places.	

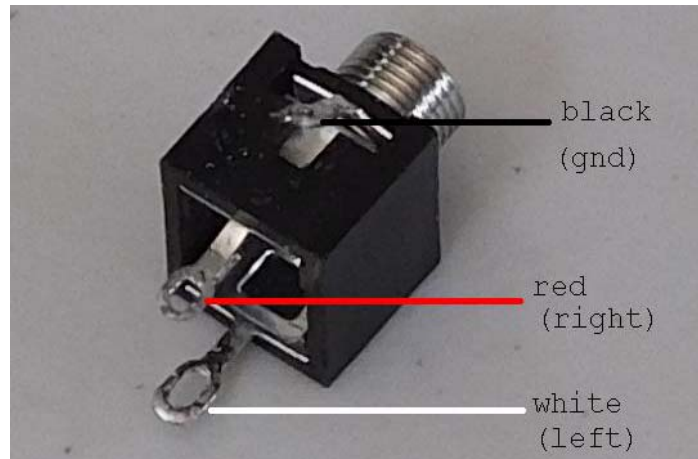


Figure 6-Headphone Jack Wiring



Figure 7-Headphone Amp Installed with jack wiring completed

Power Wiring

You can select any of the unused +/-12 terminal sets on the power supply board. We recommend using TB2. If you followed the PR-101 Assembly instructions, TB3 and TB4 are already used.

Please note the following

1. Use the recommended order, installing green wire first to minimize damage to adjacent power wires as you solder them in place.
2. While soldering, keep the wires straight as they approach the board. This will keep the insulation from peeling back as you solder.

Power Wiring	
Task	Done? (✓)
Insert the green wire into the component side of the power supply PCB into the PCB hole marked AGD on TB2. Solder from the component side.	
Route the Red/Black pair and the green wire from the Headphone amp power connector along the chassis floor, next to the stand-offs for the tone/volume board, on the rear panel side of the stand-offs.	
Insert Red wire of Red/black pair into the component side of the power	

supply PCB into the PCB hole marked P12 on TB2. Solder from the component side.	
Insert black wire of Red/black pair into the component side of the power supply PCB into the PCB hole marked N12 on TB2. Solder from the component side.	
<i>Make sure that the bare wires connecting to the power supply are short enough that they don't contact the bottom of the chassis.</i>	
<i>Double check your power wiring to make sure that Positive is to Positive, Negative is to Negative, and Ground is to Ground!</i>	

Reinstall the Tone/Volume Board

Insert the controls through the front panel. Fit the holes in the back of the PCB over the threaded inserts in the standoffs. Once everything seems lined up, reinstall the washers and nuts that hold in the volume, balance, bass and treble controls. Reinstall the 4-40 keps nuts that fasten the tone volume board to the stand-off.

Signal Connections

In this section, you'll connect the shielded cables from the headphone amp to the existing outputs of the tone/volume board. There are two ways to do this:

1. Lazy way – just tack the headphone shielded cable connections on top of the existing shielded cable connections that go to the input selector board.
2. Fastidious way - Desolder and remove the shielded cables from the input selector board that are connected to TB3 and TB4 of the tone/volume board. Use a solder sucker to clear the 4 holes in TB3 and TB4. Then follow the directions below:

Right Channel Signal Wiring	
Task	Done? (✓)
Locate the shielded cable coming from the right channel input of the Headphone Amp. It has a red wire and a drain wire.	
Insert into the component side of the tone/volume board TB3 OUT RIGHT these two red wires: <ol style="list-style-type: none"> 1. The red wire from the input selector board shielded cable. 2. The red wire from the Headphone Amp shielded cable. Solder both red wires to TB3 OUT RIGHT on the tone/volume board.	
Insert into the component side of the tone/volume board TB3 OUT RIGHT these two drain wires (recall that both drain wires are covered by 1/2" of gray insulation: <ol style="list-style-type: none"> 3. The drain wire from the input selector board shielded cable. 4. The drain wire from the Headphone Amp shielded cable. Solder both drain wires to TB3 GND RIGHT on the tone volume board.	

Left Channel Signal Wiring	
Task	Done? (✓)
Locate the shielded cable coming from the left channel input of the Headphone Amp. It has a black wire and a drain wire.	
Insert into the component side of the tone/volume board TB4 OUT LEFT these two black wires: 5. The black wire from the input selector board shielded cable. 6. The black wire from the Headphone Amp shielded cable. Solder both red wires to TB4 OUT LEFT on the tone/volume board.	
Insert into the component side of the tone/volume board TB4 GND LEFT these two drain wires (recall that both drain wires are covered by 1/2" of gray insulation): 7. The drain wire from the input selector board shielded cable. 8. The drain wire from the Headphone Amp shielded cable. Solder both drain wires to TB4 GND LEFT on the tone volume board.	

Section 6: Tests and Final Assembly

Reconnect the 10 pin control cable that runs from the controller board to the tone/volume board.

Connect AC power to the PR-101 and power it up. *Be careful as potentially lethal voltages are accessible in the PR-101 any time that it is powered with the lid removed.*

Check the plus and minus 12 volt supplies to assure that they are still within tolerance, that is, within +/- 0.6 Volts of 12 Volts DC. The easiest and quickest place to check this may be on the tone/volume board at TB5. This is a quick sanity check for (mostly) correct assembly of the Headphone Amp.

Tighten up the 4 control nuts and the two nuts that hold the tone volume PCB to the stand-offs. Re-install the knobs on the 4 controls.

Replace the cover and re-install the eleven screws that retain the cover.

Section 7: About the Headphone Preamp

Specifications

- Power supply requirements - +/-12V, 33 mA from each rail (idle)
- Distortion: all harmonics of 1 kHz more than 80 dB below 1 volt into 32 Ohms. 1 Volt corresponds to more than 100 dB SPL into most headphones.
 - 2rd harmonic about 90 dB below 1 volt
 - 3rd harmonic about 82 dB below 1 volt
 - 4th harmonic about >112 dB below 1 volt
 - 5th harmonic about 110 dB below 1 volt
 - distortion decreases for lighter loads and lower output levels

- Frequency Response: -3 dB at 2 Hz and 200 kHz (measured from the CD input to a 32 Ohm load on the headphone output)
- A-weighted SNR - >100 dB
- Maximum output-approximately 2.5 volts RMS¹ into 32 Ohms
- Output Impedance - less than 2.5 Ohm at 20 kHz, less than 25 milli-Ohms at 25 Hz.

The headphone amp has relay contacts in series with the headphone jack. A timing circuit controls this relay to only close it about ½ second after power is good, and opens it within a few 10's of milliseconds after power has been removed. These circuits minimize the turn-on and turn-off sounds transferred to your headphones.

Revision Notes

Revision 1p9 of this manual changes from BC547 transistors to 2N3904 transistors. As an interesting note, these two transistors have the same looking package, but the position of collector and emitter leads is swapped between the two. The PCB was laid out for 2N3904 pinout, but early units were populated with BC547. That means that those units, with BC547, were operating with reverse beta. It is a testimony to my robust design (and a bit of dumb luck) that even the BC547 operating in reverse performed flawlessly.

¹ Given the 4 to 1 attenuator on the input of the headphone amp, the headphone amp will appear to clip before 2.5 Volts out output, but that is only because the input signal (which would have to be 10 Volts RMS) would be clipping by that point. If you need more signal into your headphones, you can adjust the gain setting resistor(s), in the limit, replacing R19 and R20 with jumpers.

Appendix 1 – Shielded Cable Preparation

This section tells how to prepare the end of a shielded cable.

1. Cut the shielded cable to the overall required length.



2. Use a utility knife with a new, sharp blade to cut the plastic jacket of the shielded cable 1” back from the end. Hold the blade perpendicular to the cable, and draw it across the cable lightly as you rotate the cable along its long dimension. This creates a scored line through the plastic jacket. With a sharp blade, not much pressure is needed. You may need a bit of practice to get the feel.



3. If you’ve scored the jacket carefully, you can separate the jacket at the score line without using tools. Pull the insulating jacket off, exposing the cable, showing the foil shield, the drain wire, and the fuzzy string. The result is shown here, with the foil shield showing.



4. Cut off the fuzzy string. One shorter lengths of cable, it may be easier to just pull the fuzzy string out by pulling in a direction parallel to the wires.



5. Separate and twist the drain wire.



6. Peel back and remove the foil. Remove the plastic wrap from the red and black wires. The drain (bare wire), red, and black wires are exposed now that gray insulating jacket, foil shield, and plastic over-wrap have been removed.
7. Save the gray outer jacket as it will be used (perhaps cut to half length) to insulate the bare drain wire.