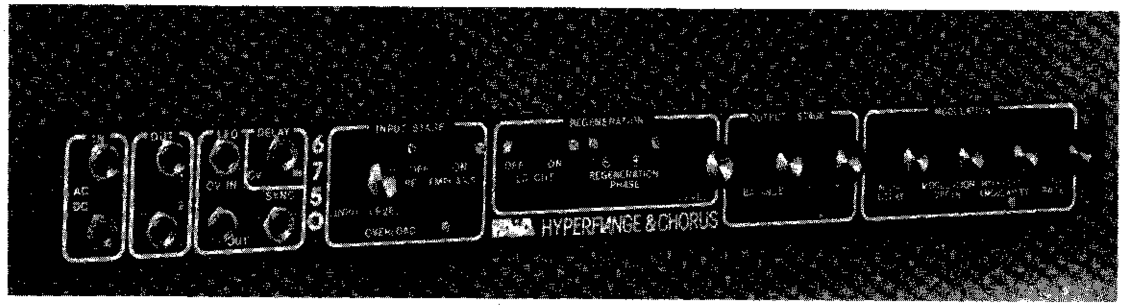
6750

HYPERFLANGE & CHORUS



ASSEMBLY & USING MANUAL

 PAiA Electronics, Inc.

DELAY CHANNEL SPECS

Dynamic range, unweighted: 80 db
Dynamic range, "A" weighted: 86 db
Maximum input before clipping, any delay time, input level up full: 2V p-p
Frequency response, R42 and R43 = 22K: -6 dB, 10 Hz; -2 dB, 20 Hz; 0 dB 50 Hz; +2 dB, 4500 Hz; -6 dB, 8500 Hz; -20 dB, 12KHz.
With R42 and R43 = 10K, response is flat to 10KHz. However, this isn't recommended - the noise becomes more obvious, but there isn't a whole lot of musical energy up there worth flanging.
Pre-emphasis boost: +14 dB @ 6 KHz (GREAT for guitar and voice)

OTHER SPECS

Straight channel frequency response: +/- 1 dB, 20 Hz to 20 KHz
Maximum notch depth: 60 dB
Sweep range, manual control: 25.6 ms to 500 usec (50:1)
Sweep range, LFO control: 25.6 ms to 350 usec (greater than 70:1)
Maximum output @ 1 KHz into 1K load: 20V p-p

FOR CUSTOMER SERVICE
PHONE 1-405-843-9626
9AM-5PM CST MON-FRI

TECHNICAL INFORMATION OR ASSISTANCE
1-405-843-6435
9AM TO 5PM
MONDAY-WEDNESDAY-FRIDAY ONLY

!! IMPORTANT !!

Prior to beginning assembly of your new kit, check the supplied parts with the following parts list. BE DILIGENT.

QNTY	VALUE	DESC. (alternate marking)
	FIXED RESISTORS	
1	10 Ohm	brown-black-black
5	33 Ohm	orange-orange-black
1	100 Ohm	brown-black-brown
2	470 Ohm	yellow-violet-brown
1	820 Ohm	grey-red-brown
3	1K	brown-black-red
1	1.8K	brown-grey-red
2	2.7K	red-violet-red
1	4.7K	yellow-violet-red
1	5.6K	green-blue-red
16	10K	brown-black-orange
1	15K	brown-green-orange
2	22K	red-red-orange
2	33K	orange-orange-orange
2	47K	yellow-violet-orange
12	100K	brown-black-yellow
1	220K	red-red-yellow
1	330K	orange-orange-yellow
1	470K	yellow-violet-yellow
3	1 Megohm	brown-black-green
1	2.2 Megohm	red-red-green
3	10 Megohm	brown-black-blue
	CERAMIC DISK CAPACITORS	
		(ALTERNATE MARKING)
2	15pF	15
6	500pF	500
2	.001 MFD.	102
1	.005 MFD.	502
7	.01 MFD.	103
	POLYSTYRENE CAPACITORS	
3	47pF	47
1	240pF	240
1	1200pF	1200 or .0012
1	2200pF	2200 or .0022
2	.1 MFD.	104
2	.22 MFD.	224

PARTS LIST CONT. NEXT PAGE

ELECTROLYTIC CAPACITORS

2	1 MFD./15V.	Greater voltage ratings acceptable.
8	2.2 MFD./15V.	
1	4.7 MFD./15V.	
6	10 MFD./15V.	
6	33 MFD./15V.	
1	100 MFD./15V.	

SEMICONDUCTORS

3	1N4001 or similar (4002 or 4003) POWER DIODE
1	TIL 209 RED LIGHT EMITTING DIODE
1	CEM3340 VCO IC
1	4046 CMOS PHASE LOCKED LOOP IC
1	4041 CMOS QUAD BUFFER IC
1	NE570 or 571 COMPANDER IC
1	SAD1024 ANALOG DELAY IC
1	4136 QUAD OP-AMP IC
3	LM301 or 748 or equivalent OP-AMP IC

POTENTIOMETERS

3	10K PC MOUNT TRIM-POT
1	50K PC MOUNT TRIM-POT
1	500K PC MOUNT TRIM-POT
3	5K LIN. PANEL MOUNT POT
1	100K LIN. DUAL PANEL MOUNT POT
2	250K AUDIO TAPER PANEL MOUNT POT
2	500K LIN. PANEL MOUNT POT

INPUT/OUTPUT JACKS

7	OPEN CIRCUIT 1/4 INCH JACK
1	CLOSED CIRCUIT 1/4 INCH JACK

MISCELLANEOUS PARTS

2	SPDT SLIDE SWITCH
1	DPDT SLIDE SWITCH
4	16 PIN IC SOCKET
2	14 PIN IC SOCKET
3	8 PIN IC SOCKET
1	3 PIN MOLEX POWER CONNECTOR (includes PC mount piece AND mating plug with 1 male and 2 female connecting pins).
2	"L" BRACKETS
8	4-40 X 1/4" MACHINE SCREW
2	4-40 X 3/4" MACHINE SCREW
8	4-40 NUT
2	5/16" SPACERS
8	POT NUT
8	JACK MOUNT NUT and WASHER (may be packed on jacks).

PARTS LIST CONT. NEXT PAGE

5 1/2 FT.	RG174/U CO-AX CABLE
15 FT.	#22 INSULATED WIRE
2 FT.	BARE WIRE
8	CONTROL KNOB
4	WIRE TIE
1 1/4"	SMALL (#10) PLASTIC TUBING
1/2"	LARGE (20 guage) PLASTIC TUBING
1	6750 PC BOARD
1	6750 FRONT PANEL

NOTES

HYPERFLANGE & CHORUS

Assembly Instructions

INTRODUCTION

Thank you for buying the PAIA 6750 HYPERFLANGE+CHORUS kit. We realize that you are anxious to get on with the assembly, but before you start, please take the time to read the hints and suggestions that follow.

-- BEFORE YOU BEGIN --

Familiarize yourself with this manual. It's not necessary to read the whole thing in detail, but at least go through and look at the illustrations. Get a feel for the parts and how they fit together. It is particularly important to check the parts supplied against the parts list in the front of this manual.

While assembling, keep yourself alert and if you find yourself getting tired or bored, TAKE A BREAK. We know, you've been looking forward to this for some time and want to get it done as soon as possible, but do us all a favor - TAKE YOUR TIME. Time invested in careful assembly now will pay great dividends in the time saved trouble-shooting for careless errors when you're done.

SOLDERING

Successful operation of your kit, as well as its longevity, is probably more dependent on how the components are soldered in place than any other one thing that the assembly involves. There are three key rules to go by, these are as follows:

TYPE OF SOLDER: Use ONLY ROSIN CORE SOLDER. Acid core solder or paste flux should never be used to assemble electronic circuitry, and the use of either on this kit will VOID THE WARRANTY. Good 60/40 rosin core solder is expensive, but it may be considered a long term investment, and well worth it.

SOLDERING TOOL: Use a soldering iron with a power rating of about 25 watts to 35 watts, and a small pointed tip. Soldering guns are completely unacceptable for soldering solid state components, as the large magnetic fields they generate can easily damage some components.

Be sure to keep your soldering iron tip clean. Before soldering a connection, wipe the tip on a damp sponge. This will aid in heat transfer and prolong tip life.

SOLDERING TECHNIQUE: We recommend looking at the solder connections on commercially available amps and effects units and try to imitate them as closely as possible. A proper circuit board solder joint has just enough solder to cover the soldering pad and about 1/16" (2mm) of the component lead passing through it.

To solder, hold the tip of the iron against both the wire to be soldered and the circuit board foil (or jack lug, switch lug, or whatever). Hold it there for a second or two to let things heat up, then feed a small amount of solder onto the connection. Do not simply feed the solder onto the tip of the iron and expect it to run down onto the connection. Continue holding the iron against the connection until the solder melts fully and flows freely over the connection. Then remove the iron and let the joint cool. Do not move any of the wires while the solder is cooling; if this happens, re-heat the connection, feeding in a tiny bit more solder.

There are two types of improper connections to watch out for; using too little solder (or too little heat) will result in a connection which will appear to be soldered when actually there is a layer of flux or oxidation insulating the component lead. To cure this, re-heat the connection and flow a small additional amount of solder on the joint. Using too much solder can lead to excess solder flowing between adjacent terminals or traces of a circuit board, causing a short circuit. Unintentional solder bridges of this type can be cleaned off onto the tip of a CLEAN, hot soldering iron while holding the board upside down. Another problem with using too much solder is that it can flow over to an adjacent hole, blocking it with solder. If this happens, again hold the board upside down and flow solder away from the blocked hole and onto the tip of a clean hot iron. Use a pin to poke through any remaining solder in the hole.

Finally, avoid using too much heat or leaving the iron on the connection for too long. Excessive heat can damage many types of electronic parts, and in extreme cases can cause traces to lift from the circuit board.

CIRCUIT BOARD ASSEMBLY

CIRCUIT BOARD PREPARATION

() Prepare the 6750 circuit board for assembly by thoroughly cleaning the conductor side with a scouring cleanser (rinse the board completely with clean water and allow to dry) or Scotch Bright (R) or a clean steel wool pad. DO NOT USE PRE-SOAPED PADS. The board must be bright and shiny to accept the solder and failure to clean the board will result in poor solder joints and will VOID THE WARRANTY on the kit.

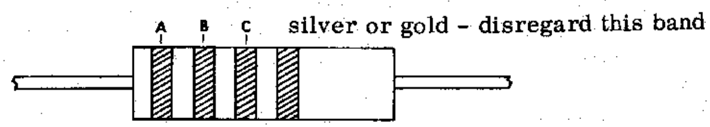
JUMPER WIRE INSTALLATION

() Using the BARE wire provided, form and install the 18 wire jumpers on the circuit board. Designations for these jumpers are the solid lines broken with the letter "J" printed on the component side of the board, and in the parts placement drawing figure 1, in the illustration supplement located in the center of the book. Working with one piece of wire, start with the longest jumpers and work through to the shorter ones. Insert one end of the wire into one of the holes provided, from the COMPONENT SIDE of the board (side printed with parts placement designators). Turn the board over and solder the connection on the CONDUCTOR SIDE (foil side).

Insert the other end of the wire into the other hole provided for the jumper, and then pull the rest of the wire through from the conductor side until the wire is stretched tightly across the top of the board so that it will not come in contact with adjacent jumpers or component leads. Solder the connection on the conductor side and clip off the left over length of wire. Move on to the next jumper and follow the same steps until all 18 jumpers have been installed. Note that the wire supplied can be straightened pulling it between your pinched thumb and forefinger severalger several times. Check to make sure 18 jumpers have been installed.

RESISTOR INSTALLATION

Solder each of the fixed resistors in place following the parts placement designators printed on the circuit board and shown in assembly drawing figure 1. Note that the fixed resistors are non-polarized and may be mounted with either of their two leads in either of the holes provided. Insert both leads in the mounting holes and push the resistor FULLY against the board. On the conductor side of the board, bend the leads outward to about a 45 degree angle to help hold the component in place while soldering. AFTER SOLDERING, clip off each lead end flush with the top of the solder joint.



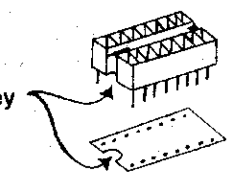
DESIGNATION	VALUE	COLOR CODE
() R1	10 Ohm	brown-black-black
() R35	33 Ohm	orange-orange-black
() R36	33 Ohm	orange-orange-black
() R37	33 Ohm	orange-orange-black
() R38	33 Ohm	orange-orange-black
() R39	33 Ohm	orange-orange-black
() R75	100 Ohm	brown-black-brown
() R2	470 Ohm	yellow-violet-brown
() R3	470 Ohm	yellow-violet-brown
() R4	820 Ohm	grey-red-brown
() R5	1K	brown-black-red
() R6	1K	brown-black-red
() R72	1K	brown-black-red
() R7	1.8K	brown-grey-red
() R40	2.7K	red-violet-red
() R41	2.7K	red-violet-red
() R8	4.7K	yellow-violet-red

( ) R9	5.6K	green-blue-red
( ) R10	10K	brown-black-orange
( ) R11	10K	brown-black-orange
( ) R12	10K	brown-black-orange
( ) R13	10K	brown-black-orange
( ) R14	10K	brown-black-orange
( ) R44	10K	brown-black-orange
( ) R45	10K	brown-black-orange
( ) R46	10K	brown-black-orange
( ) R47	10K	brown-black-orange
( ) R50	10K	brown-black-orange
( ) R51	10K	brown-black-orange
( ) R52	10K	brown-black-orange
( ) R53	10K	brown-black-orange
( ) R74	10K	brown-black-orange
( ) R60	15K	brown-green-orange
( ) R42	22K	red-red-orange
( ) R43	22K	red-red-orange
( ) R15	33K	orange-orange-orange
( ) R61	33K	orange-orange-orange
( ) R62	47K	yellow-violet-orange
( ) R63	47K	yellow-violet-orange
( ) R17	100K	brown-black-yellow
( ) R18	100K	brown-black-yellow
( ) R19	100K	brown-black-yellow
( ) R20	100K	brown-black-yellow
( ) R21	100K	brown-black-yellow
( ) R22	100K	brown-black-yellow
( ) R23	100K	brown-black-yellow
( ) R64	100K	brown-black-yellow
( ) R65	100K	brown-black-yellow
( ) R66	100K	brown-black-yellow
( ) R67	100K	brown-black-yellow
( ) R76	100K	brown-black-yellow
( ) R26	220K	red-red-yellow
( ) R30	330K	orange-orange-yellow
( ) R69	470K	yellow-violet-yellow
( ) R31	1 Megohm	brown-black-green
( ) R32	1 Megohm	brown-black-green
( ) R33	1 Megohm	brown-black-green
( ) R34	2.2 Megohm	red-red-green
( ) R70	10 Megohm	brown-black-blue
( ) R71	10 Megohm	brown-black-blue
( ) R73	10 Megohm	brown-black-blue

SOCKET INSTALLATION

Install each IC socket by inserting its pins into the holes provided from the COMPONENT side of the board and then soldering each pin to its respective pad on the CONDUCTOR (foil) side of the board. BE SURE THE SOCKET IS PRESSED FIRMLY DOWN ON THE BOARD AND THAT ALL THE PINS ARE PROTRUDING THROUGH TO THE CONDUCTOR SIDE. Some sockets may bear orientation markings on one end. While there is no electrical significance to the orientation of the socket, it is good practice to acknowledge these markings and orient the socket accordingly. Normally the marked end will correspond to the semi-circle notch at one end of the parts placement designator drawn on the circuit board.

DESIGNATION	TYPE
() IC SOCKET 4	8 PIN
() IC SOCKET 5	8 PIN
() IC SOCKET 9	8 PIN
() IC SOCKET 3	14 PIN
() IC SOCKET 8	14 PIN
() IC SOCKET 1	16 PIN
() IC SOCKET 2	16 PIN
() IC SOCKET 6	16 PIN
() IC SOCKET 7	16 PIN



CAPACITOR INSTALLATION

Install the ceramic disk capacitors. Like the resistors, these components are non-polarized. The value of the capacitor will be marked on the body of the part. Solder in place and clip the excess leads.

DESIGNATION	VALUE	ALTERNATE MARKING
() C13	15pF	15
() C14	15pF	15
() C15	500pF	500
() C19	500pF	500
() C20	500pF	500
() C21	500pF	500
() C22	500pF	500
() C52	500pF	500
() C50	.001 MFD.	102
() C51	.001 MFD.	102
() C24	.005 MFD.	502
() C3	.01 MFD.	103
() C4	.01 MFD.	103
() C5	.01 MFD.	103
() C6	.01 MFD.	103
() C25	.01 MFD.	103
() C26	.01 MFD.	103
() C27	.01 MFD.	103

Install the polystyrene capacitors in the same manner as above. These capacitors are also non-polarized and the value will be marked on the body of the part. Solder in place and clip the excess leads.

DESIGNATION	VALUE	ALTERNATE MARKINGS
() C1	47pF	47
() C16	47pF	47
() C17	47pF	47
() C18	240pF	240
() C2	1200pF	1200J
() C23	2200pF	2200
() C7	.1 MFD.	104
() C28	.1 MFD.	104
() C8	.22 MFD.	224K

Up to this point, all components have been non-polarized, (i.e. either lead can go into either hole). Electrolytic capacitors are polarized; just like a battery they have a (+) and a (-) end; and like a battery, if installed incorrectly the circuit won't work. The capacitors supplied will have either the (+) or the (-) lead marked on the body of the part. The (+) lead must go through the circuit board hole which has also been labeled positive (+). In the event that the capacitors have their negative (-) leads marked, this lead should go through the unmarked hole in the circuit board.
NOTE THAT THE SPECIFIED VOLTAGE RATING IS A MINIMUM RATING. CAPACITORS SUPPLIED WITH CERTAIN KITS MAY HAVE A HIGHER VOLTAGE RATING THAN THAT SPECIFIED.

DESIGNATION	VALUE	ALTERNATE MARKING
() C30	1 MFD./15V.	Greater voltage ratings acceptable.
() C31	1 MFD./15V.	
() C33	2.2 MFD./15V.	
() C35	2.2 MFD./15V.	
() C36	2.2 MFD./15V.	
() C37	2.2 MFD./15V.	
() C38	2.2 MFD./15V.	
() C39	2.2 MFD./15V.	
() C40	2.2 MFD./15V.	
() C32	4.7 MFD./15V.	

NOTE: When installing C9, do not cover the hole labeled (G1').

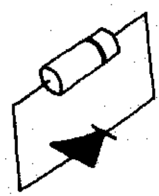
() C9	10 MFD./15V
() C10	10 MFD./15V.
() C11	10 MFD./15V.
() C41	10 MFD./15V.
() C42	10 MFD./15V.
() C43	10 MFD./15V.
() C44	33 MFD./15V.
() C45	33 MFD./15V.
() C46	33 MFD./15V.
() C47	33 MFD./15V.

() C48	33 MFD./15V.
() C49	33 MFD./15V.
() C12	100 MFD./15.

DIODE INSTALLATION

Install the diodes. Like all semiconductors, diodes are heat sensitive. To be on the safe side, heat sink each diode lead by grasping the lead with a pair of needlenose pliers ar a small copper alligator-type clip at a point between the body of the component and the circuit board. Be sure to orient the diodes as shown in the adjacent drawing.

DESIGNATION	TYPE
() D1	1N4001 or 1N4003
() D2	1N4001 or 1N4003
() D3	1N4001 or 1N4003



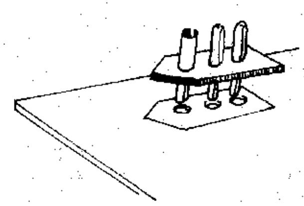
P.C. MOUNT TRIMMER POTS

Install each of the 5 P.C. mount trimmer pots by pushing the three solder lugs located at the bottom of the part through the three grouped holes provided for each pot and then soldering the lugs to the foil pads on the conductor side of the board. THESE SOLDER CONNECTIONS WILL REQUIRE SLIGHTLY LONGER "HEATING TIME" THAN DID THE OTHER COMPONENTS, IN ORDER TO DEVELOP A GOOD SOLDER JOINT. The value of the pot is marked on the body of the part.

DESIGNATION	VALUE	ALTERNATE MARKING
() R16 "LOW CLOCK TRIM"	50K	R503B
() R27 "H TRI TRIM"	500K	R504B
() R54 "CLIP"	10K	R103B
() R55 "BIAS"	10K	R103B
() R56 "CLOCK CANCEL"	10K	R103B

POWER CONNECTER

() Install the three pin Molex power connector. Note that the plastic part of the connecter is flat on one end and pointed on the other end. Note also that the part placement designator drawing has one flat end and one pointed end. Orient the power connecter to match the drawing.



POINT TO POINT WIRING

In the following steps the insulated wire supplied with the kit will be used to form the 5 insulated wire jumpers on the P.C. board. At each step, prepare the wire by cutting it to the specified length and stripping 1/4 inch (.7cm) of insulation from each end. "Tin" each end of the wire by twisting the strands together and melting just enough solder into the wire to hold the strands together.

LENGTH	FROM	TO
() 1-1/2" (3.9cm)	A	A'
() 1-1/2" (3.9cm)	B	B'
() 2" (5.1cm)	(V-)	(V-)
() 3-1/2" (9 cm)	[V-]	[V-]
() 1-3/4" (4.5cm)	G1	G1'

The insulated wire supplied with the kit will also be used to make the connections between the circuit board and the front panel mounted controls and jacks. In the following steps prepare each piece of wire as above. To make sure that you will have sufficient wire for all steps, "rotate" through the pieces supplied, at each step cutting from the longest piece available. ONLY THE CONNECTION TO THE CIRCUIT BOARD WILL BE MADE AT THIS TIME. The other end of each wire will be connected to the controls and jacks on the front panel in later steps.

LENGTH		FROM
()17 1/2"	(45.5cm)	C (LFO CV IN)
()3"	(7.7cm)	D
()2 1/2"	(6.4cm)	E
()3"	(7.7cm)	F
()3 1/4"	(8.3cm)	H
()15 1/2"	(39.4cm)	J (LFO OUT)
()16"	(40.7cm)	X (SYNC IN)
()2 1/4"	(5.7cm)	L
()2 1/4"	(5.7cm)	M
()3 1/2"	(8.9cm)	N
()2 1/4"	(5.7cm)	P
()1 3/4"	(4.5cm)	Q
()2 1/2"	(6.4cm)	R
()5 1/2"	(14 cm)	F'
()3 1/2"	(8.9cm)	J'
()2 3/4"	(7 cm)	K'
()2 1/4"	(5.7cm)	L'
()2 1/2"	(6.4cm)	M'
()6 1/2"	(16.5cm)	P'
()2"	(5.2cm)	G2
()1 3/4"	(4.5cm)	G3
()1 3/4"	(4.5cm)	G4
()1 3/4"	(4.5cm)	G5
()2"	(5.2cm)	G6
()1 1/2"	(3.8cm)	G7
()1 1/2"	(3.8cm)	G8
()3 3/4"	(9.6cm)	G9

CO-AX INSTALLATION

Several of the connections from the circuit board to the front panel will be made using the RG-174/U co-axial cable supplied with the kit. The ends of each piece of cable used in the following steps must be prepared for two connetions at the circuit board and one connection at the front panel.The shield wires will connect to ground points on the circuit board but will NOT connect to any points on the front panel.

At each step cut the cable to the specified length and then strip 3/4 inch (1.9cm) of the outer insulation from ONE END. "Un-braid" the exposed shielding wires. Pull all the strands of wire to one side and tightly twist them together. Strip 1/4 inch (.7cm) of insulation from the now exposed INNER conductor. Twist together and tin the inner conductor strands.

Prepare the other end of each cable in the same manner as above, except remove only 1/2" of the outer insulation, and clip off the SHIELDING wire flush with the end of the outer insulation.(The shield wires will not be connected to anything at this end).

ONLY THE CONNECTIONS TO THE CIRCUIT BOARD WILL BE MADE AT THIS TIME.

Working with the end of the cable prepared WITH shield, push the inner conductor of each cable through the lettered hole provided from the component side of the board and solder the connection on the conductor side. Push the shielding wires through the immediately adjacent "GROUND" connection hole and solder the connection on the foil side. All of the ground connection points for the co-ax cables are designated by solid circles joined by a solid line which terminates with a ground symbol (⏚) drawn on the circuit board.

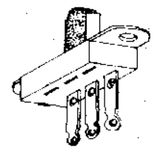
LENGTH		FROM
()8 1/4"	(21 cm)	S
()7"	(17.8cm)	T
()4"	(10.2cm)	U
()9 1/4"	(23.5cm)	V (A IN)
()10 1/4"	(26 cm)	C' (D IN)
()7 1/4"	(18.4cm)	D'
()5"	(12.7cm)	E'
()2 3/4"	(7 cm)	H'
()5"	(12.7cm)	N'

SET THE 6750 CIRCUIT BOARD ASIDE AND MOVE ON TO FRONT PANEL ASSEMBLY.

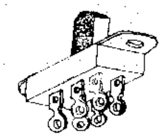
FRONT PANEL ASSEMBLY

Locate the 6750 rack mount panel. Install the slide switches on the panel using two 4-40 X 1/4" machine screws, and two 4-40 nuts on each switch. Push the screws through the mounting holes in the panel from the front, place the switch in position, and secure it with the nuts. Refer to figure 2.

DESIGNATION	TYPE
() S1 REGEN. PHASE	DPDT (6 lugs)
() S2 LO CUT	SPDT (3 lugs)
() S3 PRE-EMPH.	SPDT (3 lugs)



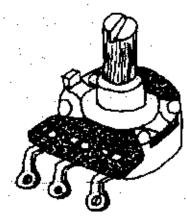
SINGLE POLE
DOUBLE THROW



DOUBLE POLE
DOUBLE THROW

Next install the control pots. Use your needlenose pliers to break off the locating tabs so that the body of the pot will go all the way up against the back of the panel when the shaft is pushed through the hole provided. Install one nut on the shaft from the front of the panel and secure the pot in place. Be sure to orient the pots as shown in figure 2.

DESIGNATION	VALUE
() R57 INPUT LEVEL	5K
() R58 OUTPUT	5K
() R59 REGEN. LEVEL	5K
() R24 INIT. DELAY	250K
() R25 MOD. DEPTH	250K
() R68 BALANCE	100K DUAL (6 lugs)
() R28 HYPERTRY.	500K
() R29 LFO RATE	500K

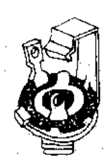


PANEL MOUNT
POTENTIOMETER

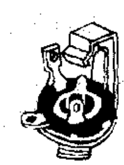
After the pots are installed, carefully bend all the lugs of all the <u>POTS ONLY</u>, down slightly so that they are at about a 90 degree angle to the front panel.

Next install the jacks. Secure each jack in place with one flat washer and one nut. Be sure to orient the jacks as shown in figure 2.

DESIGNATION	TYPE
() J1 LFO OUT	OPEN CIRCUIT
() J2 LFO CV IN	OPEN CIRCUIT
() J3 SYNC	OPEN CIRCUIT
() J4 DELAY CV IN	CLOSED CIRCUIT (3 lugs)
() J5 AC IN	OPEN CIRCUIT
() J6 DC IN	OPEN CIRCUIT
() J7 OUT 1	OPEN CIRCUIT
() J8 OUT 2	OPEN CIRCUIT



OPEN CIRCUIT
PHONE JACK



CLOSED CIRCUIT
PHONE JACK

Next we will make some inner-connections between the controls and jacks mounted on the front panel. These solder joints will require more heat than those on the circuit board, so hold the iron on the connection for a little longer before applying the solder.

() Using the bare wire provided, make the common ground connection between the #2 (ground) lugs of all 8 jacks, as shown in figure 3. Keep the wire as straight and tight as possible between connections, and leave 4 1/2" (11.5cm) of wire extending from the connection at J3 and J4. The free end of this wire will be connected to the circuit board in later steps.

() Install a 10K (brown-black-orange) resistor on control pot R68, between lugs 2 and 3 as shown in figure 3. Insert one of the resistors leads into the hole in lug 2 and the other lead into the hole in lug 3. Bend the leads around the lugs slightly to hold the component in place, but DO NOT SOLDER YET.

() In the same manner, install a second 10K (brown-black-orange) resistor between lugs 4 and 5 of R68. DO NOT SOLDER.

NOTE: The two resistors installed above are R48 and R49 respectively.

() Install C29, a .22 MFD. Polystyrene capacitor, between R59 lug 3, and S2 lug 1 as shown in figure 3. Insert one lead of the capacitor into the hole in lug 3 of R59 and the other lead into the hole in lug 1 of S2. Polarity is not important. SOLDER the connection at S2, but DO NOT SOLDER the connection at R59 yet.

() Locate the 1 1/4" (3.2cm) length of small plastic tubing supplied. Fold the tubing in half and cut it into two pieces at the fold with your wire cutters.

() Locate C34, a 2.2 MFD electrolytic capacitor and slip a piece of the tubing over each lead.

() Install C34 by inserting it's negative (-) lead into the hole in lug 3 of S2 and the positive (+) lead into the hole in lug 3 of R59. Solder both connections.

() Prepare a piece of insulated wire 12 1/2" (31.8cm) long and connect one end to lug 3 of R25. Solder the connection.

() Position this wire up against the panel and across the top of the other controls to lug 1 of J4. Solder the connection.

() Prepare a second piece of insulated wire 12" (30.5cm) long and connect one end to lug 2 of R58. Solder the connection.

() Dress this wire neatly along the panel like the first one and connect the other end to lug 1 of J7. DO NOT SOLDER.

() Prepare a piece of insulated wire 3 1/2" (9cm) long. Solder one end to lug 1 of J8 and the other end to lug 1 of J8. Dress the wire so that it will be out of the way when plugs are inserted into the jacks.

() Prepare a piece of insulated wire 5 1/4" (13.4cm) long. Connect one end to lug 2 of R68. Solder the connection.

() Connect the other end of the above wire to lug 5 of S1. Solder the connection and dress the wire.

() Prepare a piece of insulated wire 2" (5.2cm) long and connect one end to lug 2 of S3. Solder the connection.

() Connect the other end of the above wire to lug 2 of R57. DO NOT SOLDER.

() Prepare a piece of insulated wire 2 1/2" (6.4cm) long and connect one end to lug 3 of J4. Solder the connection.
() Connect the other end of this wire to lug 1 of J1. DO NOT SOLDER.

() Install the circuit board on the front panel using two 4-40 X 3/4" machine screws, two 5/16" spacers, two "L" brackets, two 4-40 nuts, and two 4-40 X 1/4" machine screws, as shown in figure 4.

() Connect the bare "ground" wire from the jacks (lugs 2 of J3 and J4), to the circuit board at the point labeled (G10). Push the wire through the hole in the board, from the top, until about 1/8 inch (.4cm) protrudes through on the conductor side. Solder the connection and clip off any excess at the solder joint.

In the following steps connect the wires from the circuit board to the specified points on the front panel controls. Refer to figure 5.
At each step insert the wire end into the hole in the lug from the bottom. On the other side of the hole, bend the wire over some to hold it in place and solder each connection as it is made. Dress the wires down neatly on the surface of the board, and in some cases, along the back of the panel near the bottom.

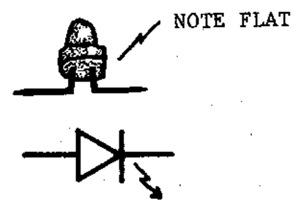
NOTE: Where wires or cables must travel from the circuit board to the jacks, route them along the same path as the bare ground wire - down the middle of the two rows of jacks.

FROM	TO
() G2	R29 LUG 1
() G3	R28 LUG 1
() G4	R25 LUG 1
() G5	R58 LUG 1
() G6	R68 LUG 1
() G7	R68 LUG 6
() G8	R59 LUG 1
() G9	R57 LUG 1
() L	R29 LUG 3
() M	R29 LUG 2
() P	R28 LUG 2
() N	R28 LUG 3
() H	R25 LUG 2
() F	R24 LUG 1
() E	R24 LUG 2
() D	R24 LUG 3
() R	S1 LUG 4
() Q	S1 LUG 6

() C	J2 LUG 1
() J	J1 LUG 1
() X	J3 LUG 1
() J'	S2 LUG 2
() L'	S1 LUG 1
() M'	S1 LUG 2
() K'	S1 LUG 3
() F'	S3 LUG 1

Next connect the center conductor of each co-ax cable from the circuit board to the designated points on the front panel controls. Use the same method as above.

FROM	TO
() N'	R68 LUG 3
() E'	R68 LUG 4
() H'	R59 LUG 2
() D'	R57 LUG 2
() C'	J6 LUG 1
() S	R58 LUG 3
() T	R68 LUG 5
() U	R57 LUG 3
() V	J5 LUG 1



Locate the red LED. Note that the lens has a flat spot on one side. This is the "cathode" or negative side of the device. The lead from this side will be connected to a bare "ground" wire.

() Place the LED in the provided hole in the panel so that the flat side is toward the jacks, (you may glue the LED in place with Super Glue[T.M.] or a similar glue, but use very little so that the LED can be replaced if necessary). Then VERY CAREFULLY bend the leads outward from each other.

() Connect the cathode lead (lead from flat side) to the near-by bare ground wire that goes to point (G10) on the circuit board. Make the connection as far out on the end of the LED lead as possible, and at a point on the bare wire near the connection to J3 and J4. Solder the connection as quickly as you can. Too much heat can destroy the LED. However, DO take enough time to get a good solder joint. It may be best to heat sink the LED lead at a point between the device and the solder joint.

() Locate the insulated wire from point (P') on the circuit board, and route it along the back of the panel toward the LED.

() Slip the 1/2 inch long piece of tubing over the wire. Connect the end of the wire to the other LED lead in the same manner as above and then slip the tubing over the solder joint.

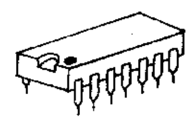
() At strategic points along the panel, bundle and tie the wires and cables using the plastic wire ties provided. See photo - figure 6.

!STOP!

At this point all solder connections on the circuit board should be complete. Check the conductor side of the board and make sure there are no un-used solder pads, (also check for solder bridges and bad solder joints). If you find any left over holes in the board - STOP and find out what is missing, then back-up to the part of the assembly instructions that deal with the installation of that part and correct the mistake.

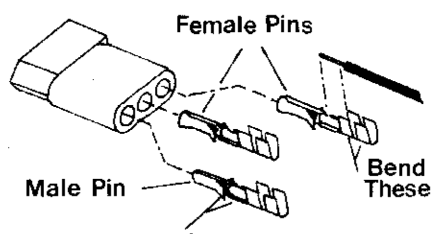
Next we will install the integrated circuits. Note that the orientation of the IC is keyed by a circular indentation or notch at one end of the case. This aligns with the semicircular key drawn on the circuit board parts placement designator. Install each IC by carefully inserting it's pins into the receptacles of the socket and pressing the device down firmly into place. BE SURE ALL THE PINS GO INTO THE SOCKET AND DO NOT GET BENT UP UNDER THE IC.

DESIGNATION	TYPE
() IC 1	CEM 3340 (16 pins)
() IC 2	4046 (16 pins)
() IC 3	4041 (14 pins)
() IC 4	301 (8 pins)
() IC 5	301 (8 pins)
() IC 6	571 (16 pins)
() IC 7	SAD 1024 (16 pins)
() IC 8	4136 (14 pins)
() IC 9	301 (8 pins)



() Install the control knobs on the shafts of the pots. Rotate the shafts of all 8 pots fully counter-clockwise and align the pointers on the knobs so that they all indicate the 7:00 O'clock position on an imaginary clock face, before pushing them into place.

We will now attach wires to the other half of the Molex power connector. Locate this white nylon part and the 3 stamped metal pins (1 male and 2 female) which are associated with it. Note that on the oval end of the connector the holes are numbered 1 (corresponding to the pointed side of the opposite end) through 3.



() Cut an 18 inch (45cm) length from the remaining insulated wire, strip 1/4 inch (.5cm) of insulation from one end and tin.

() Solder the wire prepared above to the MALE pin and crimp the pairs of "fingers" on the pin over the wire. Slip this pin into hole #1 of the connector body FROM THE OVAL END until it snaps into place and locks.
MAKE SURE YOU'VE GOT THE CORRECT HOLE.

() In a similar manner, prepare two more 18 inch (45cm) lengths of wire and solder them to the two FEMALE pins. Slide these into the connector body until they lock into place.

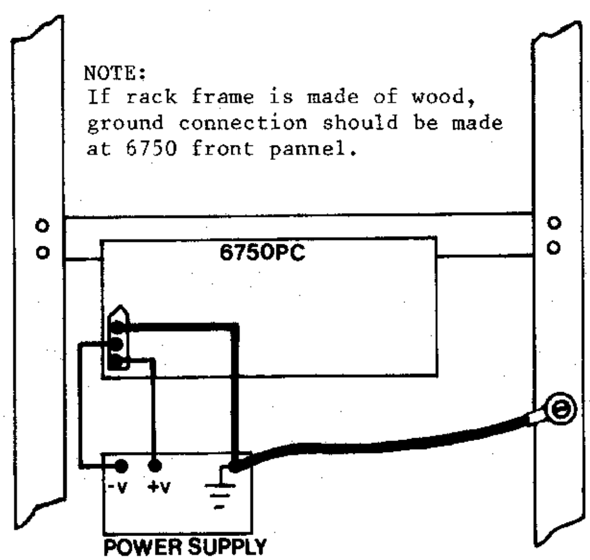
THIS COMPLETES ASSEMBLY OF THE 6750 HYPERFLANGE + CHORUS

INSTALLATION

You must provide the Hyperflange + Chorus with a stable power supply voltage or the unit will not work correctly. We recommend a tightly regulated, bipolar + and - 15V supply such as PAIA's 4771 module. Also, use heavy gauge wires to connect the supply to the Hyperflange + Chorus, especially if the power leads are more than about a foot or two long. The most important connection is the ground wire; this should be as heavy gauge as possible. For long wire runs, you might want to double or triple a bunch of wires for the ground line - even a few milliOhms of resistance can cause a voltage drop which might affect performance.

When using the Hyperflange + Chorus as a stand-alone unit, simply hook up the power supply +, -, and ground leads and treat the unit as you would any other effect.

If you decide to mount the unit in a metal rack frame, things get a little more complicated. One option is to simply hook up the +, -, and ground connections as described above, and bolt the unit into the mainframe. However, you might experience ground loop problems. If this is the case (as evidenced by hum, whistles, or other "strange" problems showing up in the output), try the connection shown below. With this set up, power connects as usual, but the ground wire running to pad G10 on the Hyperflange + Chorus is removed, and the rack frame connects directly to the ground point of the power supply through a heavy ground wire.



In some instances, you might have less ground loop problems if you leave the wire to pad G10 connected. It is impossible to predict which of these options will work best in your situation, so you might want to try the various connections. One way to see which way works best is to hook a scope probe to the Hyperflange + Chorus ground, with the scope ground going to the ground of the power supply. Whichever method puts the least amount of noise and hum on to ground is the preferred method. Note, incidentally, that improper grounding may prevent the unit from working up to its full potential, but you will not damage the unit.

CALIBRATION PROCEDURE

Correct calibration is absolutely essential for optimum operation of the Hyperflange + Chorus. Make sure that you perform the following procedures slowly and carefully, and the result will be an excellent sounding unit with quiet operation, wide sweep range, and highest possible dynamic range.

First, some general instructions. If the instructions say to turn a knob CW, that means full clockwise; CCW means full counter-clockwise. Positions in between these extremes are indicated in the same way as a traditional analog clock - for example, turning the knob to 12:00 means that the pointer should point straight up, while turning the knob to 3:00 means that the pointer would point towards the right. Also notice that there are three calibration procedures; which one you use will depend on how much test equipment you have. Remember that it will take much longer to calibrate the Hyperflange + Chorus by ear than with test equipment, however the results will be virtually as good.

Start off all calibrations with the knobs set as follows:

Input level - 12:00
Pre-Emphasis - off
Regeneration Phase - (+)
Lo Cut - off
Regeneration Level - CCW
Balance - CCW
Output - 12:00
Initial Delay - CCW
Modulation Depth - CCW
Hypertriangularity - CW
LFO Rate - 12:00
Set all trimpots (except R54) CCW as viewed from the front of the trimpot. Set R54 CW.

Begin all calibration procedures by hooking up a power supply in accordance with previous instructions, plugging a signal into the AC coupled input jack, and listening to the output through an amplifier. The balance control is selecting the dry signal only, therefore, you should hear the unmodified sound of your instrument. If you don't, check over your wiring, power supply connections, input signal, and amplifier. If all is well, unplug your input signal and proceed with the calibration. Regardless of which calibration procedure you use, begin with the following steps.

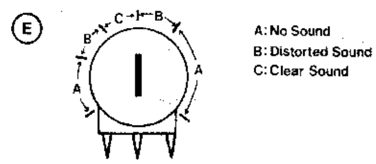
1. Turn the Balance control CW.
2. Turn your amplifier volume level down to prepare for a LOUD sound.
3. Adjust Low Clock Trim (R16) CW until you detect a very high audio frequency. Re-adjust volume if necessary to hear this high frequency signal. Set R16 for the highest frequency which you can hear.

If you wish to calibrate the Hyperflange + Chorus by ear, proceed with the next steps. Otherwise, move along to either CALIBRATION WITH OSCILLOSCOPE or CALIBRATION WITH OSCILLOSCOPE AND FUNCTION GENERATOR.

4. Adjust Clock Cancel (R56) until you hear a minimum amount of the high frequency tone. This should occur towards the middle of the trimpot. As you reach this "null point", you will probably need to

turn up the amplifier level to hear the signal better. Continue to carefully adjust R56 until there is virtually no high frequency tone present at all. In most cases you will be able to completely eliminate this tone.
5. Plug an instrument or other signal source back into the input, and turn the Initial Delay control to 9:00. Play your instrument; you shouldn't hear anything.
6. Now it's time to adjust the bias, the most critical calibration in this whole procedure. Lowest distortion, greatest dynamic range, and lowest noise level all depend on the calibration of this control, so relax and take the time to do it right.

As you play your instrument, vary R55, the Bias trimpot. At some point in its rotation, you'll hear your instrument briefly appear at the output, after which the sound may go away. This means that you're in the ballpark, and now it's time to get into fine adjustments.



7. Vary the bias trimpot in SMALL increments. Referring to figure E, as you vary the trimpot from CCW to CW you'll go through a band of no sound, then lots of distortion, a "clear spot" where the sound is undistorted, more distortion, and then finally, a band of no sound. With different units, the clear spot will occur at different places on the trimpot; figure E is representative, but don't take it too literally - your clear spot may occur more to the left or right of center, and the width of the various bands of distortion and no sound might vary. Remember to vary the trimpot only a little bit at a time, since it takes a little time for the adjustment to "settle" whenever you make a change.
8. Now that you have a feel for the operation of this trimpot, let's zero in on the clear spot of no distortion. Set R55 for minimum distortion. If there is no spot which is undistorted, then you are feeding in a fairly high level signal - adjust R55 for as little distortion as possible, then pull back a bit on the Input Level control until the sound clears up. Re-adjust R55 if necessary.
9. Now that you have a clean sounding signal, increase the input level control until you hear some distortion. Re-adjust R55 in small increments until the distortion goes away (throughout these procedures, if you are using an instrument such as guitar for your signal source play in as consistent a manner as possible to make calibration easier). Increase the level again, and re-adjust R55 again for minimum distortion. After a certain point, it will not be possible to trim out distortion with R55; when this happens, trim the input level back a little bit and adjust R55 for minimum distortion. The bias is now calibrated. To sum up, the point of this calibration is to have the lowest possible amount of distortion with the highest possible input signal level.
10. Next set the LFO rate CW, Hypertriangularity CW, and Modulation Depth CW. Adjust R27 in a CW direction; at some point, you'll start hearing a periodic modulation of the signal which is similar to vibrato. Turn R27 CCW until the modulation disappears, then CW until the modulation kicks in again. This is a good starting setting for R27, however, you might want to "tweak" it up later after you're more familiar with the unit's operation. Setting R27 to the maximum CCW position which still introduces modulation produces an exaggerated

hypertriangular control signal; turning it more CW produces more of a triangle wave effect (see figure F). Generally, you'll want the maximum possible CCW position which still gives modulation; since you can always use the front panel hypertriangularity control to make the exaggerated hypertriangular wave more triangular in nature. Note also that as you vary the HYPERTRIANGULARITY control from CW to CCW, the LFO speed increases somewhat. This is an inherent part of the way the CEM3340 generates the hypertriangular waveform, however, this is not a problem since the hypertriangular sweep is best at long sweep times. At faster speeds, triangle waves are often more appropriate.
11. Play your instrument and turn up the Input Level so that you hear distortion on peaks. Adjust clipping trimpot R54 so that the overload light flashes whenever distortion is occurring.
12. The Hyperflange + Chorus is now calibrated.

(F) HYPERTRIANGULAR WAVEFORMS

CALIBRATION WITH OSCILLOSCOPE

First, follow steps 1, 2, and 3 given above.
4. Clip probe to center terminal of R56. Set scope for DC coupling, baseline at bottom of screen, and 2V/division sensitivity.
5. Adjust R56 for thinnest scope trace.
6. Vary bias trimpot R55 from CCW to CW. Note the voltage readings at these two extremes (example: CCW, 7.6V; CW, 5.3V). Calculate the midpoint of these two voltages (example: 7.6 - 5.4 = 2.2V. Midpoint of the two voltages is 5.4 + 1.1 or 7.6 - 1.1 = 6.5V). Adjust R55 so that the scope reads 6.5V. Adjust R55 in small increments for best results.
7. Run steps 10 and 11 given above.
8. The Hyperflange + Chorus is now calibrated.

CALIBRATION WITH OSCILLOSCOPE AND FUNCTION GENERATOR

This calibration is for the perfectionists in the crowd. Begin by running steps 1, 2, and 3 as given in the first section, and steps 4 and 5 given under the CALIBRATION WITH OSCILLOSCOPE section.
6. Feed a 4V peak-to-peak triangle wave into the input, and turn the Input Level control up all the way. Adjust R55 (bias trimpot) for equal amounts of clipping on both peaks of the triangle wave.

7. Reduce input signal level for absolute maximum signal short of appreciable distortion. Then, adjust R55 so that the bottom of the triangle wave is very slightly clipped (figure G).


(G)

8. Turn the Initial Delay full CCW; the top of the triangle wave should now clip by an equal amount to the amount of clipping on the bottom of the wave in last step. If not, adjust bias for equal amounts of clipping on opposite peaks of the waveform at extremes of the Initial Delay control.
9. Run step 10 given above on calibrating R27, the Hypertri trimpot.
10. To calibrate the clipping indicator, set the Initial Delay at 12:00 and increase the input signal level so you just start to see clipping of the triangle wave peaks.
11. Turn R54 CCW until the overload LED just comes on.
12. The Hyperflange + Chorus is now calibrated.

CONTROL DESCRIPTIONS

Before discussing specific applications, let's take a general look at the controls.

INPUT LEVEL. This regulates the amount of signal going into the Hyperflange + Chorus. The idea is to put as much signal as possible into the unit short of distortion (as indicated by the overload LED when R54 is properly calibrated). Therefore, for low level signals turn up the Input Level control; for high level signals, turn it down.

PRE-EMPHASIS. The high frequency response of the average delay line is not very good at all, so the signal coming out of a delay line will often sound "duller" than the original input signal. While the Hyperflange + Chorus is better in this respect than some other delay units, for those times when you want to add a trebly "zing" to the delayed signal, turn the pre-emphasis switch to ON. Note that attempting to add pre-emphasis with a signal that has lots of high frequencies can overload the circuitry as well as cause "aliasing" effects where the high frequencies of the input signal interact with the delay line clock. If adding pre-emphasis causes these problems, switch it off. You will not be able to add pre-emphasis under all conditions with all input signals, however, in most applications it will work just fine.

REGENERATION LEVEL. This sets the amount of signal recirculated from the output of the delay line back to the input. With flanging, adding regeneration increases the sharpness and bite of the sound. Note that it is possible to regenerate so much signal that oscillation results (see next paragraph).

REGENERATION PHASE. Altering the phase of the regenerated signal changes the tonality of the flanging and chorusing effects. The (-) position gives a whooshing, breath-like sound, whereas the (+) position imparts a more metallic, zinging effect. Note that it is possible to turn up the Regeneration Level control to the point where the circuit breaks into a LOUD oscillation. To set the Regeneration Level control for a given input signal and make sure that the unit does not break into oscillation, we suggest the following:

1. Turn the output level down since you'll be generating some loud noises.
2. Turn Regeneration Level up all the way and play your instrument. The unit will break into loud oscillation. Keep playing, and turn the Regeneration Level control CCW until the oscillation just stops. Unless there is a significant increase in input level, the unit will not break into oscillation unpredictably. This "resonance lock" feature works by shutting off the compression action for very low signal levels and creating infinite expansion at low signal levels. Thus, unlike some non-companding units where noise generated in the circuitry itself can start a feedback loop, the companders lock out this noise to give more predictable regeneration.

LO CUT. In some instances, especially where you have lots of regeneration, you may not want massive resonance at low frequencies (blown speakers is one good reason why not). In the ON position, this switch introduces a low cut filter in the regeneration path which prevents low frequency resonance. In the OFF position, all frequencies are regenerated with equal intensity.

BALANCE. In the CCW position, the output consists entirely of non-delayed signal. In the CW position, the output consists entirely of delayed signal. In the mid-position, the output consists of an equal blend of delayed and non-delayed signals.

OUTPUT. This sets the overall output level coming out of the Hyperflange + Chorus. Turn CW for more output, CCW for less output.

INITIAL DELAY. CW gives minimum delay, while turning the control fully CCW gives maximum delay.

MODULATION DEPTH. This controls how much the delay line is affected by the LFO sweep. Turning the control CW gives the widest sweep range, while turning the control fully CCW gives no sweep at all.

HYPERTRIANGULARITY. Full CW gives maximum hypertriangularity; turning this control CCW makes the sweep waveform more triangular. Note that the LFO speed decreases somewhat at maximum hypertriangularity.

LFO RATE. This varies the speed of the sweep. CCW gives the slowest sweep, while CW gives the fastest sweep.

So much for the controls and switches; now for the jacks.

IN (AC). This is a capacitively coupled input to the Hyperflange + Chorus. PLEASE NOTE that AC does not refer to AC line voltages, but to the nature of the electrical coupling used. DO NOT under any circumstances plug an AC power cord into this jack, or you will seriously and irreversibly damage the unit.

IN (DC). This input couples directly into the Hyperflange without any coupling capacitor. It is the recommended input for electric guitars and any other equipment which does not exhibit a DC offset.

OUT 1, 2. Two paralleled output jacks. Note that these are not synthesized stereo outputs, but rather, two identical outputs.

LFO CV IN. Applying a 0 to +10V control voltage to this jack alters the speed of the LFO in an exponential fashion.

LFO OUT. Taps off the LFO. Provides a hypertriangular or standard triangular signal to other voltage controllable units, or can slave two Hyperflange + Chorus units together. For information on slaving one unit to another, see the section on Applications.

SYNC. A positive (+10V) pulse to this jack reverses the LFO sweep direction if the LFO is sweeping upward.

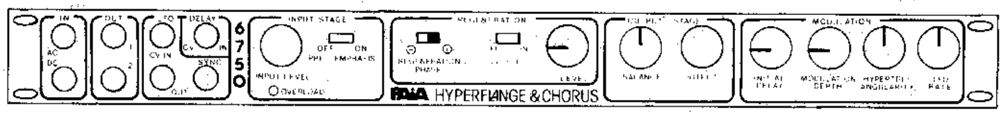
DELAY CV IN. Applying a 0 to +10V control voltage to this jack linearly varies the frequency of the clock controlling the delay time from maximum to minimum, while disconnecting the internal LFO from the clock. The initial delay and modulation depth controls are still active in this mode.

HYPERFLANGE + CHORUS APPLICATIONS

In the following examples, input level, pre-emphasis, regeneration lo cut (when regeneration is specified), and output level are adjusted to suit. All settings are initial settings, and are intended to provide a point of departure for further experimentation.

CHORUSING

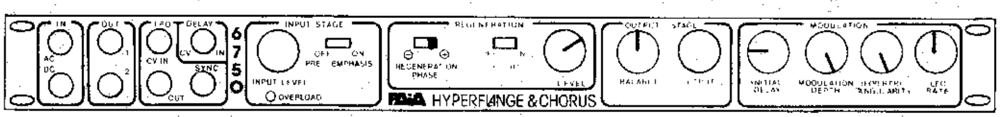
Regen Phase	Regen Level	Balance	Init Delay	Mod Depth	Hypertri	LFO rate
(+)	9:00	12:00	9:00	9:00	12:00	12:00



This gives a lush, full sound. The crucial controls are the initial delay, modulation depth, and LFO rate. If the initial delay is too long, then the sound will resemble slapback echo more than chorusing; but if it's too short, then you'll hear more flanging sound. Depth should be moderate, since at longer delays too much depth can give unpleasant detuning effects (as well as make the chorus sound less interesting). Should detuning effects occur, slowing down the LFO rate will usually minimize any problems. Triangle waveforms work well for chorusing at fast LFO speeds.

AUTO SWEEP FLANGING

Regen Phase	Regen Level	Balance	Init Delay	Mod Depth	Hypertri	LFO rate
(+)	2:00	12:00	9:00	CW	CW	12:00



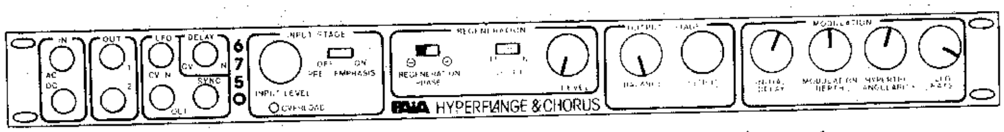
With this patch, initial delay sets the bottom of the flange sweep, while mod depth sets the top of the sweep. Setting the initial delay for the longest possible delay can give some dramatic effects with slow LFO rates. If you want a vivid demonstration of why hypertriangularity is needed, try this same patch but turn the hypertriangularity control full CCW so that the flange is swept with the standard triangle wave. You'll find the difference <u>very</u> convincing!

PEDAL FLANGING

Same as above, but plug 0 to +10V control voltage pedal output into the DELAY CV IN jack.

VIBRATO

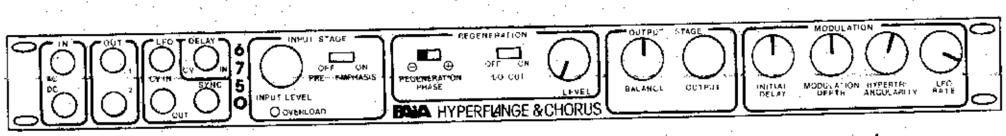
Regen Phase	Regen level	Balance	Init Delay	Mod Depth	Hypertri	LFO rate
(-)	CCW	CW	1:00	12:00	1:00	4:00



Critical controls are Hypertriangularity (which determines the "smoothness" of the vibrato), and LFO rate. Incidentally, for foot pedal controlled vibrato (where pushing down the pedal injects vibrato), patch the LFO OUT jack into the instrument input of the pedal, and then patch the amp output of the pedal to the DELAY CV IN jack. This lets guitarists vibrato entire chords - not just single notes - under foot control.

FAST ROTATING SPEAKER SOUND

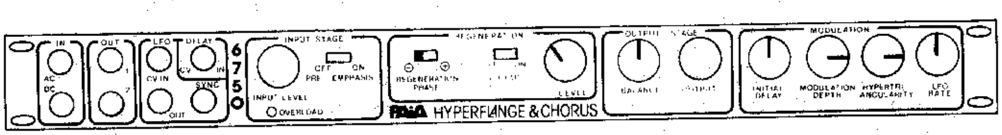
Regen Phase	Regen Level	Balance	Init Delay	Mod Depth	Hypertri	LFO rate
(-)	CCW	12:00	12:00	12:00	1:00	4:00



This is similar to the above patch. When simulating slower rotating speakers, you will probably have to pull back on the modulation depth a bit.

PHASE SHIFTER

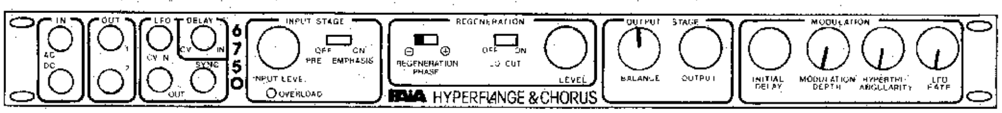
Regen Phase	Regen Level	Balance	Init Delay	Mod Depth	Hypertri	LFO rate
(-)	10:00	12:00	12:00	3:00	3:00	12:00



While flangers and phasers are quite different, this patch does a reasonably good phase shifter imitation. Be carful not to set the initial delay too long, since phasers don't give much of a time delay. Set all controls more subtly than you would for flanging effects for the most realistic sounds.

COMB FILTER (NOTCH FILTER)

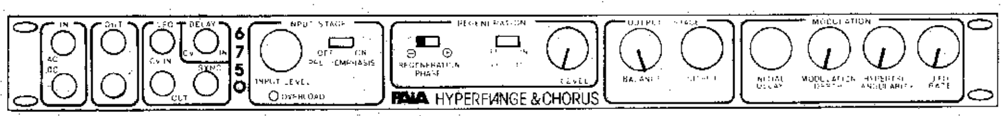
Regen Phase	Regen Level	Balance	Init Delay	Mod Depth	Hypertri	LFO rate
(-)	*	12:00	*	CCW	CCW	CCW



Not all flanger sounds involve the LFO. For static, equalizer-like effects, vary the initial delay and regen level controls for the desired tonality.

STEREO SIMULATION/SPREADING

Regen Phase	Regen Level	Balance	Init Delay	Mod Depth	Hypertri	LFO rate
(-)	CCW	CW	*	CCW	CCW	CCW



Set up the flanger as follows: Split the signal coming from your instrument or tape track. Take one split and feed that output into one channel of an amp or mixer. Take the other split and patch it into the Hyperflange + Chorus, and patch the H + C's output into the second channel of an amp or mixer. Adjusting the initial delay alters the separation effect between the two channels. If you want some "motion" to this simulated stereo, simply add some modulation depth.
Note that combining two "stereo" channels created in this manner back into mono may affect the tonal quality of the signal.

SLAVING TWO UNITS TOGETHER

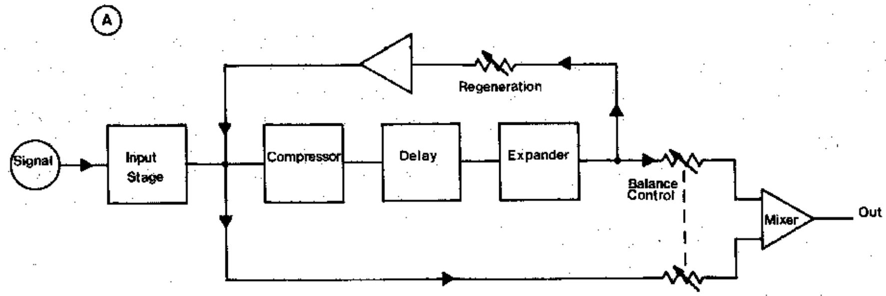
Splitting the signal through two Hyperflange + Chorus units, with each output going to a diferent channel, can provide dramatic stereo effects (particularly if the settings on the two units are somewhat different). If you want them to both track the same LFO, run a patch cord from the LFO OUT jack of the first unit to the DELAY CV IN jack of the second unit. The second unit will now be slave to the first unit.

DESIGN ANALYSIS

Time-shift effects such as flangers, once relatively rare and expensive, are now commonplace thanks to recent developments in semiconductor technology. The Hyperflange + Chorus is based on an analog delay IC known as a Bucket-Brigade Device (BBD for short), so before discussing specifics of this circuit, we'll talk about analog delay from a more general standpoint.

The Hyperflange + Chorus follows the general format shown in figure A: an audio signal appearing at the input becomes delayed by a certain amount of time, and this delayed signal appears at the output. The balance control mixes the normal and delayed signals, and the regeneration control feeds some of the delayed signal back to the input. The combination of delay, feedback, and the ability to mix the percentage of normal and delayed sounds accounts for the wide range of effects available from time-shifting devices.

A



THE TIME-SHIFT SPECTRUM. Different amounts of time delay give different effects. While there is no standard definition of the time-shift spectrum, here are some guidelines as to what kinds of sounds are associated with what kinds of delay times. You'll notice some delays are so short that we can't describe them in terms of seconds; instead, we'll be talking about milliseconds (1/1000 of a second), which is abbreviated ms.

0 to 15 ms delays: Mixing a signal delayed by 0 to 15 ms with an equal amount of non-delayed signal produces flanging sounds. Flanging is a dramatic special effect that imparts a "jet airplane"-like sound to any instrument or tape track going through the flanger.

15 to 25 ms delays: Mixing a signal delayed by 15 to 25 ms with a non-delayed signal produces the popular chorusing effect. This creates a fuller, more animated sound that resembles the sounds of two instruments playing at once.

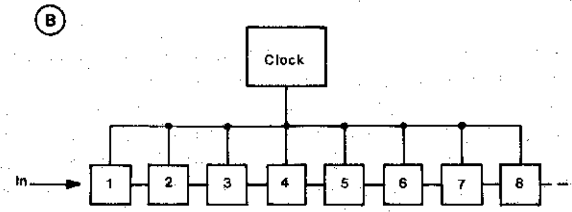
25 to 50 ms delays: This gets into the echo range, where you can perceive that the delayed signal is occuring later in time with respect to the non-delayed signal (with flanging and chorusing effects, it's difficult to tell that an actual delay is taking place because the delay time is so short). 25 to 50 ms delays yield what is popularly called "slapback" echo, a very tight echo sound.

50 ms and up: This is the range covered by most echo units. Short echoes give more of a doubling effect, or the effect associated with playing an instrument in a small room.

Because it is difficult for low-cost electronic devices to cover this wide a range of time shifting, you'll find that certain devices are optimized for certain ranges. The Hyperflange + Chorus is designd to cover the top two ranges, flanging and chorusing.

THE BUCKET BRIGADE DEVICE (BBD). Figure B shows a greatly simplified version of the first eight stages of IC7, a 1,024 stage analog delay line. The "clock" connects to a timing reference which operates at a very high frequency, usually above the range of human hearing. Like most clocks, this one goes "tick-tock"; however, these are not audible clicks. Instead, they are voltages which swing between a maximum and a minimum value.

(B)



During the "tick" of the clock, the delay line "samples" the input signal. Sampling is a process whereby the analog delay line stores the instantaneous amplitude value (level) of an input signal. If the signal at the moment of the sample is 1.1 Volts, then the delay line stores 1.1 Volts in stage one. During the "tock" of the clock, the delay line stops sampling the input and transfers the voltage held in the first stage over to stage 2.

When the next "tick" occurs, the delay line takes a second sample of the input signal and stores that sample in the first stage. During the "tock", this sample moves into the second stage, and the 1.1 Volts we had stored in the second stage moves along to the third stage. As this process of moving the samples down the delay line continues, you can see what happens: eventually, the first sample will be shifted down the delay line far enough so that it appears at the output of the delay line, followed by the second sample, the third sample, and so on. A slower clock rate transfers samples slowly, while a faster rate moves the samples down the "bucket brigade" at a faster rate.

Unfortunately, while this may look good on paper some problems creep into the process. First of all, in order to accurately represent the input signal, we need to take lots of samples - maybe one every 50 microseconds (a microsecond equals 1/1,000,000th of a second) or so. This is like the connect-the-dots games that kids play, where more dots improve the resolution of the drawing. Our delay line's resolution works in much the same manner. However, as we increase the sample rate, we're also shifting our signals down the delay line at a faster rate, which gives us less delay. So, while we can get a pretty decent sounding output signal with short delay times, at longer delay times our sampling rate goes down and the signal becomes less defined (distorted).

One solution to this problem is to increase the number of stages in order to maintain a faster sampling rate but still get reasonably long delays. The flaw in this reasoning is that each stage contributes a certain amount of noise, transfer inefficiency, and high-frequency loss that degrades the audio quality of the delayed signal. We therefore need to choose enough stages to give us the delay we want, consistent with a high enough sampling rate to give us good fidelity when we reconstruct our signal at the output of the delay line.

The above covers the basics of the analog delay IC itself; however, this IC also requires extensive support circuitry in order to operate at its maximum potential. The following sections describe this support circuitry in more detail.

THE HYPERFLANGE + CHORUS CLOCK. IC2 is a phase locked loop set up as a voltage controlled clock. Varying the voltage at pin 9 varies the clock frequency between 1.5 MHz and 20 KHz, which gives a delay range of 340 microseconds (0.0003 seconds) to 25.6 milliseconds (0.0256 seconds). This covers the flanging and chorusing ranges. R24 sets the initial delay time, while R25 mixes in the desired amount of modulation from the hypertriangular circuit (more on this later).

Since the clock line of a delay line has a certain amount of capacitance to ground, and this capacitance acts like a high-cut filter, at high frequencies you need to deliver lots of current to the analog delay chip in order to charge that clock capacitance as fast as possible. IC3 is a high current buffer capable of delivering a clean square wave clock to the delay line, even at high frequencies.

THE HYPERFLANGE + CHORUS MODULATION SECTION. While having a static clock frequency can produce musically useful results, most musicians prefer to add some modulation to the clock to produce a more animated effect. Delay lines generally use triangle wave LFOs (low frequency oscillators), however, the wide sweep range of the Hyperflange + Chorus requires a different approach.

The human ear tends to hear musical effects exponentially; that's why sweeping a delay line in a linear fashion (which occurs with a triangle wave) gives the subjective impression of the flange effect staying at the high end of the sweep for too long, and dipping only briefly through the low end of the sweep. With many flangers, which only have a sweep range of 10:1 or so, this is not too much of a problem because there isn't that much difference in delay between the highest and lowest parts of the sweep. However, with the Hyperflange + Chorus sweep range in excess of 70:1, any lack of smoothness in the sweep is greatly exaggerated as the sweep covers the range from minimum to maximum delay. Therefore, we need to sweep the clock in an exponential fashion.

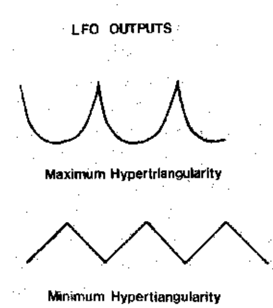
At this point, there might be a temptation to design a clock with an exponential response. Unfortunately, to produce a clock capable of sweeping from 20 KHz to 1.5 MHz exponentially is no trivial design chore. Therefore, instead of feeding a linear LFO into an exponential clock to get the right sweep quality, we can instead feed an exponential LFO sweep into a linear clock, which is far more cost-effective.

Figure C shows two curves. The solid line shows the subjective sweep sound of an analog delay modulated by a standard triangle wave LFO; note how the sweep spends very little time at the low end of the sweep range. As pointed out in an article by Jacques Boileau in Polyphony magazine (March/April 1982 issue), to compensate for this effect what we really want to do is sweep the clock in a reverse way to straighten out this curve and produce a subjectively smooth sweep. The dashed line in figure C shows the type of curve we would need to generate to accomplish this.

(C)

In Mr. Boileau's article, he suggests creating this waveform using a full wave rectified sine wave. While this is a valid approach, a more flexible way to produce this waveform is by taking a voltage controlled, low frequency oscillator and feeding its triangle wave output back into the voltage control input. However, to do this you need an oscillator with excellent stability and wide range. IC1, the CEM3340, is the perfect (albeit costly) solution. Its triangle output (pin 10) feeds a buffer (IC5) which then drives the voltage controlled input of IC2, as well as another buffer (IC4) which drives R28, the Hypertriangularity potentiometer.

(D)



This pot varies the amount of triangle wave fed back to the voltage control input; maximum hypertriangularity produces the curve shown in figure D, while minimum hypertriangularity gives a standard triangle waveform (which is still musically useful for small-range sweeps). In between these extremes, the curve varies proportionally between triangular and hypertriangular.

We can vary the modulation speed in two ways. R29 feeds a variable voltage into the CEM3340 to set the initial speed; however, you may further vary the speed by injecting a 0 to +10V control voltage into J2. For "synchro-sonic" effects, you may feed sync pulses or square waves into J3 (if a sync pulse arrives while the LFO is sweeping up, the LFO output will immediately reverse direction and start sweeping down).

Also note that you can tap the modulation section output via jack J1 if you want to slave two Hyperflange + Chorus units together, or feed other voltage controllable devices with the hypertriangular waveform. You may also control the delay by plugging a 0 to +10V control voltage into J4; however, this interrupts the connection going from the hypertriangular clock to the 4046's control voltage input, so your only modulation source is now coming from whatever is plugged into J4.

HYPERFLANGE + CHORUS AUDIO SECTION. IC8A is a preamp with choice of direct coupled (DC) or audio coupled (AC) operation. Use J6 for all applications unless you encounter distortion or other problems. In that case, plug into J5.

The signal leaving IC8A goes through an attenuator pot (R57) which matches high signal levels, such as those found in +4 dBm studios, with the input requirements of the analog delay chip (BBDs have a restricted dynamic range and cannot accept high level signals).

The signal goes next to IC6, which is a compressor/expander. The compressor squeezes the dynamic range by a factor of 2:1 by limiting high level signal peaks and boosting low level signal valleys. The input signal couples into the compressor in two ways: through an on-chip resistor, and through a pre-emphasis network (C24 and R72) to optionally add more treble to the signal. C18 is a high frequency rolloff capacitor which minimizes high frequency signals from interfering (also called <u>aliasing</u>) with the BBD clock. C18 also exhibits variable bandwidth characteristics (i.e. when the compressor's op amp, located inside IC6, is running at high gain, there is a maximum amount of high frequency attenuation). R70 adds a slight bias to C30, thereby defeating the compression action for low level input signals. R55 varies the voltage going to the compressor op amp's summing junction, which varies the output voltage of the op amp and allows direct coupling into IC7. The reason why direct coupling is important is because the input of IC7 wants to see as low an output impedance as possible from the preceding stage; this discourages bias variations as the clock sweeps over its full range, which could otherwise restrict signal levels through IC7.

IC7's output, consisting of a series of sampled voltages, doesn't really resemble our input waveform since it is more of a "stair-step" waveform (caused by the sampling process) than the smooth, continuous waveform we had at the input. IC8D is a low pass filter which not only smooths out the sampled voltages into something more continuous, but also minimizes any of the high frequency clock signal which may still be riding along with the audio signal.

The filtered signal then goes to the remaining section of IC6, which is hooked up as an expander. This "undoes" the effect of the compressor by adding a complementary amount of expansion (1:2) to the audio signal. Not only does this restore our original fidelity and dynamic range, but best of all, any noise generated in the delay line section is expanded downward, which greatly improves the signal-to-noise ratio. For more information on compression/expansion noise reduction systems, refer to literature on dbx noise reduction, which is a precision companding system for noise reduction.

Unfortunately, compansion is not perfect - it doesn't eliminate noise, but instead makes it much less noticeable. It can also interfere with the fidelity of a sound by responding improperly to rapidly changing signals. However, when you consider that the alternative is an objectionable noise level, it's no problem putting up with the much less objectionable quirks associated with companding circuitry.

IC9 is a clipping indicator which samples the voltage on the expander's filter capacitor (C31). When the voltage on this capacitor exceeds the voltage selected by R54, LED1 lights to indicate an overload condition.

The expanded output goes in two directions. One direction is towards IC8C, which recirculates (regenerates) the signal back to the input. S1A alters the phase of this stage to give positive or negative regeneration. S2 varies the low frequency response of this signal, while R59 determines the amount of regenerated signal.

The other signal path goes towards IC8, which combines the delayed and straight outputs to create frequency response cancellations that result in flanging sounds. The non-delayed signal goes directly into IC8B's summing junction (inverting input), while the expander output passes into either the inverting or non-inverting input of IC8B, depending on the setting of S1B. The purpose of S1B is to retain phase consistency of the delayed signal, regardless of whether positive or negative regeneration is being selected. The mixer output then goes through R58, which sets the overall output level, and finally appears at J7 and J8, a pair of paralleled output jacks.

6750
HYPERFLANGE & CHORUS

Illustration Supplement

Remove this Section for Easy Reference During Assembly

 1020 West Wilshire Blvd., Oklahoma City, OK 73116 (405) 843-9626 Technical Service (405) 843-6435

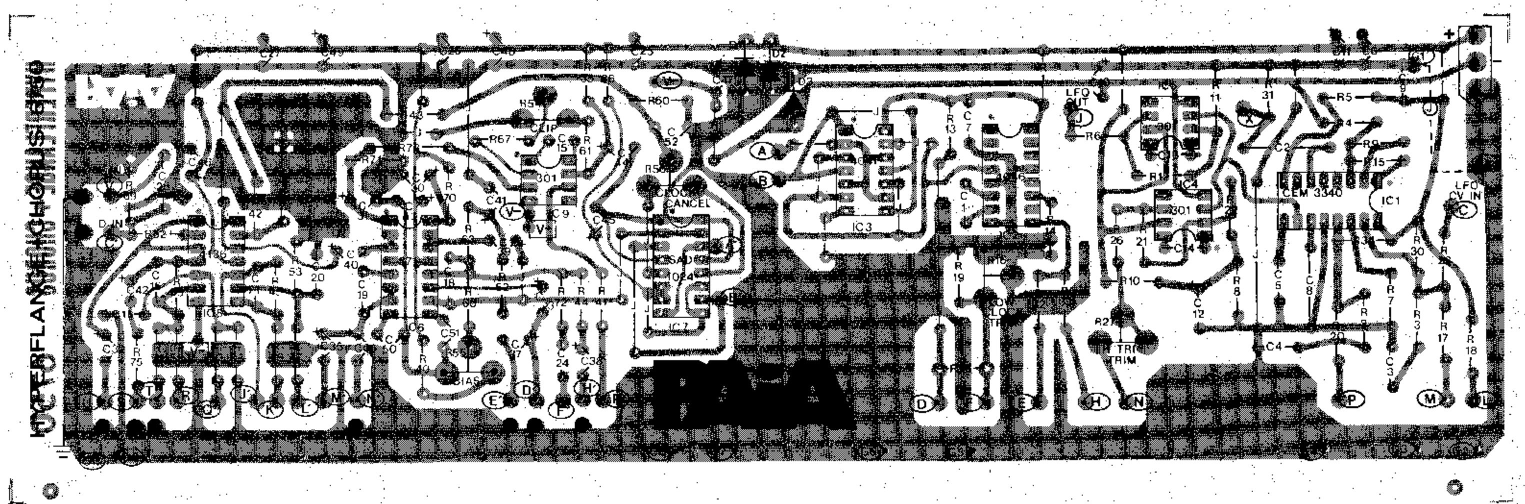


Fig.1 Parts Placement

B

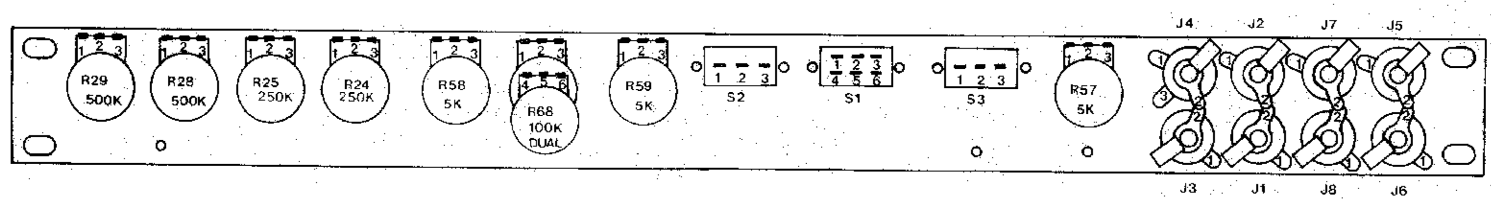


Fig. 2 Orientation of switches, controls and jacks.
Shown from rear of panel.

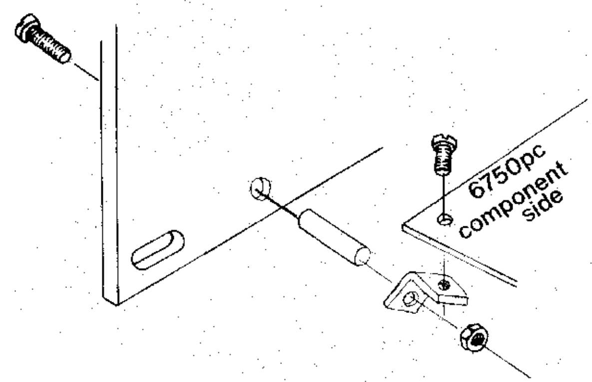


Fig. 4 "L" brackets screwed to the circuit board mounts on stand-offs from from front panel.

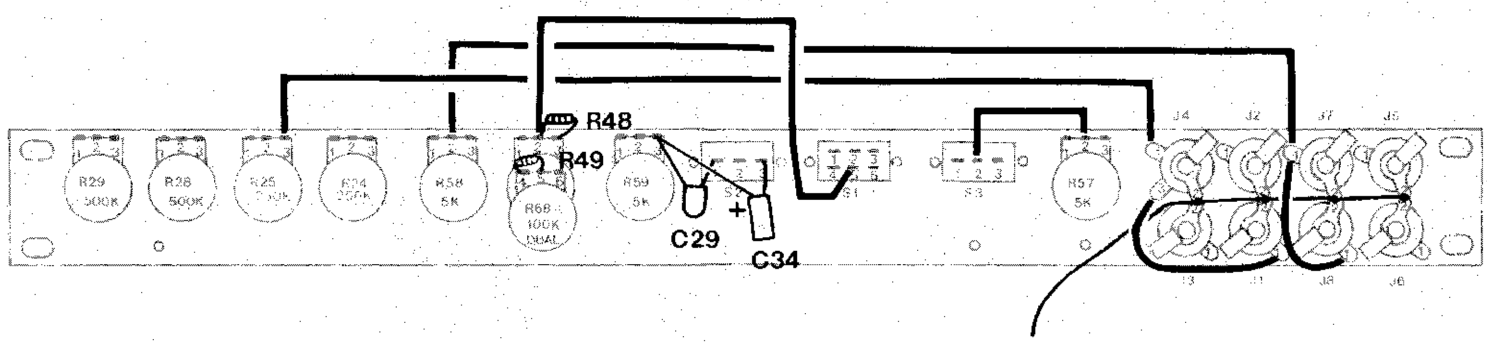


Fig.3 Initial control wiring. Note placement of R48, R49, C29 and C34.

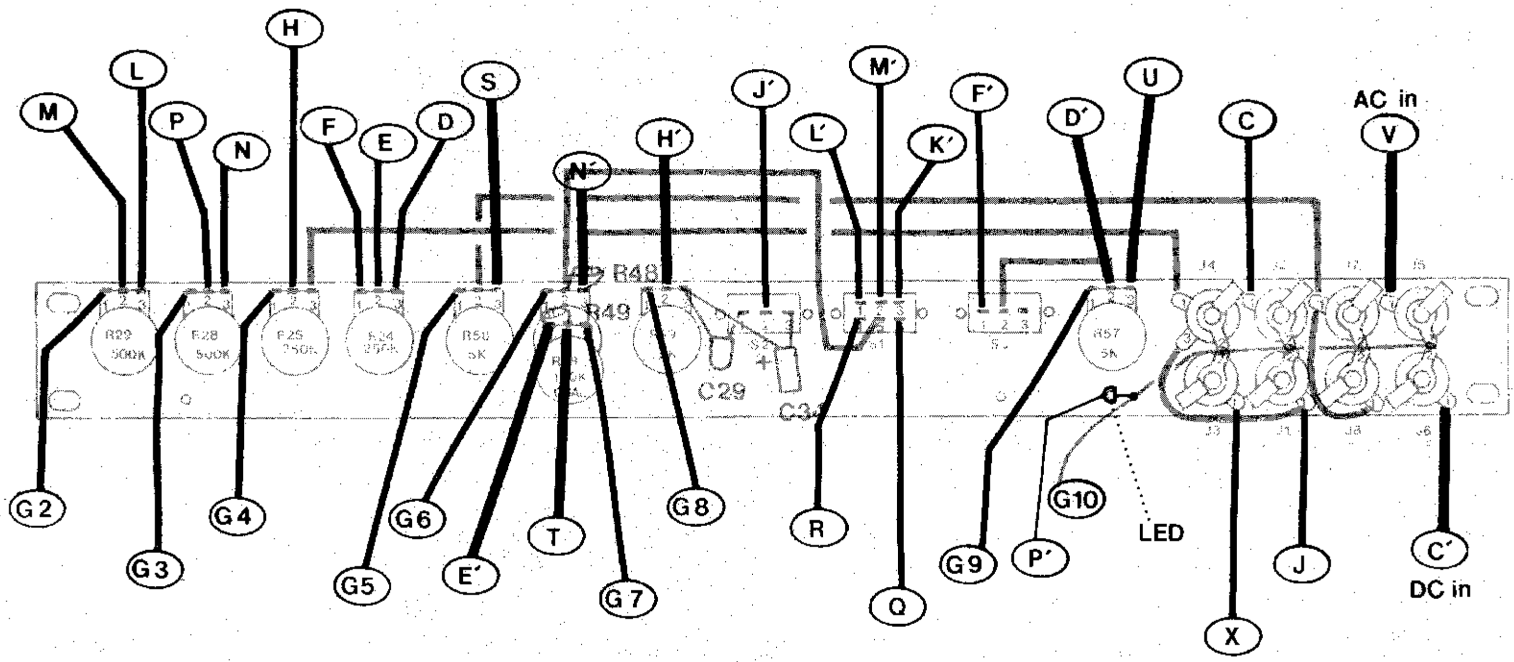


Fig.5 Front panel to circuit board wiring.

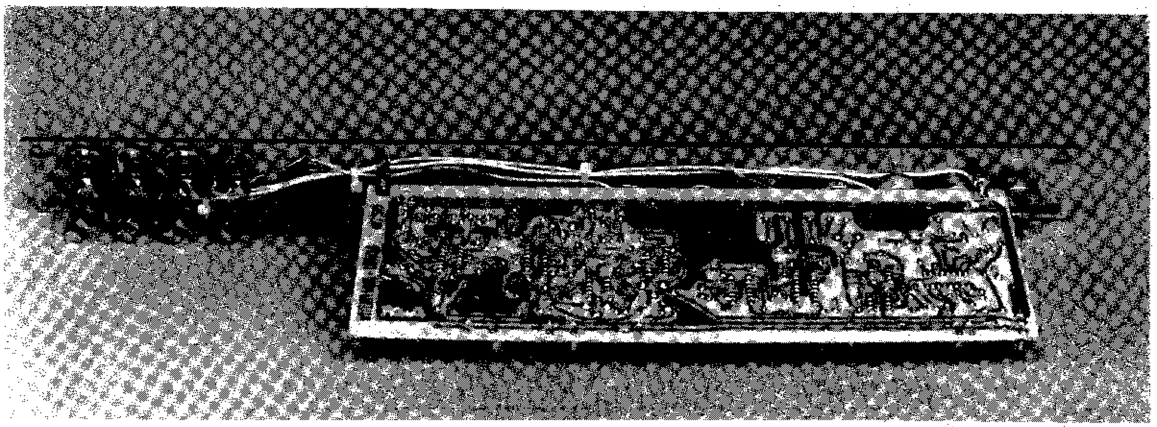
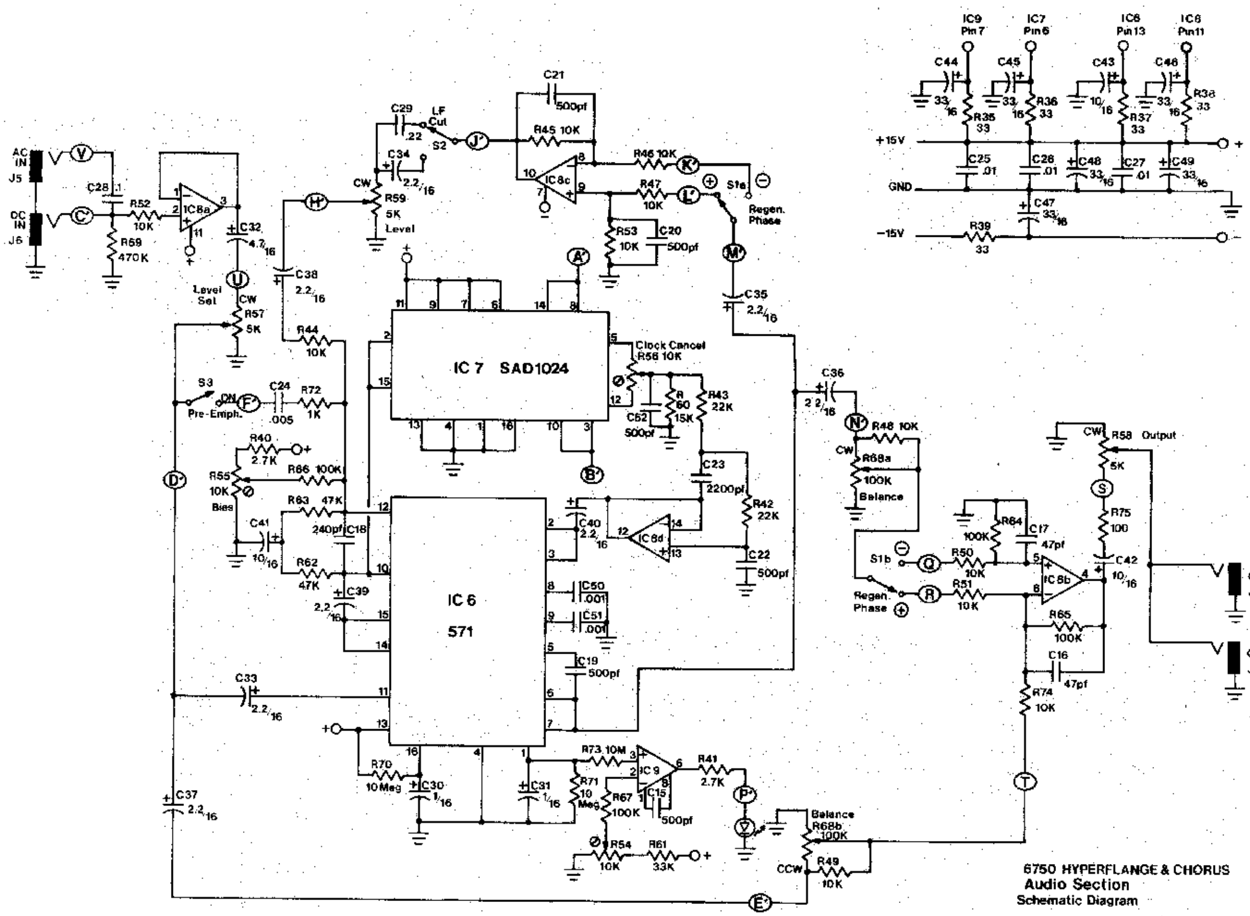
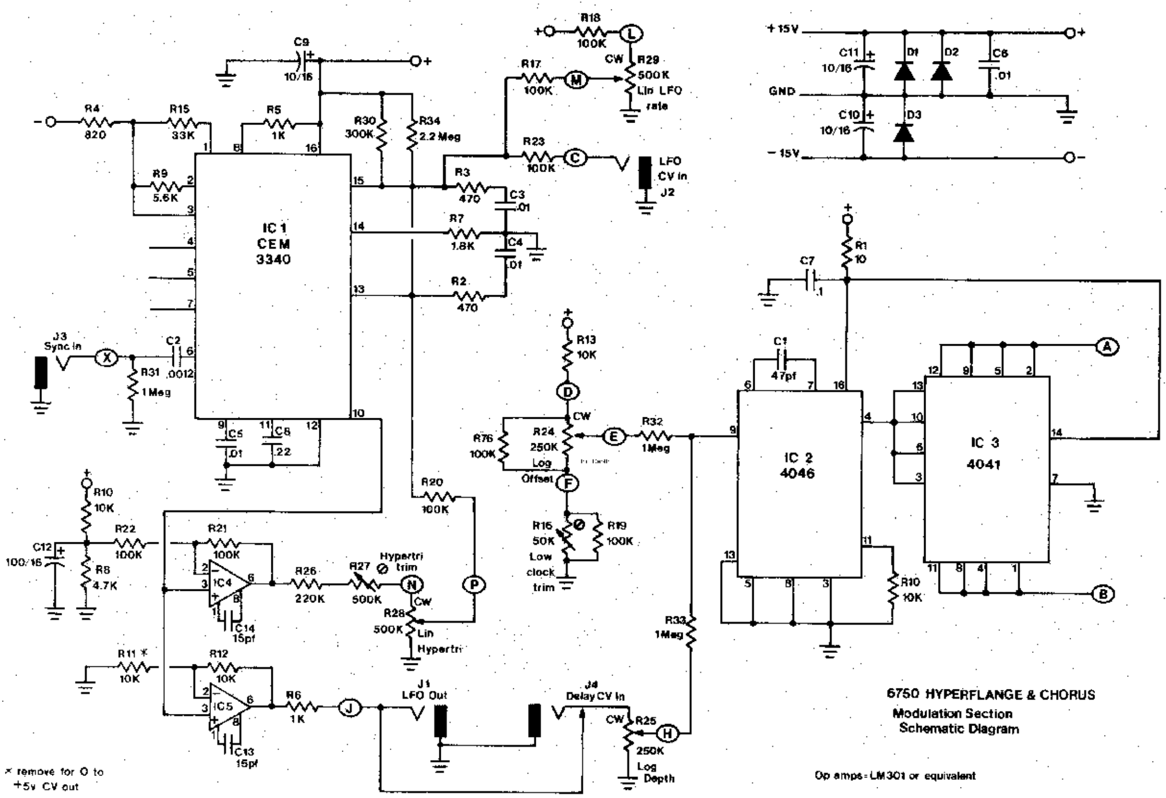


Fig.6 Completed Hyperflange.
Note wire cabling and circuit board mounting.



6750 HYPERFLANGE & CHORUS
Audio Section
Schematic Diagram

Op amps ¼ 4136, except IC 9 [301].



6750 HYPERFLANGE & CHORUS
Modulation Section
Schematic Diagram

* remove for 0 to +5v CV out

Op amps = LM301 or equivalent