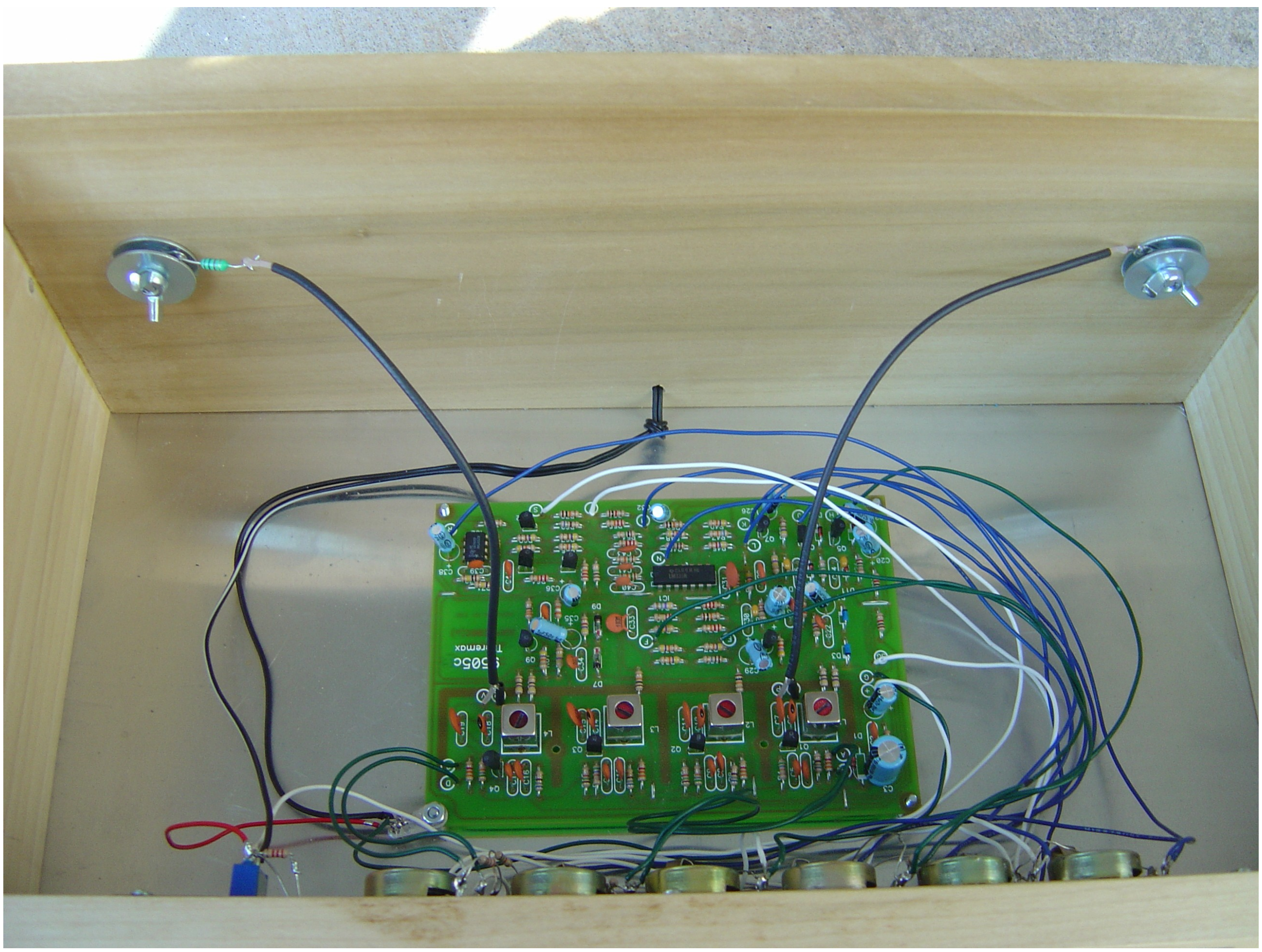
Theremax tips and suggestions:

After checking the wiring against the image contained in this guide, try the alternate tuning method. Using the test lead method, the jumper cable running near parts in the oscillator circuits can alter their frequency--the results obtained can change when the wire has been removed. The same goes for the board to panel wiring. In most instances, the kit would be built and and tuned and the unit operated without them being moved, but if one is laying alongside a capacitor or resistor or a coil slug in the oscillator circuit and further work or other movement of the wiring occurs, it can have a bearing on the tuning. The proximity of the antennae to metal or appliances, test equipment, etc., on the workbench or other area of tuning/use will have a bearing. So if you move the unit, it could need re-tuning. After tuning a few times, you'll develop a feel for getting the tuning slugs set in a good range the panel trim controls which will work as fine adjusts.



This is an image of the Theremax wiring. Arrange the wiring to look like this. If the wiring is already complete, it may be necessary to dis-connect and re-connect wires that are tangled or crossed. The board to panel destination diagram on fig. 4 of the manual illustrations is the way it is to fit the point-point wiring on the page. The wire lengths are specified so they can reach from the panel to the board, in a side ways U path to the right. The pitch and volume trim control wires take a more direct flight down from the panel to the board (the Pitch trim has a bit more slack in this path than needed--make a 1" loop and form them up against the panel to take up the excess). The pitch and volume antenna cables can arc up to their mounts on their own. The ground and plus wires can go along the lower front edge from the board to the switch and lug. The power supply wires should come in the back go along the bottom left side and to the lug and switch and kept away from the board and parts and left side antenna mount. Wires too near the parts in the oscillator circuits or the antenna cable ends, or the antennae can result in the oscillation being off-frequency and/or of decreased amplitude resulting in missing volume (or pitch) CV or other tuning troubles such as the initial tuning changing as wires are moved or a weak, noisy 'pitch tone'.

A quick tuning method (no test lead jumper used):

> Back all four tuning slugs fully out (ccw). Turn L1 and L4 one turn in. Connect the audio output to an amp/speaker and set the Volume control R83 to about 3:00. Set the Velocity to max. Slowly adjust L3 inwards through it's range listening for a faint wheep-wheep as it goes through its audio heterodyne frequencies. Now, as you go back and forth through this point, the Gate/Trigger LED should be lighting indicating the Volume CV is increasing and decreasing and the velocity cv is causing a trigger. For Traditional volume control response, leave L3 set just before the onset of the first audio band encountered with the inward adjustment. This causes a volume CV output and audio output that decreases with inward hand movement. Adjust L2 inwards for the pitch heterodyne tone (the 3:00 R83 Volume setting may be a bit high now as the pitch tone will come through loud and clear in comparison to the volume het).
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> For controller response (opposite of traditional), adjust L3 to null, or, to keep the volume heterodyne at a post-audio frequency (for no faint background volume 'pitch') adjust it further inwards to be just beyond the second volume (volume cv) peak.
>
> Note the front panel Volume Trim control is optimized for controller response, tweaking the volume pair to be at null. For these post audio heterodyne settings, start with it centered and then you'll notice it will work to bring the pair into or out of audio range. Also it won't make very much change in volume in comparison to the way it did in varying the pair about null.
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> The unit can be tuned/tested with the antennae detached. I often work on board and panel assemblies just spread out on a piece of wood or cardboard. It can sometimes make the difference having the antennae or their cables not attached if there is trouble with the proximity of the antenna (or its mount) to a ground or a conductor to the floor. A near short between the shield and the internal wire can adversely load the attached oscillators one or four.
>
> Moving the initial setting of L4 more inwards than the specified 1 turn in can provide more

output if there is something loading it more than usual. The f-v circuits must have a normal strength heterodyne (no adverse loading of either oscillator in the pair) to produce the volume CV which varies the amplitude of 'tone' to the output; whereas, the 'tone' simply must be there--it being weak or not isn't doesn't have the consequences the volume pair does.

9505 troubleshooting tips and suggestions

Using a multitester so DC voltage tests is a quick and easy way to prove whether things are right or not. Otherwise, inspect the soldering on the board and panel for suspect connections; this is the most common cause of trouble. Look for cold solder joints, solder bridges, or breaks in the printed circuit. Sometimes components are at fault, but this is usually just the mechanical parts like jacks and switches.

A cold solder joint can be caused when not enough heat was applied to a joint as it was made. The rosin flux will remain in the joint and insulate the connection. These often look like donuts of solder around the component lead; although it might be solder clumped to the lead, but not flowing to the printed circuit or solder terminal. De-solder and re-solder joints like this, or, just reheat and feed in a bit more solder.

A solder bridge is a link made between two nearby points not connected on the printed circuit. De-solder and re-solder, or, hold the board above and heat the joint from below so the solder runs down onto the tip.

Breaks in the printed circuit can occur from force against wires or components, dull cutters pulling and tearing the printed circuit, sharp cutters scoring a printed circuit in a close cut, or excess heat lifting the printed circuit from the board and it breaking.

The metal in the layer of the jacks can short if they are tightened too tight. Often their terminals have a finish that takes more heat for the solder to flow ('tinning', or pre-soldering them helps -- so does scraping or sanding them).

The I.F. Transformers (oscillator coils) used in the oscillator circuits are fragile little things. The smaller than hair-sized wires inside them can detach from their solder terminals if they splay excessively when they're installed. Too much heat during soldering could melt the

joint between the wire and terminal and open the circuit, or, melt the insulation on the wire and short the windings. Instructions for testing the circuits through these parts follow the dc voltage tests below.

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The 12V wall mount DC supply powers the board via the G and + wires. You can touch the solder lug which has one end of the G wire and the power supply (-) for the DC readings. The 12V going in to wiring point + goes to resistor R1. One side of the resistor should measure about 12V and the other end (the end attached to 8.2V Zener Diode, D1) should measure 8.2V. This voltage is labeled V+ on the schematic and you should find this 8.2V on the components on the board labeled with V+ on the schematic. This voltage is divided in half for 4.1V by the equal valued series resistors at Rs 22 and 23. This voltage is labeled Vr on the schematic and again, you should be sure that components on the board are getting the voltage as specified on the schematic. Since these voltages go to so many parts (ground/common too) they often go through jumper wires to get there. These are likely spots for an open circuit either as a result of the jumper not reaching all the way through to both ends of the printed circuit, or the tiny solder pad and connecting trace in the printed circuit for the jumper wires breaking.

IC2 gets its V+ power supply in on pin 7 (viewed from the top of the board, the pins count up around the part in a ccw direction from the notch). IC1 gets power on pin 3.

The legs of the transistors are other good spots to check for DC levels. Looking at the flat face of the part, with the legs down, they read l-r E for Emitter, B for Base, and C for Collector (on the schematic, the base is the center line "into" the part, the collector is the upward slanting line, and the emitter is the one with the arrow point, slanting downwards).

For transistors Q1-4, you should find about 2V on the emitter, 2-3V on the base, and 7V on the collector. Also, notice on the schematic that the circuits for the four oscillators are just about identical (two have panel controls, Volume Trim and Pitch Trim) while the others have a similar resistive circuit without the adjustment). DC voltage comparisons can be made between similar points in the circuits for oscillators 1 & 4 and oscillators 2 & 3. This might help isolate trouble in this area.

For transistors Q8 and Q9, you should find less than 0.1V on the emitter, about 0.5V on the base, and about 2-5V on the collector. The transistors at Qs 8 and 9 work as amplifiers for the pitch and volume heterodyne (beat) frequencies and an appx. 0.5V p-p audio signal rides on the DC level on the collector circuit of these transistors.

The signal from the collectors of transistors 8 and 9 go to comparator stages which switch on (0V) and off (8.2V) at the frequency of the volume or pitch beat frequencies (there will only be audio beat frequencies when the oscillators are tuned to very near the same frequency (null). A DC reading here (IC1:pin1 for volume, IC1: pin2 for pitch) should be in the range of 1 to 7 volts, but not 0 or 8.2 which would indicate trouble in this area, or more likely missing audio beat frequencies.

The voltage switching at the IC1 pins 1 and 2 goes to a circuit of diodes and a capacitor where its is averaged as Control Voltage and buffered for connection to the output jacks through transistors 5 and 6, for the Pitch and Volume CV outs.

The Pitch CV output could be missing and you'd probably never know, but the Volume CV output has to be there to turn "on" the VCA section comprised of transistors 10, 11 and 12. The Volume CV becomes a current flow into Q12 which allows current to flow through transistors 10 and 11 which allows the Pitch tone to get to IC2 which drives the audio output. IC2's output will measure appx. 4.1V if things are right in the VCA circuit. If you here the pitch tone with the jumper connecting D1 to the volume control, the VCA section is probably OK. Lack of volume control or volume calibration results would point to volume CV trouble; from Q6 back through to oscillator circuits three and four, schematically.

Sometimes, even though the DC readings in the oscillator circuits are right, they may not be oscillating with sufficient strength or in the desired frequency range. An AM radio can be tuned to a quiet spot in the range from 6-10 on the dial to test the operation of any of the four oscillator circuits. Their frequency is adjusted with the slug in Ls 1-4 and when they match the radio tuning you hear the oscillator 'transmitting' to the radio. When operation is confirmed, adjust the oscillator 'off frequency' and try the next.

An open circuit (bad solder or broken printed circuit) in the oscillator transistors emitter resistor (56k, green-blue-orange-gold) to ground can be the cause of trouble where the DC looks OK, but the oscillation isn't. With power off, a resistance test from the transistor (Q1-4) emitter to ground should read about 56kOhms.

Be sure the 1K and 10k pots are in the proper positions on the front panel. 10ks at the 1k positions can cause borderline (if at all) operation of the oscillators associated with these panel Trim controls.

Be sure there isn't any DC voltage on the 47ohm resistors that connect oscillator one to the pitch heterodyne modulating diodes. There is a spot that it is easy to get a solder bridge between the unbanded end of D4 and the jumper wire for the 4.1V Vr circuit.

The IF transformers rank right up there with shielded cable and the power switch as being things that are particularly heat sensitive (the manual only mentions being careful with the diodes, transistors, and ICs, but they're really more tolerant than these 'plastic' parts. The pins on these transformers don't like being splayed too much during installation either. The wire used for the coil windings can detach with heat from soldering or movement of the terminal from bending too much in installation. A multitester with a digital readout will indicate the resistance of the L1-4 (I.F. Transformer/oscillator coil) windings confirming there aren't open circuits in them.

Look on the bottom of the board for the five terminals of these parts and notice that pin 1 has a connection with the 680ohm (blue-grey-brown-gold) resistor to V+. Count from there around the part in a cw direction for pins 2-5. Here are the resistances of the wire comprising the windings and between these terminals (the side with three terminals has a tap towards one end of the winding):

From one to two, about 0.5 ohms;
from 2 to three, 4.1 to 4.2 ohms;
one to three 4.1 to 4.2 ohms; and,
from four to five, 0.5 to 0.6 ohms.

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Waveshape and vol-ctrl-response mods.

The first Theremax assembly manuals instructed calibration for "controller" mode (hand to volume antenna for volume increase) while now it is for "traditional" mode (hand to volume antenna for volume decrease). As a controller, it seems more natural to move your hand towards the antenna for increasing volume CV and Gate/S-Trigger activation, but theremin enthusiasts recognize this as opposite the way the original instruments operated.

When calibrated in the "controller" mode, the volume pair is at null and hand motion about the volume antenna results in a sweep through audio frequency heterodyne signals just like the Pitch side of the circuit. This energy manages to find it's way into the audio output just above the noise floor or enough that it is noticeable. We have the sine wave getting to the VCA section fairly hot and the high frequency response in this section and the following op-amp output section fairly low to help mask the bleed of the audio frequency volume het. This results in distortion of the intended Timbre waveforms (sine at ccw and square at cw).

Now, the calibration procedure is for "traditional" control response. The volume het. sits at the edge of audio frequency and increases with inward hand motion - the volume bleed isn't an issue. Here are some changes that get the sine and square back like they should be: Put an "attenuating" resistor (1k to 10k (6800 is often "right")) from lugs 3 to 2 on the Timbre control to bring the sine out of overdrive which sounds harsh or more square-like. Select the resistor by listening to the sound with the Timbre ccw while touching resistors to lugs 3 and 2 and listening for the highest value that will cause a smooth tone (most noticeable with the following changes). Replace the capacitors at Cs 39 and 44 with 100pF to increase the high frequency response. This returns the "edge" to the square wave.

The audio bands each side of the volume null are what makes the two volume peaks that you encounter with inward adjustment of L3. The f-v circuit which makes the volume CV, has a frequency response which causes the CV to fall as the het. increases above audio and C37's value affects this response. Sub'ing a 100pF for the 33pF here improves the volume cut with inward hand motion. If you find you have to go to close to the antenna for much change in volume, put the bigger capacitor at C37.

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