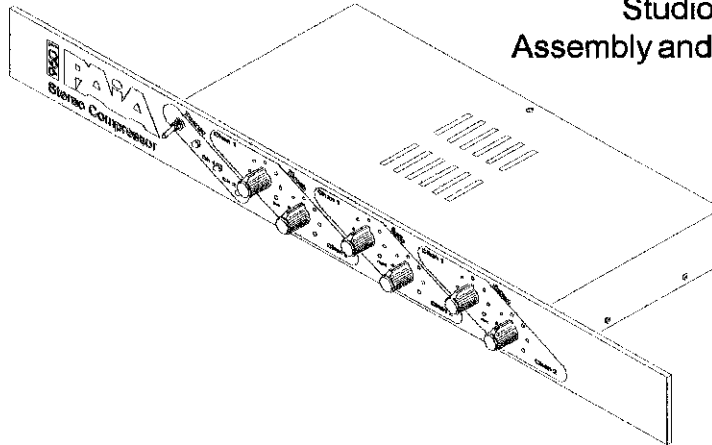


PAIA Stereo Compressor

Model 9601RMC
Studio Configuration
Assembly and Using Manual



A compressor is one of the most important, but most often overlooked, tools in any studio. Compressing a signal keeps its average level high and consequently gives it more presence in a mix. And when recording real-world acoustic instruments, particularly human voice, they can guarantee the maximum possible signal level to the tape without worrying about overloading and distortion.

The Stereo Compressor is two independent compressor circuits in one package. Based on an SSM2120 Dynamic Range Processor IC, this unit's specifications include better than 90 dB. Signal to Noise ratio and 100dB dynamic range with only .01% distortion at +10 dB. input. Features include bi-color LED indicators of activity, Side Chain Jacks, built-in Power Supply and full rack enclosure.

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an article in the August 1996 issue of
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ASSEMBLING THE Stereo Compressor

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.

*In some cases, notes packed with the parts will be used to call your attention to special situations. These notes may be in the yellow "MISSING PARTS" postcard. **If parts are missing** please notify PAiA at p405.340.6300, f340.6378, or damn!@paia.com*

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 Stereo Compressor 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.

-*-

*This product originated as a Do-It-Yourself article
by Jules Ryckebusch in the August 1996 issue of
Electronics Now magazine.*

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Wire Jumpers

Assembly begins by forming and installing the seven wire jumpers indicated by bold lines on the circuit board parts placement designators and numbered in the illustration to the right. For each jumper, cut a length of the bare wire supplied by measuring it against the distance between the circuit board holes and adding about 1/2". Bend 1/4" of each end down and push through the circuit board holes. Press the jumper fully against the board and solder both ends. Trim off excess wire flush with the solder joint.

Notice that the #7 jumper is covered with the small diameter insulating sleeving supplied. Slip the sleeving over the jumper before bending the wire ends down and placing.

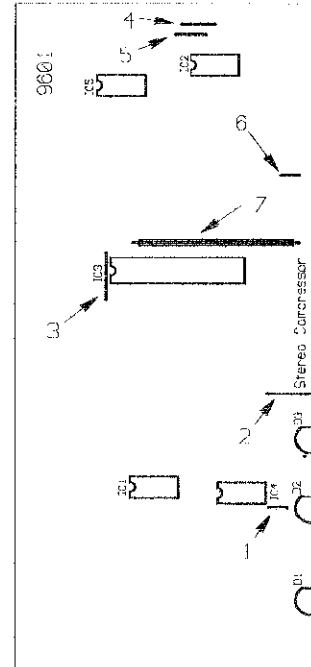
() As outlined above, form and install the seven wire jumpers used on the circuit board.

Resistors

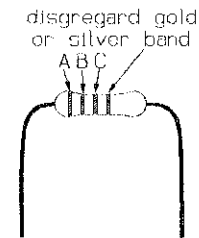
Solder each resistor in place following the parts placement designators printed on the circuit board and the assembly drawing fig 1. Note that resistors are nonpolarized and may be mounted with either lead in either of the holes in the board. Before mounting each resistor, bend its leads so that they 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.

A Tip: If you can't find the location for a resistor, go on to the next one and come back. DO NOT CHECK OFF A PART UNTIL IT IS INSTALLED AND SOLDERED.

Save a few of the resistor clippings for use in later steps.



One of the seven jumpers on the circuit board is insulated with sleeving.



DESIGNATION	VALUE	COLOR CODE A-B-C
() R22	1.5m	brown-green-green
() R25	1.5m	brown-green-green
listed below:	1000 ohm	brown-black-red
() R5	() R35	() R37 () R39
listed below:	10k	brown-black-orange
() R30	() R31	() R32 () R34
() R36	() R38	() R40 () R44
() R57	1m	brown-black-green
() R58	1m	brown-black-green
() R13	1500 ohm	brown-green-red
() R21	1500 ohm	brown-green-red
() R27	1500 ohm	brown-green-red
() R9	150k	brown-green-yellow
() R16	1800 ohm	brown-grey-red
() R17	1800 ohm	brown-grey-red
listed below:	200 ohm	red-black-brown
() R23	() R24	() R28 () R29
listed below:	2200 ohm	red-red-red
() R3	() R11	() R12 () R14
() R15	() R45	
() R4	22k	red-red-orange
() R19	22k	red-red-orange
listed below:	330k	orange-orange-yellow
() R7	() R8	() R10 () R20
listed below:	39k	orange-white-orange
() R2	() R33	() R43 () R46
() R1	47 ohm	yellow-violet-black
() R18	47 ohm	yellow-violet-black
listed below:	68k	blue-grey-orange
() R6	() R26	() R41 () R42

At this point you should have four 1000 ohm (brwn-bick-red) resistors not installed on the pc board. These resistors will be mounted on panel controls and jacks in a later step.

Disk Capacitors

Two of the capacitors used in the Stereo Compressor are nonpolarized Ceramic Disk types. 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. 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.

Disk capacitors



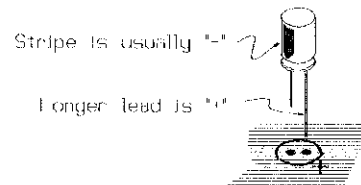
Capacitors are often marked with obscure codes that indicate their characteristics. The 3 digit number that specifies value may be preceded or followed by letters indicating such things as tolerance. Since both capacitors are the same value there should be little chance of confusion.

DESIGNATION	VALUE	MARKING
() C1	2000pF	202 or .002
() C8	2000pF	202 or .002

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.

Electrolytic capacitors



Usually the Negative lead of the capacitor is marked rather than the positive. It naturally goes through the unmarked hole.

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

DESIGNATION VALUE

listed below:	10uF / 16V Electrolytic		
() C2	() C3	() C4	() C5
() C6	() C7	() C9	() C10

DESIGNATION VALUE

- () C13 470uF / 25V Electrolytic
- () C14 470uF / 25V Electrolytic

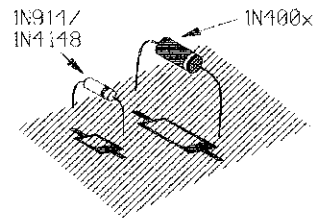
- () C11 47uF / 16V Electrolytic
- () C12 47uF / 16V Electrolytic

Diodes

Two types of diodes are used in the circuit, four 1N914 or 1N4148 silicon signal diodes in small glass cases and two 1N400x power diodes in larger cases.

Like the Electrolytic Capacitors, diodes are polarized and must be installed so that the lead on the banded end of the part corresponds to the banded end of the designator on the circuit board. Bend the leads so they are at right angles to the body of the part and insert them through the holes provided in the circuit board.

Diodes are also somewhat heat sensitive so the soldering operation should be done as quickly as possible.



The polarizing color band corresponds to the filled end of the circuit board graphic.

DESIGNATION TYPE

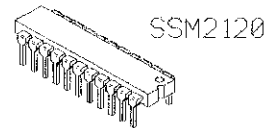
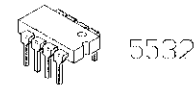
- () D8 1N4001, 1N4002, 1N4003 Silicon Power Diodes
- () D9 1N4001, 1N4002, 1N4003 Silicon Power Diodes

listed below: 1N914, 1N4148 or equiv. Silicon Signal Diodes

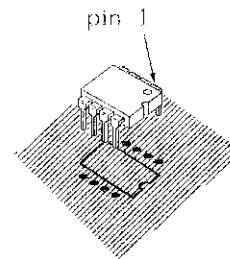
- () D4 () D5 () D6 () D7

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.



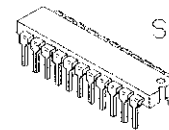
ICs are polarized in one or both of two ways; A dot formed into the case of the IC corresponding to pin 1 or a semicircular notch that indicates the end of the package with pin 1. Take care that this polarizing indicator corresponds to the similar indicator on the circuit board graphics.



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



5532

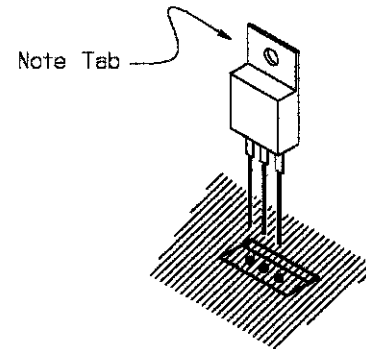


SSM2120

DESIGNATION	PART NO.	DESCRIPTION
listed below:	5532	Dual Low Noise OpAmp
() IC1	() IC2	() IC4 () IC5
() IC3	SSM2120	Dynamic Range Processor

Voltage Regulators

The two voltage regulators are polarized and must be mounted so that their tabs correspond to the tab markings on the circuit board graphics. Solder all three leads and clip any excess off flush with the solder joint.



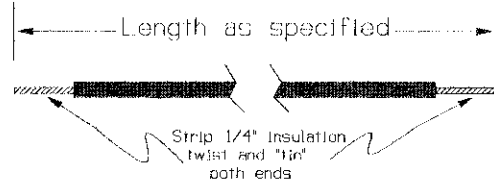
DESIGNATION	PART NO.	DESCRIPTION
() IC6	7812	+12V Regulator
() IC7	7912	-12V Regulator

"Flying" Wires

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

In the following steps, wires will be soldered to the circuit board which in later steps will be connected to the front panel controls and switches. At each step, cut a piece of wire to the specified length 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 will make soldering easier when the wires are installed and prevents fraying of the wire strands when they are pushed through the holes. Solder each connection as it is made and clip any excess wire from the solder side of the board.



Before installing any wires cut two 16" lengths of two colors from the wire supplied and put these wires aside for use when installing the LEDs. *TIP: If you cut the specified length from the longest wire available you will not be left with several pieces that are too short for the last length required.*

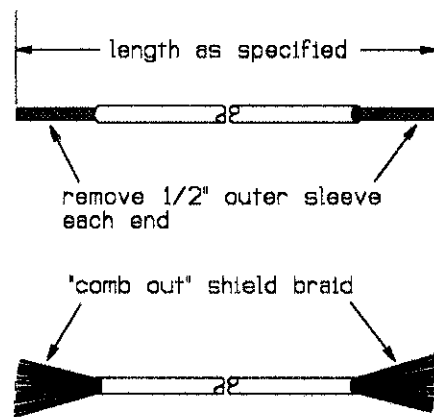
PC POINT	WIRE LENGTH	PC POINT	WIRE LENGTH
() "A"	5-3/4"	() "L"	9"
() "B"	8-3/4"	() "M"	10-1/4"
() "C"	9-1/2"	() "N"	9-3/4"
() "D"	9-1/4"	() "O"	9"
() "E"	9"	() "P"	10-1/2"
() "F"	7-3/4"	() "R"	10"
() "H"	7-3/4"	() "S"	10"
() "I"	11-1/4"	() "T"	8-3/4"
() "J"	12-3/4"	() "U"	9"
() "K"	9-1/2"	() "SG"	7-3/4"

SHIELDED CABLE

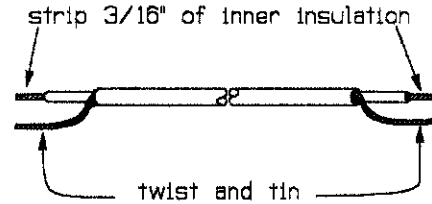
RG-174/U coaxial cable will be used to make shielded connections between the circuit board and two of the potentiometers. Cut the length of co-ax supplied into two equal length pieces and prepare them for use as follows:

Strip 1/2" of the outer insulation at each end of both wires to expose the braided shield beneath it.

Unbraid the shield by "combing" it with the dull edge of a knife blade or a ball-point pen. This will expose the separately insulated inner conductor.



On each end of both cables, pull the strands of shield to one side and twist them together. Tin these pigtails by melting a small amount of solder into them.



On each end of both cables, strip about 3/16" of the insulation from the inner conductor and twist and tin the exposed strands.

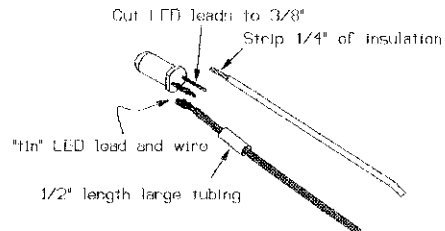
Using the lengths of co-ax prepared above, solder the inner conductor and shield at one end of each cable to the circuit board points listed in the following steps (see fig 2).

WIRE	PC POINT
Cable #1	
() (shield)	"W"
() (inner)	"V"
Cable #2	
() (shield)	"Y"
() (inner)	"X"

LEDs

Two different kinds of LEDs are used in the Stereo Compressor, a Red LED to indicate power is on and bi-color LEDs to indicate the active status of the two channels.

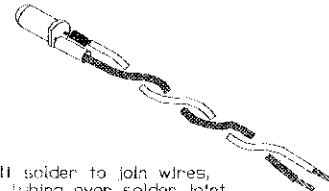
To reach from the circuit board to the holes in the front panel of the case the LED leads must be extended using the #22 stranded wire supplied. All three LEDs are prepared in the same way. Begin by cutting two wires to the length specified in the step then stripping 1/4" of insulation from each end of each wire and tinning the exposed wire strands on each end. **TIP: use two colors of wire for each LED.**



Trim the LED leads to 3/8" and tin them by melting a small amount of solder onto each one. **TIP: A pair of pliers can serve as a small vice by wrapping a rubber band around the handle to keep the jaws closed - handy for holding the LEDs while tinning the leads.**

Join the stranded wire to the LED lead by remelting the solder on each while holding them together (the surface tension of the solder will help pull them together). Hold until the solder has cooled and the

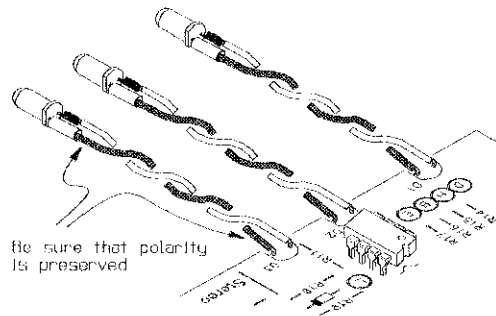
joint has set solid. Before going on to next LED, slip a 1/2" length of the large diameter tubing supplied over one of the Leads as shown in the illustrations. Twist the two leads loosely together.



Remove solder to join wires, slide tubing over solder joint and twist wires loosely together.

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

Push the two leads through the holes provided in the circuit board and solder both. Trim the leads off flush with the solder joint.



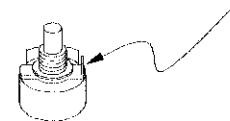
DESIGNATION	LENGTH	TYPE
() D1	4"	Red LED
() D2	5-1/2"	Bicolor LED
() D3	6-1/2"	Bicolor LED

PANEL CONTROLS

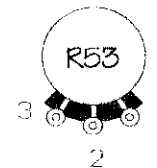
Because there will be limited space available in the Stereo Compressor Rack Case when the electronics are installed, some point-to-point wiring will be done on the potentiometers before they go in the case.

The Rack Panel can be used as a temporary fixture to hold the potentiometers in place while soldering to them. Using the flat washers and nuts supplied, mount the 6 potentiometers to the rear of the panel as shown in fig 2. Notice that the pots are not all the same value - R51 and R52 are 10K (10,000) ohm while the other four are 100k units. Also note the orientation of the panel (face down) and align the pot's solder lugs as shown. Hand-tighten the nuts so they will be easy to remove when the pots are moved. Protect the finish of the panel by working over a towel.

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



In the following steps individual solder lugs are identified by part number and lug number. For example, R53-1 means the lug labeled "1" of the Potentiometer R53. Each step includes an instruction such as (s2), which means that the connection should be soldered and at that point there will be two wires on the lug in question. If there are not the number of wires specified



at the lug when you get ready to solder, recheck to see what has gone wrong. Connections marked (ns) should be crimped to make a good mechanical connection but will be soldered in later steps.

The resistor leads saved in previous steps are now used to make connections between lugs on R53 - R56. Notice that only one end of each connection is soldered.

FROM	TO
() R53-1 (s1)	R53-2 (ns)
() R54-1 (s1)	R54-2 (ns)
() R55-3 (s1)	R55-2 (ns)
() R56-3 (s1)	R56-2 (ns)

Two 1000 ohm resistors (brown-black-red) are mounted directly on the solder lugs of the potentiometers. Install the resistors by pushing their leads through the lugs and "dressing" the part so that it's leads do not touch the body of the pots or any lugs to which they do not connect. Cut the leads off so they extend about 1/8" beyond the lug and crimp them to the lug to hold the part in place. Do not solder any of these connections.

DESIGNATION	FROM	TO
() *R47	R52-3 (ns)	R52-1 (ns)
() *R48	R51-3 (ns)	R51-1 (ns)

Now we're ready to begin connecting the ends of wires and cables originating at the circuit board to the panel controls (see fig 2).

FROM	TO	FROM	TO
()"B"	R52-3 (s2)	()"H"	R51-1 (s2)
()"C"	R52-2 (s1)	()"K"	R53-3 (s1)
()"D"	R52-1 (s2)	()"L"	R53-2 (s2)
()"E"	R51-3 (s2)	()"M"	R54-2 (s2)
()"F"	R51-2 (s1)	()"N"	R54-3 (s1)

These connections use the co-ax.

()"W"	(shield)	R55-2 (s2)
()"V"	(center)	R55-1 (s1)
()"Y"	(shield)	R56-2 (s2)
()"X"	(center)	R56-1 (s1)

We're just about ready to start moving things into the case, but first we'll do a little prep work involving the Case Bottom. Remove the protective vinyl covering from the case parts before proceeding.

- () Locate the six 1/4" Open Circuit Phone Jacks and two 1/4" Closed Circuit Phone Jacks and mount them on the rear apron of the case using the nuts and washers supplied with them (see fig 3). Note the C.C. (switching) jacks at J6 and J8 Orient the jacks so that their solder lugs are easily accessible from the open top of the case as shown in fig 2 before fully tightening the hardware.



Open Circuit Jack has two solder lugs



Closed Circuit has three lugs

Locate two 1000 ohm resistors (brwn-blck-red) and prepare them for installation on the lugs of the Jacks by slipping a 3/4" length of the small diameter tubing supplied over each lead. Use the resistors to make the connections that follow - note that only one end of each resistor is soldered.

DESIGNATION	FROM	TO
() R49	J6-SW (s1)	J5-T (ns)
() R50	J8-SW (s1)	J7-T (ns)



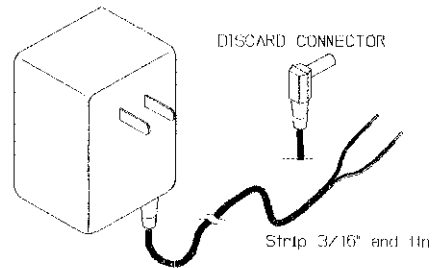
Use the #22 stranded insulated wire to make the following connections between the Jacks. At each step cut the wire to the length specified, strip 1/4" of insulation from each end and twist and tin the exposed wire strands. **A Tip: The solder lugs of the jacks require a lot of heat for soldering and should be tinned before connecting any wires. Melt a small drop of solder onto the clean tip of your iron and hold it against the lug until fresh solder will melt on the lug.**

LENGTH	FROM	TO	LENGTH	FROM	TO
() 2"	J2-S (s1)	J1-S (ns)	() 2"	J6-S (s2)	J5-S (ns)
() 2"	J1-S (s2)	J4-S (ns)	() 3"	J5-S (s2)	J8-S (ns)
() 2"	J4-S (s2)	J3-S (ns)	() 2"	J8-S (s2)	J7-S (ns)
() 3"	J3-S (s2)	J6-S (ns)			

- () Install the rubber grommet in the power supply cord hole as shown in fig 3. A pen point or small screwdriver may be helpful in deforming the grommet into the hole.

Locate the Wall Mount Transformer (PWR1).
If this part has a connector on the end of its cable,
remove and discard it as shown.

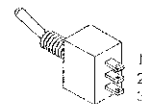
- () Pass the Transformer cord through the grommet from the outside of the Case and put a knot in the cord 7" from the end. Separate the two wires from the loose end back to the knot. Strip 3/16" of insulation from ends of both wires and twist and tin the exposed wire strands.



We can now begin installing the electronics in the case. Carefully remove the assembly of pots and fixed resistors from their temporary position on the Rack Panel.

- () Attach the Case to the Front Panel by passing the shafts of the six potentiometers through the matching holes in both panel and case and secure them with one of the washers and the nut provided with each pot (see fig 3). Some adjustment of the relative position of the Case and Panel will be necessary in later steps, so only finger-tighten the hardware at time. The Stereo Compressor circuit board may be laid in the case during this step, but do not use any hardware to mount it yet.

- () Install the Power Switch (S1) in the location shown in fig 3 by passing its shaft through the hole in the Case Top and securing it with the nut provided. Now that the Case and Panel are fully aligned, make any adjustment in the pot locations to center them in the panel graphics and fully tighten all of the panel hardware.



SPDT switches may be supplied even though only SPST are required.

- () Connect either wire from the Transformer to lug #2 of the Power Switch and solder.
NOTE: The switch can be damaged by too much heat while soldering. Tin the solder lugs before attaching wires and do not hold the soldering iron in place for more than 5 sec.



- () Connect the free wire of the Transformer to circuit board point "G" and solder.

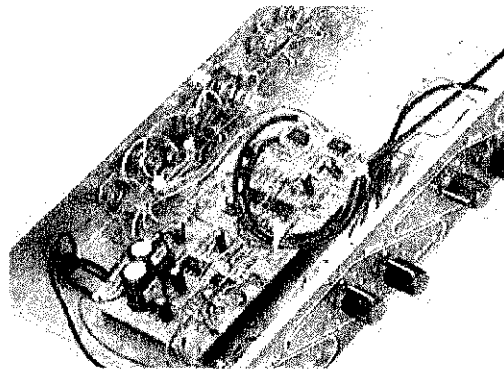
-
- () Connect the free end of the wire originating at circuit board point "A" to lug #3 of the Power Switch and solder.
 - () Mount the Stereo Compressor circuit board to the Case Bottom using four 4-40 X 1/2" machine screws, four #4 X 3/16" spacers and four #4 nuts as shown in fig 4.
 - () Insert the three LEDs into the holes provided for them in the Case. Wait until testing is complete to permanently fasten the LEDs in place with a *dab* of household cement or super-glue

Finish wiring by connecting the free ends of the remaining wires coming from the circuit board to the jacks on the rear panel as follows

FROM	TO	FROM	TO
() "I"	J1-T (s1)	() "S"	J6-T (s1)
() "J"	J2-T (s1)	() "T"	J7-T (s2)
() "O"	J3-T (s1)	() "U"	J8-T (s1)
() "P"	J4-T (s1)	() "SG"	J7-S (s2)
() "R"	J5-T (s2)		

- () Gather the wires from the circuit board to the front panel controls together and cinch the bundle with the four Nylon wire ties supplied as shown. **NOTE:** Bundle the wires from the panel controls and the wires from the jacks separately and do not include the LED wires or the wire from circuit board point "A" in the bundles.

- () Install the knobs. Rotate the shaft of the control on which the knob will be placed fully CounterClockWise and align the knob pointer with the marking at the extreme CCW end of the dial. Loosely tighten the set screw and rotate the knob back and forth to see how well it's range of rotation is balanced with the panel graphic. Reorient if not satisfied and then firmly tighten the set-screw.



THIS COMPLETES THE ELECTRONIC ASSEMBLY of the Stereo Compressor. Before completing the Case Installation we will run some preliminary tests while things are still easily accessible. Before plugging the unit in and testing it, take a break then come back and check your work completely.

TESTING THE STEREO COMPRESSOR

After rechecking your work, it's time for the all important smoke test. If anything unfortunate is going to happen, this is the most likely time. Plug the wall-mount transformer into a 120VAC outlet and toggle the Power switch to "ON." The Power LED (D1) should light and if it doesn't you should immediately unplug the unit from the wall and find out why. The problem could be nothing more than a dead wall outlet. Improperly placed components or solder bridges on the circuit board may be the cause. Check the orientation of the Integrated Circuits.

When the Power LED lights. Let the unit idle for a few minutes while you check for parts that may be getting hot or any unusual smell, smoke, etc.

The best way to test the compressor is to connect it between a CD or cassette deck and your stereo. Set the Ratio Control fully Counter ClockWise and the Threshold Control fully ClockWise. Set the Output Level Control to about ten O'clock. These are the "minimum" settings. You should hear undistorted, noise free audio. Both LEDs should be green. If there is distortion or noise, you need to go back and check your wiring and component polarities. If everything sounds good and you have green LEDs, then everything should be working fine. Now slowly rotate the Threshold Control. At some point around mid-rotation, the Active LED for that channel should start to indicate red. (If this works backwards, your LED wiring is reversed.) This means that compression is starting to occur. Rotate the Ratio Control clockwise and you should hear a decrease in volume as the compressor "squashes" the signal.

FINAL CASE ASSEMBLY

- () When you're satisfied that everything is working properly, complete assembly by installing the Case Top as shown in fig 4. The "L" bracket that fastens the rear edge of the top is attached to the rear apron of the case bottom using a #4 X 1/4" Machine Screw and #4 nut. Four #4 X 1/4"

self-tap screws secure the front edge and side panels of the top while a #4 X 1/4" machine screw into the threaded hole of the previously installed "L" bracket secures the back edge.

USING THE COMPRESSOR

When the Stereo Compressor is connected to a hi-fi VCR or DSS for late night viewing, set the Threshold Control so that the LEDs color during quiet spoken passages and set the Ratio Control as high as possible without distorting. This allows you to preserve the fidelity and stereo spread of the movie sound track, hear all the dialog, but not get blown out of your seat when the F-114 does a strafing run in your living room. The above settings are intended to be starting points, so feel free to experiment.

Compressors in Studio and PA

by *Jules Ryckebusch*

The main use for a compressor is to keep signal levels from getting out of control while recording vocals and acoustic instruments. This takes a little experimentation. For a vocalist I usually start out around a 4-to-1 compression ratio with the Threshold set so the LED indicates red when the singers reach their nominal level. This way if they hit a note 20 dB. higher than nominal (which would definitely clip most tape decks) the signal out of the compressor only increases by about 5 dB.

The Stereo Compressor can increase the apparent sustain of a sound. By using a large amount of compression and restoring the level with the OUTPUT control, the compressor will initially reduce the output signal by a large amount. As the input signal level decreases, the amount of compression will decrease and the Output level will remain relatively constant. The Beatles used this on the final piano chord of "A Day In The Life" to make the sound linger on.

To use the compressor as a limiter while recording, set the Ratio to max and set the Thresh Control so that the LEDs momentarily change from green to red on peak signals. This will preserve as much dynamic range as possible.

Using the Side-chain Jacks

By patching audio processors of different kinds into the side chain, all sorts of cool things are possible. One of the most useful is creating a de-esser. This is a device used to remove sibilance from vocals. Sibilance is that nasty "Shh" sound that occurs when "S" words are spoken or sung.

When we form an "S" sound, air passing between the teeth and tongue forms a short blast of air and a burst of white noise. If the speaker or vocalist is close to the microphone, this is picked up as a brief overload and noise burst. This burst of sound mostly contains high frequencies. By setting an equalizer to boost high frequencies and patching it into the side chain, the compressor will drastically compress the signal when the high frequencies are present, but act normally when they are not. You cannot eliminate sibilance, but it can be minimized with a de-esser.

Any equalizer will work. The best way to figure out what frequencies to boost is to listen to the audio through the equalizer (not in the side-chain yet). Start boosting until you have noticeably *increased* the sibilance then patch the equalizer with this setting into the side-chain. Anything above 3 kHz. usually works; you may have to experiment. A similar problem, although at the other end of the audio spectrum, relates to plosive sounds such as "P" and "B" and the "thump" sounds they can produce. These can be minimized the same way by boosting the offending bass frequencies (less than 300 Hz) via the side-chain.

Another abuse of a compressor is to totally squash an individual instrument signal, then restore its level. This is done with vocals, snare drums, kick drums, etc. U2 does this on a lot of their recordings. By squashing instruments that have a percussive quality (such as drums or slap bass) the amount of percussive attacks is increased. This occurs because the compressor does not respond instantly. The initial attack transient portion of the signal gets through the compressor unaffected while the remainder of the signal is compressed normally. The end result is overall increase in the percussive quality of the processed sound.

The Stereo Compressor can also be used as a ducker, a device that reduces one signal's level based on a different signal. This effect gets used a lot on radio commercials. In this case, a different audio signal, such as an announcer's voice, is fed into the side-chain. When the announcer speaks, the output of the compressor is reduced. This is useful for keeping background music at maximum volume, but letting the announcer's voice cut through the background by reducing the music level when the announcer speaks. Listen closely to any radio commercial and you will notice this effect. Duckers are also great for DJs or a presentation with background music.

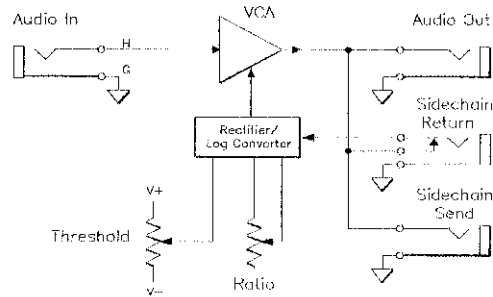
Ducking is also used in the studio to allow one instrument to cut through on a mix. If you want a particular instrument to be more noticeable, such as a snare drum, send the snare signal into the side-chain and have the rest of the mix feeding the compressor normally. Whenever the snare drum plays, it will reduce the level of the main mix, increasing the presence of the snare drum without increasing its level. Just by adding a few jacks, we have increased the power of an already useful tool.

The Stereo Compressor is a state-of-the-art audio processor. It can be used to upgrade your Home recordings, as an addition to a professional recording studio or it can just allow you to enjoy late-night movies without riding the volume.

HOW IT WORKS

The basic block diagram of a compressor is shown in the illustration. The input signal is fed to a VCA that has a nominal gain of unity. Some of the output signal is fed to a precision rectifier followed by a logarithmic circuit. The output of this block is a DC voltage proportional to the log of the average level of the input signal. By sending some of this DC voltage to the VCA we can reduce the gain of the VCA if our input signal exceeds a user determined threshold level.

It is important to note that we are determining the signal level after the VCA and not before. This allows the output level to still increase and sound normal, but not increase as much as the input signal does. By varying the amount of feedback signal we can adjust the compression ratio, which in conjunction with the Threshold Control, determines the operating characteristics of the compressor.



DESIGN ANALYSIS

Fig 5 is the schematic diagram of the Stereo Compressor. The device has two independent channels of compression, right and left. The heart of the circuit is the SSM2120 dual dynamic range processor integrated circuit IC3. The SSM2120 features two complete dynamic range processors. Each one consists of a voltage-control amplifier, a logarithmic converter, and a precision rectifier. The chip also features a dynamic range of 100 dB. at only .01 percent total harmonic distortion at +10 dB. input. The remainder of the Stereo Compressor circuit consists of input and output buffers, the control circuitry and the comparator that drives the Active LEDs.

Since the electronics for both channels is identical, we will look at the right channel in detail. The input audio signal from J1 goes to an inverting buffer circuit consisting of R40 and R44 and IC1-b. Its output signal (IC1-b, pin 7) is coupled to the signal input on IC3, pin 8, via C4, which blocks any DC component of the input signal. The SSM2120 chip is actually looking for a current input source, and R43 provides the proper amount of current to the chip. The RC filter formed by C8 and R18 eliminates any stray RF interference. The output signal from the internal VCA (IC3 Pin 4) is actually a

current signal. It is restored to a voltage signal by current-to-voltage converter IC1-a and its feedback resistor R46. The signal from IC1-a, pin 1 is routed to output stage amplifier IC5-a via R34. The output signal from IC5-a, pin 1, is coupled via R35 and C9 to jack J3. Output potentiometer R55 lets you adjust the unit's gain.

The output signal is also sent to the rectifier input (IC3, pin 9) via R36 and C7 either directly, or via the optional side-chain jack circuitry including R50. The side-chain jacks consist of a standard 1/4-inch open-circuit OUT phone jack (J7) and a 1/4-inch IN phone jack (J8) with a normally-closed switch built into them. These jacks form a normalized patch point for additional audio processing. With nothing plugged into J8, the signal path is uninterrupted. By inserting a phone plug into the side-chain IN jack (J8), the normal signal path is broken and either the processed original signal is sent to the rectifier input, or a completely different (new) signal is sent to the rectifier input.

Looking at the control side of the house, resistor R22 provides a reference current to the log-averaging circuit within IC3 via pin 2. It also forms an RC timing circuit with C5. This RC circuit determines the response time for the compressor. The time constant is set so that the compressor will respond rapidly without distorting.

Potentiometer R51, along with other resistors, develops the threshold level signal. The voltage from the wiper of R51 is sent to the threshold input of IC3 (pin 1) via R42. Another resistor, R41, across the threshold pin 1 and the control output pin 3 establishes the internal gain of the control stage. The control output signal from pin 3 goes to a voltage-divider network centered around potentiometer R53 then to the inverting VCA input of IC3 (pin 7). A positive voltage on this input reduces the VCA gain, which is what we need to make the compressor work. Note that both the inverting and non-inverting control inputs (pins 7 and 5) are tied to ground via R23 and R24. The control inputs must remain close to ground potential for proper operation. A 6-millivolt change in voltage at these control pins causes a 1 dB. change in VCA output. Diodes D6 and D7 ensure a unipolar control voltage. Potentiometer R53 is the compression Ratio Control. It gives an adjustable compression ratio of 2 to 1 all the way to about 25 to 1.

The last portion of the circuit is the comparator formed by IC4-b, two input resistors, R10 and R20, a bicolor light-emitting diode D3 and current limiting R11 for the light-emitting diode D3. Notice that OpAmp IC4-b is wired as a comparator. Normally it is unwise to use an OpAmp for this purpose because the output stage saturates, which will slow down the comparators response time. In this instance we need to get an output that changes from one supply rail to the other. This makes dual-LED interfacing very simple. Along with being an excellent audio OpAmp the 5532 functions well as a comparator in this application.

The power supply circuit consists of an externally connected Wall-Wart 12-volt AC transformer PWR1 and associated diodes and capacitors. One side of the 12-volt AC line is tied to ground and the hot side goes to half-wave rectifiers D8 and D9. These diodes deliver bipolar unfiltered DC, and each supply is filtered by electrolytic capacitors C13 and C14. Even though PWR1 is rated at 12 volts AC, the filter capacitors charge closer to the peak value of the 12-volt AC, and just about 15-volts DC is delivered to the +12-volt DC regulator IC6 and -12-volt DC regulator IC7. The output of each voltage regulator section is filtered for decoupling purposes by electrolytic capacitors C11 and C12.

Two ground systems are used in the Stereo Compressor, one for power return and the other for signal return. This design practice reduces the possibilities of ground loops that introduce unwanted AC hum to the audio signals.

NOTES

96.9.9

9601 Home Theatre Compressor

Parts List

Semiconductors

4	5532 Dual Low Noise OpAmp	IC1,IC2,IC4,IC5
1	SSM2120 Dynamic Range Proc.	IC3
1	7812 +12V Regulator	IC6
1	7912 -12V Regulator	IC7
1	Red LED	D1
2	BiColor LED	D2,D3
2	1N4001 Silicon Power Diodes	D8,D9
4	1N4148 Silicon Signal Diodes	D4,D5,D6,D7

Capacitors

2	2000pF Ceramic Disk	C1,C8
8	10uF / 16V Electrolytic	C2,C3,C4,C5, C6,C7,C9,C10
2	470uF / 25V Electrolytic	C13,C14
2	47uF / 16V Electrolytic	C11,C12

Potentiometers

4	100k Panel Mount	*R53,*R54, *R55,*R56
2	10k Panel Mount Pot.	*R51,*R52

all resistors 1/4W 5% values in ohms

2	1.5m	brown-green-green	R22,R25
8	1000	brown-black-red	*R47,*R48,*R49, *R50,R5,R35, R37,R39
8	10k	brown-black-orange	R30,R31,R32,R34, R36,R38,R40,R44
2	1m	brown-black-green	R57,R58
3	1500	brown-green-red	R13,R21,R27
1	150k	brown-green-yellow	R9
2	1800	brown-grey-red	R16,R17
4	200	red-black-brown	R23,R24,R28,R29
6	2200	red-red-red	R3,R11,R12,R14, R15,R45
2	22k	red-red-orange	R4,R19
4	330k	orange-orange-yellow	R7,R8,R10,R20
4	39k	orange-white-orange	R2,R33,R43,R46
2	47	yellow-violet-black	R1,R18
4	68k	blue-grey-orange	R6,R26,R41,R42

Misc

1	SPST Min Toggle Switch	S1
1	12VAC 400mA Transformer	PWR1
6	Knobs	
1	Circuit Board	
1	Instruction Manual	

Wire Bundle

4	36" lengths #22 Stranded Wire
1	24" length RG-174/U coax
1	1-1/2" length large dia. Tubing
1	1" length small dia. Tubing
1	7" length Bare Wire

Rack Mount Case (9601RMC)

Parts List

1	Rack Panel
1	Case Top
1	Case Bottom
1	#4 "L" Bracket
4	4 - 40 x 1/2" Machine Screws
2	4 - 40 X 1/4" Machine Screws
5	4 - 40 Machine Nuts
4	#4 X 3/16" Aluminum Stand-offs
1	1/4" Rubber Grommet
4	#4 X 1/4" self-tap Screws
6	1/4" Open Circuit Phone Jacks
2	1/4" Closed Circuit Phone Jacks
3	36" lengths #22 Insulated Wire
4	Nylon Wire Ties
1	3" length small dia. Tubing

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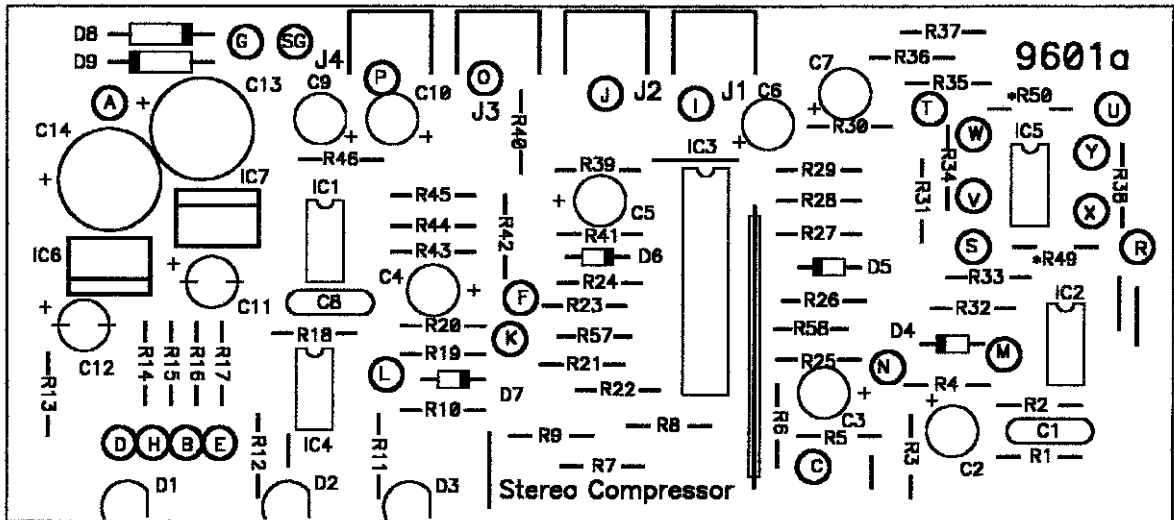


Fig 1a. Components mount on the circuit board at the locations shown in the parts placement diagram.

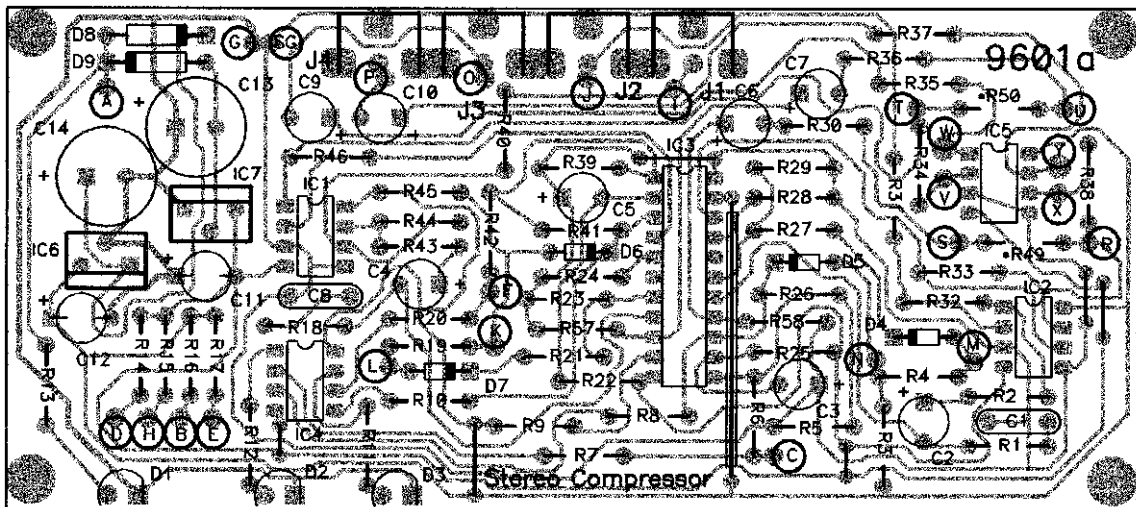


Fig 1b. This phantom view of the circuit board conductors will be useful if you need to trace out the circuit.

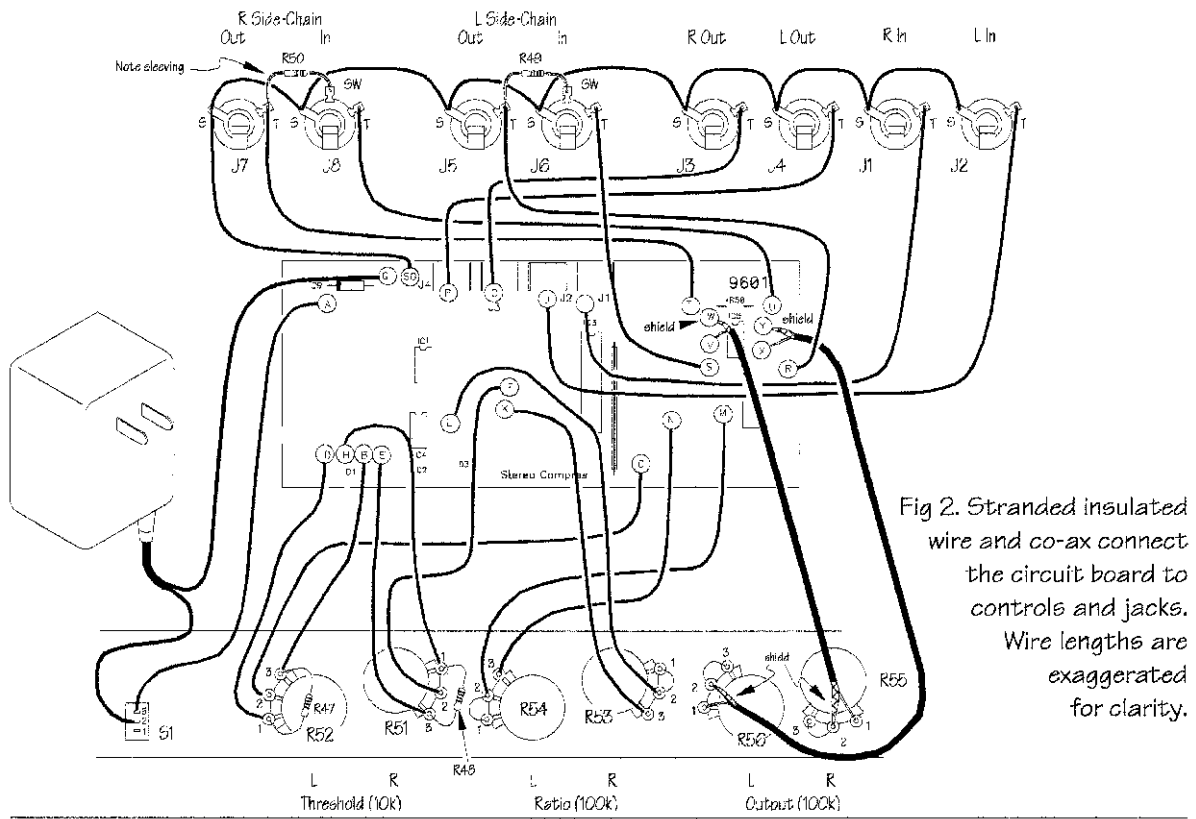


Fig 2. Stranded insulated wire and co-ax connect the circuit board to controls and jacks. Wire lengths are exaggerated for clarity.

Fig 3. The only hardware that attaches the case to the Rack Panel is the threaded bushings of the pots and power switch. Note switching Jacks (C.C.) at J6 and JB.

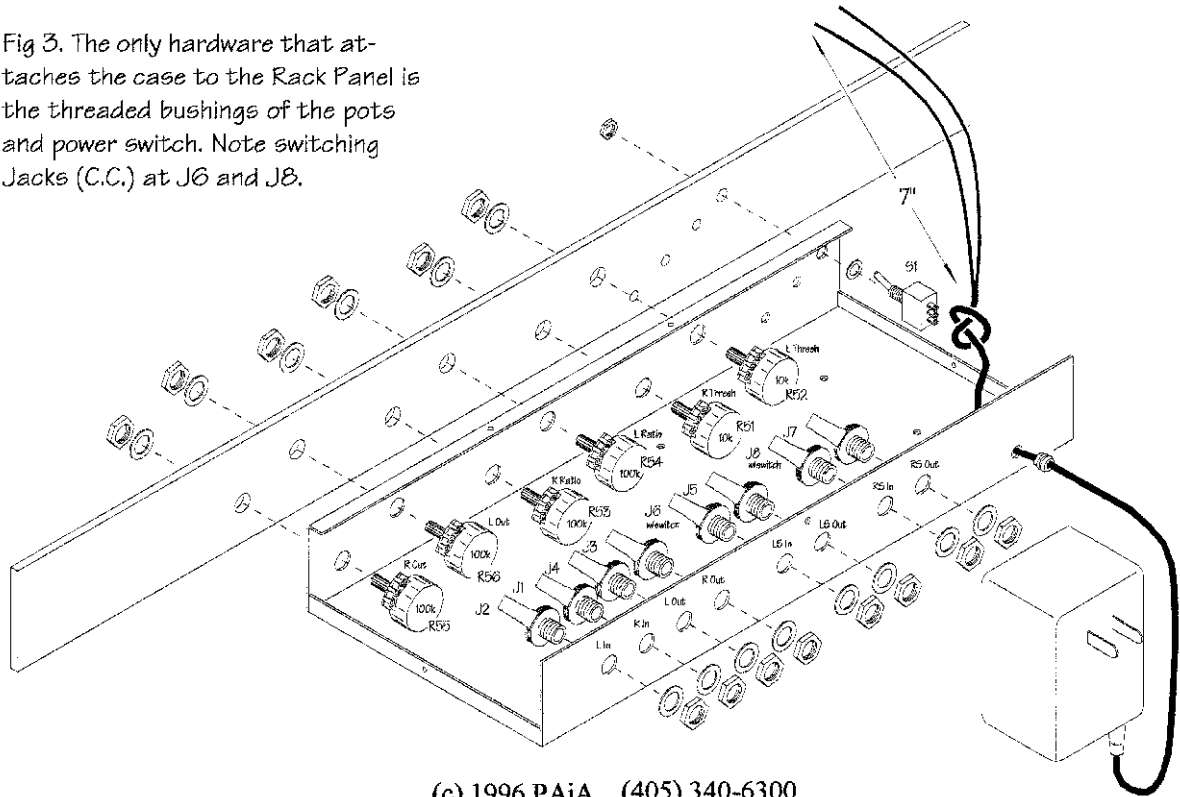
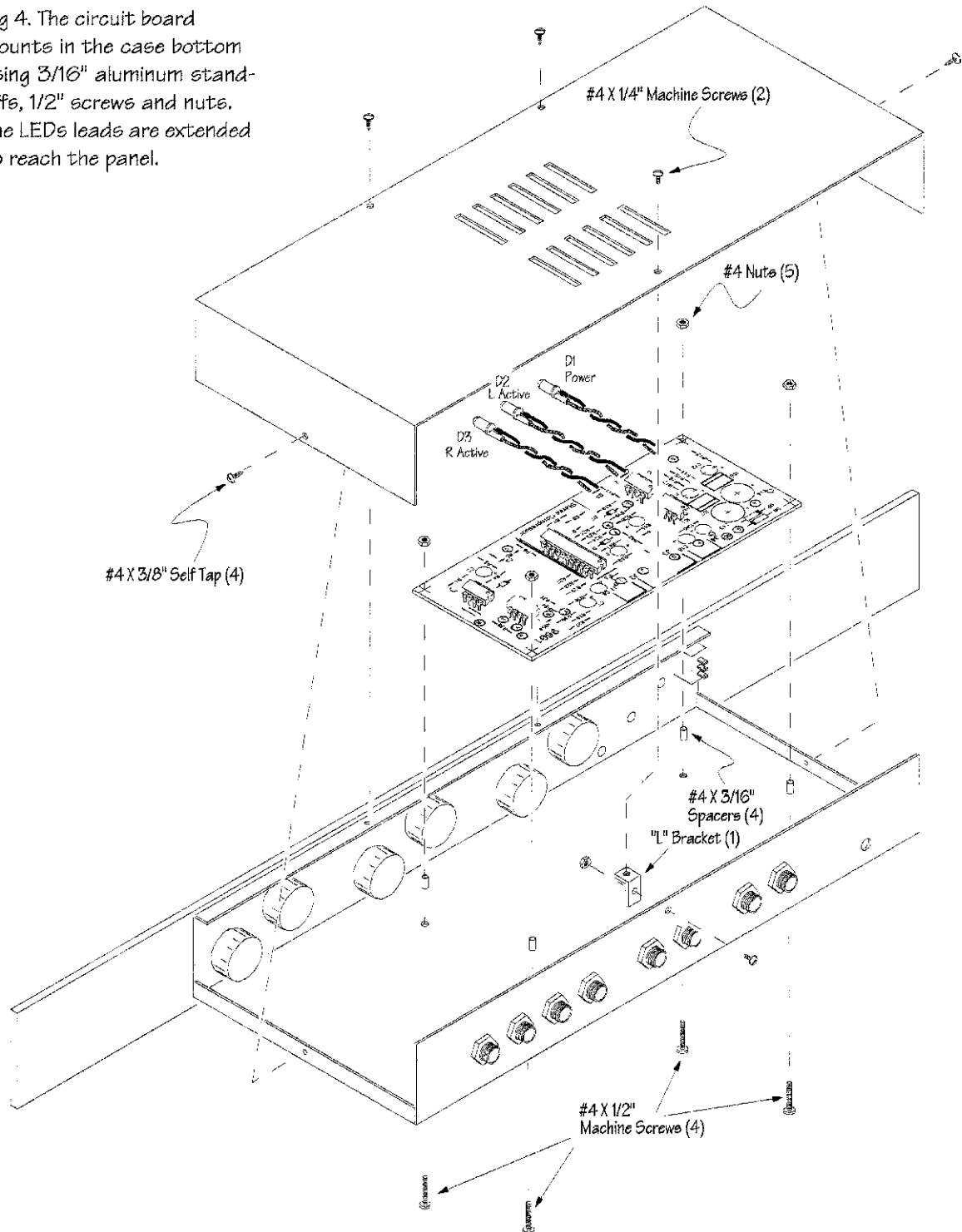


Fig 4. The circuit board mounts in the case bottom using 3/16" aluminum stand-offs, 1/2" screws and nuts. The LEDs leads are extended to reach the panel.



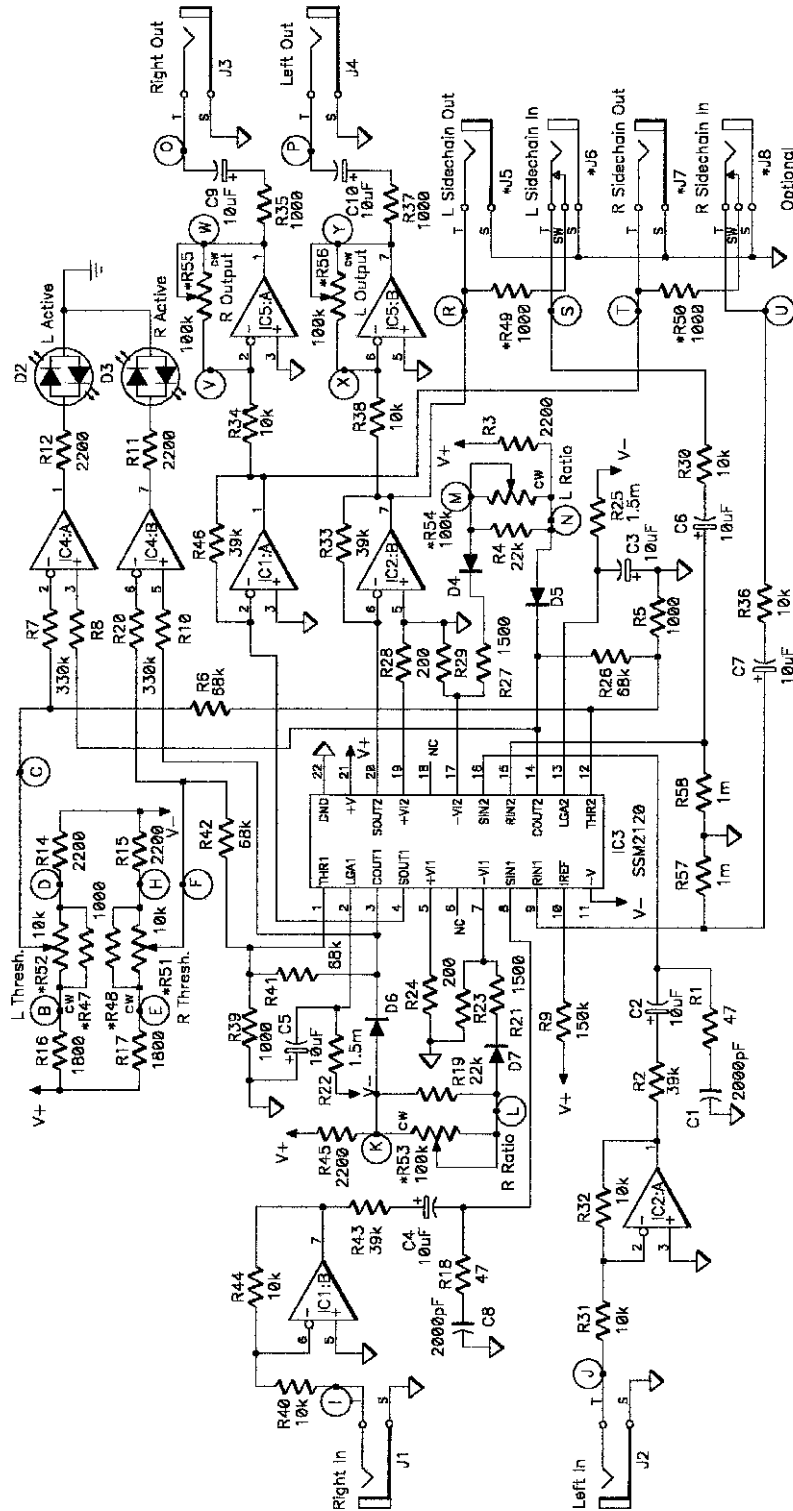
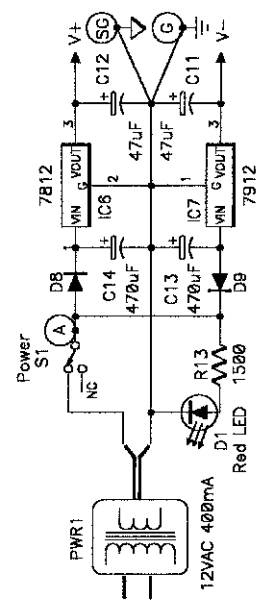


Fig 5. Stereo Compressor Schematic. Power supply components are shown below.



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