

# ***PAT-4 TOROIDAL TRANSFORMER ASSEMBLY MANUAL***



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Revision 1p7

February 27, 2021

## Table of Contents

Table of Contents .....	2
Table of Figures .....	2
Section 1: About This Manual .....	3
Who Should Attempt these Projects? .....	4
Tools and Supplies you'll need.....	4
Recommended Solder .....	4
Project Overview .....	5
Important Safety Notes .....	5
Section 2: Preliminary Disassembly, Test, and Modification.....	6
120 Volt Transformer Removal.....	6
Changing C6 (Rev A and Rev B PAT4PWR Only) .....	7
Section 3: Installing the Toroidal Transformer.....	9
Preparing the New Toroidal Transformer.....	9
Prepare the Transformer Wires .....	11
Install the Transformer and Mounting Bracket into the Chassis .....	12
Connect the Transformer wires.....	12
Check for Proper Operation .....	13
Prepare to Reconnect your PAT-4 to your Music System.....	13
Appendix 1: The Toothpick Trick .....	14
Appendix 2: First Class De-soldering.....	14

## Table of Figures

Figure 1-Removing transformer primary wires from the PAT-4 AC power connections..	7
Figure 2-Physical Mounting Arrangement for Toroid.....	9
Figure 3-Fastening brackets to mounting plate.....	9
Figure 4-Transformer mounted on plate with wires prepared for installation.....	10
Figure 5-Installing Transformer Assembly into PAT-4.....	11
Figure 6-Connecting Toroid Wires.....	12

## Section 1: About This Manual

This manual gives the information you need to remove the original transformer and install the upgraded toroidal power transformer into a Dynaco PAT-4 Preamp. The toroidal transformer has much smaller external magnetic fields than the original transformer. As part of a complete regimen of hum reduction, installing the transformer can make a large reduction in the hum produced by the PAT-4 Preamp.

The installation directions are slightly different depending upon the revision of PAT4PWR supply that you have, Rev B or Rev C. In a nutshell, you'll need to change one capacitor if your power supply is Rev B. You won't need to change a capacitor if your power supply is Rev C.

As of this writing, the following other PAT-4 upgrades are available from Updatemydynaco, a division of Akitika LLC:

- Blue Light Kit (BLUE)
- Tone Control Switch (TCS)
- Electronically Regulated Power Supply (PAT4PWR)
- Improved replacement for original channel electronics (PAT4RENEW, recommended)
- Incremental improvements of original channel electronics:
  - Line Amp Distortion Reducer (DRD4)
  - Line Stage Replacement Components (P4LSRC, the least expensive way to improve the line section of original channel electronic boards. However, PAT4RENEW is recommend instead)
  - Phono Preamp Upgrade Kit (PAT4LSRC, the least expensive way to improve the phono section of original channel electronic boards. However, PAT4RENEW is recommend instead)

The blue light kit changes the light in the power switch from original orange to beautiful blue.

The Line Amp Distortion Reducer drops the distortion of the Line Amp by a factor of ten. The Line Amp is the stage that includes the volume and tone controls. All sound from the preamp passes through the Line Amp. This upgrade makes everything played through the PAT-4 sound better.

The Tone Control Switch replaces the existing Hi Filter switch with a two position rotary switch. In the OFF position, the tone controls are disabled. In the 15 position, tone controls maintain their normal function. After this modification, the other two positions of the HI FILTER switch (10 and 7) are not available. You can install optional resistors (not provided) that drop the Line Amp gain when the tone controls are off. This drops the gain of the Line Amp, increasing Signal to Noise Ratio.

The regulated power supply kit replaces the original diodes, 3-section cap, and resistors with an electronically regulated power supply. When you install the PAT4PWR supply,

you dramatically reduce the hum in the PAT-4. It mounts conveniently in existing holes in the PAT-4.

The line stage replacement components kit replaces the 5 and 10% carbon composition original resistors with 1% metal film resistors. It also replaces Q3. We recommend that you replace Q4 as part of the DRD4 kit installation. It also supplies fresh new capacitors, and upgrades some capacitors from electrolytic to metal film. The result is much lower noise and distortion, and much better matching of the gain between channels.

The phono preamp upgrade kit replaces the transistors with modern low noise transistors and a darlington transistor. It replaces all the original 5% and 10% carbon comp resistors with metal film resistors. It replaces electrolytic caps in the signal path with film capacitors. The result is lower noise and distortion.

These upgrades can be installed in any combination, but the phono upgrade and PAT4RENEW kits require the PAT4PWR supply to be installed.

### ***Who Should Attempt these Projects?***

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, and
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 (not available as of this version of the manual)

### ***Tools and Supplies you'll need***

You'll need the following tools:

1. flat blade screwdrivers for #4 and #6 screws, #2 Philips head screwdriver
2. needle nose pliers (helpful, but not strictly necessary)
3. pencil type soldering iron of 25 to 50 Watts (no huge honking soldering guns or blowtorches)
4. wire cutters and strippers
5. de-soldering tools (see the Appendix 1 and Appendix 2)
6. Magnifying glass, if you're over 42!
7. A multi-meter for measuring Ohms and DC volts is handy, but not strictly necessary

### ***Recommended Solder***

The kit must be assembled with 63/37 Rosin Core solder. The recommended diameter is 0.031 inches. Lately I've been using Kester 24-6337-8800 50 Activated Rosin Cored Wire Solder Roll, 245 No-Clean, 63/37 Alloy, 0.031" Diameter. This is the part number for a 1 pound spool of solder, which is *much* more than you'll need to assemble this kit.

## ***Project Overview***

Broadly, the project consists of the following steps:

1. Disconnecting, then removing the old transformer.
2. Assembling the new transformer with mounting brackets and mounting plate.
3. Installing the new transformer and wiring in place.
4. Testing the resulting power supply.

## ***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 to prevent eye injuries.
- Always unplug the power before working on the equipment.
- Large capacitors hold lots of energy for a long time. Before you put your hands into the equipment:
  - Pull the AC plug!
  - Wait 1 full minute for the capacitors to discharge!
- Remove jewelry and rings from your hands and wrists, or anything that might dangle into the amplifier.
- If working in the amplifier, 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.

## Section 2: Preliminary Disassembly, Test, and Modification

1. Disconnect the PAT-4 from your music system.
2. Unplug the power cord and allow the preamp to sit for one minute before moving on.

Caution: Be sure that the preamp power is unplugged! 120 VAC can be lethal! 240 VAC can be lethal!

3. Remove and save the 4 screws that hold the cover in place, 2 on the left side and 2 on the right side. (Note: some late production PAT-4's may also have a 5<sup>th</sup> screw in the center-top of back panel. You'll also need to remove that screw.)
4. Lift the cover straight up and set it aside in a safe place.

To assure that you're beginning your modification from a sensible place, you'll next measure the power supply output voltages. Plug the PAT-4 into the AC power and turn the power switch on. ***Be careful! There are now potentially fatal voltages accessible. Keep away from the high voltages around the transformer and the fuse holder.***

<b><i>Be careful! These steps are performed with the power connected and turned on!</i></b>	Done
The voltage on eyelet 8 of both preamp PCB's should measure between -17 and -18 Volts DC (with respect to ground). <b><i>Note: this will only be so if you have installed the PAT4LP upgrade, in which case you will have re-wired the preamp PCBs and brought -17 Volts to them. Disregard this test if you haven't installed the PAT4LP upgrade.</i></b>	<input type="checkbox"/>
The voltage on eyelet 4 of both preamp PCB's should measure between 17 and 18 volts DC (with respect to ground).	<input type="checkbox"/>
The voltage on eyelet 12 of both preamp PCB's should measure between 36 and 40 volts DC (with respect to ground).	<input type="checkbox"/>
<b><i>Remove the AC power plug from the wall socket.</i></b>	<input type="checkbox"/>

If all the voltages were within spec, continue to the next section.

### ***120 Volt Transformer Removal***

5. De-solder the primary side (120 Volt side) transformer wires from the PAT-4 preamp in the indicated places. ***Make sure the preamp is not plugged in!***
  - a. Black wire connected to fuse holder terminal 1.
  - b. Black-white wire connected to fuse holder terminal 1.
  - c. Violet wire connected to AC outlet B terminal 1.
  - d. Violet-white wire connected to AC outlet B terminal 1.

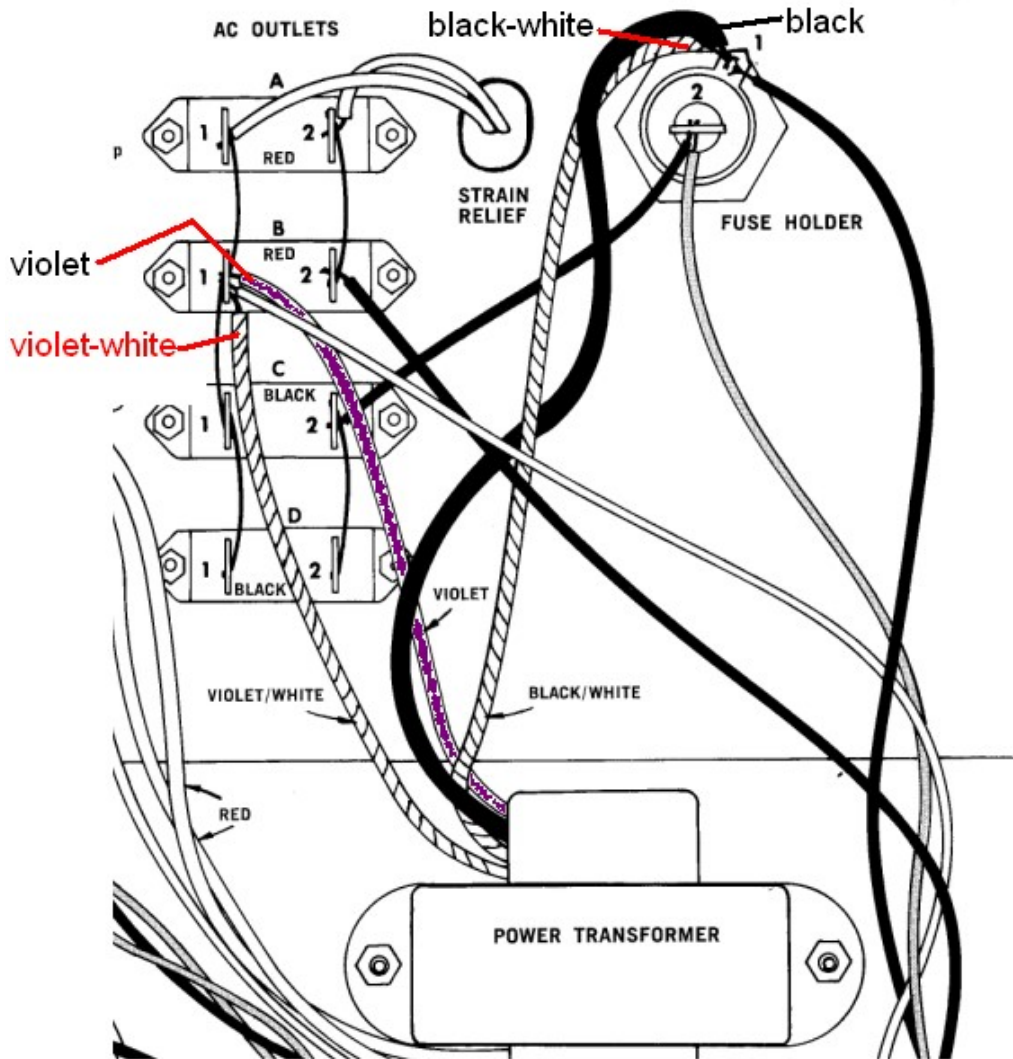


Figure 1-Removing transformer primary wires from the PAT-4 AC power connections

6. De-solder the secondary side (48-0-48 Volt side) transformer wires from the PAT-4 preamp in the indicated places. **Make sure the preamp is not plugged in!**
  - a. Red-yellow wire connected to CT terminal of PAT4 PWR board.
  - b. Red wire connected to X1 terminal of PAT4PWR board.
  - c. Red wire connected to X2 terminal of PAT4PWR board.
7. Remove the two 6-32 screws and nuts that hold the transformer in place.
8. Remove the transformer.

### **Changing C6 (Rev A and Rev B PAT4PWR Only)**

If your PAT4PWR is Rev C or later, please skip this section, moving ahead to “Section 3: Installing the Toroidal Transformer”.

If your PAT4PWR is Rev A or RevB, then do the Actions listed in this section.

The new, custom transformer is capable of delivering a bit more power than the original transformer. Because of that, the raw negative output voltage increases a bit, closer to the rating of the PAT4PWR capacitor C6, a 100 uF 63 volt capacitor.

Action	Done✓
<i>Make sure that the PAT-4 Power plug is disconnected from power.</i>	<input type="checkbox"/>
Working from the bottom of the chassis, remove and reserve the two 6-32 screws that hold the PAT4PWR supply into the chassis.	<input type="checkbox"/>
Desolder capacitor C6, a 100 uF 63 volt capacitor, located near the bottom of the PAT4PWR PCB.	<input type="checkbox"/>
Replace C6 with the supplied 100 uF 80 volt capacitor. Be sure to install it with the correct polarity!	<input type="checkbox"/>
Inspect your work, then re-install the power supply board using the two 6-32x1/4" screws. It may help to leave a bit of play in the screws for now to make it a bit easier to install the new transformer.	<input type="checkbox"/>



### Section 3: Installing the Toroidal Transformer

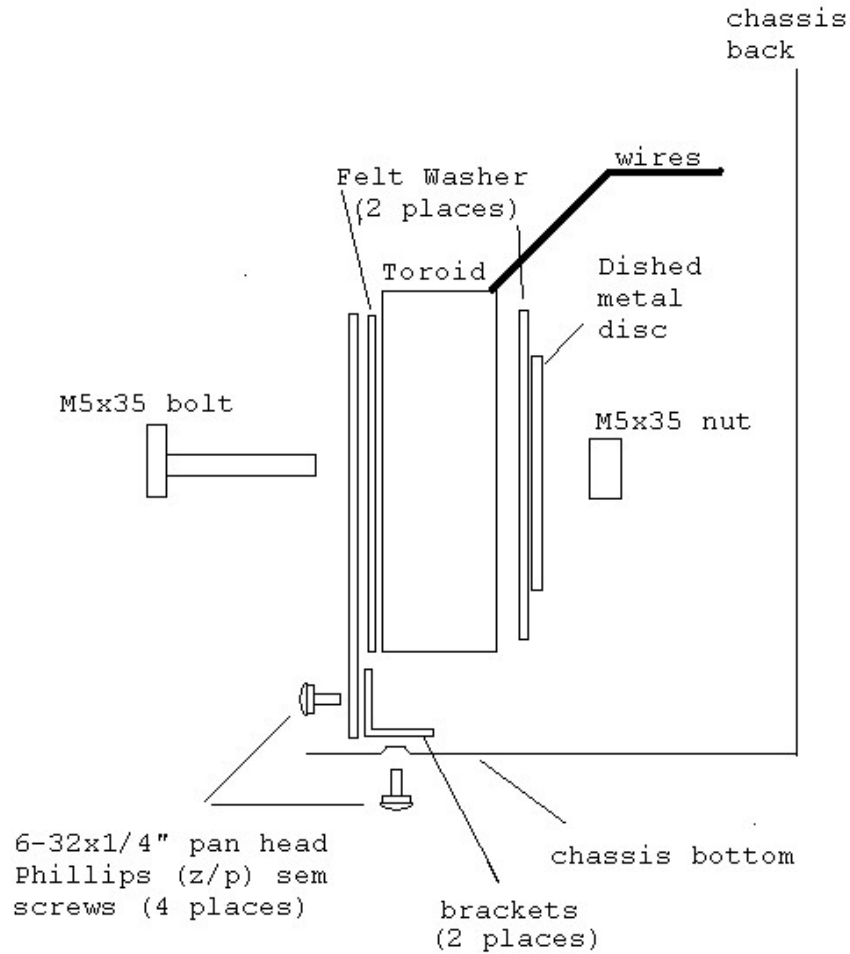


Figure 2-Physical Mounting Arrangement for Toroid

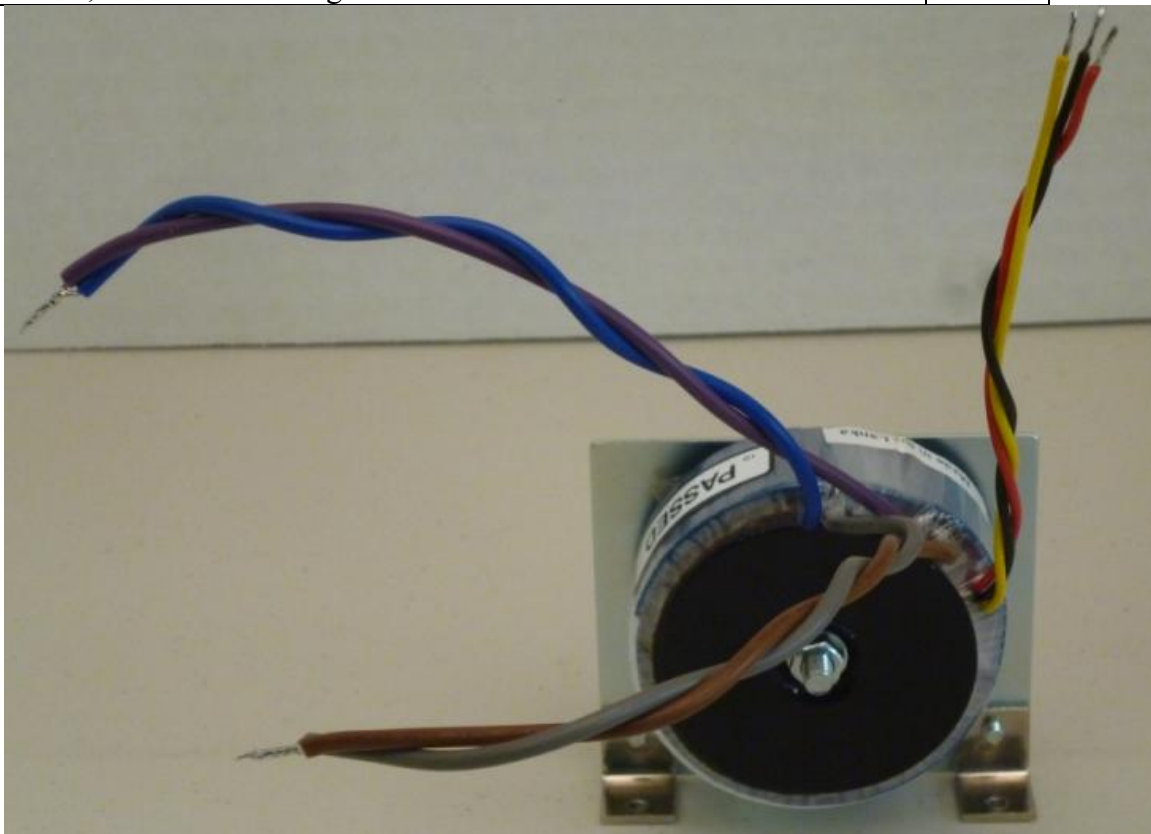
### Preparing the New Toroidal Transformer

Figure 2 shows the mechanical mounting arrangement. It covers mounting the transformer to the mounting plate. Mounting that assembly to the chassis is done later. Please refer to this figure as you follow the instructions below it.



Figure 3-Fastening brackets to mounting plate

Action	Done✓
Fasten a first mounting bracket to the transformer mounting plate using a 6-32x1/4" sems screw. The bracket is symmetric, so either leg may butt up against the transformer mounting plate.	<input type="checkbox"/>
Fasten a second mounting bracket to the transformer mounting plate using a 6-32x1/4" sems screw. The bracket is symmetric, so either leg may butt up against the transformer mounting plate.	<input type="checkbox"/>
Line up a sandwich of the mounting bracket, felt washer, toroid, a second felt washer, and the dished metal disc.	<input type="checkbox"/>
Insert the M5x35 bolt in the center hole of the transformer mounting bracket, through the sandwich of the previous step, completing the sandwich with the M5X35 nut finger-tight.	<input type="checkbox"/>
Center up the transformer, mounting plate, M5X35 bolt and nut, felt washers and dished washer. Make sure the blue and gray wires are top dead center, on the side of the transformer facing away from the transformer mounting bracket. Tighten the nut and bolt so nothing moves, but do not over-tighten it.	<input type="checkbox"/>



**Figure 4-Transformer mounted on plate with wires prepared for installation**

## Prepare the Transformer Wires

Refer to Figure 4 for the following instructions.

Action	Done✓
Red, black, and yellow wires. Cut each one to 4.25" length. Remove 1/4" of insulation from the end of each wire. Twist and tin the end of each wire.	<input type="checkbox"/>
Twist the <i>insulated</i> portion of the three wires together. They will be routed as a group to the PAT4PWR supply board. Twisting them minimizes the external hum field.	<input type="checkbox"/>
Brown and Gray wires. Cut each one to 6.25" length. Remove 3/8" of insulation from the end of each wire. Twist the insulated portion of the brown and gray wires together. This makes for a neater assembly. Twist the stripped 3/8" ends together and tin them together as they will go to the same point on the PAT-4 power circuit.	<input type="checkbox"/>
Blue and Violet wires. Cut each one to 6.25" length. Remove 3/8" of insulation from the end of each wire. Twist the insulated portion of the blue and violet wires together. This makes for a neater assembly. Twist the stripped 3/8" ends together and tin them together as they will go to the same point on the PAT-4 power circuit.	<input type="checkbox"/>

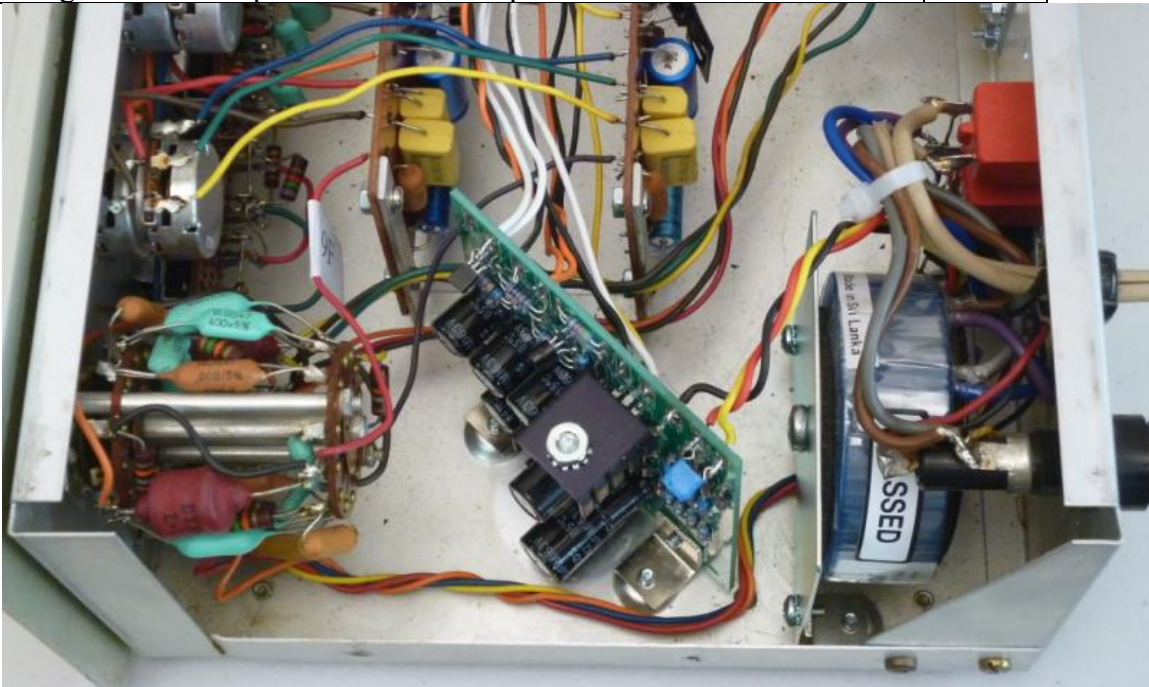


Figure 5-Installing Transformer Assembly into PAT-4

## ***Install the Transformer and Mounting Bracket into the Chassis***

Using Figure 5 as reference, install the transformer, bracket, and mounting plate assembly into the PAT-4. Use two 6-32x1/4" screws. Insert the screws from the bottom of the chassis into the brackets. Leave the screws a bit loose to give yourself a little extra room to work as you maneuver the wires into position in the next step.

## ***Connect the Transformer wires***



**Figure 6-Connecting Toroid Wires**

Recall that that three low voltage wires are twisted together to minimize external hum fields. Maintain that twist as you connect the three low voltage wires (Black, Red, and Yellow).

Action	Done✓
Insert the black wire into either of the CT holes in the PAT4PWR board, from the solder side. Solder it on the component side.	<input type="checkbox"/>
Insert the red wire into the X1 hole in the PAT4PWR board, from the solder side. Solder it on the component side.	<input type="checkbox"/>
Insert the yellow wire into the X2 hole in the PAT4PWR board, from the solder side. Solder it on the component side.	<input type="checkbox"/>

Now connect the transformer primary wires to the AC power in the PAT-4.

Action	Done✓
Connect the Brown and Gray wires (previously connected together) to the fuse holder, terminal 1, see Figure 1 and Figure 6. Note that there will be a total of three wires soldered to the terminal.	<input type="checkbox"/>

Connect the Blue and Violet wires (previously connected together) to power outlet B, terminal 1, see Figure 1 and Figure 6. Note that there will be a total of four wires soldered to the terminal.	<input type="checkbox"/>
Tighten the transformer bracket mounting screws from the bottom of the chassis. Make sure that the power wiring that runs under the center of the transformer mounting bracket is not pinched. See Figure 5.	<input type="checkbox"/>
If still loose, tighten the two 6-32x1/4" screws that hold the PAT4 PWR PCB to the bottom of the chassis.	<input type="checkbox"/>
Use the supplied cable tie to fasten the transformer wires to the input power wires as shown in Figure 6.	<input type="checkbox"/>

### **Check for Proper Operation**

Here are a few last tests before you reconnect your PAT-4 to your music system. With the top still off, plug in the AC mains. Turn on the power switch. Set your meter to DC volts. Connect one lead of the meter to ground.

<b><i>Be careful! These steps are performed with the power connected and turned on!</i></b>	Done ✓	Done ✓
The voltage on eyelet 8 of both preamp PCB's should measure between -17 and -18 Volts DC (with respect to ground). <b><i>Note: this will only be so if you have installed the PAT4LP upgrade, in which case you will have re-wired the preamp PCBs and brought -17 Volts to them. Disregard this test if you haven't installed the PAT4LP upgrade.</i></b>	<input type="checkbox"/>	<input type="checkbox"/>
The voltage on eyelet 4 of both preamp PCB's should measure between 17 and 18 volts DC (with respect to ground).	<input type="checkbox"/>	<input type="checkbox"/>
The voltage on eyelet 12 of both preamp PCB's should measure between 36 and 40 volts DC (with respect to ground).	<input type="checkbox"/>	<input type="checkbox"/>

### **Prepare to Reconnect your PAT-4 to your Music System**

- Turn off the power.
- Remove the AC plug from the wall socket.
- Replace the cover.
- Reinstall the four (perhaps five) screws that hold the cover in place.
- Reinstall the PAT-4 to your music system.

## ***Appendix 1: The Toothpick Trick***

This appendix describes an easy way to clear the solder from a hole in the PCB. It can also be used to clear the solder from terminals on pots or jacks. Doing so makes it easier to install a new component or reinstall wires that were temporarily removed to allow access to some other component.

All you'll need is a soldering iron and some toothpicks with sharp points. The diameter of the pointed part of the toothpick must be smaller than the diameter of the hole that you're trying to clear.

Heat the solder land on the component side of the board until the solder flows. Insert the toothpick from the component side of the board while pushing and twisting the toothpick. If the solder has melted, the toothpick should push through the board, displacing the solder. Remove the soldering iron, but let the toothpick remain in the hole until the solder has solidified. Now remove the toothpick. There should be a hole through the solder sufficiently large to allow you to insert the component lead or wire.

Sometimes, a bit of the toothpick will break off in the hole. If this happens, use a stiff piece of wire to push the toothpick fragment out of the hole.

## ***Appendix 2: First Class De-soldering***

De-soldering can be easy if you have the right tools. Through the years, I've used a number of "make-do" methods:

- The toothpick trick – not bad for clearing a hole if the diameter is big enough.
- Sold-a-pult- these spring-loaded, one shot solder vacuums are a step in the right direction, but can't supply both heat and vacuum action simultaneously. Some people cut a v-shaped hole in the tip to poke the soldering iron through, but it's still a bit hit or miss, and frustrating.
- Solder wick- this is copper braid that you heat up in connection with the joint. The idea is that the solder wicks into the copper braid, away from the joint. It's still slow and frustrating and takes so much heat that you worry about the board.

At some point, you'll decide that you deserve a better way to desolder, and you'll buy a heat source with a built in continuous vacuum pump. Big industrial units can cost many hundreds of dollars. Here's the best value I've found so far, the Hakko 808. I bought mine for about \$180, and it's worth every penny. Often when I de-solder components, the action is so clean that they just fall out of the board. The Hakko 808 was recently replaced by the Hakko model FR-301

Once you've treated yourself to a real de-soldering tool like the Hakko 808 or FR-301, you'll wonder why you waited so long.