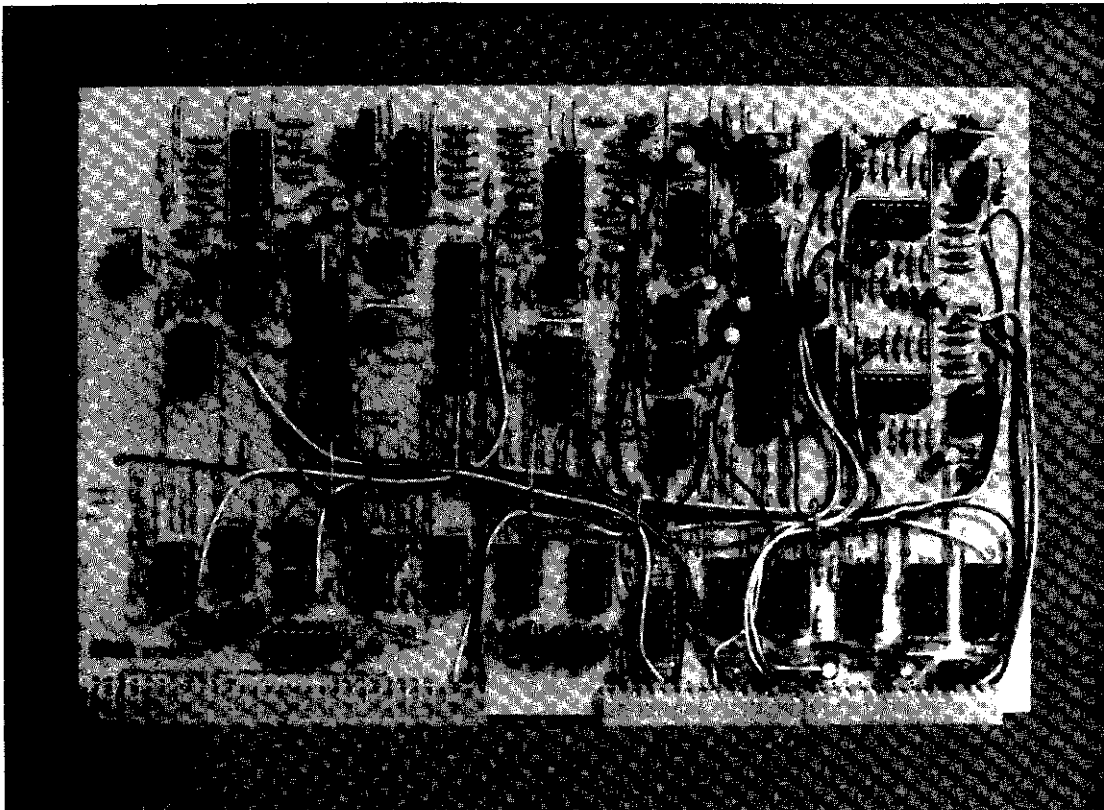# PAiA

ELECTRONICS, INC.

8750A

PROTEUS
VOICE CARD

The PROTEUS card is a complete monotonic synthesizer voice with two Voltage Controlled Oscillators, Noise source, Voltage Controlled Filter, Voltage Controlled Amplifier, Envelope Generator and Low Frequency Oscillator on a single card. The card is configured for digital control of normalization switching and multiplexing of parameter and pitch control voltages in multiple card configurations.

Prior to beginning assembly, check the supplied parts against the following parts list. Report any missing parts immediately.

<u>PROTEUS CARD parts bag</u>

6	100 ohm 5% resistor	(brown-black-brown)
1	270 ohm 5% resistor	(red-violet-brown)
1	330 ohm 5% resistor	(orange-orange-brown)
9	470 ohm 5% resistor	(yellow-violet-brown)
6	680 ohm 5% resistor	(blue-grey-brown)
2	910 ohm 5% resistor	(white-brown-brown)
11	1K 5% resistor	(brown-black-red)
1	1500 ohm 5% resistor	(brown-green-red)
5	1800 ohm 5% resistor	(brown-grey-red)
9	2200 ohm 5% resistor	(red-red-red)
1	2700 ohm 5% resistor	(red-violet-red)
11	4700 ohm 5% resistor	(yellow-violet-red)
2	5600 ohm 5% resistor	(green-blue-red)
2	6800 ohm 5% resistor	(blue-grey-red)
1	8200 ohm 5% resistor	(grey-red-red)
18	10K 5% resistor	(brown-black-orange)
4	12K 5% resistor	(brown-red-orange)
2	15K 5% resistor	(brown-green-orange)
3	18K 5% resistor	(brown-grey-orange)
2	22K 5% resistor	(red-red-orange)
3	27K 5% resistor	(red-violet-red)
9	33K 5% resistor	(orange-orange-orange)
5	47K 5% resistor	(yellow-violet-orange)
1	51K 5% resistor	(green-brown-orange)
3	56K 5% resistor	(green-blue-orange)
8	68K 5% resistor	(blue-grey-orange)
1	82K 5% resistor	(grey-red-orange)
3	91K 5% resistor	(white-brown-orange)
17	100K 5% resistor	(brown-black-yellow)
5	150K 5% resistor	(brown-green-yellow)
8	220K 5% resistor	(red-red-yellow)
3	270K 5% resistor	(red-violet-yellow)
1	330K 5% resistor	(orange-orange-yellow)
1	390K 5% resistor	(orange-white-yellow)
5	470K 5% resistor	(yellow-violet-yellow)
1	680K 5% resistor	(blue-grey-yellow)
7	1 meg 5% resistor	(brown-black-green)
3	1.2 meg 5% resistor	(brown-red-green)
1	2.2 meg 5% resistor	(red-red-green)
1	3.9 meg 5% resistor	(orange-white-green)
6	301 ohm 1% resistor	(orange-black-brown-black)
11	100K 1% resistor	(brown-black-black-orange)

3	1K pc mount trimmer potentiometer
10	10K pc mount trimmer potentiometer

1	2.2 mfd. 16v. electrolytic capacitor
9	4.7 mfd. 16v. electrolytic capacitor
2	10 mfd. 16v. electrolytic capacitor
1	33 mfd. 16v. electrolytic capacitor

3

6	100 pf. ceramic disk capacitor
5	.001 ceramic disk capacitor
2	.005 ceramic disk capacitor
10	.01 ceramic disk capacitor
3	.05 mfd ceramic disk capacitor
4	330 pf polystyrene capacitor
2	1200 pf. polystyrene capacitor
5	.01 polyester capacitor
9	.1 mfd polyester capacitor
1	3310 Transient Generator IC
1	3320 Voltage Controlled Filter IC
1	3330 Voltage Controlled Amplifier IC
2	3340 Voltage Controlled Oscillator IC
1	4066 Quad bi-lateral switch IC
1	4011 Quad NAND IC
1	3302 Quad Comparator IC
2	4051 8 channel mux. IC
4	4016 Quad bi-lateral switch IC
3	308 type op-amp IC
5	3080 Trans-conductance IC
5	4042 Quad latch IC
5	4136 Quad op-amp IC
6	4052 Dual 4 chan. mux. IC
1	2N5139 Transistor
1	Noise diode
6	1N4148 type glass signal diode
8	8 pin DIP socket
2	18 pin DIP IC socket
12	14 pin DIP socket
16	16 pin DIP socket
4	15 pin edge connector
4-5'	22 guage insulated wire
18'	bare wire
6'	tubing

4

PROTEUS CARD ASSEMBLY

SOLDERING

Use care when mounting all components. Use only rosin core solder. Use of acid
core solder or paste fluxes will VOID THE WARRANTY of this kit. A proper solder
joint has just enough solder to cover the round soldering pad and about 1/16
inch of the lead passing through it. There are two types of improper
connections to beware of: Using too little solder will result in a connection
which will appear 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 connection and flowing additional solder into the joint. If
too much solder is used on a connection, there is a danger of the excess solder
flowing between adjacent connections or circuit board paths causing a short
circuit. Unintentional bridges can be cleaned off by holding the board up-side
down and flowing the excess solder off onto the tip of a clean, hot soldering
iron.

Select a soldering IRON with a small tip and a power rating of not more than 35
watts. Soldering GUNS are completely unacceptable for assembling solid state
equipment, as the large magnetic field they generate can damage some components.
Be sure to KEEP YOUR SOLDERING IRON TIP CLEAN. Before soldering a connection,
wipe the tip on a damp sponge or rag. This will aid in heat transfer and
prolong tip life.

CIRCUIT BOARD ASSEMBLY

() Prepare the circuit board for assembly by thoroughly cleaning the conductor
    side of the circuit board with a scouring cleanser or steel wool pad. Rinse
    the board with clear water and dry completely. A BRIGHT SHINY BOARD IS
    ESSENTIAL TO SUCCESSFUL SOLDERING!

                                 JUMPERS

There are three kinds of solid wire jumpers indicated in the parts legend on the
circuit board.

These jumpers are to be formed from either resistor
clippings or the solid bare wire provided. Cut the   ———— J ————
jumper somewhat longer than needed and use pliers to
pull the tail on the foil side of the circuit board
until the jumper is straight and flush with the board.
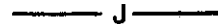
() Install these jumpers at this time.

These jumpers are as above but with an appropriate
length of the hollow plastic sleeving slipped on prior   ———(J)———
to installation.

() Install these jumpers.

These are sleeved jumpers as above, but are reserved for use as hold downs for
stranded wire cabling. As this cabling is not yet installed, DO NOT INSTALL THESE
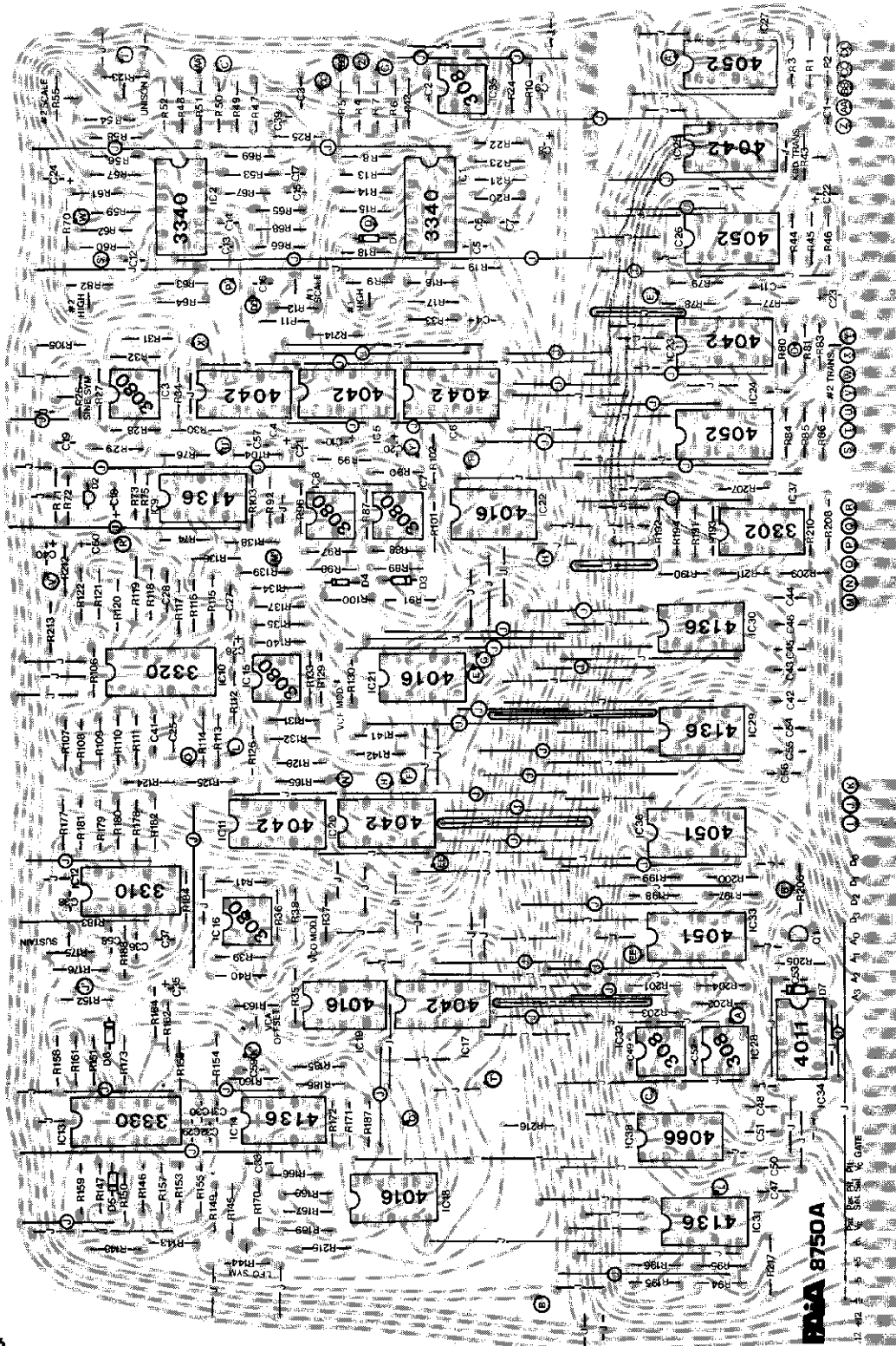JUMPERS AT THIS TIME.

figure 1: Proteus Card parts placement

6

Solder each of the 1/4 watt 5% tolerance resistors in place following the parts placement designators printed on the circuit board. Note that the fixed resistors are non-polarized and may be mounted with either of their 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 flush with the top of the solder joint. The 1% tolerance resistors and trimmer potentiometers will be installed in later steps, so not all resistor numbers are used at this time.

A B C
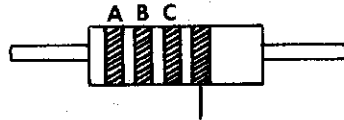
Silver or gold disregard this band

DESIGNATION	VALUE	COLOR CODE A-B-C
() R1	47K	yellow-violet-orange
() R2	220K	red-red-yellow
() R3	1 meg	brown-black-green
() R7	220K	red-red-yellow
() R8	1 meg	brown-black-green
() R10	470 ohm	yellow-violet-brown
() R11	10K	brown-black-orange
() R13	27K	red-violet-orange
() R14	5600 ohm	green-blue-red
() R15	6800 ohm	blue-grey-red
() R16	10K	brown-black-orange
() R17	4700 ohm	yellow-violet-red
() R18	10K	brown-black-orange
() R19	10K	brown-black-orange
() R20	470 ohm	yellow-violet-brown
() R21	1800 ohm	brown-grey-red
() R22	1.2 meg	brown-green-red
() R23	270K	red-violet-yellow
() R24	100 ohm	brown-black-brown
() R25	100 ohm	brown-black-brown
() R27	100K	brown-black-yellow
() R28	330 ohm	orange-orange-brown
() R29	2700 ohm	red-violet-red
() R30	68K	blue-grey-orange
() R31	18K	brown-grey-orange
() R32	4700 ohm	yellow-violet-red
() R33	1800 ohm	brown-grey-red
() R34	1K	brown-black-red
() R35	15K	brown-green-orange
() R36	8200 ohm	grey-red-red
() R38	47K	yellow-violet-orange
() R39	270 ohm	red-violet-brown
() R40	100 ohm	brown-black-brown
() R41	15K	brown-green-orange
() R42	100K	brown-black-yellow

( )	R50	390K	orange-white-yellow
( )	R52	270K	red-violet-yellow
( )	R53	470 ohm	yellow-violet-brown
( )	R54	10K	brown-black-orange
( )	R56	27K	red-violet-orange
( )	R57	5600 ohm	green-blue-red
( )	R58	1 meg	brown-black-green
( )	R59	56K	green-blue-orange
( )	R60	10K	brown-black-orange
( )	R61	6800 ohm	blue-grey-red
( )	R62	10K	brown-black-orange
( )	R63	10K	brown-black-orange
( )	R64	4700 ohm	yellow-violet-red
( )	R65	470 ohm	yellow-violet-brown
( )	R66	10K	brown-black-orange
( )	R67	1800 ohm	brown-grey-red
( )	R68	1.2 meg	brown-red-green
( )	R69	470K	yellow-violet-yellow
( )	R70	1800 ohm	brown-grey-red
( )	R71	100 ohm	brown-black-brown
( )	R72	1 meg	brown-black-green
( )	R73	100K	brown-black-yellow
( )	R74	1 meg	brown-black-green
( )	R75	150K	brown-green-yellow
( )	R76	1 meg	brown-black-green
( )	R77	470K	yellow-violet-yellow
( )	R78	100K	brown-black-yellow
( )	R79	33K	orange-orange-orange
( )	R80	1 meg	brown-black-green
( )	R81	220K	red-red-yellow
( )	R87	33K	orange-orange-orange
( )	R88	470 ohm	yellow-violet-brown
( )	R89	470 ohm	yellow-violet-brown
( )	R90	12K	brown-red-orange
( )	R91	1K	brown-black-red
( )	R92	10K	brown-black-orange
( )	R94	100K	brown-black-yellow
( )	R95	100K	brown-black-yellow
( )	R96	33K	orange-orange-orange
( )	R97	470 ohm	yellow-violet-brown
( )	R98	470 ohm	yellow-violet-brown
( )	R99	12K	brown-red-orange
( )	R100	1K	brown-black-red
( )	R101	470 ohm	yellow-violet-brown
( )	R102	1K	brown-black-red
( )	R103	10K	brown-black-orange
( )	R104	22K	red-red-orange
( )	R105	10K	brown-black-orange
( )	R106	91K	white-brown-orange
( )	R107	47K	yellow-violet-orange

( )	R108	100K	brown-black-yellow
( )	R109	91K	white-brown-orange
( )	R110	220K	red-red-yellow
( )	R111	100K	brown-black-yellow
( )	R112	51K	green-brown-orange
( )	R113	68K	blue-grey-orange
( )	R114	100K	brown-black-yellow
( )	R115	1800 ohm	brown-grey-red
( )	R116	100K	brown-black-yellow
( )	R117	1500 ohm	brown-green-red
( )	R118	100K	brown-black-yellow
( )	R119	220K	red-red-yellow
( )	R120	91K	white-brown-orange
( )	R121	100K	brown-black-yellow
( )	R122	220K	red-red-yellow
( )	R124	68K	blue-grey-orange
( )	R125	68K	blue-grey-orange
( )	R126	68K	blue-grey-orange
( )	R128	18K	brown-grey-orange
( )	R129	47K	yellow-violet-orange
( )	R131	100 ohm	brown-black-brown
( )	R132	100 ohm	brown-black-brown
( )	R133	33K	orange-orange-orange
( )	R134	56K	green-blue-orange
( )	R137	68K	blue-grey-orange
( )	R140	470K	yellow-violet-yellow
( )	R141	100K	brown-black-yellow
( )	R142	22K	red-red-orange
( )	R143	1K	brown-black-red
( )	R145	3.9 meg	orange-white-green
( )	R146	12K	brown-red-orange
( )	R147	680 ohm	blue-grey-brown
( )	R148	910 ohm	white-brown-brown
( )	R149	220K	red-red-yellow
( )	R150	680 ohm	blue-grey-brown
( )	R151	910 ohm	white-brown-brown
( )	R152	220K	red-red-yellow
( )	R153	10K	brown-black-orange
( )	R154	1K	brown-black-red
( )	R155	1K	brown-black-red
( )	R156	150K	brown-green-yellow
( )	R157	680K	blue-grey-yellow
( )	R158	150K	brown-green-yellow
( )	R159	150K	brown-green-yellow
( )	R160	150K	brown-green-yellow
( )	R161	4700 ohm	yellow-violet-red
( )	R162	2.2 meg	red-red-green
( )	R164	100K	brown-black-yellow
( )	R165	1K	brown-black-red
( )	R166	56K	green-blue-orange

( )	R167	68K	blue-grey-orange
( )	R168	330K	orange-orange-yellow
( )	R169	68K	blue-grey-orange
( )	R170	47K	yelow-violet-orange
( )	R171	10K	brown-black-orange
( )	R172	33K	orange-orange-orange
( )	R173	18K	brown-grey-orange
( )	R176	2200 ohm	red-red-red
( )	R177	12K	brown-red-orange
( )	R178	10K	brown-black-orange
( )	R179	10K	brown-black-orange
( )	R180	680 ohm	blue-grey-brown
( )	R181	680 ohm	blue-grey-brown
( )	R182	680 ohm	blue-grey-brown
( )	R184	82K	grey-red-orange
( )	R185	470K	yellow-violet-yellow
( )	R186	470K	yellow-violet-yellow
( )	R187	1.2 meg	brown-red-green
( )	R188	10K	brown-black-orange
( )	R190	1K	brown-black-red
( )	R191	4700 ohm	yellow-violet-red
( )	R192	4700 ohm	yellow-violet-red
( )	R193	4700 ohm	yellow-violet-red
( )	R194	4700 ohm	yellow-violet-red
( )	R195	100K	brown-black-yellow
( )	R196	100K	brown-black-yellow
( )	R197	2200 ohm	red-red-red
( )	R198	2200 ohm	red-red-red
( )	R199	2200 ohm	red-red-red
( )	R200	2200 ohm	red-red-red
( )	R201	2200 ohm	red-red-red
( )	R202	2200 ohm	red-red-red
( )	R203	2200 ohm	red-red-red
( )	R204	2200 ohm	red-red-red
( )	R205	1K	brown-black-red
( )	R206	10K	brown-black-orange
( )	R207	1K	brown-black-red
( )	R208	33K	orange-orange-orange
( )	R209	33K	orange-orange-orange
( )	R210	33K	orange-orange-orange
( )	R211	33K	orange-orange-orange
( )	R212	4700 ohm	yellow-violet-red
( )	R213	4700 ohm	yellow-violet-red
( )	R214	27K	red-violet-orange
( )	R215	270K	red-violet-yellow
( )	R216	4700 ohm	yellow-violet-red
( )	R217	100K	brown-black-yellow

() Install R183, 680 ohms (blue-grey-brown) by cutting a 3/4 inch (2 cm.) length of the clear plastic sleeving provided and slipping this sleeeving over one of the leads of the resistor.

Install each of the 1/4w. 1% tolerance fixed resistors following the parts placement designators printed on the circuit board. Note that these resistors have 5 color bands, of which 4 are significant

ABCD

disregard this band.

color code A-B-C-D

DESIGNATION	VALUE	COLOR CODE A-B-C-D
() R4	100K	brown-black-black-orange
() R5	100K	brown-black-black-orange
() R6	100K	brown-black-black-orange
() R44	301 ohm	orange-black-brown-black
() R45	301 ohm	orange-black-brown-black
() R46	301 ohm	orange-black-brown-black
() R47	100K	brown-black-black-orange
() R48	100K	brown-black-black-orange
() R49	100K	brown-black-black-orange
() R51	100K	brown-black-black-orange
() R84	301 ohm	orange-black-brown-black
() R85	301 ohm	orange-black-brown-black
() R86	301 ohm	orange-black-brown-black
() R135	100K	brown-black-black-orange
() R136	100K	brown-black-black-orange
() R138	100K	brown-black-black-orange
() R139	100K	brown-black-black-orange

Install the ceramic disk capacitors. Without exception the value will be marked on the body of the part or the part will be bagged separately with the value marked on the bag.

DESIGNATION	VALUE	ALTERNATE MARKINGS
() C2	100 pf.	
() C3	.005 mfd.	502
() C4	.001 mfd.	102
() C5	.001 mfd.	102
() C7	.01 mfd.	103
() C9	.01 mfd.	103
() C11	.05 mfd.	503
() C12	.01 mfd.	103
() C13	.01 mfd.	103
() C15	.01 mfd.	103

ceramic disk
capacitor

()	C16	.01 mfd.	103
()	C17	.01 mfd.	103
()	C19	.05 mfd.	503
()	C29	.001 mfd.	102
()	C30	.001 mfd.	102
()	C31	.01 mfd.	103
()	C32	.01 mfd.	103
()	C33	.05 mfd.	503
()	C36	.005 mfd.	502
()	C37	.01 mfd.	103
()	C49	100 pf.	100K
()	C52	100 pf.	100K
()	C53	.001 mfd.	102
()	C57	100 pf.	100K
()	C58	100 pf.	100K
()	C59	100 pf.	100K

Install the polyester capacitors. These capacitors will have their value marked
on the body of the part, or will be bagged separately with the value marked on
the bags.

DESIGNATION	VALUE
() C1	.1 mfd.
() C38	.01 mfd.
() C42	.01 mfd.
() C43	.1 mfd.
() C44	.01 mfd.
() C45	.1 mfa.
() C46	.1 mfd.
() C47	.1 mfd.
() C48	.1 mfd.
() C50	.1 mfd.
() C51	.1 mfd.
() C54	.1 mfd.
() C55	.01 mfd.
() C56	.01 mfd.

polyester capacitor

Install the polystyrene capacitors. These will have their values marked on the
body of the part, or will be bagged separately with the values marked on the
bags.

DESIGNATION	VALUE
() C6	1200 pf.
() C14	1200 pf.
() C25	330 pf.
() C27	330 pf.
() C28	330 pf.
() C41	330 pf.

polystyrene capacitor

Up to this point all components have been non-polarized and either lead could be placed in either of the holes provided without affecting the operation of the unit. Electrolytic capacitors are polarized and must be mounted so that the "+" lead of the capacitor goes through the "+" hole in the circuit board. In the event that the "-" lead rather than the "+" lead of the capacitor is marked it is to go through the unmarked hole on the circuit board.

Note that the operating voltage (v.) specified for a capacitor is the minimum acceptable rating. Capacitors supplied with specific kits may have a higher voltage rating than that specified and may be used despite this difference. For instance, a 100 mfd. 25v. capacitor may be used in place of a 100 mfd. 16v. capacitor without affecting the operation of the circuit.

Mount the following electrolytic capacitors and solder them in place. Their values, voltage rating and polarization are marked on the body of the part.

electrolytic capacitor

DESIGNATION	DESCRIPTION
() C8	4.7 mfd. 16v.
() C10	4.7 mfd. 16v.
() C18	33 mfd. 16v.
() C20	4.7 mfd. 16v.
() C21	4.7 mfd. 16v.
() C22	10 mfd. 16v.
() C23	10 mfd. 16v.
() C24	2.2 mfd. 16v.
() C26	4.7 mfd. 16v.
() C35	4.7 mfd. 16v.
() C39	4.7 mfd. 16v.
() C40	4.7 mfd. 16v.
() C60	4.7 mfd. 16v.
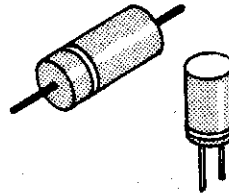
Next install the diodes. Note that all semiconductors are heat sensitive and may be damaged if allowed to get too hot while soldering. To be on the safe side, heat sink each diode lead during the soldering operation by grasping it with a pair of needlenose pliers or a small alligator type clip at a point between the circuit board and the body of the component. When mounting the diodes, note that they are polarized by a colored band around one end of the diode body. This coding relates to the circuit board designators as shown in the accompanying drawing.
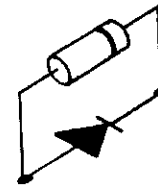
diode

Note all diodes are identical,1N914 or 1N4148 type signal diodes. Install and solder in place. Trim excess leads.

| DESIGNATION	TYPE NUMBER
() D1	1N4148 or 1N914
() D3	1N4148 or 1N914
() D4	1N4148 or 1N914
() D5	1N4148 or 1N914
() D6	1N4148 or 1N914
() D7	1N4148 or 1N914

Note that the middle lead of one of the transistors has
been removed. This transistor has been selected for its
noise generating characteristics and is intended for
use as D2. Install the transistor as shown.

() D2   noise diode   noise diode

Install the 2N5139 transistor, Q1. This transistor may be in one of two
different case styles. If the transistor supplied with your kit has in-line
leads, bend the center lead slightly toward the flat face of the case so that
the leads will match the triangular hole pattern on the circuit board.

IN-LINE   DOME CASE
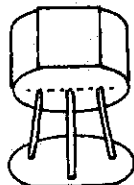
bend center lead   note that dome cased
to match holes.   transistors leads match
                                     holes but polarizing flat
                                     does not correspond to graphics.

() Q1   2N5139

Install the Integrated Circuit sockets. Note that four
socket sizes have been supplied; 8 pin, 14 pin, 16
pin, and 18 pin. DO NOT INSTALL ANY IC's AT THIS TIME.
Some sockets will have a small notch at one end. This
should correspond to the notch on the parts placement
graphics.

Install 8 pin sockets in the following locations;

() IC3   () IC15   () IC32   *NOTE KEY*
() IC7   () IC16   () IC35
() IC8   () IC28
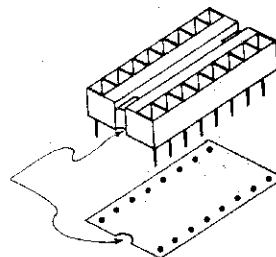
Install 14 pin sockets in the following locations;

() IC9   () IC19   () IC29   () IC34
() IC14   () IC21   () IC30   () IC37
() IC18   () IC22   () IC31   () IC38

Install 16 pin sockets in the following locations;

() IC1   () IC6   () IC20   () IC26
() IC2   () IC11   () IC23   () IC27
() IC4   () IC12   () IC24   () IC33
() IC5   () IC17   () IC25   () IC36

Install 18 pin sockets in the locations for IC10 and IC13.

() IC10
() IC13

IC socket

Install the trimmer potentiometers;

DESIGNATION	VALUE
( ) R9	10K
( ) R12	10K
( ) R26	10K
( ) R37	10K
( ) R43	1K
( ) R55	10K
( ) R82	10K
( ) R83	1K
( ) R123	10K
( ) R130	10K
( ) R144	10K
( ) R163	10K
( ) R175	1K

trimmer potentiometer

In the following steps the stranded insulated wire provided will be used to interconnect isolated points on the circuit board. At each step cut the wire to the length called for and prepare it for installation by stripping 3/16 inch (5mm) of insulation from both ends. Twist the exposed wire strands tightly together and "tin" them by melting a small amount of solder into the strands. Make sure that your soldering tip is VERY CLEAN WHILE TINNING. The ends of the wire should be nice and cylindrical, without loose strands or excess solder (see below).

| DESIGNATION	LENGTH
( ) A to A'	9.5"(24cm)
( ) B to B'	5.0"(13cm)
( ) C to C'	12.5"(31cm)
( ) D to D'	4.5"(12cm)
( ) E to E'	4.5"(12cm)
( ) F to F'	5.0"(13cm)
( ) G to G'	7.5"(19cm)
( ) H to H'	4.75"(12cm)
( ) I to I'	12.0"(30cm)
( ) J to J'	8.0"(20cm)
( ) K to K'	7.0"(18cm)
( ) L to L'	7.25"(19cm)
( ) M to M'	5.75"(15cm)
( ) N to N'	9.5"(24cm)
( ) O to O'	7.25"(18cm)
( ) P to P'	8.5"(22cm)
( ) Q to Q'	7.5"(19cm)
( ) R to R'	7.0"(18cm)
( ) S to S'	7.5"(19cm)
( ) T to T'	7.75"(20cm)
( ) U to U'	7.5"(19cm)
( ) V to V'	8.0"(20cm)
( ) W to W'	7.5"(19cm)
( ) X to X'	6.5"(17cm)
( ) Y to Y'	5.25"(14cm)
( ) Z to Z'	5.25"(14cm)
( ) AA to AA'	6.25"(16cm)
( ) BB to BB'	5.0"(13cm)
( ) CC to CC'	5.5"(15cm)
( ) DD to DD'	8.0"(20cm)
( ) EE to EE'	2.75"(7cm)

LOOSE STRANDS

EXCESS SOLDER

GOOD!

UNGOOD!
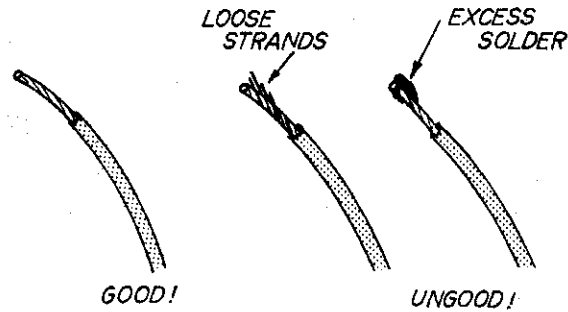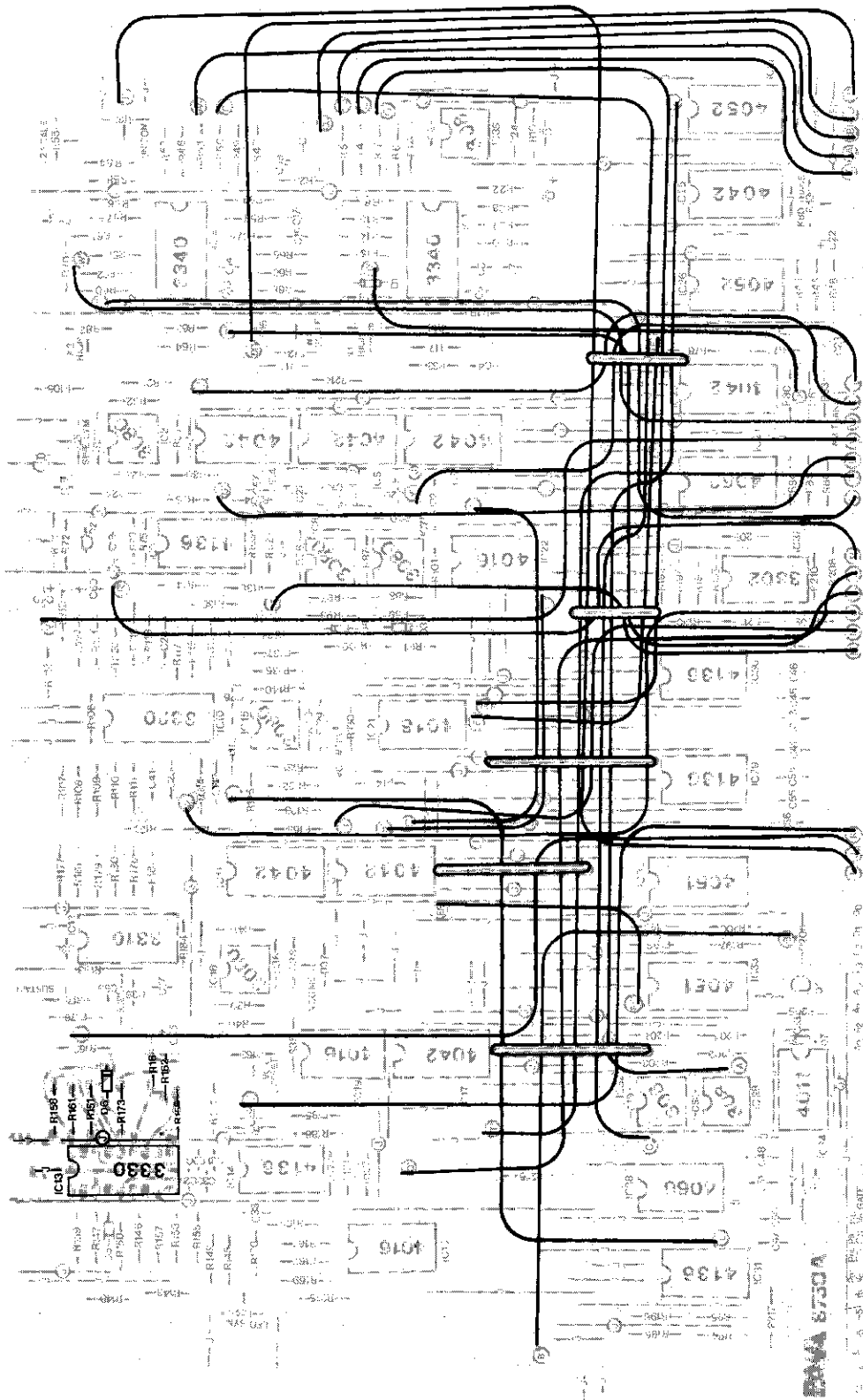
figure 2: wire routing

( ) Referring to figure 2, the last of the solid wire jumpers should now be
installed. These should ALL be insulated with an appropriate length of
clear plastic tubing. As wire hold downs, these jumpers should gather the
stranded wire jumpers into bundles for neatness. These wire hold downs need
not be extremely tight or pulled flat against the circuit board.

( ) Install the four 15 pin Molex edge connectors
as shown in the figure.
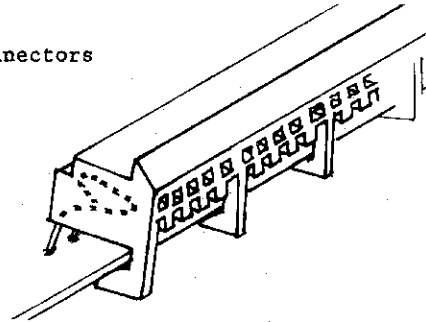
We are now ready to begin installing the integrated circuits. Open the
integrated circuit package and install the integrated circuits in their
respective sockets. Notice that the orientation of the Integrated Circuits is
keyed by a semi-circular notch at one end of the device, and that the position
of this notch should correspond with the notch that is part of the circuit board
graphics.

WARNING CMOS CIRCUITS

Some of the integrated circuits used in this kit are Complementary Metallic
Oxide Semiconductors (CMOS). While state of the art internal protection is
provided, these circuits are still susceptible to damage from STATIC
ELECTRICITY. You should not experience any difficulties if you observe the
following precautions.

1) The circuits are supplied to you inserted in blocks of conductive foam.
Leave them in these blocks until you are ready to install the part.

2) Do not install the parts in sequence other than that called for in the
instructions.

3) Do not wear synthetic clothing (e.g. nylon) while handling these parts.

Observing polarization markings, install the following CMOS ICs in their
sockets.

DESIGNATION	TYPE NO.
( ) IC4	4052
( ) IC5	4052
( ) IC6	4042
( ) IC11	4052
( ) IC17	4042
( ) IC18	4016
( ) IC19	4016
( ) IC20	4042
( ) IC21	4016
( ) IC22	4016
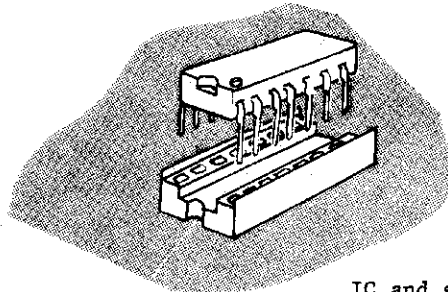
IC and socket

```
( )  IC23        4042
( )  IC24        4052
( )  IC25        4042
( )  IC26        4052
( )  IC27        4052

( )  IC33        4051
( )  IC34        4011
( )  IC36        4051
( )  IC38        4066
```

Next, observing polarizing markings, install the remaining integrated circuits
in their respective sockets.

```
DESIGNATION      TYPE NO.

( )  IC1         3340
( )  IC2         3340
( )  IC3         3080
( )  IC7         3080
( )  IC8         3080

( )  IC9         4136
( )  IC10        3320
( )  IC12        3310
( )  IC13        3330
( )  IC14        4136

( )  IC15        3080
( )  IC16        3080
( )  IC28        308
( )  IC29        4136
( )  IC30        4136

( )  IC31        4136
( )  IC32        308
( )  IC35        308
( )  IC37        3302
```

NORMALIZATION ANALYSIS

The PROTEUS card is a complete monotonic synthesizer voice with two Voltage Controlled Oscillators, Noise source, Voltage Controlled Filter, Voltage Controlled Amplifier, Envelope Generator and Low Frequency Oscillator on a single card. The card is configured for digital control of normalization switching and multiplexing of parameter and pitch control voltages in multiple card configurations.

As can be seen from the normalization block diagram in figure 3 below, the signal and control voltage flow through the PROTEUS card is fairly straight-forward. A pair of Voltage Controlled Oscillators offer a variety of waveforms which may be individually selected and mixed to provide a signal to the 24 db/oct Low Pass Filter. The unmodified input to the filter and the filtered output may be selected or mixed as the input to the Voltage Controlled Amplifier.
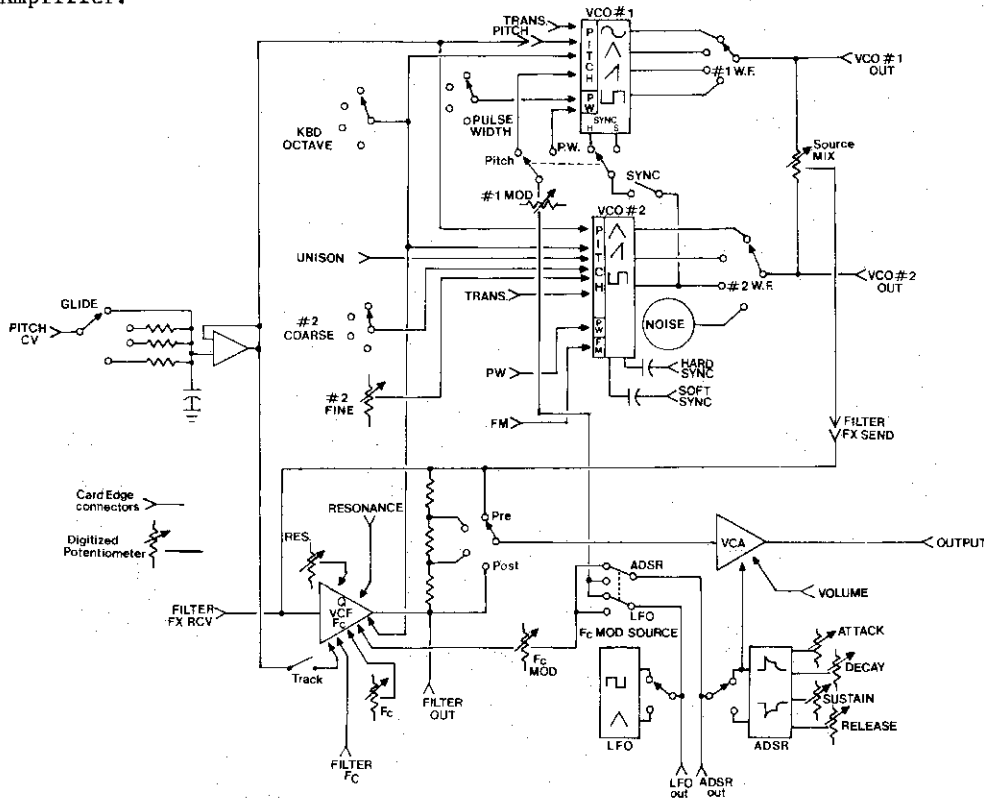

figure 3: Normalization Block Diagram

The ADSR Envelope Generator is hard-wired to the VCA to provide control of dynamics as well as being available in either a normal or inverted form as a VCO or VCF modulation source. The Low Frequency Oscillator is the second modulation source which has repeating square or triangle waveforms available. VCO or VCF destination of the modulation source is selected by the single Fc MOD SOURCE switch and is arranged so that when the ADSR is selected as the filter modulator, the LFO is automaticly selected to modulate VCO #1. Conversely, when the ADSR is modulating the oscillator, the LFO is selected for the filter.

At VCO #1, the action of the selected source can be switch selected to be either
Pitch Modulation or Pulse Width Modulation. While sync has a separate switch to
enable it, Hard Sync or Soft Sync is automaticly selected at the same time that
VCO modulation destination is. Selecting Pitch Modulation produces Hard Sync,
while P.W. Modulation selects Soft Sync.

CIRCUIT DESIGN ANALYSIS

Two major groups of controlling signals enter the PROTEUS card on the edge
connector: Pitch control voltage and multiplexed parameter data and address.
See figure 4 below.

figure 4: Pitch and Parameter De-Multiplexing

PITCH C.V. DE-MULTIPLEXING

After entering the card on edge connector pin 10, the Pitch Control Voltage
(PICV) is routed through one of the four bi-lateral switch sections of IC38
which, under control of the Pitch Select (PIS) signal on edge connector pin 9,
allows for multiplexing of this control signal in multiple card configurations.
When the PIS line is high, the switch is on, allowing the control voltage to be
applied to the Sample and Hold circuit comprising the op-amp IC28 and holding
capacitor C51.

The PIS control line also allows for the multiplexing of the GATE signal which
accompanies PICV. The GATE signal is an indication of the state of the AGO key
corresponding to the pitch control voltage. When the key corresponding to the
pitch is down, GATE is at a high logic level and correspondingly, when the key
is up, GATE is low. The GATE signal is de-multiplexed by being applied to one
of the inputs of one of the NAND gate sections of IC34. The other input of the
NAND gate is the PIS control line. When both the PIS and GATE signals are high
the output of the gate responds by going low. This low output is inverted by Q1
and provides a signal which, when high, produces the appropriate response from
the Envelope Generator and its associated circuitry. Also involved with the
de-multiplexing of the gate signal is the slight time delay produced by the
network consisting of D7, C53 and R205.

In single card configurations, PIS is simply tied to a high logic level,
allowing PICV and GATE continual access to the card.

PARAMETER DATA DE-MULTIPLEXING

Parameter data enters the card in equivalent digital and analog forms, both of
which are time-multiplexed even in single card configurations. At any given
instant in time, a 4 bit digital word, a Parameter Control Voltage (PACV) and a
4 bit parameter address all appear on their respective control lines. Whether
the analog voltage or digital data will be used for any given address is
hard-wired into the Proteus card de-multiplexing logic.

The DATA lines coming onto the card are buffered by the Quad comparator IC37 and
simultaneously level shifted from the 0 to 5v. logic levels at the card edge
inputs to the -5v. (logic 0) to +5v. (logic 1) levels required by the bipolar
analog processing elements used throughout the card. One final line, Parameter
Select (PAS) is a signal which when high signifies that the other lines
represent valid data, i.e. that an appropiate settling time has expired between
the last parameter and the current one.

As is indicated by the Parameter Address map in figure 5, the 16 mixed digital
and analog parameters entering the card can be thought of as being divided into
two groups of 8 parameters each. The first group of 8 is de-multiplexed by IC36
while the second group is handled by IC33. Three gates from IC34 are used to
logicly separate these two groups by decoding the most significant address line
A0 and to allow the selected de-multiplexer to be enabled only when the PAS line
is high.

The first group of parameters (0-7) are exclusively control voltages and, unlike
the PACV signal which appears at the edge connector, are "negative going". That
is, their allowable range of values is from ground (0v.) to -5v. To allow for
this, the input of de-multiplexer IC36 is driven from the output of the unity
gain inverter comprising one of the op-amp stages of IC31 and resistors R195 and
R196. Each of these parameters, as they are selected, are stored in one of the

8 S/H circuits built around the quad op-amps IC29 and IC30 and associated holding capacitors and from there are distributed to the appropriate points in the synthesizer circuitry.

Address	PARAMETER(S)			
	D3	D2	D1	D0
0	VCO #1 MOD ATTENUATOR			
1	ADSR DECAY			
2	ADSR RELEASE			
3	ADSR ATTACK			
4	VCO #1		#2 MIX	
5	LFO FREQUENCY			
6	VCF CORNER FREQ			
7	VCF MOD ATTENUATOR			
8	#2 WAVEFORM		#1 WAVEFORM	
9	ADSR SUSTAIN			
A	VCO #2 FINE OFFSET			
B	GLIDE		KBD TRANSPOSE	
C	VCO #1 PULSE WIDTH		VCO #2 COARSE PITCH	
D	VCF RESONANCE			
E	FILTER PRE/POST		SYNC	#1 MOD° PITCH/P.W.
F	FILTER TRACK/FIXED	ADSR NORM/INV	FILTER MOD ADSR/LFO*	LFO WAVEFORM ∧ / ⊓

°When #1 MODULATION of PITCH, HARD SYNC selected
*Alternate LFO/ADSR selected as VCO modulator

figure 5:   Parameter Address Map

The second group of 8 parameters are a hybrid mix of control voltage and digital (switch) signals and because of this the de-multiplexer responsible for these parameters has at its input only a high logic level. The select line coming from pin 13 is typical in that it terminates in resistor R197 which returns to the -5v. supply, consequently, when address $8 is specified and selected, a short duration +5v. pulse appears across this resistor. This pulse is subsequently used to strobe the data into a latch; in this specific example IC6, which in turn selects the output waveform from the two VCO's. Three of the paramters in this group of 8 ($9, $A and $D) are positive going (0 to +5v.) control voltages which are switched into the appropriate S/H circuits by using the strobe signals from the de-multiplexer to turn on switch sections from IC38.

SIGNAL SOURCES

The PROTEUS card's primary signal sources are Voltage Controlled Oscillators built around CEM 3340 type VCO ICs. See figure 6. The Pitch controlling voltage coming from the previously described keyboard control voltage S/H (IC28) is first applied to the input of one section of the 4052 type 4 channel multiplexer chip IC27 which under control of D0 and D1 of control word $B selects one of 4 glide determining time constants (R1, R2, R3, C1). IC38 buffers this control voltage before it is distributed to the oscillators and filter (when the filter is selected to track the keyboard).

D2 and D3 of control word $B are applied to the 4 channel multiplexer IC26 which acts as a switch to select one of the octavely related control voltages

originating at the voltage divider consisting of R43 - R46. The voltage selected from this divider string is applied to the VCOs and VCF where it serves the function of raising or lowering all pitch related parameters of the card in octave increments. This has the effect of transposing the AGO keyboard.

A total of four control voltages determine the Pitch of VCO #1; the KBD control voltage as it appears at the output of the Glide buffer IC35, the KBD Transpose voltage from IC26, the pitch modulation voltage (when selected) from IC16 and the off-card transpose voltage which comes in on R4. Of particular note is the fact that the KBD Pitch Control Voltage passes through two edge connector fingers before going to the VCO so that this oscillator can be disconnected from the Pitch Control Voltage if desired.

Bits D0 and D1 of word $C are applied to the multiplexer chip IC24 which selects one of the octavely related control voltages generated by the divider string R83 - R86. This control voltage is applied to VCO #2 only where it provides a means to offset the pitch of this oscillator by octaves. Only VCO #2 is affected.

The fine (semi-tone) offset of VCO #2 is determined by the control voltage derived from word $A which is applied to R50. Again, only VCO #2 is affected.

D2 and D3 of word $C control the simple R-2R type Digital to Analog Converter (R77 - R81 at the output of the 4042 latch IC23) the output voltage of which is applied to the Pulse Width input of VCO #1 (IC1). When P.W. modulation of this oscillator is selected, it is implemented by modulating the output of this DAC by applying the control voltage to the junction of R78 and R79.

Either pulse width modulation (as discussed above) or Pitch Modulation (by way of R7) of VCO #1 is selected by word $E's bit D0 which, depending on its state, causes either of two switches in IC21 to be on. The transconductance amplifier IC16 is used as an electronic attenuator under the control of the analog voltage represented by word $0 to set the amount of modulating signal available.

On-card sync is controlled by the 4 switch section in IC22. The sync is turned on by the section represented by pin 13 under control of D1 of word $E. The switch section represented by pin 5 of this IC is driven from D1's complement so that when sync is not selected the sensitive soft sync input of VCO#1 is grounded to prevent interference from stray signals.

Hard Sync or Soft Sync is determined by turning on the switch section of IC22 controlled by either pin 12 or pin 6 respectively. These switches work in conjuction with the VCO #1 modulation destination switching (D0 of word $E) so that when Pitch Modulation is invoked, Hard Sync is selected and when P.W. Modulation is invoked Soft Sync is selected.

A sine wave output from VCO #1 is derived by using this oscillator's triangle waveform to slightly overdrive the transconductance amplifier IC3 causing the triangle peaks to round off into a approximation of a sine wave. This sine wave, along with VCO #1's triangle, ramp and pulse wave outputs are routed to the 4 channel multiplexer (IC5) where one of them is selected as the final oscillator output. Selection is controlled by D0 and D1 of word $8.

The noise source associated with VCO #2 is produced by the avalanching reverse biased base-emitter junction of D2. Shot Noise generated by this process is buffered and amplified by two cascaded inverting amplifiers comprising two op-amp stages from IC9 and R73 - R76.
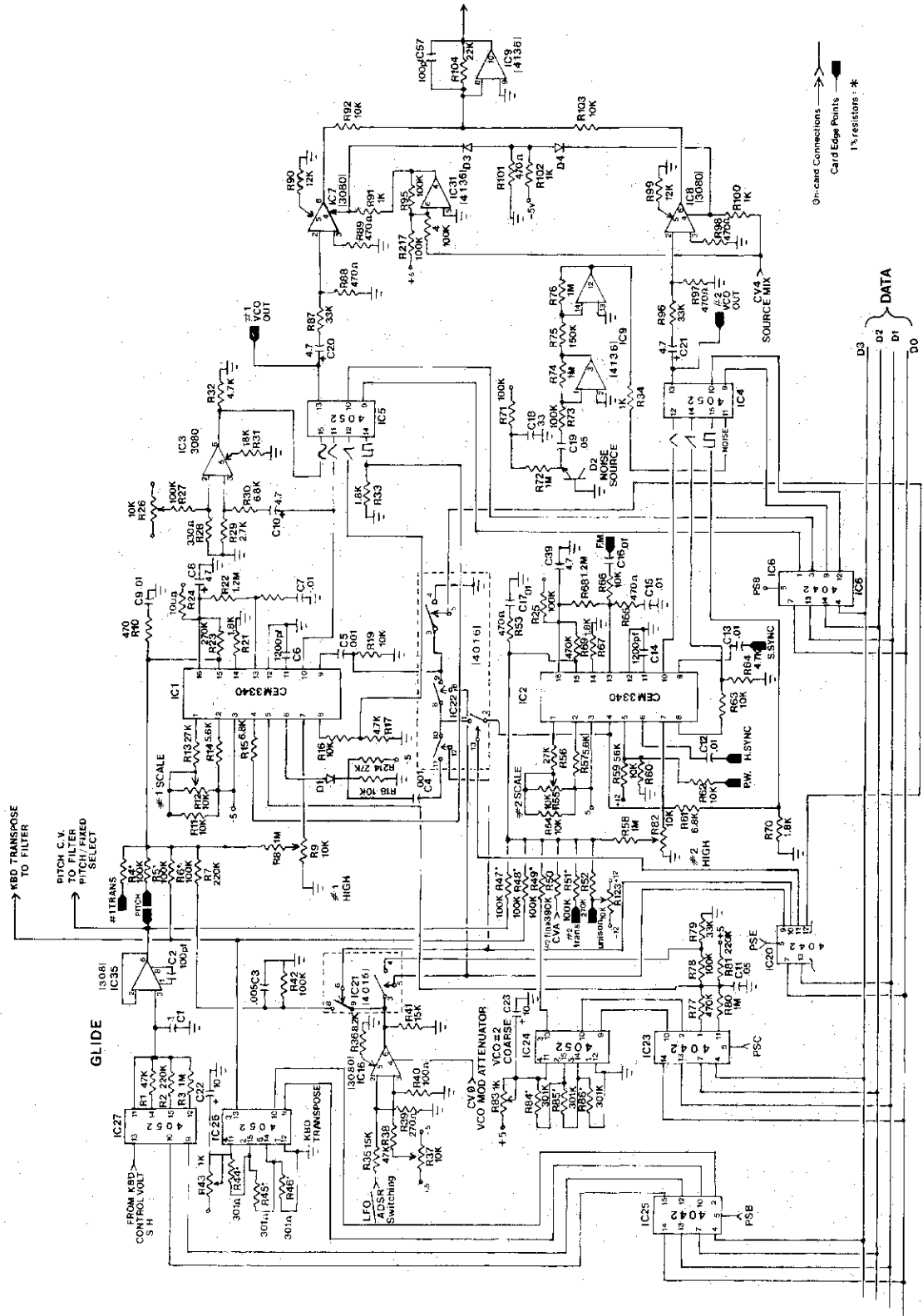
figure 6: Signal Sources

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The noise output along with the triangle, ramp and square wave outputs of VCO #2 are applied to the inputs of the 4 channel multiplexer IC4 where D2 and D3 of word $8 select one of the four as the final output of this source.

Six inputs set the pitch of VCO #2; keyboard C.V. from IC35, KBD Transpose from IC26, VCO #2 Coarse from IC2, VCO #2 Fine from IC35, the off-card transpose C.V. and the off-card Unison voltage.

SOURCE MIX

Mixing of the two sources is controlled by transconductance amplifiers IC7 and IC8 under control of the voltage corresponding to word $4. This control voltage is applied directly to the control input of IC8. The same control voltage is also inverted and offset by the inverter consisting of one stage of IC31 and associated components before being applied to the control input of IC7. The net result is that as control voltage $4 decreases to turn on IC8 (this is one of the negative going control voltages) the pin 4 output of IC 31 rises from a negative value to turn off IC7, producing a cross fader action. Diodes D3 and D4 serve as soft clamps on the control voltages to IC7 and IC8 to approximate the logarithmic response of the ear so that subjective volume level is constant regardless of the mix.

The current outputs of IC7 and IC8 are summed and converted to a voltage by IC9 whose output is then routed to the input of the Low Pass Filter.

LOW PASS FILTER

The 24 db/oct Voltage Controlled Filter consists of IC10 (CEM 3310) and associated components (see figure 7). Disregarding modulation and keyboard tracking control voltage inputs, the initial frequency of the filter is set by the control voltage corresponding to word $6. Resonance is set by the control voltage corresponding to word $D.

The output of the source mixer is hard-wired to the input of the filter and the action of the filter (how much effect of the filter can be heard) is controlled by selecting and mixing the audio signal as it goes into the filter (Pre) with the output of the filter (Post). This mixing is accomplished with the resistor string R124 - R126. The signal at the top of R124 is completely without filtering, while that at the bottom or R126 is only filter output. The two taps in between have a mix of the filtered and the non-filtered signals. Selection of one of these 4 signals is accomplished by the 4 channel multiplexer in IC11 under control of bits D2 and D3 of control word $E.

The output of the filter Pre/Post selection is hardwired to the input of the PROTEUS card main VCA (IC13 pin 13) by C35 and R164. The current output of the Curtis VCA is converted to a voltage and buffered by R160 and one of the op-amp stages in IC14 whose output is the main audio output of the card.

Altogether 5 variable control voltages can be summed to set the corner frequency of the filter; the output of the modulation attenuator IC15, the voltage from the track/fixed switch IC21, the front panel corner frequency represented by control word $6, the keyboard transpose control voltage from IC26, and an external control voltage from the Filter Fc edge connection fingers.
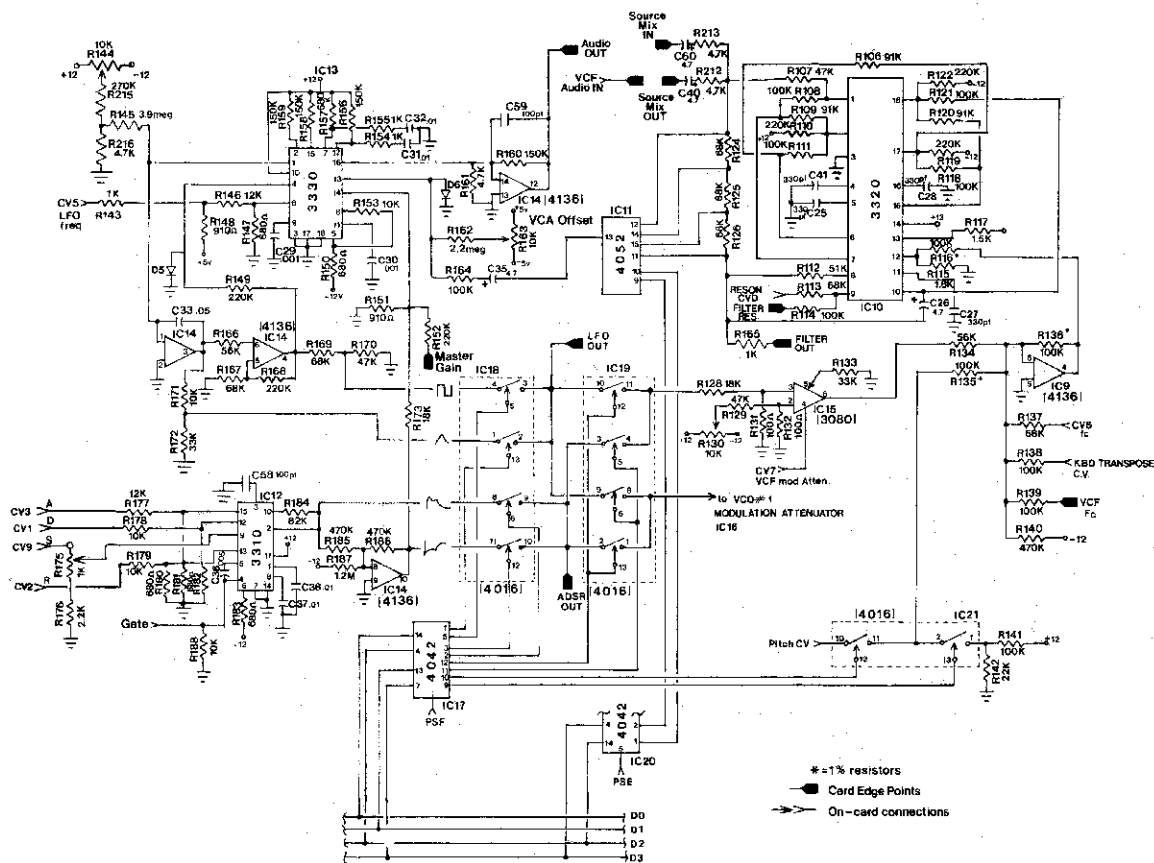
figure 7: Filter, VCA, and Modulation Sources

ENVELOPE GENERATOR

The envelope generator design uses a CEM 3310 ADSR chip (IC12). Attack time is set by the control voltage corresponding to word $3. Initial Decay is set by word $1. Sustain level is set by word $9 and final Release controlled by word $2. The trigger for the ADSR is derived from the pitch control voltage de-multiplexing circuitry as described earlier.

The output of the transient generator is inverted and level shifted by one of the op-amp stages in IC14 and R185 - R187 and hard wired to the control input of one of the two Voltage Controlled Amplifiers in the CEM 3330 VCA which serves to control dynamics.

LOW FREQUENCY OSCILLATOR

The second VCA stage in IC14 is used as the exponential response voltage controlled element in the PROTEUS card's Low Frequency Oscillator. The LFO design is a common configuration consisting of an integrator comprising C33 and one op-amp stage from IC14 followed by a Schmitt trigger comprising R167 and R168 and a second section of IC14. The output of the Schmitt trigger feeds what would ordinarily be the audio input of the VCA (pin 4), while the current into the integrator comes from the VCA output (pin 1). The control input of this VCA section is driven by the analog control voltage corresponding to word $5.

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MODULATION SELECTION

Either the triangle waveform from the junction of R171 and R172 at the output of the integrator or the square wave from the junction of R169 and R170 at the output of the Schmitt trigger is selected by turning on one or the other of the IC18 switch sections represented by pins 13 and 5. These two switches are under control of D0 and its complement $\overline{D0}$ of word $F.

Similarly, either the normal envelope generator waveform available at pin 2 of IC12 or its inverted replica at pin 10 of IC14 is selected by one of the remaining two switch sections in IC18 under control of D2 of word $F.
The selected LFO and envelope generator waveforms are routed to the four switch sections in IC19. Under control of D1 of word $F these switches either route the LFO to modulate the #1 VCO while the envelope generator modulates the filter (when D1 is a logical 1) or vice-versa (when D0 is low).

The remaining bit of word $F (D3), when set, causes the corner frequency of the filter to track the keyboard by turning on the switch section of IC21 represented by control pin 12. When this bit is low, the switch represented by pin 13 is off causing the filter Fc to ignore the keyboard control voltage changes.

━━━━━━━━━━━━━━ **NOTES** ━━━━━━━━━━━━━━

**FILTER/MOD**

PROTEUS CARD CALIBRATION

Calibration of the PROTEUS synthesizer card is covered in detail in the
applications manual for the device which uses the card, but in the interest of
completeness calibration objectives will be reviewed here.

| NAME	PART #	CALIBRATION
SUSTAIN	R175	Adjust so that the voltage at pin 9 of IC12 is the same as the voltage reached at the end of the Envelope Generator's Attack cycle.
#1 SCALE	R12	Adjust to set control response to lv./oct. (or other exponential scale response as desired).
#1 HIGH	R9	Adjust to compensate for the tendency of the CEM 3340 VCO chips to go slightly flat at frequencies above 5 kHz.
#2 SCALE	R55	Same as #1 SCALE above.
#2 HIGH	R82	Same as #1 HIGH above.
UNISON	R123	Adjust so that the frequencies of VCO #1 and VCO #2 are the same when parameter word $C is $2 (0010 in binary) and parameter word $A is $0 (0000 in binary).
KBD Trans.	R43	Adjust for octave changes in frequency of VCO #2 (pin 10, IC2) as transpose is increased.
VCO #2 Trans.	R83	Adjust for octave changes in output frequency of VCO #2 (pin 10, IC2) as transpose is increased.
LFO Symmetry	R144	Adjust for symmetrical triangle at pin 4 of IC14 or for 50% duty factor of the square wave at pin 3 of IC14. Since symmetry errors are most prominent at low current flows from the VCA stage used as the LFO control element, adjust at the lowest frequency possible.
VCA Offset	R163	Adjust so that the output waveform remains balanced about ground as volume is increased or when ADSR Envelope Generator is triggered.
VCO Modulation	R37	Select LFO modulation of VCO #1. Set R37 so that the waveform which appears at pin 6 IC16 is balanced about ground as modulation level is increased.
VCF Modulation	R130	Select LFO modulation of Filter. Set R130 so that the waveform which appears at pin 6 IC15 is balanced about ground as modulation level is increased.
SINE sym.	R26	Adjust for lowest distortion sine wave at pin 6 IC3.

NOTES

CALIBRATION

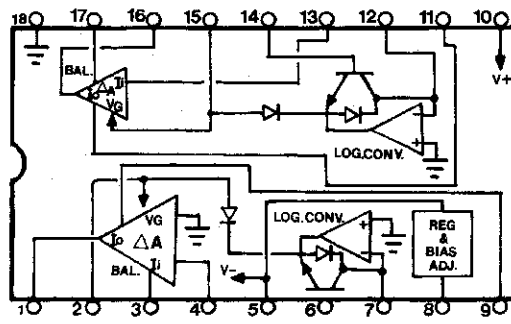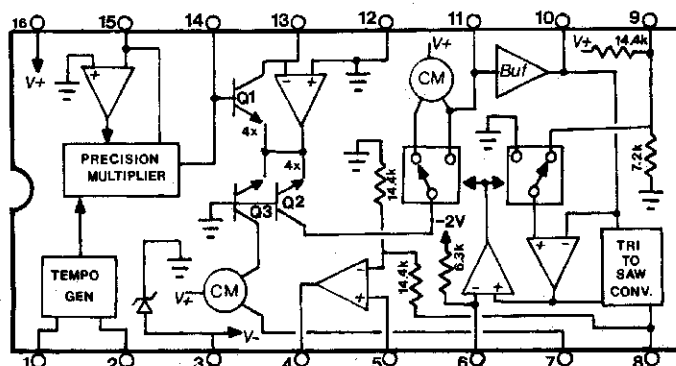# CURTIS SYNTHESIZER CHIP SET
PIN-OUTS
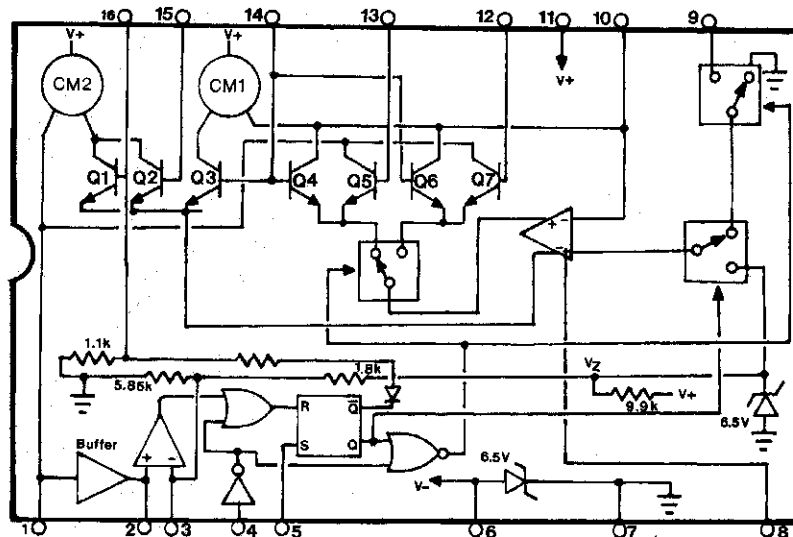
CEM 3310 VOLTAGE CONTROLLED ENVELOPE GENERATOR
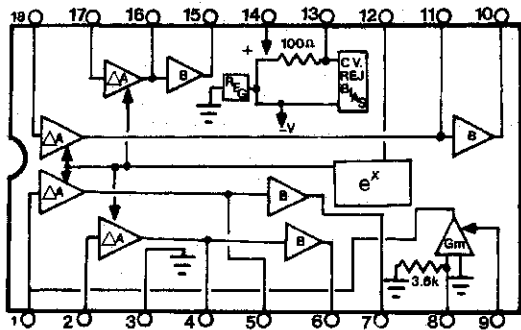
CEM 3320 VOLTAGE CONTROLLED FILTER

CEM 3330 DUAL VOLTAGE CONTROLLED AMPLIFIER

CEM 3340 VOLTAGE CONTROLLED OSCILLATOR

* * *