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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 Fender forum.

The Fender Amp Field Guide is a terrific resource for all amps Fender

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
Aron from diystompboxes.com

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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!
# Version Control

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Change</th>
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<tr>
<td>2.0</td>
<td>1 Oct 12</td>
<td>New issue for New board &amp; layout</td>
</tr>
<tr>
<td>2.01</td>
<td>6 Oct 12</td>
<td>Added 240V Transformer Wiring layout</td>
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<tr>
<td>2.1</td>
<td>16 Jul 13</td>
<td>Updated BOM; Note on transformer mounting added.</td>
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<tr>
<td>2.2</td>
<td>8 Mar 14</td>
<td>Note added to test PT AC voltages before proceeding.</td>
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<tr>
<td>2.3</td>
<td>9 Jun 14</td>
<td>Clarified start up procedure with numbered steps.</td>
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<tr>
<td>2.4</td>
<td>6 Aug 14</td>
<td>Added HI Capacity PT and 8/4 Ohm OT</td>
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<tr>
<td>2.5</td>
<td>28 Jan 15</td>
<td>BOM Updated, Added Optional PI resistor; clarifications mad; input jack theory added</td>
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<td>Updated eyelet board layout ; added power transformer testing section</td>
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<td>25 Aug 18</td>
<td>Updated 240V layout picture</td>
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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 manufacture. 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. Here 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.
Full middle boost with no bass or treble actually gives a near-flat frequency response, allowing you to hear the natural sound of your pickups.

**Fender and Marshall tone controls**

Here are circuit diagrams of typical Fender and Marshall tone controls. They both meet the criteria of compensating for pickups' low-middle emphasis, as well as providing a useful range of tone adjustment.

![Circuit diagrams of Fender and Marshall tone controls.](image)

**Fender Tone Controls**  
**Marshall Tone Controls**

The Fender and Marshall circuits are each tailored to suit their own styles, which are quite different. Although a generalization, Fender's market and consequently the power output stage are geared towards provided clean and chunky tones at clean and early-overdrive levels. Marshall amps are best at low-middley and crunchy rock tones, played at medium to high overdrive levels.

Here is a simple comparison of Marshall and Fender response with what might loosely be called 'typical settings' of Bass on 3, Middle on 4, and Treble on 6. The most obvious difference is that the Marshall lets more level through, and their tone controls have less range of adjustment. The higher level means that by using the same number of preamp tube stages, a Marshall can overdrive the output stage more.
Bearing in mind that 6-string guitar notes don't go below 80Hz, and typical guitar speakers cut above about 5KHz, these responses are similar. Both have a middle dip that is primarily compensation for typical pickups' middle emphasis, rather than an obvious dip in middle response. The Marshall circuit has this cut about an octave higher than the Fender, leaving the low mids and bass intact for that full Marshall sound. On the other hand, Fender's tone controls allow high-mids to pass with the treble response, and add little bass boost for the sparkling and tight sounds they're famous for.

Here are charts each of the Fender controls. In all cases, the other two controls are left at 5. For example, the treble chart shows the effect of varying Treble from 0 to 10, with Bass and Middle both at 5. Notice that all controls have a wide range of adjustment, and that the bass control has most effect from 0 to about 3. Anyone who has used a Fender will know this, and this control could easily be replaced by a control with a stronger logarithmic taper to smooth this out without changing the range of available tones.
The Fender circuit also has the unusual side effect that if all controls are set to 0, then no sound is produced at all. The Marshall design avoids this, but the tone with all controls set to 0 is not something you’d be likely to use anyway.

Here are the same charts for Marshall tone controls. As mentioned already, the main points to note are the smaller range of adjustment, the higher frequency for the middle cut control, and the higher overall signal level. The smaller adjustment range and higher level are both caused by the use of the 33K resistor in place of Fender's 100K. The also gives the tone stack a lower input impedance, requiring it to be fed from a lower output impedance (cathode follower) preamp tube stage.
Tube power amplifiers often provide an additional presence control (which reduces negative feedback in the power amplifier section) to provide a small amount of boost at frequencies above the treble control.

**Interactive Volume Controls – Fender Tweed Amps**

The Tweed has what’s referred to as “interactive volume controls”. This is also a characteristic of the Tweed Bassman, Twin, Super, Bandmaster etc.
In these amps, there are two volume controls each controlling one stage of a 12AY7 tube. They are very simple and economical circuits, only 5 parts per circuit. Each output comes from the volume control and passes through an “isolation” resistor – a resistor placed in the circuit to isolate the two volumes from each other, and at the same time to mix them for the next single input tube stage.

The “feature” is that the isolation resistors values (270K) do not isolate the stages from each other enough – one stage can still “see” the grid load resistance from the other. It appears to the channel you are plugged into, that there is another resistor in the circuit formed by the other unused volume control and its isolation resistor.

The real “magic” of it all is probably one of the absolute best “lessons” you can learn about vacuum tubes. You would guess that the best and loudest tone would be with the highest resistance, with the unused pot turned all the way up, but that isn’t so. It is somewhere near 5 or 6 (on old amps, a new amp may have different pot tapers and it could appear at different points.)

When you are turning the unused volume control you are “fine tuning” the grid load resistor to the next stage of the amp. An optimum (best sounding) value is not all the way up, but somewhere near the middle – the lesson? Tubes are NOT linear or mathematical devices – they do not respond to exact mathematical figures and have “hills and valleys” in their response – maximum performance can not be calculated directly – you have to hear it and you have to be aware that the “truth” may not be at some exact calculated place, but at some far more imprecise figure.

**The Tweed Deluxe is unique** in that the volume controls are not voltage dividers and work by loading down the signal from the plates of the pre-amp tube. Because of this, you get the maximum mids in the channel you are plugged into when the other volume control is at it’s mid position. Max midrange scoop occurs when the other control is turned to full.

Set one channel (say Normal one) to max and the other (Bright) to mid position. When you select the Bright channel, you should get nice clean tones and when you select the Normal channel, you will get nicely distorted tones.

The clean tones work because you are not overdriving the bright channel and you are scooping the mids. On the Normal channel, you get the nice lead tones because you are overdriving the output stage and boosting the mids.
So, each of the Tweed volume controls affects your tone to a noticeable degree by creating a hidden voicing control allowing the player to sculpt the tone in a way that no other regular multi-band tone controls will permit. The effect is somewhat like scooping out the mid-range and extending the bass and treble frequencies as you turn up the adjacent volume control. In other words, the Normal volume interacts with the Bright and vice versa. This allows the player to control the midrange of the channel used by turning the volume of the channel not being used.

Maximum midrange occurs when the volume control of the unused channel is set about half up (about 5). Maximum midrange scoop occurs when the volume control of the unused channel is almost all the way up. When plugged into the bright channel with the volume about half up and then turning the normal channel almost all the way up (around 10) will give a cleaner tone.

**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 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.
Introduction to Vacuum Tubes and Common Terms

Reprinted with permission from Aaron from diystompboxes.com

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

![Diagram of a tube stage](image)

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.

Sometime 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 as 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 less, .68uF is 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.
Input Jack Theory

These first two circuits represent the typical Hi/Lo jacks found in most Fender and Marshall amps. Many other amp manufacturers use this circuit as well.

**Using the Lo Input**

![Diagram of Lo Input](image)

The LO jack delivers the signal to a 2:1 voltage divider made up of the two 68K resistors. The 1meg is shorted out by the switch contacts on the Hi jack. The signal taps off the junction of the two 68Ks. Half the signal is dropped across each 68K, therefore only 50% of the signal is applied to the tube.

~ from 18watt.com

**Using the Hi Input**

![Diagram of Hi Input](image)

The HI jack delivers **ALL** the signal to the tube. The signal enters the HI jack and first sees a 1 Meg resistor to ground. Since the LO jack switch is closed, the two 68Ks are parallel for an effective resistance of 34K and the signal travels through the paralleled 68Ks to the tube. There is no voltage divider so 100% of the signal arrives at the tube.
Circuit Description

Below is a brief description of the original Fender 5E3 circuit and function of each stage.

Power Supply
This circuit takes in the AC line voltage, steps it up with a power transformer and uses 3 pairs of secondary tap locations to power the circuit, heat the tube filaments, and drive the rectifying tube. The rectifying tube contains a pair of vacuum diodes and the following capacitors help to rectify the signal close to DC voltage to drive the circuit. In the original amp, there was no true earth ground in the two prong plug. The ground polarity switch (which we took out because we used a 3-pronged plug) in conjunction with the unpolarized AC 2-prong plug and .05uF/500V capacitor to the chassis provided a quasi-ground for the chassis. This was a safety hazard for musicians because of the dangerous static discharge.

Input Stage
This circuit receives the incoming guitar signal and sends the signal into the first preamp.

First/Second Preamp Stage
The filtered input signal at the grid of the triode is amplified by a factor determined by the behavioral properties of the triode and the situational bias. This amplified signal is present at the plate (anode) and is 180 degrees out of phase with the input signal.

Equalization
This is the location of the “Volume” and “Tone” knobs (potentiometers). The Volume potentiometer determines the amplitude of the signal coming from the plate of the first preamp. In effect, it controls the gain of that triode. The Tone potentiometer controls the frequency response of the signal, determining whether high frequencies or low frequencies are to be attenuated. When the potentiometer is at 0Ω, high frequencies are shunted to ground. When the pot is at 1MΩ, the high frequencies are passed through and the frequencies below the 3dB point of the filter are taken to ground.

This single tone control acts a treble roll off as it is rotated counter clockwise, and a high treble "boost", similar to a bright switch, as it gets towards it's most clockwise position. The .0047 uF cap is the treble cut cap, and the 500pf cap on the other end of the tone control is the "bright" shunt cap. When the wiper is fully clockwise, the 500pf cap is essentially connected between the wiper and the high side of the volume control. High frequencies bypass the resistance of the volume control. It's acting as a high pass filter at this point.

What Makes the Bright Channel Bright? The Bright channel's signal cap feeds into the “bright” shunt capacitor (500pF) that is part of the tone control design. This circumvents the Bright Volume potentiometer. To obtain a more distinctive Bright channel, you can replace the 0.1uF coupling cap with a 0.047uF or 0.022uF value.

Phase Inverter
The triode is biased such that the voltage amplification is only unity. The result is ideally a signal present at the plate with an equal magnitude as the grid voltage but out of phase by 180 degrees. The cathode of the triode will ideally be a clone of the grid signal. The output of the phase inverter is ideally two equal magnitude signals out of phase with one another by 180 degrees.

Power Stage
The power stage is composed of two pentodes and their respective bias circuitry. Each of the two out of-phase signals coming from the phase inverter are fed into their own pentode to be further amplified. The two amplified signals are output at the pentode plates. This circuit uses a Push-Pull Class A power tube arrangement where the current flows in each tube at all times but out of phase by 180 degrees.
Output Stage
Each of the two power stage output signals flow into a lead on the primary of the center-tapped output transformer. The transformer steps down the high voltage and steps up the low magnitude current. An 8 ohm speaker is connected to the transformer secondary to output the sound.

Original Fender 5E3 Schematic

Original Circuit with outlined stages
Tweed Specifications

The 5E3 Tweed is about 15 watts cathode bias 6V6, concertina phase inverter simple tweed preamp with very strange and interactive volume and tone controls for each channel, this amp was used by Neil Young.

Year: 1955-1960

Model: Tweed Deluxe; Circuit: 5E3

Configuration: Combo

Control Panel: Chrome top facing w/ white screened labels, controls numbered 1-12

Control Layout: Ground Switch, Fuse (2A), Power Switch, Pilot Lamp, Bright Volume, Normal Volume, Tone, Bright Input (X2), Normal Input (X2)

Knobs: Black pointer

Cabinet: 55: Narrow panel, 16.5" x 18" x 8.75" (41.9 x 45.7 x 22.2 cm)

55-60: 16.75" x 20" x 9.5" (42.5 x 50.8 x 24.1 cm)

Cab Covering: Diagonal tweed

Cab Hardware: Leather Handle, glides

Grille: Dark brown linen (55) or brown grille cloth

Weight: 25 lbs. (11.3 Kg)

Speakers/Load: 1 x 12"/8 ohms

Speaker Model: Recommended Tone Tubby Alnico [Jensen P12R or Jensen P12Q]

Output: 15 Watts

Preamp: 12AY7, 1/2 12AX7

Power: 2 x 6V6GT

Bias: Cathode Biased

Rectifier: 5Y3GT

Phase Inverter: 1/2 12AX7 (split load)

Comments: A speaker jack and external speaker jack are located under the chassis.
**Fender amps own the blues …**

No discussion of blues guitar amps would not include Fender amps. They own the blues, any amp maker today has to compete with or try and pry these old jewels from the guitar players hands. Favorites are the early tweed Deluxe and the AB763 versions of all the amps.

Each era of Fender amps produced many very useful guitar amps The most heavily "cloned amps are the 5E3 Fender Deluxe of course the tweed champ 5F1 and the mother of all guitar amps the 1959 tweed Bassman 5F6A, The AB763 is the most heavily cloned topology for clean channels in many guitar amps made today. This circuit first appeared in the blackface twins.
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 voltages 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.

Use 18 Gauge stranded for mains 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 in. internal hole that fits a ½ in. 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**
* 25 Watt, pencil tip soldering iron
* 60/40 rosin core solder (.032” dia)
* wire stripper
* wire cutter
* needle nose pliers
* screwdrivers (Philips, slot)
* 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:
- Use 60/40 rosin-core solder.
- Keep the tip of the soldering iron clean. If it's dirty, wipe it on a damp sponge to clean it.
- Set the temperature of your soldering iron to about 700F.
- 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.
- Make a good mechanical connection first, and then make a good solder joint.
- Heat the leads to be soldered by touching it with the tip of the iron.
- Touch the solder to the leads. The solder should flow onto the leads. Avoid breathing the fumes.
- Remove the soldering iron and allow the solder joint to cool.
- Note: Do not apply the tip of the soldering iron to the eyelet 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**

- V1 and V2 are the preamp tubes. 12AY7 and 12AX7 respectively
- V3 and V4 are the 6V6 power tubes
- V5 is the 5Y3 rectifier

The pins on a 9-pin tube socket are numbered 1 to 9 in a clockwise direction when 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.
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; connect to the pilot light.
3. Install Power Transformer and wire the Power Supply.
4. Install the Output Transformer and Wire to the B+, output tube sockets and jacks
5. Assemble the eyelet board
6. Install the eyelet board.
7. Connect the eyelet board wires to power, sockets, and controls.
8. Wire and install input jacks. Connect to board.
9. Check components, wiring and connections.
10. Follow Start-Up procedure.
Mounting Hardware Locations

Install Hardware

Install all the hardware on the chassis to make sure it all fits properly. Don’t install the transformers yet.

The classic Fender layout was followed with some changes. We use 1/2" stand-offs for mounting the circuit board to the chassis and also two ground connections (power & per-amp). We also insulate the input jacks from the chassis.
Install all the tube sockets. The sockets with the shields are for V1 to V2. The other 8 pin sockets and clip retainers are for the 6V6 or 5Y3 tubes. The orientation of the sockets is as follows. Locate pin 1 of each socket and orient it so that pin 1 points away from the board. Fasten in place with screws into the 4-40 threaded hole in the chassis using #4 screws. This orientation is done to slightly minimize the heater wiring and make connections to the board and transformer a little more convenient. See layout diagram.

Note: Some people prefer to wire up the rectifier socket before installing the fuse holder.

Insert 2 grommets for wire leads passing through the chassis from a choke or output transformer.

Ensure the potentiometers are located in the correct positions according their values and the layout. Cut off the locating tabs on the potentiometers in order to flush mount them. For the jacks you will need to use fibre washers to isolate them from the chassis. More on that later.

Trinity Tweed Front View

When you mount the fuse holder, switch, and pilot light make sure that these components are tight and that if they come loose in the future they can't 'windmill' into each other and short out! The pots and input/output jacks must also be tight. In the original Tweed design, they were grounded to the rest of the circuit this way so the speaker output jacks depend on a tight mechanical connection for grounding and proper operation.

Install the IEC Socket for the power cord into the large rectangle hole mounting with two #4 screws.
Install the DPDT Impedance Switch into the ¼ inch hole located between the two output jack holes.

**Wiring**

The original design was not grounded to the AC line, since most homes in the '50s only had two wire outlets. We've chosen to ground the amp for safety. We did deviate slightly from the original design in that a mains ground is used. Power and preamp star grounding is used and the mains ground is bolted to the chassis. We run the individual pre-amp grounds directly to a separate star instead of 'bussing' them as on the original. This was done to reduce the background noise.

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

- Use 22 gauge 600V solid for hook up to tubes
- Use 22 gauge 600V solid/stranded for hook up to pots/front panel
- Use 20 gauge 600V pre-twisted wire for tube heater wiring
- use 20 Gauge, stranded or solid, 600v for power supply hook up - to transformers, rectifier, standby etc.
- Re-use stranded cut offs from the transformers.
Wire Up Heater Wires
Install the pilot lamp socket if you haven’t already.

It is important to wire the tube filaments carefully. Use the Red-Black pre-twisted wire to do this. If you need to make up some heater wire, tightly twist two long lengths of wire tightly together. This will help to minimize any hum.

Solder each wire to the indicator socket.

It is imperative that where possible, the signal wires run close to the chassis, while the heater wires run as far away from the signal wires as possible. Make sure the signal wires hug the chassis and the heaters have a tight twist on them. For the 12AX7 and 12AY7, we have had success running the connection wires to them from as shown in the layout.

Note: Don’t substitute smaller gauge heater wires. The wires need to be big enough to carry the current back to ground and keep hum low.

One wire comes from the indicator socket to the first 6V6 Power Tube to pin 7, the other wire to same 6V6 Power Tube but pin 2. Then these go to pins 7 and 2 respectively of the second Power Tube. From there, the wires daisy chain across the preamp tubes. Run the heater wires for the preamp as far away from the board as possible, along the inside of the chassis edge. One wire connects to both pins 4 and 5 of each preamp tube and the other wire to pin 9. Connect the same color heater wire to the same pin(s) as you progress from tube to tube e.g. Black on pin 7 of both 6V6 and Red on pins 2. Do the preamps tubes using the same process. Black on pins 4 & 5 tied together and Red on pins 9. Don’t switch the heater wire polarity.

Once soldered, in place at each tube socket, press it flat, tight against the chassis.
Install Power Transformer

Locate the hole for the transformer with the 4 #8 bolts/studs holding the transformer plates and bell covers together. Put the transformer in place and hold in place with the #8 nuts with washers as supplied. Tighten up the nuts.

Note: Leave the original nuts in place so as to provide a gap between the transformer and chassis. This provides some heat and electrical isolation to the chassis.
Now, wire up the 2-3.15VAC (6.3 VAC total) from the power transformer and solder to the indicator socket lugs with the heater wires to the tubes.

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

Then connect the Red-Yellow 0V center tapped wire to the “Power” ground.

Solder the grounds in place.

Wiring the Tweed Rectifier Socket

Connect the Yellow 5 V Rectifier heater wires from the transformer to pins 2 and 8 of the 5Y3 rectifier socket.

Connect the Red high voltage wires to pins 4 and 6 of the 5Y3. Connect the Red-Yellow center tap of the high voltage from the transformer, and ground it at the power ground point.

Trinity Tweed Grounding Scheme

Our amps use a two point grounding scheme where the power side of the amp is connected to a single common ground point, and the pre amp part is connected to another point on the chassis that is located immediately beside the input jacks.

Note: 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.

Power Amp Side Ground             Pre-Amp Side Ground

**Mains Power Connection**

Wire up the rest of the main power supply.

Start at the mains IEC Socket. Attach the ground lug to the chassis immediately beside the socket and ensure it is grounded well. Tighten as much as possible with the #8 KEPS lock nut.
Connect a Black/Hot line from the IEC Line lug to the fuse holder. Run a wire from the lug on the side of the fuse holder and from the end of the holder to the power switch. Make sure the switch is in the desired on position, the connection is ‘made’. The switch may have the option of being ‘On’ in either ‘Up’ or ‘Down’ position. From the other side of the switch, connect to the transformer Black/Red – White/Red pair (120V input).

The other side of the IEC is connected to the Black – White pair (‘Common’ side) of the power transformer.

Tie off any unused taps that are not required for the Tweed 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.
120V - use the primary in parallel hooking Black/Red to White/Red and Black to White. Connect 120 mains to Black/Red and White.

240V - use the primary in series hooking Black to White/Red. Connect 240 mains to Black/Red and White.
Connect a Black/Hot line from the IEC Line lug to the fuse holder. Run a wire from the lug on the side of the fuse holder and from the end of the holder to the power switch. Make sure the switch is in the desired on position, the connection is ‘made’. The switch may have the option of being ‘On’ in either ‘Up’ or ‘Down’ position. From the other side of the switch, connect to the transformer Black/Red lead (240V input).

The other side of the IEC is connected to the White lead (‘Common’ side) of the power transformer.
Connect the Black and White/Red, solder and insulate with some shrink tubing.
Tie off the unused taps (110V) that are not required for the Tweed 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.
The original Deluxe did not have a standby switch but one is included in this design and fits in the original ‘Ground Switch’ position. Another improvement.

Connect a wire from pin 8 of the rectifier tube to one side of the standby switch. Attach a wire to the other side of the standby switch that is long enough to route neatly and reach the first capacitor on the eyelet board, per the layout diagram. Give yourself an extra few inches.

Connect to the center tap of the Output Transformer to the same side of the standby switch. For proper voltage mains connections, refer to the Power Transformer schematic.

Once you have wired up the transformer, fuse, stand-by and pilot light socket, it is a good time to check that the Power transformer is working properly.

**Testing the Power Transformer**

Install the appropriate fuse. Double check that the wiring is as per layout and that the transformer is wired correctly for your Mains Voltage.

**DO NOT INSERT ANY TUBES.** Carefully apply power to the circuit (use Variac if possible, or current limiting light bulb) and check that the AC voltages are within range of the spec. Note that they will be higher with NO tubes plugged in.

- Carefully measure the AC MAINS VOLTAGE
- Carefully measure the AC VOLTAGE across the INDICATOR lugs. You should measure around 6.3VAC
- Carefully measure the AC VOLTAGE across Pins 2-8 of the RECTIFIER SOCKET. You should measure around 5.0VAC
- Carefully measure the AC VOLTAGE across Pins 4-6 of the RECTIFIER SOCKET. You should measure over 700VAC.

If everything measures correctly, then move on to the next step. If not, this is the time to resolve the issue. If voltages are half what was expected, check the PRIMARY WIRING matches your local MAINS voltage.

If voltages are very low, check that there are no shorts circuits to ground.

**Install the Output Transformer - Output Jacks**

Orient the Output Transformer so that the Yellow and Black output (secondary wires) are closest to the output jacks and Blue, Red and Brown (primary wires) closest to the Power
tubes. Feed all the leads through the previously installed plastic chassis grommets. Bolt the Output Transformer in place with two #8 bolts & nuts with lock washers. Tighten.

If not already installed, install the output jacks ‘connected’ or grounded to the chassis. No fibre washers are used. Refer to the Output Transformer schematic. Twist the output leads from the transformer to the output tubes. Leave enough transformer lead length to reverse the leads from one 6V6 to the other if necessary to eliminate amplifier squealing.

Start by soldering the Brown output lead to V4 pin 3 and the Blue lead to V3 pin 3. Refer to the Output Transformer schematic below and wire up the 2 output jacks in parallel paying particular attention to the Yellow and Black colored leads.

**Impedance Switch**

The Primary leads from the transformer should be twisted together and the secondaries braided and both fed through the two chassis grommets.

Cut a wire long enough to route from the Impedance switch center pole terminals to the closest output jack. Hook a wire into the two center poles of the switch and solder it in place. Solder the other end two the closest output jack. Connect the other output jack with another piece of wire making sure they’re connected to the same jack terminals. In this case, the positive or “Tip” end.

Neatly route and solder in place the 4 ohm, Green lead, to one side of the DPDT Switch, both terminals. Neatly route and solder in place the 8 ohm, Yellow lead, to the other pole of the switch.

Connect the black Output Transformer lead to the other speaker jack. Connect the other output jack with another piece of wire making sure they’re connected to the same jack terminals. In this case, the negative or ”Ring” end.

Note: You may choose to only wire the 8 ohm, asper traditional Tweed wiring. If the 4 ohm is not to be used, omit the impedance switch and hard wire the 8 ohm to the speaker jacks and then put some shrink tubing over the end of the GREEN lead.
TWEED 8/4 OHM CONNECTION

- Brown - 4K
- Red - CT
- Blue - 4K
- Green - 4 ohm
- Yellow - 8 ohm
- Black - common

8 ohm impedance connection
4 ohm speaker impedance
8 ohm speaker impedance
Assemble the Eyelet Board
Except for the location of the Phase Inverter resistor network, the layout is based on the original Fender 5E3 Deluxe. If you do not have a pre-built Trinity amps eyelet board, now is the time to build it.

Install the Jumpers – Install the jumper wires on the underside of the board. Some leads go under the board (these are the dashed lines on the supplied layout diagram). Follow the pictures below and the layout. Do not solder in place yet.

Some builders prefer to run the jumpers on the Top side of the board for ease of future service. You will have to transpose the layout if you prefer this technique.

Trinity Tweed Board Underside Layout – Jumpers Only

Install the Eyelet Board Components - Align the board according to the layout diagram and follow the diagram closely as you build the board.

Carefully identify all the board components and their values. Measure those that you can to confirm the values. See the section on how to read Resistor and Capacitor codes.

When installing Electrolytic Capacitors (power supply, bypass caps), ensure that they are aligned with the correct polarity on the board. There may be a ‘+’ sign, or indentation to identify the positive end of the capacitor or arrows pointing to the negative (ground) end of an electrolytic capacitor. Usually, capacitors with values less than 1 μF have no polarity requirements or markings.
Install the components on the board by following the layout from left to right.

Start with the bigger parts on the power supply side of the board. Then, work your way over to the signal components. Make all of your connections as neatly as possible. At each eyelet, mount and solder ALL of the components including the flying leads that belong in each eyelet and solder once.

Crimp all wires tightly at the connection point before soldering. Remember, if your solder joints are not bright and shiny; do them over until they shine like jewels. Double check all of your connections for shorts against adjoining components or terminal posts.

**Flying leads** are also installed at this time. Cut connecting wires in various colors and about 6” (rear) -8” (front) long each. Following the layout, install the connecting wires to the bottom of the board leaving plenty of extra length, wire is not expensive and it'll save aggravation later.

Start with the 250 ohm 5Watt / 25uF capacitor pair. Note: Make sure the cathode pair are separated slightly as this resistor emits some heat. Install flying leads and solder in place.

Move on to the 3 - 16uF 500V filter capacitors and power supply resistors.

Continue with the remaining parts, following the layout provided.

Note: For multiple component leads that must fit into one eyelet or eyelet, 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 eyelet squarely and neatly. Solder each eyelet once all component leads that connect to it, jumpers and flying leads are in place.

Tip: Circle each "eyelet" on a printed copy of the layout as you complete each connection to that point to track progress and confirm that all parts are in the correct orientation and position. It's well worth the time to re-check the eyelet board layout before installing it in the chassis.

The old style 'point to point' wired eyelet board used in this project is mounted on stand-offs to the chassis. This is an improvement over the original design which allowed the board to 'float'.

For convenience, the holes for the #6 standoff bolts are threaded in the chassis so screw the bolts into place from the outside then put the standoffs on these. Install the eyelet board
followed by the nuts to hold the board in place. You can also do the reverse and screw the bolt through the board, stand-off and finally into the chassis without the need for a nut.

**Connecting the Board**

Now is the time to make the connections from the eyelet board to the tubes and potentiometers.

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

1. Connect and solder the power wire from the standby switch to the board.

2. Connect and solder the Output Transformer Red centre tap to the B+ on the board (optionally route it back to the stand-by switch).

3. Connect and solder the ground wire from the ground side of the 250 ohm /25uF power tube cathode resistor pair to the Power Ground.

4. Connect and solder the ground wire from the ground side of the 820 ohm /25uF preamp tube cathode resistor pair to the Pre-Amp Ground.

Then start at one end of the board and work your way sequentially around the board doing the point-to-point wiring with the flying leads to tube sockets. Board to tube pin; board to tube pin etc. Start at V1, pin 1 and move to the far end of the board to V4.

**Connect Board to Potentiometers**

The easiest way to wire these correctly is to carefully follow the layout, and do one terminal connection at a time.
Install the jumpers first but do not solder as some of the terminals require more than one wire connection, so again, arrange accordingly and solder once.

Locate the 500pf capacitor and pre form it to fit between the Tone and Bright channel Volume pots. Use some heat shrink tubing make ensure it does not touch the other tone capacitor. Attach the flying lead from the bright channel and solder in place. Locate the .0047uF capacitor and pre form it to fit between the Tone and Bright channel Volume pots. Again, use some heat shrink tubing make ensure it does not touch the other tone capacitor. Solder it in place with the ground on the volume pot.

Co-Axial Cable to Volume Control

This is an improvement to reduce noise. 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 one 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"
Follow the layout provided and connect the centre of the co-ax cable to the right side potentiometer lug and the co-ax shield to Ground, left side. Be sure to ground only at this end of the cable.
Connect the centre of the other end of the co-ax cable to V2, pin 2.

**Input Jacks**

To wire up the input jacks, it is easiest to remove the jacks from the chassis, set the spacing per channel pair correctly to match the chassis, wire them with the 1M Carbon Film resistors and jumpers and then reinstall them. Leave enough wire flying lead for the ground wires on the input jacks go to the pre-amp ground and about 6” to reach the board from each jack. The ground wire and insulated jacks are another improvement over the original design. Use wire from the input jacks to the eyelet board

Install the Switchcraft switched input jacks. Use the supplied black shoulder washers to insulate the jack from the chassis. This is an improvement in design for noise reduction. Refer to the diagram and install the washers with the shoulder of the outside inserted into the chassis. The rear washer has no shoulder or if it does, faces away from the chassis and they are sandwiched in place by the jack and mounting nut. Tighten securely. Once installed, test to confirm that there is no electrical connection from the jack to chassis.

Then connect and solder the leads to ground tag and input leads to the 4-68K input grid resistors on the board.
Optional Input to V1 – Parts are not provided to do this but in some cases, it may be desirable to eliminate noise for some Studio applications. This modification may help.

Acquire 2 - 3 terminal tag strips and install it at the base of V1 closest to the board. Use the tube socket mounting bolts to hold the strips in place.

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

Prepare some shielded cable (not provided) 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.

On the input jack end, connect the 2 shields together, and connect them to the ground point on the jacks. Do not connect the shields at both ends or you will induce hum.

Final checkout
When you finish assembling the amp, double-check the wiring and the components. Trace or highlight the connections on a copy of the layout provided with the amp to ensure the amp is wired correctly. Check everything at least once!

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 less than 1 ohm, typically 0.5 ohms.

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

***SAFETY WARNING READ THIS FIRST!!!!***

**Working Inside A Tube Amplifier Safely**

Working inside a tube amplifier can be dangerous if you don't know the basic safety practices. If you aren't prepared to take the time to learn and apply the right precautions to keep yourself safe, don't work on your own amp. You can seriously injure yourself or get yourself killed.

**Unplug** Pretty self explanatory. Do not, ever, ever, leave the equipment plugged in and start work on it. Leaving it plugged in guarantees that you will have hazardous voltages inside the chassis where you are about to work.

**Sit** If the amp has been turned on recently, the caps will still have some high voltage left in them after the switch is turned off. Let it sit for five minutes after you turn it off.

**Drain** When you open up an amp, you need to find a way to drain off any residual high voltage. A handy way to do this is to connect a shorting jumper between the plate of a preamp tube and chassis ground. This jumper will drain any high voltage to ground through the 50k to 100K 2W plate resistor on the tube. To do this successfully, you will need to know which pins are the plate pins. Look it up for the amp you're going to be working on. You'll need to know this for the work anyway. Leave the jumper in place while you do your work. Remember to remove it when you finish your work. You can also permanently install a 220K 2W resistor on the B+ line to chassis ground to do this.

**Test** Take your multimeter and ground the negative, black lead to the chassis. With the positive, red lead, probe the high voltage cap terminals or leads and be sure the voltage across them is low. Preferably to less than 10V.

**Close** First take the shorting jumper out. Put the chassis back in the cabinet, making sure all of your tools, stray bits of solder, wire, etc. are out of it. You don't have to actually put all the screws and so forth back in if you believe more work might be needed, but make sure that the chassis is sitting stably in the cabinet and won't fall out.

First note that most meters have three input jacks (some have four) one is marked COM, the BLACK lead goes there. Another jack is marked V, ohm, mA, the RED lead goes there for most measurements. The third jack is a high current jack usually marked 10ADC (sometimes it is 20 or some other number). This jack is used only for high current measurements. The four jack models use separate jacks for current measurements, this makes accidentally setting the meter to a current mode harder, but it still can be set to resistance. For vacuum tube electronics we can usually ignore the high current mode. Put your test leads into the COM and V(ohm)mA jacks and leave them there.
Making a Voltage Measurement

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

- Is this a DC or AC voltage?
- How much voltage will be present?
- If things are not working correctly what is the highest voltage that I might find?

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

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

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

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

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

Discharging the Power Supply

If you need to service the amp after having it on, you must “discharge” the power supply capacitors. This is done by unplugging the amp, turning the power and standby to the on position and letting it sit for 30 seconds or so. If you do not have a standby switch, you will need to short the capacitor positive leads to ground with a 220K 2W resistor on a lead with an insulated wire. You hear a small pop when this is done. This is just the cap discharging itself. Always use a multimeter to check the residual B+ voltage in the large filter capacitors to make sure it is fully discharged.
REMEMBER: DO NOT OPERATE YOUR AMP WITHOUT A LOAD

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.

1. **With no rectifier in place**, apply power and test the High voltage AC and ensure that it is on the correct pins of the rectifier (pins 4 & 6) and in the correct voltage range (greater than 350 Volts AC). Between pins 4 & 6 should read in the order or 760 V AC. From pin 4 or 6 to ground, should be about half of that.

2. Test the filament voltages and ensure they are on the correct pins for all tubes.

3. 5 VAC across pins 2 and 8 or V5, 5Y3 Rectifier.

4. 6.3 VAC across pins 2 and 7 on V4, V3 6V6 Power Tubes

5. 6.3 VAC across pins 4-5 pair and 9 on V2 12AX7 and V1 12AY7 Pre-Amp Tubes

6. If all is OK, then shut off, install the rectifier and apply power without the preamp or power tubes installed. Turn on the Stand-By switch on the Tweed. Check the plate voltages on the tube sockets. The plate voltages will be higher than the voltages listed on the schematic because there is no load provided by the tubes. It will be in excess of 400 Volts DC.

7. If everything is okay, power off the amp, install the 12AX7/AY7 and two power tubes (6V6), connect a speaker and power on again.

8. Measure the DC voltages from tube pin to chassis ground and compare to the layout, schematic or Trinity Tweed Voltage Chart.

<table>
<thead>
<tr>
<th>Tube</th>
<th>Plate Pin(s)</th>
<th>Cathode Pin(s)</th>
<th>Heater (pins)</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1 - 12AX7</td>
<td>1,6</td>
<td>3,8</td>
<td>4+5, 9</td>
</tr>
<tr>
<td>V2 - 12AY7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V3, V4 - 6V6</td>
<td>3</td>
<td>8</td>
<td>2, 7</td>
</tr>
<tr>
<td>V5 – 5Y3</td>
<td></td>
<td></td>
<td>2, 8</td>
</tr>
</tbody>
</table>

9. If the voltages seem close to the chart, then with volume setting at minimum and NO instrument plugged in, power up again. Listen for sounds that may indicate a problem. Loud transformer vibrations or humming or other crackling sounds. Observe if any of the components besides the tubes are getting hot – check the power resistors. Carefully check and make note of the voltages on all the tubes.

10. If all seems in order, and the fuse has not blown, turn the volume up a bit. If everything seems fine, plug in a cable, and touch one end. You should get a loud 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.

11. 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.
General Amplifier Operation

Some DO NOTS

- Never, Never, Never run the amp without a speaker plugged in. This can cause major Output Transformer 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.

Note that in the long term, unless you have an impedance switch, the impedances should be matched to the OT, as in this case of the Tweed, 8 ohms, or 2 16s in parallel.
- Overdrive the stuffing out of it. Tubes are very forgiving of massive overdrives, unlike solid state stuff. As long as they tubes don't overheat or stay overdriven for long periods, it's not fatal.
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Trinity Tweed Voltage Chart
(Used to record your measured voltages)

<table>
<thead>
<tr>
<th>AC Mains Voltage</th>
<th>120 VAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>B+ No tubes installed</td>
<td>VDC</td>
</tr>
<tr>
<td>B+ All tubes installed</td>
<td>400 VDC WITH SOVTEK 5Y3. 367 VDC WITH JJ 5Y3 (in brackets)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TUBE</th>
<th>Pin 1</th>
<th>Pin 2</th>
<th>Pin 3</th>
<th>Pin 4</th>
<th>Pin 5</th>
<th>Pin 6</th>
<th>Pin 7</th>
<th>Pin 8</th>
<th>Pin 9</th>
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</thead>
<tbody>
<tr>
<td>V1</td>
<td>130</td>
<td>--</td>
<td>2.0</td>
<td>--</td>
<td>--</td>
<td>133</td>
<td>--</td>
<td>2.0</td>
<td>--</td>
</tr>
<tr>
<td>12AY7</td>
<td>(120)</td>
<td></td>
<td>(1.8)</td>
<td></td>
<td></td>
<td>(120)</td>
<td></td>
<td>(1.3)</td>
<td></td>
</tr>
<tr>
<td>V2</td>
<td>158</td>
<td>--</td>
<td>1.4</td>
<td>--</td>
<td>--</td>
<td>204</td>
<td>18</td>
<td>50</td>
<td>--</td>
</tr>
<tr>
<td>12AX7</td>
<td>(148)</td>
<td></td>
<td>(1.3)</td>
<td></td>
<td></td>
<td>(191)</td>
<td>(17)</td>
<td>(45)</td>
<td></td>
</tr>
<tr>
<td>V3</td>
<td>380</td>
<td>348</td>
<td>22</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6V6</td>
<td>(356)</td>
<td>(326)</td>
<td>(20)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V4</td>
<td>380</td>
<td>348</td>
<td>22</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6V6</td>
<td>(356)</td>
<td>(326)</td>
<td>(20)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

THE ABOVE DC VOLTAGES ARE MEASURED FROM TUBE PIN TO CHASSIS GROUND
The above layout above indicates areas of the Trinity Tweed where you should take extreme caution. There are voltages in this area in excess of 400 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, 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!

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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, 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 10K 1/2W 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/450V, triangle ∆=20uF 450V, 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 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. These amps are supplied with Carbon Composition 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 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 (AKA Mojo).

The best place to use CC's 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.

If all that doesn't work reverse the output transformer leads Yellow & Black, on pin 3 on 6V6 V3, V4.

Explanation from s2 Amplification: 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.
In extreme cases, if they are not, you may need to ground the output jacks to the chassis.

**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 voltage from that pots terminals to ground. If you have DC voltage, a leaky coupling capacitor or tone stack can 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 eyelet 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)
Tone Tweaking

Below are some modifications you might choose to implement in order to change the tone and response of your Trinity Tweed. There are several Fender interest groups on the Internet who can provide some direction.

Reducing Low End Response

Change the 1st two coupling caps from .1uF to .022uF to reduce the low end response [boominess]. Reduce the value of just the coupling cap on the bright channel from 0.1uF to 0.022uF to brighten it up a little bit and to increase the difference in tone between the two channels.

You can reduce the 0.1uF coupling caps between the PI and the power tubes from 0.1uF to 0.047uF or 0.022uF.

Increase Headroom

Remove or add a switch to toggle the value of the 2nd stage cathode capacitor: either 25uF (stock value) or 0.68uF (less bass, brighter overall tone) or remove this bypass capacitor completely. This would be effective for reducing the woofiness of a humbucker for example and also less break-up at higher volumes. Distortion wont start until volume is closer to 5 instead of 3.

Smoothen Distortion

Add a try 470K to pin 7 of V2 feeding the phase invertor to smoothen out the break-up, and minimize any 'blatting', 'swirling' or 'grainy' sounds sometimes heard in amps using the Tweed cathodyne kind of phase inverter. Make sure the resistor goes right on the pin as it is acting as a 'grid=stopper'.

Use the same Volume and Tone circuit as the 6G3 Brownface Deluxe.

Rewire the pots to mix the 2 channels with a pair of 220K resistors. The reason for installing this mod is that the standard Tweed ramps up fast and breaks up very soon with reduced range in the volume pots. The tone/volume mod fixes that and at the same time smoothes out the response and volume curve. Plus it reduces the dark muddy tones as you play louder. After this mod is installed both channels are a little brighter and cleaner. The normal channel is more useable and the bright channel is special with better highs and note definition, while the amp doesn't crank out until the volume pots are around 4.5-7 instead of 1.5 to 3.

Add a modification that allows you to switch in a [56K from 8 ohm output] negative feedback loop to reduce overall volume and tighten and brighten up the sound a little bit and flatten out the frequency response (reduce bass response) when tone control is centered. Connect the feedback to pin 3 of V2. Put a .0022 cap in the tone control instead of .005 uF to reduce Bass control response curve.

DC-bias the phase inverter. The result is a slightly smoother breakup at higher volumes and slight increase in headroom (though not much).
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 with metal film types. This can help reduce hiss.
Running 6L6 Output Tubes

1. Replace the 5W 6V6 250R cathode resistor with a 10W to enable use of 6L6GT output tubes.
2. Replace the OT with our optional Heyboer OT that has 5K & 8K impedance leads and hook up the 5K leads (BROWN-WHITE / BLUE-WHITE) to the 6L6GT plates, pins 3. Tie off the 8K leads, they can be used for 6V6 in the future if desired.
3. Use an 5AR4 or SOVTEK 5Y3 tube rectifier to increase B+ to approx. 400-380VDC when running 6L6 tubes.
4. Install a 470R 3W screen resistor on pin 4 (anchor on unused pin 1).
5. Connect the leads from the 2nd 16uF filter cap to pins 1 on V3 & V4

This mod will deliver about 25 watts output power and the amp will be noticeably louder while retaining the Classic Tweed tone.

NOTE: Our stock Tweed Output Transformer is NOT guaranteed with this modification. Do not use the stock OT in this configuration.

You should be familiar with Tube Amps before attempting this.

**Screen Resistors**

Optional 470R 3W Power Tubes Screen Resistor

**Upgraded 6L6 OT**

*Diagram showing impedance connections and resistor values.*
**Tube Substitutions**

12AX7 - ECC83, 7025, ECC803, E83CC, 6681, 12AX7R, CV10319, CV492, 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

12AY7 – 6072, CV2650, CV3650, 6072, 6072A

The 12AX7 family of dual-triode preamp tubes consists of the 12AX7, 5751, 12AT7, 12AY7, 12AV7 & 12AU7. These are all pin compatible with one another, the only differences being the gain factor of each tube. A common substitution is to replace a 12AX7 with a 5751 or a 12AT7 to tame a preamp that tends to overdrive too easily, allowing you to get a better 'clean' sound out of your amp.

<table>
<thead>
<tr>
<th>Tube</th>
<th>Gain</th>
<th>Acceptable Substitutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>12AX7</td>
<td>100</td>
<td>5751, 12AT7, 12AY7</td>
</tr>
<tr>
<td>5751</td>
<td>70</td>
<td>12AX7, 12AT7, 12AY7</td>
</tr>
<tr>
<td>12AT7</td>
<td>60</td>
<td>5751, 12AY7</td>
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<td>12AV7</td>
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<td>12AU7</td>
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</tbody>
</table>

The above is not carved in stone and any of these tubes can be substituted for any other. You can always replace a higher-gain tube with a lower-gain tube, using your ears to tell you whether this was a good idea or not. As example, the Fender Pro Junior amp came stock with two 12AX7 tubes – one for the preamp and one for the inverter. If you re-tube it with a 12AU7 in the preamp stage and a 12AT7 for the inverter the 12AU7 in the preamp will provide a nice clean sound, and the 12AT7 inverter helps prevent overdriving the power amp.
How to read Resistor Color Codes

First the code

<table>
<thead>
<tr>
<th>Black</th>
<th>Brown</th>
<th>Red</th>
<th>Orange</th>
<th>Yellow</th>
<th>Green</th>
<th>Blue</th>
<th>Violet</th>
<th>Gray</th>
<th>White</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
</tbody>
</table>

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.
How to read Capacitor Codes

Large capacitor have the value printed plainly on them, such as 10.0uF (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 puF 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>
<thead>
<tr>
<th>Third digit</th>
<th>Multiplier (this times the first two digits gives you the value in Pico-Farads)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>1,000</td>
</tr>
<tr>
<td>4</td>
<td>10,000</td>
</tr>
<tr>
<td>5</td>
<td>100,000</td>
</tr>
<tr>
<td>6 not used</td>
<td></td>
</tr>
<tr>
<td>7 not used</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>.01</td>
</tr>
<tr>
<td>9</td>
<td>.1</td>
</tr>
</tbody>
</table>

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 103J is a 10,000 pF with +/-5% tolerance

Typical Capacitor Markings
<table>
<thead>
<tr>
<th>Code</th>
<th>pf</th>
<th>nf</th>
<th>uF</th>
</tr>
</thead>
<tbody>
<tr>
<td>510</td>
<td>51</td>
<td>0.051</td>
<td>0.0000510</td>
</tr>
<tr>
<td>181</td>
<td>180</td>
<td>0.18</td>
<td>0.00018</td>
</tr>
<tr>
<td>501</td>
<td>500</td>
<td>0.5</td>
<td>0.0005</td>
</tr>
<tr>
<td>472</td>
<td>4700</td>
<td>4.7</td>
<td>0.0047</td>
</tr>
<tr>
<td>103</td>
<td>10000</td>
<td>10</td>
<td>0.1</td>
</tr>
<tr>
<td>123</td>
<td>12000</td>
<td>12</td>
<td>0.12</td>
</tr>
<tr>
<td>203</td>
<td>20000</td>
<td>20</td>
<td>0.2</td>
</tr>
<tr>
<td>223</td>
<td>22000</td>
<td>22</td>
<td>0.022</td>
</tr>
<tr>
<td>104</td>
<td>100000</td>
<td>100</td>
<td>0.1</td>
</tr>
<tr>
<td>684</td>
<td>680000</td>
<td>680</td>
<td>0.68</td>
</tr>
</tbody>
</table>

Table 2 Letter tolerance code

<table>
<thead>
<tr>
<th>Letter symbol</th>
<th>Tolerance of capacitor</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>+/- 0.10%</td>
</tr>
<tr>
<td>C</td>
<td>+/- 0.25%</td>
</tr>
<tr>
<td>D</td>
<td>+/- 0.5%</td>
</tr>
<tr>
<td>E</td>
<td>+/- 0.5%</td>
</tr>
<tr>
<td>F</td>
<td>+/- 1%</td>
</tr>
<tr>
<td>G</td>
<td>+/- 2%</td>
</tr>
<tr>
<td>H</td>
<td>+/- 3%</td>
</tr>
<tr>
<td>I</td>
<td>+/- 5%</td>
</tr>
<tr>
<td>K</td>
<td>+/- 10%</td>
</tr>
<tr>
<td>M</td>
<td>+/- 20%</td>
</tr>
<tr>
<td>N</td>
<td>+/- 0.05%</td>
</tr>
<tr>
<td>P</td>
<td>+/-100%</td>
</tr>
<tr>
<td>Z</td>
<td>+/-80%</td>
</tr>
</tbody>
</table>
FAQ

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.

Q: The pictures show the power and standby switches as "top and bottom" on the back of the switch, the layout shows them as "front and back" and I have back mounted "left and right". Does it make a difference as to what orientation I choose to make sure the switch operate correctly, i.e. on is on and off is off?
A: It does 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" is where resistance is zero. Then rotate the switch so that DOWN is ON (UK style).

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 the shield at both ends on the volume pot OR input cables.

Q: The wire looks to be two basic sizes, "thin" and "thick". From the pictures, it looks like the "thin" is used for the pot wiring and the "thick" is for the tube sockets. Is this correct?
A:
Use 20 gauge solid for hook up to tubes;
Use 22 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 eyelet board?
A: Use the provided solid 22 ga or the stranded supplied for jumpers, it is not critical.

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 grey/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: Do you need use both of the fiber shoulder washers when mounting the input jacks?
A: Yes, we recommend that you do. Not required for the output jacks

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 not go the transformer mount as there is a 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, but I would 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 gives you me 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 & 18 Watt forum. Right click on them to download if you want print in large, colour format.

Schematic: trinityamps.com Forum Index -> Resources -> Trinity Tweed Deluxe Docs

TIP: Flatten or remove the locating tabs on the pots so that they tighten properly on the chassis.

TIP: Sometimes carbon comp resistors are hard to decode the 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 22 or 20 ga wire.

TIP: There is no bleed resistor in the Deluxe. You don't need to worry about this unless you are going to poke around inside immediately after it's shutdown. For safety, unplug the amp, then turn on the stand-by switch for a minute to help drain the caps. If you want to check them, measure B+ after you've done that. If there is still high voltage there, drain it again.

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. You can use 22 ga solid for heaters. It is rated for more than 5A anyway.
## TWEED Bill of Materials (BOM)

<table>
<thead>
<tr>
<th>BAG</th>
<th>TWEED ITEM</th>
<th>QTY</th>
<th>BAG</th>
<th>TWEED ITEM</th>
<th>QTY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>250 5 WATT RESISTOR</td>
<td>1</td>
<td></td>
<td>SWITCHCRAFT 12A JACK (SWITCHED)</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>820 OHM CARBON COMP 1/2 W RESISTOR</td>
<td>1</td>
<td></td>
<td>SWITCHCRAFT 11 JACK (UNSWITCHED)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>1K5 OHM CARBON COMP 1/2 W RESISTOR</td>
<td>2</td>
<td></td>
<td>SHOULDER WASHER 3/8&quot; - FIBRE</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>1K5 OHM CARBON FILM 1 W RESISTOR</td>
<td>2</td>
<td></td>
<td>WASHER 3/8&quot; - FIBRE</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>4K7 OHM 2 W METAL RESISTOR</td>
<td>1</td>
<td></td>
<td>#4 X 5/16&quot; MACHINE SCREW</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>22K OHM METAL OXIDE 2 W RESISTOR</td>
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<td></td>
<td>#4 HEX NUT</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>56K OHM CARBON COMP 1/2 W RESISTOR</td>
<td>2</td>
<td></td>
<td>#4 CHASSIS LUG</td>
<td>2</td>
</tr>
<tr>
<td>MEDIUM (23)</td>
<td>68K OHM CARBON FILM 1 W RESISTOR</td>
<td>4</td>
<td></td>
<td>#6 X 3/4&quot; MACHINE SCREW</td>
<td>4</td>
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<tr>
<td></td>
<td>100K OHM CARBON COMP 1/2 W RESISTOR</td>
<td>3</td>
<td></td>
<td>#6 X 3/8&quot; MACHINE SCREW</td>
<td>1</td>
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<td>220K OHM CARBON COMP 1/2 W RESISTOR</td>
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<td>#6 HEX NUT</td>
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<td>470K OHM CARBON FILM 1 W RESISTOR</td>
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<td></td>
<td>#6 LOCK WASHER</td>
<td>4</td>
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<tr>
<td></td>
<td>1M OHM CARBON COMP 1/2 W RESISTOR</td>
<td>1</td>
<td></td>
<td>#6 CHASSIS LUG</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>1M OHM CARBON FILM 1 W RESISTOR</td>
<td>2</td>
<td></td>
<td>#6 STANDOFFS NYLON 1/4&quot; OD 3/8&quot; LONG</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>500 pF SILVER MICA CAPACITOR</td>
<td>1</td>
<td></td>
<td>#8 X 3/8&quot; MACHINE SCREW, GROUND BOLT, OT.</td>
<td>3</td>
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<tr>
<td>LARGE (13)</td>
<td>.0047uF MALLORY 150 AXIAL CAPACITOR</td>
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<td>#8 HEX NUT</td>
<td>7</td>
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<tr>
<td></td>
<td>.022 uF/600 ORANGE DROP STYLE CAP</td>
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<td></td>
<td>#8 CHASSIS LUGS</td>
<td>1</td>
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<tr>
<td></td>
<td>.1 uF/600 ORANGE DROP STYLE CAP</td>
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<td></td>
<td>#10 X 1-1/4&quot; MACHINE SCREW</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>16uF 450V ELECTROLYTIC CAPACITOR</td>
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<td></td>
<td>#10 HEX KEPS NUT</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>25 uF/600 AXIAL ELECTROLYTIC CAPACITOR</td>
<td>3</td>
<td></td>
<td>#10 WASHER</td>
<td>2</td>
</tr>
<tr>
<td>LARGE</td>
<td>1M-AUDIO POT (3/8&quot;)</td>
<td>3</td>
<td></td>
<td>22 GAUGE SOLID WIRE, VARIOUS COLOURS (FEET)</td>
<td>10</td>
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<tr>
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<td>CHICKEN HEAD KNOB - BLACK</td>
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<td></td>
<td>SHIELDED CABLE (FEET)</td>
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</tr>
<tr>
<td>MED</td>
<td>IEC CHASSIS SOCKET</td>
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<td></td>
<td>18 GA STRANDED WHITE INCHES</td>
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</tr>
<tr>
<td></td>
<td>PANEL MOUNTED BAYONET FUSE HOLDER</td>
<td>1</td>
<td></td>
<td>18 GA STRANDED BLACK INCHES</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>FUSE 2A SLO BLO (1A for 220/240V)</td>
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<td></td>
<td>HEAT SHRINK TUBING - 1/16&quot; 4&quot;</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>PILOT LAMP ASSEMBLY 6.3V WITH RED JEWEL</td>
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<td></td>
<td>HEAT SHRINK TUBING - 1/8&quot; 4&quot;</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>PILOT LAMP 6.3V</td>
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<td></td>
<td>HEAT SHRINK TUBING - 1/4&quot; 2&quot;</td>
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</tr>
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<td>CARLING SPST TOGGLE SWITCH 125V 5A</td>
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<td>TIE WRAPS</td>
<td>6</td>
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<td>CHASSIS GROMMETS (1/2&quot;&quot;)</td>
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<td>DELUXE EYELET BOARD</td>
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<td>LARGE</td>
<td>9-PIN RETAINER</td>
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<td>9-PIN MICALEX TUBE SOCKET</td>
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<td>POWER CORD 8&quot;, 18/3</td>
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<tr>
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<td>8-PIN MICALEX TUBE SOCKET</td>
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<td>POWER TRANSFORMER - TWEED HI CAPACITY</td>
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<tr>
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<td>8-PIN TUBE RETAINER</td>
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<td></td>
<td>OUTPUT TRANSFORMER - TWEED 3108 4, 8 OHM</td>
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<td>SWITCHCRAFT 12A JACK (SWITCHED)</td>
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<td>6V POWER TUBES JJ</td>
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<tr>
<td></td>
<td>SWITCHCRAFT 11 JACK (UNSWITCHED)</td>
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<td></td>
<td>ECC83 / 12AX7 TUBE JJ</td>
<td>1</td>
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<tr>
<td></td>
<td>SHOULDER WASHER 3/8&quot; - FIBRE</td>
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<td></td>
<td>12AY7 EH</td>
<td>1</td>
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<td>WASHER 3/8&quot; - FIBRE</td>
<td>4</td>
<td></td>
<td>5Y3 - RECTIFIER, FULL WAVE, JJ / SOVTEK</td>
<td>1</td>
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<tr>
<td></td>
<td>TWEED BUILDERS GUIDE</td>
<td>1</td>
<td></td>
<td>TWEED BUILDERS GUIDE</td>
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</tr>
</tbody>
</table>

*Note - Some hardware may be used to ship transformers in place.*
Some of the parts contained in this kit are subject to availability. Trinity Amps reserves the right to substitute any part without notification. Substitutions are guaranteed not to affect the integrity or operation of your amplifier kit.

Addendum: New Power Transformer Hook-Ups

![Diagram of power transformer hook-ups]

Trinity Amps 9114-2-EX Power Transformer 120V HOOK-UP
Trinity Amps 9114-2-EX Power Transformer  230V HOOK-UP
Trinity Amps Schematics and Layouts