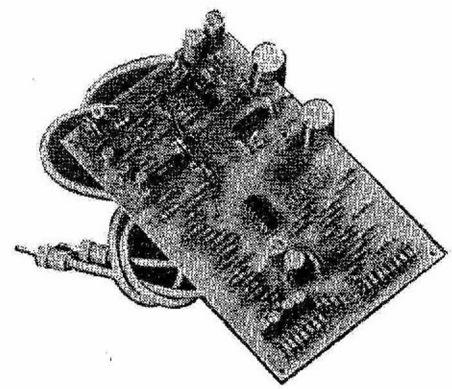
PAiA ELECTRONICS, INC.

3790

STEREO CHORD EGG



The EGG plugs into any stereo amplifier to create soothing, flowing environmental sound textures - and through headphones it's incredible. The chords and notes EXIST in your mind, they pan and swell and phase their way through your psyche in unpredictable patterns, never repeating.

The combination of LSI organ technology with synthesizer-type processing and digital randomizing/control elements make the EGG an altogether intriguing package from either technological or metaphysical viewpoints.

SOLDERING

Use care when mounting all components. Use only rosin core solder. Acid core solder or paste fluxes should never be used, and their use will void the warranty. A proper solder joint has just enough solder to cover the round soldering pad and about 1/16-inch of lead passing through it. There are two improper connections to beware of: using too little solder will sometimes result in a connection which appears to be soldered but actually there is a layer of flux insulating the component lead from the solder bead. This situation can be cured by re-heating the joint and applying more solder. If there is too much solder used on a connection there is the danger that a conducting bridge of excess solder will flow between adjacent circuit board conductors forming a short circuit. Unintentional bridges can be cleaned off by holding the board upside down and flowing the excess solder off onto a clean, hot soldering iron.

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

CIRCUIT BOARD ASSEMBLY

( ) Prepare for assembly by thoroughly cleaning the conductor side of the circuit board with a scouring cleanser. Rinse the board with clear water and dry completely.

Solder each of the fixed resistors in place following the parts placement designators printed on the circuit board and assembly drawing figure 1. Note that fixed resistors are non-polarized and may be mounted with either of their two leads in either of the holes provided. Cinch the resistors in place prior to soldering by putting their leads through the holes and pushing them firmly against the board. On the conductor side of the circuit board, bend the leads outwards to about a 45-degree angle. Clip off each lead flush with the solder joint after the part has been soldered in place. SAVE THE EXCESS CLIPPED OFF LEADS FOR USE AS JUMPERS IN LATER STEPS.

Silver or gold - disregard this band.

DESIGNATION	VALUE	COLOR CODE A-B-C
( ) R1	22K	red-red-orange
( ) R2	10K	brown-black-orange
( ) R3	330K	orange-orange-yellow
( ) R4	1 meg	brown-black-green
( ) R5	3.9 meg	orange-white-green
( ) R6	3.9 meg	orange-white-green
( ) R7	470K	yellow-violet-yellow
( ) R8	1 meg	brown-black-green
( ) R9	3.9 meg	orange-white-green
( ) R10	3.9 meg	orange-white-green

DESIGNATION	VALUE	COLOR CODE A-B-C
( ) R11	330K	orange-orange-yellow
( ) R12	1 meg	brown-black-green
( ) R13	3.9 meg	orange-white-green
( ) R14	3.9 meg	orange-white-green
( ) R15	270K	red-violet-yellow
( ) R16	1 meg	brown-black-green
( ) R17	3.9 meg	orange-white-green
( ) R18	3.9 meg	orange-white-green
( ) R19	680K	blue-grey-yellow
( ) R20	1 meg	brown-black-green
( ) R21	3.9 meg	orange-white-green
( ) R22	3.9 meg	orange-white-green
( ) R23	150K	brown-green-yellow
( ) R24	1 meg	brown-black-green
( ) R25	3.9 meg	orange-white-green
( ) R26	3.9 meg	orange-white-green
( ) R27	56K	green-blue-orange
( ) R28	270K	red-violet-yellow
( ) R29	150K	brown-green-yellow
( ) R30	56K	green-blue-orange
( ) R31	270K	red-violet-yellow
( ) R32	150K	brown-green-yellow
( ) R33	150K	brown-green-yellow
( ) R34	56K	green-blue-orange
( ) R35	270K	red-violet-yellow
( ) R36	270K	red-violet-yellow
( ) R37	150K	brown-green-yellow
( ) R38	56K	green-blue-orange
( ) R39	150K	brown-green-yellow
( ) R40	150K	brown-green-yellow
( ) R41	56K	green-blue-orange
( ) R42	56K	green-blue-orange
( ) R43	150K	brown-green-yellow
( ) R44	150K	brown-green-yellow
( ) R45	56K	green-blue-orange
( ) R46	56K	green-blue-orange
( ) R47	56K	green-blue-orange
( ) R48	56K	green-blue-orange
( ) R49	10K	brown-black-orange
( ) R50	10K	brown-black-orange
( ) R51	10K	brown-black-orange
( ) R52	10K	brown-black-orange
( ) R53	150K	brown-green-yellow
( ) R54	150K	brown-green-yellow
( ) R55	150K	brown-green-yellow
( ) R56	150K	brown-green-yellow
( ) R57	680 ohm	blue-grey-brown
( ) R58	10K	brown-black-orange
( ) R59	47 ohm	yellow-violet-black
( ) R60	1000 ohm	brown-black-red

DESIGNATION	VALUE	COLOR CODE A-B-C
( ) R61	10K	brown-black-orange
( ) R62	10K	brown-black-orange
( ) R63	10K	brown-black-orange
( ) R64	10K	brown-black-orange
( ) R65	10K	brown-black-orange
( ) R66	10K	brown-black-orange
( ) R67	10K	brown-black-orange
( ) R68	10K	brown-black-orange
( ) R69	10K	brown-black-orange
( ) R70	10K	brown-black-orange
( ) R71	10K	brown-black-orange
( ) R72	10K	brown-black-orange
( ) R73	10K	brown-black-orange
( ) R74	10K	brown-black-orange
( ) R75	10K	brown-black-orange
( ) R76	10K	brown-black-orange
( ) R77	10K	brown-black-orange
( ) R78	10K	brown-black-orange
( ) R79	10K	brown-black-orange
( ) R80	10K	brown-black-orange
( ) R81	10K	brown-black-orange
( ) R82	4700	yellow-violet-red
( ) R83	4700	yellow-violet-red
( ) R84	4700	yellow-violet-red
( ) R85	10K	brown-black-orange
( ) R86	4700	yellow-violet-red
( ) R87	4700	yellow-violet-red
( ) R88	82K	grey-red-orange
( ) R89	100K	brown-black-yellow
( ) R90	680K	blue-grey-yellow
( ) R91	68K	blue-grey-orange
( ) R92	82K	grey-red-orange
( ) R93	100K	brown-black-yellow
( ) R94	68K	blue-grey-orange
( ) R95	680K	blue-grey-yellow
( ) R96	10K	brown-black-orange
( ) R98	2200	red-red-red
( ) R99	2200	red-red-red
( ) R100	680K	blue-grey-yellow

( ) **Using seven (7) pieces of excess wire clipped during resistor installation, form and install the seven wire jumpers indicated by the solid lines in figure 1 and printed on the circuit board.**

Install the ceramic disk capacitors. Without exception the values will be marked on the body of the part.

DESIGNATION	VALUE
( ) C1	500 pf.
( ) C2	.01 mfd.
( ) C4	.01 mfd.
( ) C17	.05 mfd.
( ) C18	.01 mfd.
( ) C19	.01 mfd.
( ) C20	.01 mfd.
( ) C21	.01 mfd.

ceramic disk 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 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 in 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 without affecting performance of the unit. For example: a 100 mfd. 25 v. capacitor may be used in place of a 100 mfd. 10 v. capacitor.

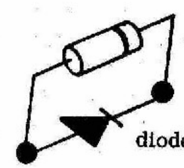
Mount the following electrolytic capacitors and solder them in place. Their values, voltage rating and polarization are marked on the body of the part.

DESIGNATION	DESCRIPTION
( ) C3	10 mfd. 15 v.
( ) C5	100 mfd. 15 v.
( ) C6	100 mfd. 15 v.
( ) C7	33 mfd. 15 v.
( ) C8	33 mfd. 15 v.
( ) C9	33 mfd. 15 v.
( ) C10	33 mfd. 15 v.
( ) C11	33 mfd. 15 v.
( ) C12	33 mfd. 15 v.
( ) C13	33 mfd. 15 v.
( ) C14	33 mfd. 15 v.
( ) C15	100 mfd. 15 v.
( ) C16	100 mfd. 15 v.
( ) C23	2.2 mfd. 10 v.
( ) C24	100 mfd. 15 v.
( ) C25	33 mfd. 15 v.

electrolytic capacitor

Install the diodes. Being semiconductor devices, diodes are heat sensitive and may be damaged if exposed to too much heat for too long. To be safe, heat sink each diode as it is being soldered into place by grasping the lead with a pair of needlenose pliers at a point between the diode itself and the circuit board connection.

DESIGNATION	TYPE NO.
( ) D1	1N914
( ) D2	1N914
( ) D3	1N914



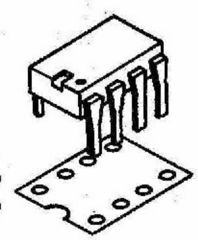
diode

DESIGNATION	TYPE NO.
( ) D4	1N914
( ) D5	1N914
( ) D6	1N914
( ) D7	1N914
( ) D8	1N914
( ) D9	1N914
( ) D10	1N914
( ) D11	1N914
( ) D12	1N914
( ) D13	1N914
( ) D14	1N914
( ) D15	1N914

Install the integrated circuits. Note that a properly oriented integrated circuit will have a square notch or dimple at one end of the case which aligns with the semicircular designation printed on the circuit board. Use extreme care when installing integrated circuits. Like other semiconductors, they are heat sensitive and should not be exposed to high heat for extended periods of time. Make sure the integrated circuit is properly oriented prior to soldering it in place, as these units cannot be removed without destroying them.

NOTE: IC1, IC2 and IC3 in this kit are MOS units, which means they are extra sensitive to static electricity. When installing these units, observe the following precautions. Do not wear synthetic materials such as nylon or rayon. Immediately before installing the IC's, touch a cold water pipe or other source of good ground. Also touch the soldering iron tip to a grounded point. After all static has been discharged, remove the MOS IC from it's holder, insert into the circuit board, and solder into place. Avoid excessive motion during this installation to keep static buildup to a minimum. Most manufacturers now are installing static discharge paths in the IC itself, but we recommend following these precautions for added safety.

DESIGNATION	TYPE NO.
( ) IC1	50240 Top Octave Generator
( ) IC2	4001 Quad Nor Gate
( ) IC3	4001 Quad Nor Gate
( ) IC4	LM3900 or CA3401 Quad Norton Amp
( ) IC5	LM3900 or CA3401 Quad Norton Amp



Install the trimmer potentiometer.

DESIGNATION	VALUE
( ) R97	10K

trimmer potentiometer

( ) Prepare a 4-inch length of the insulated wire as follows. Strip 1/4-inch of the insulation from each end of the wire. Twist the individual inner strands of wire tightly together, and "tin" the exposed strands by melting a small amount of solder into the strands. Insert one end of this wire at point "A". Solder this connection.

( ) Insert the free end of the above wire at point "C". Solder.

( ) In a similar manner, prepare another 4-inch length of the insulated wire. Insert one end of this wire at point "B". Solder.

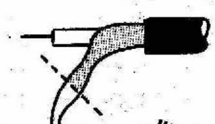
( ) Insert the free end of the above wire at point "D". Solder.

( ) Locate the 3-foot length of coaxial cable terminating in molded RCA type phono connectors. Cut this cable into two equal 18-inch lengths.

( ) Prepare both lengths of the above cable by stripping away 3/4-inch of the outer insulating sleeve to expose the shielding wire. Twist the shielding wire strands together and tin them. When tinned, cut away 1/2-inch of the shield so that only a stub 1/4-inch remains. Strip 1/4-inch of the insulation from the inner conductor and twist and tin the exposed strands.

( ) Insert the inner conductor of one of the previously prepared lengths of coax into point "E" on the circuit board and solder.

( ) Insert the shield wire of the above cable into the adjacent hole labeled "⏚" and solder.



REMOVE 1/2" TINNED SHIELD

( ) Insert the inner conductor of the remaining length of the coax cable into point "F" and solder.

( ) Insert the shield wire of the above cable into the adjacent hole labeled "⏚" and solder.

THIS COMPLETES ASSEMBLY. Your chord egg is now fully hatched.

USING THE CHORD EGG

The Chord EGG is a lot easier to use than a radio, there are no bothersome decisions on what station to listen to. It's better than television because you get to make up your own pictures.

PLUGGING IN

The output chords supplied with the EGG terminate in RCA type phone plugs which are compatible with most hi-fi and stereo amplifiers. We recommend that you use the ubiquitous "auxiliary" inputs found on most amplifiers, though if these are for some reason not available other inputs such as "tuner" will work with the possibility that the high signal level from the EGG will produce distortion.

If the EGG is going to be used in mono rather than stereo, there are two possible ways to go. Either use only one of the two output lines provided - which one does not matter - or tie points "E" and "F" of the EGG board together and use them as a single output.

The effect of the EGG is by far more spectacular when experienced through headphones rather than speakers. With 'phones you get the full panning and phasing effects.

But don't shy away from using the EGG with speakers. It makes a great background to conversations.

POWER

The EGG is designed to operate from a nominal 12 volt DC supply and we recommend that such a supply be realized by series connecting 8 "AA" or "C" size flashlight cells.

The EGG will operate on as little as 9 volts, but its hefty 40 ma. typical current drain will exhaust the average 9v. "transitor" battery in short order. Also, low operating voltages manifest themselves as an increase in the percentage of the time that the circuitry is completely silent.

The high limit on supply voltage is 18 volts. Above this level there is the danger of destroying some of the integrated circuits. Higher supply voltages than the 12 volts recommended will also tend to decrease the prominence of single notes that would otherwise be accentuated during the EGG's random pattern generation.

When power is first applied to the EGG, you should immediately hear a swelling chord from the amplifiers speakers or headphones. After a second or so the chord will begin to undergo subtle changes as single notes from the chord spelling come and go in prominence. On the order of 20 seconds after the power is applied the first chord change should occur. If it occurs during a period in which the EGG is producing a full chord, this change will be heard as an instantaneous key change. If the EGG happens to be in a silent period, the change may not be at all noticeable.

From the time of the first chord change, the operation of the circuitry is for all practical purposes unpredictable.

TONE TRIMMER

The EGG's only operating control is the trimmer resistor R97 which is an adjustment of the control voltage required to change the parameters of the two filters. The setting of this control is personal preference and should be guided by these facts:

At the extreme counter-clockwise rotation of the control (as viewed from the nearest edge of the circuit board) the filters are at their highest frequency setting and are undergoing the maximum change possible.

While it may seem contradictory, the panning effect will become less noticeable as the control is rotated in a CCW direction. At some point between the extremes of the controls rotation will be a point which is most pleasing to you for both it's panning and filtering characteristics.

CHANGES YOU CAN MAKE!

If you don't like your EGG just like it is, here are changes you can make to achieve different effects.

EFFECT	CHANGE	SIDE EFFECTS
Increase prominence of single notes within chord structure	R57-Lower values (down to 100 ohms) increase single note prominence. Higher values (3.3K max) make chord structure prominent.	Lower resistor values lower total output signal level; produce greater apparent filter noise.
Completely silent too much/not enough	R53 - R56-Lower values make EGG completely silent a smaller percentage of the time. 1 meg max. 47K min.	Lower values make single notes less prominent.
Pitch change	R2-Increasing (100K max) lowers pitch; decreasing (2.2K min) raises pitch.	Possible voltage instability, clock may stop at low values.
More filter action	R88 &R92-Lower values (27K min) produce greater filter changes; higher values (680K max) produce less.	Filter tends to "ring" at higher frequencies.
Altered random time constants	(See design analysis) Capacitors C5-C16, R3, R7, R11, R15, R19, R25, R100	Astables may "lock" to one another.
Different chords	Everything	Possible nervous collapse.

DESIGN ANALYSIS

At first glance at the schematic of the CHORD EGG (figure 1) may be a little intimidating. But, like most things technical, it's only a collection of simple things. To illustrate this we'll divide the EGG into seven simple things and analyze each individually. These will be: 1) Tone Generator, 2) Chord Randomizer, 3) Chord Decoder, 4) Note Randomizer, 5) Control Voltage Summing Matrix, 6) Voltage Controlled Attenuators and 7) Voltage Controlled Filters.

Tone Generator - The tone generator portion of the EGG comprises two gates from a CMOS quad NOR package (IC-2 a & b) configured as an astable multivibrator with a frequency of approximately 250kHz. This clock frequency is applied to the input of IC-1, a 50240 type top-octave generator, which in turn produces at its 13 outputs a complete octave (plus one note) of equally tempered musical pitches. The frequency of the astable is determined by the R2/C1 time constant while C4 and C2 provide high frequency by-passing on the supply lines of IC-1 & 2. Electrolytic capacitor C3 provides low frequency by-passing on the supply to the top-octave generator.

Chord Randomizer - Essential to the operation of the chord randomizer is a circuit used extensively in this project, a long period astable multivibrator. The astable built from IC-4a is typical of all of them; R6 is a biasing resistor, R5 provides positive feedback for hysterisis, R4 converts the voltage appearing across the timing capacitor C5 to a current that the amplifier can work with and R3 sets the time required for C5 to charge to the threshold voltages established by the rest of the components. Two of these circuits are built up from 2 of the 4 amplifier stages in a single LM-3900 quad current differencing amplifier package (IC-4a and IC-4b). Periods of these two astables are about 15 and 25 seconds respectively and naturally (since their periods are different) they run asynchronously. We can think of the outputs of these two circuits as representing the 4 states of a 2 bit binary number which drives the 2 to 4 decoder consisting of the 6 NOR gates IC-2c & d and IC-3a & d.

When the two asynchronous astables are combined with the 2 to 4 decoder we come up with a circuit that selects one of four lines in a pseudo-random pattern and raises that one line to a high state while leaving the other three output lines low. All four lines go to the:

Chord Decoder - where they select one of four possible chord structures. Each note output that we are going to use from the top-octave divider immediately connects to a diode (D5 - D12). The diodes are used as switches that allow the notes needed for a particular chord to pass while blocking the un-used notes. If, for example, the F chord is selected, diodes D5, D7 and D9 are forward biased by the voltage applied to resistors R64 - R66 and positive excursions of the square waves provided by the top-octave chip on the F, A and C lines can pass. Because the remainder of the resistors in the chord decoder matrix terminate at ground (either directly or through the 2 to 4 decoder), the remainder of the diodes are reverse biased and block the un-used outputs of IC-1. Resistors R81 - R87 are provided to compensate for the fact that while some lines in the chord decoder have a single selecting resistor attached to it others have two or three. Without these compensating resistors, lines that connect to a single selecting resistor would have a significantly higher signal level than the rest.

Resistors R73 - R80 serve to passively mix the selected notes onto three of the four audio busses which are in turn connected to the:

Voltage Controlled Attenuators - We need a separate audio buss for each note because we don't want the chord to rise and fall in volume as an entity, but rather we want the individual notes that spell the chord to, themselves, rise and fall independently of one another. The voltage controlled attenuators work in essentially the same manner as did the switching diodes in the chord decoder with one important exception. Instead of being biased on with a constant voltage, all mixed

to a single output, they are controlled by a pseudo-randomly time varying voltage whose source we will investigate momentarily. As the time-varying control voltages applied to R45 - R48 increase, the point at which the diodes clamp also increases thereby increasing the amplitude of the square wave on that line.

Control voltages for the attenuators begin their existance in the:

Note Randomizer - which is in all important aspects identical to the guts of the chord randomizer. The differences are that instead of 2 astables we have 4 (all amplifiers of IC-5) and these astables have shorter periods (in the 5 to 10 second range) than the previous examples. The conversion of binary data that these astables represent to a smoothly varying control voltage is handled by the:

Control Voltage Summing Matrix - R27 - R44 and integrating capacitors C11 - C16. A total of six control voltages, 4 for VCA's and 2 for VCF's are produced by this matrix and all six are the result of charging and discharging a capacitor through one of three resistors which may be either at the positive supply voltage or ground depending on the states of the astables; for example, C11 charges and discharges through resistors R27, R28 and R29. The important thing to notice here, is that of the four voltages produced for the VCA's, each is unique because the outputs of the 4 astables are combined three at a time in the matrix. The two voltages that will be applied to the filter are not unique because of the combinations of astable outputs that produce them but are unique because of the resistor values used in the matrix. An R-2R ladder could have been used as the basis of this matrix but would have been significantly more cumbersome without producting significantly better results.

The circuitry, as described to this point, is interesting; chords are randomly selected and individual notes randomly accentuated. But, if we stop here, we have a device with a definite "Gardens of Eternal Peace" quality to it. Morticians love it but thoses of us interested in more light hearted applications would be less than enchanted.

There are still two stages of current differencing amp left over and we can make the transition from dirge to delight by turning them into:

Voltage Controlled Filters - of the bridged T, band-pass type. These filters are tuned by putting diodes D13 and D14 into the circuit topology at positions ordinarily occupied by a frequency determining resistor. By changing the DC current flow through these diodes we can change their AC impedance and consequently the tuning of the filter. Note that these diodes terminate at a point (the junction of R96 and R97) that is removed from ground. The tuning voltage applied to the filters must exceed this offset voltage before the tuning will change.

The outputs of these two filters are the stereo outputs of the EGG and the subtle differences in the center frequency and attenuation of the filters provide the apparent motion of the device in the stereo field. It is interesting to note while listening to the EGG the number of times that the apparent motion is not constrained to the horizontal plane.

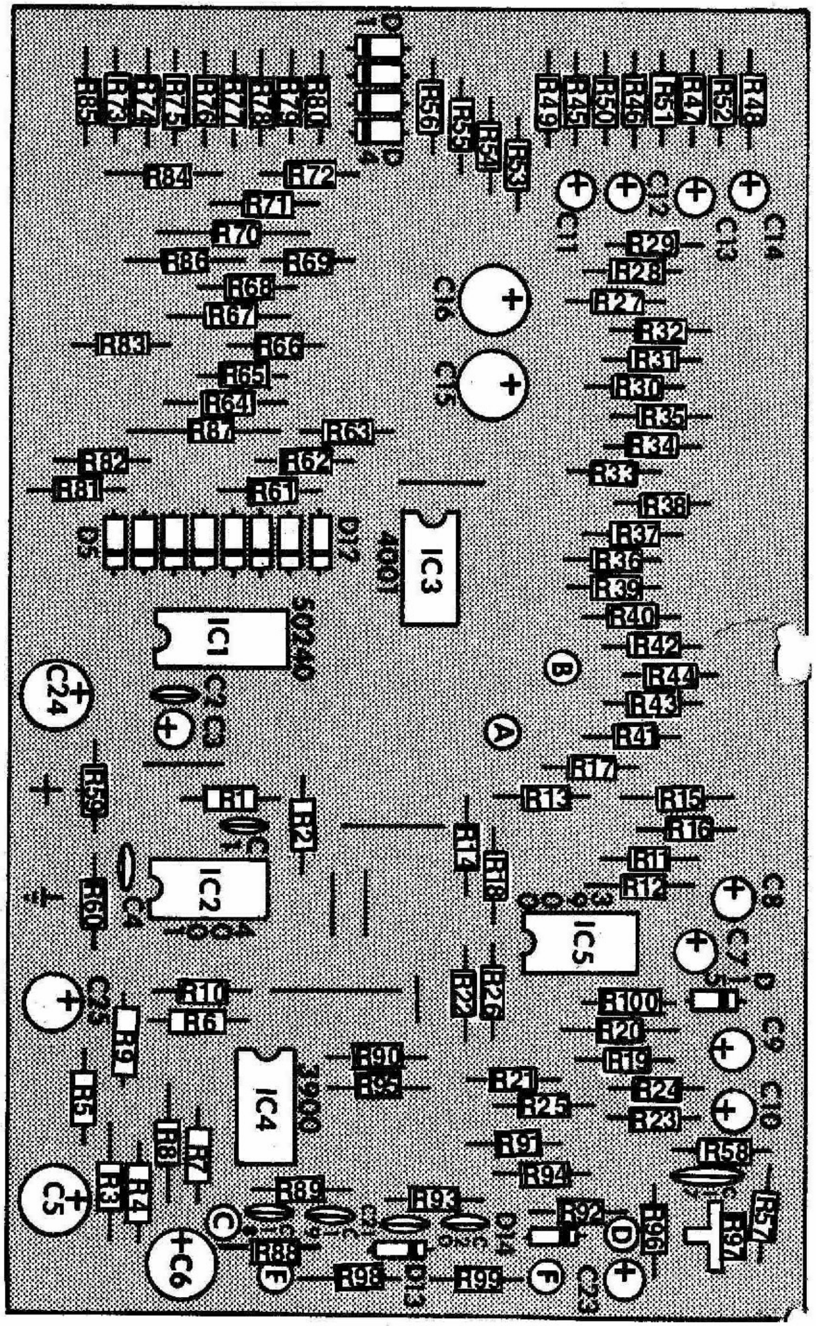


Figure 2 - Parts Placement

3790 ASSEMBLY DRAWINGS

Remove this section for easy reference during assembly.

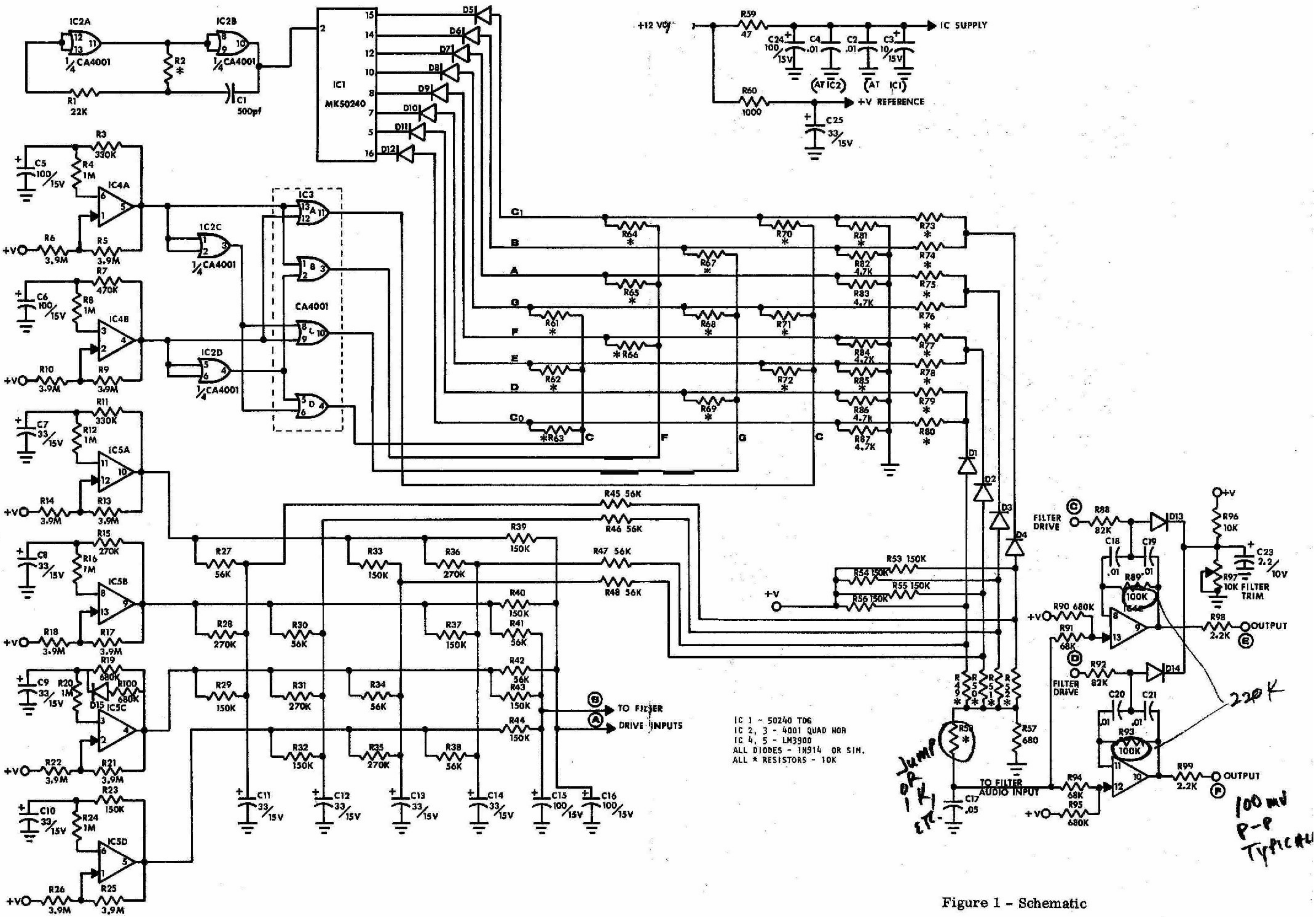


Figure 1 - Schematic

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