Thomas Organ Vox Amplifiers Repair/Replacement PCB

Table of Contents

What is this and WHY is this?

This article outlines the design, and application of a PCB that can repair many models of Thomas Organ Vox amplifiers from the 1960s. The amps referred to are difficult and expensive to repair because of the fragile and confusing nature of their internal wiring.

This PCB sidesteps the very difficult repairs on these amps by ***replacing everything inside the preamp chassis except the original controls themselves.***

The fragile wiring harness that makes repairs so difficult is removed entirely, as is the original circuit board or boards. It's effectively a complete rebuild of the preamp, using the original audio circuits implemented in modern parts.

How is this even possible?

I think it's possible because Thomas Organ was a maker of organs, not guitar amps. Electronic organs are highly modular – meaning that many copies of the same, or nearly the same circuits are used and stacked together to get the overall functions. In organ design, you design a circuit once, then use it with slight variations in many places. This is how Thomas approached guitar amps. There are other ways their background as an organ builder caused oddities that hindered their amps, but this one helped.

The whole upper end of the Thomas Organ Vox line is composed of a few modules that were used over and over across models and model years, and varied slightly to give a variation in cost and features for marketing purposes.

For instance, the basic preamp circuit is used in all of what I call the "big head" models, from the first introduction through the last models. This same circuit was varied a little within the amp for special features - "Normal" versus "Brilliant" versus "Bass" for instance – and more or less of the circuits were used in different amps. Only in the final year of issue – the V11n3 models – did the basic preamp get updated from two bipolar transistors to a JFET and a bipolar. And the individual circuits served the same internal function.

Special effects were added in small internal add-on boards in early years, and in later years subsumed into one comprehensive main circuit board. The lesser-function models in later years were made by leaving subsets of parts off the same main board.

What makes this practical as opposed to merely possible is that Thomas made the mechanical setup the same across years and models. The same sheet metal preamp enclosure, with (in general) the same holes punched in the same places, varied only trivially over the years. In lower models with fewer features, the dress panel covered up the unused holes on the outside. Inside, the PCB mounting was invariably the same, a plastic rail front and back that the PCB sits in.

Thomas Organ's desire to keep the same physical setup and re-use circuits is what enables a single PCB that will work in all the "big head" amps.

Why did I do this?

I'm a bit of Vox nut, at least in this one small area. I like the Thomas Vox amps, a lot. And I hate to see them junked because they're hard to repair. And they are hard to repair. Most amplifier technicians will flatly refuse to work on them at all. The techs have, over time decided that they can't charge the owners enough to make the hours they must spend on these amps worth while.

So I designed a PCB with the following aims:

1. Keep the same signal circuits to keep the tone the same.
2. Make the wiring simpler and less fragile by imbedding much of the wire harness on the PCB.
3. Update the circuits where there are modern parts which make 1 and 2 easier to do.
4. Provide ways that one board can be used to retrofit all of the "big head" models.

The point is to replace the original board in a way that is both simpler and quieter, and also easier to work on when it does have a problem.

What amplifier models will this work in?

In a word, all of them in the top end of the line. It will not work in the smaller combos or the Berkeleys.

The actual circuits on the reproduction/repair PCB are from the Vox V1143 "Beatle" amplifier. The V1133 Royal Guardsman, V1123 Buckingham and V1154 Viscount are subsets of these exact circuits, lacking only the repeat percussion effect and having different power amplifiers. So these are the most "natural" amplifiers for the board.

Since only the potentiometers, switches and jacks are preserved from the original circuits, there's not much to keep it from working well in earlier models Thomas used the same resistance values for the pots across all the years, so even the pots don't change. The same board will physically fit in and operate correctly in the earlier Beatle, Royal Guardsman, Buckingham and Viscount by selectively leaving off certain bits of the wiring. For a good guide to the various models in the Thomas Vox line, check out the Vox Showroom (http://www.voxshowroom.com/contents/index.html) and read the sections on US Vox Amplifiers.

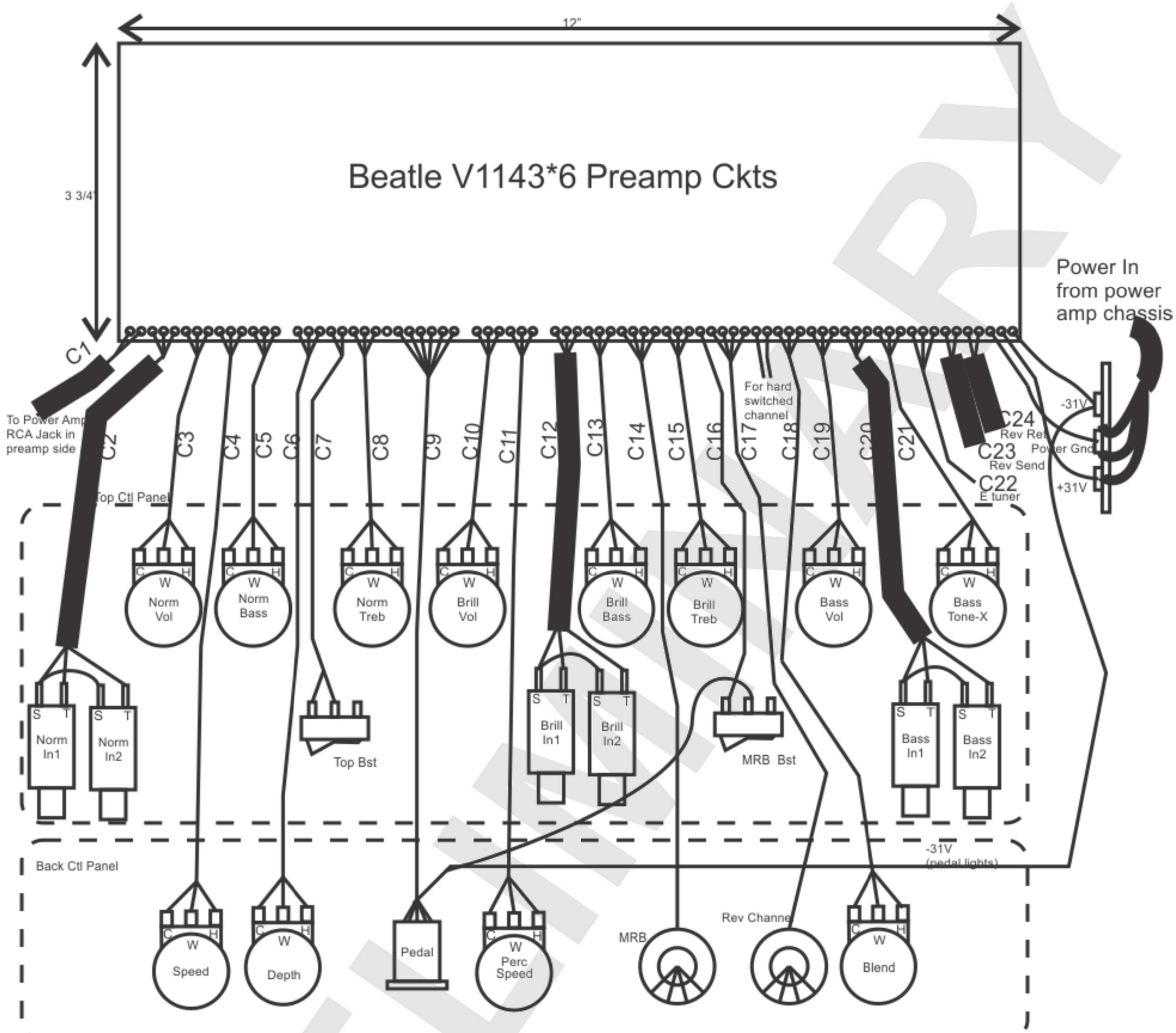
Could I use this to make my own "Beatle" in a different chassis?

Well … sure, I guess so. That's not what it was intended for, and the wiring would not be so tidy, but then it wouldn't be as bad as the wiring in the Thomas originals were, in my opinion. But you're on your own. If you're determined, get out your soldering iron and dig in. You'll have to figure out how to provide the board with +/- 30-38V for its power at about 100ma for the + side, 0-80ma for the – side. And then there's the power amp and power supply, and all that stuff. As an aside, the Hammond 17x7x3 chassis base might work OK. (http://www.hammondmfg.com/pdf/1444-1773.pdf) If you get one of these running let me know.

Board Design

The replacement PCB schematic matches the ones in the Thomas Organ Vox service literature, down to preserving part numbers from the V1143 schematic, as much as possible. It's very close to the size of the originals in the dimensions that let it fit in the box. However, there are some minor changes from the originals in terms of the circuit details.

The signal processing circuits were preserved almost completely intact, so there should be no change to the tone qualities from the original circuits. However, with nearly 50 years' progress in electronic parts, there were some changes that were made to the switching arrangements and to the power supplies. The really big issue with these amps is the complexity and fragility of the wiring, so I concentrated on making the off-PCB wiring as simple as I could make it. The picture below shows the idea:



The PCB layout started with the pads for the wires to the off-board controls as close to the actual control as it was possible to get them, so that the wires to the controls were simple "cables", one bundle of a few wires to the control. This put the actual wiring to the controls as the first priority. Everything else was laid out around the wiring placement, which had the effect of absorbing all the back and forth wiring into the PCB itself, where complexity and flexing are not problems.

In order to apply this replacement to earlier models, I looked at the schematics for all of the Thomas Vox line, from the first versions up through the last "Beatle". This revealed a progression of adding features in a simple modular fashion, by changes to one section or another, but without massive redesigns. Even the values of the potentiometers were the same from model to model.

The biggest changes Thomas made in the actual signal processing circuits were the change from bipolar transistors to JFETs in the preamp inputs, and the change from a transformer reverb driver to a solid state, non-transformer reverb tank driver. The modularity Thomas used let me make one board that will connect to the controls in any of the line and work properly by ignoring the sections that the model did not have from the factory. This works largely because the idea of using only selected subsets of the full batch of circuits is what Thomas used to get the lesser models from the full-featured Beatles.

So this replacement board converts any of the earlier models to the V1143 Beatle circuits, but this is pretty much an OK and consistent thing to do.

The physical part of the board design makes the replacement board fit in the original board holders just like the original did. The board is the same front-to-back size as the Thomas boards were, so it fits in the mounting brackets in all the amps. It is not the same length as any original Thomas Vox PCB, being shorter than some and longer than others. But it fits in all the preamp boxes because the sheet metal parts and mounting brackets are identical.

Installing a completed board

Installation in general

Remember the song “The First Cut is the Deepest”? You start by clipping away all the wires from all the controls and switches on the preamp chassis. Remove the original PCB and wiring entirely. It is good if you preserve the wires that go to the reverb tank by unsoldering them from the old PCB, and also if you unsolder and remove the inductors (copper wire donuts) from the old PCB. If you have some illusions about older transistors somehow sounding better, you are free to remove the old ones from the old board if you like.

With the old board and wiring out of the way, check the new PCB to ensure it fits in the old mounting brackets. It should, but it's better to know about any problems now instead of later.

With the old board and wiring out of the chassis, you'll need to modify the chassis wiring. There is a network of resistors and capacitors under the old PCB that was used to create the necessary power supply voltage. This is now superfluous. Find the place where +31V, power ground, and -31V from the power chassis connector connect to the wiring strips. These will have power resistors and capacitors connected. Remove the power resistors and caps from these lugs. The lugs will serve only as connection points for the power wiring to the new PCB. The new PCB itself will do its own power/voltage regulation and the old resistors and caps are no longer needed. You can leave them there or remove them, as you please as long as they don't connect to any of the new circuits.

It makes sense to remove the remaining bits of wire and solder from the controls and switches now, too.

When the fit is verified, you need to make a decision about how you will wire the old controls to the new PCB. There are two main ways: leave the controls in the preamp chassis and wire the PCB to the controls with the controls in place, or take the controls out, do all the wiring outside the chassis and then reinstall the controls and PCB after they're wired together. Leaving the controls in the preamp chassis makes it harder to poke and run wires to them, but there's little chance of getting controls confused. Removing them all and doing the wiring with the PCB and controls laid out flat makes the wiring a breeze, but also means it's easy to get a volume pot confused with a speed control. If you do this method, I suggest putting a bit of masking tape on each pot and writing what the control is on the back so you can check yourself BEFORE you take it out of the chassis.

There are up to 76 wires to connect. It's easy to get confused unless you're organized about it

On all of the models, you will have to decide whether you want to keep the old wiring for the reverb channel select switch or use the newer version implemented on the replacement PCB. See Reverb Channel Switch Wiring on page 34.

Once the wires are soldered and the controls and PCB in place in the chassis, check your wiring and fire it up.

Installation in particular models

What follows is **some o**f the models Thomas produced. I keep finding out about others as I go.

Model Name	Model #	Pwr Out	Pre-amps	Rev [1]	Trm	MRB	Distn [2]	Rpt Perc	E-Tune	Ftsw Button	Ftsw lights
Super Beatle	V-14 V-114	120	NPN	R1	Y	Y				2/1 [3]	0
Super Beatle	V-1141	120	NPN	R1	Y	Y	D1		some	4	1
Super Beatle	V-1142	120	NPN	R1	Y	Y	D1		some	3	0
Beatle	V-1143	120	JFET	R2	Y	Y	D2	Y	Y	5	4
Royal Guardsman	V-13 V-113	60	NPN	R1	Y	Y				2/1 [3]	0
Royal Guardsman	V-1131	60	NPN	R1	Y	Y	D1		some	4	1
Royal Guardsman	V-1132	60	NPN	R1	Y	Y	D1		some	3	0
Royal Guardsman	V-1133	60	JFET	R2	Y	Y	D2		Y	4	1
Buckingham	V-12 V-112	35	NPN	R1	Y	Y				2/1 [3]	0
Buckingham	V-1121	35	NPN	R1	Y	Y	D1		some	4	1
Buckingham	V-1122	35	NPN	R1	Y	Y	D1		some	3	0
Buckingham	V-1123	35	JFET	R2	Y	Y	D2		Y	4	1
Viscount	V-15 V-115	35	NPN	R1	Y	Y				2/1 [3]	0
Viscount	V-1151	35	NPN	R1	Y	Y	D1		some	4	1
Viscount	V-1152	35	NPN	R1	Y	Y	D1		some	3	0
Viscount	V-1153	35	JFET	R2	Y	Y	D1		some	4	1
Viscount	V-1154	35	JFET	R2	Y	Y	D2		Y	4	1

Notes:

1. There were two reverb circuits, a transformer driven one and an all-transistor one. “R1” indicates the earlier transformer version, “R2” indicates the later all-transistor one. The replacement board uses the R2 version.
2. There were two versions of the distortion circuit. The circuits were very similar, but in the earlier amps they were in front of the normal preamp and switched by a relay, much like a pedal that was mounted inside the enclosure. The later JFET models put the distortion after the normal preamp and switched it with JFETs. “D1” indicates the relay version, “D2” the JFET switched version. The replacement board uses the D2 distortion.

V1143 “Beatle”

This is the amplifier that the replacement board implements directly. Install the board and connect up all the wires. Notice that the wiring to the footswitch for the V1143 requires using the DIN connector shield wire for ground and all six of the other wires in the cable. There is so much current from the

-31V source that I elected to make this wire and a ground wire run from the main -31V connection into the preamp chassis rather than running it through the signal circuits on the PCB to keep noise down. Take a wire from the power supply connections for both -31 and ground on the chassis and run it directly to the DIN socket on the preamp chassis panel directly. Leave the DIN socket ground wire for the DIN connection from the PCB off. Refer to the wiring diagram for the V1143 footswitch.

V1141 "Beatle"

The V1141 Beatle lacks the "repeat percussion" feature of the 1143, so leave off the wire from the PCB to the DIN socket for enabling the repeat percussion. There is only one light on the V1141 footswitch, so run the wire for ground to the DIN socket from the PCB, and run -31V from the power supply terminals on the chassis to the DIN socket. Refer to the wiring diagram for the V1141 footswitch.

V1131/1132/1133 "Royal Guardsman"

The V1131 and V1133 Guardsman both use a single-light footswitch like the V1141 above, and lack repeat percussion. So wire up the DIN socket like the V1141.

The V1132 Guardsman uses a "no-lights" footswitch.

V1121/1122/1123 "Buckingham"

The V1121 and V1123 Buckingham both use a single-light footswitch like the V1141 above, and lack repeat percussion. So wire up the DIN socket like the V1141.

The V1122 Buckingham uses a "no-lights" footswitch.

V1151/1152/1153/1154 "Viscount"

The V1151, Vll53and V1154 Viscount all use a single-light footswitch like the V1141 above, and lack repeat percussion. So wire up the DIN socket like the V1141.

The V1152 Viscount uses a "no-lights" footswitch

V14/V114 "Beatle", V12/V112 "Buckingham" V15/V115 "Viscount"

All of these amps use the earliest footswitch setup. The reverb and tremolo are on a 1/4" stereo phone jack, and the MRB is on a separate one-switch "egg" footswitch with its own cable and connector.

Footswitch wiring

All of the footswitch effects across all years and models are either activated or de-activated by a switch closure to ground.

Reverb and tremolo are DE-activated by a footpedal closure to ground. They are designed so an open circuit on the footpedal socket pin leaves them active and controlled by the depth knobs on the preamp chassis. Distortion, repeat percussion, and MRB are ACTIVATED by a footswitch closure to ground. This distinction of ground-to-activate or ground-to-deactivate only matters on the four-lights footswitch where the reverb and tremolo lights have to come on the right way. The one-light and no-light footswitches don't have this issue. It does matter if you're poking wires into the DIN socket to turn things on and off, though.

In pedals with lights on the pedal, the lights are activated by a separate switch section inside the footpedal itself. You'll need a double pole switch for those contacts.

Lights in the footpedal are powered by -31Vdc from the head.

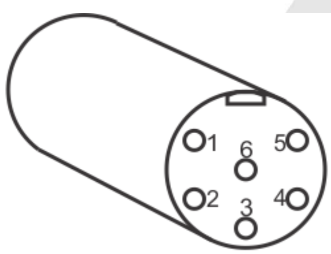
Only the V1143 Beatle had repeat percussion, which required a 7th conductor on the cable to the pedal. Thomas changed the pedal to use the shell and cable shield for carrying ground.

On all models, MRB switch in the pedal is momentary, and does not have a light. The MRB panel switch is electrically in parallel with the footpedal switch, but is alternate action (i.e. On-Off), and not momentary.

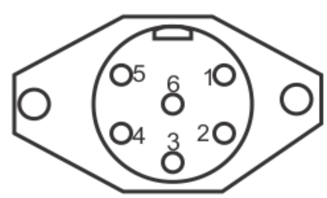
Like the chrome trolleys, the footswitch pedals seem to have been lost from many of these amps. It is entirely possible to build a workable and not even very ugly substitute for this part of the amp. I like the cast aluminum boxes from Hammond Manufacturing for footpedals, as they are rugged and easy to machine. You can simply buy footswitches and install them in holes you drill in a metal box, then wire up the footswitches to a cable. The cable must have a DIN six-conductor-plus-shield plug on the end for the V1143 Beatle, and a DIN six-conductor plug with or without the shield for all the rest of the amps which use a DIN plug. (The V12/V11, V13, V113, V14/V114, and V15/V115 do not use a DIN plug.)

This is not nearly as complicated as making your own distortion pedal, and may be critical for your use of your amp as the internal distortion is completely unavailable without the footpedal to turn it on. There are NO on-chassis controls for the distortion – another Thomas Vox oddity.

Here is the DIN connector pinout numbering:



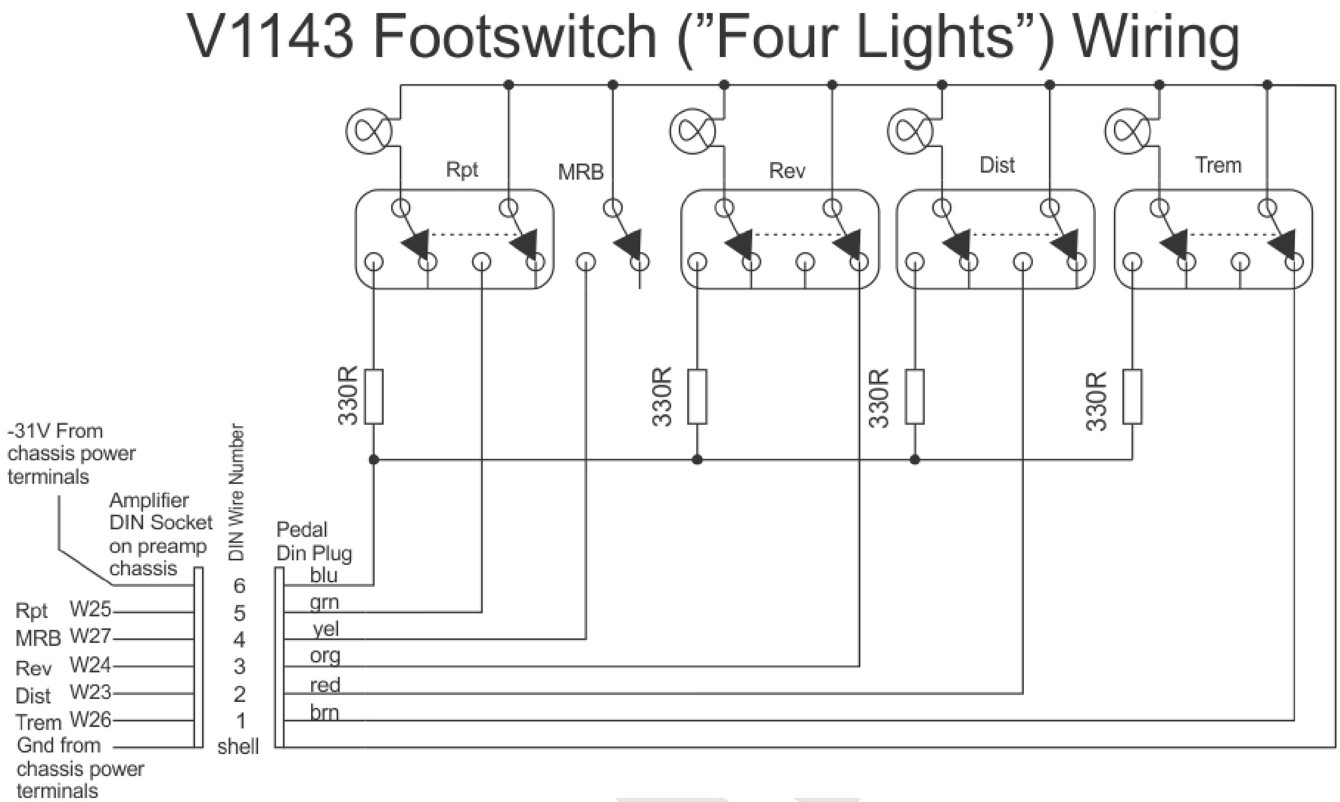
Looking into the plug



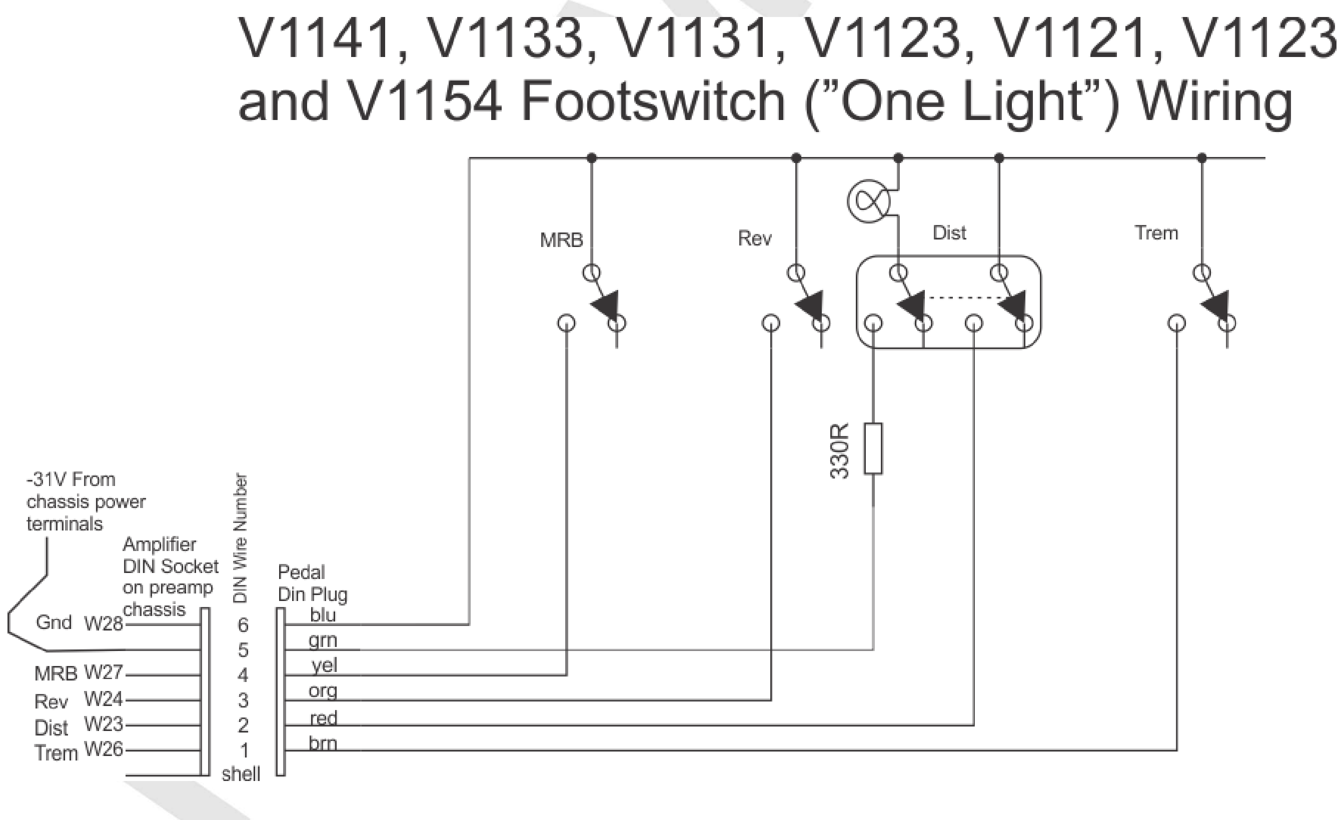
Looking at the socket from the outside of the chassis

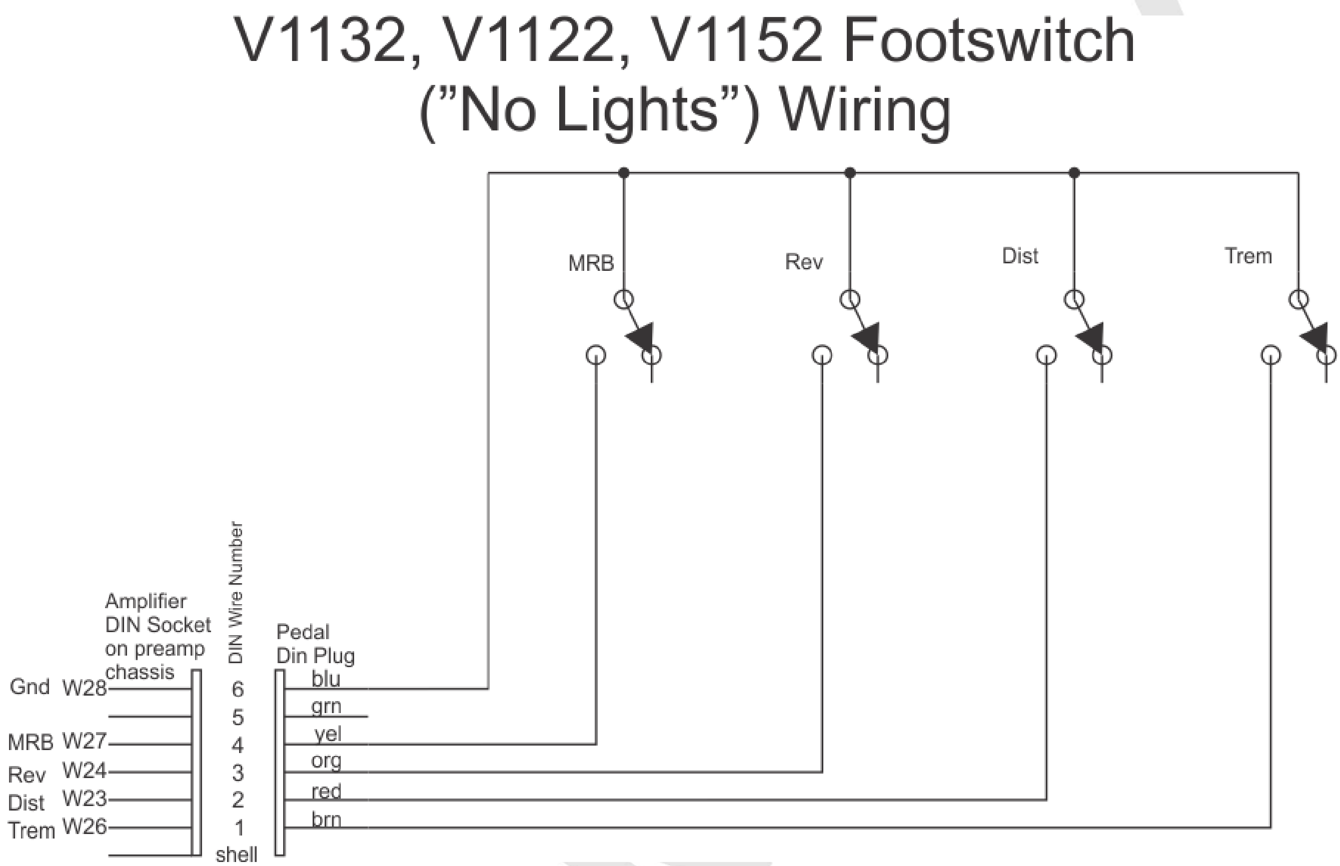
Remember that on the V1143 only there is a seventh connection – the shell of the socket and plug. The shell carries ground to the footswitch for the V1143 only. The shell/ground is the keying tab position.

Also remember if you're making up cables and wiring these connectors from scratch, you'll be soldering to the pins on the back sides of these connectors, which reverses the pin numbers where you're soldering.



V1143 Footswitch WiringV1141, V1133, V1131, V1123, V1121, V1151 and V1154





Footswitch Pedals from Scratch

As noted above, you can build your own. The difficulties here are solely mechanical. You'll need to find a suitably rugged metal box to house the footswitches themselves, and find six-conductor or seven-conductor cable, a six-conductor-with-shield DIN plug, and do some mechanical fabrication and soldering. Effects-pedal builders will have no trouble doing this.

Building the board from scratch

Build options

Appendices

Differences from the originals

Power Supply Changes

The original Thomas Organ power supplies used the resistor/capacitor method of both dropping power supply voltages and isolating sections from one another. This was picked up directly from tube amplifier practice. However, this practice provides less-clean power than the modern practice of using three-terminal regulators. I used three-terminal regulators on the PCB itself and eliminated the power resistors and their wiring in the bottom of the preamp chassis.

The power resistors and capacitors which sit under the preamp PCB in the preamp chassis may be removed entirely or disconnected from the incoming DC power and ignored. Power for this PCB is simply the +31/ground/-31 volts that the power from the power amp chassis provides. It is regulated on the PCB down to the necessary voltages for the individual circuits.

One issue that is not often appreciated about the Thomas Vox amps is that their grounding scheme is actually very good. It approaches a star grounding setup; possibly this is a hidden advantage of the electronic organ heritage of the Thomas Vox amps. In electronic organs, cross coupled noise is a huge problem, so Thomas had to work out solutions for it. In any case, the replacement PCB was set up to replicate this as much as possible, but on the printed circuit where it will be stable, not in individual wires. A broken ground wire will make an original Thomas Vox amp very hummy indeed.

The power devices on the replacement PCB have been laid out so they can have a heat sink attached if they get hot. Extensive modeling and analysis indicates that the power dissipation is low enough in all cases that no heat sink is really needed, excepting for IC1, the uA7824 regulator that makes +24V from the raw 31Vdc from the power amp.

It is likely that no heat sink will be needed for any other power part if the recommended TO-220 package devices are used. This includes the power transistors in the reverb driver circuit. They are all laid out for heat sinks, but a sink is probably not needed. The layout is intended for the Wakefield 274-1AB ($0.23 each in ones, Mouser, July 2014), but a simple flat piece of aluminum will work as well.

In testing the first board, only IC1 got noticeably warm to my fingertip. I measured it as a 42F/23C rise over ambient. However I was using only a 28V raw DC supply, not 31V, and the power will go up as the raw DC increases. I put the specified heat sink on it, and the temperature promptly dropped by 12F. It would probably be wise to put a heat sink on this one. I don't think the others need it.

Other Circuit Changes

I tinkered a bit to work with modern parts and clean up things not in the signal path. Here are some of the things I changed.

Distortion Switching

The V1143*6 already uses JFETs for switching the distortion signal in and out. But it uses one P-channel and one N-channel, and the switching involves using the -31V supply to get the right control signal for the N-channel. I used two P-channels, and adapted two bipolar transistors to properly switch the P-channels without using the -31V supply.

Reverb Channel Switching

The four-pole, three-throw rotary switch that Thomas used for moving the reverb from the normal to brilliant channel or turning it off is one of the Thomas wiring disasters. It's often a problem in the amps. I kept the same function, but put CMOS signal switches on the main PCB to actually switch the signal. Instead of six wires carrying signals out to the rotary switch, I used only four wires carrying the logical control signals to tell the CMOS how to route the signals. It does the same signal routing, but uses fewer wires and does not run the signal off the board to a failure prone switch.

And I gave in to the group in the back of the room that will cry "But it's not original!". I put extra pads for wires and designed in optional wires and patches to the PCB so that the original rotary switch can be used as in the originals. It's more wiring, and a bit clumsy, but it's available if you want it.

Output Signal Limiting Adjuster

The original limiter adjuster used a 1W carbon composition pot to set a 0-2.5ma current that set the limiter threshold. Running so much current through a pot is not a great practice, so I put the trimmer on the PCB where its wires can't break, and modified the adjuster circuit a bit for better control-ability and lower current through the wiper. And again, I put pads on the PCB so you can run wires to the original pot if you like the location better.

Repeat Percussion Circuit

The original repeat percussion circuit used a 2N2646 uni-junction transistor (UJT). These are getting hard to find, and expensive. There is another device, the PUT (programmable Uni-junction Transistor) that does the same job with a couple of resistor changes, and is cheap and widely available. I put the pads for both of these on the PCB so it can be built either way. Neither way changes the sound any, it's just two ways to do the same thing.

If you use the original 2N2646, make R145 be 1K, R146 be 100R, and R146b be an open circuit.

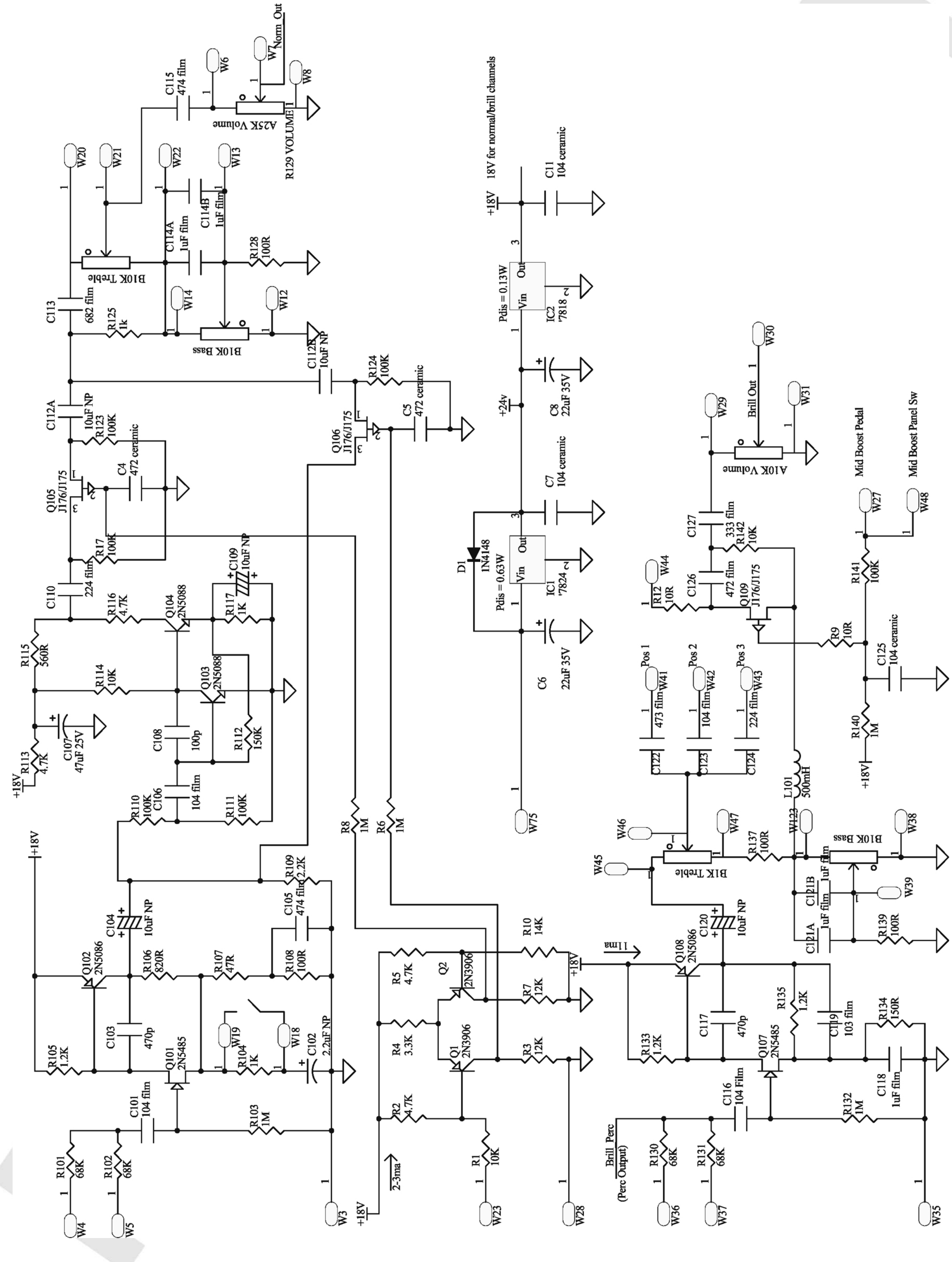
If you use the 2N6027, change R145 to 2.7K , R146 to 10R, and install a 4.7K for R146b. These alternate values for the three resistors were chosen to make the 2N6027 act as much like the 2N2646 as possible with 5% resistors.

Of course this only matters if you are fixing a V1143 Beatle, the only amp with this effect built in.

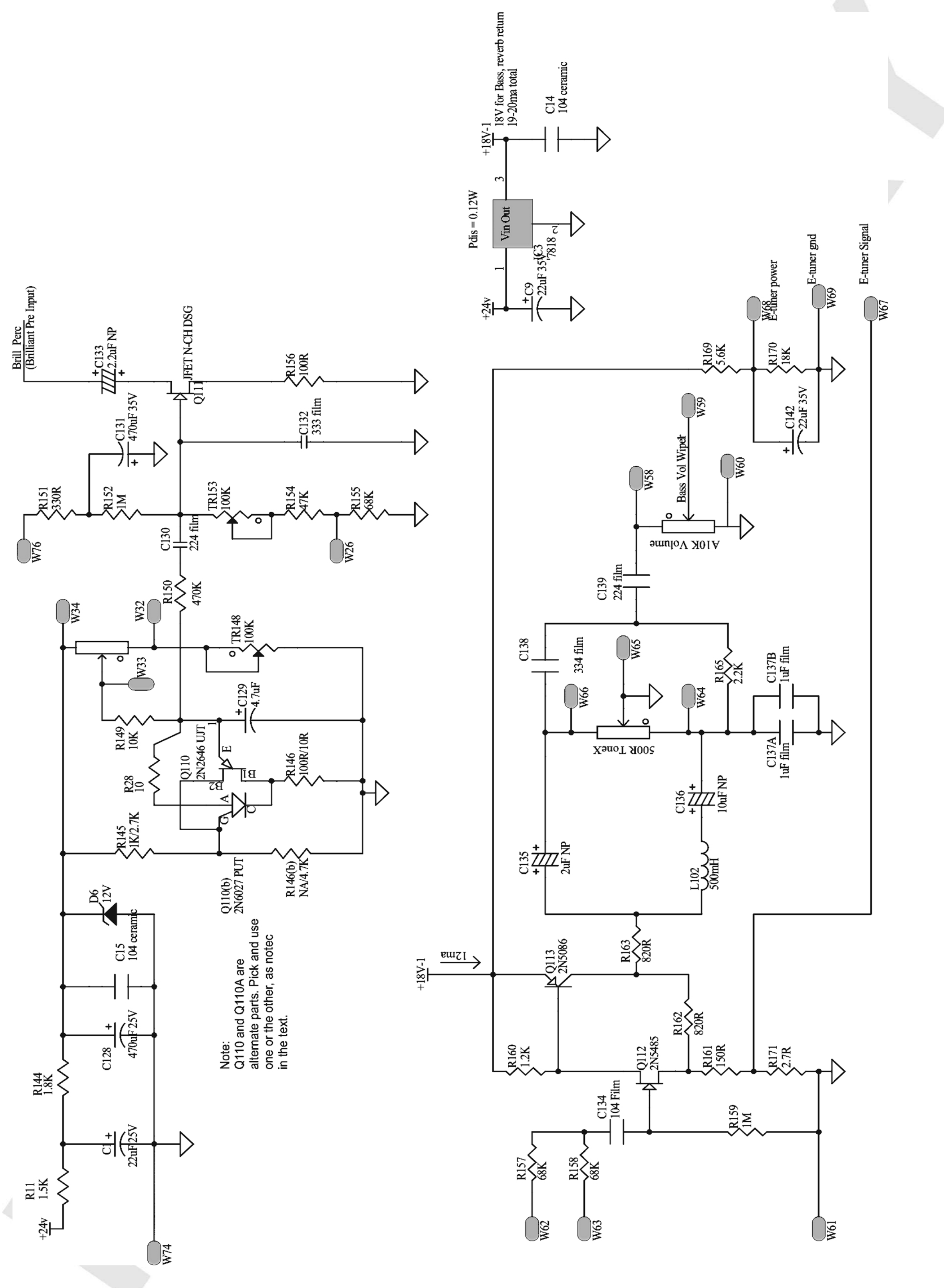
Appendix

Schematics

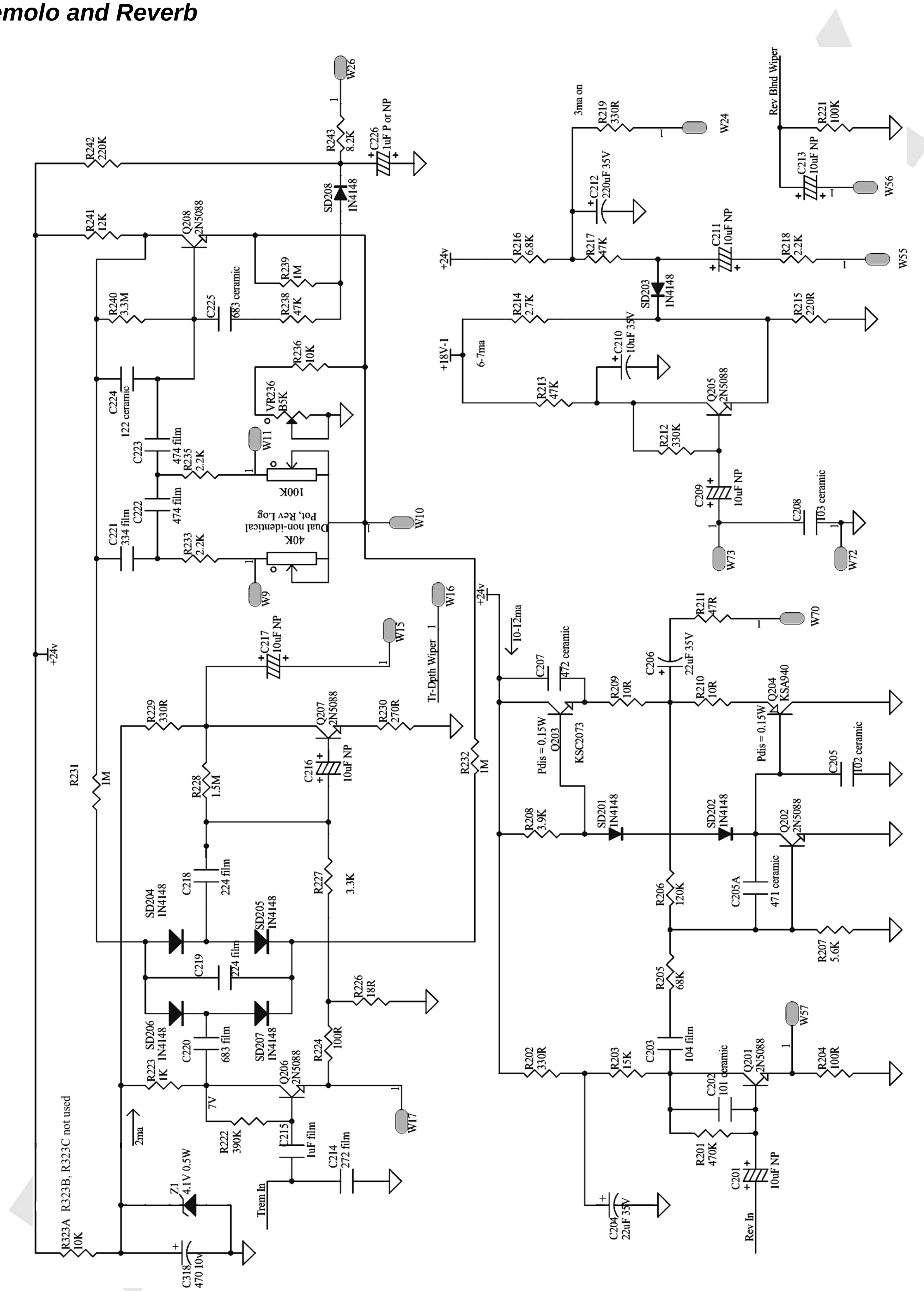
Normal and Brilliant Preamps



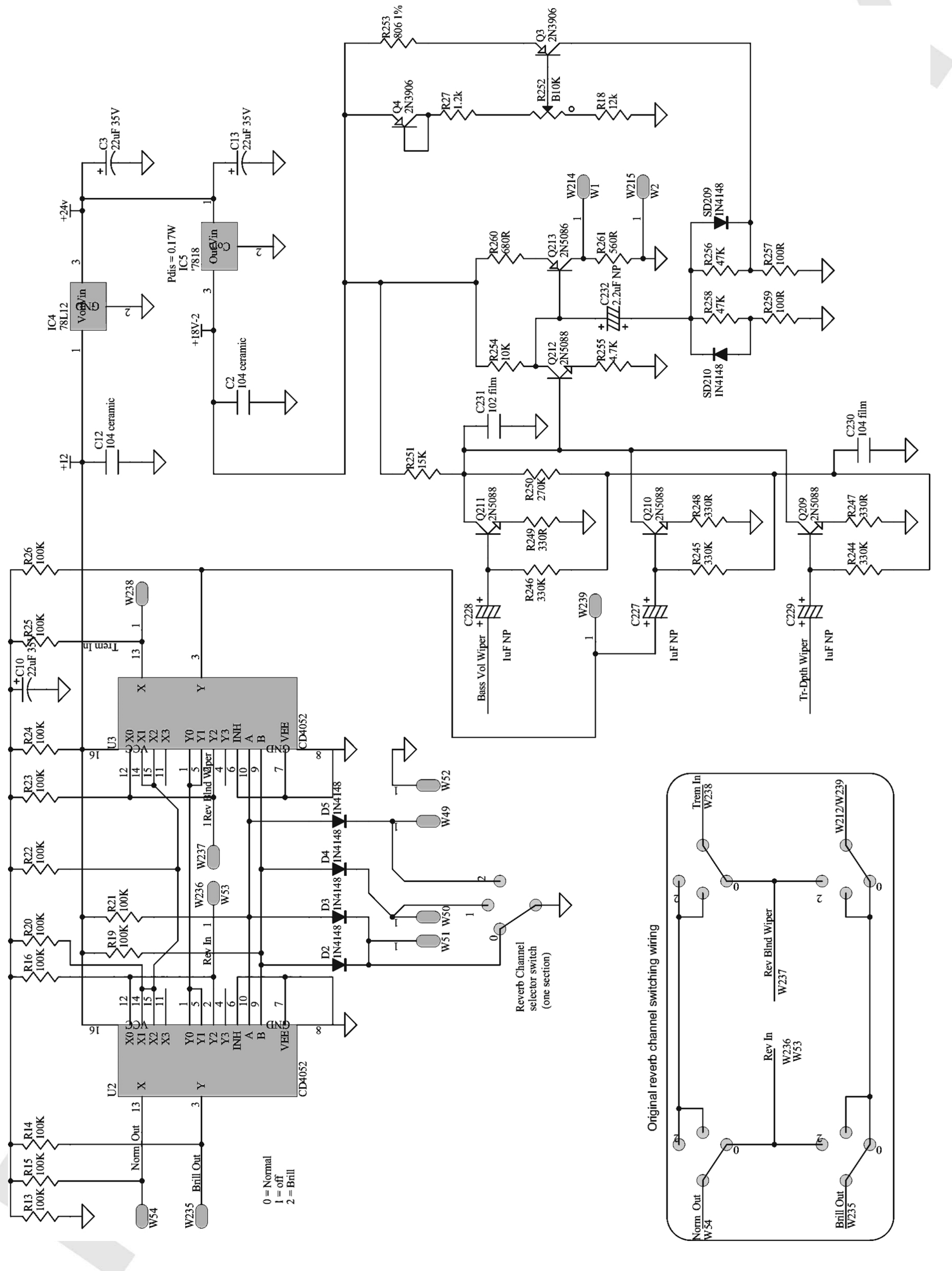
Bass Preamp and Repeat Percussion



Tremolo and Reverb



Reverb Channel Switching and Mixer-Limiter



Wires and Cables

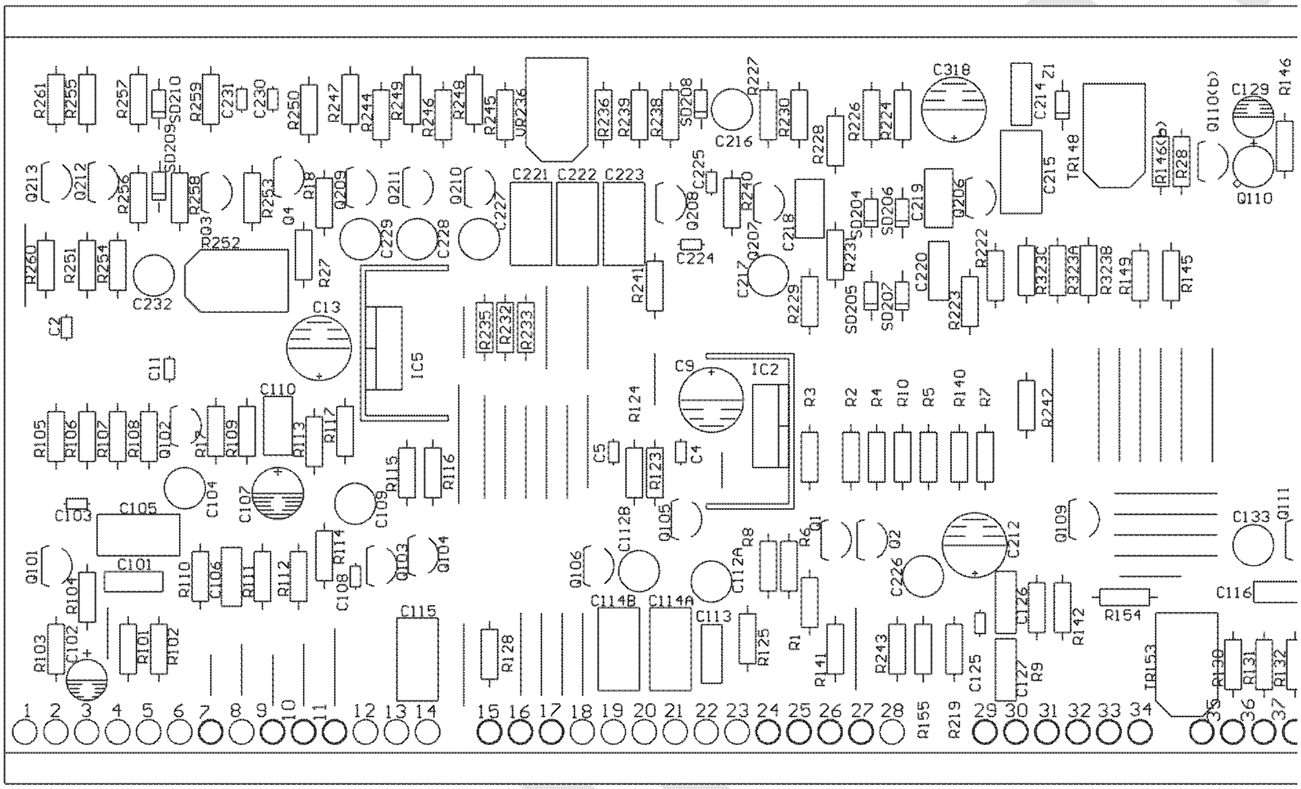
The wires are marked 1 through 76 on the PCB for reference. Here's what they do:

Wire #	Use
1	Signal Out to power amp chassis; solder to RCA socket on preamp chassis wall
2	Signal Out Ground to power amp chassis
3	Normal Channel input jacks ground
4	Normal Channel input 1
5	Normal Channel input 2
6	Normal Channel Volume CW
7	Normal Channel Volume Wiper
8	Normal Channel Volume CCW
9	Tremolo Speed CW (40K pot section)
10	Tremolo Speed pots common – both wipers and both CCW lugs
11	Tremolo Speed CW (100K pot section)
12	Normal Channel Bass CW
13	Normal Channel Bass Wiper
14	Normal Channel Bass CCW
15	Tremolo Depth CW
16	Tremolo Depth Wiper
17	Tremolo Depth CCW
18	Top Boost Switch 1
19	Top Boost Switch 2
20	Normal Channel Treble CW
21	Normal Channel Treble Wiper
22	Normal Channel Treble CCW
23	Footpedal: Distortion Enable; internally pulled up, switch to ground to enable
24	Footpedal: Reverb Enable; internally pulled up, switch to ground to disable
25	Footpedal: Repeat Percussion Enable; internally pulled up, switch to ground to enable
26	Footpedal: Tremolo Enable; internally pulled up, switch to ground to disable
27	Footpedal: MRB Enable; internally pulled up, switch to ground to enable
28	Footpedal: Ground for enable signals
29	Brilliant Channel Volume CW
30	Brilliant Channel Volume Wiper
31	Brilliant Channel Volume CCW
32	Repeat Percussion Speed CW
33	Repeat Percussion Speed Wiper
34	Repeat Percussion Speed CCW
35	Brilliant Channel Input Ground
36	Brilliant Channel Input 1

37	Brilliant Channel Input 2
38	Brilliant Channel Bass CW
39	Brilliant Channel Bass Wiper
40	Brilliant Channel Bass CCW
41	MRB effect 1
42	MRB effect 2
43	MRB effect 3
44	MRB switch common/pole
45	Brilliant Channel Treble CW
46	Brilliant Channel Treble Wiper
47	Brilliant Channel Treble CCW
48	Mid Boost panel switch; pull to ground to enable; connects to footpedal contact
49	Reverb Channel Switching 1 (To mixer/limiter in original wiring scheme)
50	Reverb Channel Switching 2 (Tremolo In for original wiring scheme)
51	Reverb Channel Switching 3 (Reverb Out in original wiring scheme)
52	Reverb Channel Switching Common/pole (Brill out in original wiring scheme)
53	Reverb In signal, used for original reverb channel switching wiring only
54	Normal Out signal, used for original reverb channel switching wiring only
55	Reverb Blend CW
56	Reverb Blend Wiper
57	Reverb Blend CW
58	Bass Volume CW
59	Bass Volume Wiper
60	Bass Volume CCW
61	Bass Input ground
62	Bass Input 1
63	Bass Input 2
64	Tone-X CW
65	Tone-X Wiper
66	Tone-X CCW
67	E-tuner Signal; 67, 68, 69 go to the plug in connector for an e-tuner, if fitted
68	E-tuner Power
69	E-tuner Ground; note, ground not used on some amps; wire it to match your amp
70	Reverb Drive to reverb tank input
71	Reverb Drive ground/shield
72	Reverb Return ground/shield
73	Reverb return from reverb tank output
74	Power Ground from power chassis
75	+31V from power chassis
76	-31V from power chassis

Wires connect in groups of 2, 3, 4 or 6 (“cables”) from the PCB to the control/switch. Each “cable” goes only from the PCB to the control/switch. For ease of servicing in the future, it is important to make the wires noted as “hookup wire” from good quality stranded hookup wire in 24 or 22 gauge and be careful to NOT nick the wire when stripping the insulation. This was one of the original sins Thomas committed that got us all into this in the first place.

Here's where to find the wire numbers:



The wire numbers are immediately above the circle around the wire pad. This picture shows the left half of the PCB with wire locations number 1 through 37.

As the picture of the overall board cabling, I organized the wiring into short, direct cables that run directly from the PCB pads to the control. I did the PCB layout to force the pads to be as close to the control that the pads service as possible when mounted inside the standard Thomas Vox chassis.

Here are the wires organized into cables. The idea is to bundle up the proper number of wires, cut all of them to length for the control, strip and tin the wires, then wire them to the control. The wire length is sufficient but not overly long for the control inside the box, so you can wire up all the controls outside the chassis, then insert the board and controls into the chassis when all is wired and tested. This converts a delicate repair-in-place electronic surgery to a manufacturing process, where you don't have to be careful not to kill what's already there.

Cable	Wires	Length, Inches	Use
C1	W1, W2; RG-174 coax	9	Preamp output to RCA jack for power amp
C2	W3-W5; Shielded twisted pair or 2x RG-174	5	Shielded input jack cables, Normal channel
C3	W6, W7, W8; 3x hookup wire twisted	6	Normal Volume

C4	W9-W11; 3x hookup wire twisted	6	Tremolo Speed
C5	W12-W14; 3x hookup wire twisted	6	Normal Bass
C6	W15-W17; 3x hookup wire twisted	6	Tremolo Depth
C7	W18, W19; 2x hookup wire twisted	5	Top Boost switch
C8	W20-W22; 3x hookup wire twisted	6	Normal Treble
C9	W23-W28; 6x hookup wire	7	Footswitch pedal jack
C10	W29-W31; 3x hookup wire twisted	5.5	Brilliant Channel Volume
C11	W32-W34; 3x hookup wire twisted	5.5	Repeat Percussion speed
C12	W35-W37; Shielded twisted pair or 2x RG-174	5	Shielded input jack cables, Brilliant channel
C13	W38-W40; 3x hookup wire twisted	5	Brilliant Channel Bass
C14	W41-W44; 4x hookup wire twisted	6	MRB effect select switch
C15	W45-W47; 3x hookup wire twisted	5	Brilliant Channel Treble
C16	W48; 1x hookup wire	6.5	Mid Boost panel switch
C17	W49-W52; 4x hookup wire twisted (or 6X, see text)	8.5	To Reverb Channel select, see text
C18	W55-W57; 3x hookup wire twisted	8.5	Reverb Blend
C19	W58-W60; 3x hookup wire twisted	5.5	Bass Channel Volume
C20	W61-W63; Shielded twisted pair or 2x RG-174	7.5	Shielded input jack cables, Bass channel
C21	W64-W66; 3x hookup wire twisted	7	Bass Channel Tone-X
C22	W67-W69; 3x hookup wire twisted	23.5	E-tuner connector; note ground not used on some amps; It's l
C23	W7, W71; RG-174	33.5	Shielded reverb send
C24	W72-W73; RG-174	35.5	Shielded reverb return
	W74-W76; Wires to power lugs #24-#22 hookup	9	DC power for the board from the power chassis

Wiring notes;

1. Cables to pots are left to right CW/wiper/CCW on the PCB. It makes sense to dedicate one wire color to “pot CW”, one to “pot wiper”, another to “pot CCW” and make up enough feet of twisted three-wire cable to run all the lengths. Cut pot cables to length, then strip/tin/solder into PCB, and into the pot loose on the workbench. Then place wired board and controls in the box after all or most wiring is done.
2. Cable length includes 3/8” strip/tin length added to each end of hookup wire. Cut to length, then strip 3/8” inch from each end for soldering. Coax/shielded cable includes1 1/2” extra length for soldering prep, 3/4” on each end.
3. There's a total of 104.5”, 2.65m of 3-conductor pot or power wiring; 7”/178mm of 6-conductor, 14.5”/368mm of 4-conductor hookup wires if you want to make bundles all at once.

Initial Setup and Testing

Once you have the PCB in the chassis, you need to make sure it's functioning before going through the somewhat laborious process of putting it all back in the wooden enclosure. This requires that you either make a temporary power supply (see “A Test Power Supply” in the appendix) to run the thing while you check it out, or that you connect it to the power amp chassis to tap off the +/- 31Vdc to run the circuits on the PCB.

The +/- 31Vdc is not terribly dangerous itself, but the exposed primary wiring on the power amp chassis IS dangerous. If you do not already know how to work with exposed primary wiring DO NOT try to do this yourself. It's not worth getting electrocuted for. Go find a qualified tech who does have the skills. Do the same if any of this setup information does not give you enough information for you to complete it correctly and with confidence.

Set up and check out the DC power

Connect your DC power source to the terminal lugs in the preamp chassis, being careful to get +31V, ground, and -31V in the right places. There is no internal polarity protection on the PCB, and you might damage it if you get the power supply backwards.

Clip your meter to the ground lug where the incoming DC wires terminate on lugs. Clip the +/red lead to the +31V lug, set your meter to a voltage greater than 35Vdc maximum, and turn the DC power supply on, then immediately off. Check to be sure your meter showed the right polarity, as some voltage will persist for a short time after the DC power is turned off. Do the same for the -31V supply and be sure you have them the right direction.

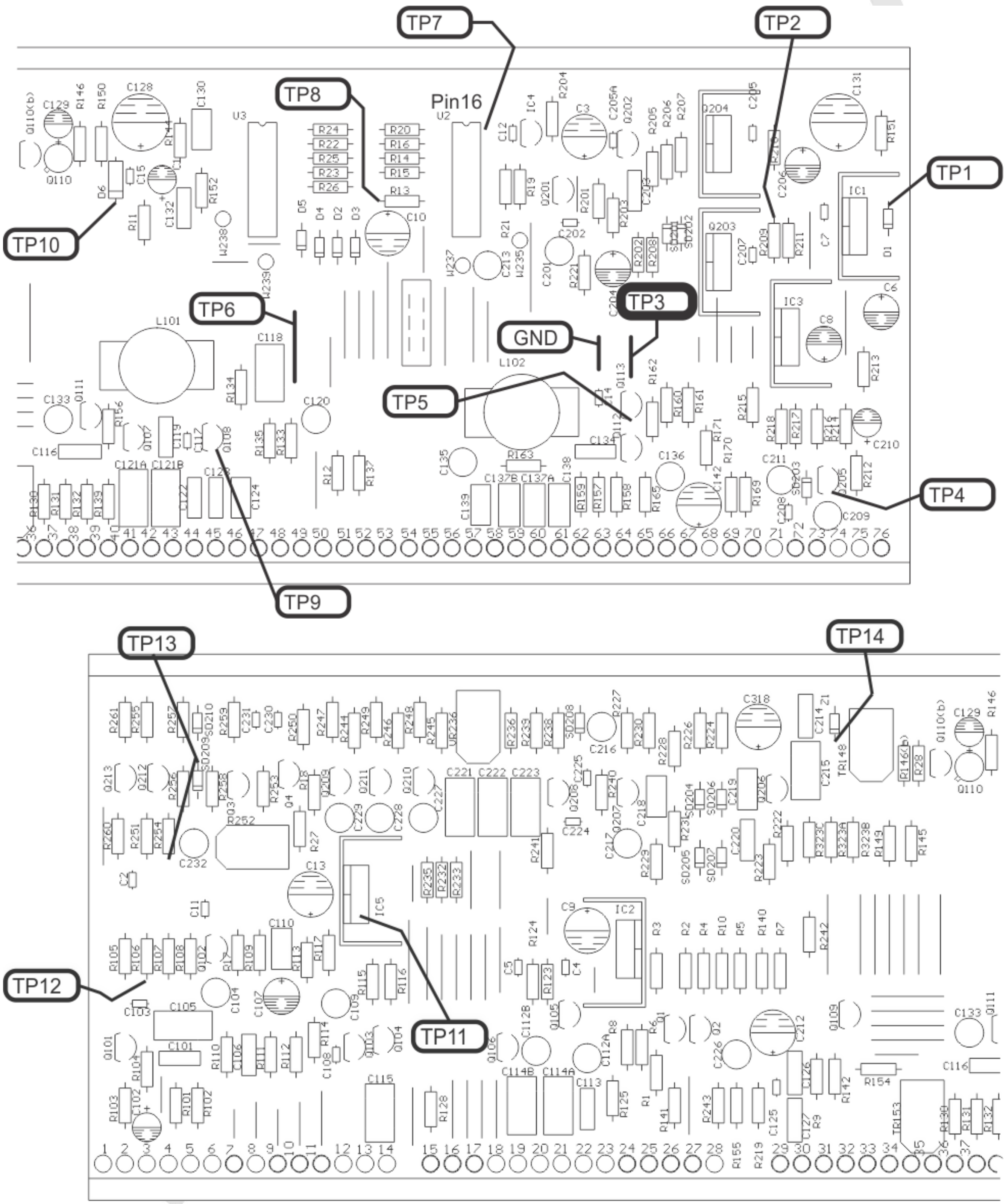
If all is well, turn the DC power on and verify that the “+31V” supply is more than 26Vdc and less than 40Vdc. Likewise, ensure that “-31” is more negative than -26Vdc, and less negative than -40Vdc. If this is OK, you can begin working on the PCB itself. First, test the “ground” point for 0.0V. Then:

Check and verify the DC voltages on each of the following Test Points:

TP1	Top of D1	24Vdc +/-5%
TP2	Top of R209	+12-+16Vdc (careful not to short to R211 lead)
TP3	Trace/Jumper pad	+18Vdc +/- 5%
TP4	Collector Q205	
TP5	Collector Q113	+7 to +12Vdc
TP6	Trace/Jumper pad	+18Vdc +/- 5%
TP7	U2 pin 16	+12V +/-5%
TP8	Left end of R13	+6V +/- 10%
TP9	Collector Q108	+7 to +12Vdc
TP10	Anode D6	~ +12Vdc
TP11	Bottom pin IC5	24Vdc +/-5%
TP12	Right Pin C103	+7 to +12Vdc
TP13	Bottom lead R254	+7 to +12Vdc
TP14	Anode Z1	+3.9Vdc to +4.3Vdc

Service and Debugging Information

To check out the design, I simulated the circuits extensively. Thomas Organ service literature is full of



minor errors, especially on the voltages they indicate for various points in the circuit. This is another of those little things that make service people hate to work on these amps. Not being able to trust the factory service literature is a big problem for a repair man. It costs the tech time, and that converts directly to a loss of money, and money is why they do this in the first place.

The DC voltages on the various parts in the absence of signal is a great diagnostic tool, though. Here's a table of the voltages on the transistor and IC pins. Voltages are taken with normal mains AC input voltages and zero input signal. Any variation will be variations from the devices and resistor tolerances, as the power supplies are regulated to +/-5% by IC1-IC5, unlike in the original amps.

Circuit Point	Voltage	Notes	Device/Pinout	
Q1 Collector		~ 12V distortion engaged, 0V when not engaged	2N3906 EBC	
Q1 Base		12.3 engaged, 18V not engaged		
Q1 Emitter	12.9-14.3	12.9 engaged, 14.3 not engaged		
Q2 Collector		0V when distortion engaged, ~12V when not engaged	2N3906 EBC	
Q2 Base	13.7			
Q2 Emitter	12.9-14.3	12.9 engaged, 14.3 not engaged		
Q3 Collector	17.5	This transistor is temperature compensation for Q4.	2N5088 EBC	
Q3 Base	17..5			
Q3 Emitter	18			
Q4 Collector		0.08 to 1.1V depending on the setting of the limiter		
Q4 Base		+16.6 to +9.0, depending on the setting of the limiter potentiometer		
Q4 Emitter		+17.3 to +9.5, depending on the setting of the limiter		
Q101 Drain	17.5	Normal Channel input JFET	2N5485 DSG	
Q101 Gate	0			
Q101 Source	+1 – 1.7			
Q102 Collector	+7 - +11	Change the value of R105 until this is true; this compensates	2N5086 EBC	
Q102 Base	17.5	for the variations in Q101 JFET		
Q102 Emitter	18			
Q103 Collector	1.5-1.6	Same as Q104 base		
Q103 Base	0.6-0.7			
Q103 Emitter	0	Connected to ground		
Q104 Collector	5.3			
Q104 Base	1.5-1.6	same as Q103 collector		
Q104 Emitter	0.8-0.9			
Q105 Drain	0V		J175 DGS	
Q105 Gate		0V engaged, 12V not engaged		
Q105 Source	0V			
Q106 Drain	0V		J175 DGS	
Q106 Gate		12V engaged, 0V not engaged		
Q106 Source	0V			
Q107 Drain	17.5	Brilliant Channel input JFET	2N5485 DSG	

Circuit Point	Voltage	Notes	Device/Pinout	
Q107 Gate	0			
Q107 Source	+1 – 1.7			
Q108 Collector	+7 - +11	Change the value of R133 until this is true; this compensates	2N5086 EBC	
Q108 Base	17.5	for the variations in Q107 JFET		
Q108 Emitter	18			
Q109 Drain	0		J175 DGS	
Q109 Gate	+18/0	pulled up to +18 inactive, down to 0.0 MRB active		
Q109 Source	0			
Q110 Base 1			2N2646 (diag) see text re Q110A	
Q110 Emitter				
Q110 Base 2				
Q110A Anode			2N6027 AGK see text re Q110	
Q110A Gate				
Q110A Cath				
Q111 Drain	~0V			
Q111 Gate		varies 0V to -10V depending on setting of TR153 trimmer		
Q111 Source	~0V			
Q112 Drain	17.5	Bass Channel input JFET	2N5485 DSG	
Q112 Gate	0			
Q112 Source	+1 – 1.7			
Q113 Collector	+7 - +11	Change the value of R160 until this is true; this compensates	2N5086 EBC	
Q113 Base	17.5	for the variations in Q112 JFET		
Q113 Emitter	18			
Q201 Collector	1.5-3V		2N5088 EBC	
Q201 Base	0.8-0.9V			
Q201 Emitter	0.2-0.3V			
Q202 Collector	14-16V	Same as Q204 base	2N5088 EBC	
Q202 Base	0.5-0.7			
Q202 Emitter	0V	Connected to ground		
Q203 Collector	24V	connected to +24V power supply	KSC2073 / 2SC2073	
Q203 Base		0.6V higher than emitter		
Q203 Emitter	14-16			
Q204 Collector	0V	connected to ground	KSA940 / 2SA940	
Q204 Base		0.6V lower than emitter		
Q204 Emitter	14-16V	0.2-0.3V lower than Q203 emitter		
Q205 Collector			2N5088 EBC	
Q205 Base				
Q205 Emitter				

Circuit Point	Voltage	Notes	Device/Pinout	
Q206 Collector			2N5088 EBC	
Q206 Base				
Q206 Emitter				
Q207 Collector			2N5088 EBC	
Q207 Base				
Q207 Emitter				
Q208 Collector		Varies with LFO cycle/speed	2N5088 EBC	
Q208 Base		Not measurable reliably		
Q208 Emitter		Varies with LFO cycle/speed		
Q209 Collector	2.2	Mixer transistor	2N5088 EBC	
Q209 Base	0.7			
Q209 Emitter	0.1			
Q210 Collector	2.2	Mixer transistor	2N5088 EBC	
Q210 Base	0.7			
Q210 Emitter	0.1			
Q211 Collector	2.2	Mixer transistor	2N5088 EBC	
Q211 Base	0.7			
Q211 Emitter	0.1			
Q212 Collector	14.9-15		2N5088 EBC	
Q212 Base	2.2			
Q212 Emitter	1.5-1.6			
Q213 Collector	1.9V		2N5086 EBC	
Q213 Base	14.9-15	Same as Q212 collector		
Q213 Emitter	15.7V			
IC1 pin 1	+30-31V	Voltage regulator	uA7824	
IC1 pin 2	0V			
IC1 pin 3	24			
IC2 pin 1	24	Voltage regulator	uA7818	
IC2 pin 2	0			
IC2 pin 3	18			
IC3 pin 1	24	Voltage regulator	uA7818	
IC3 pin 2	0			
IC3 pin 3	18			
IC4 pin 1	24	Voltage regulator	uA7812	
IC4 pin 2	0			
IC4 pin 3	12			
IC5 pin 1	24	Voltage regulator	uA7818	
IC5 pin 2	0			

Circuit Point	Voltage	Notes	Device/Pinout	
IC5 pin 3	18			
U2 pin 1	6	CMOS signal switching IC	CD4052	
U2 pin 2	6			
U2 pin 3	6			
U2 pin 4	NA			
U2 pin 5	6			
U2 pin 6	0			
U2 pin 7	0			
U2 pin 8	0			
U2 pin 9	0.6 or 12	depends on the position of the reverb channel select		
U2 pin 10	0.6 or 12	depends on the position of the reverb channel select		
NA	NA			
U2 pin 12	6			
U2 pin 13	6			
U2 pin 14	6			
U2 pin 15	6			
U2 pin 16	12			
U3 pin 1	6	CMOS signal switching IC	CD4052	
U3 pin 2	6			
U3 pin 3	6			
U3 pin 4	NA			
U3 pin 5	6			
U2 pin 6	0			
U2 pin 7	0			
U2 pin 8	0			
U2 pin 9	0.6 or 12	depends on the position of the reverb channel select		
U2 pin 10	0.6 or 12	depends on the position of the reverb channel select		
U2 pin 11	NA			
U3 pin 12	6			
U3 pin 13	6			
U3 pin 14	6			
U3 pin 15	6			
U3 pin 16	12			

Bill of Materials for the PCB

Line Index	Comment	Qty	Components
1	1uF NP	4	C226 C227 C228 C229
2	2.2uF NP	4	C102 C133 C135 C232
3	10uF NP	12	C104 C109 C112A C112B C120 C136 C201 C209 C211 C213, C216 C217
4			
5	4.7uF	1	C129
6	10uF 35V	1	C210
7	22uF 25V	1	C1
8	22uF 35V	9	C3 C6 C8 C9 C10 C13 C142 C204 C206
9	47uF 25V	1	C107
10	220uF 35V	1	C212
11	470uF 10V	1	C318
12	470uF 25V	1	C128
13	470uF 35V	1	C131
14			
15	102 film	1	C231
16	272 film	1	C214
17	472 film	1	C126
18	682 film	1	C113
19	103 film	1	C119
20	333 film	2	C127 C132
21	473 film	1	C122
22	683 film	1	C220
23	104 film	5	C101 C106 C116 C123 C230
24	224 film	8	C110 C124 C130 C134 C139 C203 C218 C219
25	334 film	1	C138
26	474 film	4	C105 C115 C222 C223
27	1uF film	8	C114A C114B C118 C121A C121B C137A C137B C215
28			
29	101 Ceramic (1	3	C108 C202 C221
30	471 Ceramic (4	3	C103 C117 C205A; note, C205 may not be needed
31	102 Ceramic	1	C205
32	122 Ceramic	1	C224
33	472 Ceramic	3	C4 C5 C207
34	103 Ceramic	1	C208
35	683 Ceramic	1	C225
36	104 Ceramic	7	C2 C7 C12 C11 C14 C15 C125
37			
38	100R/10R	1	R146
39	1K/2.7K	1	R145

40	NA/4.7K	1 R146(b)
41	2.7R	1 R171
42	10R	5 R9 R12 R28 R209 R210
43	18R	1 R226
44	47R	2 R107 R211
45		
46	100R	9 R108 R128 R137 R139 R156 R204 R224 R257 R259
47	150R	1 R134 R161
48	220R	1 R215
49	270R	1 R230
50	330R	7 R151 R202 R219 R229 R247 R248 R249
51	560R	2 R115 R261
52	680R	1 R260
53	806'1%	1 R253
54	820R	3 R106 R162 R163
55	1K	4 R104 R117 R125 R223
56	1.2K	5 R27 R105 R133 R135 R160
57	1.5K	1 R11
58	1.8K	1 R144
59	2.2K	5 R109 R165 R218 R233 R235
60	2.7K	1 R214
61	3.3K	2 R4 R227
62	4.7K	1 R255
63	3.9K	1 R208
64	4.7K	4 R2 R5 R113 R116
65	5.6K	2 R169 R207
66	6.8K	1 R216
67	8.2K	1 R243
68	10K	8 R1 R114 R142 R149 R236 R241 R254 R323A
69	12k	3 R3 R7 R18
70	14K	1 R10
71	15K	2 R203 R251
72	18K	1 R170
73	47K	6 R154 R213 R217 R238 R256 R258
74	68K	8 R101 R102 R130 R131 R155 R157 R158 R205
75	100K	19 R13 R14 R15 R16 R17 R19 R20 R21 R22 R23 R24 R25 R26 R110 R111 R123 R124 R141 R221
76	120K	1 R206
77	150K	1 R112
78	220K	1 R242
79	270K	1 R250

80	330K	4	R212 R244 R245 R246
81	390K	1	R222
82	470K	2	R150 R201
83	1M	10	R6 R8 R103 R132 R140 R152 R159 R231 R239
84	1.5M	1	R228
85	3.3M	1	R240
86			
87	1N4148	17	D1 D2 D3 D4 D5 SD201 SD202 SD203 SD204 SD205 SD206 SD207 SD208 SD209 SD210
88	12V	1	D6
89	7824	1	IC1
90	7818	3	IC2 IC3 IC5
91	78L12	1	IC4
92	2N3906	4	Q1 Q2 Q3 Q4
93	2N5485	3	Q101 Q107 Q112
94	2N5086/5087	4	Q102 Q108 Q113 Q213
95	2N5088	12	Q103 Q104 Q201 Q202 Q205 Q206 Q207 Q208 Q209 Q210 Q211 Q212
96	J176/J175	3	Q105 Q106 Q109
97	2N6027 PUT	1	Q110(b) alternate part number
98	2N2646 UJT	1	Q110 original part number
99	JFET N-CH DS(	1	Q111
100	KSC2073	1	Q203
101	KSA940	1	Q204
102	B10K	1	R252
103	100K	2	TR148 TR153
104	B5K	1	VR236
105	CD4052	2	U2 U3
106	4.1V 0.5W	1	Z1
107			
108	500mH	2	L101 L102; Most wah inductors can be used on the PCB

Notes on BOM and building the board:

Cost: If you buy parts one at a time and have to buy all of them that way, you'll spend $35-50 on the parts put on the PCB. If you have even modest stocks of parts from other electronics building, the cost drops because most of these are very common parts that you are likely to have already, at least in part. The biggest expenses will be the JFETs, the trimmers, and the wah inductors. Notice that if you are replacing a board in an existing amp, the inductors can be salvaged from the PCB that was already in the amp. That cuts $10-20 from the parts cost all by itself.

By reference to the item number:

53: Resistor R253 is 806 ohms, 1%. It really needs to be 1%, as an 820 ohm won't work nearly as well. 1% resistors are expensive – about $0.05 each... 8-)

95: I selected the 2N5088 because it is widely available, cheap, and quiet as well as a good low signal amplifier and high gain. Most high-gain, low noise transistors will work for these parts. The original was a 2N2925. There are alternatives in the BC5xx line and the 2SC Japanese style part numbers. If you select something other than 2N5088, be sure to check the pin arrangement on the datasheet and place them in the boards accordingly. The BC line has pins in the opposite arrangement from the EBC arrangement of the 2N5088, so these parts would be reversed compared to the orientation shown on the PCB. The 2SC series, like many earlier 2N parts (including the 2N2925) is pinned out ECB, so the pins must be bent to reverse the positions of B and C. Whatever you use, get the pinout right. The same advice applies to all of the transistors: check the pinout of the devices you actually use and put the pins in the right holes.

97 & 98: Repeat Percussion parts. The original used the 2N2646 UJT. This device is moderately hard to find, expensive, and variable. The PUT is a modern replacement that's cheaper, easier to find, and more consistent from unit to unit. Pick one of these and use it and the three resistor alternatives necessary for the changed device. All the pads are on the PCB so you can simply place the device you select. For the 2N2646 UJT, use R145=1K, R146= 100R , and R146b = not populated. For the 2N6027 PUT, use R145=2.7K, R146=10R, R146b= 4.7K.

102: This trimmer adjusts the limiter for the output of the preamp. You can use the 10K pot on your amplifier preamp chassis by soldering three wires into the pads for this trimmer and running them off the PCB to the chassis mounted pot. I prefer the rigidity and lack of wires with the adjuster on the PCB, so I put a place for the trimmer on the PCB and drilled a hole above the trimmer so I can insert a screwdriver through the top plate of the chassis for this adjustment.

108: Inductors. The simplest source for 500mH inductors is a wah inductor, available from pedal parts suppliers. The layout has been set up to accommodate many of these.

JFETs and Bias Resistors;

If you are assembling a board, you're going to run into some issues with the JFETs and with biasing the preamps. The original JFET in the front end of all three preamps was the 2N4303. There are long obsolete. You can possibly find some of them at the sites of semiconductor dealers on the net, but these people specialize in making a profit from obsolete stuff, so the prices tend to be qutite high. I searched for 2N4303's for my prototype. Didn't find a one under $10 apiece. I was offended by the pricing. There was a plastic-case version of the 2N4303 called the PN4303, but they're all vanished too. So if you're building a board and can afford it, you can possibly/probably find three of them.

Unfortunately, that is no guarantee the real thing will work correctly either. JFETs vary a lot, and it's possible the slightly shady surplus semiconductor market is selling mild rejects. No way to tell up front. It's also possible that Thomas preselected JFETs. I decided to see how to make a different JFET work.

There are a few critical parameters to JFETs, different from bipolars. A JFET can never conduct more current than the “Idss” spec, and it will turn completely off at the (Vgsoff) voltage. These have to be at least similar for a JFET to substitute. Also, JFETs come in two major variations: amplifier JFETs and switching JFETs. It's the amplifier JFETs that are getting scarce, and the switching JFETs that are still around, for a while at least.

I had some 2N5485 switching JFETs from a previous project that had compatible Idss and Vgsoff to the 2N4303, at least crudely. I decided to see if I could make them work. To shorten up a long story, I did. It turns out that they pull a lot more DC current in the Vox preamp setup than I liked, and turned on the PNP transistors after the JFET too hard. But there is a resistor across the PNP base-emitter that could be changed to 'eat' some of the excess base current and let the PNP bias properly. I found that if I used 2N5485s and changed resistors R105, R133, and R160 from 1.2K to 680 ohms, the DC conditions became close to the originals, and the gain was what simulation said it should be.

There are other JFETs out there that are still being made, and have roughly similar characteristics to the 2N4303, close enough to work with a tweaking of R105, R133, and R160. I'll dig more of these up as I go. But it is still possible to get JFETs that work. And there are probably still 2N4303s in the world, too. Somewhere.

If you're assembling your own PCB from a bare board and parts, I like to put the parts on by height, lowest parts first. So I would put all the 1/4W resistors and any jumpers/wires on first, then solder. Next any DIP ICs, then low-sitting transistors, then... well, you get the idea. This lets you turn the PCB over for soldering and not have the placed parts fall out.

If you can get 60-40 tin-lead solder use it. Lead free solders are much more difficult to work with, and you won't use enough leaded solder to change the environment, nor are you likely to put this board in a landfill every year or so. It's really OK to do it the easy way this one time only. If you feel conflicted about this, you can ease your conscience by disposing of the old PCB you're replacing as hazardous waste, taking it out of the waste stream in a morally and politically correct fashion, much like buying carbon offsets.

Pots

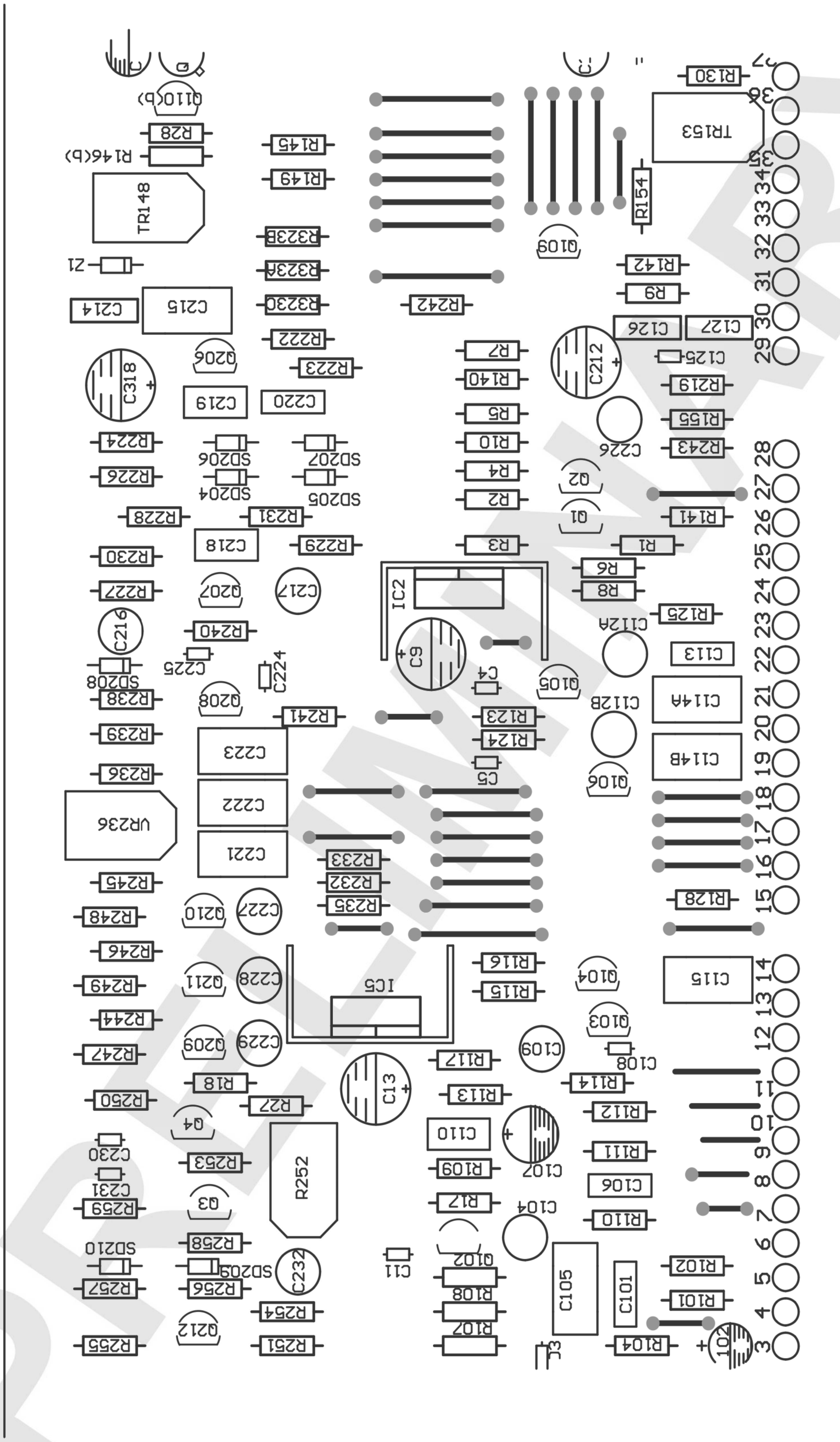
If you find you have to replace the tremolo speed pot, you're in for some issues. It's a 40K/100K reverse log taper. It had to have been custom made for Thomas. You can get reverse log pots sometimes; you can get 100K dual audio/log pots; you can get 50K dual audio/log pots, but you can't buy the exact match off the shelf. Best I've been able to do is to buy one 50K dual and one 100K dual, disassemble them and make two 100K/50K linear pots. If you could buy a 100K 30-section pot, you could just parallel two of the 100K sections into one 50K pot. This still leaves the issue of it not being 40K, and not reverse log taper.

However, extensive simulation shows that a dual 100K pot will make the tremolo oscillate, it just won't go as slow or as fast as the original pot would. You might be able to double up the 0.47 and 0.33 caps and slow it some more if you like very slow tremo. And you might be able to taper a linear pot to do a pretty good fake reverse log taper. But replacing that part is hard to do well.

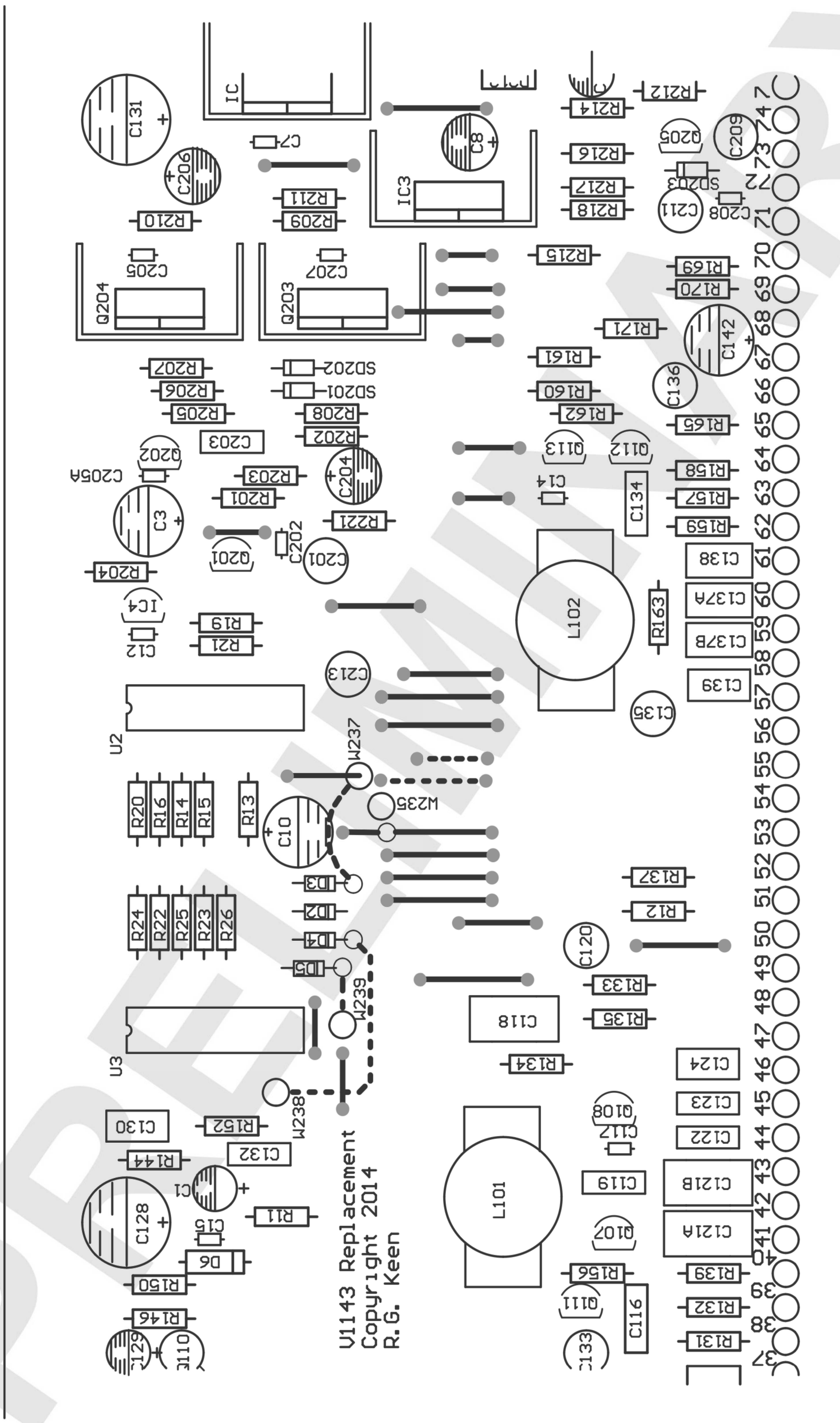
You can (as of August 2014) get 25K reverse audio (C taper) pots for the repeat speed control from Mouser.

For the 500 ohm Tone-X, if you can't find 500 ohm, you can usually find 1K duals and parallel all the lugs. The B3K for the tremolo depth is odd; you can use a B2.5K or parallel a dual B5K to get a B2.5K.

Parts Placement A: Left Half of PCB

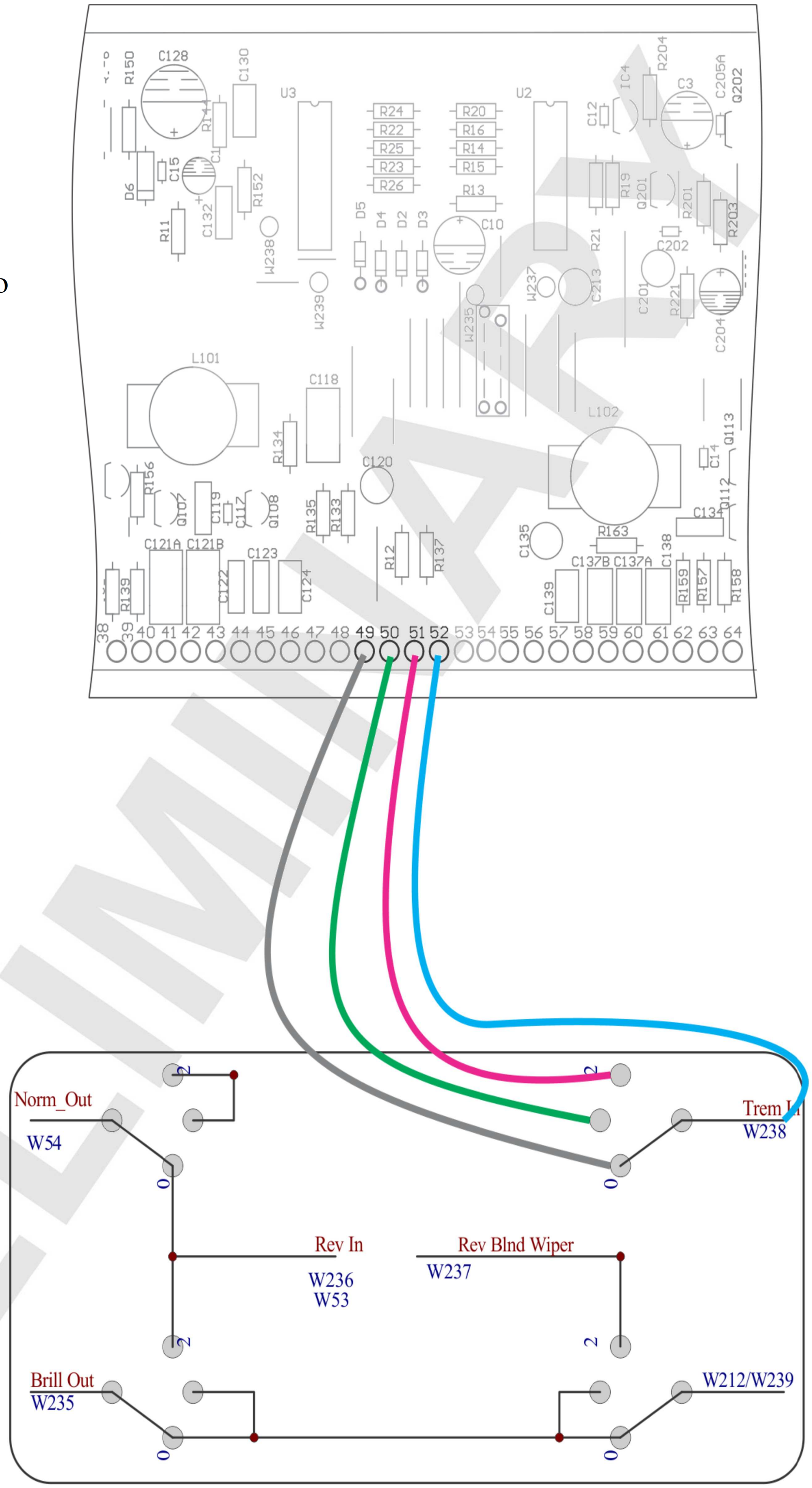


Parts Placement B: Right Half of PCB



Reverb channel switching wiring

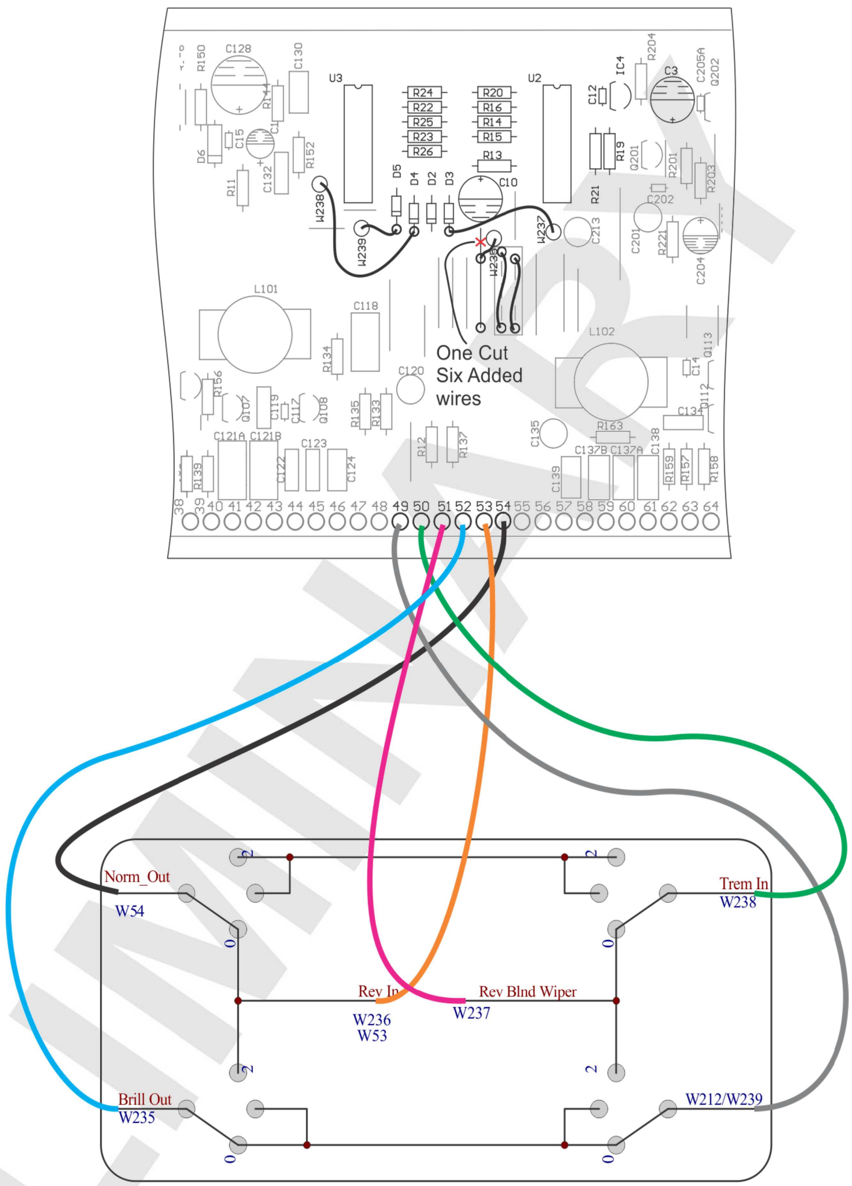
The picture at left shows the wiring for the reverb channel switch as designed onto the replacement PCB. The switching is all done by analog switches U2 and U3 on the PCB, and the panel mounted switch is rewired to only “tell” the switch chips what to to do. This simplifies the off-board wiring a lot, as shown. If the four-pole, three-throw panel switch is broken, you only have to have one of the four identical sections work to enable the PCB. Or you can substitute in a single-pole, three-throw switch for a broken original switch.



New style reverb channel switching wiring

The second picture at right shows how you would use the original switching arrangement, ignoring the onboard switching ICs. To do you, you would cut one trace as shown, and add six wires on the PCB. This connects the signal traces with wiring pads on the PCB so the original switch can be used in the original way.

The wiring is a bit messier, and you open up the possibility of hum and noise creeping in from the signals flying off to the switch and back. It's not a huge problem, but possible. Besides, the on-PCB signal switching lets you use a simpler and easier to find replacement switch if your original switch is broken, as some of them are.



Original reverb channel switching wiring

Adjusting the Limiter

Once the board is installed, the limiter level needs to be adjusted for correct operation with the original Vox power amplifier.

There are two schools of thought about why Thomas put a limiter in the amps. One is an issue of survival: the somewhat archaic circuit design used in the Thomas Vox power amplifiers was not self protecting in the face of overloads and other abuse that a modern amplifier design with internal protection would simply shrug off.

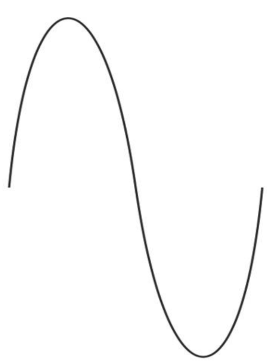
This school of thought contends that the power amplifier must be kept from clipping itself, as this can cause heat damage to the output transistors themselves, as they were not all that great to start with (by today's standards at least), so the way to protect them was to never feed them a signal that would drive them to clipping.

The second school of thought holds that Thomas was remarkably forward thinking in putting in what we would today call “soft clipping” purely for sonic reasons. Whatever the reason, it's there and has to be adjusted for all of them.

You need an oscilloscope to do this right. The Thomas service literature is a little opaque about what you're doing, but the procedure is right. You rig up a scope to look at the speaker outputs, including loading them. I believe this was done at the factory with a resistor load on the speakers, as the Beatles would be producing something like 110-125 db sound pressure level with these kinds of inputs. That's well into the hearing damage range. I recommend you either wear ear plugs and don't do this for long, or use a resistor. The Beatle was once advertised as being possible to hear for five miles.

With the scope showing the waveforms,

1. Turn the input signal down to zero.
2. Turn the limiter to the middle of its range.
3. Turn up the input signal until you see a slight flattening of the peaks.
4. Turn the limiter adjuster pot one way, then the other. One direction causes the peaks to be less limited, the other causes more flattening. Turn the limiter fully in the direction of less limiting.
5. Turn up the input signal until you see a little limiting again. This is the power amp itself limiting, which we do not want.
6. Turn the input signal down a little until the power amp limiting just goes away. The input signal is now undistorted.
7. Now turn the limiter control towards the more-limiting direction until you see the signal once again start lattening the peaks. This is now the limiter flattening the peaks before the power amp itself would start clipping. Stop when you have just a small amount of clipping of the peaks.
8. The limiter is now adjusted per Thomas Organ's intentions.



(Figure 0 for reference)

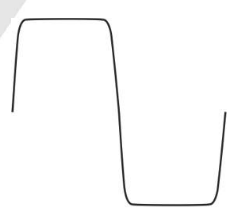


FIGURE 1.

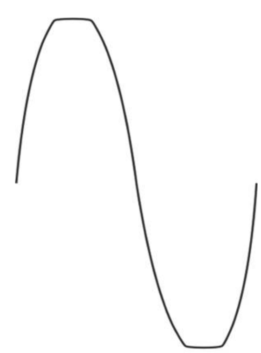
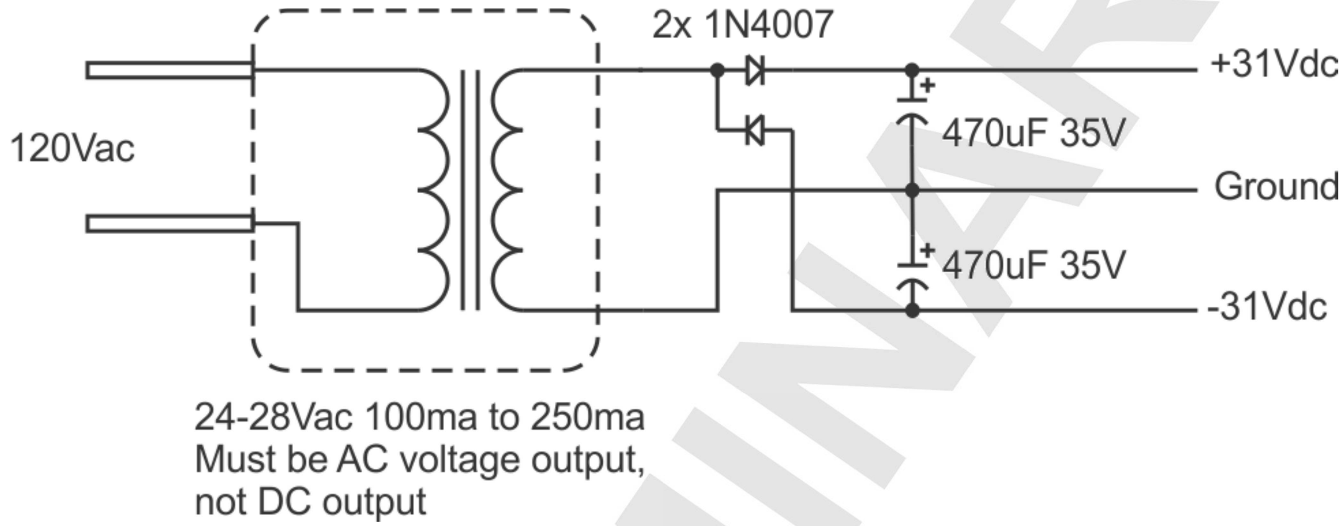


FIGURE 2.

A Test Power Supply

Here's a power supply suitable for powering the PCB for initial testing and setup. It is a minimal power supply for only this purpose, and doesn't have a lot of other uses after setup is over. It's probably only worth while if you already have the parts in your parts boxes.



The diodes can be any of the 1N400x series above 4001: 4002-4007 work OK, as will many others if you want to substitute. I know the 1N4007 works. The 470uF caps can be larger, and don't necessarily have to both be the same value if you have higher capacitance and/or voltage electrolytic caps in your junk box.

The wall transformer MUST be AC output, not a packaged switching power supply. Energy conservation legislation has effectively forced a stop on simple AC output transformers, so you may have to go to some thrift store to find one if you don't already have one.

Factory Setup: "Fair-Use" Scans of a few Thomas Service Pages

On the following pages I have inserted some scans of parts of the Thomas Vox service manual literature that I believe is covered under the "fair use" provisions of USA Copyright law. The scans are the original factory adjustments for the early amplifiers.

They contain the somewhat cryptic procedures for adjustments.

FACTORY SET UP PROCEDURE

These controls are set at the factory and should not be readjusted unless absolutely necessary.

TEST EQUIPMENT REQUIRED: Oscilloscope, AC/DC VTVM, Audio Oscillator.

LIMIT LEVEL CONTROL (R 245)

SET UP

1. Connect the vertical input leads from the oscilloscope, across the audio output with the appropriate load connected.
2. Inject a 1 KC sine wave signal into J 101 or J 102, (input jacks for the Normal channel.)
3. Turn Volume control and both tone controls to their maximum clockwise position, (Normal channel).

PROCEDURE

1. Turn Limit Level control fully clockwise.
2. Increase the audio oscillator output until the sine wave display on the oscilloscope starts to clip. (See Figure 1).
3. Adjust the Limit Level control counter clockwise until the sine wave is normal then reverse the direction of adjustment until the sine wave just starts to flatten out. (See Figure 2). The Limit Level control is now set.

NOTE: The potentiometer is located on the right side of the preamplifier when looking from the rear. (This is on the same side as the power bracket.) It is recessed, and a hole is provided in the chassis for easy access to it.

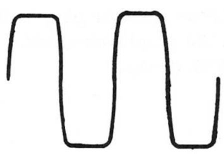


FIGURE 1.

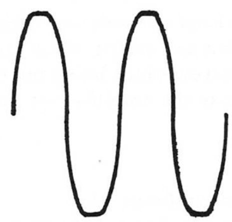


FIGURE 2.

TREMOLO BALANCE CONTROL (MOD. BAL. R 230)

SET UP

1. Connect the input leads of the AC-VTVM to the output jack J 301 of the preamp. (If plug P 301 is disconnected, it will be necessary to connect a cliplead from the preamp chassis to the power amplifier chassis for DC ground return.)
2. Turn volume control and both tone controls to their maximum clockwise position.

PROCEDURE

For this set up there should be no signal input.

1. Set Tremolo Speed control to its maximum clockwise position.
2. Adjust the Tremolo Depth control for maximum output indication on the voltmeter.
3. Adjust the Tremolo Balance control for a minimum output indication on the voltmeter.

This voltage should not exceed:
70 millivolts on the V 114 and V 1141
40 millivolts on the V 113 and V 1131
25 millivolts on the V 112, V 115, V 1121 and V 1151

DRIVER BIAS CONTROL (R 305)
(ON MODELS V 113, V 114, V 1131 & V 1141 ONLY)

SET UP

Connect the input leads of the DC-VTVM across R 307, the emitter resistor of the driver transistor Q 302.

PROCEDURE

Adjust the driver bias control for a reading of +3.5 volts.
NOTE: The potentiometer is located on the left side of the Power Amplifier towards the top, when looking from the rear. It is recessed and a hole is provided in the chassis for easy access to it.

VOX AMPLIFIER DISASSEMBLY INSTRUCTIONS (MODELS V 112, V 113, V 114, V 1121, V 1131 & V 1141)

Removal of the various chassis from the cabinet, for repair or replacement, is the same for all of the above listed models. The reverb delay line, the preamplifier chassis and the power amplifier chassis are all mounted in the (upper) amplifier cabinet.

TOOLS REQUIRED: 1/4" Spintite (Stubby), 1/4" Spintite (Long Shank-10" min.), 11/32" Spintite (Long Shank-10" min.), Phillips Head Screwdriver.

The following procedures should be followed for the removal of these assemblies:

PRELIMINARY

A. Using the Phillips head screwdriver withdraw the four back screws and remove the back. Disconnect the 3 contact plastic speaker plug and socket which connects the external speaker plug to the amplifier output signal leads.
B. Remove the wing screw which holds the clamp securing the amplifier cabinet to the stand, lift the amplifier cabinet from the stand. Lay the amplifier on its face (grille cloth down).

PROCEDURE

A. Removal of the Reverb Delay Line
   1. Disconnect the two phone plugs from the rear of the delay line and push the cables to the sides of the cabinet.
   2. With the stubby 1/4" Spintite, withdraw the two hex head screws which mount the delay line to the cabinet.
   3. Remove the delay line from the cabinet. It may be necessary to lift the delay line slightly before pulling.
B. Removal of the Preamplifier Chassis
   1. Disconnect the phone plug from the left side of the preamp chassis and push the cable to the side of the cabinet.
   2. Insert the 11/32", long shank Spintite into the access holes which are adjacent to the two rear plastic feet. Angle the Spintite approximately 30° forward and push up until it engages the spinloc nut. (The nut is visible from the back of the chassis.) Loosen the nuts on each side of the chassis, but do not remove them at this time.
   3. Remove the 11/32" Spintite and insert the 1/4", long shank Spintite into the same holes. This time angle the tool approximately 30° towards the back. Push up until the hex head screw is engaged. Remove the screws from both sides.
   4. Support the preamp chassis, on the bottom, with one hand to prevent it from dropping and completely remove the two spinloc nuts loosened in Step 2.
   5. Lower the preamp chassis until it has cleared the mounting studs and pull the chassis out.

   NOTE: The preamplifier chassis may be removed from the cabinet without removing the delay line.
C. Removal of the Power Amplifier Chassis
   1. With the Phillips head screwdriver remove the 4 screws, from the bottom of the cabinet which secure the power amplifier.
   2. Pull the power amplifier out.

   NOTE: It will be necessary to remove the preamp chassis and the reverb delay line before the power amplifier can be removed.

When reassembling the chassis, reverse the outlined procedure.