"HOLY TERROR"

Mercury™ Upgrade Kit

for the ORANGE™ "Tiny Terror"

MERCURY UPGRADE ASSEMBLY MANUAL

Featuring custom Axiom® Transformers & Chokes!

VERSION 111611

“HOLY TERROR”

Written & produced by the staff of

9167 Independence Ave.
Chatsworth, CA 91311
(818) 998-7791 • FAX: (818) 998-7835
Skype: paul.patronete or patrick.selfridge
www.MercuryMagnetics.com
info@MercuryMagnetics.com

Circuitry design by Alan Cyr
(www.Amp-Exchange.com)

If you do not know how to read a schematic, we strongly recommend that you take this project to a qualified technician for installation.

All ***Mercury Magnetics*** products are 100% handmade by us in California, USA.

Mercury Magnetics products are UL (Underwriters Laboratories Inc.) recognized components for the USA and Canada. OBJY2 component systems, electrical insulation, E120568. UL Recognition, class 130(b) – Class 200(n). OBJY8 component systems, electrical insulation, certified for Canada, class 130(b) – Class 200(n).

Mercury Magnetics transformers and other products are in compliance with the European Union RoHS Directive 2020/95/EC with respect to the following substances: lead (Pb), mercury (Hg), cadmium (Cd, hexavalent chromium (CR (VI)), polybrominated biphenyls (PBB), and polybrominated diphenyl ethers (PBDE).

Attention: Modifying your Tiny Terror amp voids the Orange Amp warranty!

Table of Contents

CAUTION! The voltages in your amplifier can be dangerous. Transformers and chokes are not user servicable parts. Installation of these components should always be performed by an experienced technician. The simple ability to use a soldering iron is not enough to qualify a "do-it-yourself person." Those who are inexperienced in working with electronic circuits should never attempt to service their amplifiers. Household line currents can be deadly!! Transformers, chokes and large filter capacitors can store dangerous charges for several days, or longer, after the amplifier has been unplugged. Never touch the terminals of these components without being certain of their charge status. Risk of shock and damage to equipment may result from mishandling and/or improper use of these components. Please use common sense and always think safety first. After all, great tone is most enjoyed when you are alive to hear it.

SOLDERING NOTE: The ***Orange*** **"Tiny Terror"** is assembled using *RoHS* compliant, lead-free solder. Working with lead-free solder is different than standard solder. Generally a hotter iron is necessary. For more information we recommend doing a web-earch for "lead-free soldering techniques."
CAPACITOR DISCHARGE WARNING: Safe discharging of *filter* capacitors matters. It is essential for your safety and to prevent damage to the amp's circuitry, that large or high voltage capacitors be fully discharged before measurements are made, soldering is attempted, or the circuitry is touched in any way. For information on how to do this, web-search "capacitor discharging." Also see the appendix for additional information.
CAPACITOR POLARITY: Note that many capacitors have positive and negative polarity, and are stamped accordingly. Be sure that their polarity is correct when soldering to a PCB.
BRAIDING, TWISTING AND COILING LEADS: Do not braid, twist or coil the power transformer's B+ lead wire. Check our reference illustrations and photos to see which leads are twisted together. Typically only the filament leads of the power transformer. Other positioning of leads may be necessary to minimize amp noise. Follow are diagrams and instructs for optimal performance.
TRIMMING TRANSFORMER LEADS: To minimize noise, measure and trim the solderable lead lengths of the transformers and ***Mini-Choke***™. Route all wires cleaning around the tubes, chassis, *etc.*
CLIPPING *vs.* UNSOLDERING PCB COMPONENTS: To make this ***Upgrade*** it will be necessary to remove several components from the Main PCB of the amp. Due to quality issues with modern off-shore PCB manufacturing, it can be difficult to unsolder an item without creating other problems, the most typical of which is an eyelet detaching from the PCB. Therefore we've indicated which components should be clipped vs. unsoldered. To unsolder heat your iron to 800ºF, then very quickly heating up one side of the existing solder connection while pulling it through on the other. If the iron is not hot enough, or you linger too long, the eyelet will get damaged (or fall off). If this happens you'll have to fabricate a repair, or created a jumper to a trace. See this manual's appendices for tips.
POWERING UP A GUITAR AMP: After making any modifications to an amp's circuit (e.g. this ***Upgrade***) use a *Variac* along with an current meter (some have both) to slowly apply power to the amp while checking for warning signs of circuitry errors or shorts. See the section on "Using a Variac" at the end of this manual.
LOADING OUTPUT TRANSFORMERS: You must connect a speaker or speaker cab to your amp before powering it up. Without a load the output transformer will blow.
MINI-CHOKE FACTOID: A ***Mercury Mini-Choke***™ replaces a resistor and adds a disernable amount of tonal dimension to the circuit.
TRANSFORMER BREAK IN PERIOD: As a general rule, transformers require approximately 30 hours of ***playing time*** to be fully broken in. Please refer to ***Mercury's*** website for more information.

BE SAFE! ALWAYS USE PROTECTIVE EYEWEAR!

"HOLY TERROR"

Component Identification

Identifying the components included with the Holy Terror *Upgrade Kit*:

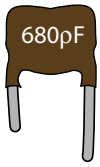
ORP-TT-A
(power transformer)

ORO-TT
(output transformer)

Mercury nameplate

Mercury "Holy Terror" sticker

CAPACITORS (silver mica)

1x 

2x 

".022µF" capacitor may be marked as "223K"

RESISTORS (carbon film)

1x  300KΩ 1/2W (orange/black/yellow/gold)

2x  470KΩ 1/2W (yellow/violet/yellow/gold)

1x  2.2KΩ 1/2W (red/red/red/gold)

1x  1.8KΩ 1/2W (brown/grey/red/gold)

2x  100KΩ 1/2W (brown/black/yellow/gold)

2x  10KΩ 1/2W (brown/black/orange/gold)

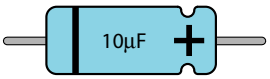
1x  330KΩ 1/2W (orange/orange/yellow/gold)

CAPACITORS (electrolytic)

1x 

1x 

1x 

1x 

Note that many capacitors have +/- polarity. Be sure to study the schematics for the correct directions when ***Upgrading*** your amp.

Instructional CD ROM

8x 

8-32 size washers

OTHER COMPONENTS

1x 

double-poled, double-throw switch

Mercury guitar case sticker

~12 in. coils 

Shielded RED, BLUE & YELLOW wire

~6 in. 

insulation "spaghetti"

~6 in. 

Unshielded filament wire

"HOLY TERROR"

Component Identification

Your Holy Terror *Mercury Upgrade Kit* for the *Orange* "Tiny Terror" includes:

Axiom® Holy Terror *Upgrade Kit* for Versions 2, 3 & 4 of the "Tiny Terror" TT-KIT1

- **Axiom®** Power Transformer (part #: ORP-TT-A) 1
- **Axiom®** Output Transformer (part #: ORO-TT).....1
- ***Mercury Magnetics*** "Equipped with" metal plate (part #: MM-Plate-1).....1
- **Holy Terror** I.D. sticker (goes over the original *"Tiny Terror"* on the front of the amp).....1
- CD-ROM with photographic instructions (with schematics) 1
- Coil of wire insulation "spaghetti" ..... ~6"
- Coil of unshielded wire..... ~6"
- Coils of red, blue and yellow insulated wire..... ~12" ea.
- 8-32 washers (for mounting transformers to chassis) 8
- 1μF (electrolytic) capacitor.....1
- 4.7μF (electrolytic) capacitor (VERSION 2 KOREAN PCB ONLY).....1
- 10μF (electrolytic) capacitor (radial) 1
- 10μF 50V (electrolytic) capacitor (axial) (VERSION 4 CHINESE PCB ONLY).....1
- 680ρF (silver mica) capacitor (VERSION 2 KOREAN PCB ONLY).....1
- .022μF (silver mica) capacitors.....2
- 1.8KΩ ½W (carbon film) resistor 1
- 2.2KΩ ½W (carbon film) resistor 1
- 10KΩ ½W (carbon film) resistors 2
- 100KΩ ½W (carbon film) resistors 2
- 300KΩ ½W (carbon film) resistor 1
- 330KΩ ½W (carbon film) resistor (VERSION 4 CHINESE PCB ONLY).....1
- 470KΩ ½W (carbon film) resistor 1
- Switch—double-poled, double-throw (for Pentode/Triode modes) 1

Recommended tools for this project:

- Good quality 25–35W solder iron (capable of temps at ~800ºF)
- Electronics grade solder (60/40 rosen core)
- Solder sucker and/or wick
- Set of screw drivers (Philips)
- Small needle-nose plyers
- Wire stripper & cutter
- Needle-nose pliers
- Various open-ended & box-headed wrenches (metric)
- Drill & drill bits for making 1/4" & 7/16" holes in metal chassis
- *Loctite 290* (green)
- Pure isopropyl alcohol & Q-tips or electronic-grade contact cleaner
- *Variac* & current meter
- Dremel Tool – can be used for deburring & enlargening small holes, *etc*.

Holy Terror Assembly Sequence

Please see individual Version sections for specific instructions

0. The first thing you must do is determine which version of the **"Tiny Terror"** you have. The manual covers several versions so in order to get the optimum tone from your ***Upgraded*** amp, you'll need to follow the correct instructions. Look for the main PCB's (printed circuit board) right hand corner for the "ORO-PC211-X" (where "X" is a number from 1 to 4). Then, using the clues in the manual, determine which version of **"Tiny Terror"** you own.
1. Remove the amp's top and bottom covers. Remove the tube retainers and pull the tubes.
2. Discharge the caps! See appendix.
3. Disconnect clip leads from the main PCB for the OT (output transformer) and PT (power transformer).
4. Remove the output jack PCB by unscrewing the 3 output jack retaining nuts. Then desolder the three transformer leads.
5. Pull the knobs and unscrew any retaining nuts for the Volume, Tone, Gain and Guitar Jack. The knobs are pressure-fit, so use either a knob-puller, or a large screwdriver to carefully ply them off.

   Note: Do not remove the lamp, but you'll need to unclip the yellow & black leads in order to get the main PCB out of the chassis. Also remove any leads going to switches, chassis ground, *etc*., from the PT.
6. Remove both transformers and save the bolts, you'll reuse them when mounting the ***Mercury*** transformers.
7. On the chassis, mark off and drill the new holes (per the specifications of the manual's illustrated diagrams) for the OT, and the optional Pentode/Triode Switch (PTS) if you are planning to install it (we recommend that you do). For the OT only, swap the rubber grommets from the old holes to the new holes. Do NOT bolt the PTS into the chassis, yet.
8. Mount the transformers in the locations and directions indicated in the illustrations noting which hole each cluster of wires pass through. Use *Loctite* on the bolts.
9. Following the illustration, unsolder the components from the main PCB as indicated.
10. Following the illustrations, solder on all new components onto the main PCB. If you are installing the optional PTS, tin and solder in the leads and extensions to R1 and R2, but do not connect them to the actual switch, yet. We recommend building the "Voltage Divider" and the optional "RC Network" separately to make installation easier.

    At this point, triple check your work to make sure that nothing is missing or incorrectly modified. You are about to reassemble the amp. If you later have to debug your work, it'll take considerable more time later.
11. Bolt back in the main PCB back into the chassis, using *Loctite*, but follow the hook-up sequence indicated below.
    a. Trim, tin and solder the OT's Blue/Red/Blue-White leads onto their indicated locations on the main PCB. Note to cut the wires so that they can be tucked off the top edge of the board.
    b. Trim, tin and solder the Blue/Red/Black leads to the output PCB, and re-attach it back into the chassis. Note to tuck the wires towards the far wall of the chassis, away from the main PCB.
    c. Complete the hookup of the PTS and bolt it into place. Depending upon your technique, you may find it easier to bolt it into place first and complete the soldering from there. Do NOT over tighten the PTS's retaining nut or you will strip the threads.
    d. Reattach the chassis ground lead (Green-Yellow), trim and tin the PT's Green-Yellow lead – bolt them both into the chassis in the original location.

e. Tightly twist the twin Yellow leads from the PT, trim tin and attach to main PCB nodes TX4 and TX3.

f. Trim, tin and solder the PT's Grey and Purple leads to the "7/15 Watt" switch.

g. Trim, tin and solder the PT's Black lead to the On/Off switch.

h. Trim, tin and solder the PT's Green lead to main PCB node TX2.

i. Trim, tin and solder the PT's Brown lead to the I.E.C. tab as indicated in the illustrations.

j. Reconnect all Yellow & Black plug-in leads onto the main PCB, including the lamp's connector.

k. Re-connect the Volume, Tone, Gain and Output Jack's fasteners – but not the knobs, yet.

l. Re-attached the tube retainers and tubes into their sockets.

Triple-check your work. Go over it with a "fine-tooth comb" comparing it with the manual's diagrams. Once you are absolutely sure that everything is correct. It is time to plug the amp into a Variac (see appendix) and test your handiwork.

After you have successfully powered the amp up using a Variac and verified it is working, Loctite the transformers and the main PCB's retaining screws, re-attach the top and bottom covers, and press-fit the knobs back onto the front panel.

Congratulations! You're done!

Be sure to read and follow these helpful hints and tips!

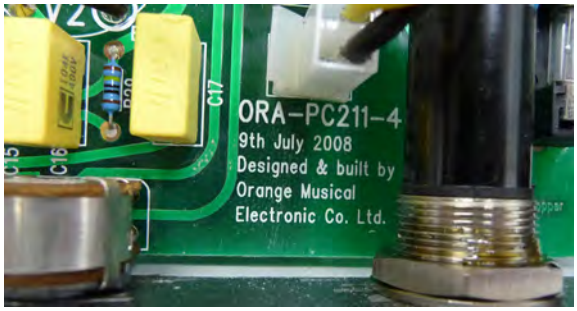
Tech hint: The main PCB is double-density board – with separate circuits etched on the top and the bottom layer. It is sometimes easier to solder to the top of the board than the bottom, especially if the eyelets have been damaged in the de-soldering of the components you've removed.

Tip: Use parts trays to hold the parts as you are disassembling the amp.

Tip: When removing components from the PCB, remove all of the old solder from the holes. Also, use an electronics-approved contact cleaner to clean the board after the initial parts removal and then again after you've made all of the upgrades (but before the PCB is bolted back into the chassis).

Note: On some **"Tiny Terrors"** that the retaining clips of the leads (primarily from the transformers) are "spring loaded." The clips won't just pull off – you have to pull back the clear plastic sheathing, and using a tiny screw driver (or something similar) push the retaining metal "lip" in while pulling off the clip.

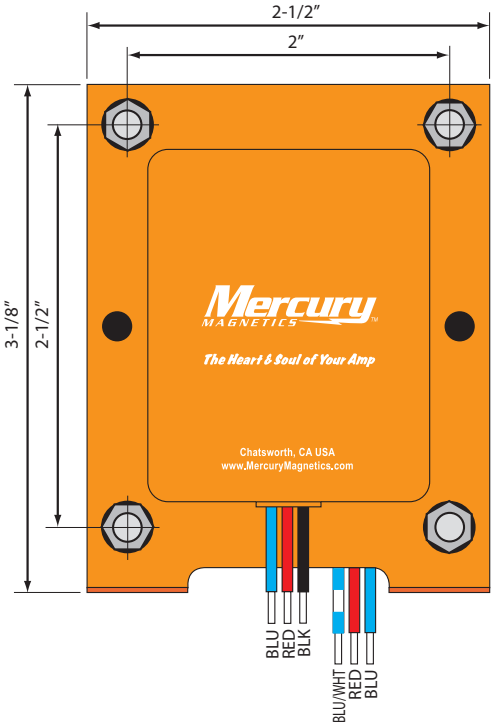
Versions of the "Tiny Terror": There are currently four versions of the **"Tiny Terror."** The original (Version 1) was a relatively limited run and rare. Version 2 can be identified by the "Made in Korea" marking on the back of the amp. Version 3 can be identified by the "Made in PRC" (Republic of China) marking on the back and the marking "ORA-PC211-X" (where "X" is "1," "2" or "3") on the main PCB. Version 4 is also "Made in PRC" and has the marking "ORA-PC211-4" on the main PCB.

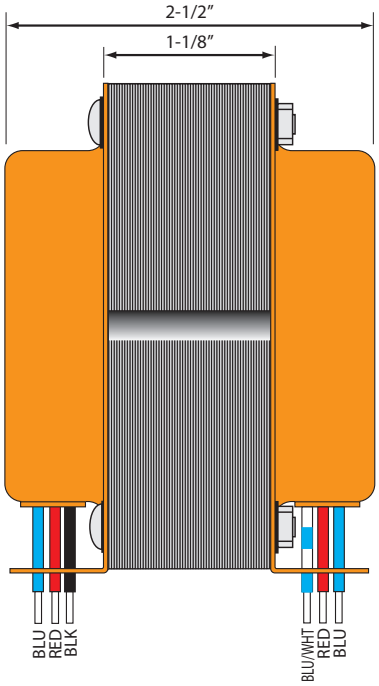


Note: The this manual is divided into two sections, one for Versions 1, 2 & 3 and another for Version 4.

Mercury Magnetics
9167 Independence Ave. • Chatsworth, CA 91311
(818) 998-7791 • FAX (818) 998-7835
www.**MercuryMagnetics**.com
100% of our products are designed & handmade in So. California, USA. • Established in 1954

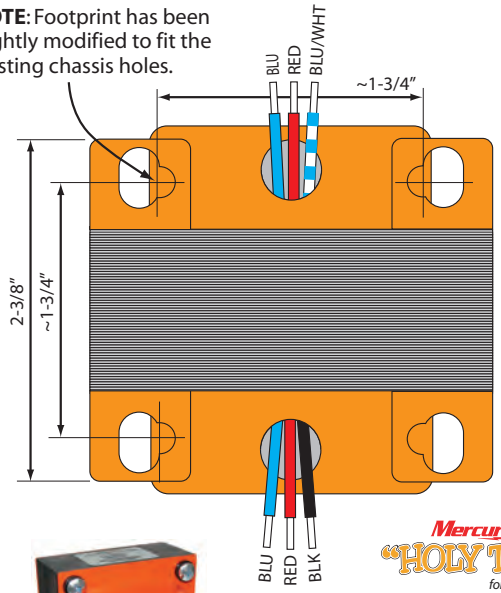
ORO-TT

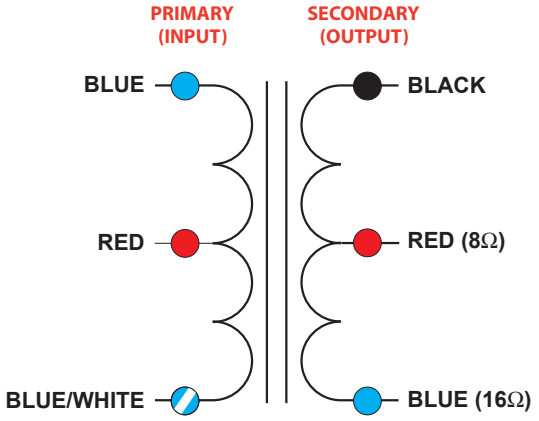




(All dimensions are nominal)

NOTE: Footprint has been slightly modified to fit the existing chassis holes.





Mercury Upgrade
"HOLY TERROR"
for the
ORANGE "TinyTerror"

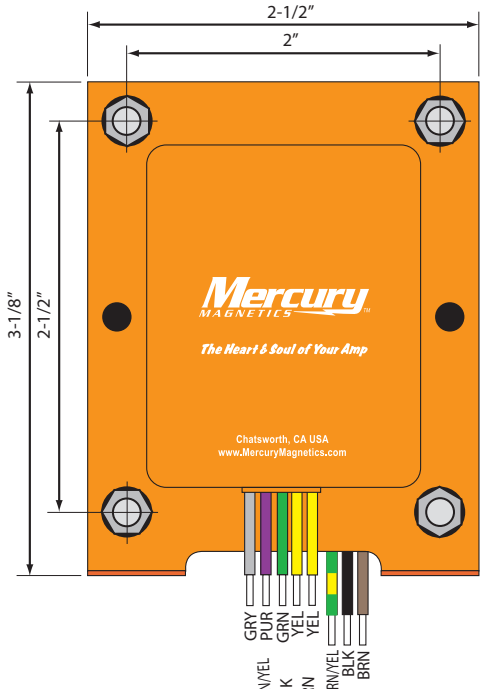
Origin: *Billy Yates* of the *Venice Amp Company*

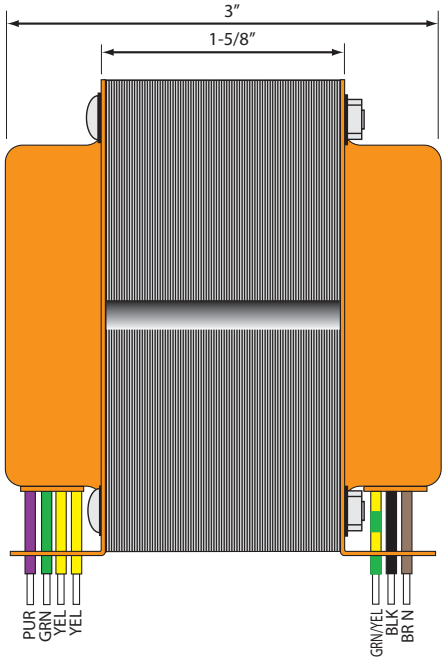
CLASS: Axiom®
TYPE: Output Transformer
PART NO.: ORO-TT
ORIGINAL ORANGE PART NO: "Tiny Terror Output"
MOUNTING: Vertical
POWER RANGE: Our OTs are rated to handle up to 50% more power than the original manufacturer spec.
DATE: 06-22-11

ORO-TT

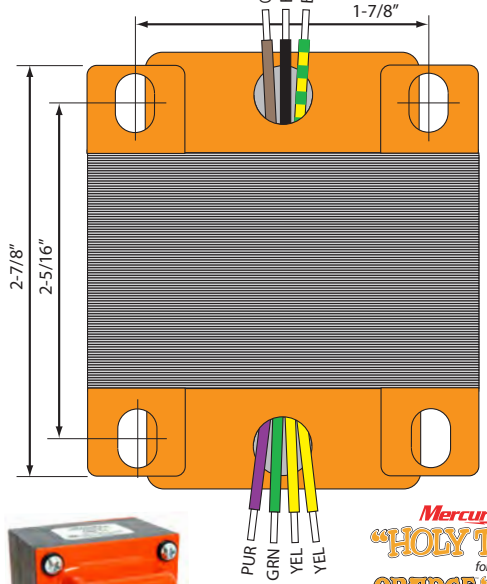
Mercury Magnetics
9167 Independence Ave. • Chatsworth, CA 91311
(818) 998-7791 • FAX (818) 998-7835
www.**MercuryMagnetics**.com
100% of our products are designed & handmade in So. California, USA. • Established in 1954

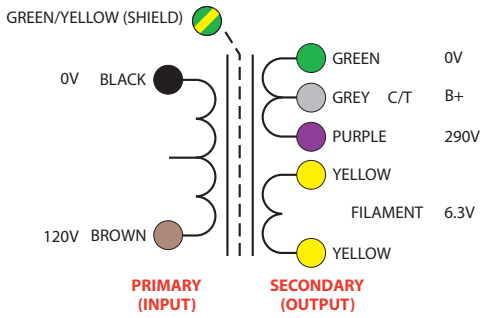
ORP-TT-A





(All dimensions are nominal)





Low flux/high inductance design with primary to secondary humbucking winding configuration.

Mercury Upgrade
"HOLY TERROR"
for the
ORANGE "Tiny Terror"

Origin: *Billy Yates* of the *Venice Amp Company*

CLASS: Axiom®
TYPE: Power Transformer
PART NO.: ORP-TT-A
ORIGINAL ORANGE PART NO: "Tiny Terror Main"

MOUNTING: Vertical
VA RATING: 30VA
DATE: 04-14-08
REVISED: 10-01-09

ORP-TT-A

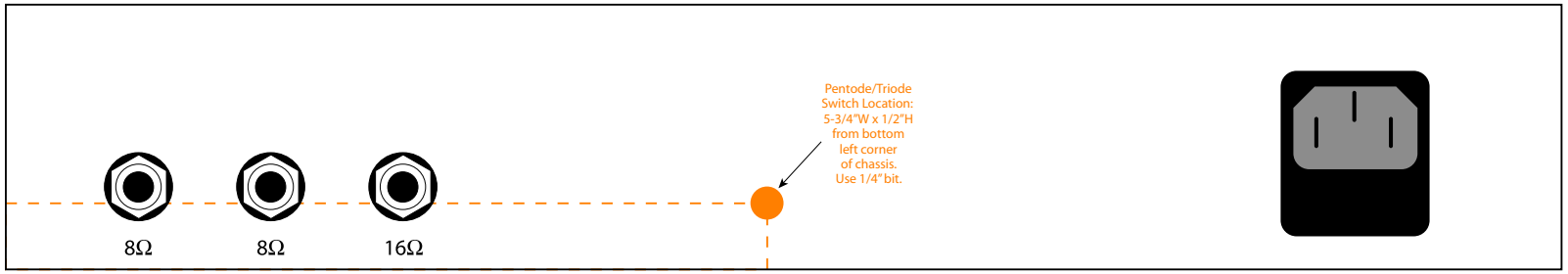
www.MercuryMagnetics.com
Info@MercuryMagnetics.com
(818) 998-7791

"HOLY TERROR" Mercury Upgrade

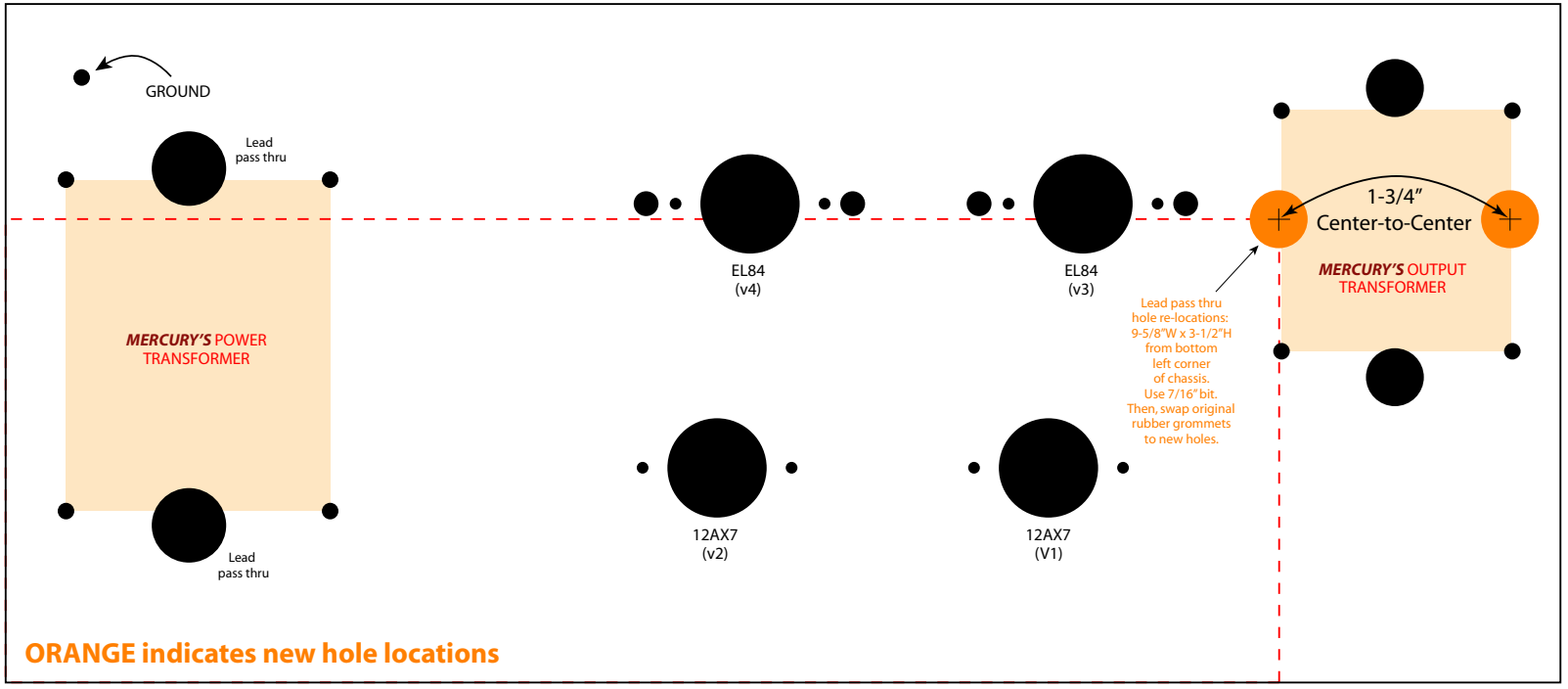
The "Holy Terror" *Upgrade* for the Orange "Tiny Terror"

Chassis mods for Version 1 & 2 (Korean PCB), Version 3 & 4 (Chinese PCB) amps

Back panel view



Top view



~11-3/4" x 5-1/9" x 2" CHASSIS TOP and BACK PANEL VIEW (all specifications shown are nominal)

FRONT

VERSION: 10-02-09

“HOLY TERROR”

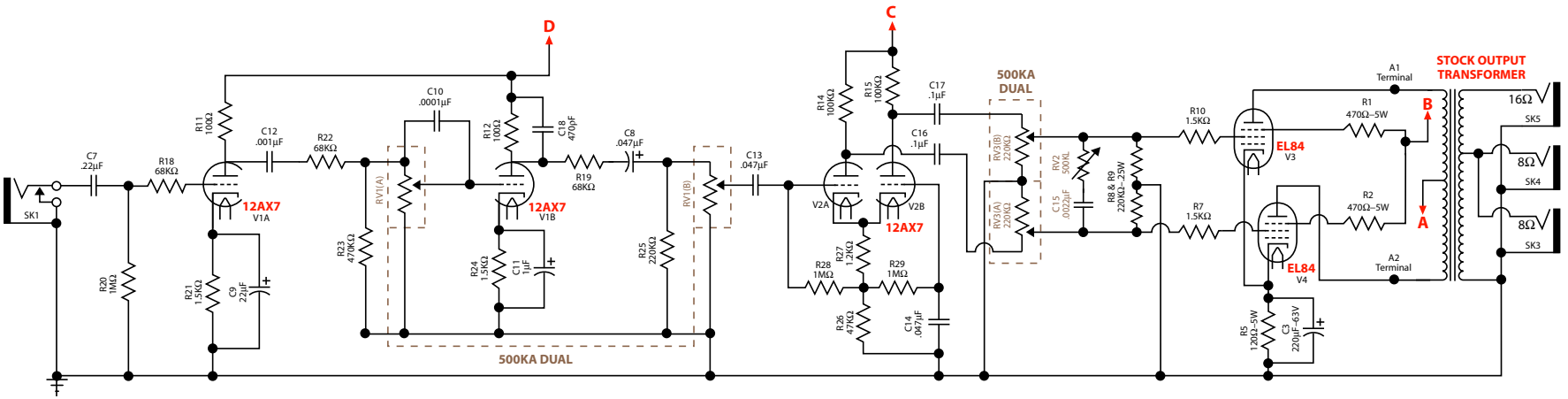
Versions 1, 2 & 3 PCB SECTION

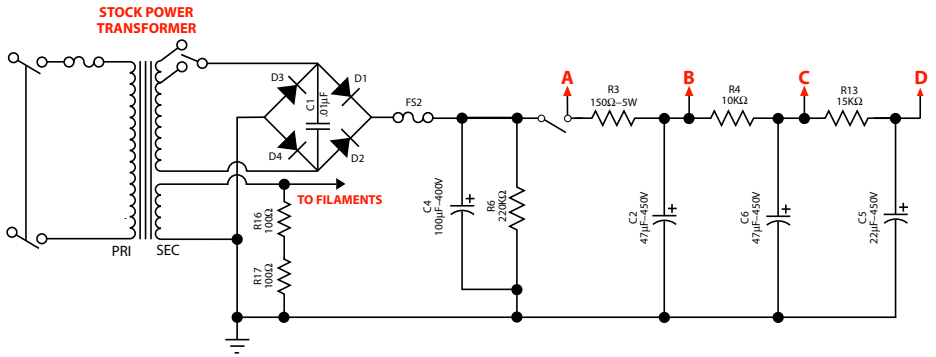
The following pages pertain ONLY to Version 1, 2 and 3 **“Tiny Terror”** amplifiers. You can easily identify which version you have by the main PCB (printed circuit board); look for the following text, printed in white ink, on the lower right-hand quadrant:

ORO-PC211-X (where “X” is either “1,” “2” or “3”)

Orange Tiny Terror • Stock Wiring Schematic

Stock Schematic for Version 1, 2 PCB (Korean) & Version 3 PCB (Chinese) Amps

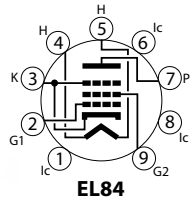




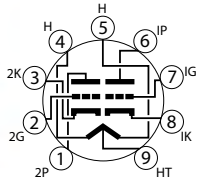
ORANGE™

www.OrangeAmps.com

PCB VERSION: ORA-PC211-1
JULY 4, 2006
ORANGE MUSICAL ELECTRONIC CO. LTD.



EL84



12AX7

Schematic drawn by —

Mercury MAGNETICS — The Heart & Soul of Your Amp

www.MercuryMagnetics.com

VERSION: 09-02-08
REVISED: 02-12-10

Mercury Upgrade "HOLY TERROR" for the ORANGE "Tiny Terror"

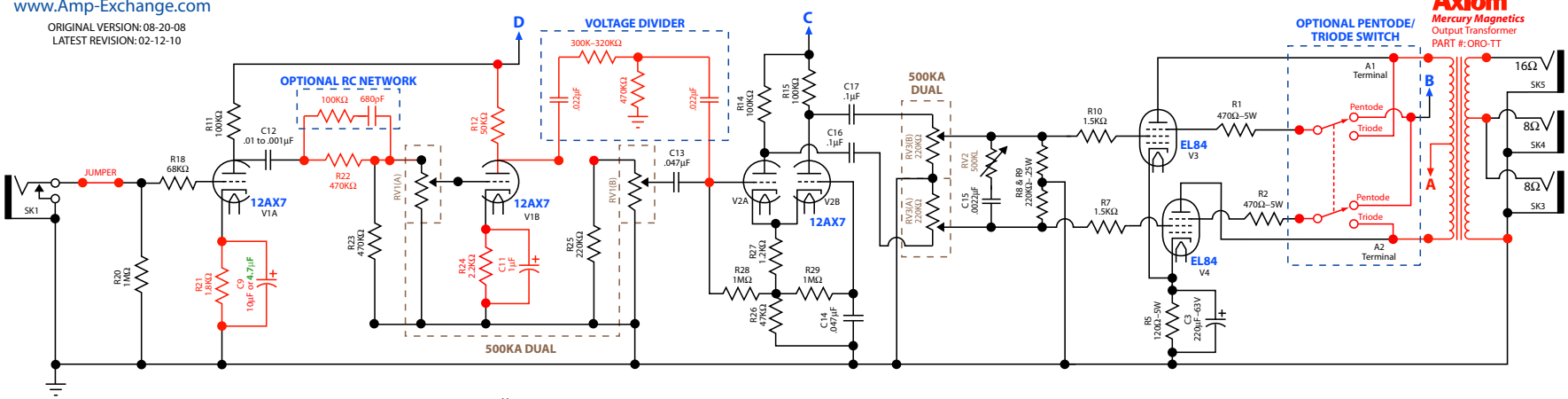
Upgraded Schematic for Version 1, 2 PCB (Korean) & Version 3 PCB (Chinese) Amps

Schematic drawn by —

Mercury Magnetics — The Heart & Soul of Your Amp

www.MercuryMagnetics.com
www.Amp-Exchange.com

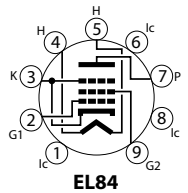
ORIGINAL VERSION: 08-20-08
LATEST REVISION: 02-12-10



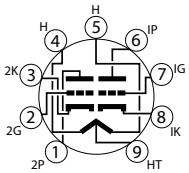
Axiom Mercury Magnetics Output Transformer PART #: ORO-TT

ORANGE™
www.OrangeAmps.com

FROM BOARD VERSION: ORA-PC211-1
JULY 4, 2006
ORANGE MUSICAL ELECTRONIC CO. LTD.

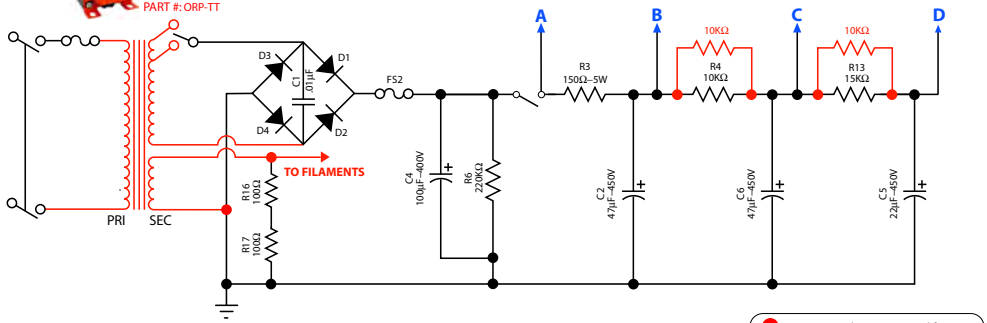


EL84

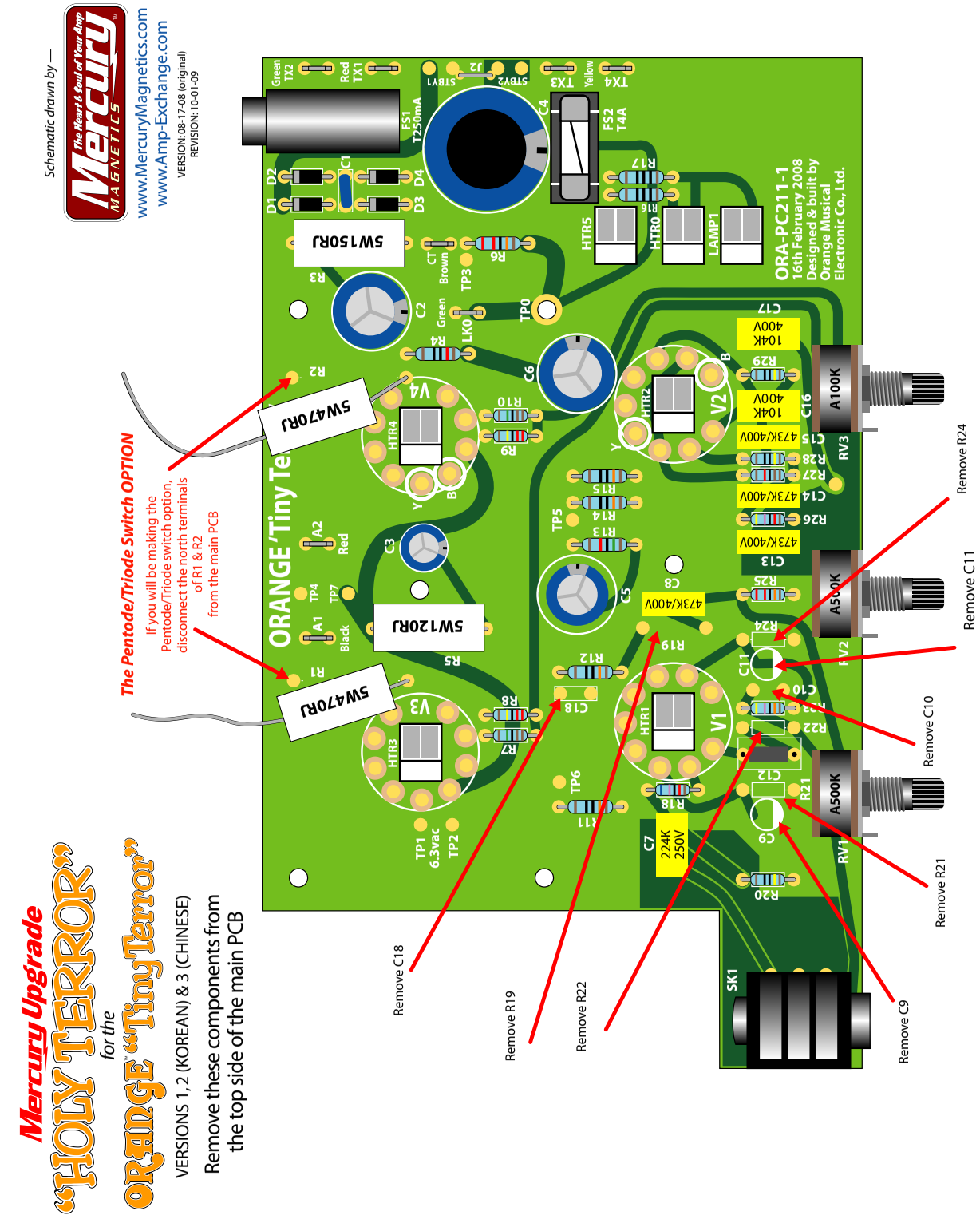


12AX7

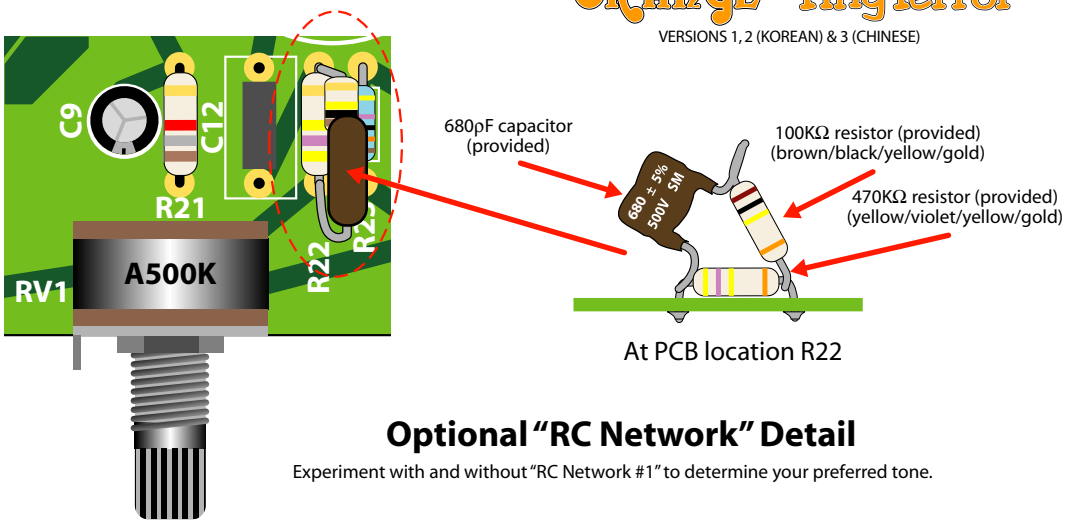
Axiom Mercury Magnetics Power Transformer PART #: ORP-TT



= Korean & Chinese PCB Modifications
= Korean PCB-only Modifications



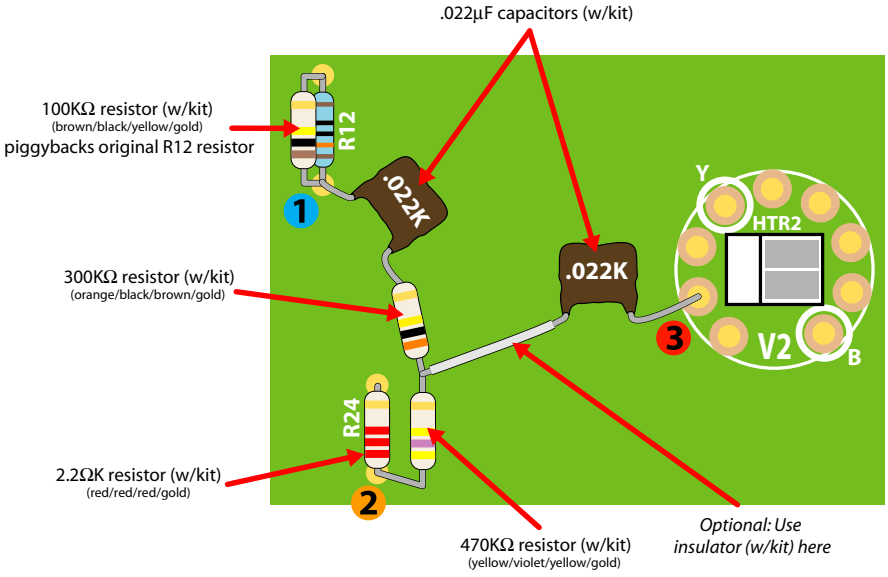
Mercury Upgrade
"HOLY TERROR"
for the
ORANGE™ "Tiny Terror"
VERSIONS 1, 2 (KOREAN) & 3 (CHINESE)



Optional "RC Network" Detail

Experiment with and without "RC Network #1" to determine your preferred tone.

"Voltage Divider" Detail



Note: The "Voltage Divider" connects, as shown, to 3 points to the Main PCB at:

1. **R12 (south terminal)**
2. **R24 (south terminal), *and***
3. **V2 (at pin 8)**

It is best to build it separately before mounting to the Main PCB. See reference photographs for more clues.

Schematic drawn by —

Mercury Magnetics — The Heart & Soul of Your Amp

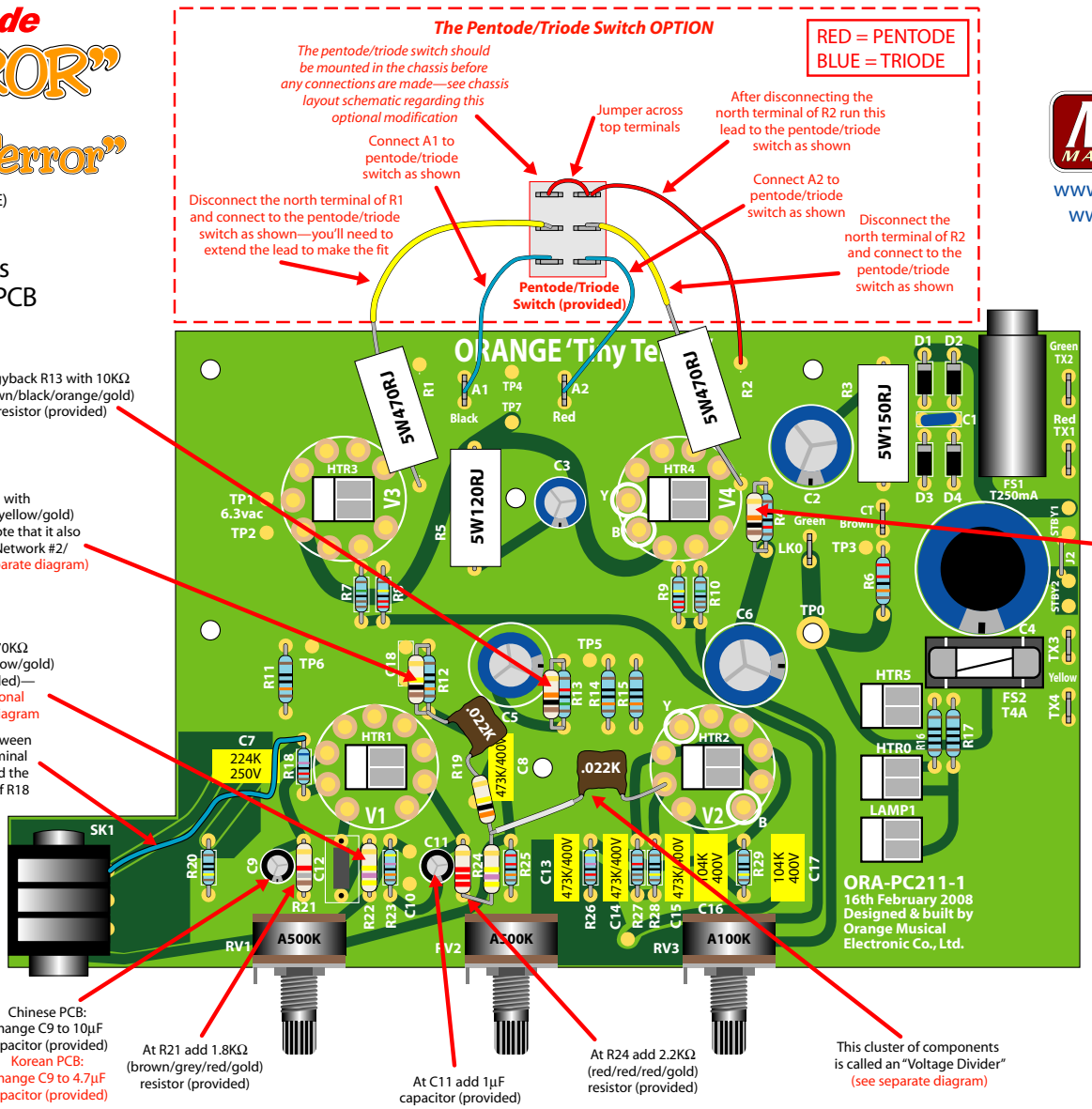
www.MercuryMagnetics.com
www.Amp-Exchange.com

VERSION: 08-12-08 (original)
Revised: 05-26-11

Mercury Upgrade "HOLY TERROR" for the ORANGE™ "Tiny Terror"

VERSIONS 1, 2 (KOREAN) & 3 (CHINESE)

Make these modifications to the top side of the main PCB



Schematic drawn by —

The Heart & Soul of Your Amp
Mercury MAGNETICS™

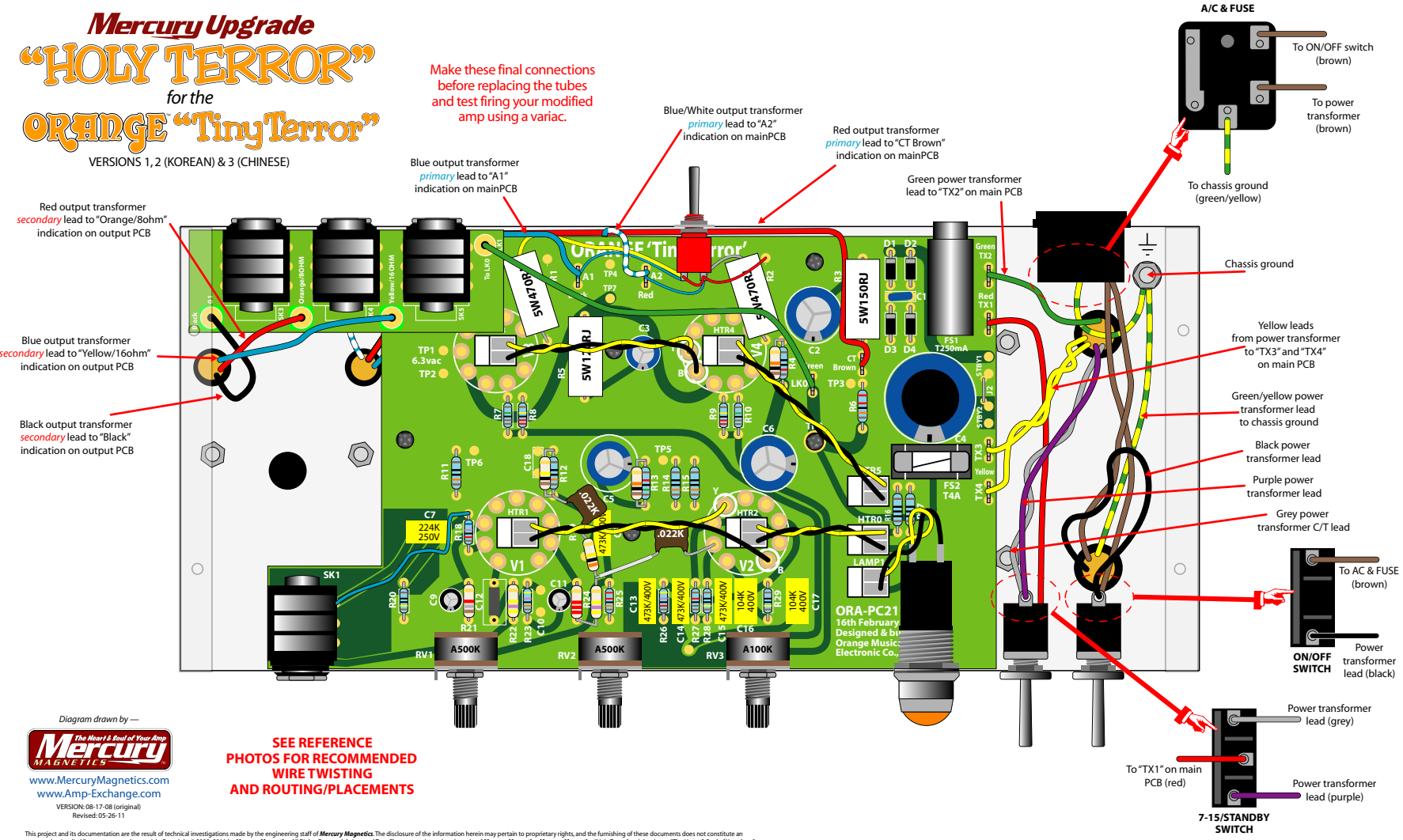
www.MercuryMagnetics.com
www.Amp-Exchange.com

VERSION: 08-17-08 (original)
Revision: 05-26-11

Mercury Upgrade "HOLY TERROR" for the ORANGE "Tiny Terror"

VERSIONS 1, 2 (KOREAN) & 3 (CHINESE)

Make these final connections before replacing the tubes and test firing your modified amp using a variac.



SEE REFERENCE PHOTOS FOR RECOMMENDED WIRE TWISTING AND ROUTING/PLACEMENTS

Diagram drawn by —

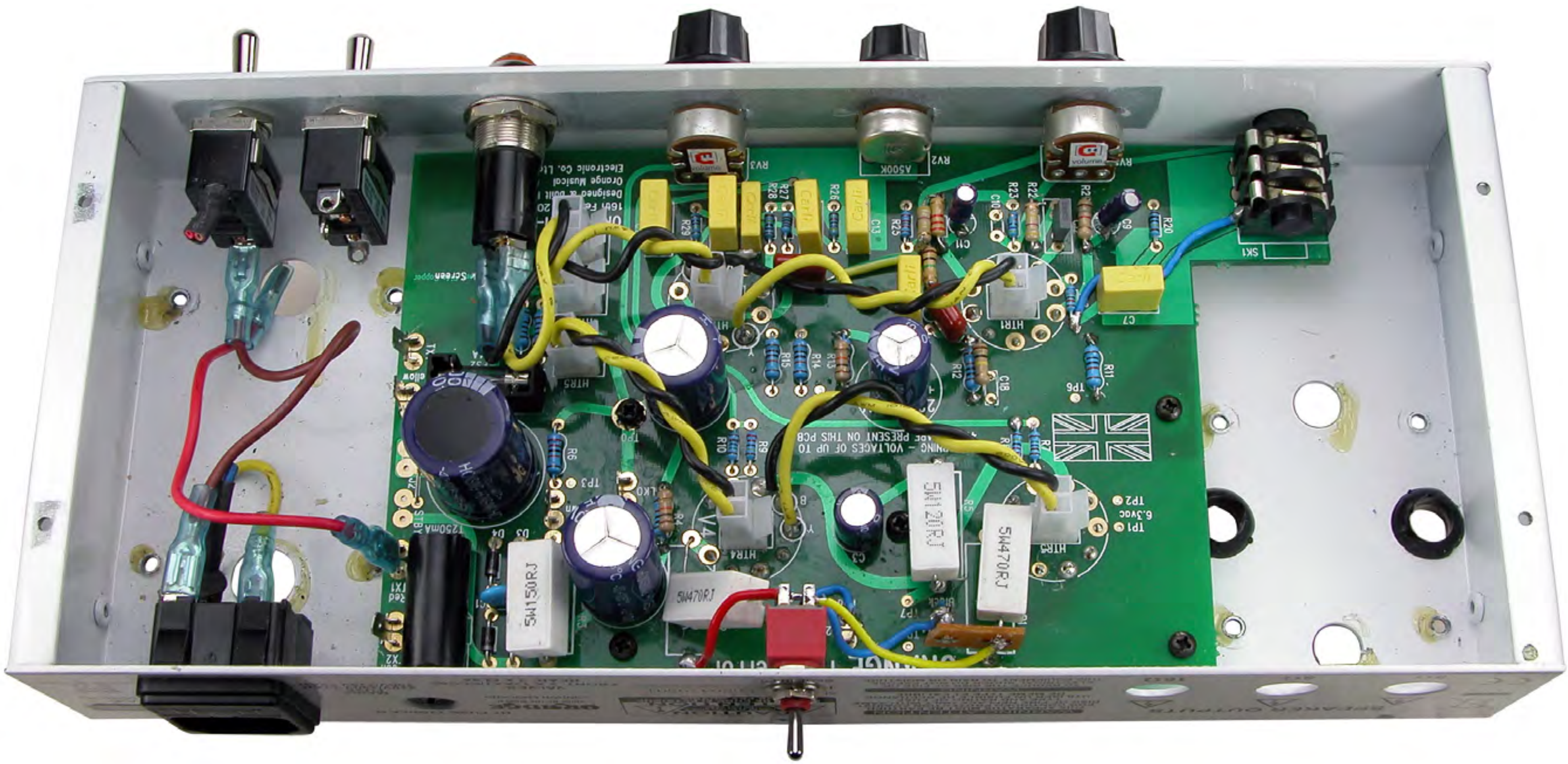
Mercury Magnetics — The Heart & Soul of Your Amp

www.MercuryMagnetics.com
www.Amp-Exchange.com

VERSION: 08-17-08 (original)
Revised: 05-26-11

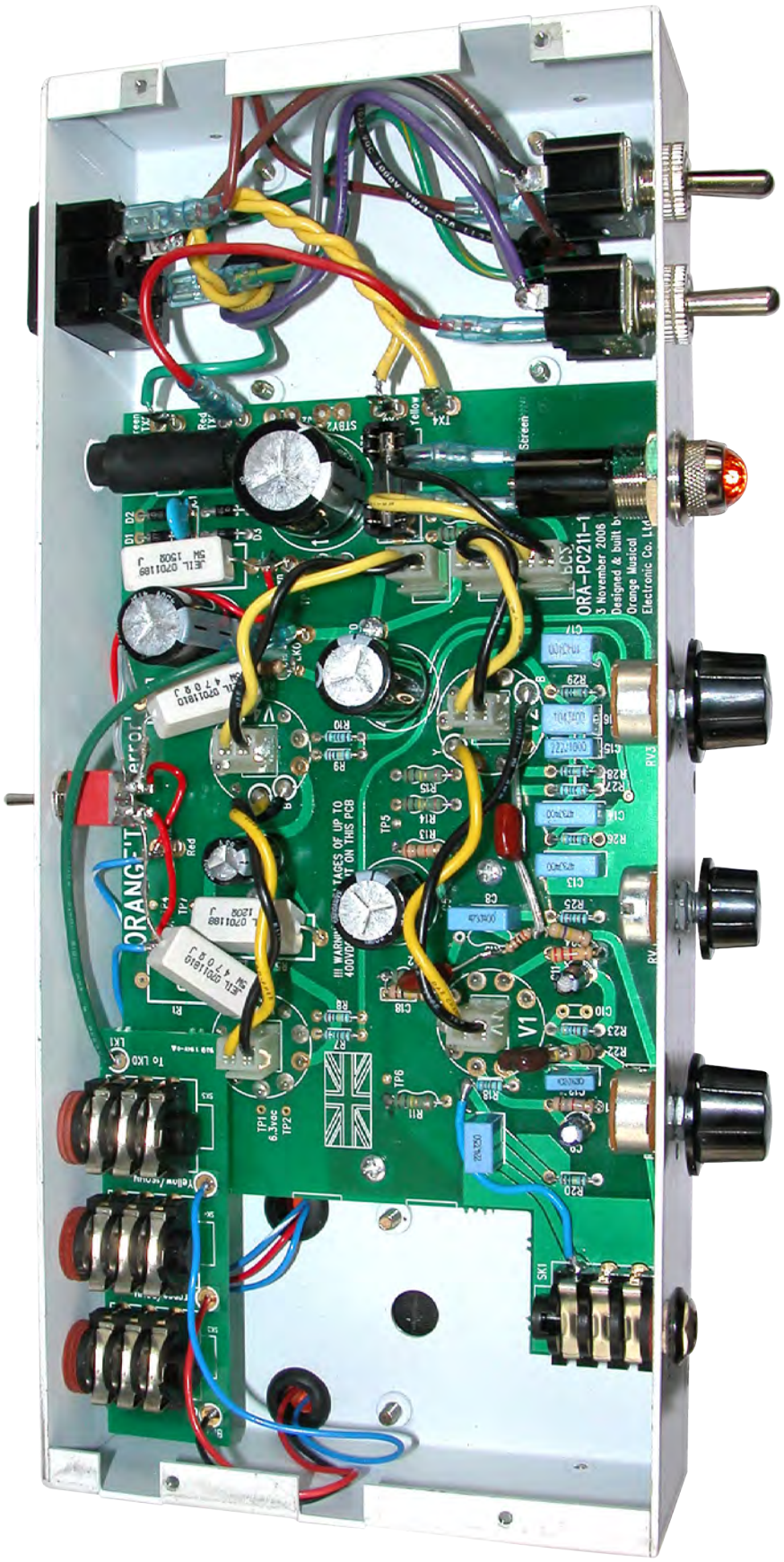
This project and its documentation is the result of technical investigations made by the engineering staff of ***Mercury Magnetics***. The disclosure of the information herein may pertain to proprietary rights and the furnishing of these documents does not constitute an expressed or implied license to use such materials.

Chassis reference photo: A fully modified main PCB (version 1, 2 & 3). Note that lead colors and standoff to PTS are different than description in manual.



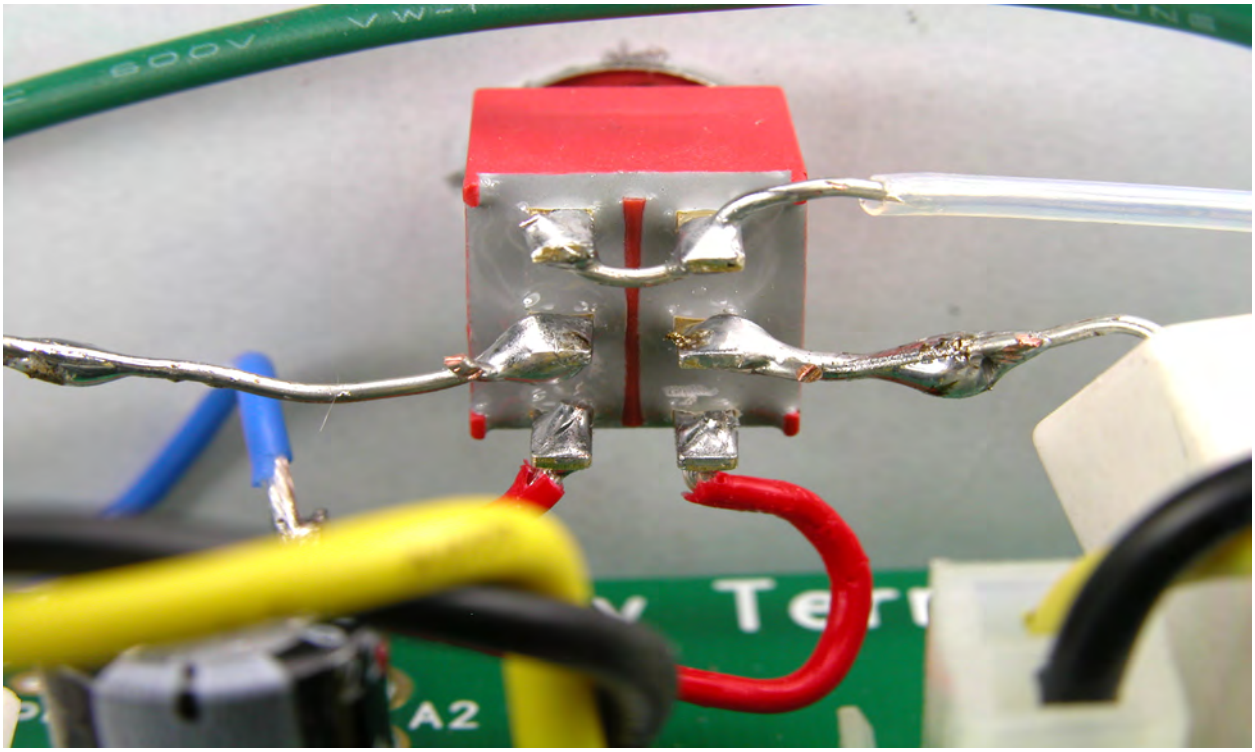
Chassis reference photo: A fully modified main PCB (version 1, 2 & 3). Note that lead colors and standoff to PTS are different than description in manual.

Chassis reference photo: A fully reassembled chassis (version 1, 2 & 3). Note that lead colors and standoff to PTS are different than description in manual.

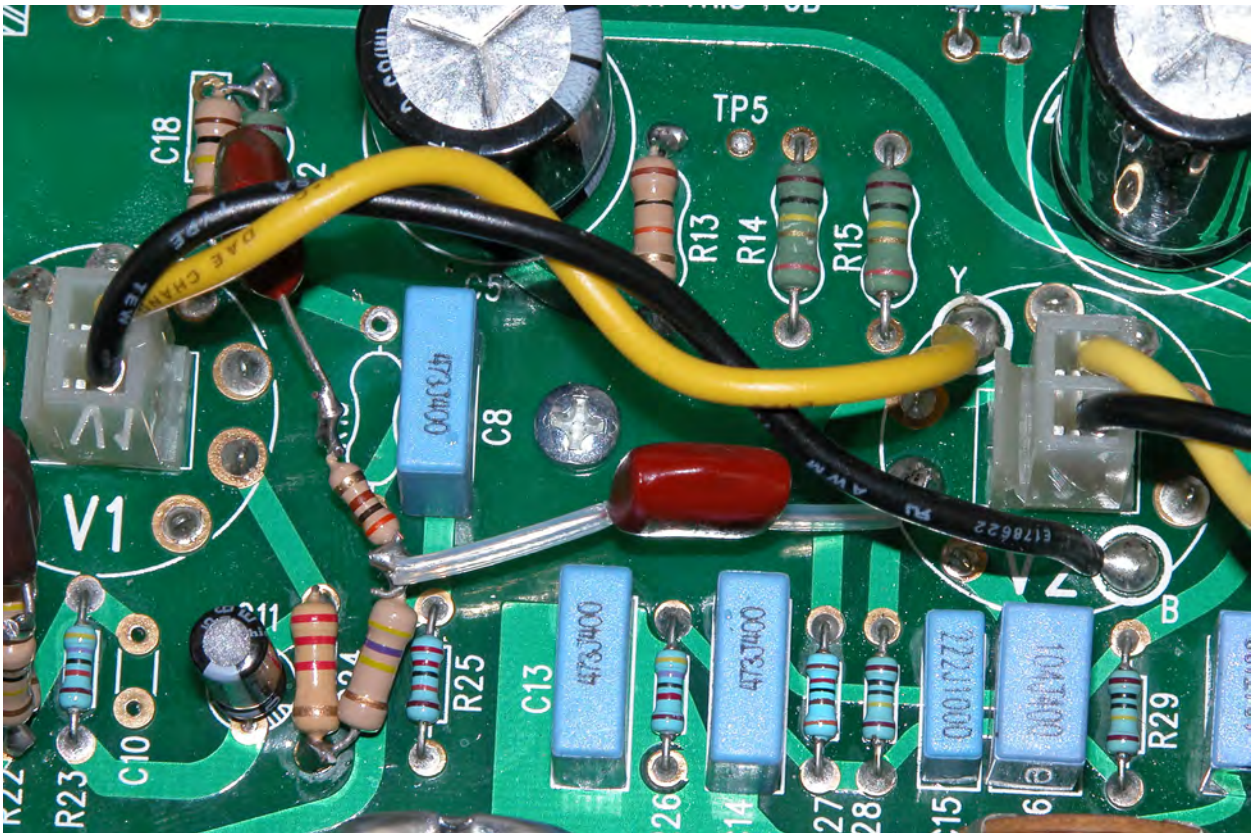


Chassis reference photo: A fully reassembled chassis (version 1, 2 & 3).

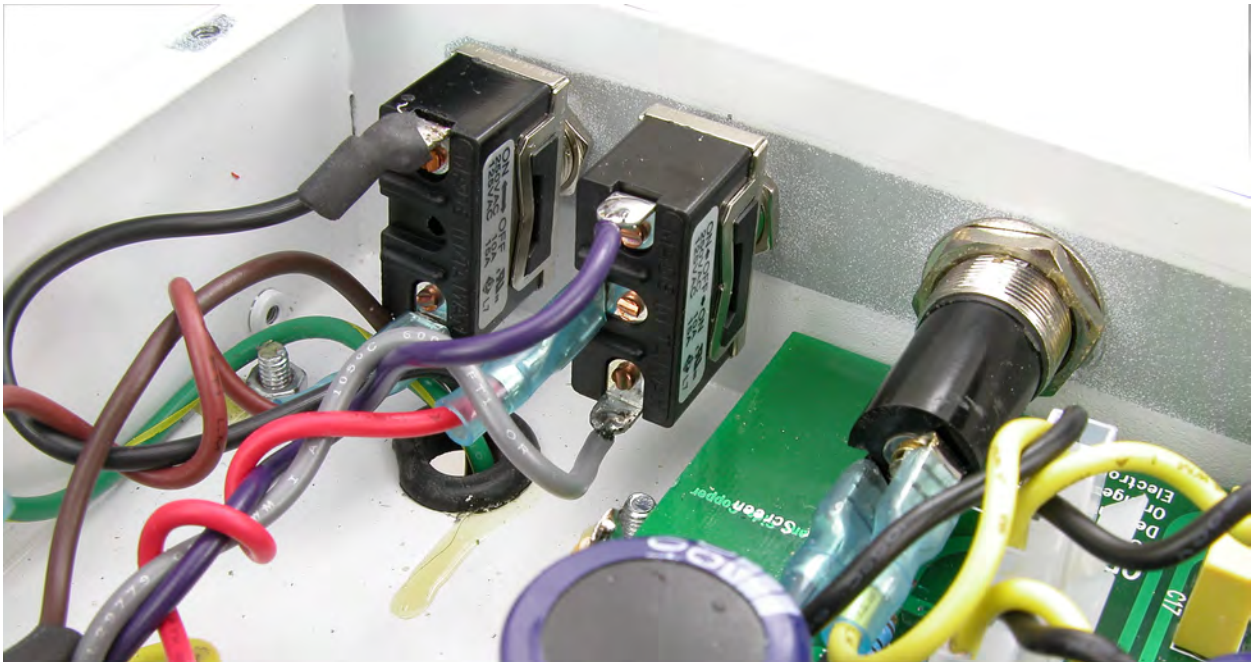
PTS (Pentode/Triode Switch: Here's where the switch mounts.
Note that the down position is the Triode mode, the up is Pentode mode.



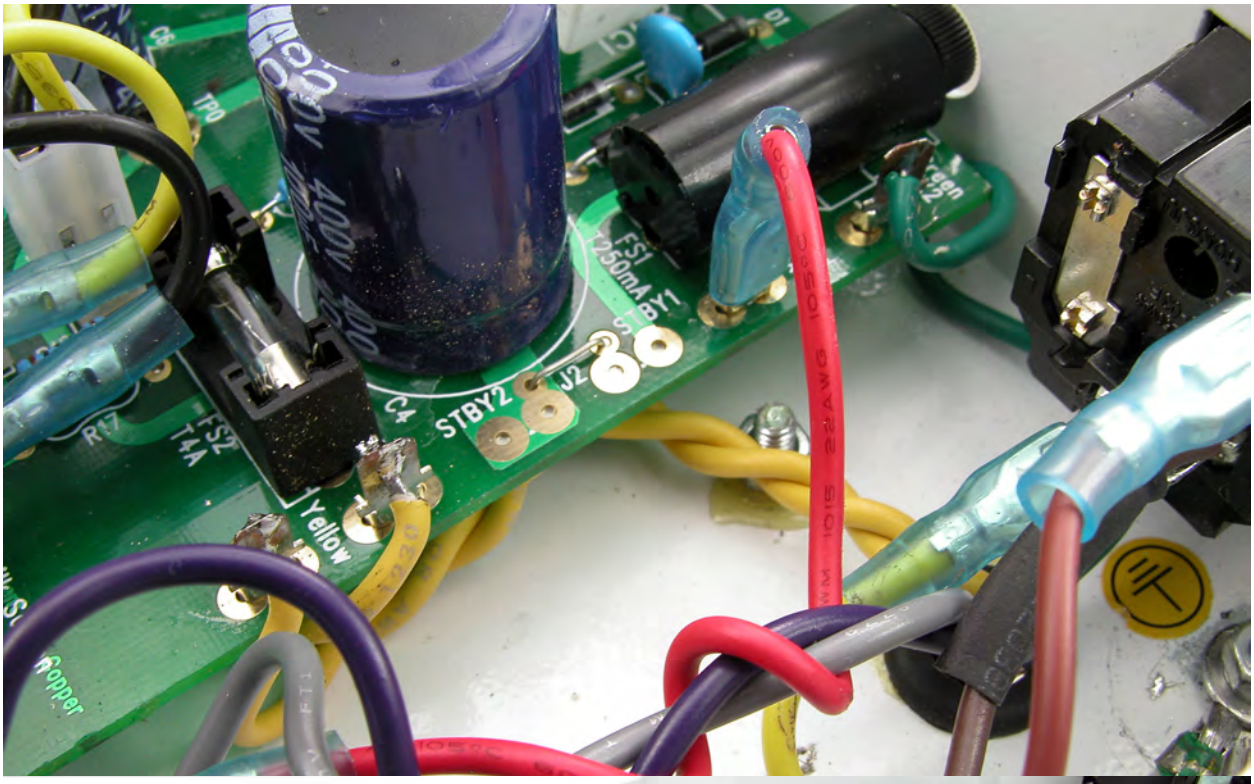
Reference photo showing the connections to the PTS.

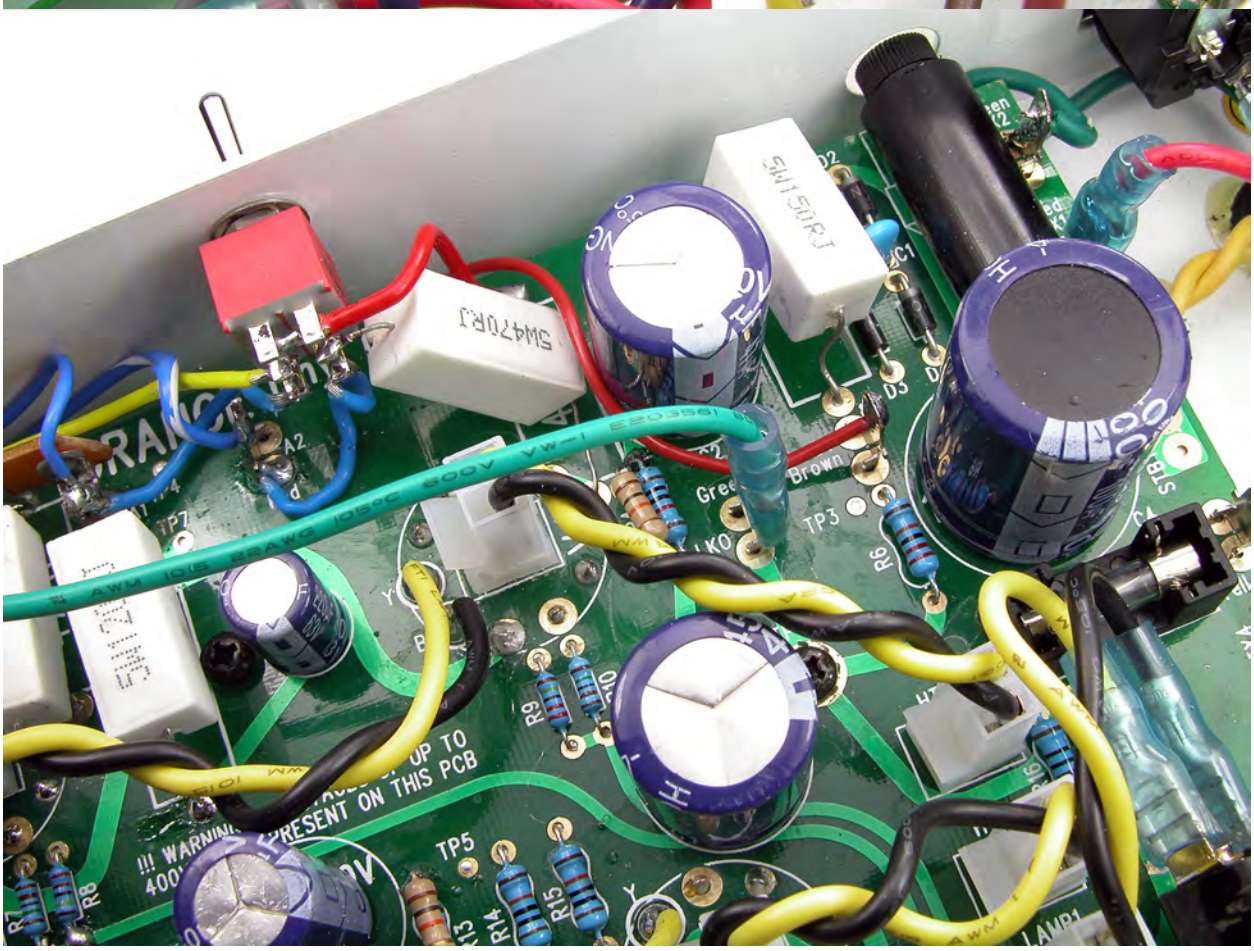


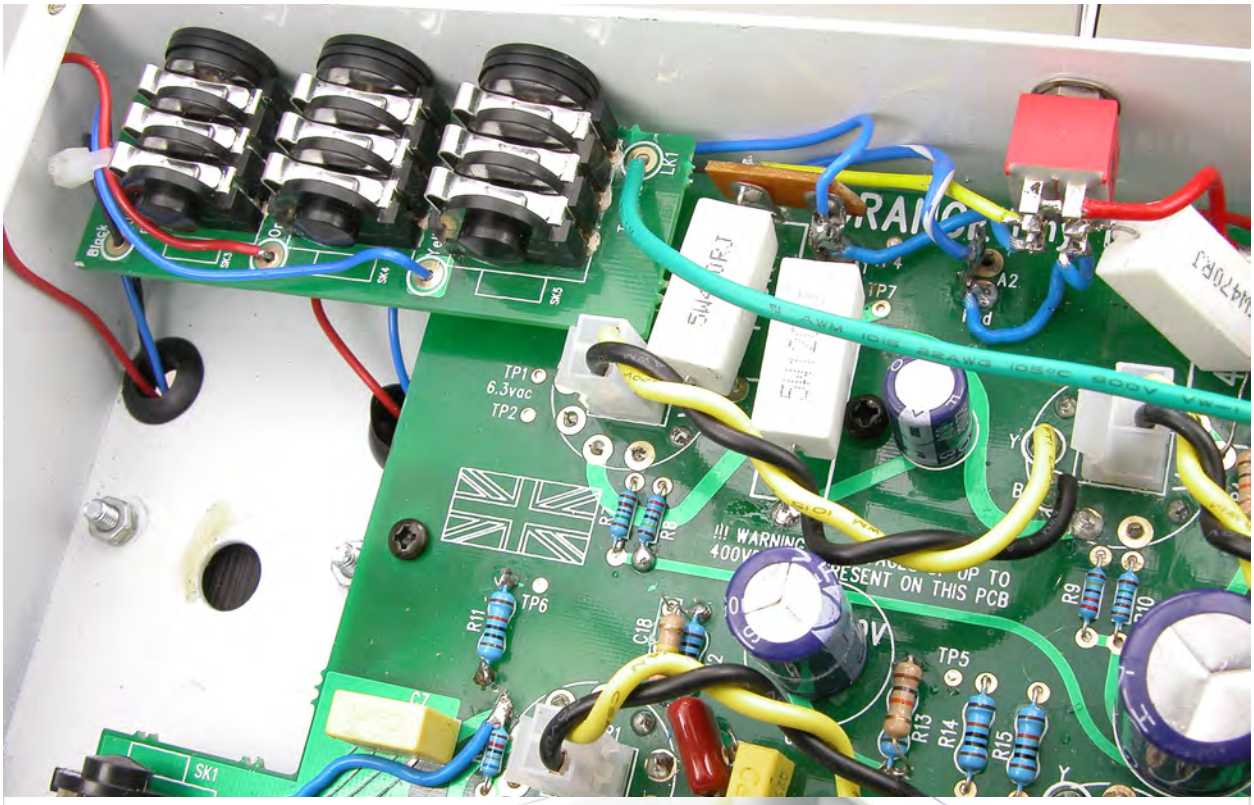
Reference photo showing how a correctly built and connected Voltage Divider should look.

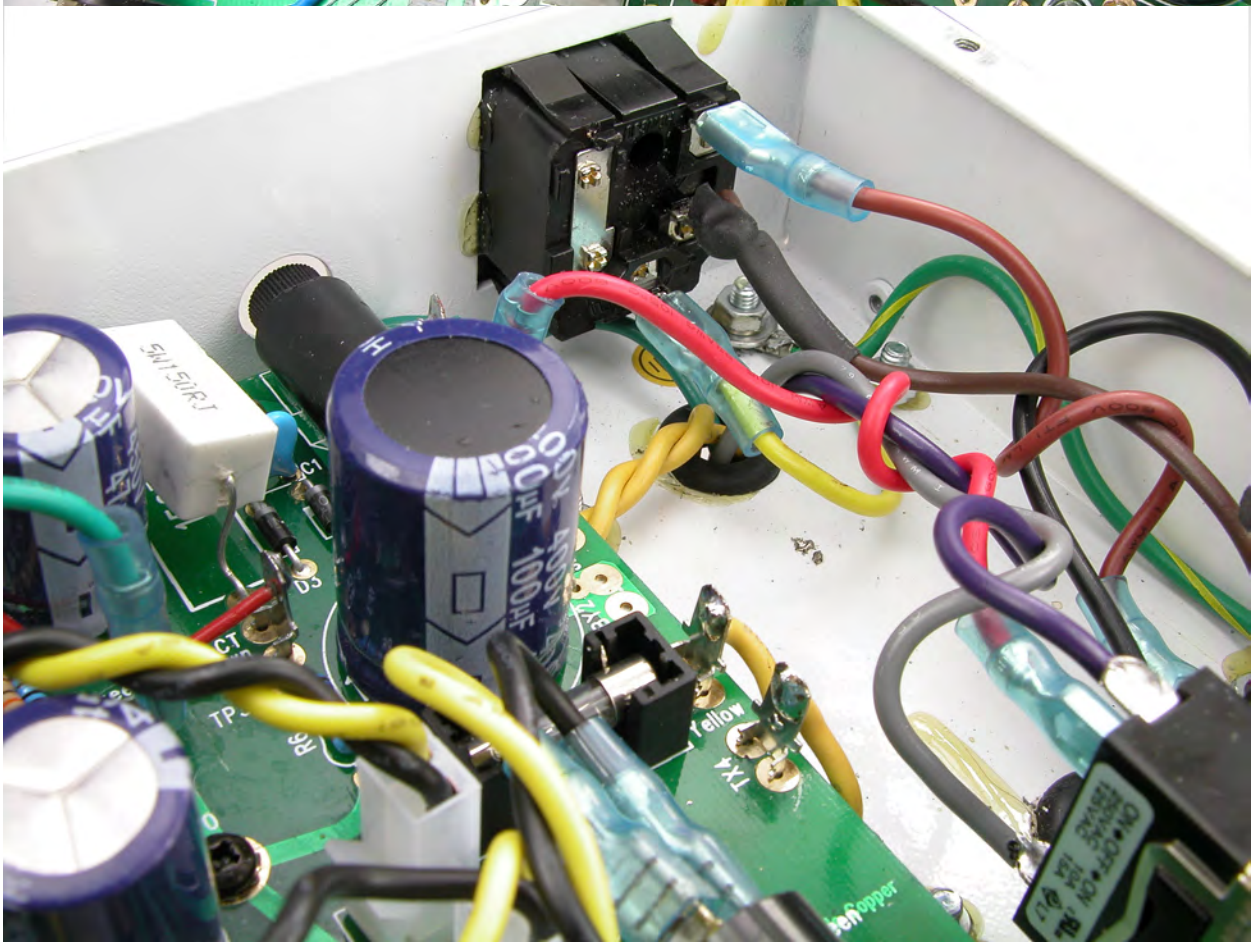


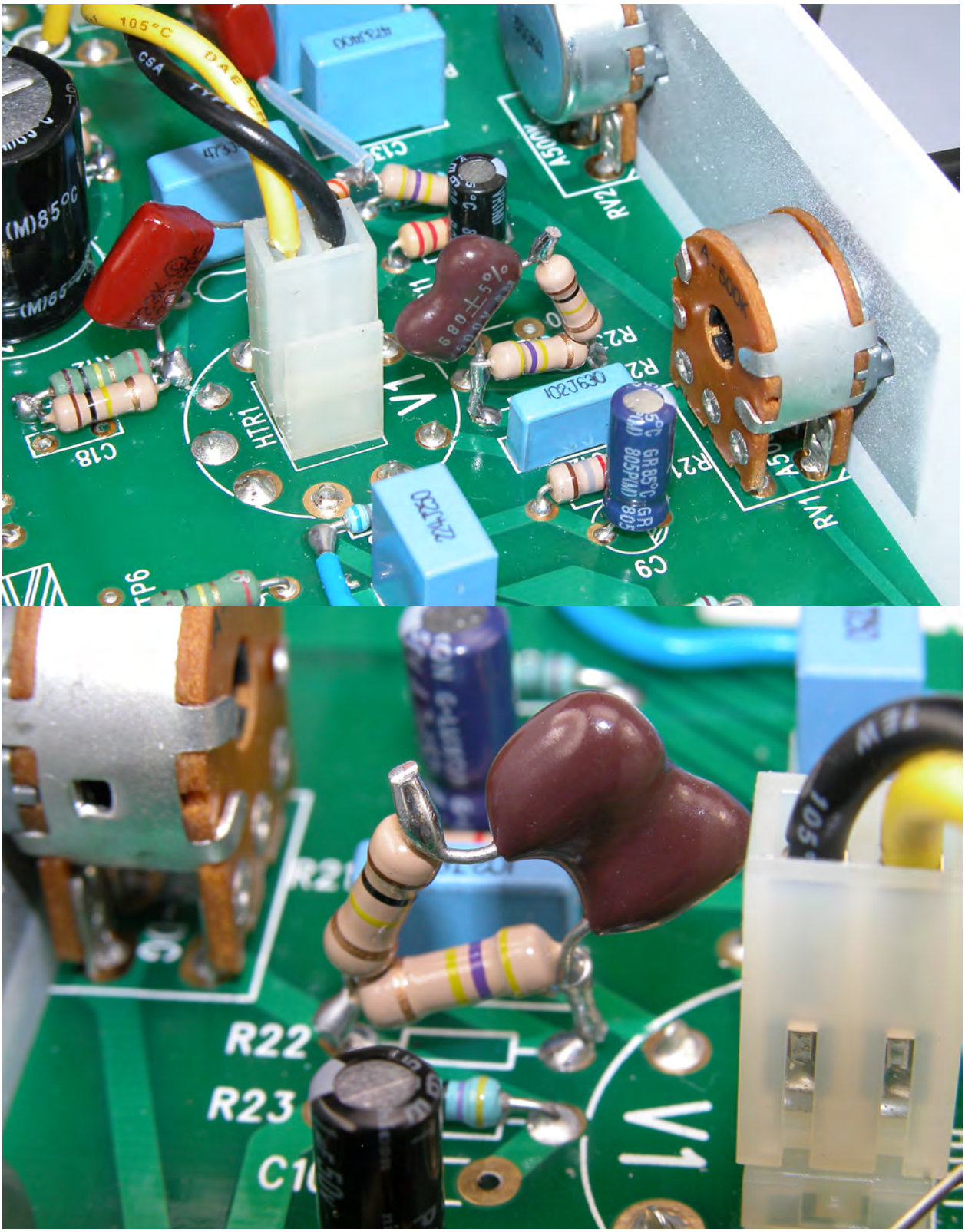
This photo and those on the next 2 pages are intended for reference purposes. Note that the filament leads (the twin yellow leads coming from the PT) are the only leads that must be “braided” – which lessens RF.











These photos show the “RC Network.” Generally it’s easier to build it first, and install it into the main PCB after it is assembled.

“HOLY TERROR”

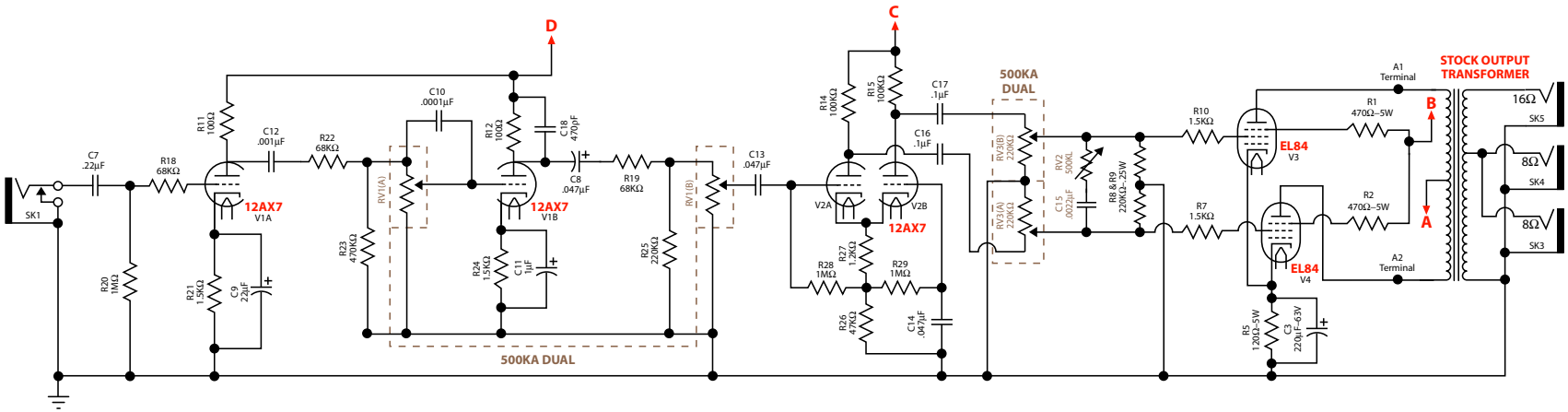
Version 4 PCB SECTION

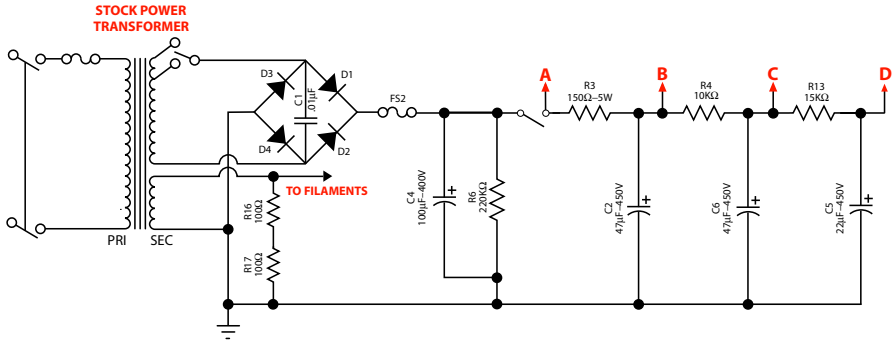
The following pages pertain ONLY to Version 4 **“Tiny Terror”** amplifiers. You can easily identify which version you have by the main printed circuit board (PCB); look for the following text, printed in white ink, on the lower right-hand quadrant:

ORO-PC211-4

Orange Tiny Terror • Stock Wiring Schematic

Stock Schematic for Version 4 PCB (Chinese) Amps

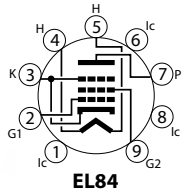




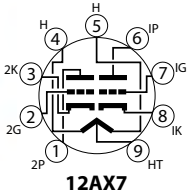
ORANGE™

www.OrangeAmps.com

PCB VERSION: ORA-PC211-4
JULY 9, 2008
ORANGE MUSICAL ELECTRONIC CO. LTD.



EL84



12AX7

Schematic drawn by —

Mercury Magnetics
The Heart & Soul of Your Amp

www.MercuryMagnetics.com
VERSION: 09-02-08
REVISION: 02-12-10

This project and its documentation is the result of technical investigations made by the engineering staff of ***Mercury Magnetics***. The disclosure of the information herein may pertain to proprietary rights and the furnishing of these documents does not constitute an expressed or implied license to use such materials.

Schematic drawn by —

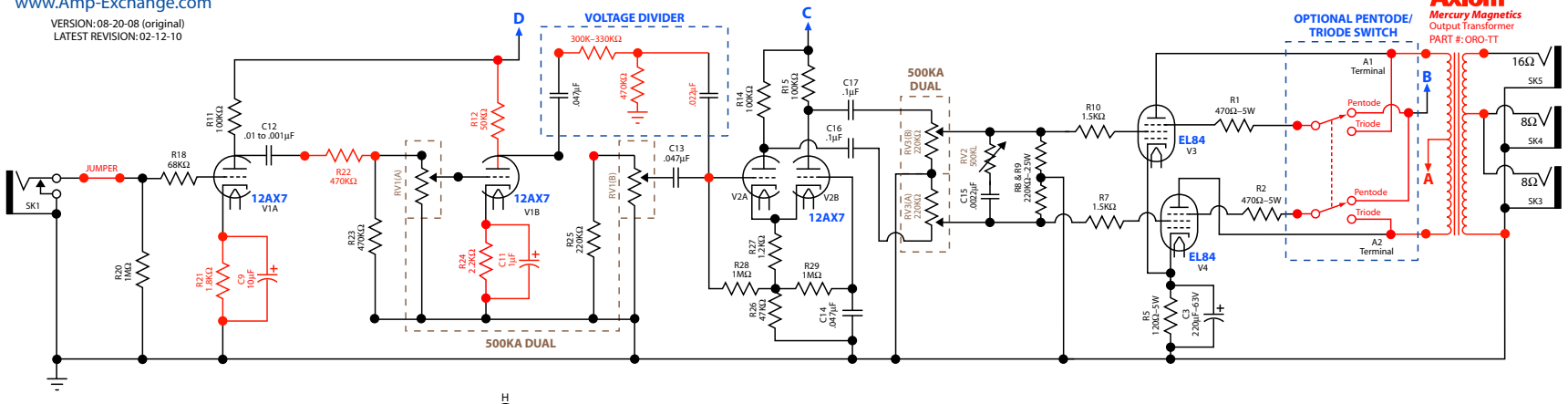
The Heart & Soul of Your Amp
Mercury MAGNETICS

www.MercuryMagnetics.com
www.Amp-Exchange.com

VERSION: 08-20-08 (original)
LATEST REVISION: 02-12-10

Mercury Upgrade "HOLY TERROR" for the ORANGE "Tiny Terror"

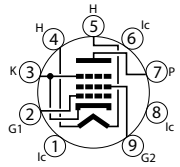
Upgraded Schematic for Version 4 PCB (Chinese) Amps

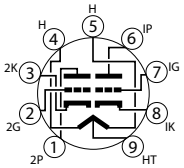


Axiom
Mercury Magnetics
Output Transformer
PART #: ORO-TT

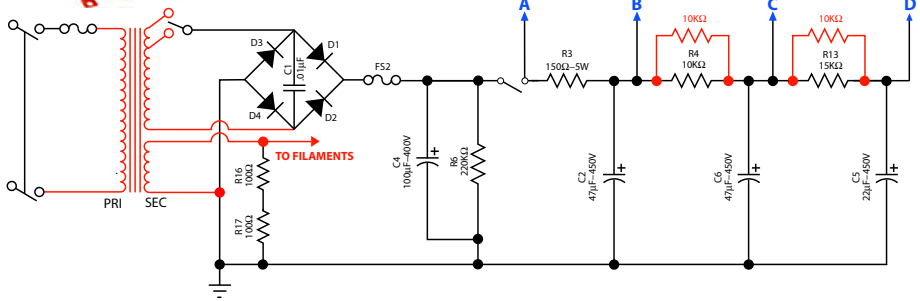
ORANGE™
www.OrangeAmps.com

PCB VERSION: ORA-PC211-4
JULY 9, 2008
ORANGE MUSICAL ELECTRONIC CO. LTD.

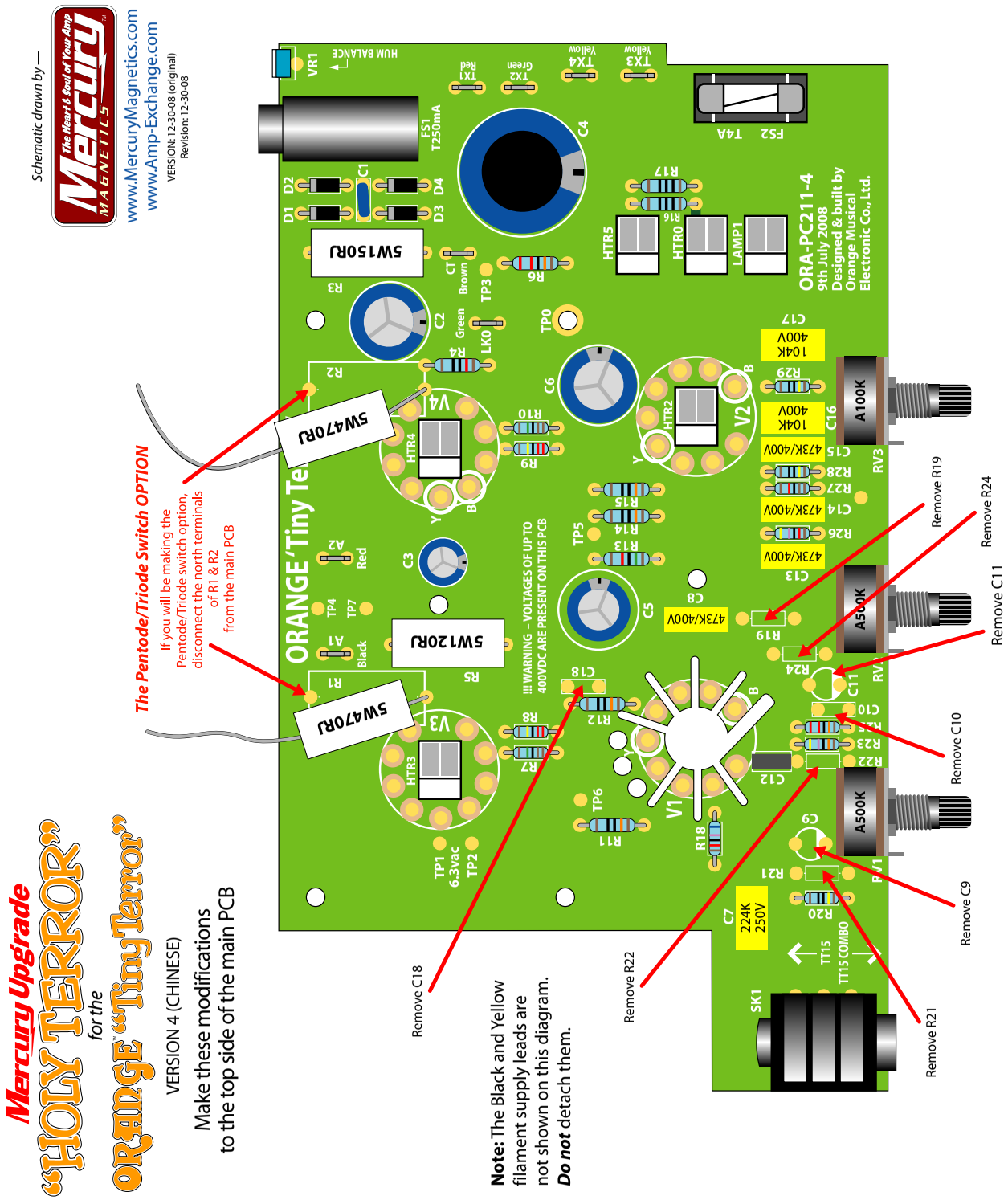




Axiom
Mercury Magnetics
Power Transformer
PART #: ORP-TT



This project and its documentation is the result of technical investigations made by the engineering staff of *Mercury Magnetics*. The disclosure of the information herein may pertain to proprietary rights and the furnishing of these documents does not constitute an expressed or implied license to use such materials.



Mercury Upgrade
"HOLY TERROR"
for the
ORANGE "Tiny Terror"
VERSION 4 (CHINESE)

Schematic drawn by —

Mercury MAGNETICS
The Heart & Soul of Your Amp

www.MercuryMagnetics.com
www.Amp-Exchange.com

VERSION: 11-16-11

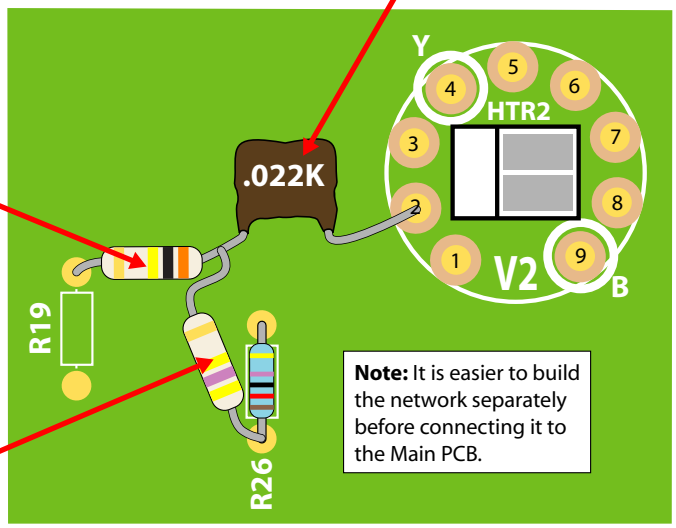
"Voltage Divider" Detail

.022K (marked 223K)
silver mica capacitor

300KΩ
(orange/black/yellow/gold)
or
330KΩ
(orange/orange/yellow/gold)
carbon film resistor

Note: you may swap this resistor for any other value up to 1MΩ for extending the clean headroom.

470KΩ
(yellow/violet/yellow/gold)
carbon film resistor

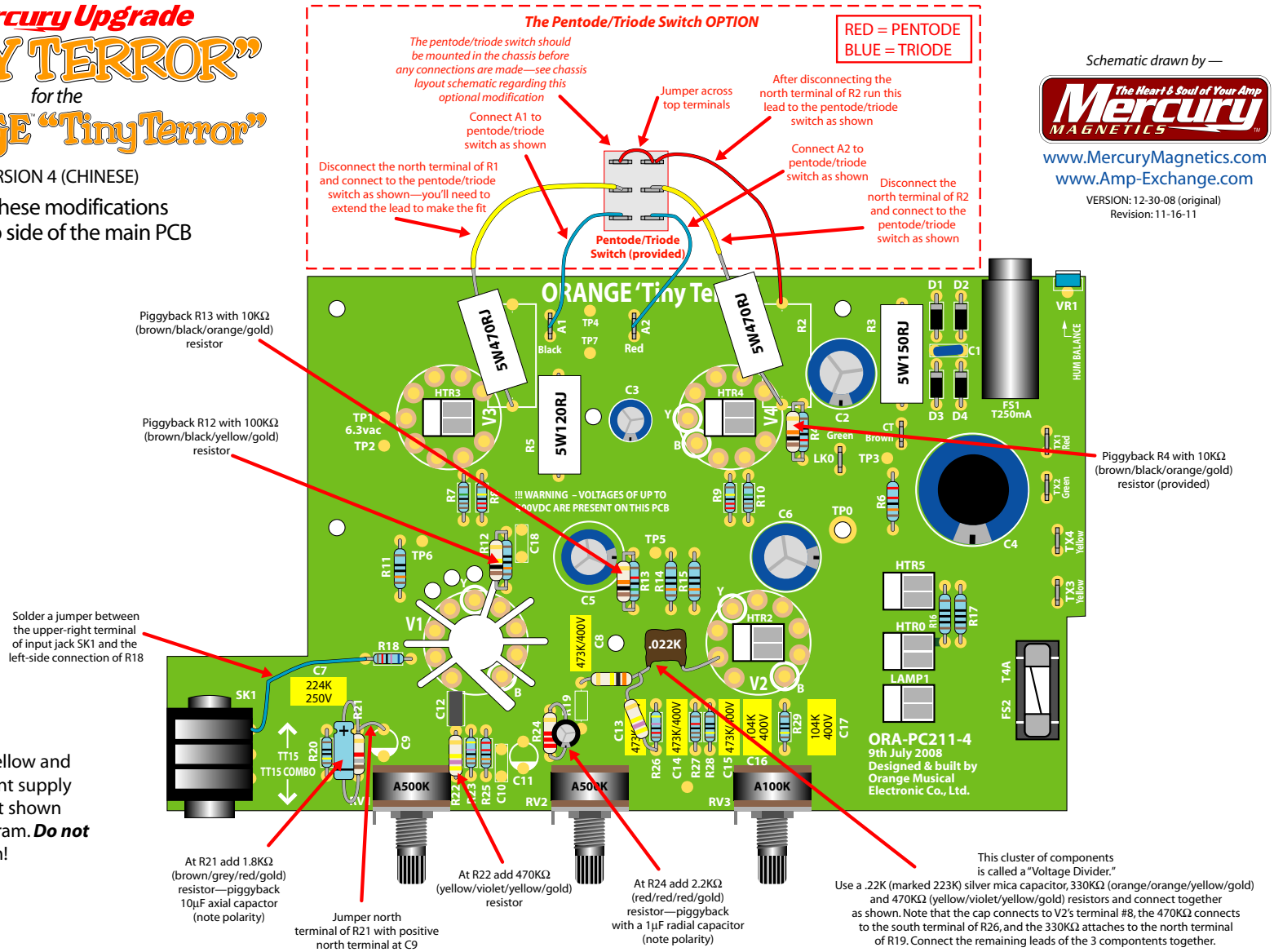


COMPONENT SIDE VIEW OF PCB

Mercury Upgrade "HOLY TERROR" for the ORANGE™ "Tiny Terror"

VERSION 4 (CHINESE)

Make these modifications to the top side of the main PCB



Note: The Yellow and Black filament supply leads are not shown on this diagram. ***Do not*** detach them!

Schematic drawn by —

The Heart & Soul of Your Amp Mercury MAGNETICS™

www.MercuryMagnetics.com
www.Amp-Exchange.com

VERSION: 12-30-08 (original)
Revision: 11-16-11

This project and its documentation is the result of technical investigations made by the engineering staff of ***Mercury Magnetics***. The disclosure of the information herein may pertain to proprietary rights and the furnishing of these documents does not constitute an expressed or implied license to use such materials.

Mercury Upgrade "HOLY TERROR" for the ORANGE "Tiny Terror"

VERSIONS 4 (CHINESE)

Make these final connections before replacing the tubes and test firing your modified amp using a variac.

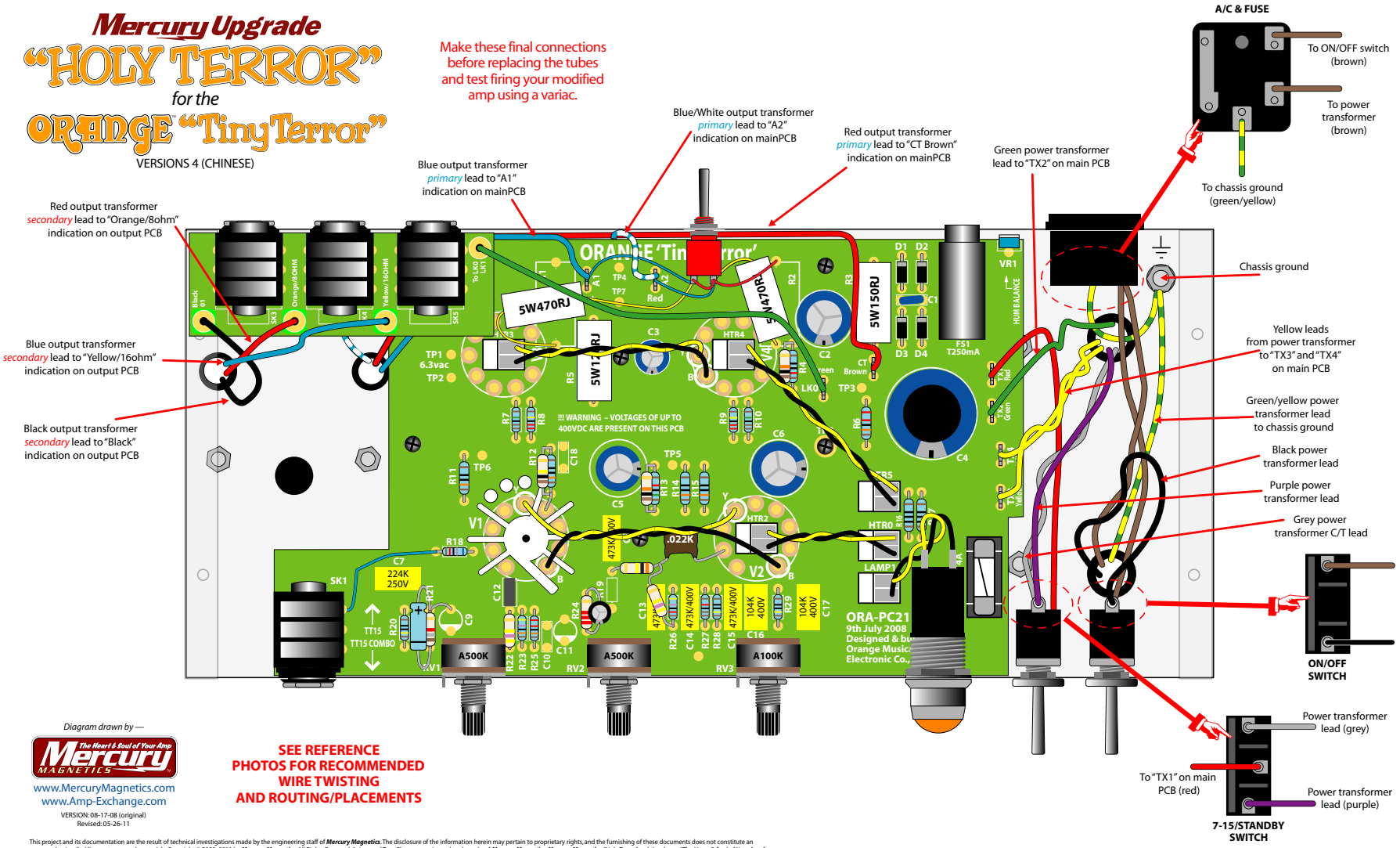


Diagram drawn by —

Mercury Magnetics — The Heart & Soul of Your Amp

www.MercuryMagnetics.com
www.Amp-Exchange.com

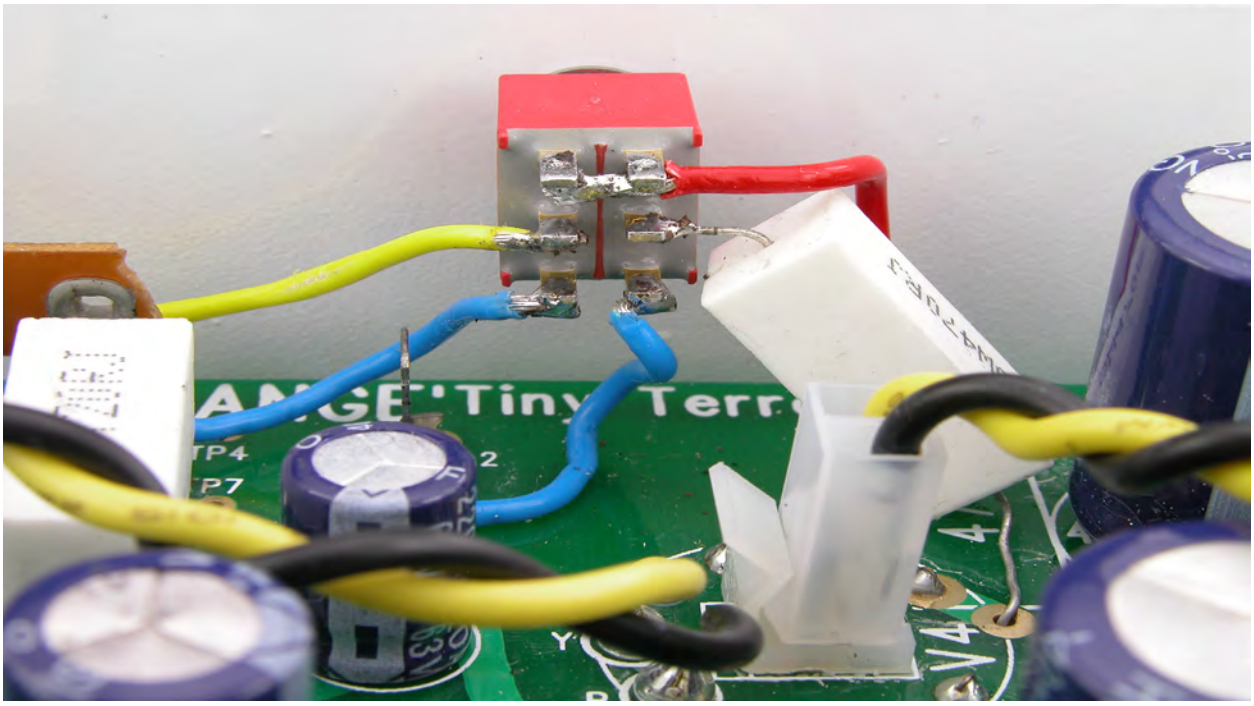
VERSION: 08-17-08 (original)
Revised: 05-26-11

SEE REFERENCE PHOTOS FOR RECOMMENDED WIRE TWISTING AND ROUTING/PLACEMENTS

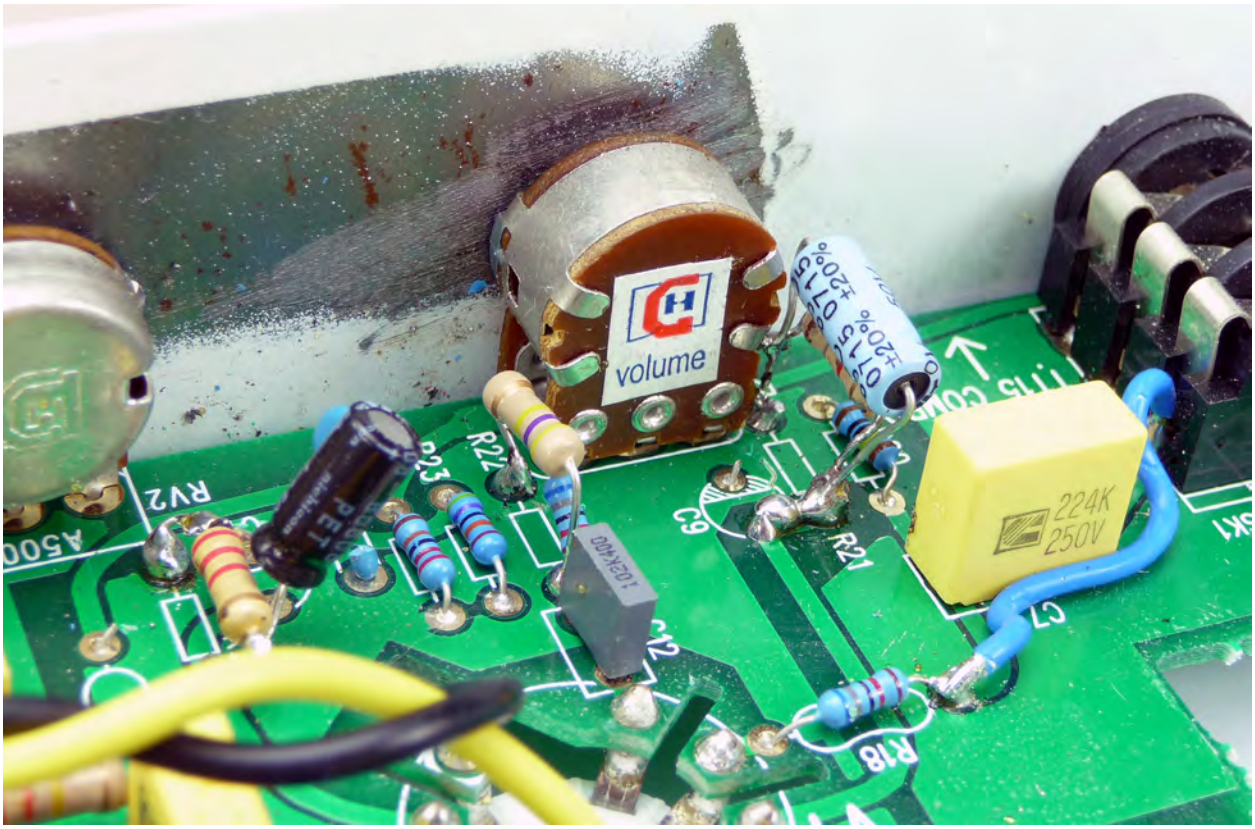
Reference photo: A fully ***Upgraded*** and reassembled **"Holy Terror"** from a Version 4 "Tiny Terror."

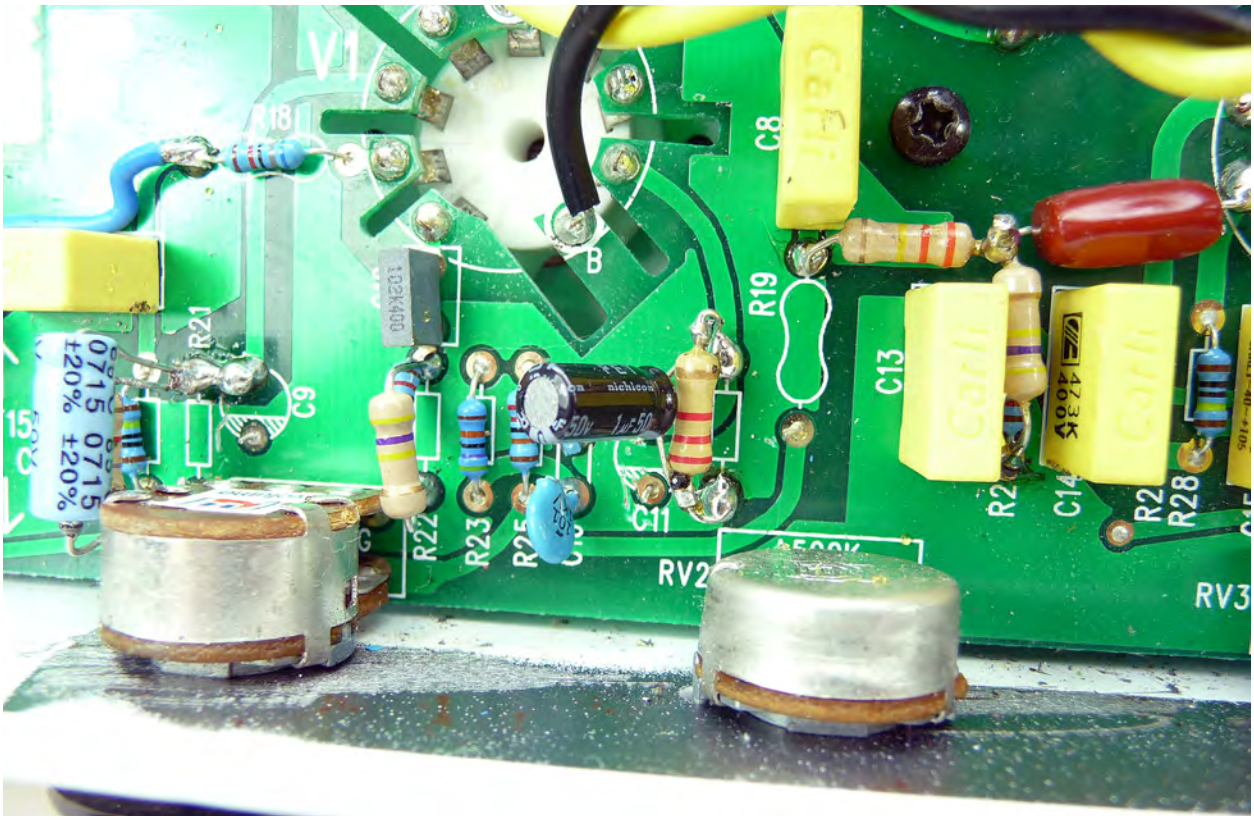
Reference photo: A fully ***Upgraded*** and reassembled **"Holy Terror"** from a Version 4 "Tiny Terror."

PTS (Pentode/Triode Switch: Here's where the switch mounts.
Note that the down position is the Triode mode, the up is Pentode mode.

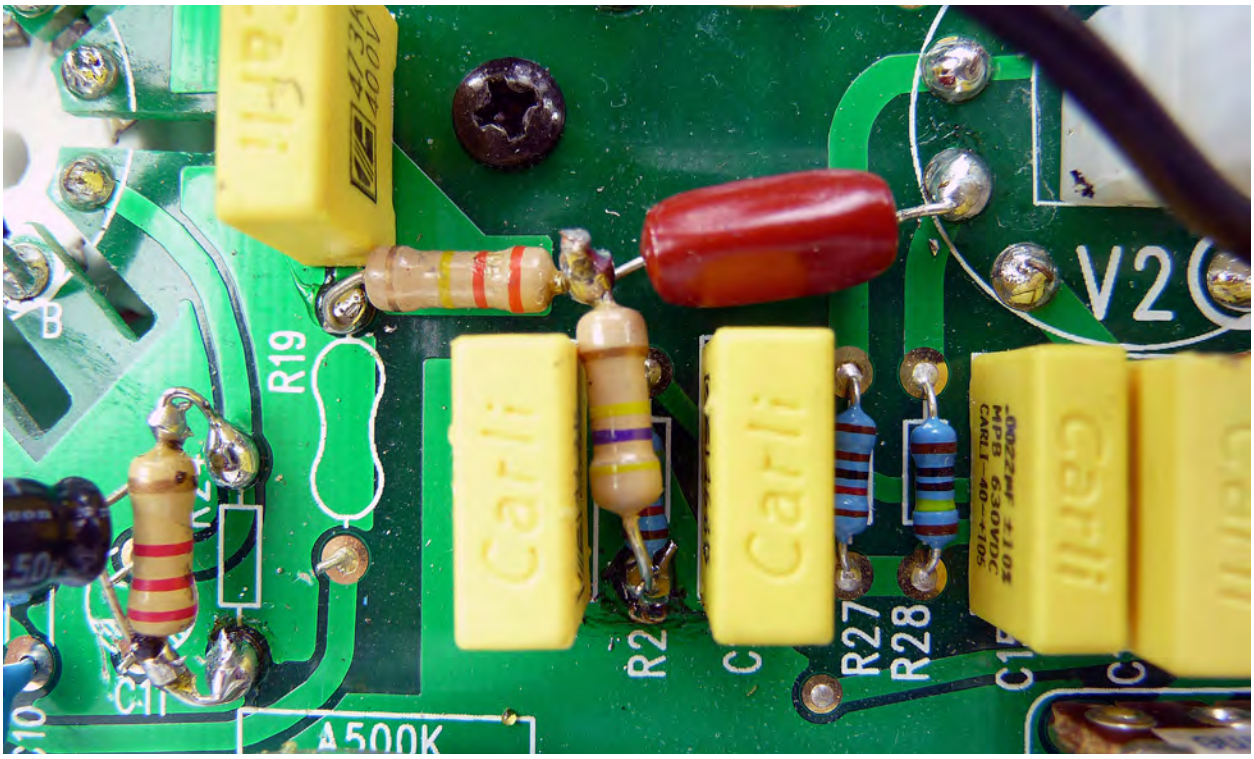


Reference photo showing the connections to the PTS.

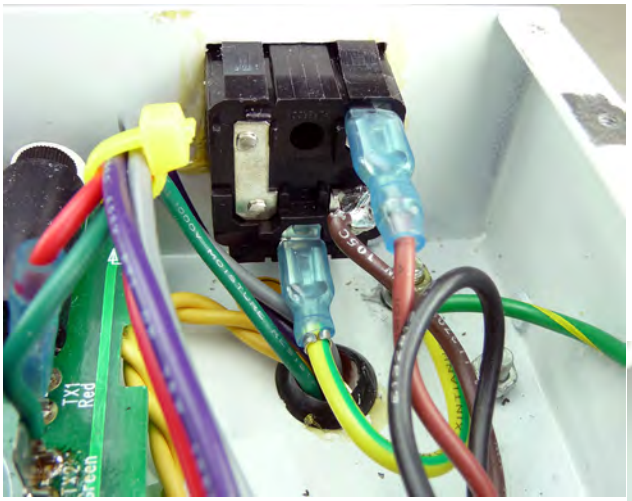


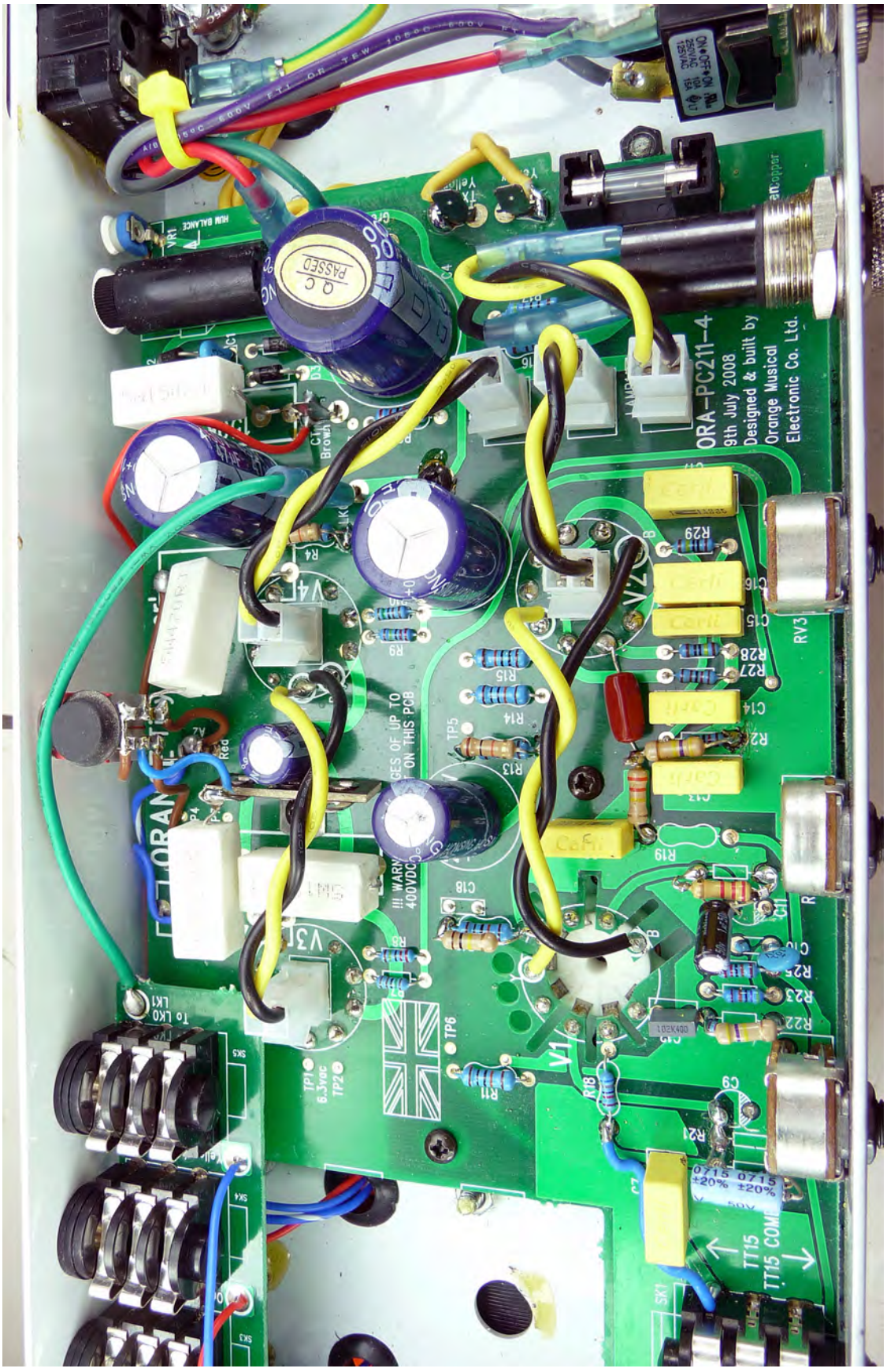


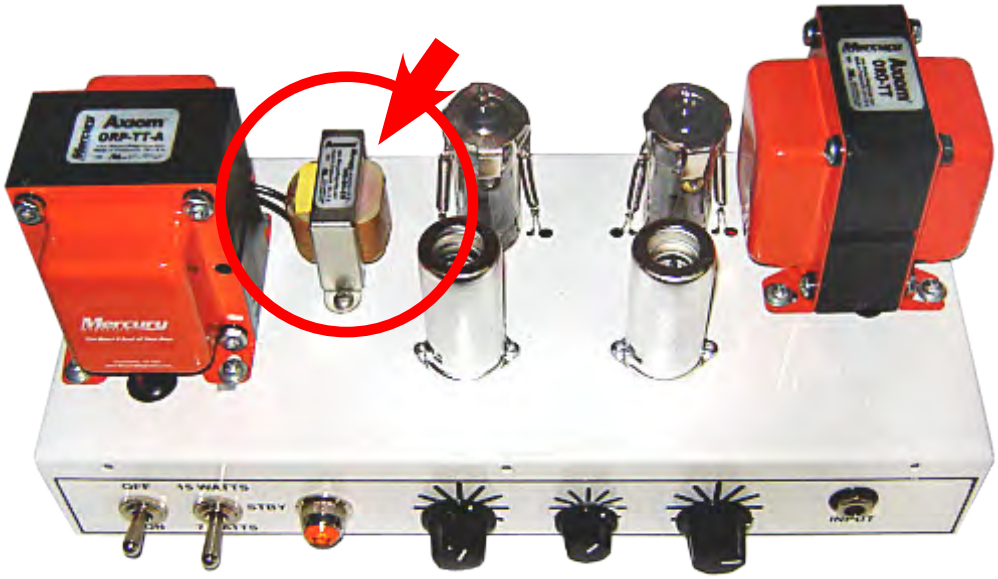
Note that the “Voltage Divider” in these photographic examples uses a 330KΩ resistor instead of a 330KΩ.



Reference photo shows the “Voltage Divider” on an ***Upgraded*** Version 4.







Bob McGilpin's "McMod"

A toneful new option for *Mercury's* "Tiny Terror" *Upgrade*

by Bob McGilpin of MV Amps

The following explains how to add a 9 Henry ***Mini-Choke*** to ***Mercury's*** **"Holy Terror"** ***Upgrade Kit***. It's a very easy and worthwhile modification to do. And, it'll greatly expand the tonal range of your amp.

Click on the above photo to see a movie produced by Bob McGilpin to demonstrate his "McMod."

Bob **wrote**: "I added a ***Mercury*** 9 Henry ***Mini-Choke*** to my ***Holy Terror***. Why? Because I now know that adding a *choke* makes an amp sound better. It makes for a smoother and warmer sounding amp with a touch of vintage to the amp's tone.

Why a 9 Hentry? Well, the ***Holy Terror*** runs at about 15 watts, close to a ***VOX AC15***. However the original vintage ***Vox AC15*** used a 10 Henry *choke* – although the size of the original was quite a bit larger. So I settled for a smaller 9 Henry ***Mini-Choke*** (an innovation of ***Mercury***!).

"I believe when you listen to my sound samples that you will you decide to take your ***Holy Terror Upgrade Kit*** all the way by adding the *9 Henry* ***Mini-Choke*** as well. It'll give you an even

Continued on page 44 ➡

NOTE: If you are adding ***Mercury's Mini-Choke*** after you've already made the **"Holy Terror"** ***Upgrade*** you will probably not be able to easily remove the circuit board. So, instead of removing the PCB, you may very, very carefully drill small holes for self-tapping metal screws for the ***Mini-Choke***. Mount and secure your ***Mini-Choke***, pull the leads through the hole, and then follow the instructions for removing the 5 watt 150Ω resistor and soldering your new ***Mini-Choke*** into place. See the chassis diagram on the next page for the hole locations and sizes.

www.MercuryMagnetics.com
Info@MercuryMagnetics.com
(818) 998-7791

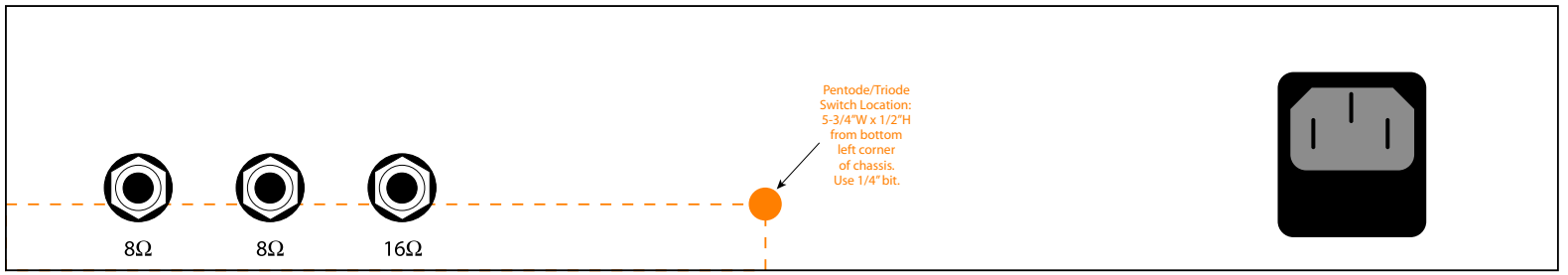
"HOLY TERROR"

Mercury Upgrade

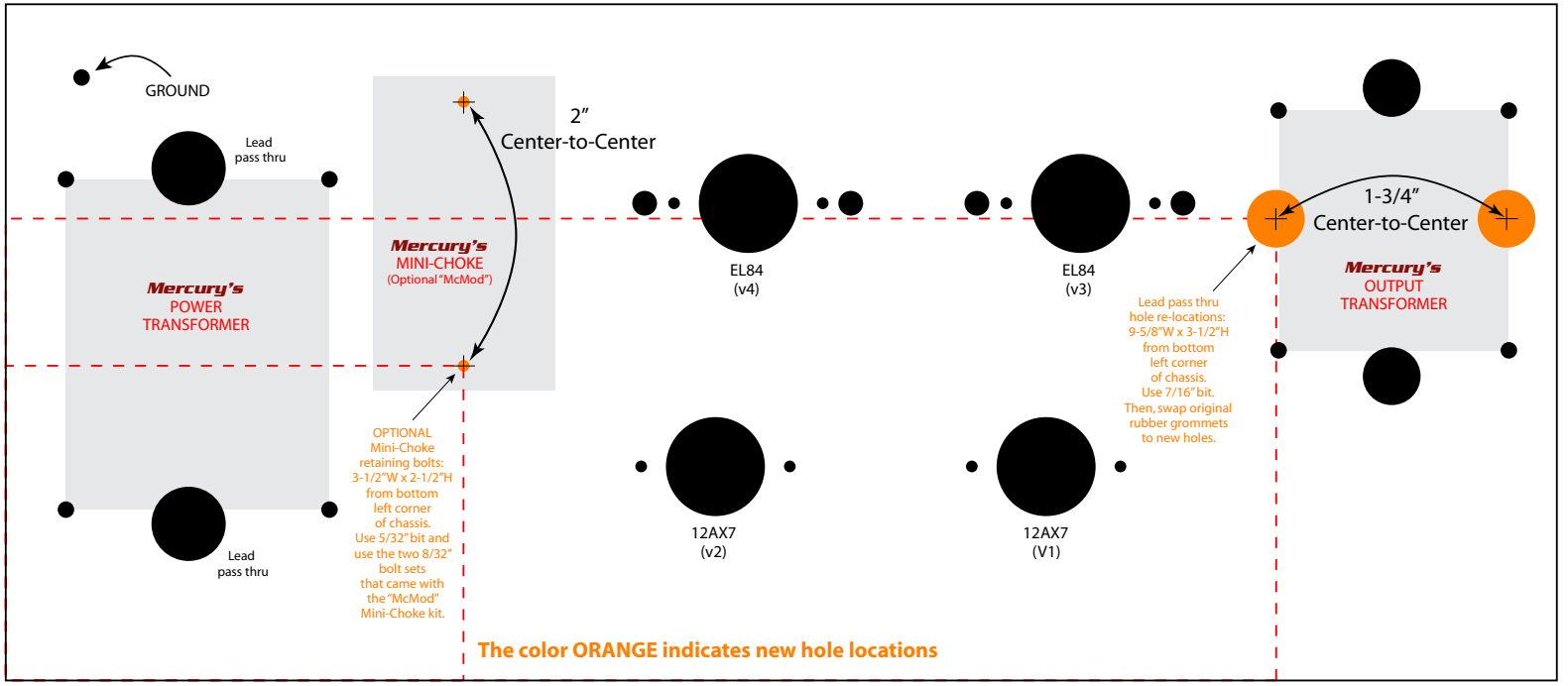
The "Holy Terror" *Upgrade* for the Orange "Tiny Terror"

Chassis mods for all current versions of this amp

Back panel view



Top view



~11-3/4" x 5-1/9" x 2" CHASSIS TOP and BACK PANEL VIEW (all specifications shown are nominal)

FRONT

VERSION: 04-28-10

Mercury Upgrade "HOLY TERROR" for the ORANGE "Tiny Terror"

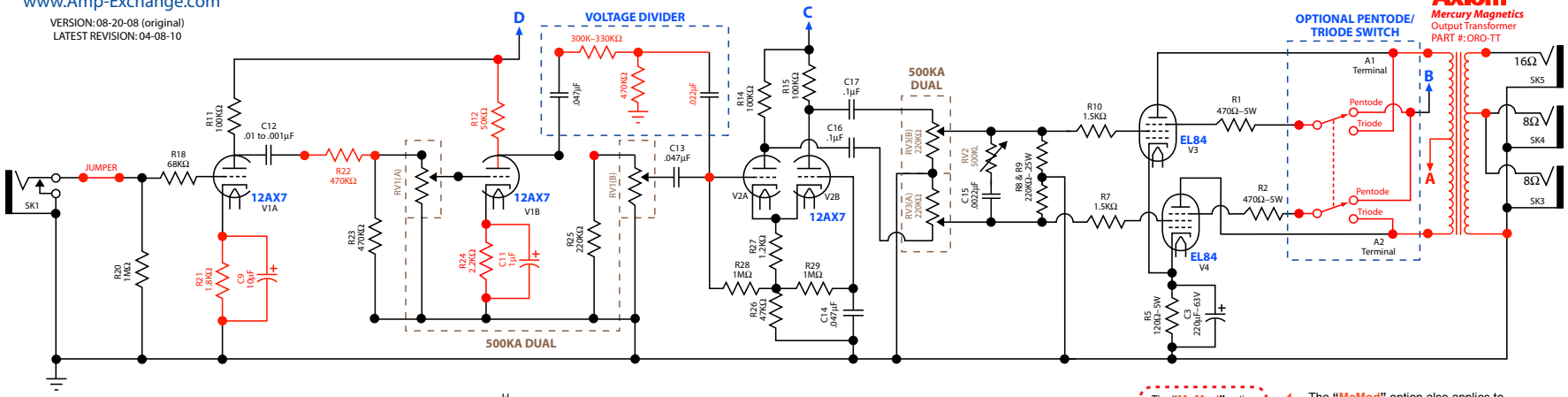
Upgraded Schematic for Version 4 PCB (Chinese) Amps

Schematic drawn by —

Mercury Magnetics — The Heart & Soul of Your Amp

www.MercuryMagnetics.com
www.Amp-Exchange.com

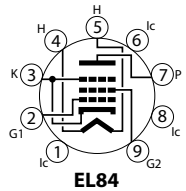
VERSION: 08-20-08 (original)
LATEST REVISION: 04-08-10



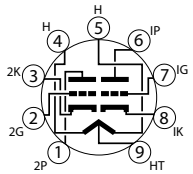
Axiom
Mercury Magnetics
Output Transformer
PART #: ORO-TT

ORANGE™
www.OrangeAmps.com

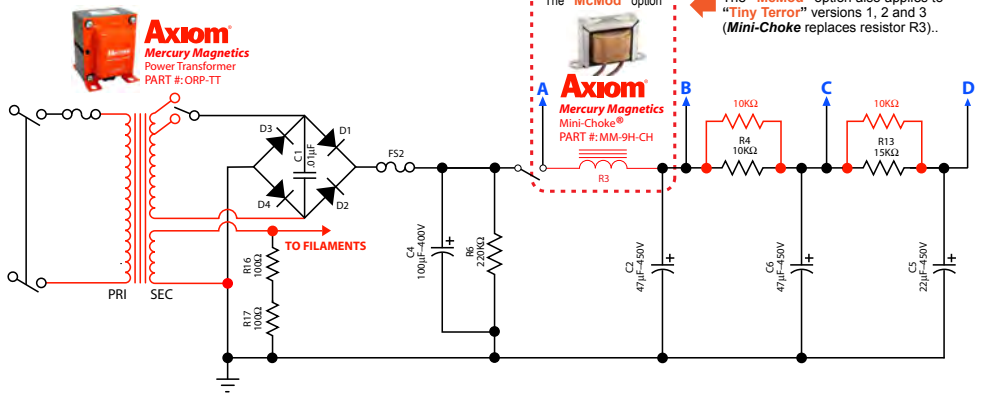
PCB VERSION: ORA-PC211-4
JULY 9, 2008
ORANGE MUSICAL ELECTRONIC CO. LTD.



EL84



12AX7



The "McMod" option also applies to "Tiny Terror" versions 1, 2 and 3 (*Mini-Choke* replaces resistor R3)..

This project and its documentation is the result of technical investigations made by the engineering staff of *Mercury Magnetics*. The disclosure of the information herein may pertain to proprietary rights and the furnishing of these documents does not constitute an expressed or implied license to use such materials.

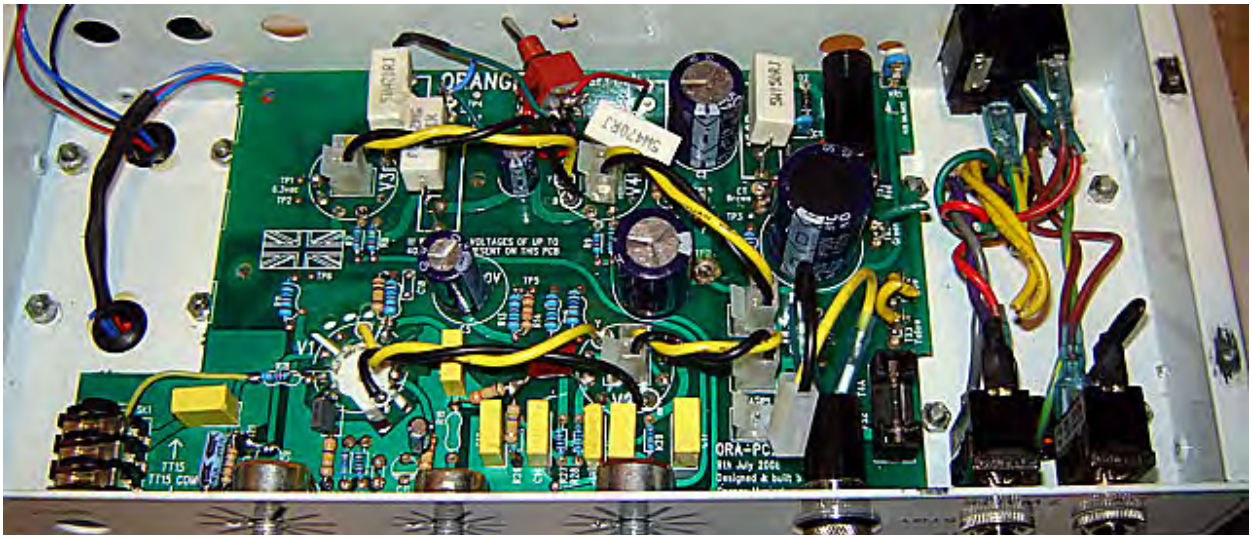
Continued from page 41

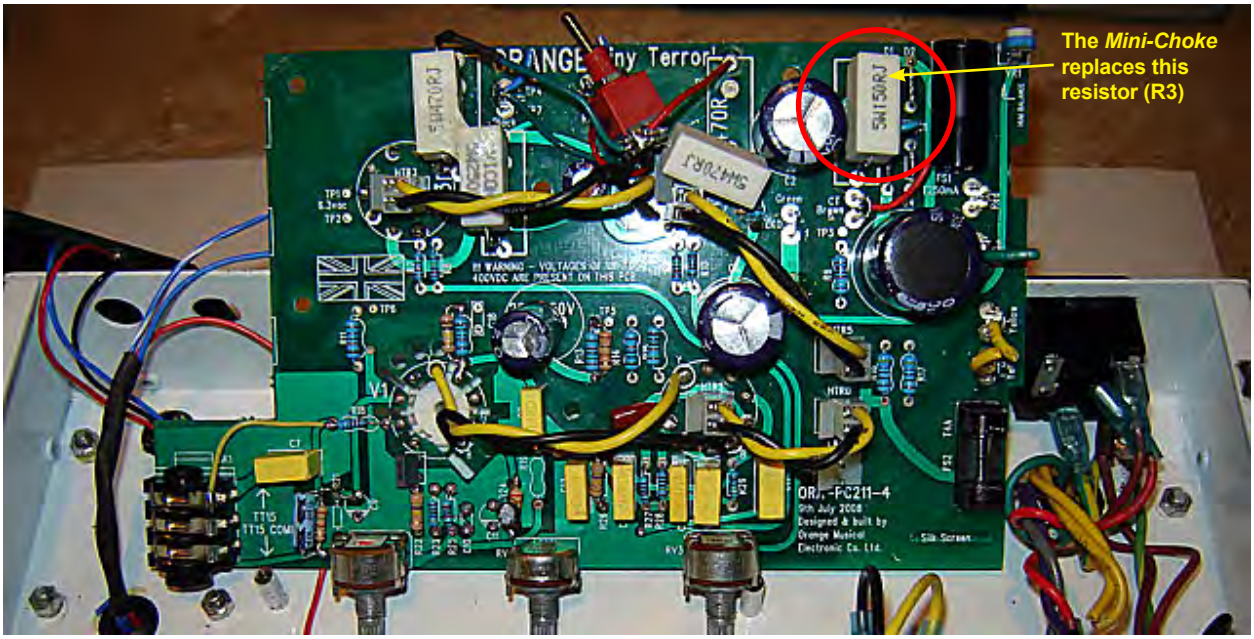
more awesome sounding ***Holy Terror*** amp!"

Bob* advises**: "When I convert the ***Tiny Terror and transform it into the ***Holy Terror*** I completely remove the main PCB (printed circuit board) from the entire amp. It makes it much easier to do and allows you to use a de-solder wick or a de-solder pump and cleanly place the new parts in position before soldering them into place. By doing it this way the component changes will be better anchored and be more reliable over the long term.

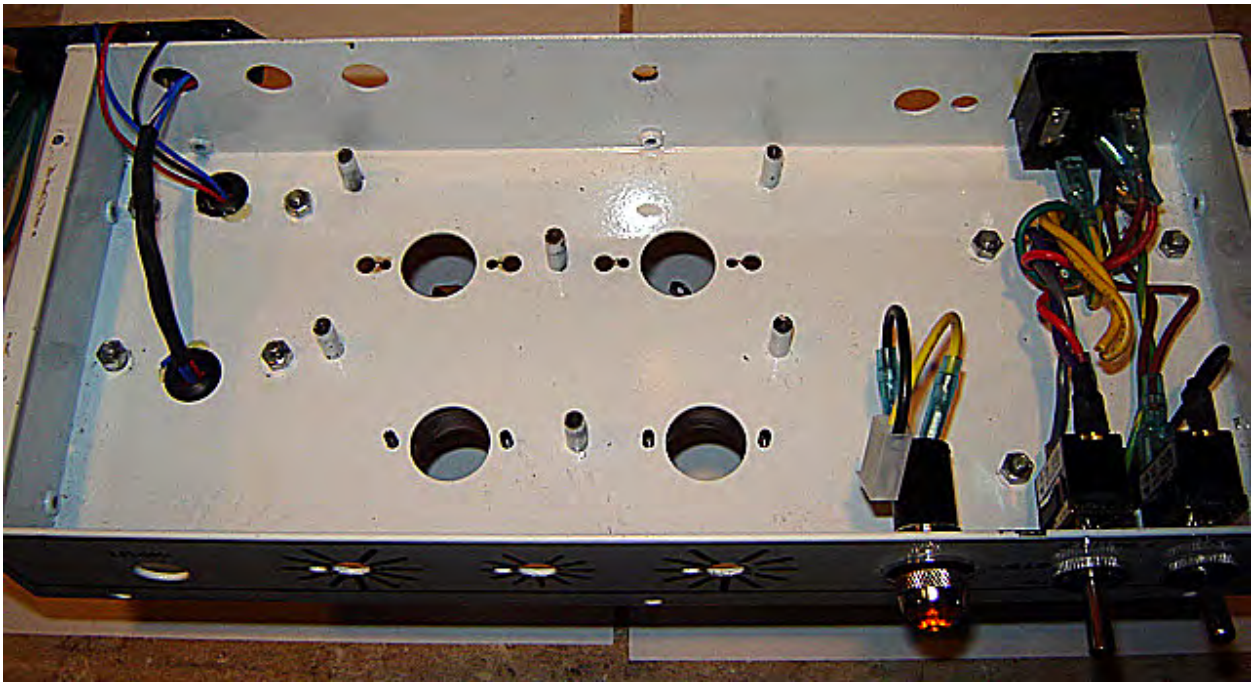
"Make all your changes to the PCB just as ***Mercury's*** manual explains. Also removing the circuit board will make it easier to drill the 2 holes necessary to mount your ***Mini-Choke***. Adding a ***Mini-Choke*** can be done with the PCB in place BUT it require a very steady hand and drilling holes just large enough for self tapping metals screws."

"If you are not an experienced tech, you should probably find one do the job for you (like me for example!)."

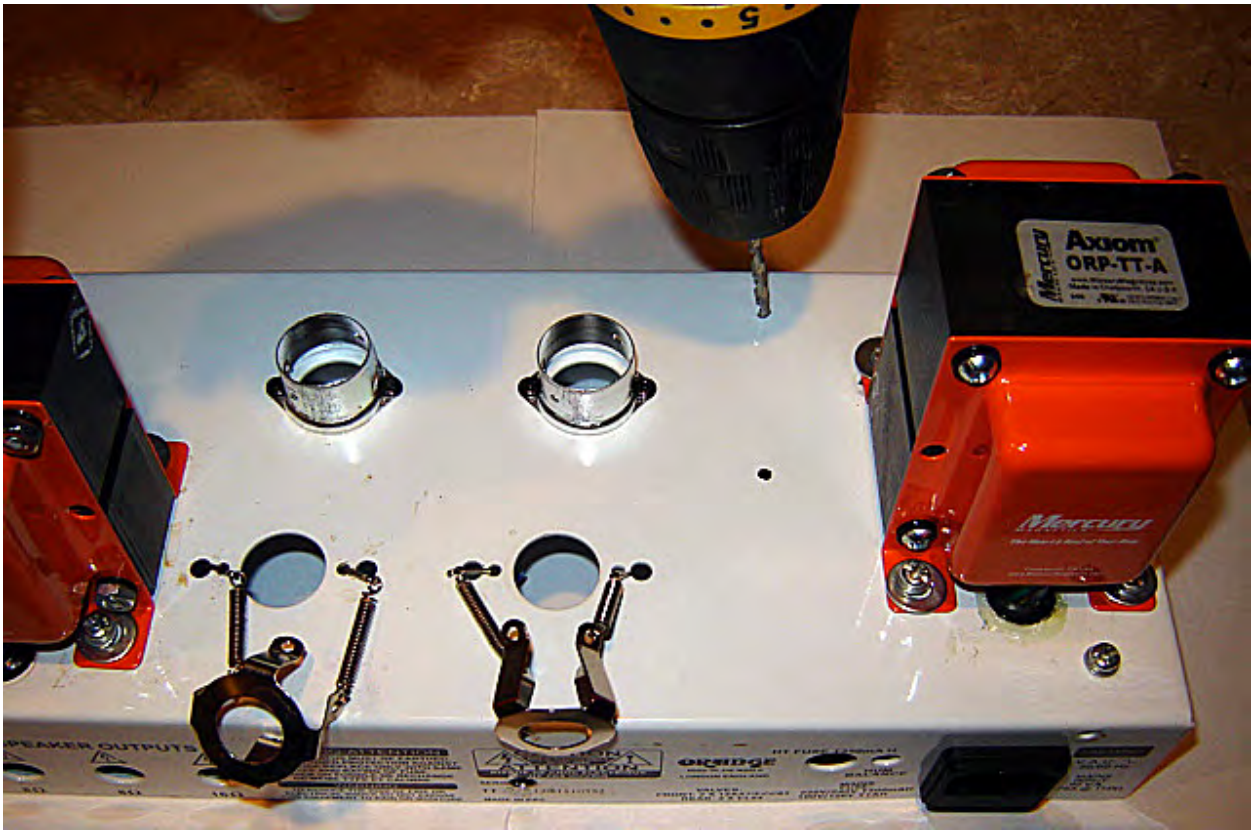




Pictures 1 & 2: These show the removal of the circuit board. Disconnect the filaments to the pilot light. Also, clip and remove resistor R3. Leave yourself plenty of the resistor's lead wire so that you can easily bend a hook to solder the ***Mini-Choke*** leads into place.



Picture 3: Once you have an empty chassis mount your new **Axiom** *Power* and *Output Transformers* into place. You now prepare the chassis for the ***Mini-Choke***.

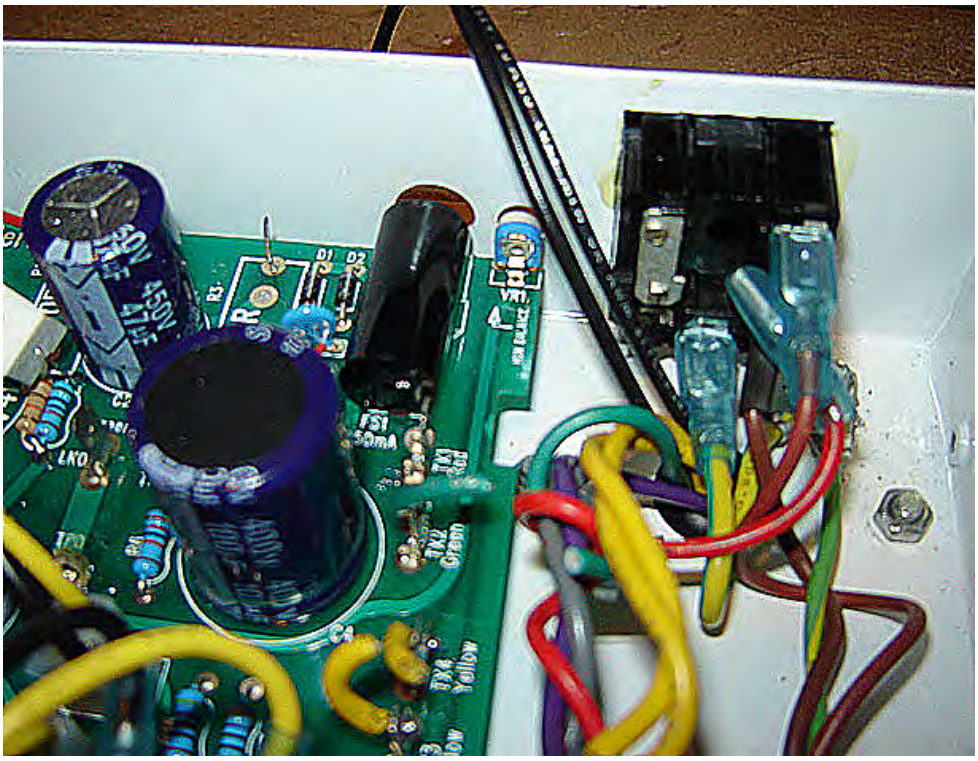


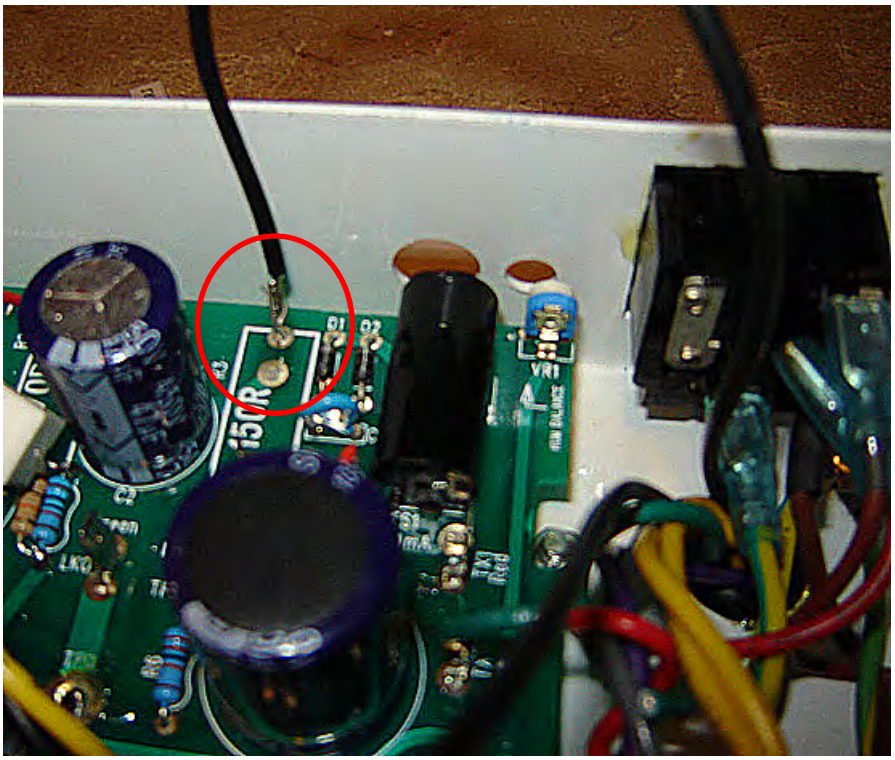
Picture 4: This shows where the new 9 Henry ***Mini-Choke*** will be placed near the *Power Transformer* (see the chassis diagram at the first of this section for the exact placement). Mark the holes and carefully drill the 2 holes for ***Mercury's Mini-Choke***.

Picture 5: The ***Mini-Choke*** leads will fit through the existing hole used for the *Power Transformer's* leads. Mount your ***Mini-Choke*** and carefully pull the leads through that hole.

Picture 6: The chassis with the new *Transformers* and the ***Mini-Choke*** in place looks great!

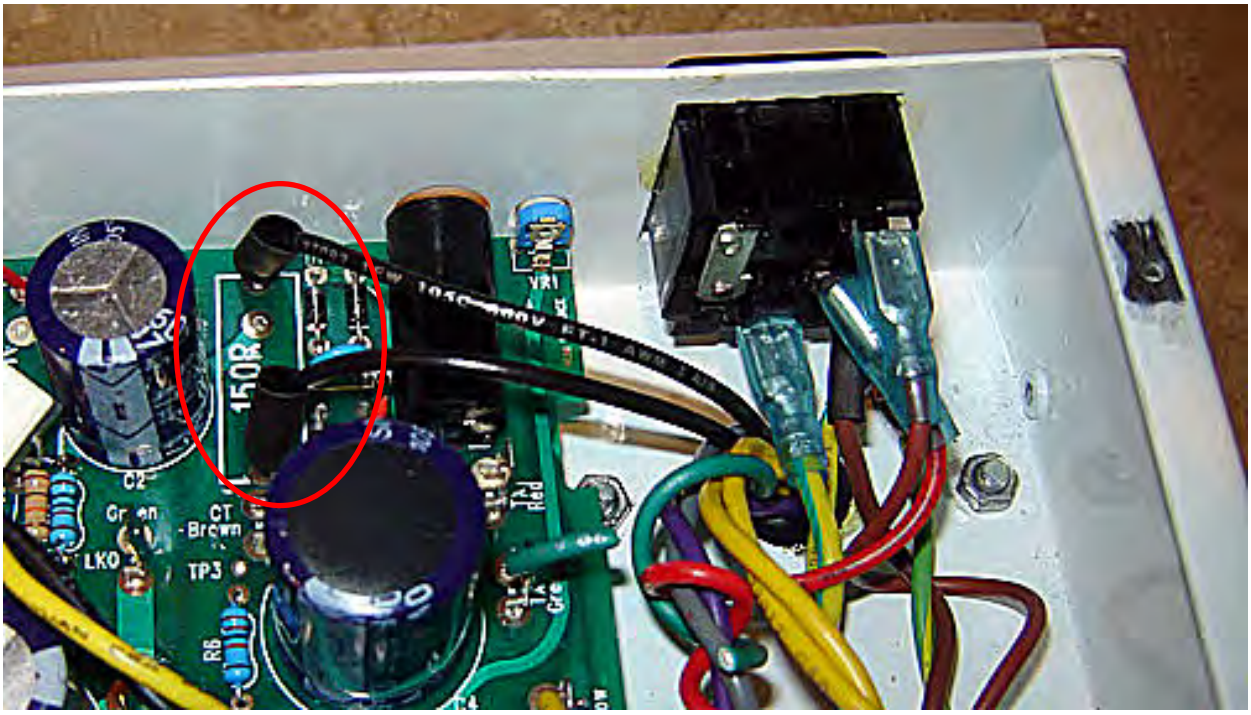
Picture 7: Prepare to solder the ***Mini-Choke*** leads to the clipped resistor leads in location R3.





Picture 8: Solder the ***Mini-Choke*** leads onto the old resistor wires of R3.

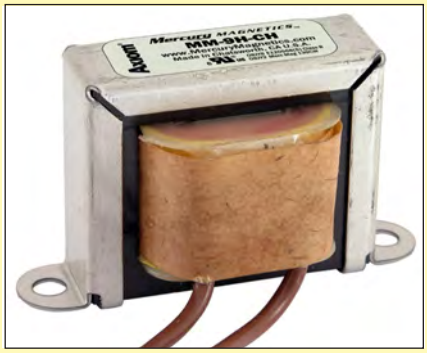
REMEMBER to add a little shrink tubing to the ends of the ***Mini-Choke*** leads.



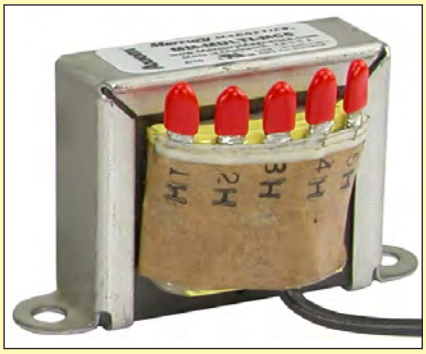
Picture 9: Slide the shrink tubing in place and secure.

To Make the "McMOD"

Give ***Mercury*** a call. You'll need ***Mercury Magnetics' Mini-Choke*** (Part No. MM-9H-CH). Also considering experimenting with other *choke* values. ***Mercury*** makes a ***Multi-Choke*** compatible with this amp size (Part No. MM-MULTI-9C). This version of the ***Multi-Choke*** can be set from 1 Henry to 9 Henry in single Henry increments. Enjoy!



The Mercury Mini-Choke



The Mercury Multi-Choke

BE FOREWARNED!

IF YOU BYPASS THIS STEP THERE IS A VERY REAL POSSIBILITY THAT YOU WILL CAUSE DAMAGE TO THE AMP AND/OR SERIOUS HARM TO YOURSELF!

Using a Variac & Current Meter

Don't power-up your amp without 'em!

NOTE: IF YOU ARE NOT A QUALIFIED AMP TECH, DO NOT ATTEMPT TO POWER UP YOUR MODIFIED AMPLIFER, YET. INSTEAD, ***Mercury*** RECOMMENDS THAT IT BE INSPECTED BY A QUALIFIED TECHNICIAN. AN AMP TECH WILL GO OVER YOUR WORK AND VERIFY THAT IT IS SAFE TO POWER IT UP.

After modifying your amp, the next step is to power it up using a *variac* and current meter.

The *Variac* and current meter allows you to slowly add voltage while checking the indicators to make sure that your handiwork is correct. Without a *variac* you run the *extreme* risk of frying your amp or some of its components, getting hurt, electrocuted, *etc*.

A *Variac* is a standard amp tech tool. No amp tech should be without one. They are available from many electronic stores or online, eBay, *etc*. Prices start at about $50 and go up from there. The better units (such as the *Tenma* isolated variable AC power supply shown in these photos) include output current metering. Consider that the cost of a *Variac* is free, because a single error without one can easily cost more than the *Variac* itself!

As the following instructions show, you'll need to monitor the output current while increasing power to the amp with the *Variac*. If your *Variac* doesn't have a self-contained current meter this can also be done with a separate amperes meter connected to the fuse-holder of the amp (with the fuse removed).

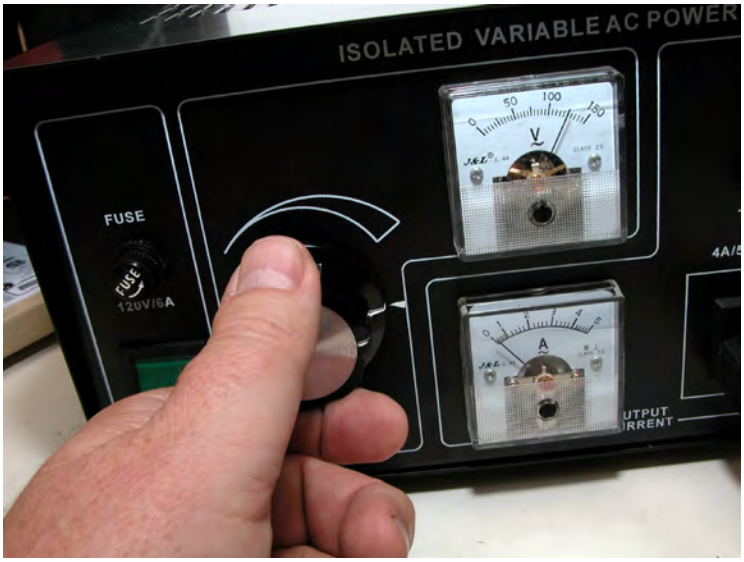
Specific instructions for how to use *Variacs* and current meters are beyond the scope of this manual. Check the web or owner manuals of the devices for specific methods.

STEP A: Make sure that your amp is OFF. Plug it into the *Variac*. The *Variac* is OFF with the output voltage knob set to zero (0). Turn on the *Variac's* power. Then, turn on the amp's power.

Variac: A variable transformer used to vary AC voltages. Also the tradename for a brand of variable AC transformer. There are other brands, but the term is generically used to describe all of them. A *variac* allows adjustment of the incoming AC mains voltage. The better quality units have meters for voltage and current, or both, and fuses for protection. *Variacs* come in many shapes and sizes. But their function is basically the same. If your *variac* does not have an amperes (current) meter, you'll need to use a separate meter.

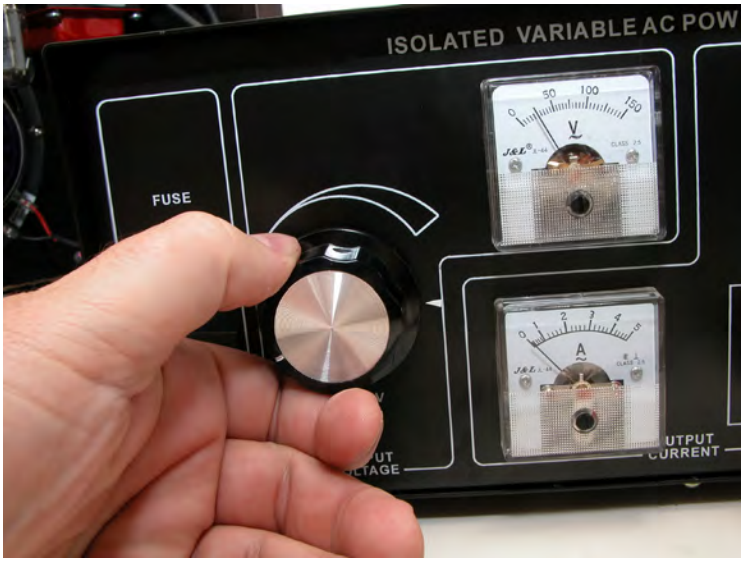
NOTE: The *Variac* in the photo to the left does not have an amperes meter whereas the *Tenma* model does.

STEP B: Turn on the amp's power.



STEP C: While watching the current (amp) meter, slowly roll on the *Variac's* output voltage knob. The amp should turn on at about 45 volts.

When you get to about 60 volts you don't want to see more than a few hundred milliamps. If the current meter reaches anywhere above half an amp, roll the *Variac* back to zero, shut everything down, discharge the caps, and look for the error, short or bad component. Correct the problem and repeat until this test passes.



STEP D: Once you can reach 120 volts drawing less than half an amp, you are in good shape.

NOTE: If you don't have a current meter on your *Variac*, remove the fuse from the amp, and with an amp meter across the empty fuse holder socket, turn on the amp and perform the test above.

Tips 'n Tricks for
Working on PCBs

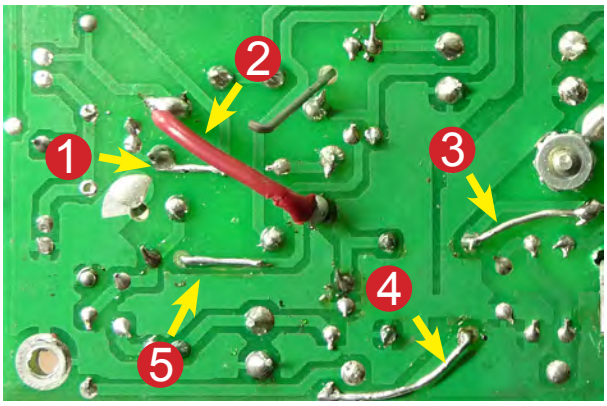
A PCB (printed circuit board) begins life as a solid sheet of thin copper foil across a backing material made of epoxy resin. Then, using a photographic process, a circuit is imprinted onto the foil and all unnecessary copper is etched away. What's left are copper foil "traces" that take the place of wires. To prevent shorts, PCBs are laminated with a colored insulating material that functions just like the shielding around insulated wire.

Although PCBs may be from one to many layers thick, the PCB used in the **"Tiny Terror"** is double-layered, which makes it fairly easy to work on or modify.

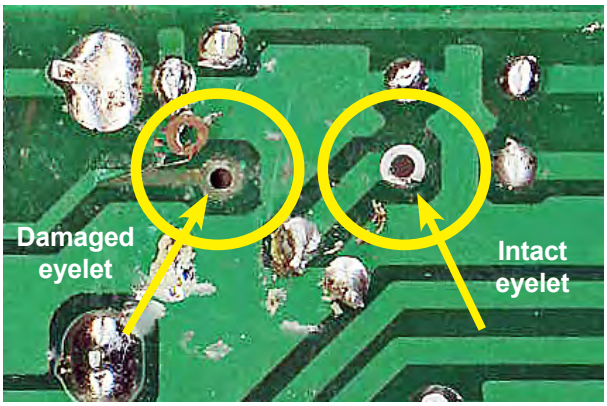
PCBs cost substantially less to produce than their predecessors, i.e. *point-to-point* circuit boards. And are used by amp manufacturers to maintain affordable prices for consumers.

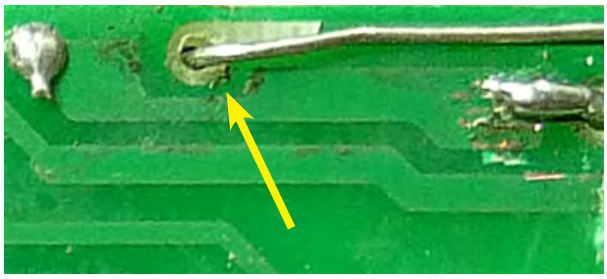
On a PCB components are often attached to the top of the board and then soldered from the back via pass-through conductive "eyelets" where they follow the copper traces that make up the circuit.

Asian-made PCBs are typically not as resilient as those made in the west. Therefore they're likely to require patching and repair work as you make the ***Upgrade***. This is normal, and easy to do – as long as you know a few tricks.



Various examples: 1. Jumper. 2. Jumper. 3. Trace repair (jumper soldered from terminal to terminal on same trace). 4. Trace repair (ditto). 5. Damaged eyelet repair (lead is soldered to a revealed trace).





Repair to a damaged eyelet: The lead from component bypasses the damaged eyelet and is soldered to either a revealed trace or another terminal on the same trace (as in this example).

Revealing a Trace: Sometimes we need to "reveal" traces so that the PCB can be modified or repaired. An easy way to do this is to take a sharp knife or *Exacto* and carefully scrape away the lamination to "reveal" the copper foil under it. Use high-grade (99%) Isopropyl alcohol and a Q-tip to clean these new contacts before soldering to them.

Continued on next page ➔

How to Repair Damaged Eyelets: The PCB's conductive eyelets are easily damaged and often just fall off in the process of desoldering components, making repairs and modifications. If this happens the easiest workaround is to reveal about 1/8" of trace material (near the eyelet hole on the same circuit) and solder the component's lead connection directly to that.

Or, if there's a nearby soldered connection on the same trace, you can use the component's lead to jumper directly to the terminal.

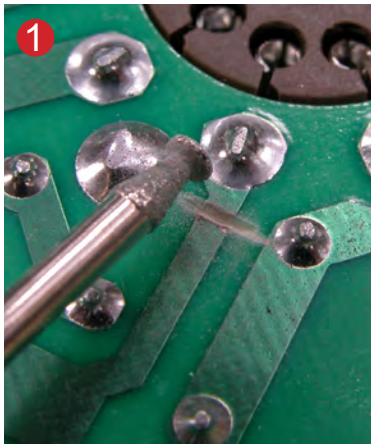
If an eyelet is damaged or missing or the trace material around it is very thin, then you may consider soldering a reinforcement jumper across it.

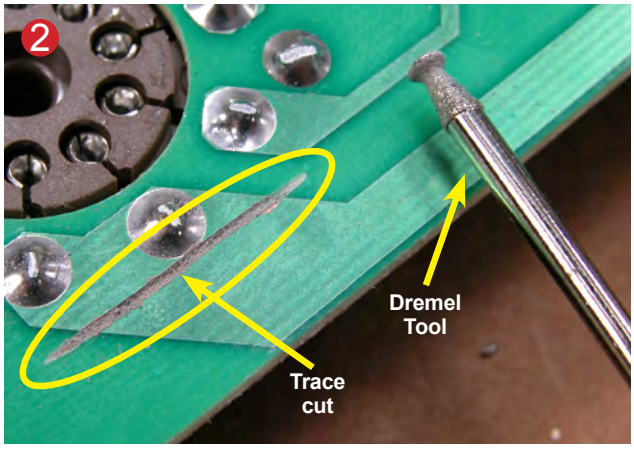
How to Cut a Trace: A "trace" is the conductive strip (foil) on a printed circuit board. It has a very thin laminate or lacquer layer over it. Cutting a trace is like clipping a wire. Use a box knife, *Exacto* knife or a *Dremel Tool* with a cutting or grinding edge attachment to make the cuts.

Various examples: This photo shows a cut trace, and a component lead jumpered and soldered to a revealed trace. It's best to not drill a hole directly into a trace. Instead make the hole off to the side of the trace and then, as in this example, solder the component's leg to the trace.

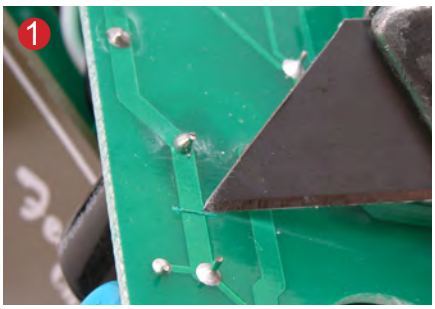
A *trace cut* severes the embedded metal laminent on a PCB. The purpose of a *trace cut* is to modify or re-route the electrical flow of the circuit.

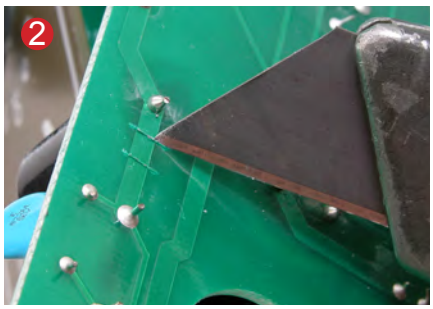
Here's two different ways to cut a trace:

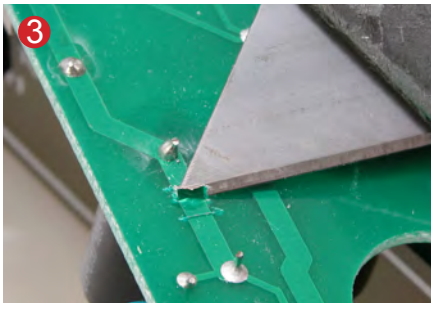


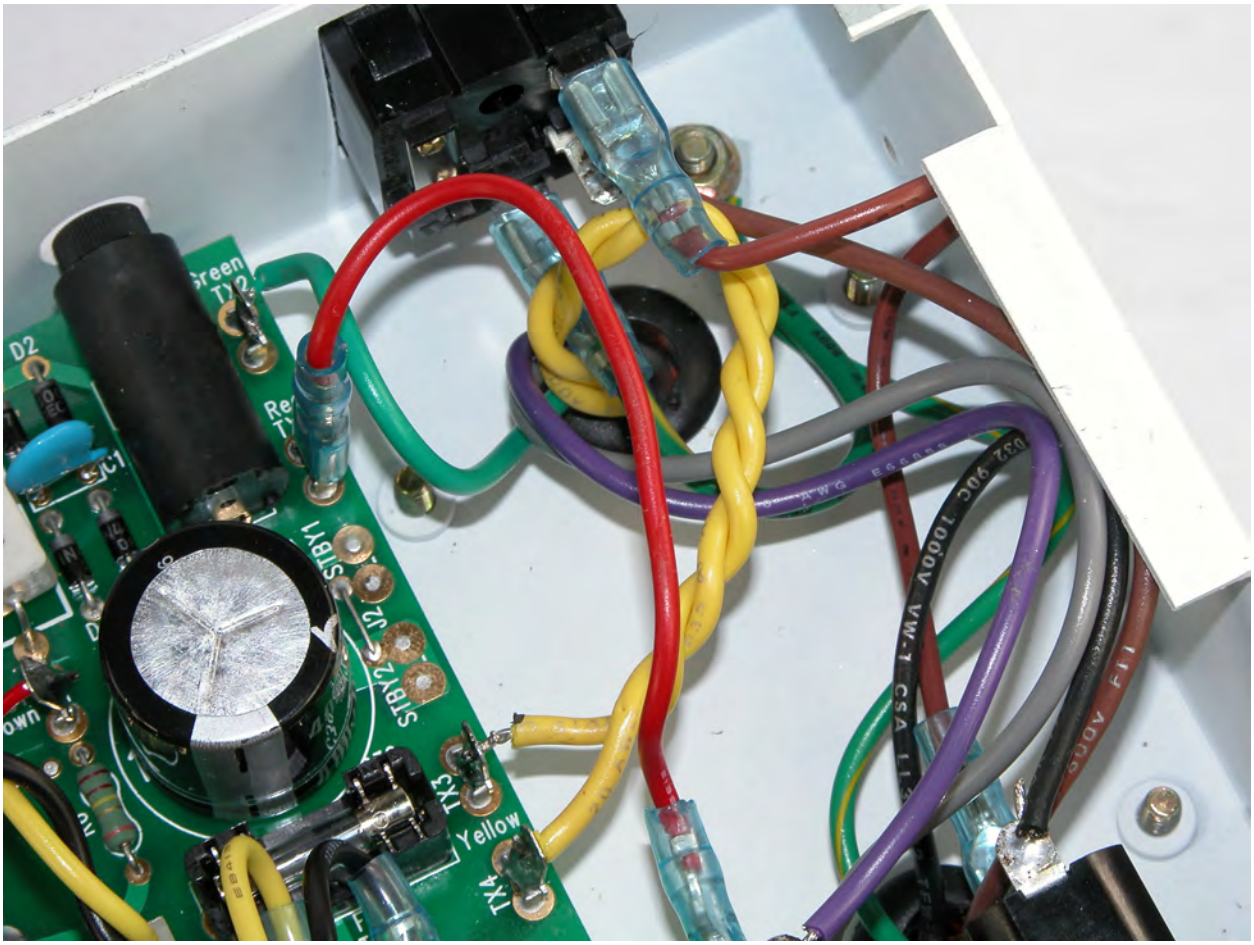


OR









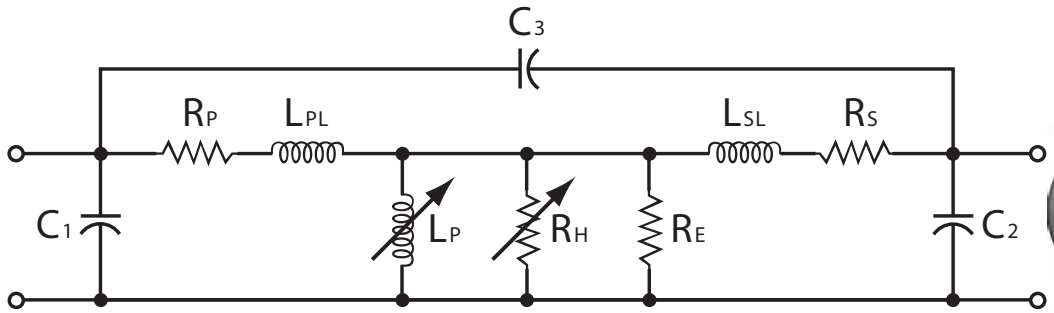
About the Filament Supply Leads

The PT with the **Holy Terror** ***Mercury Upgrade Kit*** has two yellow leads (wires) coming from the *secondary* side of the transformer's casing. See the power transformer's diagram at the front of this manual for clarification. The two yellow *secondary* leads are the "filament supply leads." The ***filament supply leads*** are the *only* wires that must be twisted together – a technique that helps to cut down RF.

This photograph shows a twisting pattern that you should aim for. Consistent, even twisting is important. Ideally about 10 twists per inch. Cable tie these leads as high off the Main PCB as possible, and as close as possible to both the power transformer. This will minimize amp noise and hum.

The Output Transformer Circuit

Mercury's circuit equivalent of an Output Transformer



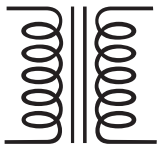
C_1	Primary Self Capacitance	L_P	Primary Inductance
C_2	Secondary Self Capacitance	R_P	Primary Resistance
C_3	Interwinding Capacitance	R_S	Secondary Resistance
L_{PL}	Primary Leakage Inductance	R_E	Core Eddy Current Losses
L_{SL}	Secondary Leakage Inductance	R_H	Core Hysteresis Losses

"Blessed are the Tone Makers"

The above circuit reveals the properties of an audio *output transformer*. The transformer is a *reactive* component—its values change depending upon the information feeding it. Transformers for tube-based electric guitar amps are designed to *intentionally provoke* the tubes into distortion—the polar-opposite of demands of *hi-fi*. The best guitar tone comes from harnessing and *manipulating* the inherent flaws of the imperfect transformer. This is where art meets science in our pursuit of great guitar tone.

—Sergio Hamernik

Consider the above *vs.* this typical dummied-down transformer symbol



DANGER! READ ME!

DISCHARGE THOSE FILTER CAPS!!!!!

The following is a collection of notes on discharging Filter Capacitors

Compiled by the staff at ***Mercury Magnetics***

DISCHARGING CAPACITORS – The filter capacitors in an amp will retain a charge for quite some time after the amp is shut off and unplugged. It is a good idea to make sure your amp is safe to work on. One way is to take a wire with an INSULATED alligator clip on each end, clip one end to a good ground point, and the other to one of the plate leads for the first stage preamp tube. Another method would be to put a 100K, 5W or more resistor in line of these two clips by attaching one end to ground (first), then the other to the filter caps themselves. NEVER SHORT THEM OUT DIRECTLY!

BE THE ONE-ARMED TECHNICIAN – There will come a time when you have to work on a chassis that is running. When doing so, if possible clip one of your meter's test leads to ground, and use only one hand to probe the circuit, keeping the other in your pocket, *etc*. That way if you DO take a shock, your heart is not in line of the path of least resistance – in one arm and out the other. When you ABSOLUTELY must use two hands, be EXTREMELY CAREFUL, and use common sense, but PLEASE try to avoid these situations!

* * *

"Filter" caps can store ***fatal*** amounts of electrical current. The caps are connected near the rectifier and are part of the power supply, and aid in converting AC to DC. In fact, they are a standard component in any power supply.

If you're completely lost, and don't understand this, DON'T MODIFY YOUR AMP. You haven't enough knowledge to work on high voltage/current circuits safely.

Several ways to discharge caps:

FIRST, UNPLUG THE AMP! (But that doesn't make it safe!)

THEN, take a screwdriver or a jumper and short the capacitors leads.

– OR jumper the power amp tube plate pin to ground for a minute or so (Class A, single power tube only)
– OR jumper the positive (+) lead of each large cap to ground for several seconds. A jumper with a built-in resistor (10K or so) will help prevent sparks here.

Some or all of these methods may result in a spark. Obviously, your flesh can act as a jumper also.

It's NEVER a good idea to touch amp circuitry when it's switched on. And don't work on amps in bare feet, or on a damp basement floor.

* * *

Letting the capacitors discharge slowly is preferable to having them do it all at once through your body while you're poking around inside the amp. Having the supplies you need on hand makes the job go faster.

You'll want screwdrivers, contact cleaner (you can use *Gunk* brand choke and carburetor cleaner or *WD-40*), a toothbrush and – unless you own an air compressor – an aerosol can of compressed air – soldering supplies and a volt/ohm meter (learn how to use them!).

Start by unplugging the amp from the wall, the speakers from the amp, and removing the amp chassis from the case. For Fender amps, removing the chassis involves unscrewing the upper back case panel, then unscrewing the chassis from the top of the case. Put the screws, nuts, and lock washers where they won't get lost.

With the chassis out of the case, you can locate the filter capacitors you'll want to avoid touching as you perform the tune-up. These will be cardboard cylinders (usually orange or tan or vintage Fenders) with "+" printed near one terminal. It's also a good idea to steer clear of wiring connected to the power transformer because it's a discharge path for the filter capacitors.

If you haven't given the capacitors a couple of days to discharge – or if you just want to be cautious – you can use a short length of insulated wire with alligator clips on the ends to discharge them. First, make certain that the amp is unplugged. Attach one alligator clip to a capacitor's positive (+) lead, then touch the other clip to the amp chassis several times. Repeat the procedure for each capacitor marked with a voltage (VDC) rating higher than 25. The time spent on this precaution can spare you from a numbing electric shock that you'll remember long after the amp is back together.

How to Discharge a Power Capacitor in Tube Amp

by Kevin Krause
eHow contributing writer

To be able to properly test and troubleshoot your tube amplifier with a multimeter it is important to discharge the capacitors located in the amp's power section to avoid false readings. Capacitors act as short-term batteries, storing a charge that can be called on by other components. This charge will remain in the capacitor even after the amp has been powered off, and can produce misleading voltage readings along circuit paths. Because of the high level of the stored power in the capacitor, safe discharging is a must.

Things you'll need:

1. High wattage resistor
2. Alligator clip
3. Copper wire
4. PVC tube or dowel rod
5. Soldering iron
6. Solder
7. Multimeter

Instructions

Level of difficulty: Moderate

Step 1: Strip about 1/4 inch of insulation off each end of a 2-foot length of insulated copper wire, and solder one end of the wire to one of the leads of a high wattage resistor. The resistance required can be determined by adding 5 to 50 ohms per volt of the capacitor's rating. For instance, a 100V capacitor would require a resistor rated anywhere from 500 to 5k ohms.

Step 2: Attach the other end of the wire to an alligator clip.

Step 3: Solder the free lead of the resistor to a short piece of bare copper wire.

Step 4: Tape the resistor and bare copper wire to one end of a length of non-conductive material, such as PVC tubing or a dowel rod. Make sure enough of the copper wire is exposed to act as a contact point.

Step 5: Attach the alligator clip to one of the capacitor's leads. Be sure the amplifier is completely powered off before doing so.

Step 6: Touch the bare wire end of the PVC tube or dowel rod to the other lead of the capacitor. It is very important to not touch any of the exposed leads or wires at this time. Hold the bare wire on the lead for at least several seconds to fully discharge the capacitor.

Step 7: Test the capacitor with a multimeter to be sure all voltage has been safely removed.

Discharging Capacitors in a Guitar Tube Amp

Take pride in how safe you can be.
You can't play guitar or build amps if you're dead.

You may have heard various horror stories about things inside amps that can store a charge that can kill you. Well, it's true! However, those dangerous voltages can be easily drained in just a few minutes, so take your time and don't rush.

It is absolutely vital that we drain the filter capacitors in the DC power supply before working on any guitar amplifier. These often hold a charge of several hundred volts, which is potentially deadly. Capacitors can hold their charge for a long time, even with the power off and the amp unplugged. It's very important that we learn to properly "drain" this residual voltage so that we may safely work on the inside of our amplifiers.

What You'll Need:

Filter Capacitor Discharge Tool

1. **Safety glasses.** Always use safety glasses. If you wire a capacitor in backwards there is a very good chance that it will explode in your face.

2. **Digital multi-meter.** Capable of reading 500 volts DC.
3. **Capacitor discharge tool.** A jumper wire consisting of alligator clips on the ends, with a resistor in series in the middle of the jumper.
4. **Needle nose pliers.** With very good insulation on the handles for holding the alligator clips of the capacitor discharge tool.

Always make sure your tools are in good condition. If there's any question, replace them. Cracked insulation is one of the first things to check, and check often.

Turn the power switch OFF, and place the standby switch in the ON position. This isn't the same as having your amp "on standby."

Always unplug the amp from the wall. Unplugging from the wall will not drain the filter capacitors completely, but again this is for our own safety. Unplugging is the equivalent to "locking out" before working on a downed machine.

Because filter caps are almost always of the electrolytic type, they're "polarized" and therefore have a positive and negative end. We can identify the positive or negative ends by looking for the "polarity indicator" printed on the cap's side.

Our first objective is to check for residual voltage with a multi-meter. In some cases most of the voltage may have already been drained. Many amplifiers will incorporate "bleeder" resistors, which will drain the capacitor charge automatically in a few minutes after the amp is turned off. Don't depend on this resistor to do the job. Never assume the caps have been drained to a safe level without checking with a reliable multi-meter.

Here's a couple of ways to measure the residual voltage contained in the filter capacitors. Note that these are also equally valid for draining the caps:

1. **Across the capacitor**.
2. **From the positive side of the cap to the chassis**. This is essentially the same as draining "across" the caps since the negative side is at the same electrical potential as the chassis.
3. **From the chassis to a tube pin**. This can be done at pin 3 of any power tube, or pins 1 or 6 of any preamp tube. By shorting the chassis to the correct pin the caps will be forced to drain through the plate load of that tube. This prevents sparking from high current.

IMPORTANT NOTE, HOW NOT TO DO IT: In old electronics books they tell you to use a screw driver with an insulated handle to short out the caps. "Shorting" with a screwdriver will almost instantly drain the caps to zero volts, causing sparks from high current. This is not acceptable. If there are several hundred volts stored in the caps, be prepared for a nice sized spark. It will most likely leave a black mark on the chassis, and in extreme cases, partially weld the screwdriver to the chassis.

Now we're ready to start testing and discharging

Set your multi-meter to read DC voltage. Adjust the meter's range so that it's above 500 volts. Clip the black lead of your multi-meter to the chassis. Using only one hand, with the other hand far from the chassis (preferably in your pocket or behind your back), measure the DC voltage across one of the filter capacitors. You can adjust the meter's range down if you can't get a clear reading. Any DC voltage readings less than 5 volts are harmless, so the amp can be safely worked on, but do a double check of all the caps just to make sure. If not we must drain off the residual voltage with a resistor until it is safe.

Use a resistor value somewhere between 10K and 100K, with a power rating of 5W or so (a high power rating is not really necessary for heat dissipation reasons, but mainly because the higher power resistors are physically more robust and won't tend to break). The larger the resistor value, the longer it will take to discharge. If your capacitors do not have a dangerously high voltage, say around 30 volts, feel free to use a smaller 1K 1 Watt resistor.

Now take your capacitor discharge tool and clip one side to the chassis. Always clip to the chassis ground first before connecting to the circuit. If you clip to the circuit first you will have a hot wire hanging out of your amp, which is very dangerous. Once you have one side clipped to the chassis, take your needle nose pliers with good insulation on the handles and hold the alligator clip that will go to the circuit with the needle nose pliers.

Clip this to pin 1 or 6 of the first preamp tube. This seems to be the safest way of discharging the capacitors. If you're working on the first preamp tube socket, then clip your discharge tool to pin 1 or 6 of the second preamp tube. Wait a few minutes (about 5 minutes, if the amp has bleeder resistors this time will be shorter) then, while the discharge tool is still in place recheck all the capacitors with your multi-meter and keep that other hand behind you. Keep checking until the voltage has reached a safe level. Note: This procedure must be done every time you turn the amp on then off.

Remember to remove the discharge tool before powering on the amp. Make it a bright color like

yellow and maybe put a piece of shiny tape on it to make it more visible. You can even put a fuse in series with the resistor on the discharge tool in case you forget to remove it.

Filter capacitors are wired in parallel, so draining one should drain them all, but never assume. Always recheck for residual voltage in every filter capacitor until there's absolutely no doubt in your mind that all are drained.

Less than 5 volts is safe, but I prefer to drain mine to 1 volt for peace of mind. Don't be surprised if you find the capacitors slowly recharging themselves. This phenomenon is known as dielectric absorption and is quite normal in electrolytic capacitors. The filter caps shouldn't recharge to a lethal level, but leave the discharge tool in place while working on the amp.

A few final notes:

1. Never work on an amp if you're tired, fatigued, frustrated or intoxicated.
2. Never work while distracted.
3. Never work on an amp around small children. There are just too many dangers involved to take that chance.
4. Try to have a plan in case something does go wrong. You might consider asking someone in your household to take a CPR class.
5. Take your time and don't rush.
6. Use common sense.

http://tubenewbie.com/discharge_capacitors.html