The
TRIWATT
Builder's Guide

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Thank You

Thank you for purchasing your TRIWATT 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

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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, **PLEASE 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!

Custom TRIWATT Lead Description

The TRIWATT was designed by Trinity Amps to capture the classic HIWATT sound without the usual classic ear-bleeding volume levels. It is closely based on an early '70s style Hiwatt DR, but utilising either 6V6 or KT66 power tubes for more usable power output. Furthermore, it has the 3-input configuration used by David Gilmour of Pink Floyd, plus an Overdrive stage, as found in early '80's "Biacrown era" Hiwatt Lead amps.

Bright channel - perfect right out of the gate. The entire travel of gain knob yields usable tones. Bright is AMAZING from zero to dimed, with lots of subtle colours in between. This channel really cuts through the mix.

Normal channel - has usable gain from the bottom all the way to the top, and lots of subtle shades of clean and semi-clean from around 10 o'clock to 3 o'clock. This channel is important because it's where most people will probably spend most of their time. The tone, is big and more detailed.

Link - is like jumping the two channels on a 4-holer. There are infinite shades of tone possible by blending the two channels' volume controls. The actual "sound" of the link inputs is subtly more scooped-mid and sparkly, giving one set of knob settings two slightly different tones.

Tone Controls - Treble, Middle, Bass, Presence - these are less like "boost/cut" knobs and more like "real" tone controls. They do a lot to the tone in a very subtle way. With Fenders/Marshalls extreme settings can get painful. TRIWATT never gets painful. Presence in particular is very authentic - rather than boosting a high treble, it opens up or extends the top end of the tone to add "air" to the sound. TRIWATT EQ knobs are in very similar places when compared to original Hiwatt amps, dialed in to similar tones.

Master Volume - turning the master down isn't a tone killer like in some amps. The tone is not compromised when the master is under around 11 o'clock. IF you set the OD up appropriately (see below), even with the MV way down - 7 or 8 o' clock, it still sounds huge. This control sounds big, quiet, and it it sounds big loud!

Overdrive - This control may be the reason someone who owns arguably a Hylight-era Hiwatt 4-holer, would want the TRIWATT. This is where the TRIWATT "art" lives – a . Pull out the Overdrive control and you get the extra gain stage of a Biacrown era Hiwatt Lead amp (push the knob in and it's out of the circuit). This gain stage naturally gives you more gain and more distortion, as well as more compression. So, for rhythms as well as leads, it's incredible! The way it works, is that when the Overdrive stage is engaged by pulling the Overdrive knob, the stage's drive/gain level is set by the Normal and Bright volume controls, and the stage's outout level is set by means of the Overdrive knob. So it's possible to set the stage to provide a lot of extra gain but at the same volume level as when its not engaged. But there are more possibilities. If you have to play lead, bring up the bright/normal gain stage and starve the overdrive gain and the tone comes forward is more dynamic and bigger. Turning up the Overdrive, with an LP and humbuckers reveals big metal tones, yet rolling back the guitar volume and playing more gently yields delicate, transparent, sparkling cleans with the Overdrive still on. And you can imagine all the shades in between!!!

Guitars - The TRIWATT can handle many guitars with aplomb. Tele, Strat, Danos, Ric, Les Paul with P90's for the single coils, and Les Paul, SG, Seymour Duncan hot-rodded Fender Cyclone for 'buckers, PRS Mira in both 'bucker and single mode - have all been tested with this amp, and every guitar sounds GREAT. Also, Hiwatts are known for taking a lot of pedals really well. The TRIWATT does not disappoint in this area either.

Key Points about the TRIWATT Design

- Big Hiwatt DR clean tones and breakup at more ear-friendly levels
- Vintage style early '70s 103 preamp (with cathode-follower)
- Three-inputs - Normal, Bright and Link, like Dave Gilmour's 3-input amps
- Switchable 80s' "Biacrown era" high-gain OL/Lead mode, with Overdrive control and optional footswitch
- Early Hiwatt style 12AT7 phase invertor, with 12AX7 option for increased breakup
- Solid State rectified, fixed-bias, 22 Watt 6V6 power stage, based closely on Hiwatt original
- Optional 6V6 or KT66 operation with External Bias Control and Bias Test Points
- Transformers closely based on original Hiwatt Partridge transformers for definitive tone
- Preamp easily modded for Pete Townshend or Jimmy Page/SAP variants
- Compact physical format and cabinet - chassis also fits other standard cabs

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 it 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

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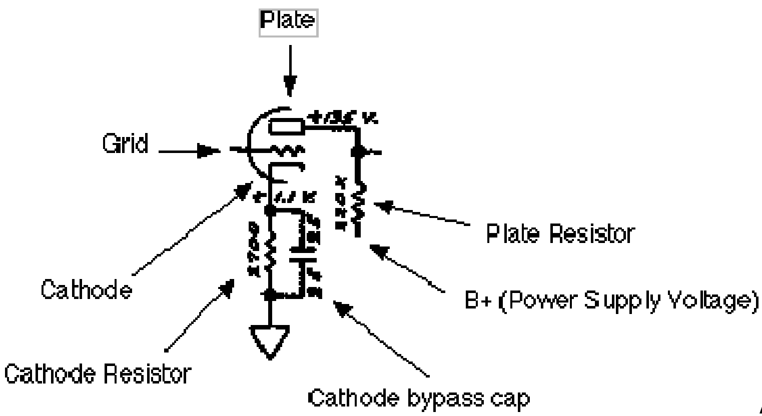
Here are a few terms that you may see online when referencing tube schematics. Like distortion pedals, tube circuits seemingly have their own language! I present this knowledge in the hopes that it may help you decipher the interesting life of tubes! :-) Below, is a picture and a very simplistic view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

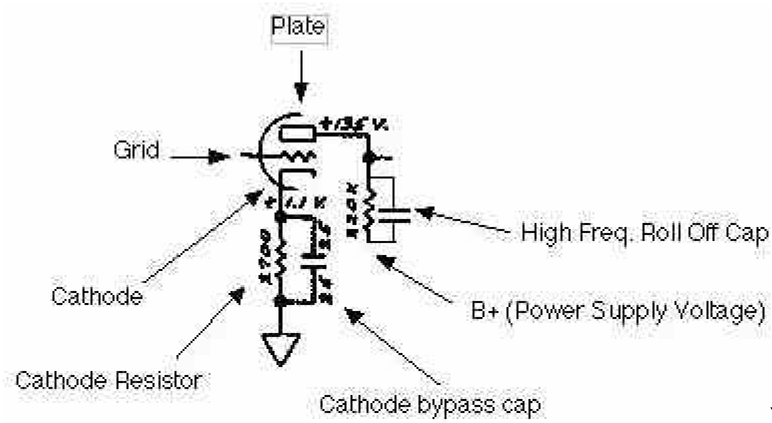
Plate - the plate is usually connected to a plate resistor which is usually connected to the B+ or power supply voltage. Typical Plate Resistor values are 100K, 150K, 220K. Larger values equal more gain.

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

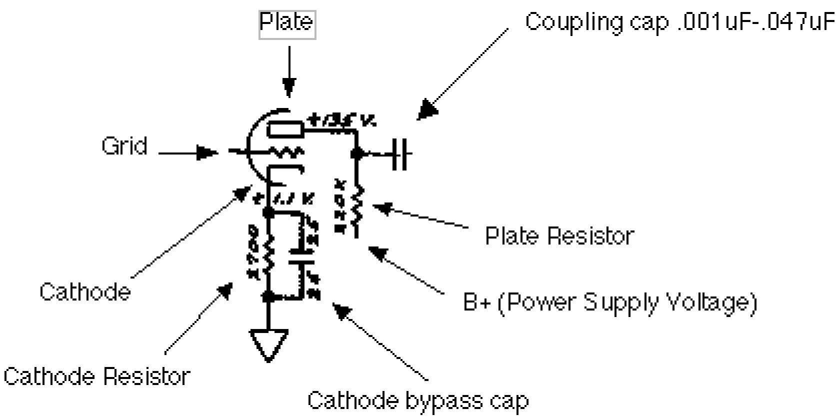
The Cathode is usually connected to a cathode resistor which usually goes to ground. The cathode resistor, along with the Plate resistor, control the gain of the tube stage. Typical values are anywhere from 100 ohms to 10K. Smaller values = more gain.

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.

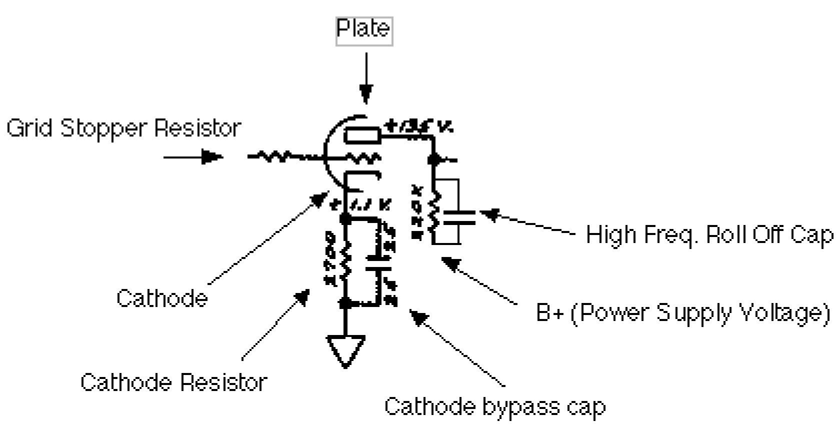
Sometimes you see a capacitor in parallel with the plate resistor, much like the cathode resistor bypass cap. It is usually a small value (i.e. .001uF) and it rolls off highs in the stage. Sometimes you see a high frequency roll off cap going from the plate pin to the cathode pin - 350pf->500pf in value.



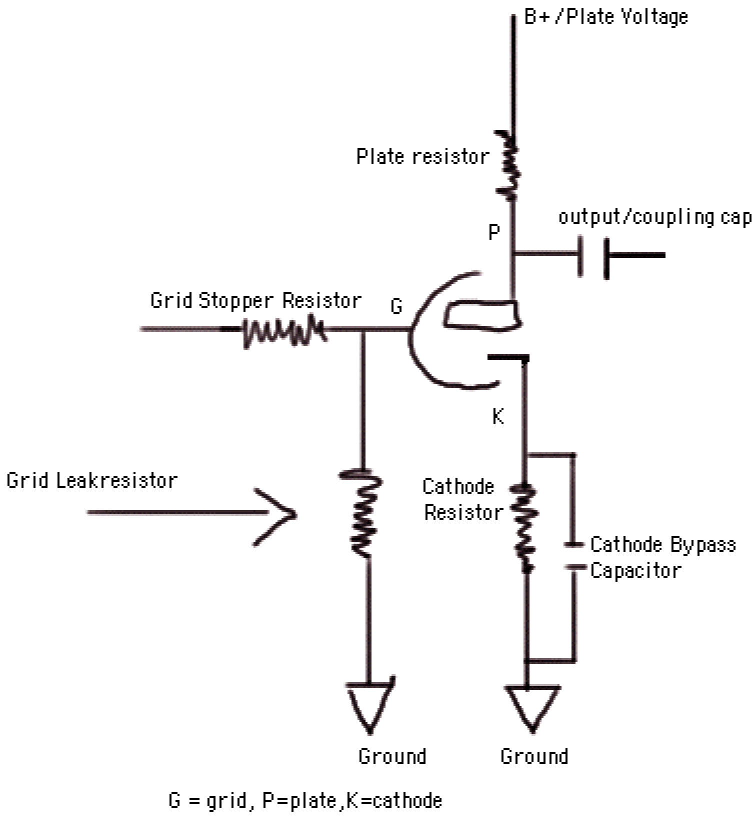
You will also see a coupling cap in between triode stages. The coupling cap controls the bass and rolls off bass between stages and blocks DC from entering the next stage - which could throw off the bias on the next tube stage. As usual, smaller values roll off more bass, larger values retain more bass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



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 20 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:

1. 30 to 40W soldering iron
2. 60/40 rosin core solder
3. wire stripper
4. wire cutter
5. needle nose pliers
6. screwdrivers
7. 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:

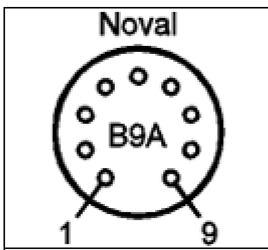
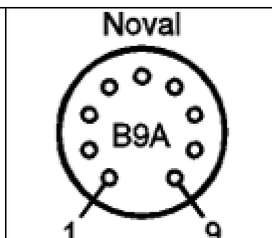
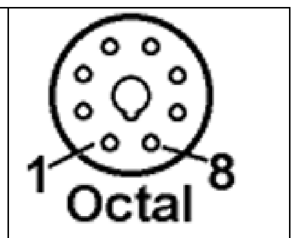
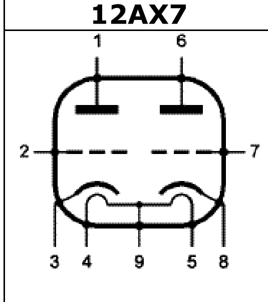
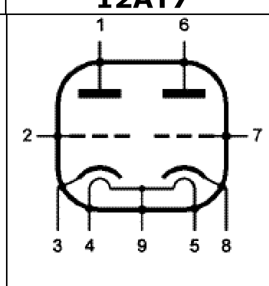
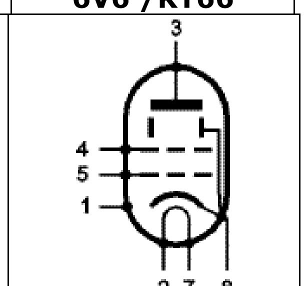
1. Use 60/40 rosin-core solder.
2. Keep the tip of the soldering iron clean. If it's dirty, wipe it on a damp sponge to clean it.
3. Set the temperature of your soldering iron to about 700F.
4. Melt some solder on the tip of the iron. The molten solder helps to efficiently transfer heat from the soldering 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.

The solder joint should be clean and shiny. 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.

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. The pins on an 8-pin tube socket are numbered 1 to 8 in a clockwise direction when viewed from the bottom. Note that there is a gap between pins 1 and 8.

		
12AX7	**12AT7**	**6V6 /KT66**
		
12AX7	**12AX7**	**6V6**

The pins on the potentiometers are 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 Hardware on the Chassis.

2. Wire up the heater wires to the sockets.

3. Install Transformers on the chassis.

4. Wire up the power supply - Mains, Transformers, power switch and pilot light.

5. Assemble the turret board and Install on chassis.

6. Connect turret board leads to tubes installing off-board parts as you proceed.

7. Connect turret board leads to controls installing off-board parts as you proceed.

8. Remove input jacks. Wire with 1M film resistors and shielded cable. Re-install.

9. Check Wiring.

10. Follow Start-Up procedure.

1. Install the Hardware

Install all the tube sockets. The sockets with the shields are for V1 to V4. The other 8 pin sockets are for the two 6V6 or KT-66 output tubes. For KT66 tubes, you may need to install the sockets under the chassis to gain some extra clearance in the cabinet.

Install the two dual capacitor can caps using the bracket to hold it in place.

Insert the 5 grommets for wire leads passing through the chassis from the power transformer and output transformer.

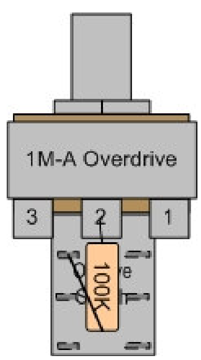
The front panel is installed and held in place by installing the pilot light, power switches, potentiometers and jacks. Ensure the potentiometers are located in the correct positions according to their values and the layout. There are locating holes cut into the chassis for the potentiometers, so they won't spin if the control ever loosens. For the jacks you probably will need only 1 fiber washer on the inside to mount them flush with the front panel.

TRIWATT Front View

If supplied, the rear panel is installed and held in place by installing the IEC mains connector, Mains strain relief, fuse holder, output jacks and possibly an impedance selector.

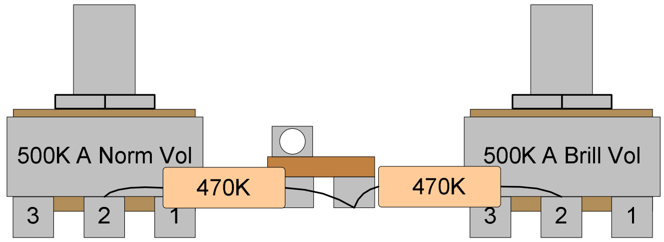
TRIWATT Rear

Some components are more easily installed on other components prior to installation. Use the following illustrations as a guideline.

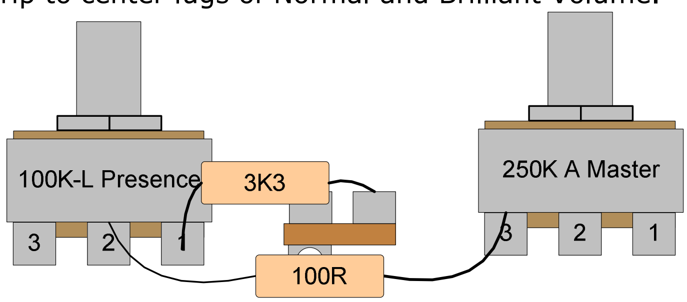


Before installing the Overdrive switch, pre-wire the switch with 100K resistor as shown. * This step not required when the relay board is being used for the footswitch option.

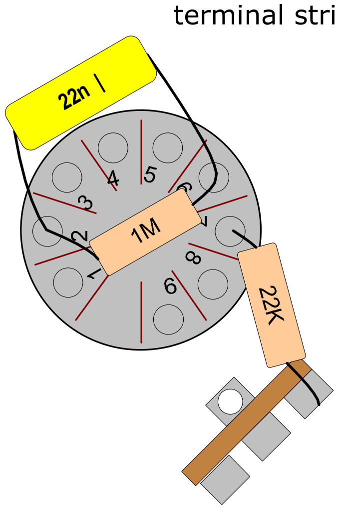
Inside the chassis, install terminal strips (several solder lugs or 'terminals' attached to an insulated strip) for the power connections, the 1K 5W plate resistors to the 6V6/KT66, and the 68K input resistors to V1, and V3's 22k resistor. See diagrams for the areas where these are used.



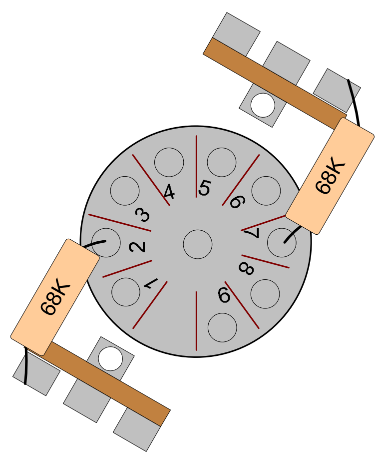
Install parts from terminal strip on chassis and parts on chassis. Connect 470K resistors from terminal strip to center lugs of Normal and Brilliant Volume.



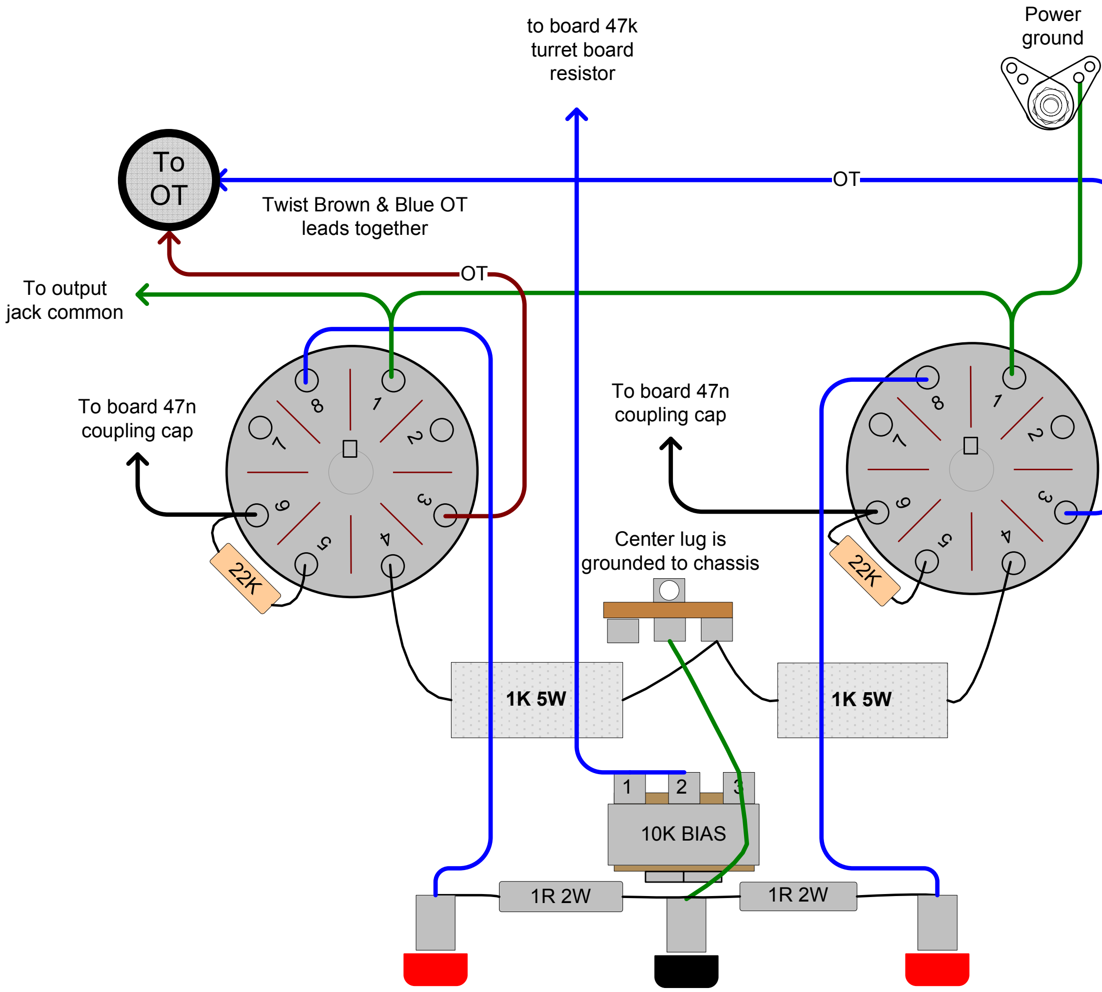
Install parts from terminal strip on chassis and parts on chassis. Connect 3K3 resistor from terminal strip to one lug of the Presence Control.



Install terminal strip on chassis and parts on V3 socket. Connect resistor from terminal strip to V3 socket

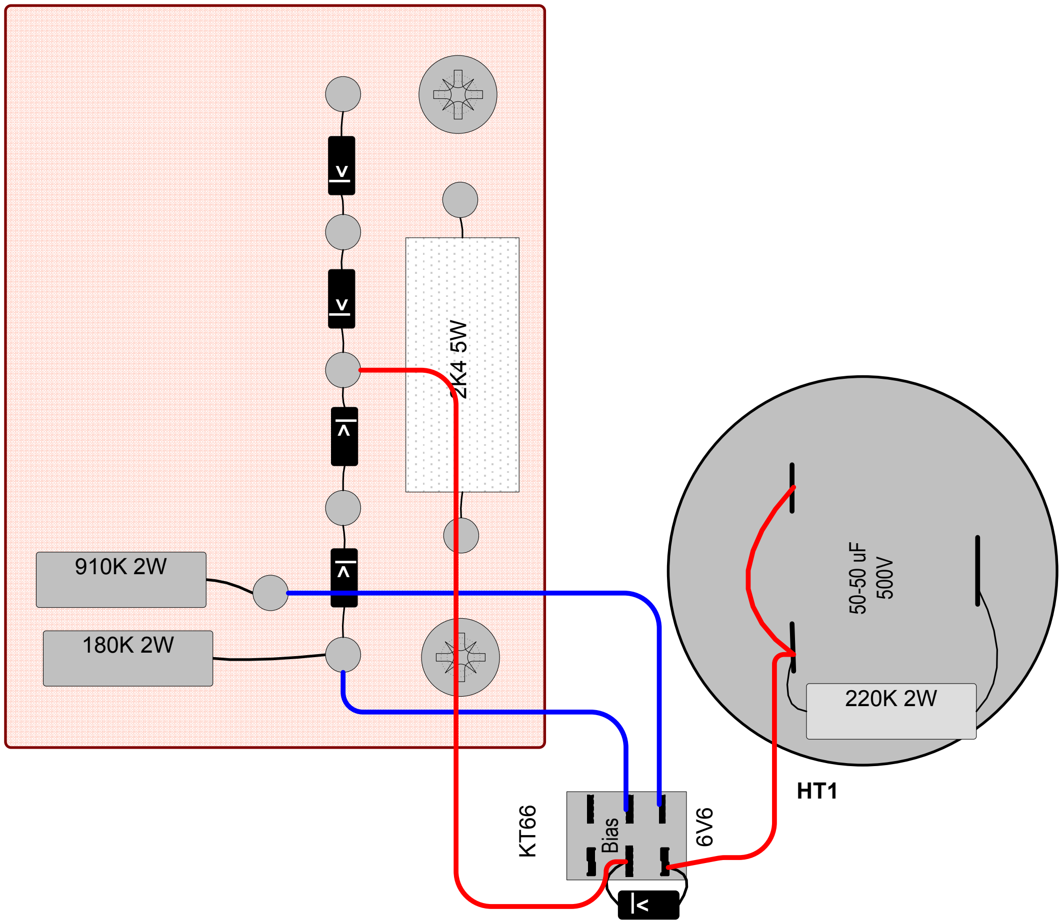


Install 2 terminal strips on the chassis. Connect 68K resistors from terminal strip to V1 2 & 7



Install terminal strip on chassis and 22K resistors on V5, V6 socket. Connect 1K5 resistor from 1 terminal strip common point (**NOT** the center lug which is connected to ground) and then on V5, V6 socket pin 4

Continue wiring up the bias terminal points (2-Red, 1-Black) with 1 ohm precision resistors soldered between them and the 10K bias pot and the connecting wires to the tube sockets. Solder the bias pot ground to the terminal strip center lug which is bolted to ground.



Wire up the bias switch so that in one position, the two resistors are connected to two terminals (center and outside) and the 18V 5W zener diode to the other two (center and outside) of the DPDT toggle switch.

Use care when soldering to the switch terminal so as not to melt the switch body.

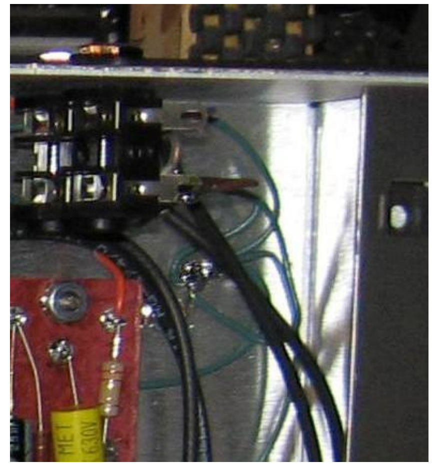
2 Wiring

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

- Use 20 gauge solid for hook up from board to tubes
- Use 20 gauge solid for hook up from board to pots/front panel
- Use 20 gauge solid stripped for turret board buss bar
- Use 20 gauge solid twisted pair supplied for tube heater wiring
- Use Yellow and Blue etc. 20/18 Gauge, stranded, for power supply hook up - to transformers, rectifier, standby etc.
- Re-use cut offs from the transformers for the power supply side as well.
- Use RG174U for input to V1 and as indicated on layouts
- Use green wires for ground wires.

Grounding Scheme

The TRIWATT use 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 that is located immediately beside the input jacks.



For grounding these amps, we strongly recommend that you follow the layout provided. We don't recommend that you deviate, but if you do, use a collected one-point star grounding scheme. Everything connected together and marked with the 'earth' symbol on the schematic is connected together locally, and then that local common is connected to the star point.

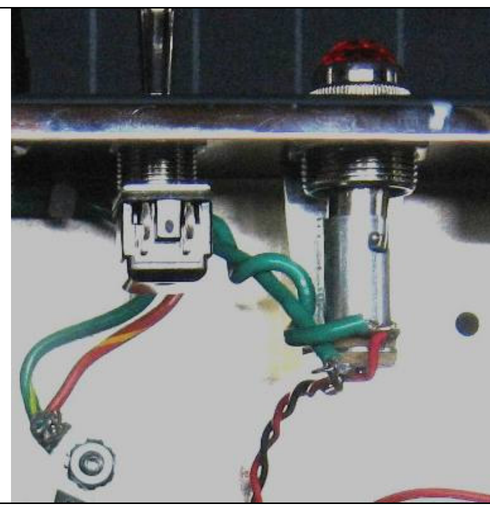
There is also a separate AC supply safety ground point near the IEC connector, which doesn't form part of the actual amplifier circuit. WARNING: THIS CONNECTION IS VITAL FOR SAFETY REASONS.

Install the pilot lamp socket if you haven't already.

Tightly twist the two green 6.3 V AC heater wires from the power transformer.

Connect the two 6.3V AC leads to the pilot lamp socket terminals.

Connect the Green-Yellow 0V 6.3V center tapped wire to the "Power" ground made of 3 #6 lugs connected to the chassis



Heater Wiring

For the heater wires, the two twisted 20 gauge wires connect to the pilot lamp socket and then to the terminals of the first Power Tube to pin 5, the other wire to same Power Tube but pin 4. Then these go to pins 4 and 5 respectively of the second Power Tube. From there, the wires daisy chain across the preamp tubes, one wire to both pins 4 and 5 of each preamp tube and the other wire to pin 9. This phasing or 'polarity' on the preamp heaters needs to be maintained. The two power tube sockets also need to have their heaters wired in the same phase (using the same colours) to reduce hum.

It is important to wire the tube filaments carefully. Use the pre-twisted 20 gauge wire to minimize any hum. Solder each wire to the pilot light assembly. Now route the twisted pair wire around the outside perimeter of the chassis, following the layout diagram, pressing it flat against the chassis. Connect the same color heater wire to the same pin(s) as you progress from tube to tube e.g. Red on pin 4 of both Octal sockets and Brown on pins 5. Do one tube socket at a time. Complete the 12AX7s using the same process. Red on pins 4 & 5 tied together and Brown on pins 9. Don't switch the heater wire polarity.

3 Install Transformers

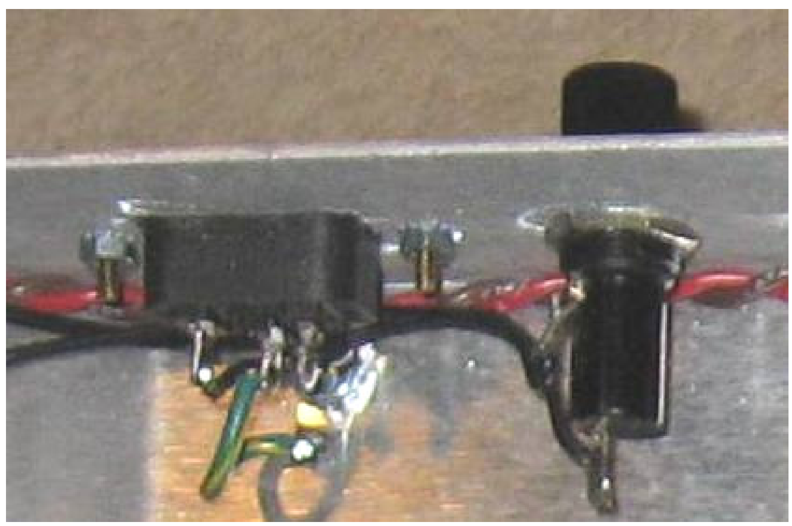
Install the power transformer. The Power transformer lies down along it's 'long axis'. Tightly twist the AC mains leads (Black/Black) together. Braid the High voltage (Red - Red/Yellow - Red) and the heater leads (Green – Green/Yellow - Green).

Align the AC mains leads so they face towards the outside of the chassis. The High voltage (Red - Red/Yellow - Red) and heater leads (Green – Green/Yellow - Green) face inwards. Feed the leads through the 3 grommets installed in the chassis with the High voltage and heater leads going through separate grommets. Bolt the transformer in place with the supplied 8-32 bolts & Keps nuts.

Install the Output transformer. The Output transformer lies down along it's 'short axis'. Braid the High voltage leads together (Brown – Red – Blue) and also braid the secondary winding leads (Yellow (4 ohm), Green (8), Orange (16) Black (Common).
Align the High voltage leads so they are pointing towards the Power transformer. Feed the leads through the 2 grommets installed in the chassis with the High voltage and Secondary lead going through separate grommets. Bolt the transformer in place with the supplied 8-32 bolts & Keps nuts. The secondary leads should be in-line with the impedance switch.

4 Power Supply Wiring

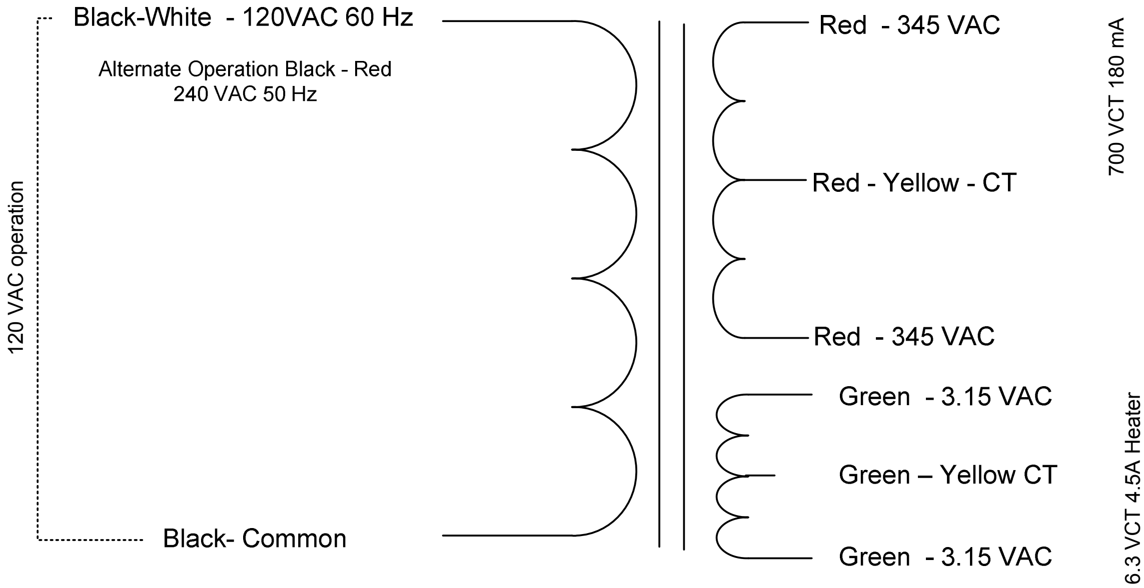
Now is the time to wire up the rest of the main power supply. Start with the IEC socket and ensure it is grounded to the bolt/lug on the chassis immediately beside the socket. Tighten the ground bolt tightly. Run a wire from the 'Hot' or 'Line' side of the IEC connector to the lug on the side of the fuse holder and from the end of the fuse holder to the power switch. Make sure the switch was installed with the desired 'On' position when the connection is 'made'.



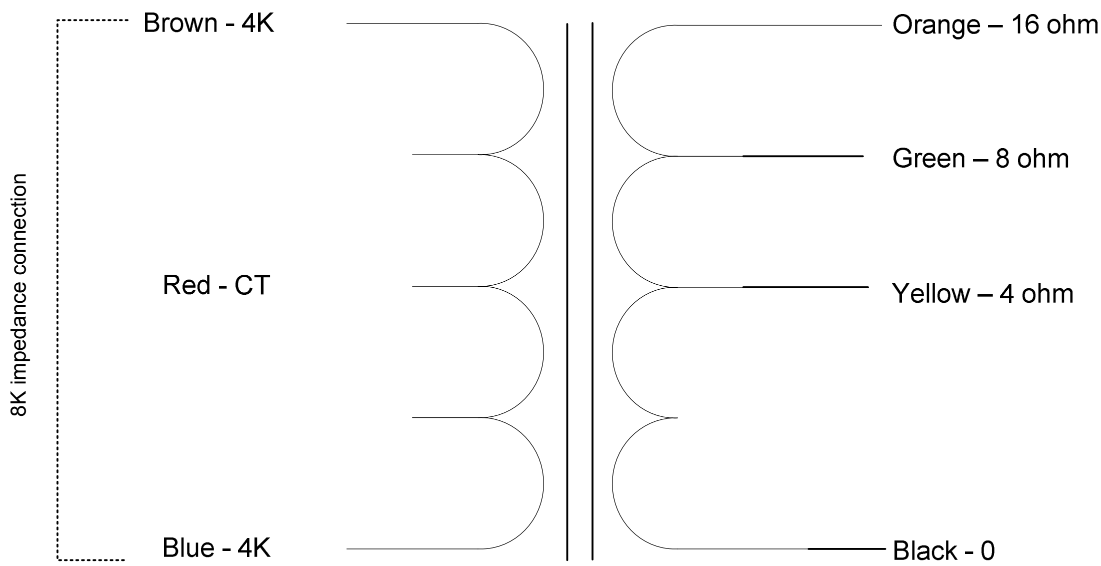
The other side of the IEC socket or 'Neutral' gets connected to the 'Common' side of the power transformer.

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.	

If necessary, tie off any unused taps that are is not required for the build. Tie it off by cutting off the exposed wire and then put heat-shrink over the end and then tuck it away as it is not used. You can also connect unused wires to a terminal strip.



Trinity Amps HTS-9642 Power Transformer

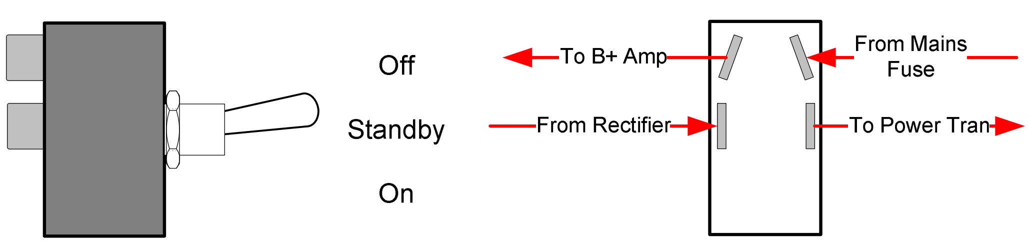


Trinity Amps HTS-9641-1 50EZ Output Transformer

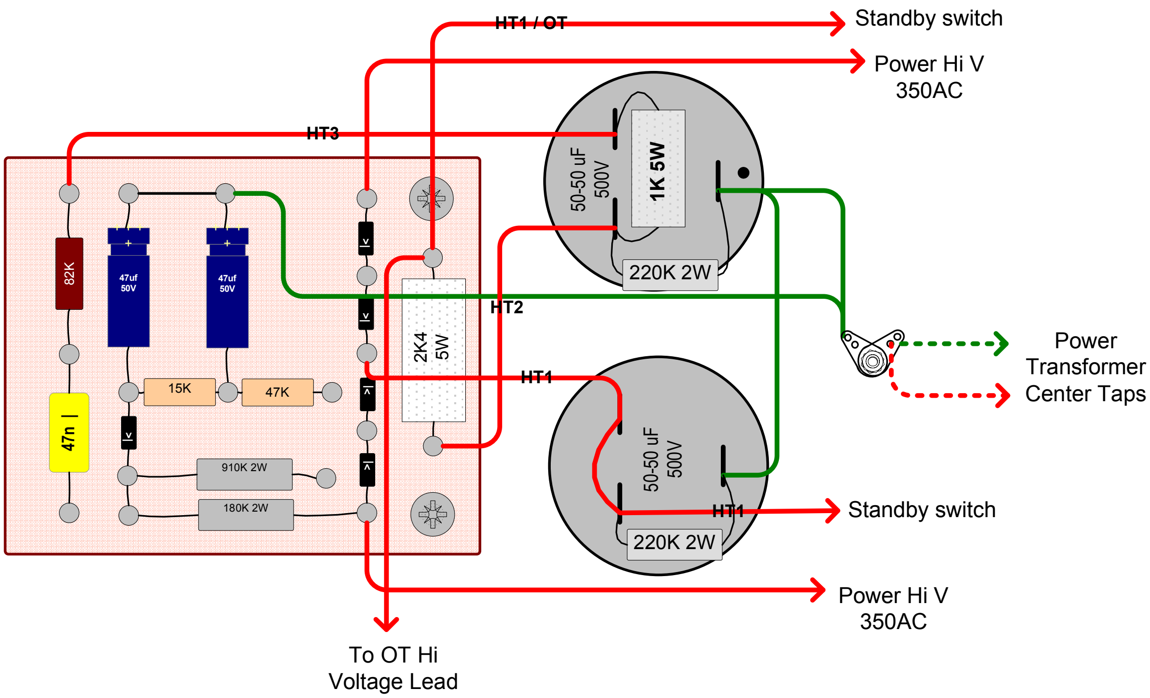
Wiring the Progressive Power Switch

This amp has a special power switch that combines both Power and Standby into one convenient switch. In one extreme position, the amp is Off, in the middle position it is on Standby and in the third position it is in the On position. This switch is **not wired up like other power switches** so follow the diagrams below and layout closely.

Make sure the switch is in the desired on position when it is on. Align according to the front panel. Connect the twisted leads to the AC side of the switch. Now connect the lead from the rectifier center position to the switch DC side, and then return to the board 2.4K resistor for the DC side.



Attach a wire to the other side of the standby contact and route that to one side of the can cap following the layout. From this point connect to the centre tap of the Output Transformer. Connect from the other side of the dual cap, and the 1K5 power resistor, to the turret board following the layout. Connect the centre of the can cap to the power amp star ground point.



Connect the center tap of the high voltage leads from the transformer to the power amp star ground point.

Test the Power Transformer

This is a good time to check your mains wiring to the power transformer and ensure all wires are safely connected or tied off.

Without tubes installed, mains supply **unplugged**, trannies **NOT** soldered to the board, get out an ohmmeter. Remove the pilot lamp from the 6.3 V assembly. Use an ohmmeter to verify that the connection points for the Power Transformer (PT) secondaries are open circuits. With no tubes and no pilot lamp, the 6.3VAC (Volts A C) secondary should be open circuit i.e. no continuity. With solid-state diodes, there is continuity to the filter caps. So, you will see an initial low resistance that increases with time as the filter caps charge. Use the continuity setting on your meter for this.

If all is well, solder in your transformer's low voltage secondary leads (120 or 230 volt primary). Don't solder in the High Voltage (HV) secondary. Also solder in your Output Transformer (OT) secondary.

Install your pilot lamp and the slo-blo mains fuse. Switch to standby for 1 second just to see the pilot come on nice and bright. This checks that the 6.3VAC supply line is not shorted and is properly connected to the lamp. If the lamp did not come on, check to see if the fuse blew. If not, try another lamp and do the 1-second power thing again. If the fuse blows, there is a short on the PT or mains. If the fuse survives, then it's likely that the 6.3VAC is not properly connected to the pilot lamp. Use your AC voltmeter to check for 6.3VAC (actually more like 7VAC with no tubes installed) at the lamp and all the tube sockets.

In the following steps, B+ is going to go to full voltage. **Be extremely careful**.

Assuming you now have a bright pilot light, connect your AC voltmeter to the power transformer's High Voltage secondary (which is still not soldered into the circuit). Turn the power on just long enough to get a reading to verify it is correct. You should get a value 10 to 20% higher than the rated output voltage of 700 VAC. Measure the AC voltages to ensure they are within spec of the provided transformer schematics and specs.
If you get a value less than the rating, shut down the amp and check the fuse. If you get a proper value from the HV secondary, power down and solder the secondary to the recto tube or diodes. Hook your Volt Ohm Meter (VOM) to the HV secondary again.

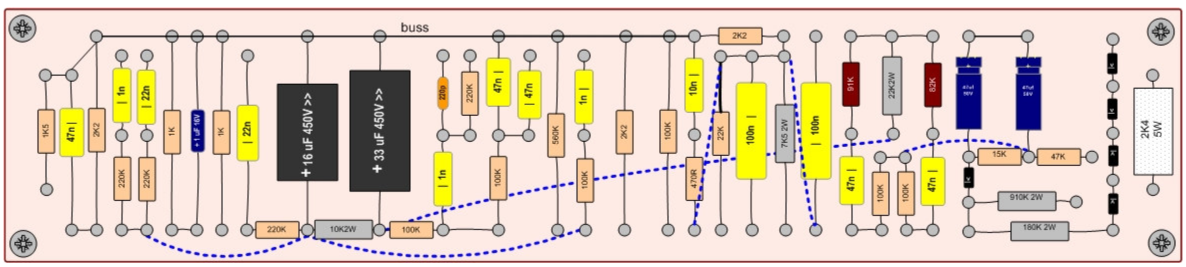
BE VERY CAREFUL at this point. Your B+ will charge up for this power up.

Connect up the Power Supply Filter Capacitors. If not already done, install the two 50+50uF can caps onto the chassis. These are held in place by a large clamp bolted to the chassis. **Take special note of the polarities of the can caps**. Identify the two positive terminals and orient the cap connectors as per the layout diagram. Attach the 1K5 filter and 220K 2W bleeder resistors to them. Connections to the ground terminals and chassis ground are now made. Also, install the jumper across the first filter cap between the two positive terminals. Wiring to the board will wait until the board is installed.

5 Turret Board Construction

If you do not have a pre-built Trinity amps turret board, now is the time to build it.

Install the 6 jumper wires on the underside of the board. Follow the pictures below.



TRIWATT Board

Strip a piece of the supplied 20 gauge solid core wire long enough for the buss bar. Bend it at each end and install the ground buss bar onto the board. Do not solder in place yet.

Carefully identify the board components and their values. Measure the resistor values to confirm. 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 diagram closely.

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.

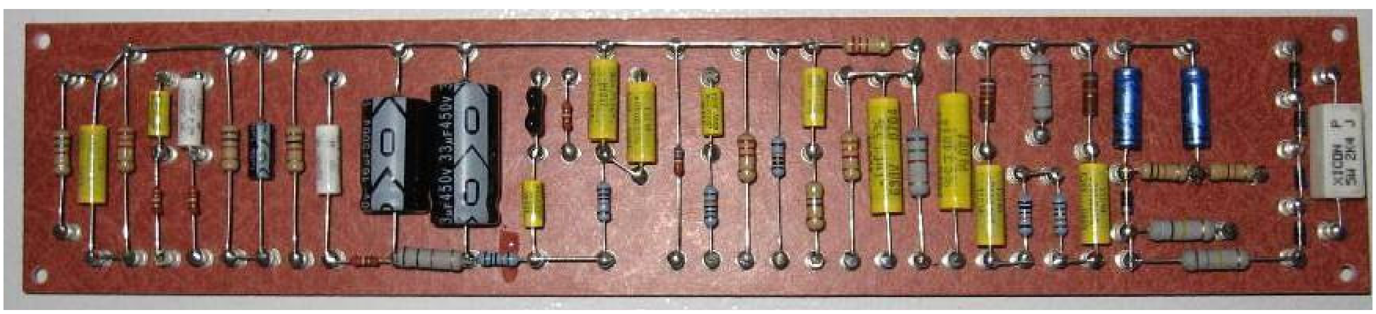
If a signal travels into a coupling capacitor and enters the outside foil side, this will act as a shield, minimizing induced noise interference. Ideally you would be able to connect the outer foil to the incoming signal point or to the lower impedance stage. For capacitors that are used as cathode bypass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

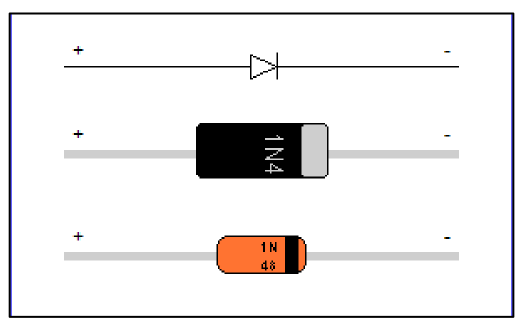
Set your oscilloscope to a low AC setting [10 - 20mV] and hold the capacitor between your fingers to induce noise. Connect the oscilloscope probes to the capacitor leads. One orientation of leads will result in a lower reading. In this case, make note of the lead that is connected to the oscilloscope 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 TRIWATT board layout.

Install the components on the board by following the layout – from left to right.

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



TRIWATT Completed Board Top View



Diode Orientation: Pay particular attention to the orientation of the 5 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 1N4007 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.

Now, cut connecting wires to the control side in various colors to about 9” to 12” long each and to about 6” long to the tube pin side. We suggest you confirm the approximate lengths before cutting.

Use 18/20 gauge stranded wire for connections to ground, power switch, B+ to output transformer and diodes. These can be cut-offs from installing the transformers or any provided wire.

Following the layout, install the connecting wires to the bottom of the board leaving plenty of extra length, wire is cheap, and it'll save aggravation later.

When the board is built, double check all components, jumpers and leads against the layout. If all is correct, carefully install the board into the amp. Locate the 4 -#6 X 1” screws, spacers and lock nuts. At one end, put two screws through the chassis, install spacers, align the board holes and install the board. Loosely tighten nuts. Repeat at other end and then tighten nuts firmly.

6 Connecting the Turret Board

Now is the time to make the connections from the turret board to the tubes.

Tip: On a copy of the layout, highlight the connections as you complete them to make sure they are done correctly.

Also, some tube sockets require components or jumpers to be installed on them.. Some builders prefer to do this work out of the chassis. Pre-form these components to fit into place and you may use some heat shrink tubing make sure they do not touch other parts or pins especially the jumper on V4. Solder the parts in place following the layout provided keeping in mind what connections to the board still may need to be made.

Start at the V1 end of the amp and work your way sequentially to V6 doing the point-to-point wiring. Board to tube pin; board to tube pin etc. Start at V1, pin 1 and move to the far end of the board to V6.

Do not connect the leads to the power supply or diodes yet.

7 Connecting the Turret Board to Controls

Now is the time to make the connections from the turret board to the potentiometers.

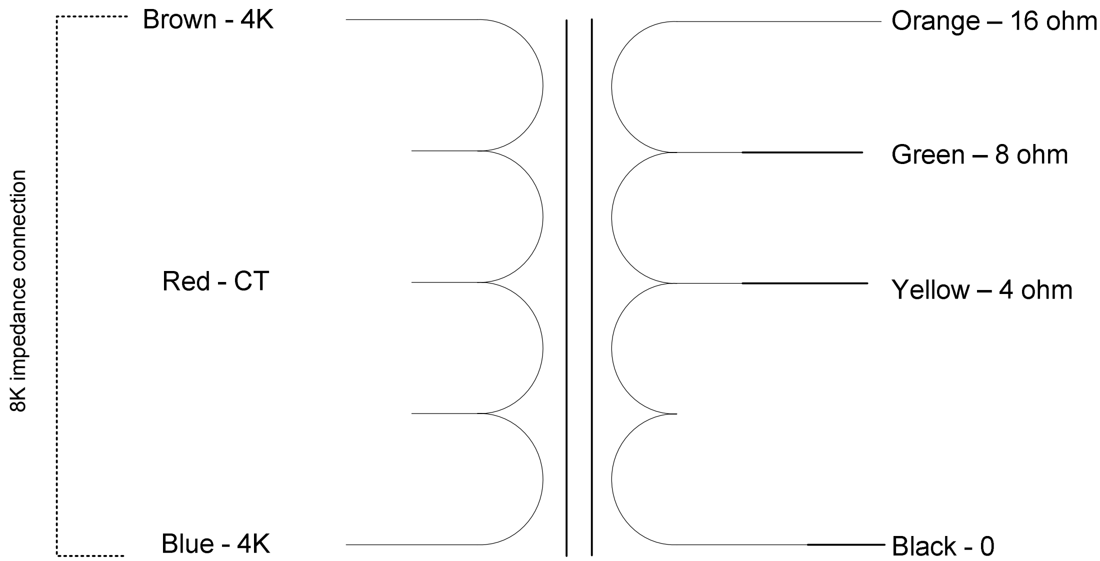
The easiest way to wire these correctly is to follow the layout, and do one terminal connection at a time. Some of these terminals require more than one wire connection, so arrange these accordingly and solder once.

Some controls may require components need to be installed for tone controls etc.. Pre-form these components to fit into place and use some heat shrink tubing ensure they do not touch other parts. Solder them in place following the layout provided.

8 Output Transformer - Output Jacks

Refer to the Output Transformer schematic. Twist the Blue & Brown output leads from the transformer to the output tubes. Leave enough transformer lead length to reverse the leads from one 6V6/KT66 to the other if necessary to eliminate amplifier squealing.

Start by soldering the Brown output lead to V4 and the Blue to V5.



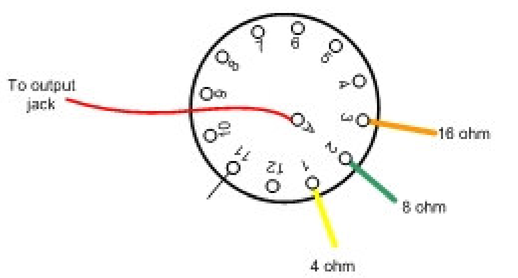
Trinity Amps TRIWATT Partridge Output Transformer

Connecting the Impedance Selector

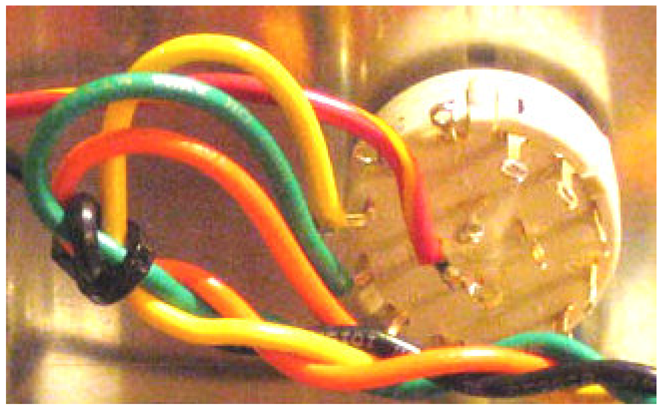
Referring to the Output Transformer schematic above, wire up the Impedance Selector to the transformers and output jacks paying particular attention to the leads for the correct impedance. Refer to the diagram below for the connections.

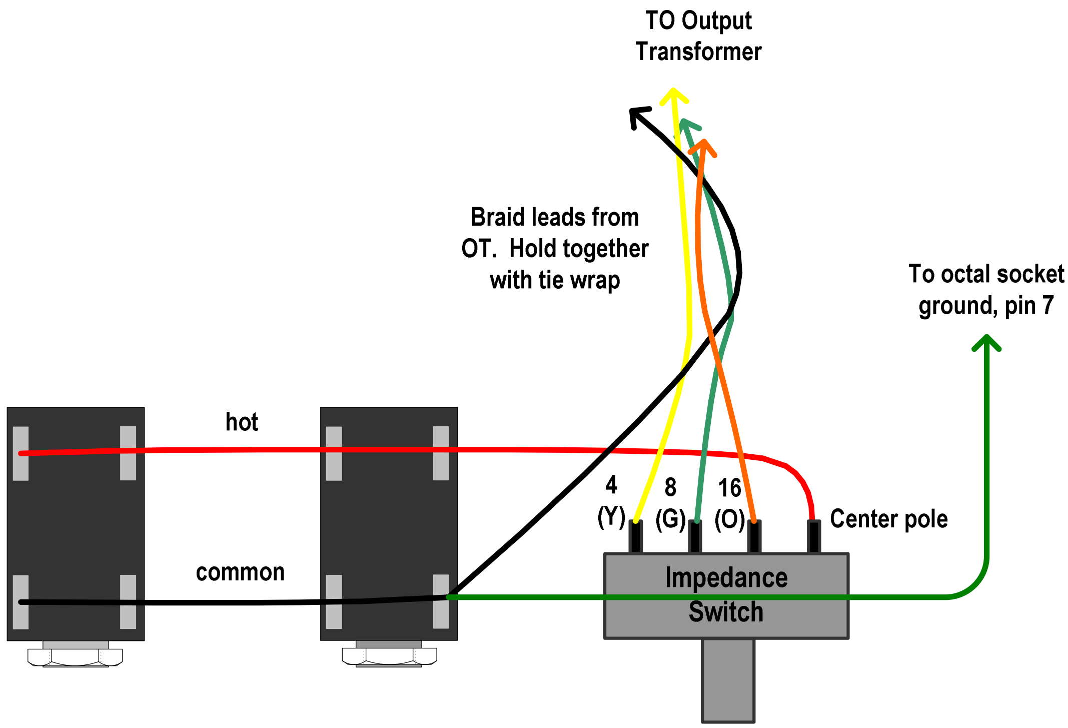
Important Note: Set the switch to 3 positions only. If not pre-set, then adjust the number of positions by turning the switch fully anti-clockwise and then rotating the tang washer provided to adjust number of positions (3). The tang on the flat side sets the switch for three positions.

Tang Washer



Impedance Switch Rear View
5A hook-Up





Connect from the center pole of the switch to the Tip position of the pair of output jacks. Use some cut-off stranded wire and strip enough wire to bridge between both jacks. Connect from the output transformer's Common / Black lead to the Ring position of the pair of output jacks. Strip enough wire to bridge between both jacks. Follow the layout and remember to connect the jack common to ground at the power tube sockets.

Check your speaker jack with and without a speaker plugged in to make sure it isn't shorted.

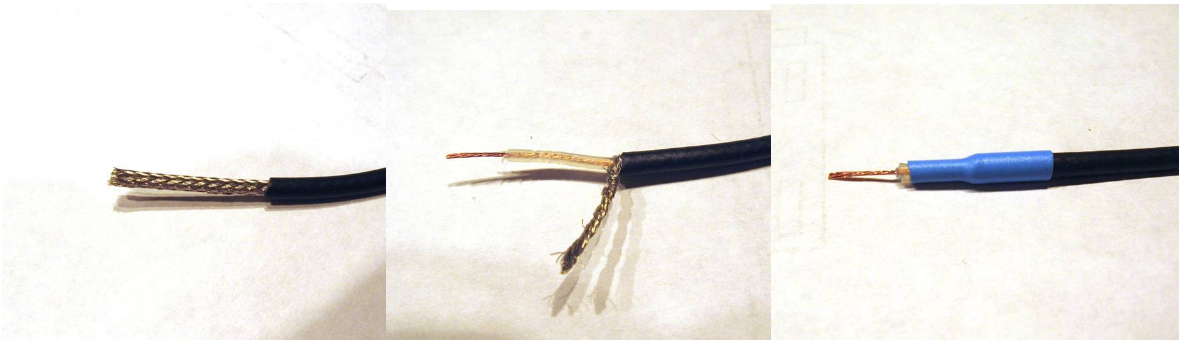
9 Input Jacks

Wire up the input jacks. Use shielded wire from the input jacks to the tube and be careful when wiring switched input jacks. It is easiest to remove the jacks, wire them with the resistors and jumpers and then reinstall them. The ground wires on the input jacks go to the pre-amp ground along with the board ground at that end.

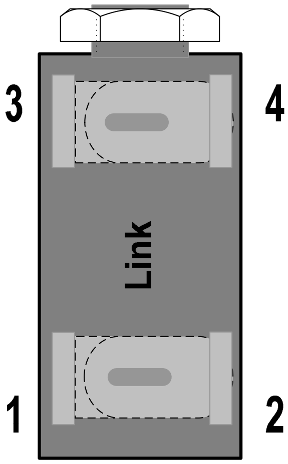
To prepare the co-axial cable for connections:

1. Cut back the outside plastic covering at both ends by about 5/8" to reveal the braided shield.
2. At on end, pull back the shield and cut it off at the 5/8" mark. Put some heat shrink around the end covering the area where it was cut off.
3. At the other end, pull back the shield but poke a very fine screwdriver or pick into the shield and work out a ‘hole’. Fish the inside conductor through this hole and pull it through.
4. Twist the braid together.

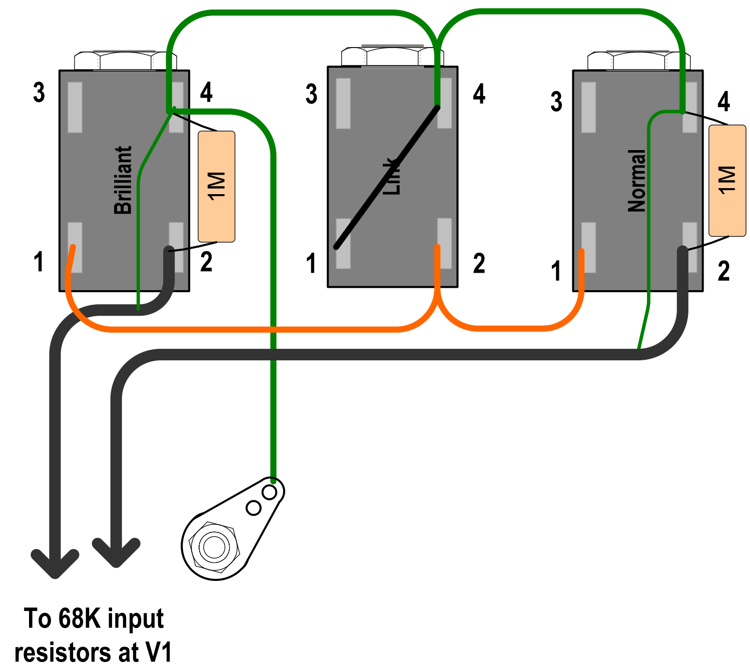
5. Finally, cut back the outside plastic covering on the inside conductor at both ends by about 1/4"



Cliff Jacks - Cliff Jacks have 2 normally closed contacts and 4 terminals. The contacts open when a ¼" plug is inserted into the jack. The Tip connection is at the very end of the plug and is normally 'positive' polarity. This is sometimes referred to as the 'Hot' side. The other part of the plug is typically ground or 'common'.



Bottom view of a Cliff Jack showing the hidden connections, underneath with dotted lines



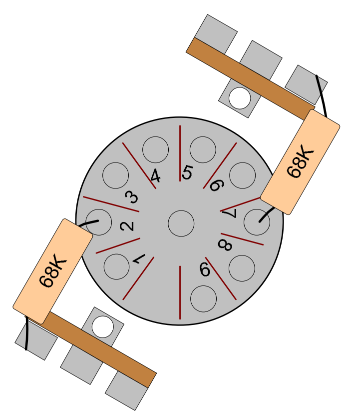
On the input jack end, connect the 2 shields together, and connect them to the ground point on the jacks, which in turn go directly to the pre-amp ground. Do not connect the shields at both ends of the cable or you will induce hum.

Measure enough shielded cable to reach from the input jacks to the terminal strip, routing the cable around the end of the turret board. Prepare the shielded cable for connection and put some heat shrink over the end to ensure there is no chance the shield will connect to ground or touch the tube pins. Solder the shielded cable centre conductor to each 68K resistor on each tag.

Input to V1

If you haven't already, install 2 3-lug terminal strips at the base of V1 closest to the board. Use the tube socket mounting bolt to hold the strip in place.

Connect the two 68K input resistors from two of the tags to the input (pin 7 and pin 2) of V1. Make the end that connects to the input pin 7 as short as possible.



Input to V1

9 Final checkout

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.

10 Power Up

REMEMBER: DO NOT OPERATE YOUR AMP WITHOUT A LOAD

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.

Complete all the basic circuit checks already mentioned before soldering the transformers into the rest of the circuit. **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.

Install a 2 AMP SLO BLO fuse.

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.

Test the 6.3 AC filament voltages and ensure they are on the correct pins for all tubes. Remember this is AC voltage, not DC so set your meter.

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 turret board 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:
- pilot lamp comes on brightly; and
- High Voltage secondary goes 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. The included 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, 700VAC across the full secondary in the above steps, then each half is delivering 350VAC. B+ will be ~40% above this, which is ~490VDC.

KEEP IN MIND that every time you power up from now on that B+ will be high. In all the following, 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 killed 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 put some tubes in. Power down and install all the signal tubes. 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 and gain pots all the way down and tone controls to center. Turn the 10K bias control pot all the way down (fully anti-clockwise) to start (most negative grid voltage possible). Power up and, again, watch for the following signs:

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

Bias Setting: Check power tube current and bias appropriately soon after power up to make sure all is well.

Set the tube selector toggle switch to select your type of power tubes - 6V6 or KT66.

Set your meter to the mV scale. With the 10K bias control pot all the way down (fully anti-clockwise), insert the black (negative) test probe into the Black bias test point jack. Put the other into the Red bias test point jack.

Turn on the amp

You should have a small reading in mv. Since you are measuring across a 1 ohm resistor, then this is the equivalent ma bias. i.e. 10mv on your meter is reading 10 ma bias.

Slowly move the pot with a small screwdriver until the readings are as follows:

6V6 Bias	15 ma min	23 ma max
KT-66 bias	30 ma min	40 ma max

You should be able to hear a little hiss or hum from the speaker. Of course, hopefully this is at a low level, requiring your ear up next to the speaker to tell (make sure the Overdrive control is pushed in -ie Off). If hiss and hum is loud at this point, there are problems. If there is dead silence, something is likely wrong, too.

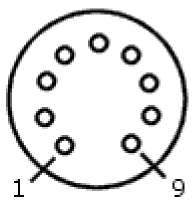
With the bias set correctly, you can now test all the voltages and compare them with the voltage chart. Measure and write down the B+ levels at each filter cap. Also write down cathode and plate voltages at all stages and also the screen grid voltage at the power tubes. Compare all the DC voltages to those on the supplied Voltage Chart. As a rule of thumb, the triode gain stages should have ~1V on the cathode, 0V on the grids and ~1/2 to 1/3 B+ on the plates. If the DC voltages are not in the ballpark (within 50% of the general rule just stated), take some time to check the circuitry of the offending stage. If you have a cathode follower in the signal path, the grid should be at the plate voltage of the previous stage and the cathode should be about a volt higher.

If all seems in order, and the fuse has not blown, turn the volume up a bit. Plug in a guitar input 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.

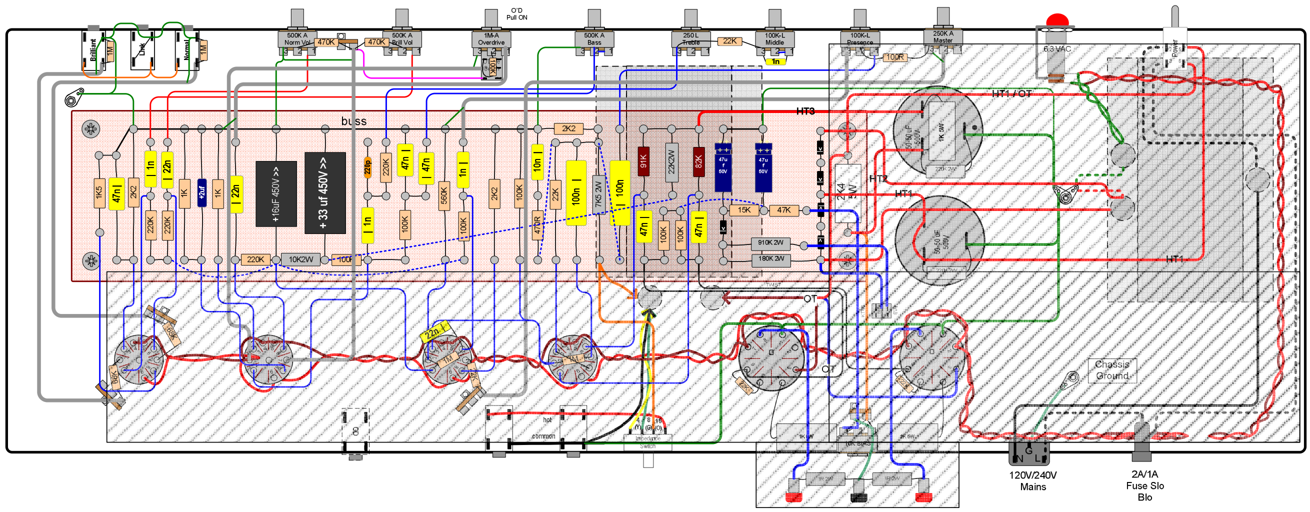
Hopefully, there are no problems but if you think there are e.g. hum, squeal etc., then move on to the troubleshooting section of this manual.

Trinity TRIWATT 6V6 Voltage Chart

AC Mains Voltage 122VAC;B+ 460 VDC no tubes installed;442 VDC with tubes



12AX7/12AT7			6V6						
TUBE	**Pin 1**	**Pin 2**	**Pin 3**	**Pin 4**	**Pin 5**	**Pin 6**	**Pin 7**	**Pin 8**	**Pin 9**
V1 (12AX7/ECC83)	150	0	1.2	--	--	120	0	1.0	--
V2 (12AX7/ECC83)	179	0	1.2	--	--	106	0	0.7	--
V3 (12AX7/ECC83)	269	67	71	--	--	188	0	1.5	--
V4 (PI) (12AT7/ECC)	274	71	74	--	--	236	64.4	74	340
V5 6V6 (1)	0	--	441	411	39 *	39 *	--	0.02	
V6 6V6 (2)	0	--	441	411	39 *	39 *	--	0.02	



The shaded area in the above layout above indicates areas of the TRIWATT where you should take extreme caution. There are voltages in this area in excess of 450 VDC.

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. TRIWATT 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.

Tone Tweaking

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

V1 Pin 8 - Townshend/Who CP103 1k5 + 64uF
V1 Pin 8 - Jimmy Page amp 2k2 + 100uF with additional parallel 1k5 resistor
V1 Pin 8 - SAP DR 103 2k2 + 100uF (no additional resistor)
V1 Pin 8 - Late '70s, Late '80s and OL/Lead 1k5 + 150uF

V2 Pin 3 - Townshend /Who CP103 2k2 + 47nF (47nF = .047uf)
V2 Pin 3 - Page/SAP DR103 1k5 + 47nF

If you want to mod your TRIWATT to any of these versions, solder the extra components onto the existing turrets.

Normal channel gain can be reduced a little more by changing the cathode resistor on V1 Pin 8 from 1k5 to 2k2, like in early '70s models. Just another small tweak you may want to consider.

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 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 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.
- Add grid stopping resistors to help tame oscillation. If you have oscillation with your amp, you can sometimes help it by installing grid stopping resistors. The grid stoppers can also subtly roll off high end as well.
- Add high frequency roll off caps in parallel with the plate resistor. This is sometimes used to "mellow" out a stage (reduces highs).
- 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 1 - Tube Substitutions

12AX7 - **High-Mu Twin Triode**
Close or identical : 12AX7R, CV10319, CV492, ECC83
Different rating or performance : 12AX7A, 12AX7S, 12AX7WA, 5751, 5751WA, 6057, 6681, 6L13, 7025, 7382, 7494, 7729, B339, CK5751, CV4004, CV4017, CV8156, CV8222, CV8312, E2164, E83CC, ECC803, ECC803S, ECC863, M8137, QB339

12AT7 - **Medium-Mu Twin Triode**
Close or identical: CV10662, CV455, CV8154, CV9859, ECC81
Different rating or performance: 12AT7WA, 12AT7WC, 6060, 6201, 6679, 7492, 7728, A2900, B152, B309, B739, CC81E, CK6201, CV4024, E2157, E81CC, ECC801, ECC801S, M8162, QA2406, QA2407, QS2406

6V6GT – Audio Beam Tetrode Power Tube
Close or Identical: 5871, 6AY5, 6P6C*, 6V6, 6V6G, 6V6GTA, 6V6GTY, 6V6Y, 7184, CV509, CV510, CV511, OSW3106, VT107, VT227, WT2100082, WTT123, 6Pi6

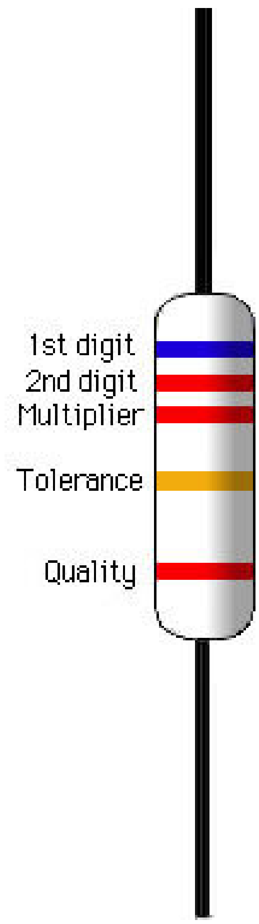
KT66 - Audio Beam Tetrode Power Tube
Close or identical CV1075, CV321, VT75(RAF)

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 - 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 TRIWATT, 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 TRIWATT, it is measured between the joined lugs of the 50+50 cap and chassis ground. It should be about 450 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: For the impedance switch, do I use the 5 amp or 20 amp wiring?   From the layout I would guess the 5 Amp.
A: Use 5 A for the impedance switch. The amp is fused at 2A anyway, so 5 is plenty.

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 20 Gauge solid for hook up to tubes;
Use 20 Gauge, twisted tightly for tube heater wiring;
Use 20 Gauge solid/stranded for hook up to pots/front panel; and
Use 18 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): 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?
A: 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 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.

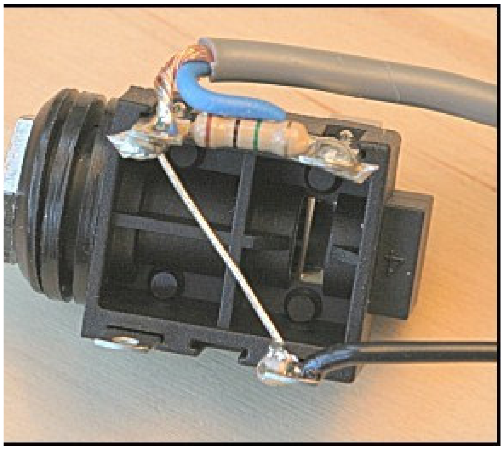
TIP: Sometimes it is hard to decode the resistors colours. It is a good idea to check the resistances of these parts before assembly.

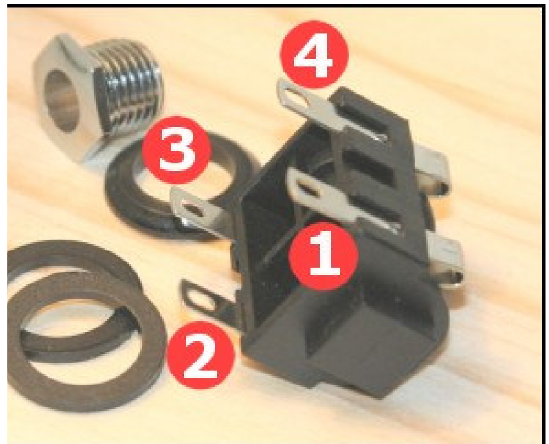
TIP: Use insulation tubes from the wiring on the resistor / cap leads around the tubes and pots by using longer pieces of insulation stripped from the supplied 20 ga wire.

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 ga solid for heaters. It is rated for more than 5A/600Volts.

Appendix 5 - Cliff Jacks Explained

Here's a Cliff-style jack wired for a single input.





With no guitar plugged in, there's continuity to ground for lugs 2 and 4 (a direct connection) and also for lug 1 (it's not switched and therefore mechanically connected to lug 2 with the crossover wire). With a guitar plugged in, the switching breaks, and now there's only continuity between lugs 2 and 4 and ground. Of course, with a guitar plugged in, you'll read a resistance of 6-12K for lug 1 to ground - depending on your pickups. If your guitar's Volume pot is at zero, you'll find continuity to ground instead.

You should get continuity between the tip and chassis with nothing plugged in because of the shorting jack and the cross over wire. From 18W Forum – loverocker & ebe

Hardware

There are many nuts bolts etc. required. Here are some guidelines.

Part	Qty	Where to use
4-40 X 5/16 (no nuts reqd.)	20	Mount tube sockets, [optional lock washer under head on threaded chassis];
4-40 nuts	12	Mounting terminal strips, ground point, IEC socket
4-40 X 7/16	*8*	*If supplied – to mount tube sockets with terminal strip, use nut to hold terminal strip with nut/lock washer or lock nut. Use with nuts/lock washer to mount IEC connector, 5 lug terminal strip and 1-#4 pre-amp chassis lug. Mount tube sockets on **non-threaded chassis** with lock nut*
6-32 X ½	5	Mount 3 power ground # 6 chassis lugs with lock nut. Mount Capacitor clamp
6-32 X 1-¼	4	Mount turret board to chassis using stand-off. Use with lock nut.
8-32 X ½	1	Mount Mains ground **ONLY**. Use additional lock washers with #8 chassis lug.
8-32 X ½	8	Mount Output and Power trans. with lock nuts.
8-32 lock nuts	9	8 "Keps" for power transformer; 1 "Keps" for ground bolt.
10-32 X 1-½	4	Mount chassis to cabinet. Use cage nuts in square holes pressed into chassis.

Appendix 6- TRIWATT Bill of Materials

	QTY	DESCRIPTION	COMMENTS
	2	M FILM RES 2W 1 OHMS 1%	
	1	1W C FILM RES 100 OHMS	
	1	1W C FILM RES 470 OHMS	
	3	5W POWER RES 1.0K OHMS	
	2	1W C FILM RES 1K OHMS	
	1	1W C FILM RES 1.5K OHMS	
	3	1W C FILM RES 2.2K OHMS	
	1	5W POWER RES 2.4K OHMS	
	1	1W C FILM RES 3.3K OHMS	
	1	2W M OXIDE RES 7.5K OHMS	
	1	2W M OXIDE RES10K OHMS	
	1	1W C FILM RES 15K OHMS	
	5	1W C FILM RES 22K OHMS	
	1	2W M OXIDE RES 22K OHMS	
	1	1W C FILM RES 47K OHMS	
	2	1W M FILM RES 68K OHMS	
	1	C COMP RES 82K 1/2W	
	1	C COMP RES 91K 1/2W	
	6	1W M FILM RES 100K OHMS	
	1	1W M OXIDE RES 180K OHMS	
	4	1W M FILM RES 220K OHMS	
	2	2W M OXIDE RES 220K OHMS	
	2	1W M FILM RES 470K OHMS	
	1	1W M FILM RES 560K OHMS	
	1	1W M OXIDE RES 620K OHMS	
	4	1W M FILM RES 1M OHMS	
	1	CAP SILVER MICA 220PF @500V	
	4	CAP, MALLORY 150 .001 µF @ 630	
	1	CAP MALLORY 150'S .01 µF @ 630 V	1n
	3	CAP MALLORY 150'S .022 µF @ 630 V	22n
	5	CAP MALLORY 150'S .047 µF @ 630 V	47n
	2	CAP, MALLORY 150 0.1 µF @ 630	
	1	CAP 1 UF 50 V AXIAL ELECTRO	
	1	CAP 16 UF 500 V AXIAL ELECTRO	
	1	CAP 33 UF 450 V ELECTRO	
	2	BCC GP AX ACAP 63V 47uF 150mA 6.5x18	
	2	CAP, ELECTROLYTIC, 50/50 µF @ 500 VDC	
	5	DIODE FAST 1000V 1A DO-41	
	1	18V 5W ZENER DIODE 1N5355 DO-41	
	1	10K BIAS TRIM POT	
	2	POT - ALPHA, 100K LINEAR, 3/8" BUSHI	
	1	POT - ALPHA, 250K LINEAR, 3/8" BUSHI	
	1	POT - ALPHA 250K, AUDIO TAPER, 3/8	
	3	POT - ALPHA, 500K AUDIO, 3/8" BUSHIN	
	1	POT - ALPHA, 1 MEG AUDIO W/DPDT SWITC	
	4	SOCKET 9 PIN TOP MOUNT MICALEX BELTON	
	4	SHIELD SILVER ALUM WITH BASE	
	2	SOCKET OCTAL MICALEX	
	2	TUBE CLIP OCTAL	
	1	CARLING PROGRESSIVE SWITCH	

	1	ROTARY SWITCH SHORTING 2-12 POS	
	1	DPDT ON-ON 5A/125V	
	9	KNOB - CHICKEN HEAD BLACK	
	5	JACK, MONO INPUT, METAL NUT	
	1	SCREW TYPE FUSEHOLDER CSA	
	1	FUSE SLO-BLO 2 AMP	
	6	TERMINAL STRIP 3 LUG 2ND LUG COMMON HO	
	1	JEWEL, RED, REPLACEMENT FOR FENDER	
	1	PILOT LAMP HOLDER REPLACEMENT FOR FEND	
	1	DIAL LAMP #47 T-3-1/4 6.3V .15 AMP BAY	
	1	IEC AC CHASSIS JACK CSA/UL	
	2	CLAMP, CAP 1-3/8" DIAMETER	
	2	BANANA JACK RED	
	1	BANANA JACK BLACK	
	5	HEYCO SNAP BUSHING SB 375-4 BLK	
	12	MACHINE SCREW NUT W/TOOTH WASHER 4-40	
	20	MACHINE SCREW 4-40 THREAD, 5/16" LEN	
	1	TERMINAL LUG LOCKING TINNED#4	
	4	NYLON SPACER .500 STD	
	3	TERMINAL LUG LOCKING TINNED#6	
	5	MACHINE SCREW NUT W/TOOTH WASHER 6-32	
	4	MACHINE SCREW 6-32 THREAD, 1" LENGTH	
	5	MACHINE SCREW 6-32 THREAD, 3/8" LENG	
	9	MACHINE SCREW HEX NUT 8-32 SCREW	
	9	MACHINE SCREW 8-32 THREAD, 3/8" LENG	
	1	TERMINAL LUG LOCKING TINNED#8	
	4	18-8 SS MACHINE SCREW 10-32 THREAD, 1	
	4	10-32 CAGE NUT	
	1	CORD, POWER, 3 CONDUCTOR, IEC 8', 18	
	1	CHASSIS TRIW ALUM HEAD	
	1	TRIWATT TURRET BOARD	
	1	TRIWATT PANEL	
	4	1/8 INCH HEAT-SHRINK TUBING (IN)	
	10	TIE WRAP 3 IN	
	4	1/16 INCH HEAT-SHRINK TUBING (IN)	
	6	BELDEN #26 PE BRD PVC, BLK FT.	
	15	20 GA. SOLID CORE WIRE FT	

Trinity Amps Schematics and Layouts