Four-Band EQ

Model 9303
Assembly and Using Manual

One thing that separates compact mixing boards from their big studio cousins is a good EQ section. It's true that today's world of multi-timbral sound sources doesn't need a lot of EQ for most things. Yet, inevitably, there are those tracks that need more than a simple Hi/Low Boost/Cut. Minor stuff like vocals and mic'd instruments (remember those).

The Four-Band EQ provides up to 16 dB of continuously adjustable Boost or Cut in four overlapping frequency bands from 35Hz to 15kHz. This unit is quiet and can be used with either low level or line level signals. It's the perfect complement to the great inexpensive mixers available today.

ASSEMBLING THE Four Band EQ

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 Four Band EQ 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 July 1993 issue of* Home & Studio Recording *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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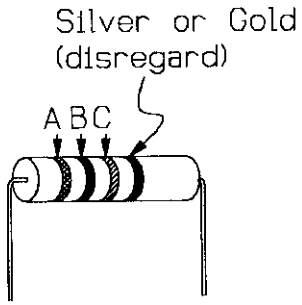
RESISTORS

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	150	brown-green-brown
( ) R3	150	brown-green-brown
( ) R4	100k	brown-black-yellow
listed below:	10k	brown-black-orange
( ) R5 ( ) R6 ( ) R9 ( ) R14		
( ) R15 ( ) R18 ( ) R23 ( ) R24		
( ) R27 ( ) R32 ( ) R33 ( ) R36		
listed below.	47k	yellow-violet-orange
( ) R8 ( ) R10 ( ) R17 ( ) R19		
( ) R26 ( ) R28 ( ) R35 ( ) R37		
listed below:	4700	yellow-violet-red
( ) R11 ( ) R13 ( ) R20 ( ) R22		
( ) R29 ( ) R31 ( ) R38 ( ) R40		
( ) R41	100	brown-black-brown

DISK, MYLAR AND POLYSTYRENE CAPACITORS

Most of the capacitors used in the Four-Band EQ are nonpolarized Ceramic Disk, Mylar 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 and Mylar 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 3 digit number that specifies value may be preceded or followed by letters indicating such things as tolerance. If you get confused about which capacitors are which, it may help to group them by same type and check them against quantities on the packing list at the end of this manual.

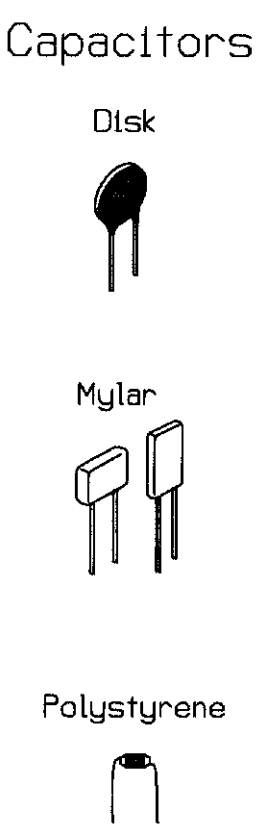
Ceramic Disks

DESIGNATION	VALUE	MARKING
listed below:	.01uF	103

( ) C5 ( ) C6 ( ) C7 ( ) C8

Mylar and Polystyrene

DESIGNATION	VALUE	TYPE	MARKING
( ) C9	.047uF	mylar	473
( ) C10	.047uF	mylar	473
( ) C11	.01uF	mylar	103
( ) C12	.01uF	mylar	103
( ) C13	.0039uF	mylar	392
( ) C14	.0039uF	mylar	392



DESIGNATION	VALUE	TYPE	MARKING
( ) C15	.0022uF	poly	222 or 2200
( ) C16	.0022uF	poly	222 or 2200

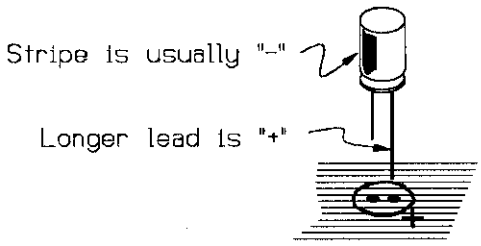
Polystyrene

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:	100uF / 16V

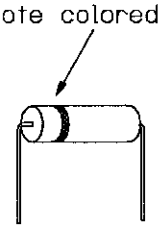
( ) C1 ( ) C2 ( ) C3 ( ) C4

POWER DIODES

The 1N400x power diodes used in the Four-Band EQ are in dark opaque cases with a single white band. The actual diodes supplied may be marked 1N4001, 1N4002, 1N4003, or etc.

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.

Note colored band



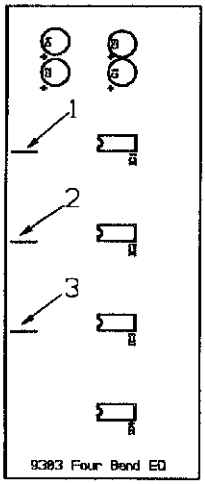
These parts are also somewhat heat sensitive so the soldering operation should be done as quickly as possible.

DESIGNATION TYPE

( ) D2 1N4001
( ) D3 1N4001

JUMPERS

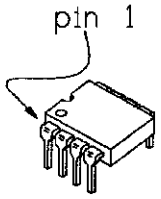
( ) Using excess leads clipped from the resistors, form and install the three circuit board jumpers which are designated by bold lines. Be careful that the jumpers do not touch nearby component leads.



There are 3 jumpers on the Four Band EQ circuit board.

INTEGRATED CIRCUITS

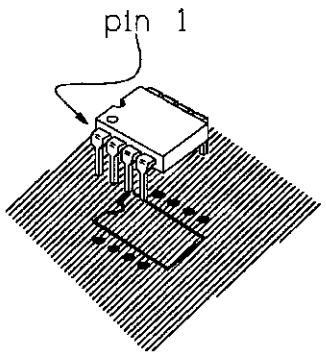
Of all the parts, the ICs are the most easily damaged and should be treated with some respect. In particular, they may be destroyed by discharges of static electricity. Modern ICs are not nearly as sensitive to this kind of damage as were earlier versions, but it is still good practice to handle these 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.

. . . IC installation continued



DESIGNATOR	PART NO.	DESCRIPTION
listed below:	5532	Dual Low Noise OpAmp

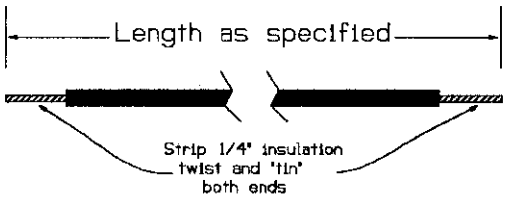
( ) IC1 ( ) IC2 ( ) IC3 ( ) IC4

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

In the following steps, wires will be soldered to the Four-Band EQ circuit board which in later steps will be connected to the front panel controls and connectors. Three different kinds of wire are used; Co-axial and twin-axial cable in places where shielding to prevent noise pickup is important and single conductor stranded wire for the less noise sensitive connections.

Stranded Wire

( ) Cut a 3 inch length of single conductor stranded wire and strip 1/4" of the 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 in the circuit board. Solder one end of this wire to point "O" on the circuit board by pushing it through the hole from the component side. Solder the connection and clip off any excess flush with the joint.

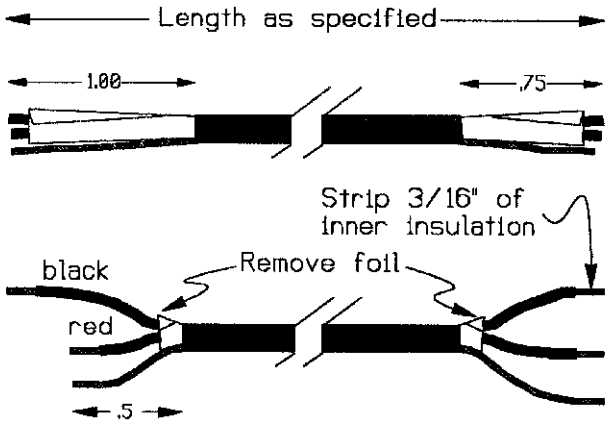


Twin-Axial Cable

Belden 9501 twin-ax will be used to make shielded connections between the circuit board and the Dual Section Potentiometers. At each step, cut a length of the cable as specified and prepare the ends as follows:

On one end of the cable, remove 3/4" of the outer insulating sleeve. Hold the bare drain wire aside and tear off the exposed foil flush with the outer insulation to reveal the red and black insulated conductors.

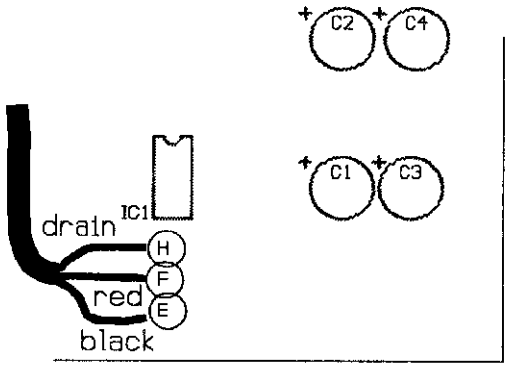
On the other end of the cable remove 1" of the outer insulation and tear the foil back flush. Cut the red insulated wire and the bare drain wire back to a length of 1/2".



On both ends, strip 3/16" inch of insulation from both the red and black leads. Twist and tin the exposed wire strands. On both ends, tin about 1/4" of the drain wire.

Use the end with the equal length red, black and drain wires to make these connections to the circuit board.

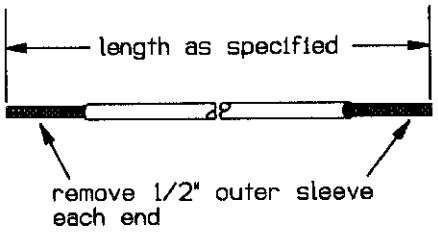
LENGTH	WIRE Color	PC point
( ) 6-1/4"	black	"E"
( )	red	"F"
( )	drain	"H"
( ) 7-3/4"	black	"L"
( )	red	"M"
( )	drain	"N"
( ) 9-1/4	black	"S"
( )	red	"T"
( )	drain	"U"
( ) 10-3/4	black	"X"
( )	red	"Y"
( )	drain	"Z"



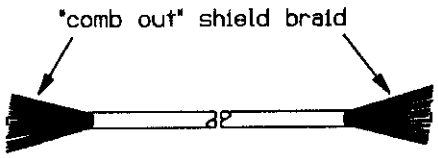
Co-Axial Cable

RG-174/U coaxial cable will be used to make shielded connections between the circuit board and Potentiometers. Each piece of co-ax should be prepared as described on the following page.

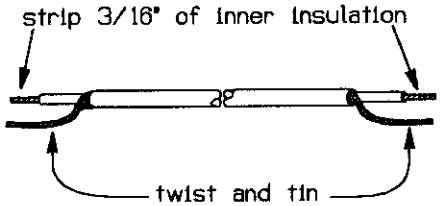
Cut a section of the co-ax supplied to the length specified in the instruction step. Strip 1/2" of the outer insulation at each end of both pieces to expose the braided shield beneath it.



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



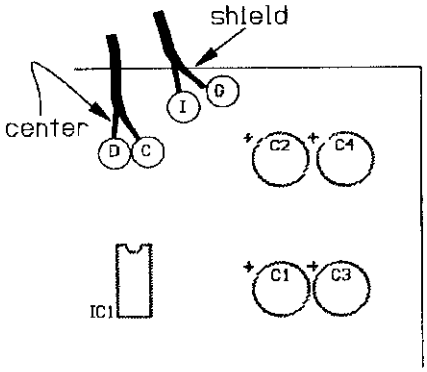
On both ends of each piece, pull the strands of the shield to one side and twist them together. Tin this pigtail by melting a small amount of solder into it.



Strip about 3/16" of the insulation from the inner conductor of both ends of both cables and twist and tin the exposed strands.

Using the lengths of co-ax prepared as above, solder the inner conductor and shield on one end of each piece to the circuit board points given in the steps.

LENGTH	WIRE	PC POINT
( ) 5-1/4"	shield	"G"
( )	center	"I"
( ) 10"	shield	"C"
( )	center	"D"
( ) 11"	shield	"J"
( )	center	"K"
( ) 12"	shield	"P"
( )	center	"R"
( ) 13"	shield	"V"
( )	center	"W"



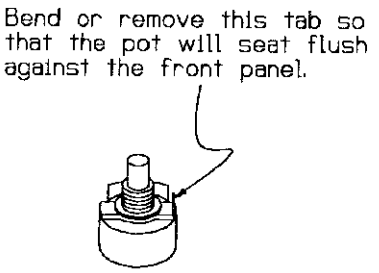
Notice that circuit board points "A" and "B" do not yet have wires connected to them.

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.

( ) Using the flat washers and nuts provided, mount the eight potentiometers as shown in Fig 2. Note that a single section 10k ohm pots are used for R7, R16, R25 and R34. Dual section 100k ohms pots are used for R12, R21, R30 and R39. Orient the lugs of the pots as shown in Fig 3 and fully tighten the nuts to secure these parts.



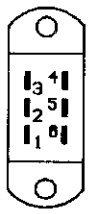
( ) Using the flat washers and nuts provided with them, mount the 2 Open Circuit jacks J1 and J2 as shown in Fig 2. Orient as shown in Fig 3 and tighten the hardware.

( ) Using two 4-40 X 1/4" machine screws and nuts, mount S1 in the location shown in Fig 2. Notice that the DPDT slide switch provided for S1 is symmetrical, so it doesn't matter which end is which as long as you're consistent throughout assembly.

PANEL PRE-WIRING

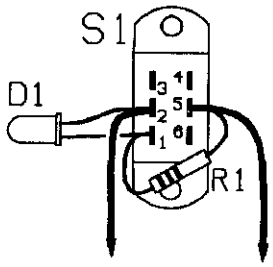
The POWER LED is completely supported by the wiring that connects it to S1 and R1. The following instructions should be followed carefully so that the LED will align with the hole provided for it in the Rack Panel. In this application the LED is not sensitive to polarity so you need not be concerned with the orientation of the polarizing flat on its case. See Fig 3.

( ) Locate the 330 ohm 5% resistor that is used for R1 (color code: orange-orange-brown). Clip both leads of R1 off to a length of 1/2" from the body of the part. Slide one of these leads through lug #1 of S1 and crimp the free end back to hold it in place. DO NOT SOLDER.



( ) Slide the other end of R1 through Lug #5 of S1 and crimp the free end back to hold it in place. DO NOT SOLDER.

( ) Locate the Red LED D1. Slide the longer of the two leads of the LED through Lug #1 of the switch and the other lead through Lug #2 so that the body of the led is slightly less than an inch away from the switch. Solder the two wires connected to lug #1. DO NOT SOLDER the LED lead at Lug #2.



( ) Strip and tin a 3" length of stranded wire. Form a hook in one end and the hook over Lug #5 of S1. Crimp the hook tightly over the lug. Solder this wire and the lead of R1 previously connected to this lug.

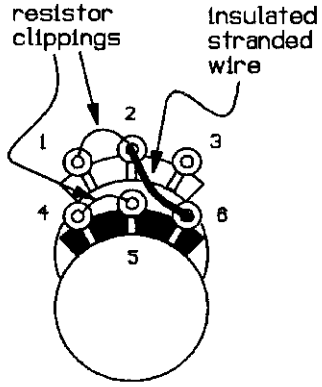
( ) Strip and tin a 3" length of stranded wire. Form a hook in one end, loop it over Lug #2 of S1. Crimp and solder this wire and the LED lead previously connected to this lug. Bend the LED so that it protrudes through the hole in the Rack Panel.

The dual section potentiometers have some wiring between the lugs. All of these pots (R12, R21, R30 and R39) are wired in he same way.

( ) On each of the dual section pots use a resistor lead clipping to connect Lug #4 to Lug #5. Solder the connection at Lug #4. DO NOT SOLDER Lug #5.

( ) On each of the dual pots use a lead clipping to connect Lug #1 to Lug #2. Solder Lug # 1 only. DO NOT SOLDER Lug #2

( ) On each dual pot use a 1" length of stranded wire that has been stripped and tinned on both ends to connect Lug #2 to Lug #6. Solder the two wires connected to Lug 2. DO NOT SOLDER lug #6.



Stranded wire is used for the remaining 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, R34-1 means the lug labeled "1" of the Potentiometer R34 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 are 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.

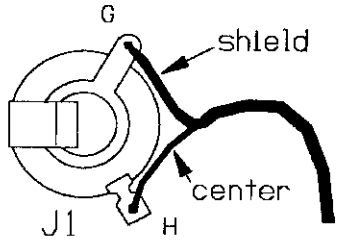
LENGTH	FROM	TO
( ) 4"	R34-1 (S-1)	R25-3 (NS)
( ) 4"	R25-1 (S-1)	R16-3 (NS)
( ) 4"	R16-1 (S-1)	R7-3 (NS)
( ) 6-3/4"	R7-1 (S-1)	J1-H (NS)
( ) 2"	J1-G (NS)	J2-G (S-1)

The circuit board should now be mounted to the rear of the front panel as shown in Fig 4.

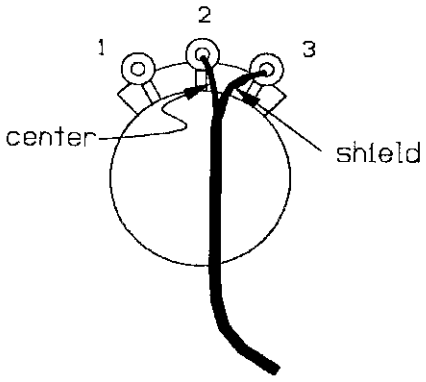
( ) Using the (2) "L" brackets, (2) #4 nuts and (4) 4-40 X 1/4" machine screws provided, attach the partially wired circuit board to the rear of the rack panel. Notice that the "L" brackets have both threaded and unthreaded holes. Use the unthreaded holes and machine nuts to attach the bracket to the circuit board and the threaded holes to attach the bracket to the panel.

Wiring of the Four-Band EQ continues by connecting the wires previously soldered to the circuit board to the pots and jacks as detailed in Figs 5 & 6. Notice that previous wiring has been eliminated from these drawings to give a better view of the present operations.

The following connections are made with the center and shield conductors of the 4 co-ax sections as shown in Fig 5.



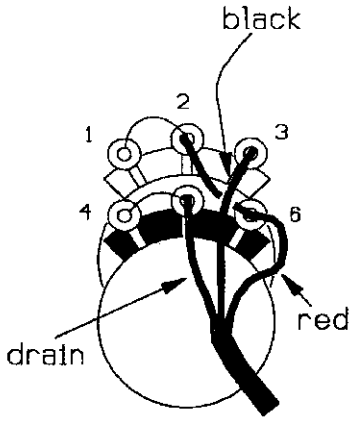
ORIGIN	WIRE	TO
( ) "G"	(shield)	J1-G (S-2)
( ) "I"	(center)	J1-H (S-2)
( ) "C"	(shield)	R7-3 (S-2)
( ) "D"	(center)	R7-2 (S-1)
( ) "J"	(shield)	R16-3 (S-2)
( ) "K"	(center)	R16-2 (S-1)
( ) "P"	(shield)	R25-3 (S-2)
( ) "R"	(center)	R25-2 (S-1)
( ) "V"	(shield)	R34-3 (S-1)
( ) "W"	(center)	R34-2 (S-1)



These connections are made with the wires in the four twin-ax cables coming from the circuit board. See Fig 6 and the illustration of the facing page..

ORIGIN	WIRE	TO
( ) "E"	black	R12-3 (S-1)
( ) "F"	red	R12-6 (S-2)
( ) "H"	drain	R12-5 (S-2)

ORIGIN	WIRE	TO
( ) "L"	black	R21-3 (S-1)
( ) "M"	red	R21-6 (S-2)
( ) "N"	drain	R21-5 (S-2)
( ) "S"	black	R30-3 (S-1)
( ) "T"	red	R30-6 (S-2)
( ) "U"	drain	R30-5 (S-2)
( ) "X"	black	R39-3 (S-1)
( ) "Y"	red	R39-6 (S-2)
( ) "Z"	drain	R39-5 (S-2)



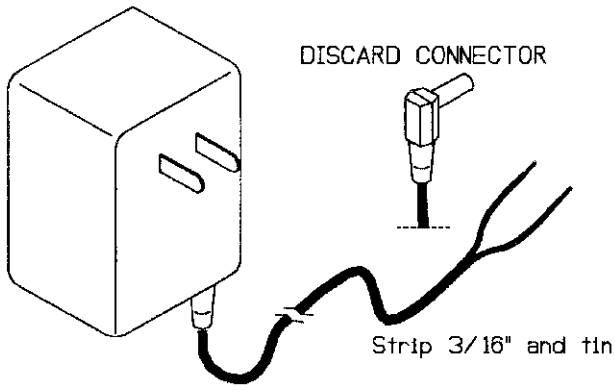
( ) Connect the wire originating at circuit board point "O" to J2-H. Solder this connection.

( ) Twist the two wires coming from Power Switch S1 Lugs 2 and 5 loosely together and connect them to circuit board points "A" and "B". These wires are interchangeable and either can go in either hole in the circuit board.

POWER TRANSFORMER

The final connections are made using the wires from the wall-mount power transformer PWR1. If this part has a connector on the end of its cable, remove and discard it as shown.

( ) Separate the power cord coming from PWR1 into two wires for a distance of 3". Strip 3/16" of insulation from the ends. Twist and tin the exposed wire strands.



( ) Connect and solder the wires from the transformer to lugs #3 and #4 of POWER Switch S1. The wires from the transformer are interchangeable so either can connect to either of the switch lugs #3 or #4.

( ) Install the knobs. Rotate the shaft of the control on which the knob will be placed fully CCW. Use a small screw driver to rotate the set-screw in the knob CCW until the knob will fit loosely over the Control shaft. Align the pointer with the marking at the extreme counterclockwise end of the dial.

The shafts on the Dual Section Potentiometers are slightly shorter that the shafts of the single section pots. Only slide the knob onto the shorter shafts far enough to be even with the knobs on the longer shafts.

THIS COMPLETES THE ELECTRONIC ASSEMBLY OF THE Four-Band EQ. Before plugging the unit in and testing it, take a break then come back and check your work completely.

TESTING

When no power is applied, the Four-Band EQ acts like a simple resistor between the input and output. Before plugging the transformer into the wall and turning the power on, connect an audio source to the input, and then the output to your amp or mixing board. Set all the controls to their centered position. You should hear what you are sending in, but at a reduced volume. If your unit fails this test, a couple of items that you should check are the wiring to the Jacks (make sure the lugs are not interchanged) and to the Potentiometers. Do not turn on the power until you find the source of this problem.

Turn your amp or input fader all the way down (THIS IS VERY IMPORTANT) and plug in the wall wart. Slide the Power Switch to the ON position

and observe that the POWER LED lights. If you don't see the LED light, turn off the unit and find out why. In particular, check the wiring around the Power Switch S1. Also check for solder bridges on the circuit board. Make sure all polarized components are oriented properly.

Bring up the amp volume or fader and observe that the level of the signal source is about the same as it is without the Four-Band EQ in the path. Adjust the Boost/Cut and Frequency controls of each section and observe that the frequency set by the Frequency Control is attenuated at the CCW end of the rotation of the Boost/Cut control and accentuated at the CW end. If any one of the four stages is not working, examine that installation and wiring of components associated with that section (see design analysis section). If none of the controls seem to be working, check the power supply components (Diodes, Electrolytic Capacitors, R2 and R3). Also look for solder bridges on the circuit board.

USING THE FOUR-BAND EQ

This EQ is outstanding for boosting bottom end to do things like beef up drum machine kick drums, but don't forget that the pro's often produce the effect of more bottom by cutting back on the high end.

This circuit can Boost or Cut around 14 to 16dB; depending on the input level, this could be enough gain to clip the signal. Also, there is a lot of overlap between the four bands so that if two adjacent sections are tuned to the same frequency up to 32 dB of gain is available - more than enough to cause clipping on even low level signals. Of all the processors available, EQ tends to be the most abused. Moderation is your best bet.

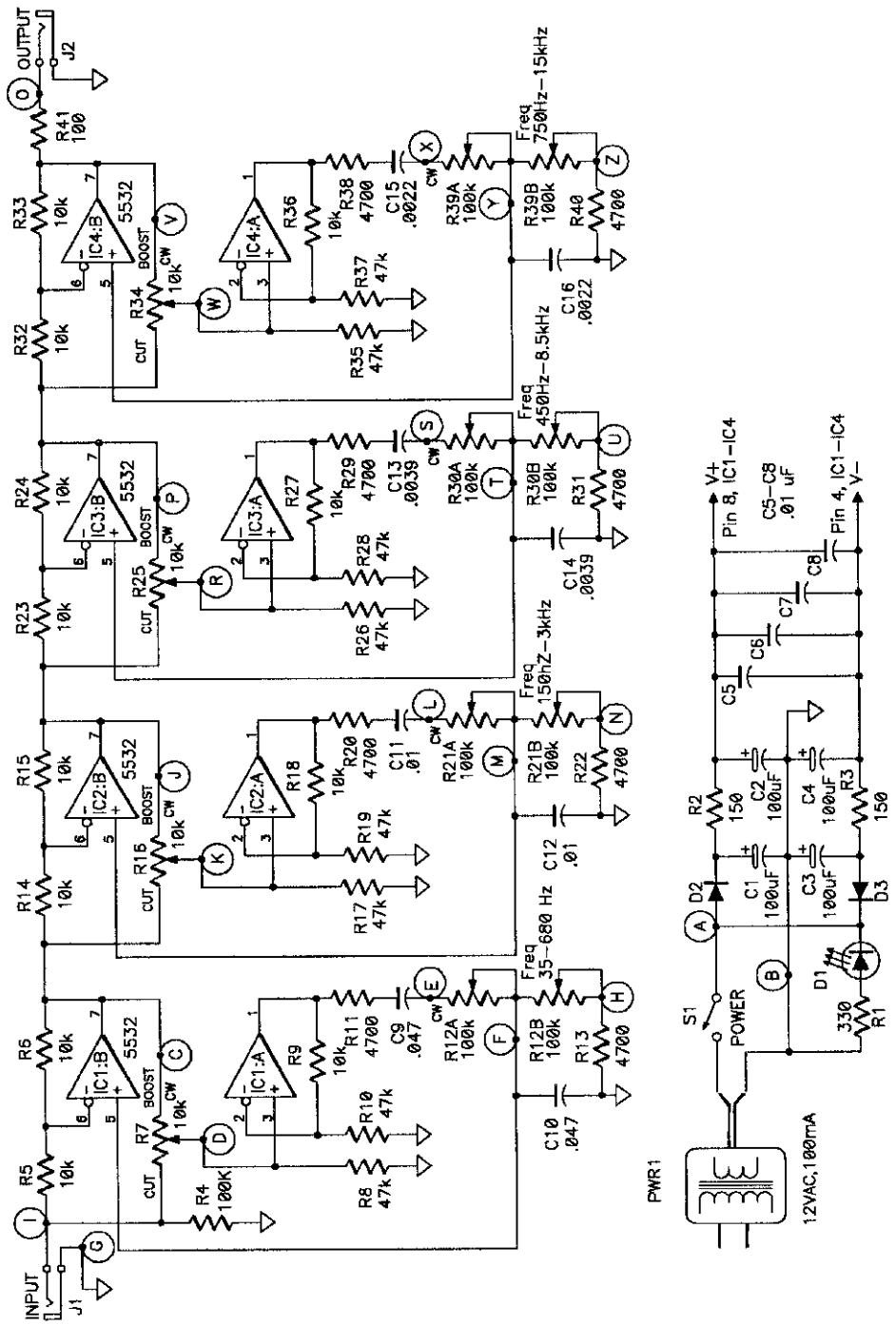
DESIGN ANALYSIS

Notice from the schematic that the design consists of four nearly identical sections. Taking the circuitry around IC1 as typical, IC1:B is set up as a differencing amplifier. If the non-inverting input (the "+" pin) of this stage were connected to ground, this would be a simple inverting buffer. However, notice that instead of being grounded the non-inverting input is driven by the group of filter components discussed below.

A bandpass filter is implemented with an input buffer (IC1:A) driving a highpass filter section (R11, R12a and C9) which in turn feeds a low pass filter section (R12B, R13 and C10). The input to the bandpass filter is taken from the wiper of the Boost/Cut pot (R7). Notice that the "CUT" end of this control is driven from the input signal while the "BOOST" end is driven from the inverted output of IC1:B (the original input, but 180 degrees out of phase). When the wiper of R7 is centered, the out-of-phase signals applied to each end of the pot cancel and the filter driving stage (IC1:A), and consequently the filter, receives no input. Under these conditions there is neither Cut nor Boost.

When the pot is set for full Cut, the original signal is sent to the filter stage. The filter components produce a 0 degree phase shift at the frequency of interest and so the output is in phase when subtracted from the original signal (which is the effect of driving the "+" input of IC1:B with the output of the filter sections.) Frequencies falling in the passband of the filter cancel with the original signal and produce a "cut" at this frequency.

When the pot is set for full Boost, the filter components are driven by a signal inverted from the original. Under these conditions, the portion of the signal that gets through the bandpass filter components is also inverted. When the inverted signal is subtracted from the original, the result is a summation that results in a Boost in the frequency selected by the filter.


INPUT
J1
OUTPUT
J2
IC1:A
IC1:B
IC2:A
IC2:B
IC3:A
IC3:B
IC4:A
IC4:B
5532
BOOST
CUT
CW
Freq
35-680 Hz
150hZ-3kHz
450Hz-8.5kHz
750Hz-15kHz
POWER
S1
PWR1
12VAC,100mA
V+
V-
Pin 8, IC1-IC4
Pin 4, IC1-IC4
C5-C8
.01 uF

9303 Four Band EQ

Packing List

4	5532 Dual Low Noise OpAmp	
2	.0022 uF Polystyrene Capacitors	
2	.0039 uF Mylar Capacitors	
2	.01 uF Mylar Capacitors	
2	.047 uF Mylar Capacitors	
4	.01 uF Ceramic Disk Capacitors	
2	1N4001 Silicon Diodes	
1	Red LED	
4	100uF/16V Electrolytic Capacitors	
4	100k Ohm Dual Section Potentiometer	
4	10k Ohm Single Section Pot.	
1	100	all resistor 1/4W 5%
1	100K	all values in Ohms
12	10k	
2	150	
1	330	
8	4700	
8	47k	
2	1/4" Open Circuit Phone Jacks	
1	DPDT Slide Switch	
1	12VAC 100mA min. Wall Mount Transformer	
8	Set Screw Knobs	
6	4-40 X 1/4" Machine Screws	
4	#4 Machine Nuts	
2	#4 "L" Brackets	
1	9303 Circuit Board	
36in.	#22 Stranded Wire	
52in.	RG-174/U Coaxial Cable	
36in.	Belden 9501 Twin-Axial Cable	

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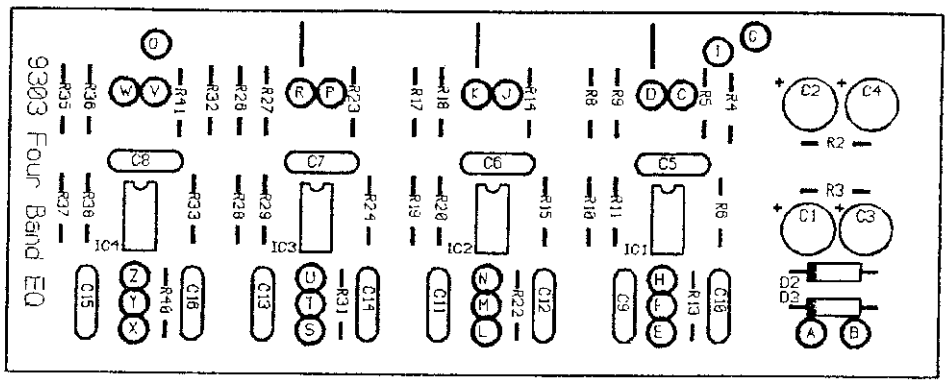


Fig 1a. Components mount on the circuit board at the locations shown in this parts placement diagram.

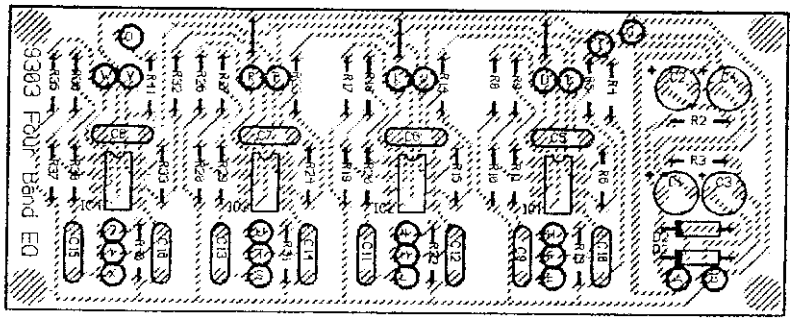


Fig 1b. This view of parts placement with phantom traces will be useful if you need to trace out the circuit.

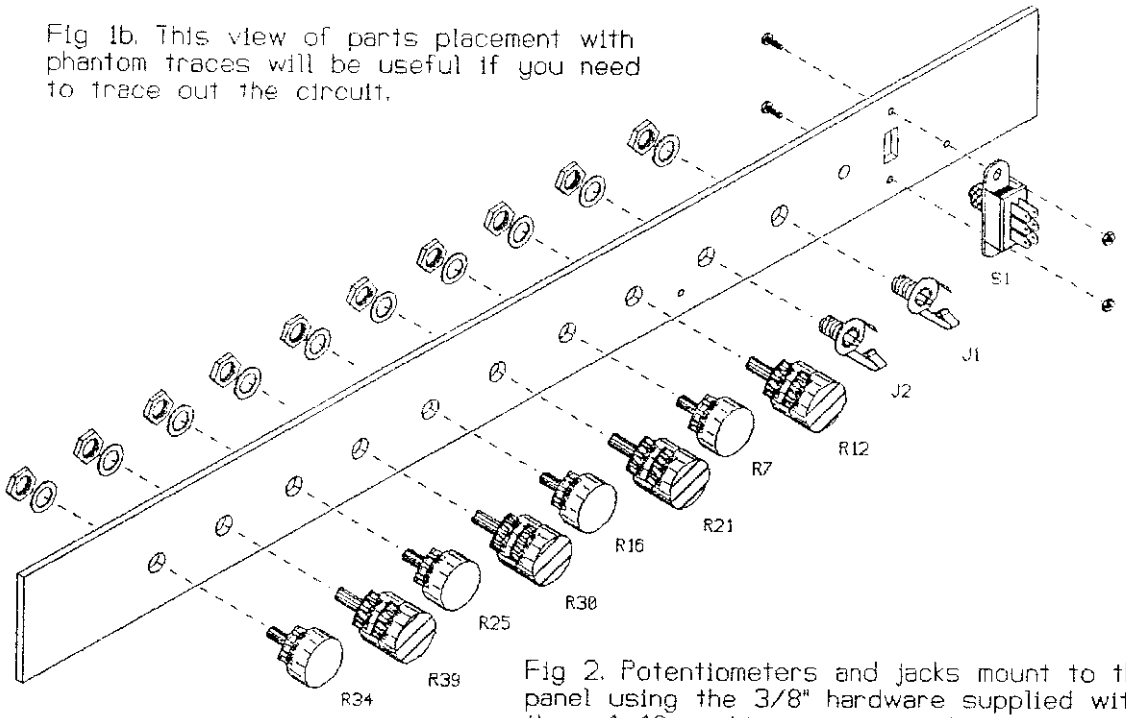


Fig 2. Potentiometers and jacks mount to the panel using the 3/8" hardware supplied with them. 4-40 machine screws and nuts mount the power switch S1.

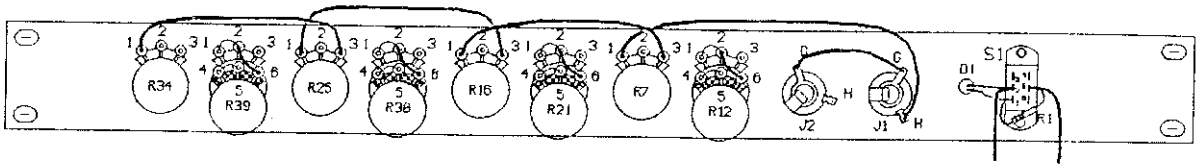


Fig 3. Single strands of insulated wire make the connections between panel controls and jacks.

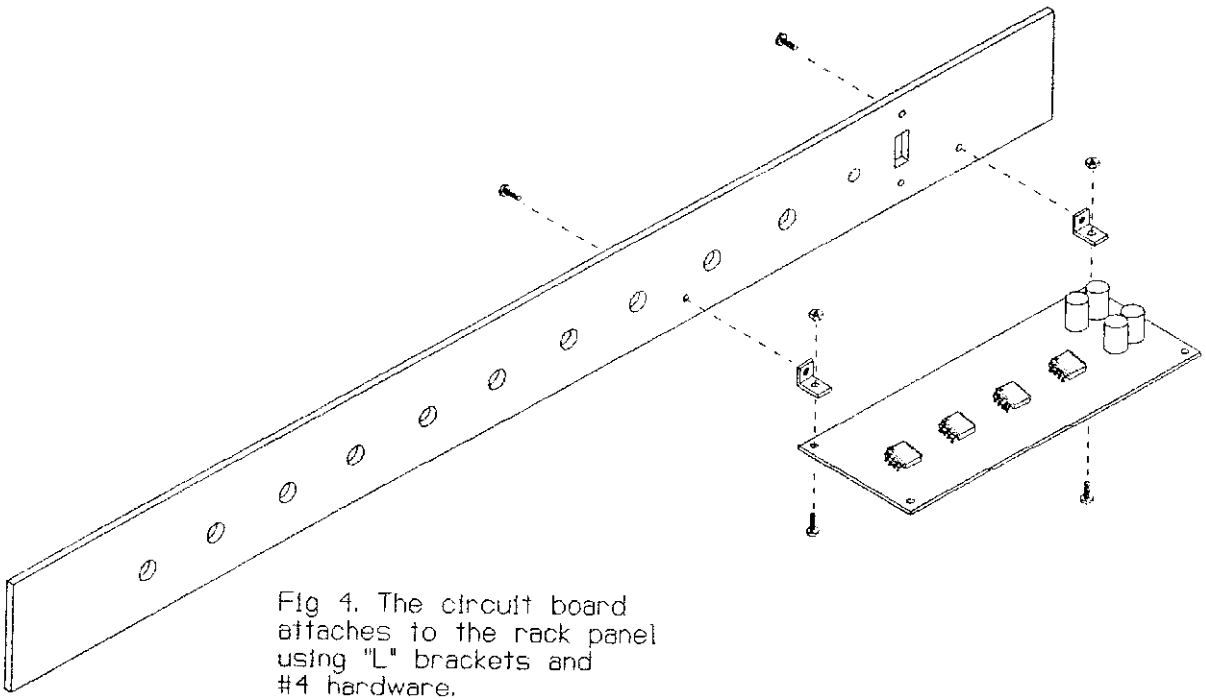


Fig 4. The circuit board attaches to the rack panel using "L" brackets and #4 hardware.

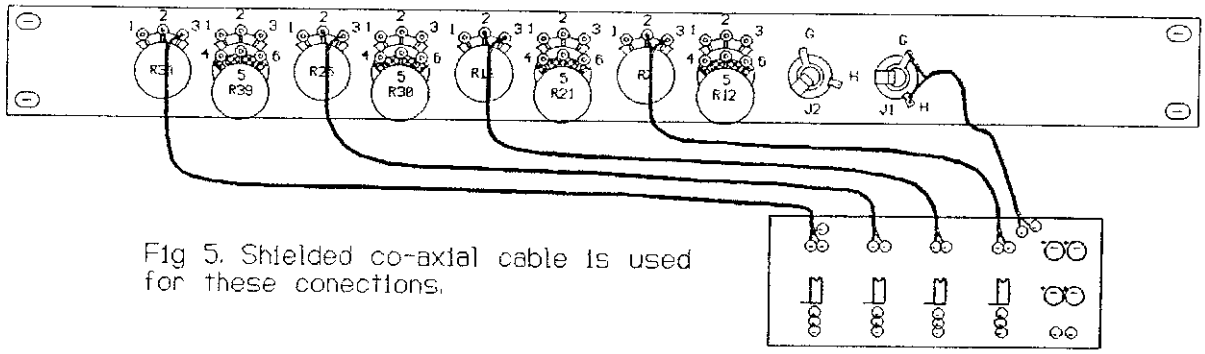


Fig 5. Shielded co-axial cable is used for these conections.

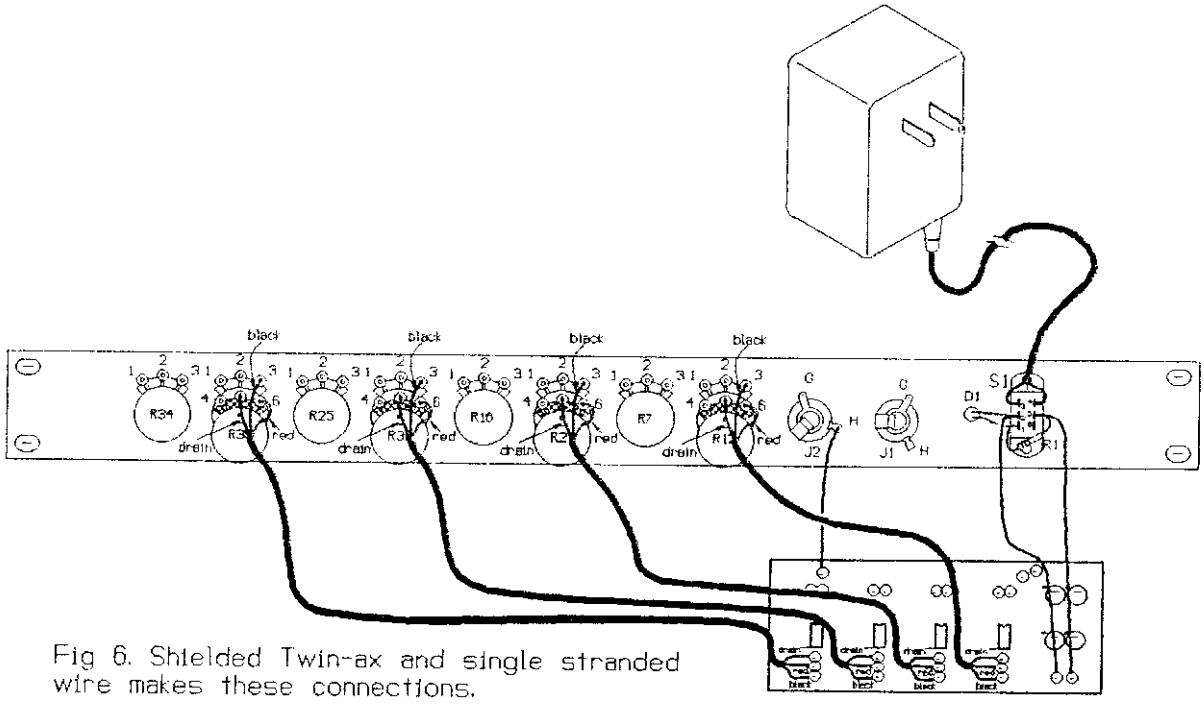
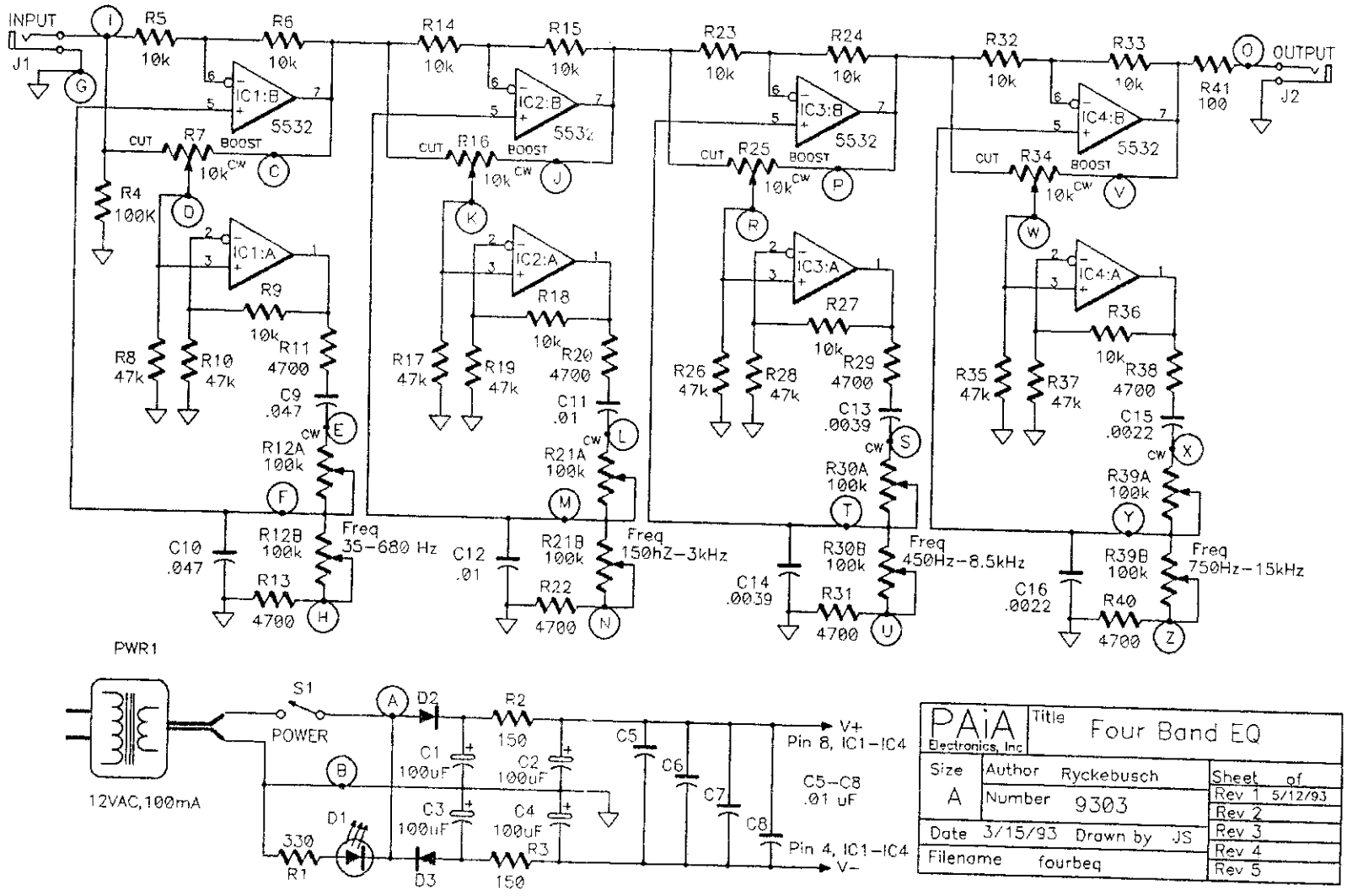


Fig 6. Shielded Twin-ax and single stranded wire makes these connections.



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	Number: 9303	Rev 1 5/12/93
Date: 3/15/93 Drawn by: JS		Rev 2
Filename: fourbeq		Rev 3
		Rev 4
		Rev 5