HissWhacker

Model 9304
Assembly and Using Manual

Downward expanders, like the HissWhacker, are useful for single-ended noise reduction in both live sound and recording situations. Unlike encode/decode systems used exclusively in recording, single-ended systems like the Hiss-Whacker require no decoding equipment when the sound is reproduced.

In principle, the HissWhacker is similar to a noise-gate. As long as signal level is above a settable THRESHOLD, the unit is transparent and has no effect. When signal level falls to the point that it can no longer mask noise which may be accompanying it the downward expander acts to quiet the channel. Unlike a Noise Gate, the Hiss-Whacker doesn't suddenly turn off when the signal falls below the threshold (which can produce audible artifacts from switching the noise off suddenly) but rather smoothly reduces its gain proportional to the decrease in signal level.

ASSEMBLING THE HissWhacker

Before beginning assembly, go through the manual. Look at the drawings. Feel the parts. You're naturally eager to plunge right in, but take a few deep breaths first.

Notice that each step in the manual is marked with a checkoff box like this:

DESIGNATION	VALUE	COLOR CODE
( ) R27	100 ohm	brown-black-brown

Checking off each step as you do it may seem silly and ritualistic, but it greatly decreases the chance of omitting a step and also provides some gratification and reward as each step is completed.

Numbered figures are printed in the Illustrations Supplement in the center of this manual. These pages may be removed for easy reference during assembly.

THE CIRCUIT BOARD

The HissWhacker is built on a single-sided circuit board. Before beginning assembly, clean oxidation from the copper side of the circuit board using scouring cleanser and water. The copper should be bright and shiny before beginning assembly.

Once you begin putting parts on the circuit board, it's a good idea to continue until all the parts are mounted. Stopping overnight may allow the copper to oxidize and make soldering more difficult.

TOOLS

You'll need a minimum of tools to assemble the kit - a small pair of diagonal wire cutters and pliers, screwdriver, sharp knife, ruler, soldering iron and solder.

Modern electronic components are small (in case you hadn't noticed) and values marked on the part are often difficult to see. Another handy tool for your bench will be a good magnifying glass. Also

use the magnifier to examine each solder joint as it is made to make sure that it doesn't have any of the problems described in the SOLDERING section which follows.

SOLDERING

Select a soldering iron with a small tip and a power rating not more than 35 watts. Soldering guns are completely unacceptable for assembling solid state equipment because the large magnetic field they generate can damage components.

Use only rosin core solder (acid core solder is for plumbing, not electronics work). A proper solder joint has just enough solder to cover the soldering pad and about 1/16-inch of lead passing through it. There are two improper connections to beware of: Using too little solder will sometimes result in a connection which appears to be soldered when actually there is a layer of flux insulating the component lead from the solder bead. This situation can be cured by reheating the joint and applying more solder. If too much solder is used on a joint there is the danger that a conducting bridge of excess solder will flow between adjacent circuit board conductors forming a short circuit. Accidental bridges can be cleaned off by holding the board upside down and flowing the excess solder off onto a clean, hot soldering iron.

Use care when mounting all components. Never force a component into place.

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This product originated as a Do-It-Yourself article by Jules Ryckebusch *in the October 1993 issue of* Electronic Muscian *magazine. There may be differences between what appeared in the article and what is supplied with the kit. These differences, and any discussion of them, will be set aside with this italicized type. In some cases, notes packed with the parts will be used to call your attention to special situations.*

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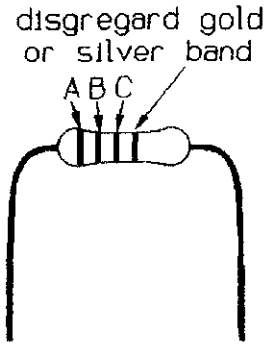
RESISTORS

Solder each resistor in place following the parts placement designators printed on the circuit board and the assembly drawing Fig 1. Note that resistors are nonpolarized and may be mounted with either lead in either of the holes provided. Before mounting each resistor, bend its leads so that they are at a right angle to the body of the part. Put the leads through the holes and then push the resistor firmly into place. Cinch the resistor in place by bending the leads on the solder side of the board out to an angle of about 45 degrees. Solder both ends of each resistor in place as you install it. Clip each lead flush with the solder joint as the joint is made. Save the clippings, we'll use them later as jumpers.



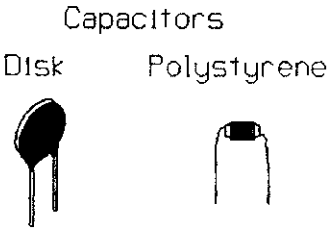
DESIGNATION	VALUE	COLOR CODE A-B-C
( ) R2	100k	brown-black-yellow
( ) R3	3.3 ohms	orange-orange-gold
( ) R4	10k	brown-black-orange
( ) R7	5600 ohms	green-blue-red
( ) R11	5600 ohms	green-blue-red
( ) R20	1.5m	brown-green-green
( ) R32	150k	brown-green-yellow
( ) R36	10k	brown-black-orange
( ) R37	100k	brown-black-yellow
( ) R38	3.3 ohms	orange-orange-gold
( ) R40	1.5m	brown-green-green

listed below:	39k	orange-white-orange	
( ) R1	( ) R6	( ) R34	( ) R39
listed below:	47 ohm	yellow-violet-black	
( ) R5	( ) R8	( ) R33	( ) R41
listed below:	47k	yellow-violet-orange	
( ) R9	( ) R15	( ) R27	( ) R30

listed below:	1000 ohms	brown-black-red	
( ) R10	( ) R26	( ) R31	( ) R35
listed below:	2700 ohms	red-violet-red	
( ) R12	( ) R16	( ) R18	( ) R28
listed below:	200 ohm	red-black-brown	
( ) R17	( ) R21	( ) R24	( ) R25
listed below:	330k	orange-orange-yellow	
( ) R19	( ) R22	( ) R23	( ) R29

POLYSTYRENE AND CERAMIC DISK CAPACITORS

Some of the capacitors used in the HissWhacker are nonpolarized Ceramic Disk and Polystyrene types. For all of these, either lead can go in either of the holes in the circuit board. The leads of the Ceramic Disk capacitors are already parallel to each other but still may need to be bent slightly to match the spacing of the circuit board holes. The leads of the Polystyrene capacitors will need to bend down prior to installation and may be further apart than the spacing of the circuit board holes. Like the resistors, insert the leads of these parts through the holes in the board and push the part against the circuit board as far as it wants to go. Don't force it, it's OK if it sits a little off the board.



Capacitors are often marked with obscure codes that indicate their values. The three digit number that specifies value may be preceded or followed by letters indicating such things as tolerance. There is little danger of confusion since all of the Polystyrene capacitors are 2200 pF., five of the disks are .01uF and two are 100pF.

Polystyrene Capacitors

DESIGNATION	VALUE	MARKING
( ) C3	2200 pF.	2200
( ) C5	2200 pF.	2200

Polystyrene Capacitors

Ceramic Disks

DESIGNATION	VALUE	MARKING
listed below:	.01uF	103

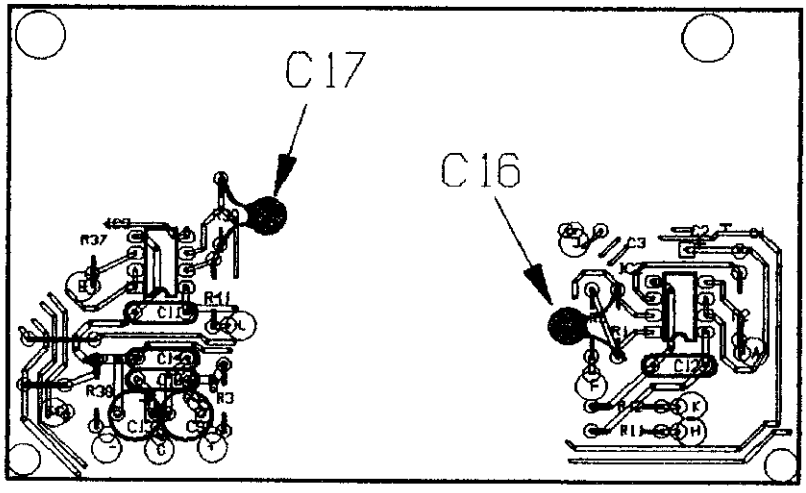
( ) C10 ( ) C11 ( ) C12 ( ) C14
( ) C15

Disk Capacitors

The final two ceramic disk capacitors mount on the trace side of the board rather than the normal component side. Begin by trimming the leads of these capacitors to a length of 1/4" and tinning the leads so that a SMALL drop of solder is left on the end.

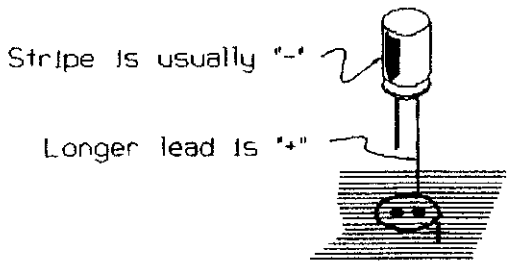
( ) Install the 100 pF ceramic disk capacitor C16 on the component side of the circuit board by soldering its leads to the two pads associated with R1 (R1 is on the component side). Hold the tinned lead of the capacitor against the previously soldered pad and heat with your soldering iron to remelt each connection. Bend the capacitor leads so they do not short against circuit traces.

( ) Similarly, mount the 100 pF capacitor C17 by soldering its leads to the pads associated with R39.



These capacitors roll off the high frequency response of the OpAmps to suppress possible very high frequency oscillation from the SSM2120 which, while not audible, could negatively affect down-strteam equipment.

ELECTROLYTIC CAPACITORS



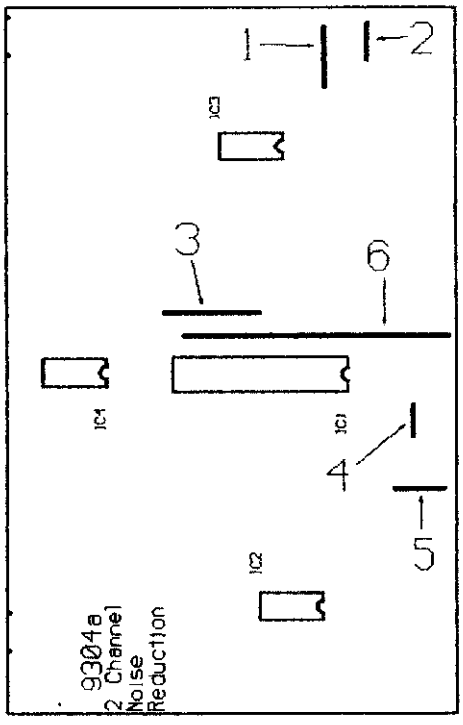
The remaining capacitors are electrolytic types. Unlike the previous components, electrolytic capacitors are polarized and the leads are not interchangeable. Leads are marked "+" and/or "-" and the "+" lead must go through the "+" hole in the circuit board. Frequently the positive lead of the capacitor is significantly longer than the negative lead.
Usually the Negative lead of the capacitor is marked rather than the positive. It naturally goes through the hole not marked "+".

Capacitors supplied with specific kits may have a higher Voltage (V) rating than the minimum specified below.

DESIGNATION	VALUE
listed below:	10uF / 6V

( ) C1 ( ) C2 ( ) C6 ( ) C7

( ) C4	4.7uF / 6V
( ) C8	4.7uF / 6V
( ) C9	100uF / 16V
( ) C13	100 uF / 16V

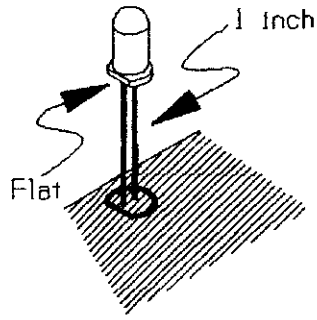


JUMPERS

( ) Using excess leads clipped from the capacitors and resistors, form and install the first five of the six circuit board jumpers which are designated by bold lines. Be careful that the jumpers do not touch nearby component leads.

( ) For the longest jumper, cut a 2-1/4" length of the stranded, insulated wire provided and strip 1/4" of insulation from each end. Twist the exposed wire strands together and "tin" them by melting a small amount of solder into the strands. This prevents fraying of the wire strands when they are pushed through the holes. Solder both ends of the jumper and clip off any excess flush with the solder joint.

LEDs



Note that the LEDs are polarized by the flat in the collar at the base of part. When properly installed, this flat will align with the corresponding flat in the LED symbol printed on the circuit board.

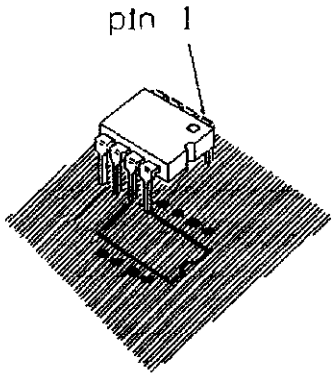
Push the two leads through the holes provided in the circuit board and space the LED above the board by about 1". Solder both leads and check the spacing from the board to the LED before trimming the leads off flush with the solder joint.

DESIGNATION TYPE

( ) D1 bi-color LED
( ) D2 bi-color LED

INTEGRATED CIRCUITS

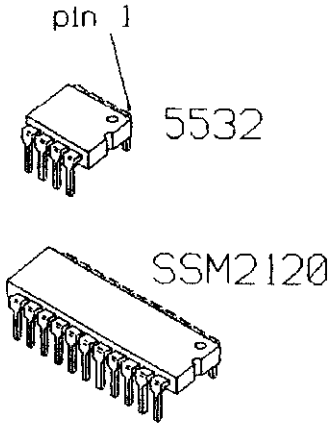
Of all the parts, the ICs are the most easily damaged and should be treated with some respect. In particular, they may be destroyed by discharges of static electricity. Modern ICs are not nearly as sensitive to this kind of damage as were earlier versions, but it is still good practice to handle these parts as little as possible. Also good practice: don't wear nylon during assembly. Don't shuffle around on the carpet immediately before assembly (or if you do, touch a lamp or something to make sure you're discharged). Don't be intimidated. It's rare for parts to be damaged this way.



ICs are polarized in one or both of two ways; A dot formed into the case of the IC corresponding to pin 1 or a semicircular notch that indicates the end of the package with pin 1. Take care that this polarizing indicator corresponds to the similar indicator on the circuit board graphics.

The pins of the ICs may be splayed somewhat and not match up exactly with the holes in the circuit board. Carefully re-form the leads if necessary so that they are at right angles to the part.

Solder each IC in place as it is installed by initially soldering two pins in diagonal corners of the pattern. Make sure that the part is seated firmly against the pc board by pressing it down while remelting the solder joint at first one corner, then the other. Finally, solder the remaining connections.



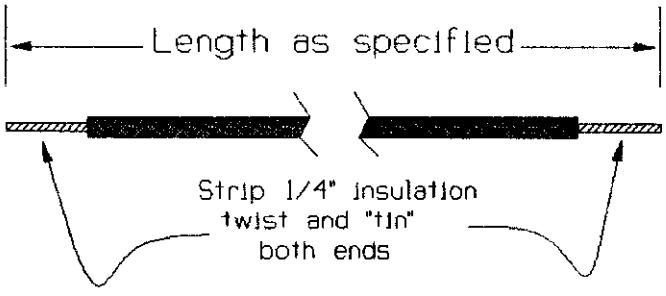
DESIGNATOR	PART NO.	DESCRIPTION
( ) IC1	SSM2120	Dynamic Range Processor
( ) IC2	5532	Dual Low Noise OpAmp
( ) IC3	5532	Dual Low Noise OpAmp
( ) IC4	5532	Dual Low Noise OpAmp

"FLYING" WIRES
(i.e. those which go from circuit board to panel mounted parts.)

In the following steps, wires will be soldered to the HissWhacker board which in later steps will be connected to the front panel controls and phone jacks. At each step, cut a wire to the specified length, strip 1/4" of insulation from each end and twist and tin the exposed wire strands.Solder each connection as it is made and clip any excess wire from the solder side of the board.

Notice that the "+", "G" and "-" circuit board pads will not have wires connected to them until later.

PC POINT	WIRE LENGTH
( ) "A"	3-1/2"
( ) "B"	3-1/2"
( ) "C"	2-1/4"
( ) "D"	2-3/4"
( ) "E"	3"
( ) "F"	2-1/2"
( ) "H"	5"
( ) "J"	4-1/4"
( ) "K"	4-1/2"
( ) "SG"	5-1/2"



We will now put the circuit board aside and begin putting parts on the front panel. This is a good time to kick back and admire your work to this point. Be critical - are the solder joints nice and shiny? Are there any blobs of solder on the board that could use cleaning up (see SOLDERING on page 3)? Are the polarized components mounted properly?

PANEL CONTROLS

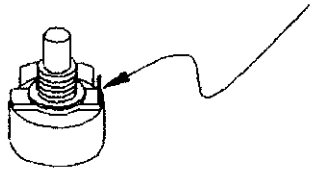
If you have the optional panel available from PAiA, you will be installing these parts as shown in Fig 2. Note that this figure shows the panel from the rear.

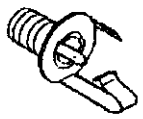
The PAiA panel is designed to mount two complete HissWhacker circuit boards. In Fig 2 the parts associated with the first board are shown bold with large component designators and the second board is shown using phantom lines and smaller designators. Since wire lengths and assembly sequences will be the same for both boards if two are being installed, the details will be provided only once.

( ) Using the flat washers and nuts provided, mount the two potentiometers R13 and R14 as shown in Fig 2. Orient the lugs of the pots as shown in Fig 3 and fully tighten the nuts to secure these parts.

( ) Using the flat washers and nuts provided with them, mount the 4 Open Circuit jacks J1 - J4 as shown in Fig 2. Orient as shown in Fig 3 and tighten the hardware.

Bend or remove this tab so that the pot will seat flush against the front panel.



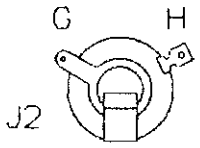


PANEL PRE-WIRING

Stranded wire is used for the connections between front panel jacks and controls as shown in Fig 3. At each step prepare a wire of the length specified by stripping 1/4" of insulation from the end and twisting and tinning the exposed strands.

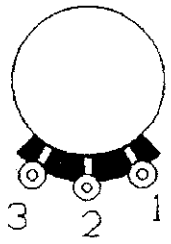
Individual solder lugs are identified by part number and lug number. For example, J2-G means the lug labeled "G" of the Phone Jack J2 as shown in the illustrations.

This convention will be followed in these steps: Do not solder a connection to a lug until told to do so with an instruction such as (S-2), which means that at that point there will be two wires on the lug in question. If there is not the number of wires specified at the lug when you get ready to solder, recheck to see what has gone wrong. Connections which should not be soldered yet will be marked (NS) for No Solder. On these unsoldered connections simply push the end of the wire through the lug and crimp it back to mechanically secure it.



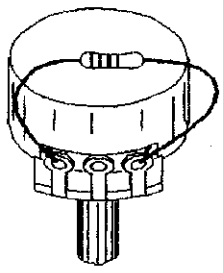
LENGTH	FROM	TO
( ) 1-3/4"	J2-G (S-1)	J1-G (NS)
( ) 3-1/2"	J1-G (S-2)	J4-G (NS)
( ) 1-3/4"	J4-G (S-2)	J3-G (NS)

Two 3300 ohm resistors (orange-orange-red) mount directly on the lugs of the pots as shown in the illustration.



( ) Cut both leads of the 3300 ohm resistor R43 to a length of 3/4" and connect this resistor between lug #1 and lug #3 of the potentiometer R13. DO NOT SOLDER these connections yet.

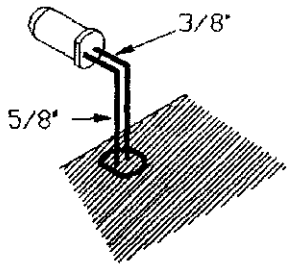
( ) Similarly, trim the leads of the 3300 ohm resistor R42 and connect it between lug #1 and Lug #3 of the potentiometer R14. Do Not Solder.



Resistors R42 and R43 were not part of the Electronic Musician article. They have been added to improve the range of the THRESHOLD control and desensitise the circuit to tolerance variations in the potentiometers.

The circuit board should now be mounted to the rear of the front panel as shown in Fig 2.

( ) Using the (2) "L" brackets, (2) #4 nuts and (4) 4-40 X 1/4" machine screws provided, attach the partially wired circuit board to the rear of the rack panel. Notice that the "L" brackets have both threaded and unthreaded holes. Use the unthreaded holes and machine nuts to attach the bracket to the circuit board and the threaded holes to attach the bracket to the panel. Bend the LEDs as shown so they engage the holes provided for them in the front panel.



Wiring of the HissWhacker continues by connecting the wires previously soldered to the circuit board to the pots and jacks as detailed in Fig 3.

FROM PC PAD	TO
( ) "A"	J1-H (S-1)
( ) "B"	R14-3 (S-2)
( ) "C"	R14-2 (S-1)
( ) "D"	R14-1 (S-2)
( ) "E"	J3-H (S-1)
( ) "F"	J2-H (S-1)
( ) "H"	R13-3 (S-2)
( ) "J"	R13-2 (S-1)
( ) "K"	R13-1 (S-2)
( ) "L"	J4-H (S-1)
( ) "SG"	J3-G (S-2)

( ) Install the knob. Rotate the shaft of the control on which the knob will be placed fully CCW and align the knob pointer with the marking at the extreme counterclockwise end of the dial. Push the knob on only slightly and rotate it back and forth to see how well it's range of rotation is balance with the panel graphic. Reorient if not satisfied and then push the knob firmly in place on the shaft.

THIS COMPLETES THE ELECTRONIC ASSEMBLY OF THE HissWhacker. Before hooking up a power supply and testing the unit, take a break then come back and check your work completely. Make sure that all polarized parts are mounted properly, that the leads from the front panel controls and jacks are correct and take a good look at all your soldering.

POWER HOOK-UP

When you've checked your work thoroughly and feel confident that there are no errors in the wiring or solder bridges on the board, it's time to apply power for the first time. If you have assembled two or more HissWhacker circuit boards, the best strategy is to apply power and test them individually.

The HissWhacker requires a bi-polar power supply with a voltage rating of +/-12v. each side of this supply should be able to provide at least 45 mA. of current. If you have elected to use the PAiA BPS-12, you can power several HissWhacker boards with no problems. The BPS-12 should be assembled following the instructions supplied with it.

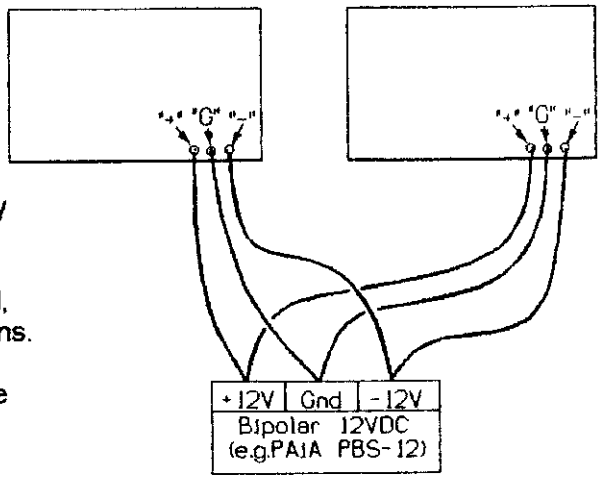
Most power supply transformers (such as that used in the BPS-12) will be well designed with a shield to contain the magnetic field they generate. But it is still a good idea to mount the power supply some distance from the HissWhacker so as to eliminate completely the possibility of hum pickup. A distance of about 12 inches between the transformer and the closest point on the circuit board should be sufficient. More is better, up to a point.

Power supply connections are made to the Hiss-Whacker at the circuit board points labeled "+" (+12V), "G" (ground) and "-" (-12V). Wire lengths for these connections are not given since exact lengths will depend on the specifics of where and how the power supply and circuit boards are mounted. Two feet of #22 stranded wire has been

provided for these connections. If you need to make them longer, use this same kind of wire.

If you are powering multiple devices from a single power supply, they should simply be wired in parallel; that is, the +12V input on each unit will connect to the +12V output of the power supply, the -12V input to the supply's -12V output and ground to the supply ground.

While power to these units is wired in parallel, you should avoid "chaining" these connections. In other words, don't make the power supply connections to one board and then power the next board by taking power from the first. Instead, run separate wires to each unit from the powersupply.



Do not chain power between multiple circuit boards. Instead, run separate wires from each board to the power supply as shown here.

CAREFULLY CHECK THE POWER CONNECTIONS BEFORE ACTUALLY TURNING THE POWER ON. Backwards connections here can be disastrous. When you are confident that everything is OK, rotate the THRESHOLD control knobs fully CounterClockWise, turn on the power and observe the LEDs, which should light green. If the LEDs do not light, immediately disconnect the power. The problem could be nothing more than a dead wall outlet. Improperly placed components, bad joints or solder bridges on the circuit board may be the cause. Check the orientation of the Integrated Circuits.

With power on and the LEDs lit, place your finger on the SSM2120 (IC1) to monitor its temperature. If it gets hot rapidly, immediately disconnect the power and find out why (assuming that the power connections are correct, a solder bridge is the most likely problem). Also finger-check the three 5532 op-amps for high temperature. These parts may get warm over time, but never so hot that they are uncomfortable to touch.

When the LEDs have lit green and the unit has idled for a few minutes without going up in smoke, continue testing by rotating the THRESHOLD knobs

slowly ClockWise. At some point in the rotation of this control the associated LED should turn red. If this doesn't happen (or doesn't happen until the knob has been turned more than half of its full rotation) try shorting the associated input either with a clip lead from the "H" to "G" lugs on the jack or by inserting a shorted phone plug. If the LED now responds properly it is an indication that there was some noise on the input, most likely from ambient sources like your bench-top.

As a final test, apply a low level signal (50 mV or so) to one of the HissWhacker inputs and listen to the corresponding output. When the THRESHOLD control associated with the output is fully CCW, the output of the HissWhacker should be approximately the same level as the input. As the THRESHOLD control is rotated CW, a point will be reached where the LED changes from green to red and at about this same point you should hear the level of the output signal decrease significantly as the Downward Expander begins to work. Increase the level of the input signal and observe that the LED changes back to green and the output level increases suddenly as the THRESHOLD set by the control is exceeded. Try the same test with the second channel.

USING THE HissWhacker

The HissWhacker is designed to be used with line level signals and should be placed after the preamplifiers for low level sources such as guitar and microphones. Maximum Threshold level is on the order of -6 dBV (about 0.5 volts) at the extreme ClockWise end of the THRESHOLD control's rotation.

While the LEDs are a useful indication of what's going on in the circuit, they are not precision instruments and your ears are. If your ears tell you the unit is working but the led doesn't, believe your ears.

For live sound, you can use a downward expander on stage microphones. When no one is singing or playing, the expander automatically reduces the signal level to the P.A., which is just background noise anyway. This reduces P.A. hiss and lets you run louder monitor levels without risking feedback.

In the studio, a downward expander can be used as a single-ended noise reducer; that is, a device to remove noise from an audio source without requiring a decoder during playback. Let's say you want to record a snare drum on its own tape track. During recording, the snare mic also picks up the rest of the drum kit. However, if you use a downward expander during recording or mixdown, the threshold can be adjusted to let the snare through, while reducing the level of the extraneous sounds.

NOTES

DESIGN ANALYSIS

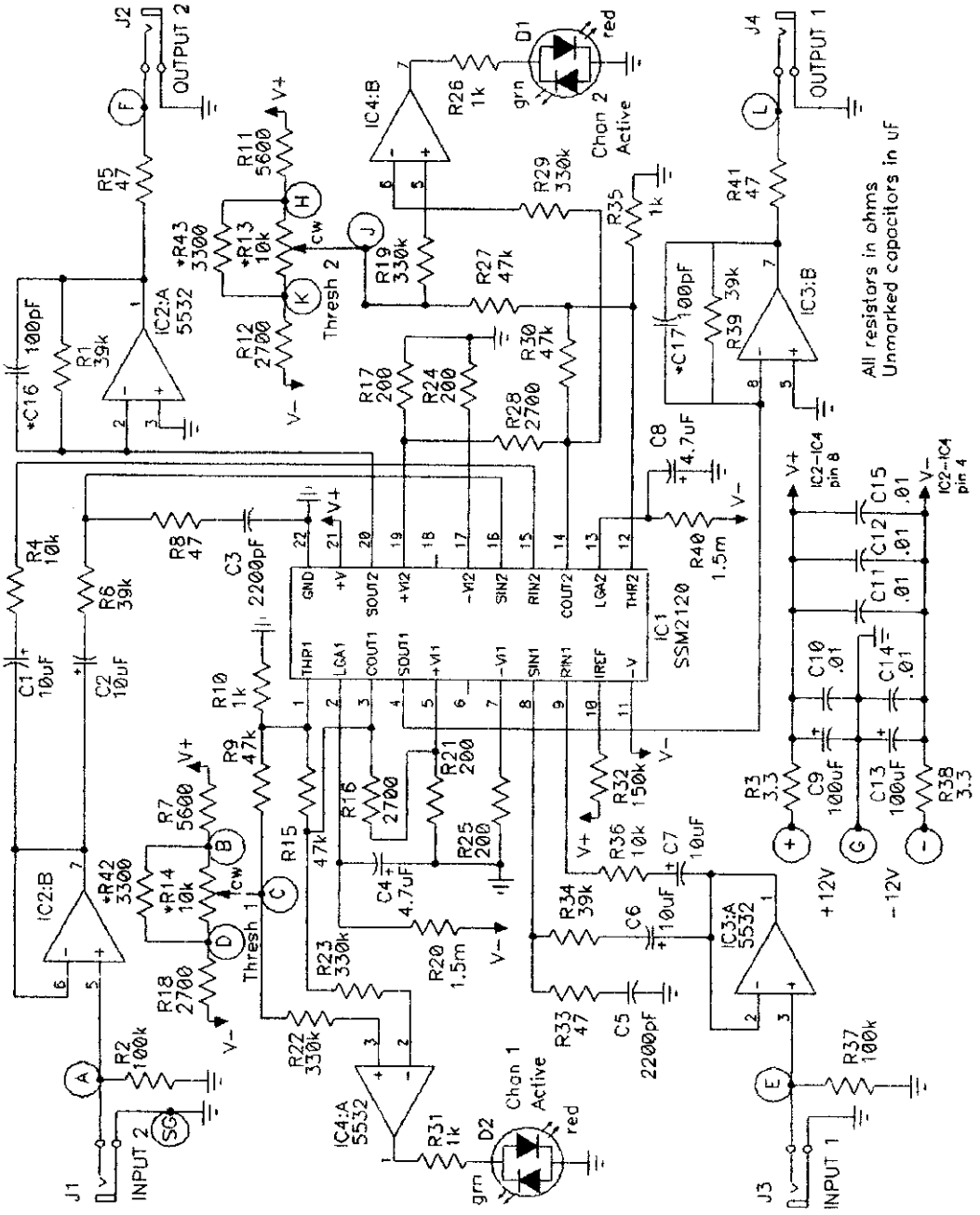
The heart of the HissWhacker is IC1, an SSM2120 Dual Dynamic Range Processor. This Integrated Circuit features two independent channels, a dynamic range of 100 dB, a THD of 0.01%, and a flat frequency response. The rest of the circuitry buffers the incoming audio, determines the threshold for expansion, sets the expansion ratio and attack/release times, and recovers the audio signal.

Each of the two input buffers consists of one-half of a 5532 dual operation amplifier (IC2:B, IC3:A). These are noninverting buffers. The signal then splits. One copy goes to the internal VCA of the SSM2120, which controls the output level. The other copy of the signal goes to a precision level-detector and log-converter, which are conveniently contained within the SSM2120. The output of the level detector is compared to the threshold setting determined by potentiometers R13 and R14.

The internal VCA has nominal unity gain; it normally passes the input signal straight through, unchanged. When the input level falls below the threshold, a negative control voltage is developed. This negative voltage is applied to the +VI1 or +VI2 pin of the SSM2120, reducing the gain of the appropriate VCA. Maximum gain reduction is about 40 dB. The expansion ratio and attack/release times are optimized for single- ended noise reduction. (The expansion ratio for the two channels is controlled by R15/R16 and R28/R30; attack/release time is controlled by C4/R20 and C8/R40.)

The output of the VCA (SOUT1, SOUT2), which is actually a current based signal, is sent to another op-amp (IC3:B, IC2:A). This is configured as a current-to-voltage converter that converts the output current of the VCA back to a voltage.

The threshold and control voltages from the level detector for each channel are sent to IC4 via 330k ohm resistors (R22, R23, R19, R29). This is a comparator circuit that visually indicates when downward expansion occurs. It drives a bi-color LED, which changes from green to red during expansion.


All resistors in ohms
Unmarked capacitors in uF
INPUT 2
INPUT 1
OUTPUT 2
OUTPUT 1
Thresh 1
Thresh 2
Chan 1 Active
Chan 2 Active
SSM2120
IC2:B
IC2:A 5532
IC4:B
IC3:B
IC4:A 5532
IC3:A 5532
+12V
-12V
V+
V-

Hiss-Whacker

Packing list

3	5532 Dual Low Noise OpAmp
1	SSM2120 Dual Dynamic Range Processor
2	Bi-color (red/green) LED
5	.01uF Ceramic Disk Capacitor
2	100pF Ceramic Disk Capacitor
2	2200pF Polystyrene Capacitor
2	100uF / 16V Electrolytic Capacitor
4	10uF / 16V " "
2	4.7uF / 16V " "
2	10k Panel Mount Potentiometer
2	1.5m all fixed resistor are
2	100k 1/4W 5% film types
2	10k
1	150k
4	1000 ohms
4	200 ohms
4	2700 ohms
4	330k
4	39k
4	47 ohms
4	47k
2	3.3 ohms
2	3300 ohms
2	5600 ohms
4	1/4" O.C. Phone Jacks
5	24" lengths #22 Stranded Wire
2	"L" Brackets
4	4-40 X 1/4" Machine Screws
2	#4 Machine Nuts
2	Push On Knobs
1	9304 Printed Circuit Board

PAiA Electronics, Inc.
phn (405) 340-6300

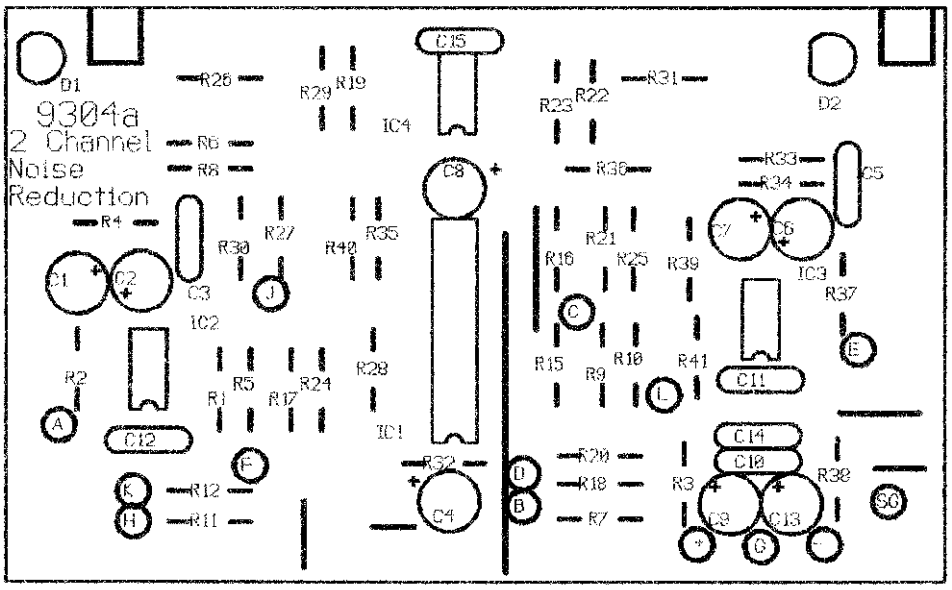


Fig 1a. Components mount on the circit board as shown in this parts placement diagram.

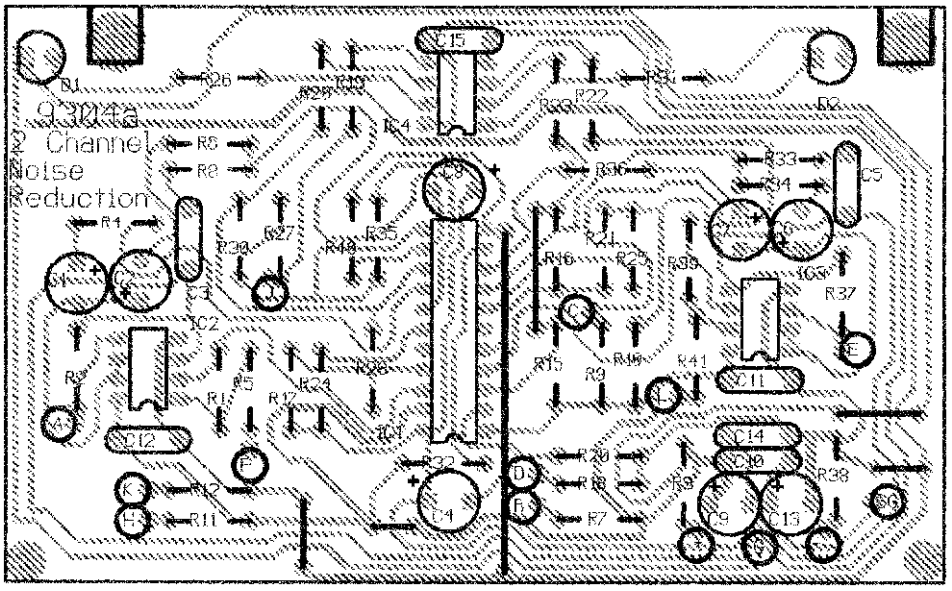
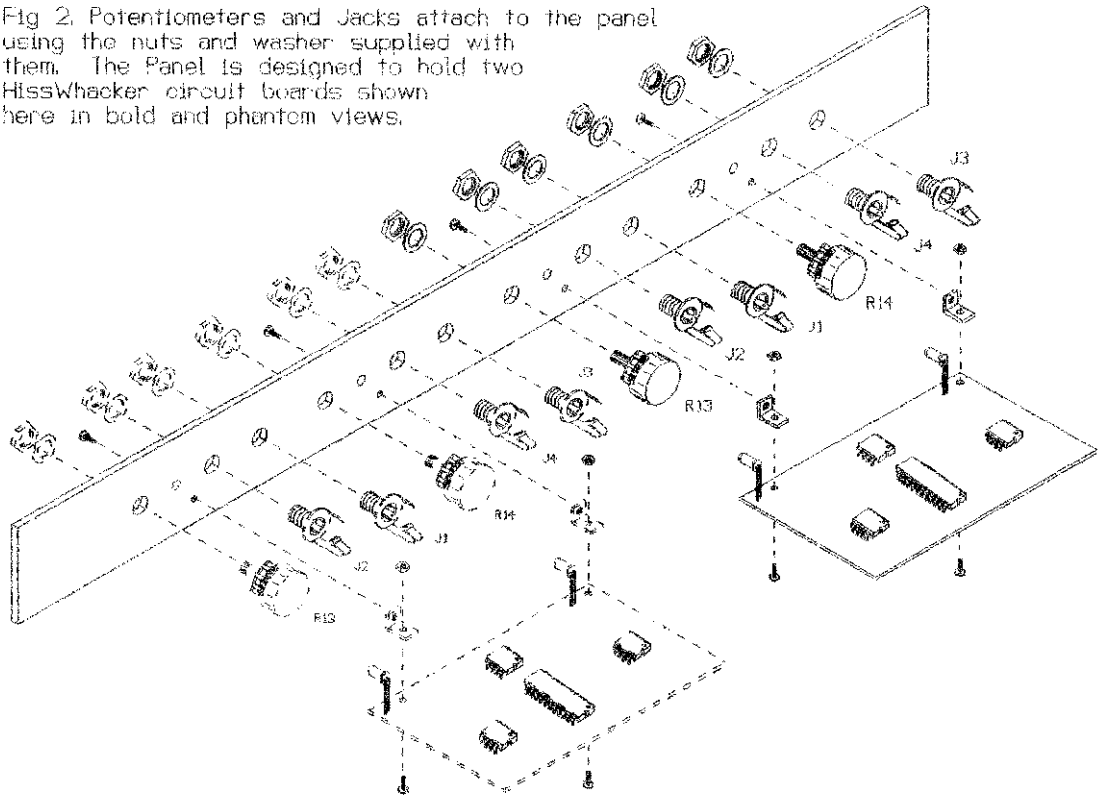


Fig 1b. This view of the circuit board with phantom traces will be useful if you need to trace out the circuit.

Fig 2. Potentiometers and Jacks attach to the panel using the nuts and washer supplied with them. The Panel is designed to hold two HissWhacker circuit boards shown here in bold and phantom views.



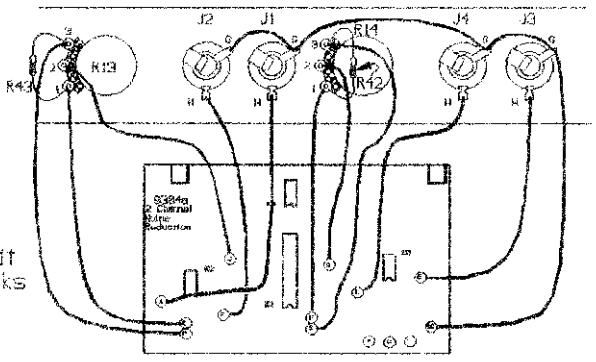


Fig 3. An assembled HissWhacker circuit board connects to its controls and jacks as shown. Note resistors R42 and R43 soldered to the lugs of the pots.