The Trinity Amps

TriFly

PCB Builder's Guide

For the sole personal use of Trinity Amps Customers.

February 2017, Version 1.1

www.trinityamps.com

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Thank You

Thank you for purchasing your TriFly kit from Trinity Amps. We truly hope that you enjoy building it and that it will be enjoyed for many years. If you have any questions please do not hesitate to contact us and. Please be sure to check the package contents in case there are any missing items.

We are always looking for feedback form our Customers on our products. We have checked the build instructions over thoroughly and are confident in our product. However, mistakes do happen so our advice is that as you connect each wire and part according to the layout, cross-check against the schematic. If you find any inconsistencies, or have any concerns, please let us know. Do not hesitate to contact us! We want this build to be successful for you and for Trinity Amps!

We're confident that you will like our product and our support and when you're completed, we'd appreciate your comments posted on any of the internet forums such as thegearpage.net, 18watt.com, AX84.com or trinityamps.com. You will find some extra business cards in the package. Please keep one and pass the rest around.

We know you have a choice in suppliers and do appreciate your business. If there is any other product we can provide to you or your associates, please get in touch and we will be happy to discuss requirements.

Sincerely,

Stephen Cohrs,

Trinity Amps

Web site: **www.trinityamps.com**

email: **stephen@trinityamps.com**

Introduction

This guide has been prepared for builders of Trinity Amps Kits. It is always being improved and we would appreciate your feedback and comments to: **stephen@trinityamps.com**

Accordingly, content and specifications are subject to change without notice.

We do try to make it as accurate as possible, but it is sometimes hard to keep up with the changes. Therefore, if you do find an error, please let us know about it and we will correct it. Suggestions are welcome so if you have one, please get in touch with us.

Sources of help.

Forums: Please use the various forums to get help. They are an excellent resource and can be found at trinityamps.com, AX84.com, the Gear Page etc..

Color assembly pictures and the latest drawings, tips, techniques are all in the Trinity Amps Forum, in the Resources Forum. To view the Resources, you need to sign up so go to **www.trinityamps.com** and click on the Forum button.

Email: We can't help with every problem but if you can not get your problem resolved, email us and we'll do our best to help.

Phone Call: If your problem can't be solved, email for a phone appointment.

Acknowledgements

Much of the content in this document is original. Rather than reinvent content, some parts are based on content from other excellent sources and are hereby acknowledged.

R.G. Keen's site **www.geofex.com** - Tube Amp FAQ, Tube Amp Debugging

AX84.com site **www.AX84.com** - Gary Anwyl's P1 construction guide version 1.0

GM Arts website **http://users.chariot.net.au/~gmarts/index.html** - Guitar Amp Basics

www.18watt.com - website for various content and diagrams – Richie TMB

Aron from diystompboxes.com

WARNING

Please Read this Information Carefully

The projects described in these pages utilize **POTENTIALLY FATAL HIGH VOLTAGES.** If you are in any way unfamiliar with high voltage circuits or are uncomfortable working around high voltages, **DO NOT RISK YOUR LIFE BY BUILDING THEM.** Seek help from a competent technician before building any unfamiliar electronics circuit. While efforts are made to ensure accuracy of these circuits, no guarantee is provided, of any kind!

USE AT YOUR OWN RISK: TRINITY AMPS EXPRESSLY DISCLAIM ALL LIABILITY FOR INJURY OR PROPERTY DAMAGE RESULTING FROM THIS INFORMATION! ALL INFORMATION IS PROVIDED 'AS-IS' AND WITHOUT WARRANTY OF ANY KIND

REMEMBER: NEVER OPERATE YOUR AMP WITHOUT A LOAD. YOU WILL RUIN YOUR OUTPUT TRANSFORMER!

Version Control

Version	Date	Change
1.0	28Dec16	First release
1.1	1Feb17	Clarified input jack wiring

TriFly Description

The design of the TriFly began with an inspiring customer call - "Please make me a small, higher gain amp that I can play but that my ears can tolerate".. His ears were suffering from an illness and he could not withstand any loud sounds. Yet he still wanted to play his guitar like his old JCM 800 .

So the research began. Our design criteria were:

- low and high gain modes but not too loud.
- cost effective iron and parts
- compact
- minimal controls (possible tone control by the guitar tone).
- Printed Circuit Board manufacture an option.
- Able to use it in our Amp Camp Training program – build it in a day.
- use traditional power supply - not complicated circuitry.
- use readily available off the shelf tubes such as 12AX7s.

We did a lot of research and in doing so, learned about the Phillips Self Split design which eliminates the need for a Phase Inverter (PI). It is less efficient than a true Push-Pull design but would help meet our design goals. It was invented by Phillips and was used in some budget amps of the day.

We also learned about a public domain amp called the Firefly that used this concept and since we had all the parts, that became our first attempt at a low power amp.

The final design while unique retains some of the Firefly heritage. Once again we settled on a Heyboer output transformer since in studio listening tests it proved the best. Surprisingly, the output tube we chose was a 12BH7 rather than the expected ECC99 because he tone was more like a Marshall. While we tried various preamp tubes, we did settle on the ubiquitous and readily available 12AX7. We tried a tone control that was quite uncommon and was used in Gibson and Garnet amps. It was a low loss control that at extremes subtly boosts treble and gain or filters out treble. We also tried a Master Volume. In the end, we went with ONE knob since most of the testers thought it was perfect that way. . So the current design has Power, Volume and Input on the front panel.

We spent several hours in the SlyFi Chapel studio. Shawn Dore played while settings were changed, tweaked, recorded, commented. We noted that the TriFly takes pedals so well; you can get pretty well anything you want out of the TriFly. And we know players who like pedals! If you want over the top distortion, this is the way to go.

After all was said and done, everyone agreed the TriFly was ready for prime time!! It really shone and the best example was when using the Ash body Tele, on the neck pick-up. Under the vast majority of situations, this arrangement would be very hard to listen to, yet the TriFly made it sound nice! With the Gretsch Country Gentlemen you could hear the detail of the hollow body in the sound. it was quite glorious!

We were aiming for a great tone at a low power in a compact package and we definitely achieved that.

Product Overview and Specs

The TriFly is a one-channel input with a single Volume control.

12AX7 Preamp tube.

12BH7 dual Triode high current

Power tube, in self-split push pull mode , running a little "hot" to deliver more symmetrical clipping.

The 12BH7 sounded like a Marshall which was a BIG surprise. It had better dynamics and feel but a little less headroom in a good way. An ECC99 can be substituted if desired.

Self-Split drive design is an arrangement where the power tubes also function as it's own Phase Invertor. The first triode drives the second one through the common cathode connection.

Volume sets the overall listening level.

Heyboer M-27 steel output transformer with 4,8 and 16 (unused) ohm taps. This transformer gave the TriFly an excellent bottom end with a thicker sound and also it had fantastic clean tone at low levels.

A Conjunctive filter is incorporated into the output stage to tame some fizz and smooth out the response.

The eyelet board / PCB for the TriFly is a new approach. Wanting to keep this design compact, we went for a layout that located the tubes in the middle of the chassis with holes through to feed the components directly to the tube pins and we used regular tube sockets. The tubes are aligned so the heater connections are closest to each other. This is a very compact and very quiet design!

Guitar Amplifier Basics

Electric guitarists can be fairly criticized for their reluctance to change to new ideas and technologies; however, there is no doubt that a classic 1950's guitar and tube amplifier in good condition still sounds great in modern recordings. This is a testament to good design from the start. What has improved today is consistency, and the cost benefits of production line manufacturing. This is offset by the rarity of good guitar wood (it makes a huge difference, even on an electric guitar), increased labour costs for both guitars and amplification equipment, and the availability of good and consistent quality tubes.

There is also an element of nostalgia, with memories of many of the great players of years gone by, and the desire to use the same types of instruments and equipment to recapture the magic. Vintage instruments and equipment have also become valuable collectors items (some with very inflated prices) which adds further to the desirability of older tools of the trade. There has been a recent trend by many companies to re-market their original instruments and equipment; new guitars can even be bought now 'pre-aged'!

This desire for vintage equipment is also related to guitarists' reluctance to part with tube amplification, and there are many reasons why tube and solid state amplifiers behave differently. Quite simply, if players prefer the sound of tubes, they will continue to buy and use them. Below are some fundamentals.

Input Impedance Typically 1M, 500K minimum (humbucking pickup guitars have volume pots up to 500K, single coil pickup guitars typically of 250K) .

Tone Controls Magnetic guitar pickups are inductive, and require compensation, although this opportunity is also used for tone enhancement, not just correction. Without compensation, they have a strong low middle emphasis and little high frequency response - overall a very muddy and muffled sound. This is why typical hi-fi Baxandall treble & bass controls are unsuitable.

To hear the natural sound of a pickup, use a typical guitar amp with the middle set to full, and bass and treble on 0. This is actually sets a flat response in the amp (see below). Expect to hear a muffled and muddy sound. And that's the whole point of these tone controls providing compensation for the natural sound of a pickup - the middle control simply boosts the pickup's normal 'middley' sound. The treble and bass controls do the opposite - they boost higher and lower frequency levels, leaving a notch in-between for middle cut (see the Fender/Marshall comparison below). So with typical settings of a bit of bass, middle and treble, the overall tone equalization complements the natural pickup sound for a balanced response of lows, mids and highs.

Distortion

The overdriven sound of a tube power amplifier is highly desirable, with many different output stage designs to produce the variety of trademark sounds heard on modern recordings. The only problem is that a tube power amplifier is only capable of producing this sound at one volume (usually, fairly loud!).

There are probably 3 distinctly identifiable types of tube power amplifiers used:

Leo Fender's classic early designs used 6V6 tubes, and later, the higher powered 6L6's. This gave a characteristic full and punchy sound, suitable for many styles of the day, and later. Steel and country players like the chime-like clean sounds, and blues players were quick to discover the classic way it breaks up when pushed hard. At really high overdrive, though, the sound becomes quite dirty, with bass in particular sounding flabby.

Marshall designs started as Fender copies, but soon switched to EL34 output tubes, possibly for local supply reasons. Anyway, the rest is history. These tubes exhibit a softer overdrive transition, and maintain clarity even at high overdrive levels. They also have a limited middle response, giving rise to the famous Marshall crunch sound. The lower powered EL84 tubes have similar characteristics.

Vox AC30 (and the more popular top boost model) uses a Class AB power amplifier design, with the tubes biased 'hot', so while this operates in class A at lower levels, it is a class AB design. There's no negative feedback in the power amp either, so this gives a different sound, often described as a sweeter overdrive. Listen to Brian May's sounds for plenty of good examples.

The Fender and Marshall designs use class AB for their output designs, biased with the tubes almost off with no signal. This is more efficient (more watts per tube), and better for tube life. When you play, tubes take turns handling each half of the signal. This leads to some (unwanted) distortion as the tubes cross over. Class A designs are rare in medium to high power guitar amps, but true class A has the tubes operating at half power, with no signal applied. When you play, the tube fluctuates between full and no power, so there is no switching to add unwanted distortion. This is a very superficial explanation; please read elsewhere on the Internet for more detailed descriptions.

Wide Dynamic Range A plucked guitar string requires a wide dynamic range to handle the initial peak, and then cleanly amplify the decaying string vibrations. Some poor designs do not have this capability in their preamp stages, let alone the power amp to handle this. Pre-amplifier stages need generous power rails, and should not have gain stages which cause the initial plucked part of the string sustain envelope to be clipped.

Instrument Speakers Unlike hi-fi speakers, which are designed to keep the coil entirely within the magnetic field to maximize linearity, instrument speakers are designed to have the coil partially leave the magnetic field at the extremes of cone travel. This is partly to protect the speaker, but also produces a 'soft-clipping' effect which is desirable with guitar amplifiers. It is also therefore important to match speaker power ratings reasonably closely with the power of the amplifier. Popular instrument speakers are available from Tone Tubby, Celestion, Jensen and others.

Note: If you were to use two cabinets hooked directly into the amp, be sure to set the amp at half the impedance of the cabinets. For example, if your cabinets are 8 ohms each, set the impedance selector to 4 ohms.

Durability Most musical styles will require the amplifier to be overdriven for extended periods of time, and the amplifier must be designed to provide this without duress on any components. Common non-guitar design principles assume that circuitry will be designed to avoid overdrive, and technicians working in this field have to 'un-learn' many basic assumptions. Popular circuits have evolved through trial and error, due to a general lack of documented knowledge in the field of non-linear amplification.

Road Worthiness Musical equipment of this type needs both physical and electrical protection. A band often has its equipment transported and set up by a road crew with little guarantee of physical care. Likewise, an assumption should be made that the output stage will at times be inadvertently shorted, so most professional equipment is designed to handle this contingency, preferably electronically, and at the very least without fuses inside the chassis.

General Amplifier Operation

Some DO NOTS

- Never, Never, Never run the amp without a speaker plugged in. This can cause major damage.
- Do not flip the power switch off, and then back on rapidly. This can cause power supply damage.
- Never replace a burned out fuse with a bigger-amperage one. Remember - there was a reason the first one burned out, usually protecting something more expensive. Putting a bigger fuse in will just ratchet up the power level until something really vital burns out. If the second equal-rating fuse pops, turn it off and get a tech to look at it.
- Never ignore signs of high heat inside - a wisp of smoke or a burning smell is **NOT** normal.
- Your amp produces lots of heat, and will continue to do so even if you block the fresh air vents. Blocking the vents will overheat the amp and you may have to get some very expensive repairs done.
- Never ignore a red glow other than the small orange ends of the filaments. A red glow over a large part of the internal plates of the output tubes means they're about to melt. If you notice this, shut it down and get a tech to help you find out what is wrong.

Some DOs

Add another speaker into the "external speaker" jack; a mismatched speaker load won't kill it, while an open circuit (disconnected speakers) may do so.

Overdrive the stuffing out of it. Tubes are very forgiving of massive overdrives, unlike solid state gear. As long as they tubes don't overheat for long periods, it's not fatal.

Introduction to Vacuum Tubes and Common Terms

Reprinted with permission from Aron from diystompboxes.com

Here are a few terms that you may see online when referencing tube schematics. Like distortion pedals, tube circuits seemingly have their own language! I present this knowledge in the hopes that it may help you decipher the interesting life of tubes! :-) Below, is a picture and a very simplistic view of a tube stage.

As you can see above, in this tiny snippet of a tube schematic, the terms you commonly see are there in this triode stage example.

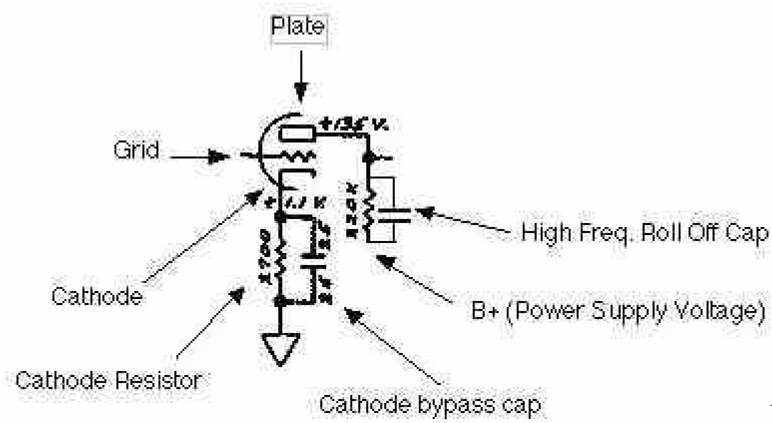
Plate - the plate is usually connected to a plate resistor which is usually connected to the B+ or power supply voltage. Typical Plate Resistor values are 100K, 150K, 220K. Larger values equal more gain.

The **Grid** is where the signal enters the tube.

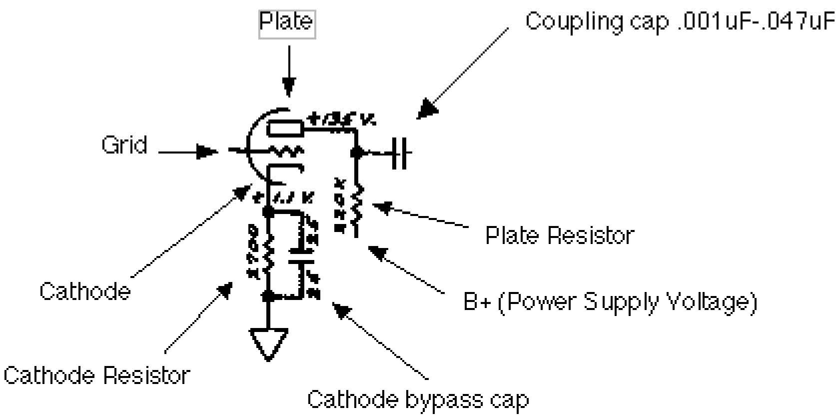
The Cathode is usually connected to a cathode resistor which usually goes to ground. The cathode resistor, along with the Plate resistor, control the gain of the tube stage. Typical values are anywhere from 100 ohms to 10K. Smaller values = more gain.

It is common to see a cathode bypass cap connected in parallel with the cathode resistor. By altering the values of the cathode resistor and cathode bypass cap, it is possible to roll off various degrees of bass with this triode stage. The cathode resistor and plate resistor control the biasing of the tube. The cathode bypass cap also gives the stage more gain.

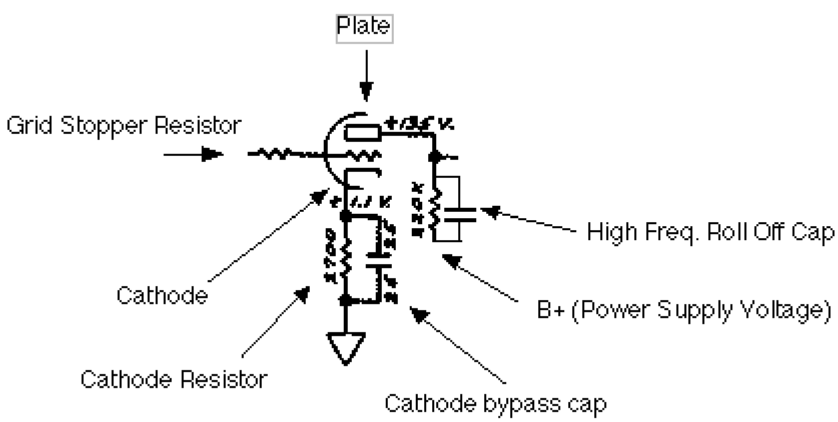
Sometimes you see a capacitor in parallel with the plate resistor, much like the cathode resistor bypass cap. It is usually a small value (i.e. .001uF) and it rolls off highs in the stage. Sometimes you see a high frequency roll off cap going from the plate pin to the cathode pin - 350pf->500pf in value.



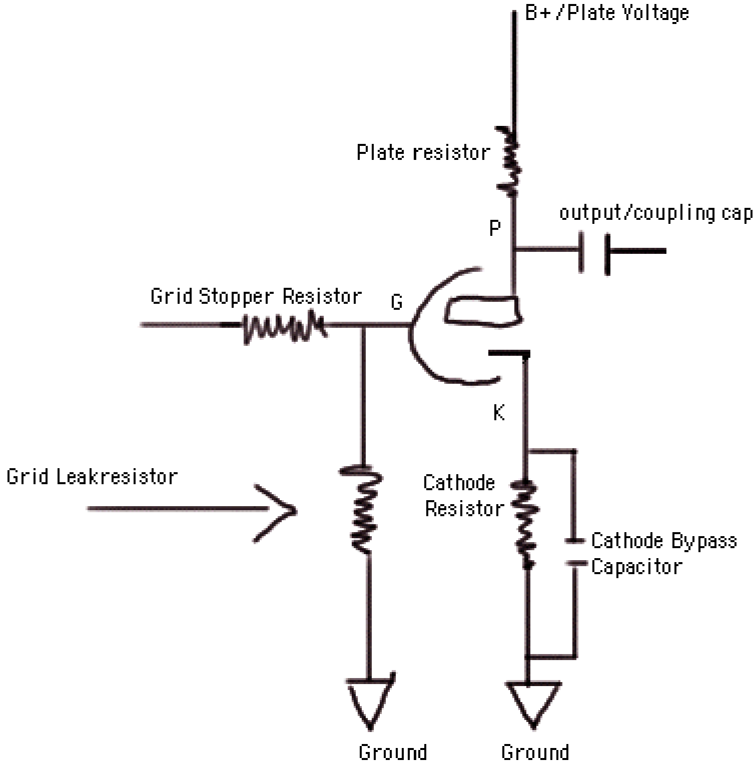
You will also see a coupling cap in between triode stages. The coupling cap controls the bass and rolls off bass between stages and blocks DC from entering the next stage - which could throw off the bias on the next tube stage. As usual, smaller values roll off more bass, larger values retain more bass between stages.



Another modification you may see is a Grid Stopper Resistor, this can also control gain between stages and also interacts with the tube to roll off highs. Values can be 1.5K->100K. Larger values roll off more highs and reduce gain between stages. The Grid Stopper Resistor works best when mounted directly or as close as possible to the grid pin.



"Complete" typical tube preamp stage:



G = grid, P=plate,K=cathode

The grid ("leak") resistor, typically sets the impedance of the stage and biasing. It is interesting because it and the previous stage's plate resistor form a voltage divider on the signal. What this means to you is that the grid leak resistor can be used to control the level into the stage. Low grid leak values will attenuate the signal into the tube stage. If you look at different tube amp schematics, you can see where they control the level into the stage by using different values for the grid leak resistor. There is a maximum value that you need to adhere to. Check the datasheet for the tube you are using to see the typical value of the grid leak resistor. This particular circuit is called cathode bias which you can read about here.

In summary, the cathode resistor, plate resistor and grid resistor, determine the biasing of the tube stage. The cathode bypass cap controls the degree of bass reduction - generally 25uF passes all frequencies - commonly used in Fender amps, 1uF an 0.68uF are used in Marshall amps. A capacitor can be placed in parallel with the plate resistor to roll off highs and you see this in bass channels of amps sometimes. The plate receives the voltage from the power supply through a plate resistor, the grid receives the AC signal as input and the cathode is grounded through a cathode resistor.

Building an Amp

Warning: Do not attempt to build a guitar amp unless you know how to work safely with the dangerous voltages present in a tube amp. These can exceed 700 volts.

Introduction

If you have purchased your Trinity Amp as a kit, this guide will help you build a tube guitar amplifier. It is oriented towards someone who knows a little about electronics but is new to do-it-yourself amps. It outlines a simple path to getting a quality amp build.

Switches and wire

Use standard UL approved switches with a 125V/3A rating for the Power and Standby switches. Use 20 or 22 Gauge insulated solid wire with a 600V rating. It is good to get a variety of colors so you can color code your wiring.

Physical layout

Make sure the jacks, sockets and pots mounted along the edge won't interfere with parts mounted on the underside of the chassis. Imagine how chassis will be mounted in the cabinet and make sure there is enough clearance for the speaker and mounting brackets. Trinity amp chassis are laid out with serviceability and neatness in mind.

Grounding

It is recommended that you follow the layout provided with your Trinity Amp. It has been tested and has proven reliable. If you choose to deviate, consider the following information.

Amps traditionally use the chassis for signal ground. This is not the best choice since it can create ground loops and bad ground connections may develop over time. It is better to use star grounding in which all of the local grounds are collected at a single 'star ground' point. With star grounding there is only one connection between the chassis and signal ground.

Here are some rules for laying out a star ground. More information on grounding can be found in the Tube Amp FAQ and the Tech Info page of Aiken Amplification.

(1) Connect the power transformer center tap directly to the negative terminal of the first power supply filter capacitor (cap) then run a separate wire from the negative terminal to the star ground point.

(2) Collect the ground points of each tube and its associated resistors and capacitors to a local ground point that is not connected to the chassis. Run one wire to the star ground point from each collection.

(3) Run exactly one wire from the star ground point to chassis.

(4) Insulate the input and output jacks from the chassis.

The safety ground wire from the mains is separate from the signal ground. Run a wire from the AC ground to the chassis near where the AC power enters the chassis.

Insulated jacks

To insulate the input and output jacks either use plastic insulated jacks or metal jacks with insulating washers. Some people prefer the increased durability of metal jacks. Insulating a metal jack requires a shoulder washer with a 3/8' internal hole that fits a ½' panel hole.

Minimizing transformer interference

To minimize coupling between the power transformer and output transformer orient them so their plates are at right angles. If possible, place them at opposite ends of the chassis.

Keep the input stage wiring short and away from the output stages. This minimizes the possibility of oscillations caused by coupling of the output signal into the input.

Mount the grid resistors as physically close to the grid pins as possible.

Use a twisted pair of wires for the tube filament wiring. Route it away from AC lines and close to the chassis.

Wiring

The traditional method of constructing amps involved mounting the components on tag board or fiberboard. This is the technique that is used for Trinity Amplifiers and is the recommended approach for service and reliability.

Assembling the amp

Before You Begin

When you first receive your kit, remove all of the parts from the shipping box and place them on a well-lit, clean surface. Check all of the parts against the parts list and verify that you have everything before you begin. Contact us at once if you are missing anything, or if something appears to be damaged**.**

Tools

To assemble the amp you need:

25 watt pencil tip soldering iron

60/40 rosin core solder

wire stripper

wire cutter

needle nose pliers

screwdrivers (Philips, standard)

multi-meter with minimum 500V range

Use a stand for the soldering iron, a sponge to keep the tip clean, de-soldering wick material and clip leads. You should also have a multi-meter with at least 500V range, preferably 1000V and an audible continuity checker. Try to get a multi-meter that measures capacitance. This lets you verify the value of your components before you install them.

Soldering

Soldering is accomplished by heating the components to be soldered and allowing the molten solder to flow onto them. Do not try to melt solder on the tip of the iron and transfer it to the solder joint. It doesn't work.

Follow these steps when soldering to boards. **Note ROHS instructions**:

1. Use 60/40 rosin-core solder. (use **lead free** when soldering ROHS boards.)
2. Keep the tip of the soldering iron clean. If it's dirty, wipe it on a damp sponge to clean it.
3. Set the temperature of your soldering iron to about 700F.

ROHS: 725-750F when soldering ROHS turret boards, the dwell time (time to heat and complete the connection) is a little longer and temperature is set a little hotter. The solder used was Lead-free solder 97/3 formula tin/copper with a Rosin Core.

4. Melt some solder on the tip of the iron. The molten solder helps to efficiently transfer heat from the soldering iron to the component leads.
5. Make a good mechanical connection first, and then make a good solder joint.
6. Heat the leads to be soldered by touching it with the tip of the iron.

7. Touch the solder to the leads. The solder should flow onto the leads. Avoid breathing the fumes.
8. Remove the soldering iron and allow the solder joint to cool.

Note: Do not apply the tip of the soldering iron to the turret board any longer than it takes for the solder to flow.

Some people do have success using leaded solder on ROHS boards. Your experience may vary.

The solder joint should be clean and shiny. (ROHS joints are not as shiny as non-ROHS). If it is dull looking it may be a 'cold solder joint' which is not a good electrical connection. If a solder joint is suspect, heat it with the iron to reflow the solder.

Making a Voltage Measurement

Before attempting to make a voltage measurement, think about the anticipated result.

Is this a DC or AC voltage?

How much voltage will be present?

If things are not working correctly what is the highest voltage that I might find?

A voltage is ALWAYS measured between TWO points. Is one of those points CHASSIS GROUND? This is the most common case. If not, can you make a different measurement such that one of the measurement points IS GROUND? If your measurements are all referenced to CHASSIS GROUND, you can then connect the black lead (Negative or Common) to the CHASSIS with a clip and probe the other test point with the RED (Positive) lead.

Set the selector switch on the meter to the range that is higher than the maximum anticipated voltage of the appropriate type (DC or AC). If the maximum anticipated voltage is not known, set the meter to the highest range available.

Wherever possible connect the meter into the circuit when the circuit is OFF, then power up the circuit without touching anything.

Read the meter. If the reading is lower than the next available lower range on the meter you may set the meter to a lower range while the circuit is on. When doing this touch ONLY the meter with ONE hand, and be careful to only lower the meter one range, allow the readings to stabilize (2 or 3 seconds) before proceeding further.

Note: Accidentally setting the meter to a current or resistance range can damage the meter, and the circuit it is connected to. If the circuit has sufficient power the meter can explode or burst into flames. I know from experience that this will happen if you try to measure the resistance of the wall outlet. Most modern meters are "fuse and diode protected" this is to prevent fireworks, but will not usually save the meter from an overload of this magnitude.

Wiring

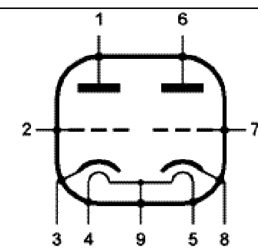
Here is a guideline for wiring the kits with the supplied wire:

- Use 24 gauge RED solid for board jumpers
- Use 22 gauge WHITE solid for hook up from board to pots/front panel
- Use 22 gauge solid BLUE and YELLOW for tube heater wiring
- Use 22 gauge GREEN solid wires for ground wires.
- Use RG174U for input to V1 if indicated on layouts
- *TIP: Re-use stranded cut offs from the transformers for the power supply side.*
- There are different nuts bolts etc. required for installation. Here are the guidelines.

Part	**Qty**	**Where to use**
4-40 X 5/16	6	Mount tube sockets with KEPS nut and IEC connector (no nut required)
4-40 X 3/4	4	Mount eyelet board with 3/8” spacer and NYLON nut
6-32 X 3/8	4	Mount transformers with KEPS nut

Tube Pin Numbering

The pins on a 9-pin tube socket are numbered 1 to 9 in a clockwise direction when a tube or socket is viewed from the bottom. Note that there is a gap between pins 1 and 9.

	
12AX7/12BH7	**12AX7/12BH7**

Potentiometer Pin Numbering

The pins on potentiometers are (virtually) numbered 1 to 3 from left to right when the shaft is facing towards you and the pins are at the top.

Assembly Steps Summary

1. Install Transformers.
2. Install IEC, Power Switch, Tube Sockets and Output Jacks
3. Wire and test the Power Transformer and Power Switch
4. Build sub-assemblies Volume Control and Input Jack
5. Build sub-assembly PCB Board
6. Install sub-assembly PCB Board
7. Install LED in V1 tube socket
8. Power Transformer Connection and Output Transformer Connection
9. Wire up the heater wires, Check Wiring
10. Start-Up.

1. Install Transformers

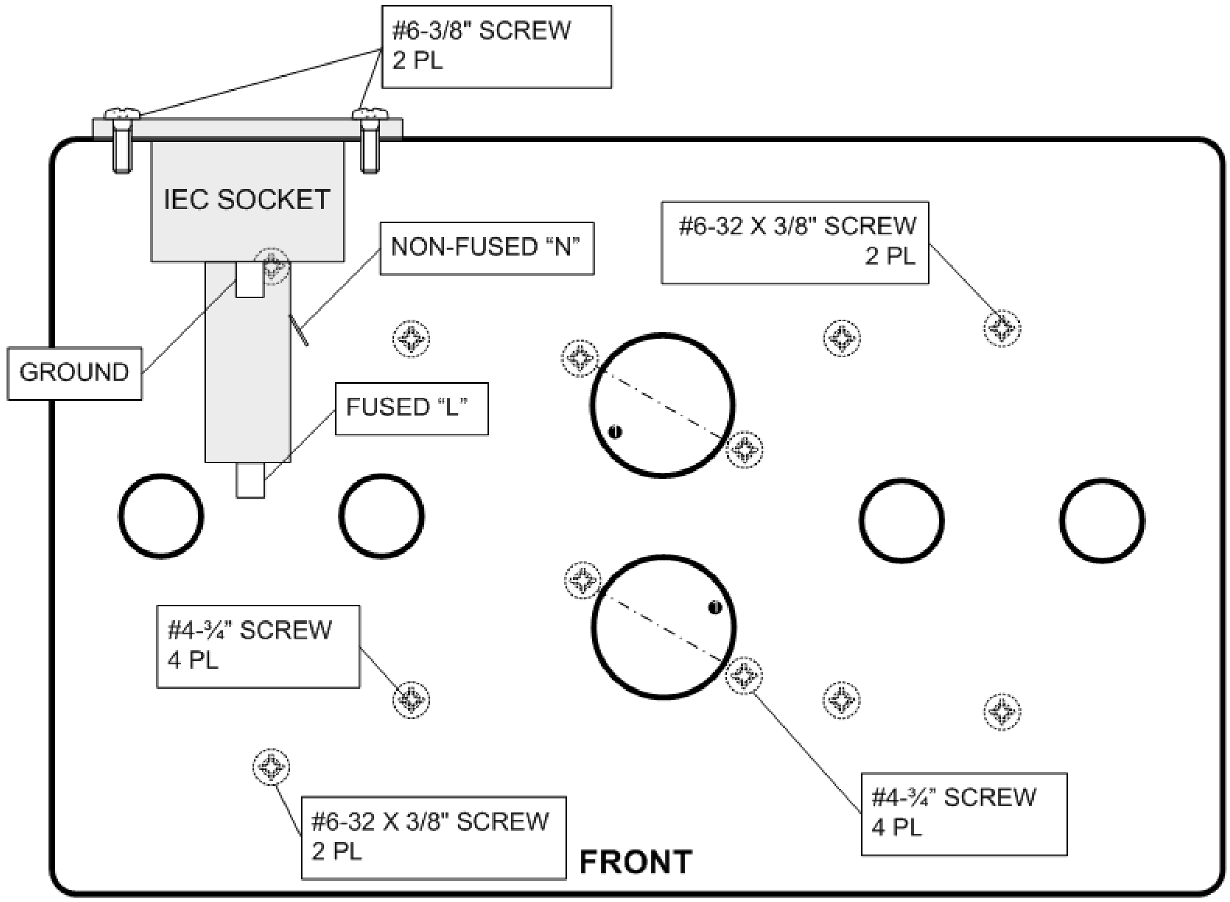
Insert enclosure grommets into enclosure.

This is important!

Mount the output transformer so the leads are aligned with the primaries (Blue, Brown, Red) facing inwards and secondarys (Orange, Green, Yellow, Black) facing outwards. Mount with 2 #6 six screws and nuts with a chassis lug under the screw closest to the input jack.

This is also important!!

Mount the power transformer so the leads are alined with primaries (Black, Black/Red, Black/White, White) facing outwards and the secondarys (Red, Red/Yellow, Green, Green/Yellow) facing inwards. . See "TriFly Heater and Power Supply Wiring" diagram later on in the manual. Mount with 2 #6 screws and nuts with a chassis lug under both mounting nuts.



2. Install IEC, Power Switch, Tube Sockets and Output Jacks

Install the IEC socket using 2 #6 screws that thread into the enclosure.

The GROUND lug should face towards you. The fused or LINE lug, is located at the end of the socket and the NON-FUSED or NEUTRAL is on the side.

The TriFly has a simple power switch and no Standby switch. Make sure the switch is in the desired on position when it is on. It can be on in either the up or down position. Align according to the front panel then install the power switch.

Locate the tube sockets and align them according to the layout and use 2 #4 nuts and bolts to attach them to the enclosure. Number 1 pin of socket 1 should face the rear of the enclosure and number 1 pin of socket 2 should face the front of the enclosure. Note that the sockets are installed from the inside of the enclosure.

Install the two unswitched Switchcraft output jacks.

Braid about 2 inches of output transformer secondarys to reach the output jacks. Tuck the unused ORANGE 16 ohm lead into the braid and insulate it with shrink tubing. Cut leads to length and connect the BLACK lead to the common of both jacks which is also connected to enclosure.

Connect the GREEN lead to the eight ohm output jack, tip lug. Connect the YELLOW lead to the 4 ohm output jack, tip lug.

3. Wire up and test the Power Transformer and Power Switch

Grounding Scheme

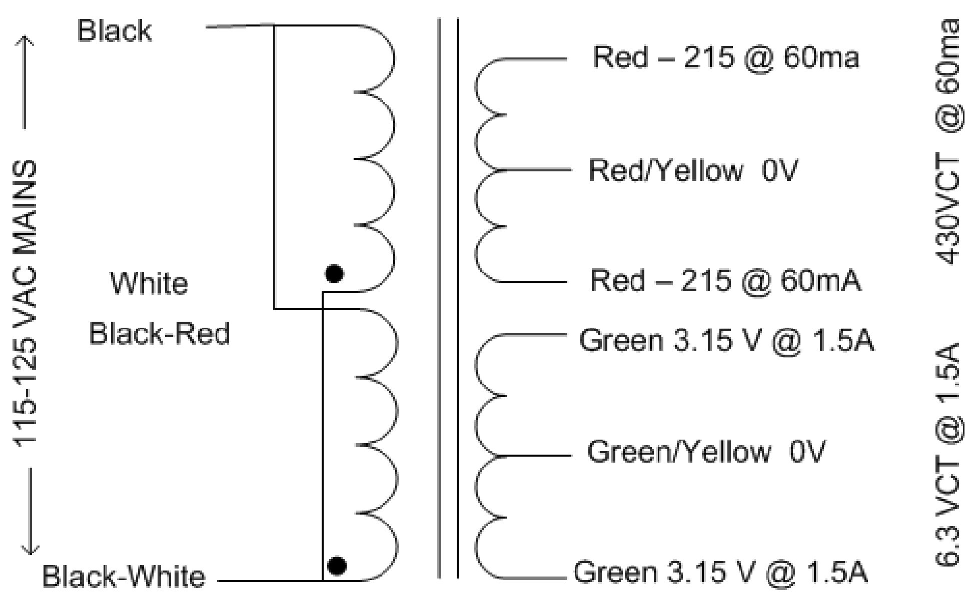
The TriFly uses a two point grounding scheme where the power side of the amp is connected to a single common ground point, and the preamp part is connected to another point on the chassis which is located immediately beside the input jacks.

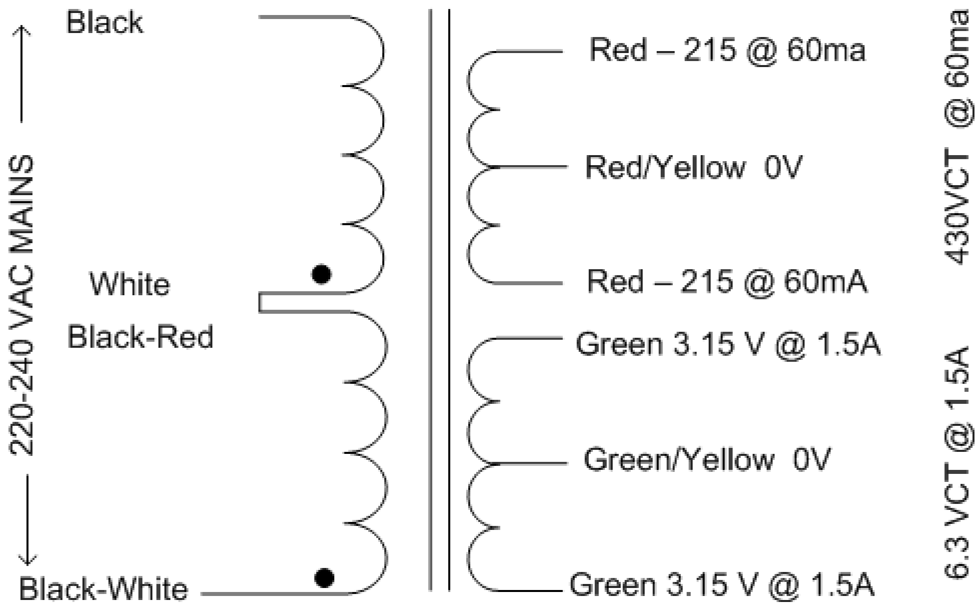
For grounding, we strongly recommend that you follow the layout provided.

There is also a separate AC supply safety ground point near the IEC connector, which doesn't form part of the actual amplifier circuit. WARNING: THIS CONNECTION IS VITAL FOR SAFETY REASONS.

Wiring of Mains circuits: European vs North America			
	Ground	Hot (L)	Neutral (N)
Europe	Green/White or Green/Yellow	Brown	Blue
North America	Green [USA-plug round prong]	Black [Small flat prong]	White [Large flat prong]
European 230V	Green/White or Green/Yellow	It makes no difference how the other two wires are matched.	

Now is the time to wire up the main power supply.





Trinity Amps HTS-11936 REV1 Power Transformer

Primary Wiring North America

On the power transformer twist the WHITE and the BLACK-WHITE wires together, cut them and solder them to the IEC socket non-fused, NEUTRAL tab.

Take an extra piece of BLACK wire cut off from the output transformer and solder it to the "fused", LINE lug of the IEC socket and then connect it to the center lug of the power switch. Twist the BLACK and BLACK-RED wires together. Cut them to length and solder them to the top two lugs of the power switch.

Tip: You can use both switch lugs to increase the contact current rating if you prefer, although it is not really necessary. The power switch is rated at 5A. You can also use the extra switch lugs to switch both LINE and NEUTRAL.

Primary Wiring 220-240V Mains

On the power transformer twist the BLACK-RED and the WHITE wires together

Cut the BLACK wire to length and solder it to the top two lugs of the power switch.

Take the piece of BLACK wire cut off from the power transformer and solder it to the "fused", LINE lug of the IEC socket and then connect it to the center lug of the power switch.

Cut the BLACK-WHITE wire to length and solder it to the IEC socket non-fused NEUTRAL tab.

Secondary Wiring – All countries

Cut the GREEN-YELLOW and RED-YELLOW ground leads, center tap, long enough to reach the POWER GROUND lug and solder them to one of the holes on the lug.

Take the piece of green and yellow wire that you cut off and connect it to the center ground lug of the IEC socket and then to the MAINS GROUND lug right beside the IEC socket. Ensure that the ground bolt is tight.

Take the remaining piece of GREEN-YELLOW gound wire and connect it to the POWER GROUND lug as it will eventually be connected to the PCB.

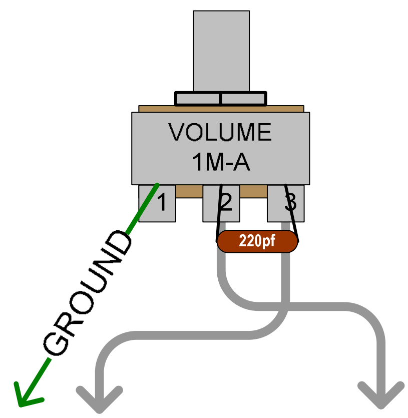
Tie off any unused taps that are not required for the build. Tie off by cutting off the exposed wire and then put heat-shrink over the end and then tuck it away if it is not used.

Install a 500 mA mini fuse into the IEC socket, fuse receptacle.

Plug in the power cable. CAREFULLY test the voltage of the secondarys between Red-Red wires. It should be around 450 VAC across the two leads. Also test the value of the two GREEN heater wires it should be over 6.3 VAC probably 6.5 VAC.

4. Build sub-assemblies Volume Control and Input Jack

Build the subassembly volume control with the 220pf BRIGHT CAP and two 4" white leads and 4" ground leads attached. Bend the rotation locking tab backwards or cut it off.

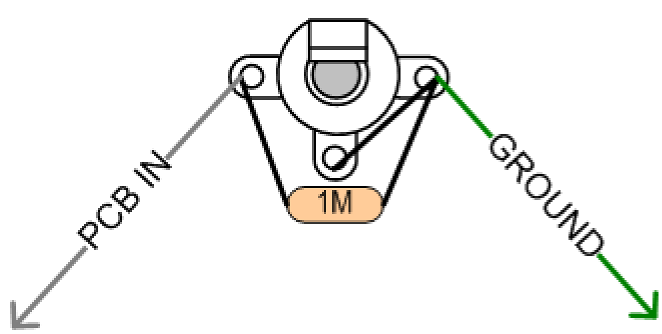


Install it in the enclosure with the terminals pointing towards the input jack.

Build the subassembly input jack as shown below using at 1M resister connected between the 2 outside lugs then double back the resistor lead from ground lug to the jack centre lug.

Solder a 3" GREEN lead to the ground lug. Solder a 3" White led to the IN lug (switched terminal).

Install the input jack in the enclosure using a fiber shoulder washer and fiber flat washer aligning the ground lug so that it is facing towards the bottom of the enclosure.



Connect the GREEN wire from the input jack ground lug to the preamp ground terminal lug on the enclosure. Connect GREEN ground wire from the volume control to the preamp enclosure ground lug also.

With continuity checker, check between ground and the input lug where the 33K resistor is connected. With no input plug inserted, it should show continuity or zero resistance. Plug in the cable and measure the resistance between the tip of the cable and the lead from the 33K resistor. It should be approximately 33K

5. Build sub-assembly Printer Circuit Board (PCB)

Carefully identify the board components and their values. **Measure the resistor values to confirm they are correct**. **If you can, check the capacitor values as well**. See the section on how to read Resistor and Capacitor codes. Ensure that electrolytic capacitors (power supply, bypass caps) are aligned with the correct polarity on the board. There will be a '+' sign, or indentation to identify the positive end of the capacitor.

Arrange the board according to the layout diagram and follow the instructions closely.

Optional Capacitor Orientation: In the manufacturing of a non-polarized capacitor, Mallory, SOZO, ETR etc., one of the foils ends up on the outside while the other is wrapped on the inside. As a result, the outside foil may be used as a "shield". To minimize amp noise, we can orient the outer foil side in circuit stages to take advantage of this inherent shielding.

If a signal travels into a coupling capacitor and enters the outside foil side, this will act as a shield, minimizing induced noise interference. Ideally you would be able to connect the outer foil to the incoming signal point or to the lower impedance stage. For capacitors that are used as cathode bypass capacitors or in tone stacks, the outer foil gets connected towards ground. For coupling, the outer foil is oriented towards the previous stage.

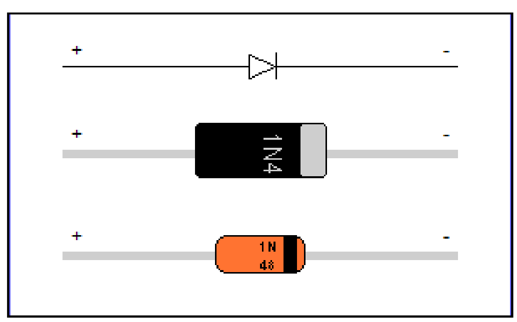
Some manufacturers such as SOZO have this polarity marked. Others do not. In this case, if you have access to an oscilloscope, you can quickly determine which lead is the outer foil.

Set your oscilloscope to a low AC setting [10 - 20mV] and hold the capacitor between your fingers to induce noise. Connect the oscilloscope probes to the capacitor leads. One orientation of leads will result in a lower reading. In this case, make note of the lead that is connected to the oscilloscope ground lead (usually has an alligator clip) and that identifies the outer foil. Mark the capacitor with a sharpie and install the cap as per the provided TRIFLY board layout.

Tip: For multiple component leads that must fit into one pad, insert them first and solder once when they are all in place. Bend each component lead at 90 degrees so that it fits squarely and neatly. Solder each pad once all component leads that connect to it are in place.

Build the PCB out of the enclosure and connect to it after installing it into the enclosure.

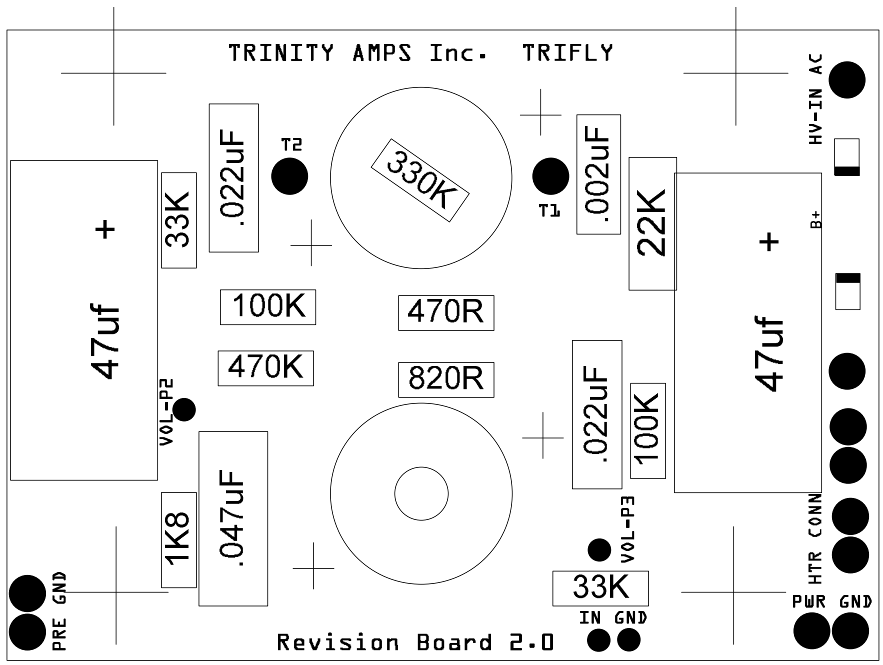
Diode Orientation: Pay particular attention to the orientation of the 2 diodes when they are installed. Even though Rectifier diodes are quite robust and require no special precautions for soldering them, use a minimum amount of heat.



Diodes must be connected the correct way round, and circuit diagrams may be labeled 'a' or '+' for anode and 'k' or '-' for cathode (yes, it really is 'k', not 'c', for cathode!). The cathode is marked by a line painted on the body of the diode. Diodes are labeled with their code in small print, and you may need a magnifying glass to read! The diagram below shows the orientation of the 1N4007UF diode.

Testing Diodes: If you ever need to test a diode, you can test with an ohm meter, using a setting that shows a picture of a diode on it. Put it to that setting and just put the red (+ve) lead on one leg of the diode and the black lead on the other leg. If you get a resistance reading the cathode is on the side where the black lead is. If you get no reading the cathode is where the red lead is. If there is a dead short you will get a buzz tone out of the meter. Same as if you touched the leads together.

Begin PCB construction by installing the two IN4007 diodes oriented so they are pointing towards each other



Then install the first 47μF filter capacitor.

Form and install the 22K 2W dropping resistor and solder in place.

Install the second 47μF filter capacitor

Form and install all remaining resistors (2 X 33K, 1K8, 2 X 100K, 470K, 470R, 820R

Form and install all remaining capacitors 2 X .022 μF, 0.002 μF , 0.047 μF

Install the two PCB sockets on the back-side of the board with no screen printing.

6. Install sub-assembly PCB

Put 4 - #4 screws from the outside through the enclosure, closest to where the sockets are located and hold them in place on the outside with a piece or two of masking tape.

Flip the TriFly enclosure upside down and align the front panel towards you.

Put 4 - 3/8" inch nylon spacers over the four protruding screws.

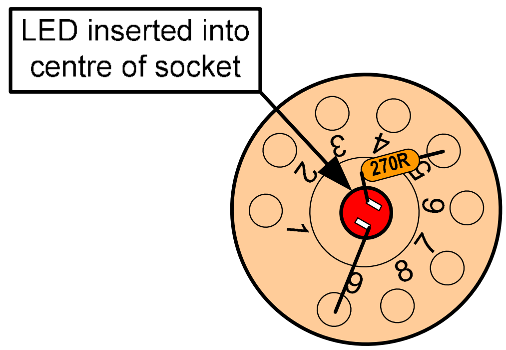
Align the PCB so that `Trinity Amps Inc. TriFly` can be read from the front and lower it on to the four #4 screws and spacers. Use 4 - #4 nuts to loosely hold the assembly in place. Do not tighten yet.

Now put a #4 screw from the outside through the enclosure, through a 3/8" inch nylon spacer and the corner mounting hole of the PCB. Put a #4 nut loosely to hold it in place. Repeat for all four corners.

When everything is in place tighten down on all the nuts.

7. Install LED in V1 tube socket

Take a pair of needle nose pliers and gripping the leads from the LED about 1/8 of an inch from the LED body, bend one lead at 90 degrees. Put that lead into the pad of pin 9 of the tube socket V1, and then install the LED so it goes into the hole in the center of the tube socket. You might tack this in place before the heater wires get installed later. Form a 270 ohm resistor so that it can be soldered to the remaining vertical LED lead and to into the pad of pin 4-5 of V1.



8. Output Transformer Connection and Power Transformer Connection

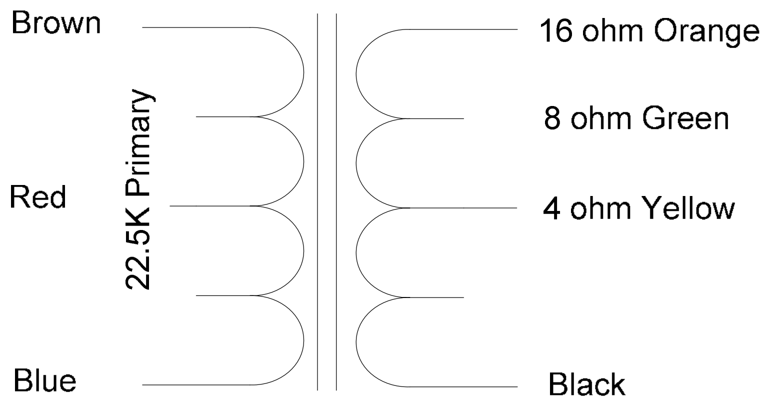
Braid the BROWN, BLUE and RED wires from the output transformer and route them around/under the board to V2. Cut to length the BLUE output transformer wire and connect it to solder pad T2 and solder in place.

Tip: Leave enough blue wire so if you have to switch leads to reach the other connection at pin 6.

Connect the BROWN transformer lead to solder pad T1 solder in place.

Note: The 33K and .0022µF pair form the CONJUNCTIVE FILTER that improves OT response linearity.

Finally trim the length of the RED center tap lead from the output transformer and connect it to the B+ solder pad beside the first filter capacitor.



Trinity Amps HTS-11654 Output Transformer

Connect the two RED, high-voltage leads from the POWER TRASNFORMER to the board. When they're connected, test your work against the schematic using a continuity checker.

TIP: Make sure when you connect a lead to the board that it does not protrude through and touch the enclosure.

Now connect the POWER GROUND and PREAMP GROUND wires to the correct solder pads on the PCB.

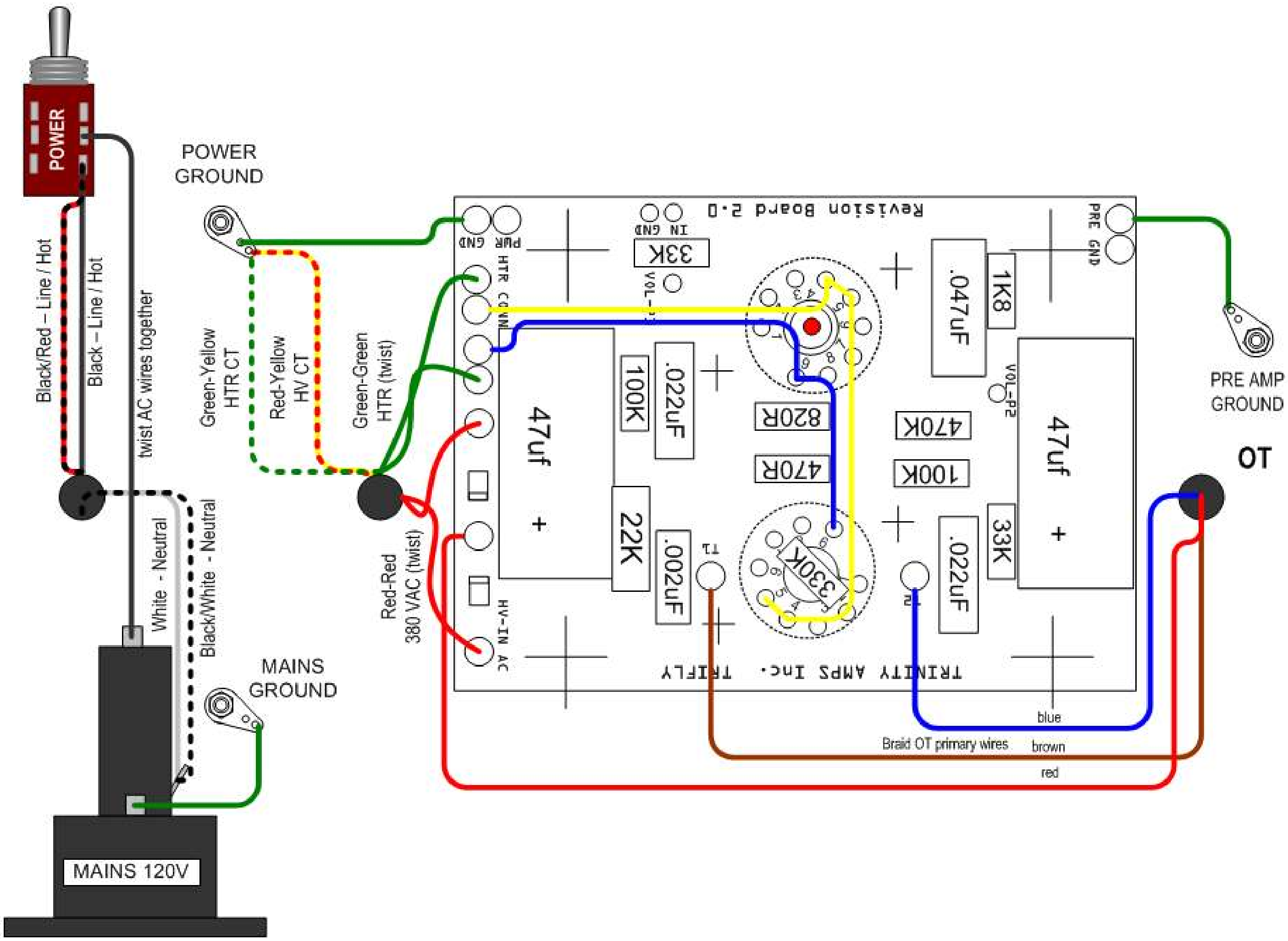
9. Wire up the Heaters; Check Wiring

Now it's time to connect the heater wires, the last task.

Pre-twist 6" of BLUE and YELLOW 22 ga solid wire. Start with V2 and take the pre-twisted wire and connect pins 4 and 5 together with YELLOW wire and pin 9 with BLUE strand of the twisted-pair. Solder in place. Make a nice neat 90 degree bend about ½" off the board, towards V1 and repeat for V1 but do not solder. Ensure that the same colour strands connect to the same pin of different tubes i.e. all pins 4 - 5 are connected to the YELLOW strand. Pre-twist a second 6" twisted pair that goes from V1 back to the pads where the two GREEN heater wires from the power transformer connect. Form the heater wires so that they are all neatly at right angles to the board and once the wires are in place on V1, solder in place.

Tip: Make nice neat bends in the wires so that it is above the board and components but still below the top of the enclosure with the lid on

When that is complete, test to make sure that the LED illuminates when the power switch is on.



TriFly Heater and Power Supply Wiring

TBD

Interior Picture of Completed TriFly

10. Start-Up

First Without tubes installed!

When you finish assembling the amp, double-check the wiring and the components.

Test continuity for all the connections. Set your meter to continuity and follow the layout diagram to make sure all the connections are correct. Trace or highlight the connections on a copy of the layout provided with the kit to ensure the amp is wired correctly. Check everything at least once! Touch each component's lead and touch the lead at the other connection.

Measure the resistances to confirm they are correct.

Measure the resistance from each part that has a ground connection to the chassis. Put your probe on the parts lead. All readings should be between 1 ohm and 0.1 ohm typically.

Make sure the Mains ground at the chassis is **very** tight.

REMEMBER: DO NOT OPERATE YOUR AMP WITHOUT A LOAD

Procedure - The following the procedure to follow for the first power up of a new amp. Don't give in into the temptation to "fire it up" as soon as the last solder joint is cold.

You should have completed all the basic circuit checks already mentioned before soldering the transformers into the rest of the circuit. Some of this is redundant but bears repeating,

If you haven't performed the Power transformer test, go back and do it now.   If you've already soldered in your trannies, take a minute to desolder the secondaries from the rest of the amp and go back and test them.

If you haven't, install a SLO BLO fuse inside the IEC socket.

Note: If you see or smell smoke when you turn on the amp, turn it off immediately and re-check the connections. It is common for new tubes to emit an odour upon initial start-up.

THIS IS IMPORTANT: Before powering up **INSPECT DIODES & FILTER CAPS**. You MUST have the **diodes and cap polarities correct**. This is critical but an easy mistake. If either the diodes or caps are wired in reverse, you can destroy the caps, diodes and possibly the power transformer!

If all is OK, install solder the power transformer leads to the PCB following the layout in the above "Power Supply Wiring" section and the main layout as well.

Power up the amp and watch the following things as quickly as possible and roughly in this order:

- LED pilot lamp comes on brightly;

- 6.3 AC filament voltages are on the correct pins for all tubes. Remember this is AC voltage, so set your meter accordingly; and
- High Voltage secondary rises to nearly the same value as it did with the lines unsoldered.

If any of these does not happen, shut off the amp immediately and find the problem by looping back to the beginning of this checklist. If these check out, power down. B+ MUST be discharged to safely continue messing with the amp guts. A 220K 2W bleeder resistor will take at least a minute to bring B+ down to safe levels.

Now hook your DC voltmeter to B+ and ground. Power up again and check the B+ voltage. With no tubes installed, all the filter caps will charge up to the same voltage. The voltage should be very close to 40% higher than the raw AC. Assuming you measured, say, 400VAC across the full secondary in the above steps, then each half is delivering 200VAC. B+ will be ~40% above this, which is ~280VDC.

KEEP IN MIND that every time you power up from now on that B+ will be high. In all the following steps, allowing B+ to bleed at each power down is implied.

If all is well, check that B+ is at the OT on all the primary taps. Without the power tubes installed, the OT primary should be at B+. If not, something is wrong at the OT. Power down immediately and check for shorts of the OT primary. This should not be the case, however. An OT short should have been caught by now by checking B+ levels in the previous steps. This is really just a final sanity check to really make sure the trannies aren't going to be destroyed by any mistakes. Leave the amp on for a few minutes and make sure neither tranny is getting warm. The OT should stay dead cold and the PT should get just a little warm supplying the pilot lamp and heaters. Make sure the negative voltage is being generated and check that it gets to the power tube grids and is adjustable with the bias pot.

Now we're ready to install some tubes!

Power down and install a 12AX7 in V1 socket and 12BH7 in V2 socket. You also need to hook up a speaker or dummy load for the OT. Use an old or less valuable speaker to get started. Turn volume all the way down. Power up and, again, watch for the following signs:

- pilot lamp comes on brightly;
- all tube filaments light up;
- tube plates do NOT glow red (overheat) paying attention to the 12BH7 power tube.

If all seems in order, and the fuse has not blown, measure all the voltages and fill in the Trinity TRIFLY Voltage Chart.

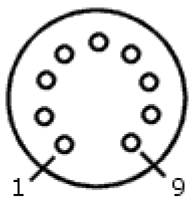
If all seems close, or within 10-20% turn the volume up a bit. Plug in a guitar cable, and touch one end. You should get a louder hum, this is a good sign. If you get this far, it's time to plug in your guitar and take the amp for a test run.

If all is good, then screw on the bottom plate of the enclosure and enjoy!

Hopefully, there are no problems but if you think there are e.g. hum, squeal etc., then move on to the troubleshooting section of this manual.

Trinity TRIFLY Voltage Chart

AC Mains Voltage 120VAC;B+ 277VDC with tubes installed



12AX7/12BH7

TUBE	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
V1 (12AX7/ECC83)	164	0	1.3	--	--	136	0	0.8	--
V2 (12BH7)	275	0	11	--	--	275	0	11	--

WARNING

Please Read this Information Carefully

The projects described in these pages utilize **POTENTIALLY FATAL HIGH VOLTAGES.** If you are in any way unfamiliar with high voltage circuits or are uncomfortable working around high voltages, **DO NOT RISK YOUR LIFE BY BUILDING THEM.** Seek help from a competent technician before building any unfamiliar electronics circuit. While efforts are made to ensure accuracy of these circuits, no guarantee is provided, of any kind!

USE AT YOUR OWN RISK: TRINITY AMPS EXPRESSLY DISCLAIM ALL LIABILITY FOR INJURY OR PROPERTY DAMAGE RESULTING FROM THIS INFORMATION! ALL INFORMATION IS PROVIDED 'AS-IS' AND WITHOUT WARRANTY OF ANY KIND.

Troubleshooting

When debugging a newly built amp the first things to do are check the wiring, make sure the correct components are installed, and look for bad solder joints.

Use a voltmeter to check voltages and compare them with the voltages listed on the schematic. Remember that you can calculate current by measuring the voltage drop across a resistor and dividing by the resistance.

An incorrect voltage or unusual current may give you a clue to the source of the problem. A low voltage often indicates that something is drawing more current than the power supply can handle and dragging down the voltage.

Probing with a non-conductive object such as a chopstick while the amp is powered on is a good way to find bad connections or problems with the way the wiring is laid out.

Remember that dangerous voltages are present when the amp is powered on. Always drain the filter caps and disconnect the mains before working on the amp. To learn how to do this safely, see the following 'Faulty power supply filter caps' discussion.

Never operate the amp without a load or you will damage the output transformer. You can use an 8 ohm 15 watt power resistor as a dummy load in place of a speaker.

Hum

Hum is the most common problem and is usually caused by AC line noise leaking into the filament wiring or input stages and getting amplified. Here we provide a comprehensive step-by-step troubleshooting guide.

First, measure the resistance from each parts ground connection to the chassis. All readings should be less than 1 ohm, typically 0.5 ohms.

Make sure the Mains ground at the chassis is **very** tight.

Volume Test

A good way to troubleshoot is to divide and conquer by turning the volume control(s). If the hum changes levels as you do this, then the source of the hum is something that affects the stages of the amp before the volume control. A faulty, humming preamp tube can be isolated this way very quickly. Conversely, if the volume control does not affect the hum, the cause is somewhere after the volume control.

Faulty tube

Tubes sometimes develop internal hum. Do some tube swapping to locate the problem. Use the volume control test.

Severely unmatched output tubes in a push pull amplifier

Push pull amplifiers get by with less power supply filtering because they're supposed to cancel this ripple in the output transformer. The cancellation can be upset by output tubes that use different amounts of bias current, allowing the hum to be heard.

Faulty power supply filter caps

There are a limited number of ways for the power supply filter capacitors to be bad. All of the tests on power filter capacitors must be considered hazardous since they may store lethal amounts of voltage and charge even with the amplifier unplugged.

Any time you suspect power filter capacitors, before testing be sure to discharge the caps. If you don't have bleeder resistors do the following: With the amplifier unplugged and the chassis open, connect one end of a clip lead to the metallic chassis. Clip the other end of the lead to a 200K 2W or larger resistor. Holding the resistor with an insulating piece of material, touch the free end of the resistor to each section of the power filter capacitors for at least 30 seconds. This will safely discharge the filter capacitors.

Then:

Visually inspect the capacitor(s) for any signs of bulging, leaking, dents and other mechanical damage. If you have any of these, replace the capacitor. Also note the condition of any series dropping resistors connected to the capacitors to see if they have been damaged by heat. Replace them if they have.

Use an ohmmeter to measure the resistance from the (+) terminal of each capacitor to the (-). This should be over 15K ohms (Ω), preferably much over that. If you get less than that on any capacitor, unsolder that capacitor and re-measure just the capacitor. Less than 15KΩ indicates a dead or dying capacitor; replace it. If the resistance is now much higher with the cap unsoldered, there is a low resistance load pulling current, not a faulty capacitor. Always check all of the power filter capacitors while you're in there. If one is bad, consider replacing them all.

If there is no obvious mechanical problem and the resistance seems high enough, temporarily solder a new, known good capacitor of at least as high a capacitance and voltage across the suspected capacitor or section, then plug in and try the amplifier again. If this fixes the problem, turn the amplifier off, unplug it, drain the filter capacitors again, and replace at least the bad section if not all of the filter capacitors.

If you are replacing a multi-section can capacitor, get a replacement can with multiple sections matching the original before you remove the original capacitor. Once you get it, make yourself a note of the symbol on each terminal of the old capacitor, such as square □=1uF/500V, triangle Δ=20uF 500V, etc. and then clip the old terminal with the symbol off the old can. Remove the old can, mount the new one, and use the symbol chart and lugs still on the leads to make sure you connect the right sections up in the new capacitor.

Faulty bias supply in fixed bias amplifiers

A bias supply with excessive ripple injects hum directly into the grids of the output tubes. Check that the bias supply diode is not shorted or leaky, and then bridge the bias capacitor with another one of equal value to see if the hum goes away.

Unbalanced or not-ground-referenced filament winding

The filament power must be referenced to the DC in the tubes in some way, otherwise you may get a lot of hum. The filaments are usually a center tapped 6.3VAC winding, with the Center Tap (CT) grounded for the necessary reference.

If the winding is not grounded and balanced around ground, it will cause hum. Measure the voltage from each side of the 6.3V to ground; it should be pretty much exactly half the AC voltage at either end. If it is unbalanced to ground, tweak the pot or change the resistors to get it to be.

Note: If you have grounded center tap style supply that is not centered on ground, this indicates a faulty power transformer.

TIP: *If your heater wires did not have a center tap to connect to ground, then put a 100 Ω anti-hum resistor to ground from each side of the heater wires to the common ground point. This will add a ground reference to the heater voltages and help to reduce hum.*

Other methods are low value pot (200-500 **Ω**) across the whole 6.3V with the wiper grounded.

Defective input jack

If the input jack is not making good contact to the guitar cord shield, it will hum. Likewise, if the jack has a broken or poorly soldered ground wire, or not-very-good connection to the grounded chassis, it will cause hum. If messing with the jack changes the hum, suspect this.

TIP: *If hum or noise exists when the input plug is removed, try re-soldering the connections to the Input jacks.*

Poor AC grounding

In amps with two wire cords, defects of the 'ground reverse' switch and/or capacitor can cause hum. A leaky power transformer can also cause this.

Induced hum

Placement of the amplifier near other equipment can sometimes cause it to pick up radiated hum from other equipment. Suspect this if the hum changes loudness or tone when you move or turn the amp. There is usually nothing you can do about this except move the amp to where the hum is less.

Poor internal wire routing

If the signal leads inside the amp are routed too near the AC power wires or transformer, or alongside the high-current filament supply wires, they can hum. Sometimes using shielded cable for signal runs inside the cabinet can help. It is hazardous to do, but you can open the amp up and use a wooden chopstick (NOT A PENCIL) to move the wires around inside to see if the hum changes. This is hard to do well and conclusively, since the amp may well hum more just because it is open. BE VERY CAREFUL NOT TO SHORT THINGS INSIDE THE AMP.

Poor AC Chassis Ground at Power Transformer

A common problem is the main ground point to the chassis. The green wire ground to the chassis, the 'line reverse' cap, the CT on the filament windings, the CT on the high voltage windings, and other things associated with power or RF shield grounding are often tied to lugs held under one of the power transformer mounting bolts. If this bolt becomes loose, or if there is corrosion or dirt under the lugs, you can get an assortment of hum problems.

Defective internal grounding

There are potentially lots of places that must be tied to ground in the internal wiring. This varies a lot from amp to amp. If one is broken loose or has a poor solder joint or poor mechanical connection, it can show up as hum. Note that modified amplifiers are particularly susceptible to this problem, as the grounding scheme that the manufacturer came up with may well have been modified, sometimes unintentionally. With the amp unplugged, open and the filter capacitors drained, carefully examine the wires for signs of breakage.

Hiss

Some noise or hiss is normal if you have used carbon composition resistors. TRIFLY kits are supplied with Carbon Film and Metal film resistors similar to the original. This style of resistor has inherent noise. If this amount of hiss is bothersome, you will need to replace the resistors in the signal chain with Metal Film resistors.

Metal Film Resistor Substitutions

If you really want to eliminate hiss, use additional metal film resistors where the signal level is small and the following amplification is high - a classical description of an input stage. The input to an amp should probably have a metal film plate resistor to minimize noise.

Substitute them on the grid resistors in all but output stages because the signal level is typically too low.

Substitute them on the Cathode resistors. They typically only have a few volts across them, and they're often decoupled with a capacitor, both of which would minimize the carbon composition resistor distortion (carbon comp "Mojo").

The best place to use Carbon Composition (CC) resistors is where there's big signal - plate resistors, and ideally the stage just before the phase inverter. The phase inverter would otherwise be ideal, with plate resistors carrying the highest signal voltage in the amp, but phase inverters are often enclosed in a feedback loop. The feedback minimizes the distortion the resistor generates.

Squealing/Feedback

Squealing usually occurs when there is coupling between the input and output stages. The positive feedback causes the amp to become an oscillator. Vary the volume and tone controls to see if it affects the oscillation. That will tell you if the coupling is occurring before or after the control. Sometimes the problem can be solved by minor changes to the wiring (moving output wires away from input wires, shortening excessively long wires, etc.).

Use shielded wire on the input jack to help a hum or squealing problem.

Ensure the shielded wire goes on top of the board, not underneath it.

Reverse the output transformer leads on pin 3 on V5, V6.

Explanation: One of the primary leads is in phase with one of the secondary taps. In a high gain amp, this phase relationship needs to be maintained.

Radio Interference

If you are picking up radio stations on your amp:

1. Try a .01 uF or 47 pf capacitor on very short leads between the 'ground' side of the input jack and chassis.
2. Make sure the chassis is fully enclosed electrically. Install a piece of thin Aluminum sheet metal or HVAC Aluminum tape sandwiched between the chassis & cabinet and make sure it makes contact with the chassis.
3. Make sure the 68K grid blocking resistors are located at/on the V1 tube socket.
4. Use shielded wire between the input jack and the 68K grid blocking resistor.
5. Place ferrite beads over the shielded input cable.
6. Try grounding the shield of the shielded input cable to the chassis instead of the preamp ground.

Other useful measures to take in extreme circumstances:

1. Use a filtered IEC connector for your mains power connection.
2. Put a 100pf across the V1 Plate and cathode pins 1&3

Scratchy Sounds on Potentiometer(s)

If you are hearing scratch sounds on a pot when you rotate it, measure the DC voltage from the terminals to ground. A leaky coupling capacitor or tone stack will cause this to happen.

Amp Buzz or Rattle When Installed in Cabinet

If you get a buzz in an amp when it's installed in a cabinet, it could be due to any one or a combination of the following things. Start with the easy things and work your way through the tests.

First, is it a metallic buzz? Is it a tube (ringing) buzz? Is it a softer buzz (wooden/plastic sound?)

Try using an external speaker, isolated from the amp to see if it goes away. This should tell you it's related to the cabinet mechanics or not.

Testing Cabinet Mechanics

- Are the Speaker mountings tight?
- Are the cabinet construction screws tight?
- Are the Vents loose? Use more fasteners; Rubber gasket between vent and chassis; hard rubber washers to hold vent assembly on
- Does the power transformer touch the mounting boards ? Check for a gap and then separate the power transformer from the mounting board.
- Is the Speaker cable rattling against back of chassis? Hold it & listen. Tie it down if necessary.

Loosen the chassis from the cabinet and see if the buzz goes away. This will isolate the chassis as the problem. If it does go away, Test the chassis mechanics.

Testing Chassis Mechanics

- Are all the nuts fastening parts to the chassis tight? (sockets, transformers, tag strips etc.).
- Are there Shields on pre-amp tubes? Remove & listen.
- Are there Spring retainers on power and rectifier tubes? Remove them or temporarily tie them down somehow & listen. Cover in heat resistant tubing if necessary to isolate them from the tubes; or remove them; or you can retain tubes with a small amount of silicone.
- Are the tubes mechanically rattling? Hold them and see if the rattle goes away. Replace if necessary.
- Are the Controls loose? (toggles/mounting rings etc.)
- Is the Chassis loose? - tighten & listen
- Is the Chassis loose against backboard? - Remove backboard & listen
- Is the Chassis pushed up hard against cabinet? Tighten; Use Rubber gasket (neoprene 3/8' X 1/8' window/door sealer) around where the chassis touches the cabinet
- Is there a gap between panels/chassis & cabinet? Tighten it up, use rubber gasket where the faceplate meets cabinet. Rubber gasket (neoprene 3/8' X 1/8' window/door sealer) between panel and cabinet
- Is the Chassis vibrating around backboard? Remove the backboard and listen. Use a Vibration damping strip or rubber gasket between chassis and backboard.
- Is the Chassis vibrating around the tranny? Hold tranny & listen; Are there washers between tranny & chassis. Flush mounting (i.e. no washers) could cause rattle. Use rubber gasket between transformer or use washers
- Is the Circuit board mounted tightly against chassis? Tighten mounting screws - check standoffs.

- Are there components touching the turret board? Use a chopstick to prod some of the larger ones first, then space them off the board; You can even silicone the rattling parts to board if necessary (especially larger caps).
- Are there Components touching each other? Use a chopstick to prod some of the larger ones first, then separate them; Silicone the rattling parts to separate them (especially larger caps)

Other Tests

- Try different tubes - if it is coming from both channels, try output tubes first. Tap them when removed from the amp to see if you can hear any rattles.
- Input/Output jacks - try plugging a spare 1/4' jack into the other jack(s) when playing or the end of a chopstick. Replace the noisy jack.
- Speaker - vibration between alnico magnet & bell cover; or voice coil rub. Try a different speaker; Replace speaker if necessary
- If you have a signal generator you can sweep from a low frequency noting where any rattles occur. Then leave the frequency generator at that position while you prod around looking for the source of the problem. Fix it and move on to the next one. If you don't have a signal generator, then you'll need to pluck certain strings of your guitar in sequence and see what excites the rattles.

At three separate and different frequencies you might find:

- Components vibrating against the board;
- Chassis rattling against the cabinet; and
- Mechanically noisy tubes (V1 for example).

Make sure all the components are away from the board and not touching, and put neoprene 3/8' X 1/8' window sealer with one adhesive side, between chassis and wherever it touches the cabinet.

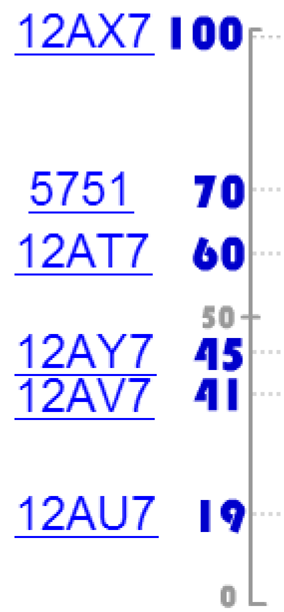
Appendix 1 - Tone Tweaking

Below are some modifications you might try in order to change the tone and response of your TriFly.

<u>DO NOT</u> *PUT A CAPACITOR ACROSS THE OUTPUT TUBE CATHODE RESISTOR.*

The TriFly design is not a conventional Push-Pull design.

To get more clean output from your TriFly, try a lower gain tube in V1. For example a 12AY7 or 5751. See the gain chart for some other possibilities.



Optionally reduce or remove the .047µF bypass cap, C2 on V1 pin 3.

You can also increase R4 1K8 to 2K2. OR increase R7 to 1K2 OR both.

For less output power, try a 12AU7. If you think it is running too hot, replace the 440R cathode resistor with a 500R.

For <u>more power AND more headroom</u>, try a JJ ECC99 power tube, but decrease the 440R cathode resistor to 150R to bias it correctly.*

To decrease / dump some gain, on V1B add a 470K grid resistor from Pin 7 to ground.

To get a thicker, heavier tone, change R4/C2 to 1K5/0.68µF

For the preamp, increase gain and thickness by increasing the cathode bypass cap C2 to 1µF or even 10µF. However, this could make it too thick or muddy.

To generally increase bass throughput, increase the coupling caps. C1 to .047 µF and / or C3 to 0.1 µF

***Calculating the 12BH7 or ECC99 Bias**

Measure B+ and Plate voltages. e.g. Vplate VDC Vb+

Measure voltage drop over the Bias Resistor e.g. Vbias VDC

Measure the Bias Resistor e.g. ohms

Calculate the total current draw through the tube = Vplate /Rbias = mA

Calculate the Power for one triode [(Vplate-Vbias)* current / 2] = W

Compare Power to tube data sheet 12BH7 W , ECC99 5W

Calculation Example: With a 390 Ohm bias resistor, . B+ is 268VDC and the plate voltage is 265.8VDC. The voltage drop over the bias resistor of 390R is 8.9VDC. The current over the both tube halves is (8.9/390=) 22.8mA or .0228A, which is within the specification of the transformer.

[(Vplate-Vbias)* current in Amps / 2] = 2.94 W so the bias is at 59% of the 5 Watt max rating of an ECC99 tube.

More Tips for fine tuning your amp

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These are very simplistic modifications you can do to your amp, let your ears be your guide:

- Change coupling caps; changing to smaller values reduces bass, changing to larger values adds more bass. Reducing the value of coupling caps can help eliminate "flabby" bass syndrome.
- Change Preamp cathode bypass caps. Adding a cathode bypass cap to a stage that doesn't have one will let the stage have more gain. Just like coupling caps, making the value larger adds bass - generally 25uF allows almost all bass through, .68uF are used in some Marshalls for a more midrange boost and 1uF and 5uF are used in some high end fusion type amps. Again, smaller values can help reduce "flabby" bass.
- Change Preamp cathode resistors - larger values reduce gain, smaller values give more gain. A "trick" is to connect a 5K+pot wired as a variable resistor instead of the standard cathode resistor - now you can turn the pot and dial in the perfect tone. After dialing the sound, remove the resistor and pot and measure it. Substitute the nearest standard value resistor in place of the pot plus a resistor.
- Adjust the grid leak resistor. Reduce the value to attenuate the signal into the stage to control the gain.
- Use a shielded cable from your input jack to the first gain stage. This can reduce RF, buzz and general reduce noise.
- Replace all plate resistors (and resistors of 100k or above) with metal film types. This can help reduce hiss..

Appendix 2 - How to read Resistor Color Codes

First the code

Black	Brown	Red	Orange	Yellow	Green	Blue	Violet	Gray	White
0	1	2	3	4	5	6	7	8	9

How to read the Color Code

First find the tolerance band, it will typically be gold (5%) and sometimes silver (10%).

Starting from the other end, identify the first band - write down the number associated with that color; in this case Blue is 6.

Now 'read' the next color, here it is red so write down a '2' next to the six. (you should have '62' so far.)

Now read the third or 'multiplier' band and write down that number of zeros.

In this example it is two so we get '6200' or '6,200'. If the 'multiplier' band is Black (for zero) don't write any zeros down.

If the 'multiplier' band is Gold move the decimal point one to the left. If the 'multiplier' band is Silver move the decimal point two places to the left. If the resistor has one more band past the tolerance band it is a quality band.

Read the number as the '% Failure rate per 1000 hour'. This is rated assuming full wattage being applied to the resistors. (To get better failure rates, resistors are typically specified to have twice the needed wattage dissipation that the circuit produces.) 1% resistors have three bands to read digits to the left of the multiplier. They have a different temperature coefficient in order to provide the 1% tolerance. At 1%, most error is in the temperature coefficient - i.e. 20ppm.

Appendix 3 - 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 1st and 2nd 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.

milli, micro, nano, pico

1 mili Farad (or any other unit) is 1/1,000th or .001 times the unit. (10^{-3})

1 micro = 1/1,000,000 or 0.000 001 times the unit (10^{-6})

1 nano = 1/1,000,000,000 or 0.000 000 001 times the unit (10^{-9})

1 pico = 1/1,000,000,000,000 or 0.000 000 000 001 times the unit (10^{-12})

Table 1 Digit multipliers	
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 0.1 µF capacitor.

Most kit builders don't need to go further but there is sometimes a tolerance code given by a single letter.

So a 102K is a 1,000 pF with +/-10% tolerance

Typical Capacitor Markings			
Code	pf	nf	uF
510	51	0.051	.0000510
181	180	0.18	.00018
501	500	0.5	.0005
102	1000	1.0	.001
122	1200	1.2	.0012
152	1500	1.5	.0015
202	2000	2.0	.002
222	2200	2.2	.0022
472	4700	4.7	.0047
502	5000	5.0	.005
103	10000	10	.01
123	12000	12	.012
203	20000	20	.02
223	22000	22	.022
473	47000	47	.047
104	100000	100	.1
684	680000	680	.68

Table 2 Letter tolerance code	
Letter symbol	Tolerance of capacitor
B +/	0.10%
C +/	0.25%
D +/	0.5%
E +/	0.5%
F +/	1%
G +/	2%
H +/	3%
J +/	5%
K +/	10%
M +/	20%
N +/	0.05%
P +100%	0%
Z +80%	20%

Appendix 4 - TriFly PCB Bill of Materials

QTY	ITEM	QTY	ITEM
1	1W C FILM RES 150 OHMS (ECC99)	1	RED 3 MM LED
1	1W C FILM RES 470 OHMS (COLD BIAS BH7 /AU7)	2	DIODE FAST 1000V 1A DO-41
1	1W M FILM RES 440 OHMS (HOT BIAS BH7)	8	NUT W/TOOTH WASHER 4-40
1	CARBON FILM RESISTORS-820 OHMS 5%	8	MACHINE SCREW 4-40 THREAD, 3/4" LEN
1	CARBON FILM RESISTORS-1.8KOHMS 5%	8	STANDOFFS / SPACERS .375" SPACER NYLON
1	METAL OXIDE RESISTORS 22KOHMS 2W	3	LUGLOCKING MATTE TINNED#6
2	CARBON FILM RESISTORS-33KOHMS 5%	6	MACHINE SCREW 6-32 THREAD, 3/8" LENG
2	CARBON FILM RESISTORS-100KOHMS 0.05	4	MACHINE SCREW NUT W/TOOTH WASHER 6-32
1	330K CARBON FILM 1W RES	1	24 GA. RED SOLID CORE WIRE FT
1	CARBON FILM RESISTORS-470KOHMS 5%	3	22 GA. SOLID CORE WIRE FT (BLU, YEL, GRN, WHT)
1	CARBON FILM RESISTORS-1MOHMS 5%	1	SHRINK TUBING (1/16, 1/8, ¼)
1	CAP SILVER MICA 220PF @500V	2	TIE WRAP
2	CAP .022 MFD 630V AX FILM CAP	1	CORD, POWER, 3 CONDUCTOR, IEC 8', 18GA
1	.047 MFD 630V AX FILM CAP	1	12BH7 - ELECTRO-HARMONIX
1	CAPACITOR - MALLORY 150S, 630 V, .002UF	1	12AX7 / ECC83 JJ
2	CAP 47UF 350V	1	TRIFLY PRINTED CIRCUIT BOARD (PCB)
1	1/4 MONO 2-INPUT JACK SWITCHED	1	TRIFLY BUILDERS GUIDE
2	1/4 MONO 2- OUTPUT JACK OPEN CIRC	1	TRIFLY RED SPARKLE ENCLOSURE
1	SHOULDER WASHER 3/8	1	TRIFLY POWER TRANSFORMER HTS-11936 REV1
1	WSHR FBR 3/8" .625"OD	1	TRIFLY OUTPUT TRANSFORMER HTS-11654
1	IEC RECEPTACLE WITH GMB FUSEHOLDER		
1	FUSE - GMD, 500mA SLO-BLO, 5mm x 20mm		
4	HEYCO SNAP BUSHING SB 500-4 BLACK		
1	KNOB SKIRTED PONTER		
1	POT - ALPHA 1M AUDIO		
2	SOCKET - 9 PIN MINIATURE PCB MOUNT		
1	DPDT TOGGLE SWITCH		

Appendix 5 - FAQ

Q: Where can I find more help and support?

A: Sign up at the Trinity Amps Forum and check the “Resources” section or post a question in the TRIFLY, Lightning Strikes or, 18 Watt forums.

NOTE: B+ stands Battery Plus == B+ and came from the old days of tubes. B+ is measured at the intersection of the rectifier DC output and the first filter cap.

On a TRIFLY, it is measured at the positive end of the first 40uF filter capacitor. It should be about 275 VDC with tubes, with 120 VAC mains.

Q: Does it make a difference as to what orientation I choose to make sure the power switch operates correctly, i.e. on is on and off is off?

A: It does it make a difference as to what orientation you choose to make sure the switches operate correctly. Put a switch in any position and measure the resistance across two terminals on the side. "ON" is where resistance is zero. Then rotate the switch so that DOWN is ON (UK style).

Q: The picture and layout show a grounding screw next to the IEC plug, the chassis is not drilled for one. Can I run the ground to the common star ground that the power transformer.

A: To meet electrical safety code, the mains ground must be connect by itself to the chassis. It is best to drill a hole to connect the 120 V ground to a bolt that fastens to the chassis.

Don't run the 120 V ground to the common star ground.

Q: I assume that the shield is only attached to the pot; it is NOT connected to the tube socket?

A: Yes. Do not connect shield at both ends on the TMB volume pot OR input cables.

Q: The wire looks to be two basic sizes, "thin" and "thick". From the pictures, it looks like the "thin" is used for the pot wiring and the "thick" is for the tube sockets. Is this correct?

A:Use 22 Gauge solid for hook up to tubes;

Use 20-22 Gauge, twisted tightly for tube heater wiring;

Use 22 Gauge solid/stranded for hook up to pots/front panel; and

Use 20 gauge, stranded, 600v for power supply hook up - to transformers, rectifier, standby etc.

Tip: Re-use cut-offs from the transformers for power supply hook up.

Q: What should I use for the jumper wires on the back of the turret board?

A: Use the provided solid 20 ga or the stranded supplied for jumpers,

Q: For the input jacks:

A: a): I should be using the shielded wire which is the thick gray/black wire that you supplied about 3' of. Does the shield braid from both lines go to the common tip lug on the lower jack while the core line goes to the individual tip lugs on both jacks? I want to make sure I am interpreting the drawing correctly.

b). The other end of the shield does NOT get connected to the tag strip at V1, correct?

c). Each pair of input jacks gets only one resistor, correct? Can I lace one lead of the resistor through both jacks for the connection?

Take a look at the drawing of the input jacks. That should help you out. Use the shielded wire which is the heavy black wire. The core goes to the hot. At the other end, the shield does NOT get connected to the tag strip at V1.

Q: How do you wire up the impedance switch? The layout shows 4 lugs on the switch while the actual switch has two concentric rings of lugs, 4 inner and 12 outer.

A: The Lorlin impedance switch inner & outer lugs are in pairs - 4 inside & 3 each for the outside. Connect the output jack to one of the inner lugs, and then connect each output tap from the transformer to the outside lugs that are 'paired' with that inner lug. You can confirm the 'pairs' by checking the resistance between the inner lug and outer lug at different switch positions.

Q: How are the three terminal tag strips next to V1 were supposed to be mounted, looked at the pictures on line and found they go under the V1 socket mounting nuts.

A: Yes. They are part of the socket mounting. Use the 4-40 nuts supplied to fasten them down.

Q: I assume you don't have to use both of the fiber/rubber washers when mounting the cliff jacks; I can get only one on, is this normal?

A: Yes

Q: Is there hardware provided for the grounding? Screws, star washers, nuts, etc.?

A: Yes, these should be in the kit.

Note: The power grounds should go to the separate hole to mount the grounding points.

Q: Is it easier to wire the pots up outside of the chassis on a cardboard with the pots spaced correctly, or can it be done easily in the chassis?

A: You can wire them in place, it's not too difficult. It is recommended that you wire the input jacks outside of the chassis with the approximate spacing to fit the panel.

TIP: It is easy to solder up the input jacks by putting them "inside out". Use a set of jack locations to the right of the normal channel and mount the jacks in their final orientation, but mounted outside of the chassis with the mounting screw inside the chassis. This keeps the orientation and spacing correct and provides a lot of room to solder the resistor, jumpers grounding wire and shielded wires. Then, when done, remove the completed jacks, mount them correctly inside the chassis and tighten up the mounting screws and solder up the other end of the shielded wires to the tag strips at V1.

TIP: More, larger format, colour pictures and the schematic & layout that are helpful in the build are posted on the Trinity Forum – Resources Section. Right click on them to download if you want print in large, colour format.

TIP: Sometimes it is hard to decode the resistors colours. It is a good idea to check the resistances of these parts before assembly.

TIP: Use heat shrink insulation tubes from the wiring on the resistor / cap leads around the tubes and pots by using longer pieces of insulation stripped from the supplied 20 ga wire.

TIP: Heater Wires: Stranded wire is very hard to twist tightly. Stranded or solid doesn't make much difference. Solid wire stays in place better once it's positioned and a bit easier to feed through holes. If they aren't well twisted make sure they are tight against the chassis. Use 20-22 ga solid for heaters. It is rated for more than 5A/600Volts.

Trinity Amps Schematics and Layouts

QTY	TRIFLY PCB BILL OF MATERIALS - ITEM	BAG
1	1W C FILM RES 150 OHMS (ECC99)	
1	1W C FILM RES 470 OHMS (COLD BIAS BH7 /AU7)	
1	1W M FILM RES 440 OHMS (HOT BIAS BH7)	
1	CARBON FILM RESISTORS-820 OHMS 5%	
1	CARBON FILM RESISTORS-1.8KOHMS 5%	
1	METAL OXIDE RESISTORS 22KOHMS 2W	
2	CARBON FILM RESISTORS-33KOHMS 5%	
2	CARBON FILM RESISTORS-100KOHMS 0.05	
1	330K CARBON FILM 1W RES	
1	CARBON FILM RESISTORS-470KOHMS 5%	
1	CARBON FILM RESISTORS-1MOHMS 5%	
1	CAP SILVER MICA 220PF @500V	
2	CAP .022 MFD 630V AX FILM CAP	
1	.047 MFD 630V AX FILM CAP	
1	CAPACITOR - MALLORY 150S, 630 V, .002UF	
2	CAP 47UF 350V	
1	1/4 MONO 2-INPUT JACK SWITCHED	
2	1/4 MONO 2- OUTPUT JACK OPEN CIRC	
1	SHOULDER WASHER 3/8	
1	WSHR FBR 3/8" .625"OD	
1	IEC RECEPTACLE WITH GMB FUSEHOLDER	
1	FUSE - GMD, 500mA SLO-BLO, 5mm x 20mm	
4	HEYCO SNAP BUSHING SB 500-4 BLACK	
1	KNOB SKIRTED PONTER	
1	POT - ALPHA 1M AUDIO	
2	SOCKET - 9 PIN MINIATURE PCB MOUNT	
1	DPDT TOGGLE SWITCH	
1	RED 3 MM LED	
2	DIODE FAST 1000V 1A DO-41	
8	NUT W/TOOTH WASHER 4-40	
8	MACHINE SCREW 4-40 THREAD, 3/4" LEN	
8	STANDOFFS / #6 SPACERS .375" SPACER NYLON	
3	LUGLOCKING MATTE TINNED#6	
6	MACHINE SCREW 6-32 THREAD, 3/8" LENG	
4	MACHINE SCREW NUT W/TOOTH WASHER 6-32	
1	24 GA. RED SOLID CORE WIRE FT	
3	22 GA. SOLID CORE WIRE FT (BLU, YEL, GRN, WHT)	
1	SHRINK TUBING (1/16, 1/8, ¼)	
2	TIE WRAP	
1	CORD, POWER, 3 CONDUCTOR, IEC 8', 18GA	
1	12BH7 - ELECTRO-HARMONIX	
1	12AX7 / ECC83 JJ	

1	TRIFLY PRINTED CIRCUIT BOARD (PCB)	
1	TRIFLY BUILDERS GUIDE	
1	TRIFLY RED SPARKLE ENCLOSURE	
1	TRIFLY POWER TRANSFORMER HTS-11936 REV1	
1	TRIFLY OUTPUT TRANSFORMER HTS-11654	