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COVER PHOTOGRAPH BY: Linda Kay Brumfield

Letters

PENULTIMATE TO ULTIMATE COMPRESSOR: CORRECTIONS AND MODIFICATIONS

I included a couple of errors in the schematic for the Penultimate Compressor; sorry if I caused any anguish. Here are the corrections:

1. Change the value of R18, R19 to 10k.
2. Add a 10k resistor between pin 7 of the NE572 and C11, C12.
3. Take four 10 Meg resistors, and connect one each to pins 2, 4, 14, and 12 of the NE572. Connect the other ends of the resistors to the positive supply. This adds a small bias current which causes the compressor to turn on only after an input threshold is reached. The compressor then acts like a unity gain amplifier when there is no input signal and dramatically reduces noise.
4. Another modification is to change C20, 21 from 10 uF to 4.7 uF. I made an erroneous statement that these caps control the sustain, thus implying that larger caps give more sustain. This is not the case. These capacitors control the release time of the gain reduction action of the compressor on signal peaks. A 4.7 uF capacitor gives faster response and a more "natural" sound. (Ed. note: Many of you have asked about the polarity of these parts. The + end of C20, C21, C22, and C23 connect to the 572, while the - end connects to the outboard op amp outputs.)
5. There is a typo in Fig. 3; C33 should be 5 uF, not 2.2 pF as shown. Also, C33 is not listed on the parts list.
6. If you want an output level control, replace R34 with a 10k pot, and connect the wiper of the pot to the output jack.
7. You can also change the 5534's compensation caps from 22 pF to 10 pF; this gives better high frequency response and higher slew rate. If you have problems with oscillation or squeals, go back to 22 pF.

With these modifications, the output noise is essentially a trace of the input noise generated by A1. A TL071 gives good performance, and even better results can be obtained with an OP-15. Please remember too that any wire traveling for more than 1 - 2" inches between the 572 and 5534s and any other audio signal must be shielded. Good single point grounding is also very important.

You can also add output capacitors to the crossover outputs, and bring the crossover outputs as well as the high and low frequency compressed outputs to the front panel. You can then use the unit as a crossover or to process high and low frequencies separately, and mix them together further down the line. Another possibility is to replace the 10 Meg bias resistors with pots for a variable threshold control. With these changes, I think that all in all this device is quiet, accurate, and clean-sounding and is truly the Ultimate Compressor.

Thomas Figueiredo
San Francisco, CA

TR-606 SYNC?

It seems to me that since the Roland TR-606 Programmable Drum Machine can sync up to other Roland units, you should be able to derive a sync output from the TR-606's DIN connector. If you recorded this on tape, then you could sync the TR-606 to the click track and thus synchronize overdubs. This would help make the unit much more flexible, for example, this would overcome the problem of having the trigger out tied up with the tom-toms. Does anyone out there know how to do this?

John Herzfeld
Belmont, MA

John -- The main problem with simply recording the click track on tape is that you need to condition the analog signal coming from the tape into a nice, clean, digital pulse capable of driving the TR-606. However, you might try recording the signal appearing at pin 3 of the DIN connector. You will probably need some kind of comparator to shape this signal up as it comes off the tape. Feed the comparator output into DIN pin 3 when syncing from tape.

To sync to tape, with the sync in/out switch set to in, bring the RUN/STOP line (pin 1 of the DIN connector) low and then high. The TR-606 is now ready to receive timing pulses; run the tape and see if it starts up okay and syncs. Note that you will have to fiddle with the level coming off the tape, the threshold of the comparator, and so on before you achieve reliable results. Drop Polyphony a line to let us know if this works or not.

Also, I designed a sync pulse recording/recovery system for PAIA Electronics called the "Master Synchronizer" (see the February issue of Keyboard). This device includes a run/stop output and also follows the 24 pulses per quarter note standard, thus making it compatible with Roland equipment. Check out this article for more on the subject of recording and recovering sync tracks from tape. Several people have reported connecting up the PAIA "Master Syncrhonizer" to a TR-606 in order to do exactly what you describe.

D.I.Y. SYNTH KEYBOARD

I have been reading Polyphony for a couple of years and now, as there have been so many synthesizer projects presented, I have decided to build a synthesizer. But I don't know how to wire up the keyboard itself -- triggers, voltage control outputs, gate voltages, and so on. Could you publish such a project in an upcoming issue of Polyphony?

Also, where can I get the following ICs: XR2209 VCO, CEM3320 VC filter, CEM3330 dual VCA, and CEM3340 VCO? And how much do they cost?

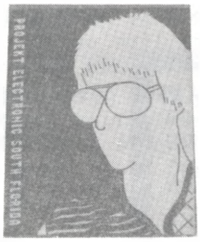
Jan Erikkson
Vasteras, Sweden

Jan -- Thomas Henry presented an excellent design for a low-cost digital keyboard (with analog CV outputs too) in Electronotes

Robert Carlberg's re-view

Michael Rother **Lust** (Polydor 815469-1). His first solo with Linn instead of Jaki on drums. Some nice synthi voicing, less guitar, and a little lower key than usual.

Lauri Paisley **Real to Reel** (cassette). Whiney synthesizers in 4-track patterns/tunes. Given a chance, the ideas could go a few rounds in a larger studio. $4 from Lauri, 947 James Street #1, Syracuse, NY 13203.



Various **Projekt Electronic South Florida** (cassette). Regional compilations rarely have any glue besides gravity to hold them together, and this one is no exception. It's a good selection from an active community in all styles. $3.50 from Sam Rosenthal, 8951 SW 53rd St., Cooper City, FL 33328.

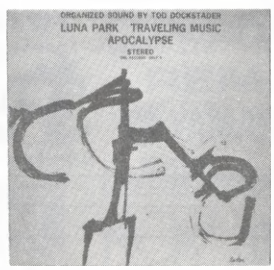
Paul Simon **Hearts and Bones** (Warner Bros. 23906-1). Even with all his success, Simon retains a measure of disillusionment. Maybe nobody speaks for a generation, but he comes close.

David Sanborn **Backstreet** (Warner Bros. 23906-1). An impressive arsenal of keyboards is listed, but these formula tunes are dominated by Marcus Miller's burping bass and Sanborn's sax, which sounds like someone letting air out of a balloon.

The Pern Project **Halo of Flux** (cassette). It's nice to know that people still do the corny things we all did with our first 4-tracks. $5 from Rick Burgmeier, 947 James Street #1, Syracuse, NY 13203.

Happy the Man **3rd -- "Better late..."** (Azimuth 1003). Progressive rock of the flute-and-string-synthesizer variety. This was a demo made in '79 to attract a new label -- it didn't and they disbanded. HTM was too sophisticated for a world gone back to basics. $7.95 from Kit Watkins, Box 3495, Arlington, VA 22203.

Tod Dockstader **Luna Park -- Traveling Music -- Apocalypse** (Owl 6). These are compositions from 1960-1 of "organized sound". The method seems a little primitive after 20 years (tape speed tricks and audio generators), but he really does create moods. (See also May/June '81 but ignore the last line.) $9 from Owl, PO Box 4536, Boulder, CO 80306.



Henry Aronson/Michael Starobin **Kite** (cassette). Commissioned by the Jennifer Muller Dance Company, this 32-minute work pits an organist and a synthesist in a race to the finish. Maybe you had to be there. $7.98 from Henry Aronson, 1204 Avenue 'U' Suite 1112, Brooklyn, NY 11229.

re-view

Tangerine Dream **White Eagle** (Virgin 2226); **Logos** (Virgin 2257); **Hyperborea** (Virgin 2292). The arrival of Johannes Schmoelling in 1981 seems to have given the Tangs a new lease on life. He brought a classical training; encouraging semi-formal song structures, genuinely amazing programming, and the taming of Froese's errant guitar. This is the highest vantage of their careers.

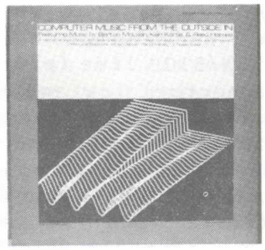
Mark Isham **Vapor Drawings** Isham was brassman with Art Lande's forward-looking jazz group, Rubisa Patrol. Here he surfaces as a digital synthesist, with only the occasional horn line or jazz lick. This is a surprisingly mature and assured debut, best described as a cross between Tangerine Dream and Jon Hassell (who've both been at it a long time).

William Ackerman **Past Light** (Windham Hill 1028). Windham Hill is Ackerman's label, and nearly everything they've done has balanced between New Age and virtuosi. I've been a fan of Ackerman's beautiful acoustic guitarwork for years, and I'm glad he has finally done a few tracks with a Lyricon-ist so I can mention him here.

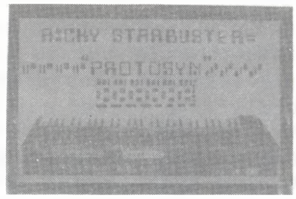
Jack Lancaster **Skinningrove Bay** (Kamera 003). Lancaster (of Blodwyn Pig and associated with Brand X) plays synthesizers and saxes, specializing in the Lyricon. It has a marvelous reedy tone, much better than his rather bland vocals.

Mark Anthony Heide **New Music for Use** (Distant Cloud 001). Rhythm box constructions for synthesizer, bass, and acoustic guitar. The synthesizer sounds inexpensive. The "use" is probably mousing. $8 from PO Box 857, Homewood, IL 60430.

Computer Music from the Outside In (Folkways 37465). Funded by Fairlight and the University of Texas, this disc introduces itself as four "major works" and repeats such platitudes as "the only limit is the imagination". Let's just say the limits aren't in the equipment.



Port Said and Anton Tibbe **Crossings** (cassette). With the addition of guitarist Tibbe, Port Said's rhythms of acoustic percussion and unusual synthesis take on new vibrancy. $6 from 132 West 24th St., New York, NY 10011.



Ricky Starbuster **Protosyn** (cassette). On his third tape, Ricky explores the outer reach of sounds in his Prophet. The structures vary from free-form sound portraits to rhythmic patterns with a Drumatix, and on side two he gets some intentionally humorous vocoder. $8.50 from PO Box 5582, Madison, WI 53705.

Emerald Web **Nocturne** (Fortuna 012, cassette). Flutes, digital synthesizers, and electronic birds & crickets in slow mournful suites. $8.98 from PO Box 5503, Berkeley, CA 94705.

Other Music **Incidents Out of Context** (Flying Fish 302). The liner notes bemoan the difficulty of summarizing their music. If they can't capsulize after 8 years of trying, what chance does a lowly reviewer have? It doesn't help that since their first record of modern gamelan music (see July/Aug '81) they've added a bewildering array of percussion instruments (dulcimer, marimba, metallophones) and non-percussion (French horns, trombones, saxophones, and synthesizers).

Bill Nelson **Savage Gestures for Charm's Sake** (Cocteau JCM3). An instrumental "mini-LP" (27 minutes) with Nelson playing everything: synthesizers, guitar, bass, and drum unit. Even without vocals, his music is heated and human.

Bunny Brunel **Touch** (Inner City 1102); **Ivanhoe** (Inner City 1162). Brunel makes the records one would have expected from Jaco Pastorius. They share a similar style on fretless bass, but Brunel's writing is fast, devious, and very jazzy.

Joan Armatrading **Track Record** (A&M 4987). A greatest hits compilation in which the unknown tracks outshine the hits. If you thought Armatrading was just a balladeer, listen again.

K. Leimer **Imposed Order** (POL rich synthi chords, meticulous treatments, and Hassell-like rhythmic pulses -- superimposed over each other like some Peter Gabriel album that never jelled. There is no "order" except coincidence, so one assumes the title is tongue-in-cheek. This is mature ambient music -- all dressed up to go no place.

Moebius-Plank-Neumeier **Zero Set** (Sky 085). I had all but written off Dieter Moebius (Aug '82) but prematurely. Mani Neumeier, drummer of Guru Guru, provides a rhythmic platform for synchrosonic synthi and assorted weirdness. It is absurd and entertaining.

Brian Eno **Working Backwards 1983-1973** (Virgin EGBS-2). The perfect gift for someone new to this planet. Includes all 9 of his solo albums plus an unrealised 2nd disc of airport music and an EP of unfinished pieces. Notably missing are his collaborations with Fripp, Byrne and 801, and early Roxy Music.

Vox Populi **Ectoplasmies** (VP 231; e.p.). 8 short tracks of Dada synth & echoed vocal. These are small productions. $4 from Axel Kyrou, 191 Avenue Du Maine, 75014 Paris, France.

Letters

#138. Write Electronotes at 1 Pheasant Lane, Ithaca, NY 14850 for information on reprints and back issues. Also, PAIA Electronics makes both 3 octave and 5 octave synthesizer keyboard controller kits ($188 and $289, respectively). These both include pitch bend and modulation wheel controllers; an exponential converter add-on ($15.95) translates the six bit digital output into an analog CV capable of driving 1 Volt/octave oscillators.

The Curtis chips you mentioned are also available through PAIA; average cost is about $8. Write PAIA for further information at 1020 West Wilshire Blvd., Oklahoma City, OK 73116. The XR2209 is available from Jameco Electronics, 1355 Shoreway Road, Belmont, CA 94002 for approximately $3.

SYNC OR SWIM REVISITED

I just received my first copy of Polyphony, and I think it's great. Now for my problem: I have a device called an "Auto-Orchestra" which produces rhythm, bass, string, and organ chord accompaniment. I use it with a Roland JX-3P which has provisions for an external sync input to drive the sequencer, but the Auto-Orchestra has no trigger output. What can I do?

Larry Deneau
Stambaugh, MI 49964

Larry -- I get quite a few questions relating to specific pieces of equipment; unfortunately, I can't do anything without a schematic (and even having a schematic doesn't always guarantee results). While I'm flattered that you think I know everything, I don't! Best bet is to write the manufacturers involved and see if they have any specific suggestions. If not, try to get your hands on a schematic and send me a photocopy; sometimes I can be of help, although of course I can't make any promises.

SUBSCRIBE see page ← 6

3-D Video

3-D Viewing Without Glasses

By: Dr. Maury Deutsch

One method of obtaining three-dimensional vision is by utilizing two photographs taken from slightly different angles (corresponding to the natural vision as experienced by each individual eye), and then viewing these photos through a device arranged to superimpose the images. In three-dimensional motion pictures, each eye sees a continuous picture shot at slightly different angles (corresponding to the natural vision of each eye). Polaroid glasses then separate the superimposed images on the motion picture film.

The alternating image process: motion pictures. Another method of obtaining three-dimensional vision involves the alternating image process. As applied to motion pictures, if two motion picture cameras shoot a scene at slightly different angles (corresponding to the natural vision as experienced by the eyes), and are computerized so that each camera alternately shoots one image of the scene and then leaves one frame blank (where the blank frame of one camera occurs simultaneously with the image of the other camera and vice versa), then the resultant films will have the following appearance:

Camera 1	Camera 2
Image	Blank
Blank	Image
Image	Blank
etc.	etc.

The films of Camera 1 and Camera 2 may then be re-shot on to a single film, yielding:

Image of Camera 1
Image of Camera 2
Image of Camera 1
etc.

The images of Camera 1 (representing the left eye) transmit a similar sensation to the brain as when the left eye is normally used alone; likewise, the images of Camera 2 transmit a similar sensation to the brain as when the right eye is normally used alone.

It requires approximately 24 successive images per second for the eye to experience a continuous picture. It is therefore necessary that Cameras 1 and 2 photograph the same scene but at approximately 48 frames per second. The composite film of Cameras 1 and 2 is also projected at 48 frames per second. This is necessary for the brain to experience the images of Cameras 1 and 2 as existing simultaneously and continuously. The above will result in three-dimensional motion pictures without glasses, regardless of whether you use two separate cameras or a single camera projecting the composite film. The 3-D effect will not be lost if viewed with one eye only.

The alternating image process: television. Taped or filmed television programs can utilize the same techniques described above; "live" television shows require the simultaneous use of twin television transmitters. These are placed at slightly different angles with respect to the scene being shot (corresponding to the natural vision as experienced by both eyes). These transmitters need to be synchronized in such a manner that each transmitter alternately transmits the scanned scene to the viewing audience. When approximately 48 of these images per second (alternately produced by the transmitters) are experienced by the television audience on their screens, the effect will be that of 3-D viewing.

While several methods have been proposed for 3-D viewing, the alternating image process has the advantage of not requiring any special glasses or video playback equipment. Video is a rapidly developing art form; hopefully this article will inspire you to develop it even further.

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NE572 Noise Reduction Unit

By: Ron Oberholtzer

Since its inception, the electronics industry has actively pursued circuits that reduce noise. While going from the tube, to the transistor, to today's integrated circuits has helped to greatly reduce noise, several pieces of hardware are available to give that last bit of noise reduction necessary to greatly improve audio performance. This article will cover a simple compander system, which is one of the more popular types of noise reduction hardware now available.

While comparatively new to the audio industry, companders have been used for many years in the telephone industry to upgrade telecommunications circuits. We owe a great debt to Signetics for manufacturing the NE570/571 and NE572 series of chips that make companders easy to build by everyone. The NE572 offers the best performance of the series, is readily available at a reasonable price, and is easy to use.

Basic system. The word 'compander' is a combination of the words compressor and expander. By compressing the dynamic range of the audio signal, processing (or recording) the compressed signal through a noisy channel, and then expanding the signal's dynamic range on playback, it is possible to achieve a very noticeable improvement in the noise level. The compander described in this article can give a dynamic range of up to 109 dB, with very little distortion produced by the compander. Simple companders give good results at reasonable cost, but those looking for the very best results should split the audio into several frequency bands and compand each band separately. Unfortunately, multi-band noise reduction systems are quite complicated to design and build, so this article will concentrate on building a single-band compander suitable for use with hi-fi systems, signal processors, and multi-track recorders.

Compander logic. The NE572 chip contains two separate systems which can be wired to provide either two compressors, two expandors, or one compressor and one expander. Good internal filtering allows for operation from a standard, single-voltage power supply. Cross talk is almost unmeasurable.

Basic functions depend on a gain cell (Δ g; see figure 1, which shows a block diagram of the NE572). The gain cell adjusts the amount of gain (or attenuation) in an external op amp to compress (or expand) the dynamic level of the audio signal. Suitable control voltages to the gain cell are provided by (1) a rectifier using an op amp, (2) a diode, (3) two transistors, and (4) three current sources. A second set of current sources drives a buffer system to provide smooth voltage control to the gain cell. A regulated power supply promotes stable operation from the complete system. The block diagram also shows how to provide external control of the attack (pins 4, 12) and release (pins 2, 14) times. Pins 6 and 10 provide an accurate external reference voltage to other components.

Connecting the gain cell in the gain loop of an external op amp produces a compressor (see figure 2). Capacitors C13 and C14 determine the attack time, while capacitors C11 and C12 set the release time. These two values are a compromise between fastest operation and adding as little as possible breathing or pumping to the audio signal. The op amp should be a low noise type, such as the NE5534, although other types will do (as discussed later in this article). The reference voltage outputs (pins 6, 10) drive the (+) inputs of the corresponding op amps (IC1A and IC1B). Zener Diodes D1-D4 clamp any output transient peaks to below 6 Volts.

For the expander function, the gain cell is in series with the audio input and an op amp (see figure 3). To insure that the gain cell is fed from a constant output impedance, a unity gain op amp supplies the audio signal to the gain cell and the rectifier system (IC4A and IC4B in figure 3). Capacitors C23 and C24 determine the attack time and capacitors C25 and C26 set the release time. Op amps IC3A through IC3D should be high quality, low noise types.

System Logic. For a stereo system it is desirable to use one NE572 for both compressors and another NE572 for both expanders. The dual compressor circuit includes a dual op amp (one for each channel), while the dual expander circuit includes a quad op amp (two op amps for each channel). (Ed. note: It may be preferable to build a compressor and its

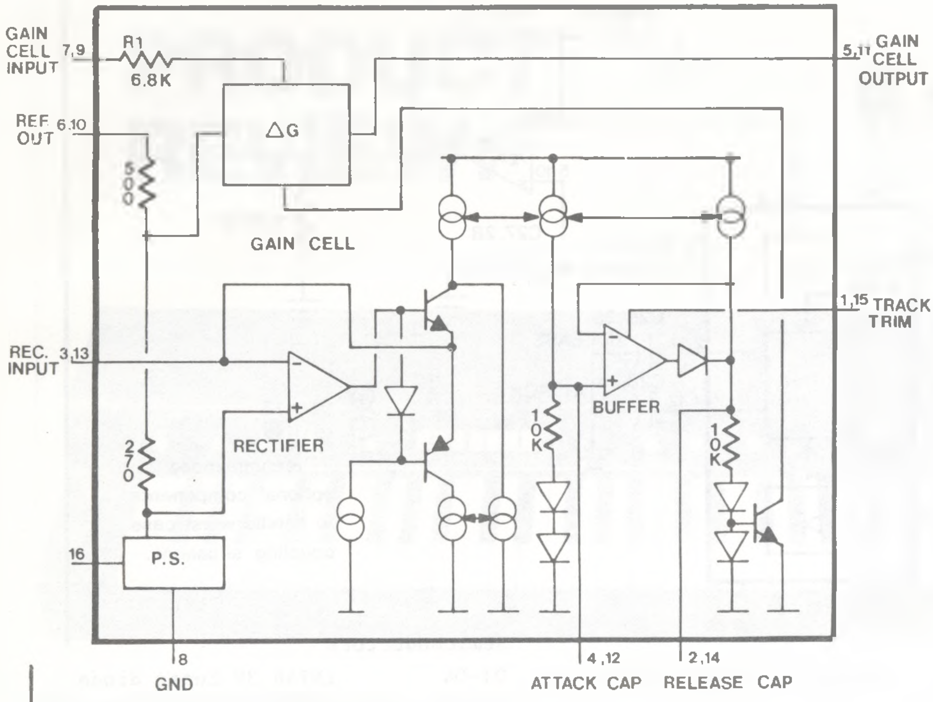


FIG. 1 BLOCK DIAGRAM···NE572 CHIP

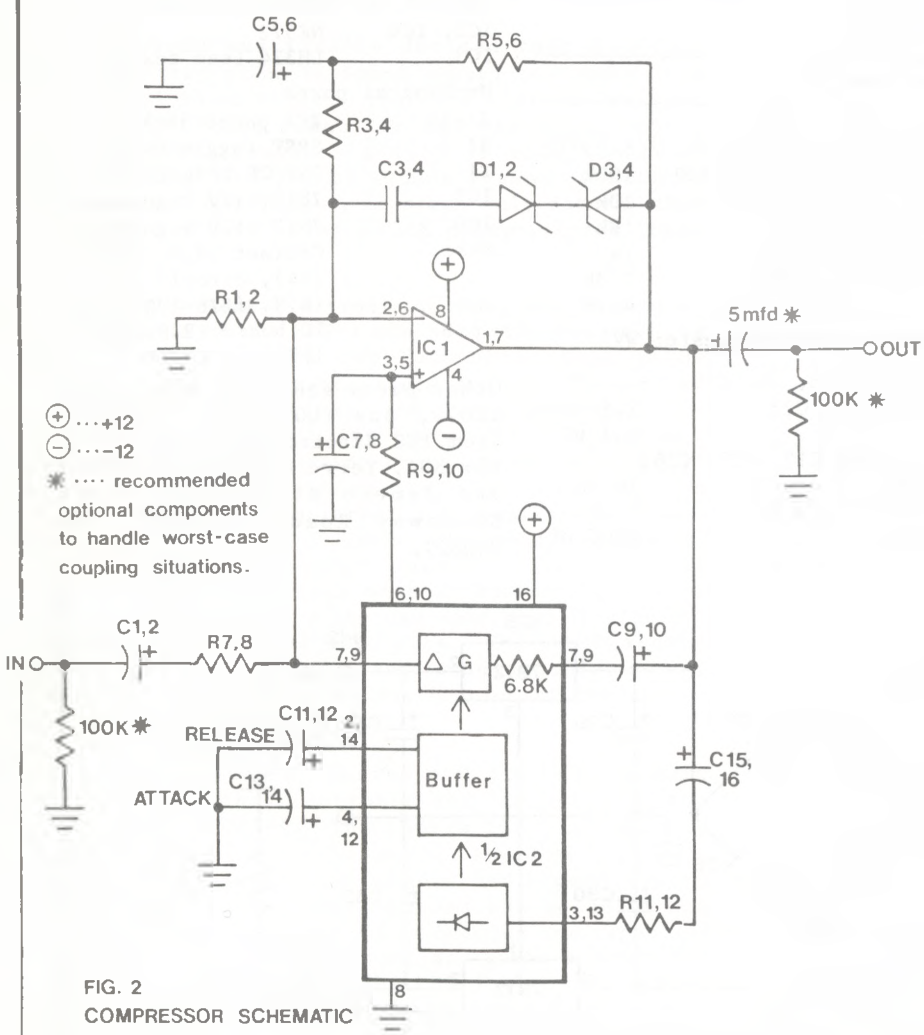


FIG. 2 COMPRESSOR SCHEMATIC

matching expander from one chip, since the characteristics of both sections would be closely matched and this would probably result in better tracking.)

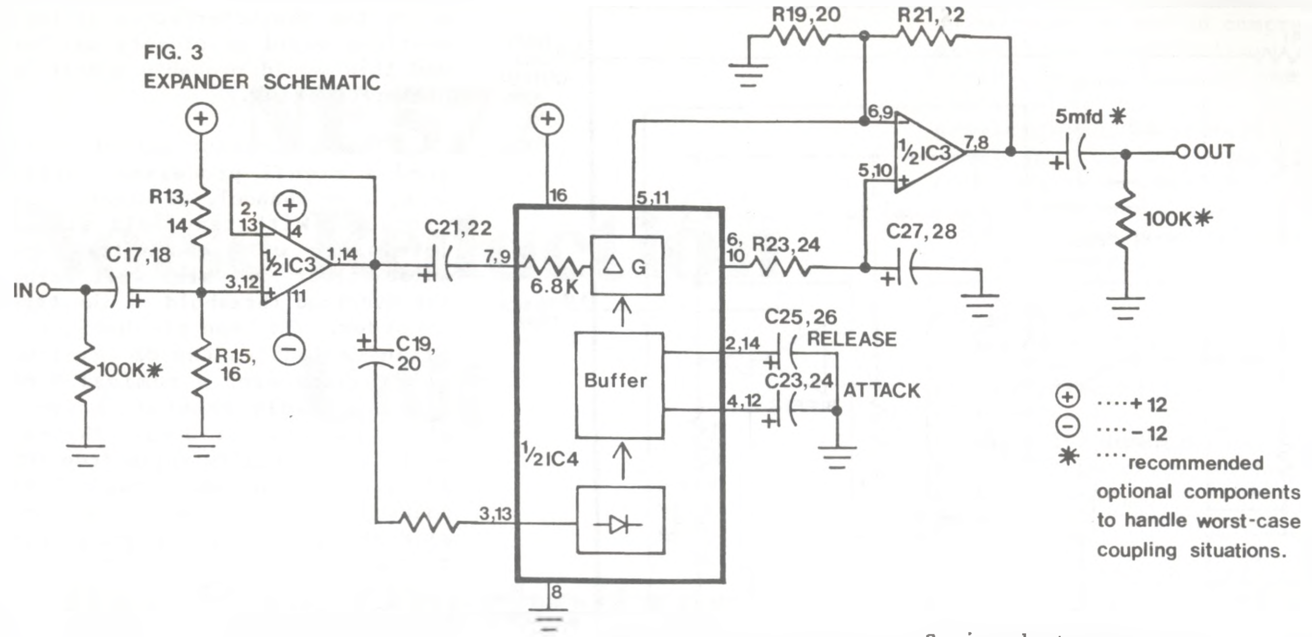
The compressor output would feed a signal processor, delay line, tape channel, or other noisy circuit. With tape, all signal levels are well above the tape noise "floor" but also well below the overload threshold of the tape recorder. On tape playback, the expander doubles the dB level of all signals over a nominal 0 dB and negatively doubles (halves) all signals under 0 dB. The result is a virtually noise-free 109 dB dynamic output range. Of course, the less noisy the original signal, the more dramatic the results of the noise reduction.

Construction. I built the compander and power supply into an 8"W X 3.5"H X 5.25"D metal case from Radio Shack, with all compandor components mounted on a Radio Shack experimenter's PC board. It took a bit of planning to squeeze everything into the box, but eventually it all fit with some space to spare.

The experimenter's PC board has 45 rows of five interconnected holes on both sides of a center island. A standard DIP socket fits the center island space, giving four additional connection points for each socket pin. A ground strip runs along each side of the board. I used an LM353 dual bifet for the compressor op amps, but the TL072, TL082, and TL092 op amps will also work (with the TL072 contributing the lowest noise). For the expander I used an LM324 to provide the required four op amps simply because I had one available; a TL074, TL084, or TL094 would also be suitable, with the TL074 contributing the least. (However, if you substitute op amps always check the pinout of any substitute op amp before you start wiring.) The board was mounted on the case bottom using #4/40 screws, nuts, and 1/8" spacers.

The power supply (figure 4) was assembled on one-half of a Radio Shack dual IC board (R.S. stock #276-159). The 24 Volt center-tapped power transformer was mounted directly on the base of the case. The front panel includes the power on/off switch

FIG. 3
EXPANDER SCHEMATIC



and LED "power on" indicator light. Eight RCA phono type jacks were mounted on the rear panel for audio interconnections, while a three-lug terminal strip provided interconnections for power and the LED indicator light.

Conclusion/Acknowledgement. Try this circuit with your tape recorder, and you will be surprised by the wide dynamic range and virtually noise-free operation. For another surprise, try the compressor by itself with audio signals or musical instruments! Remember, though, that this is the simplest possible design -- so if you like to experiment with variations on this basic circuit, go right ahead. Splitting the signal into different channels via filtering will improve operation, but expect to spend some time getting the filter values just right.

Acknowledgement: The circuits described above are based on the Signetics data sheets for the NE572, which incidentally are a wealth of information on the design and proper application of this chip.

Parts List

Resistors (5% tolerance, 1/4 Watt)

R1, R2, R13-16, R19, R20	100k
R3-6	10k
R7, R8, R21, R22	18k
R9, R10, R23, R24	1k
R11, R12, R17, R18	3.3k
R25	4.7k

Capacitors (35V or greater WV)

C1, C2, C7, C8, C9, C10, C15-C22, C27, C28	2.2 uF
C3, C4	0.1 uF
C5, C6, C11, C12, C25, C26, C31, C32	10 uF
C13, C14, C23, C24	1 uF
C29, C30	1000 uF

Semiconductors

D1-D4	1N746 3V Zener diode
D5-D8	1N4001 power diode
LED1	LED
IC1	LM353 (see text)
IC2, IC4	NE572
IC3	LM324 (see text)

Mechanical parts

J1-J8	RCA phono jack
S1	SPST toggle switch
T1	24V CT transformer
IC5	7812 +12V regulator
IC6	7912 -12V regulator
Misc.	Cabinet (R.S. #270-274), circuit board (R.S. #276-170), dual IC board (R.S. #276-159)

Other parts sources: The NE572, TL072, and TL074 are available from PGS Electronics (Route 25 -- Box 304, Terre Haute, IN 47802) and Jameco Electronics (1355 Shoreway Road, Belmont, CA 94002).

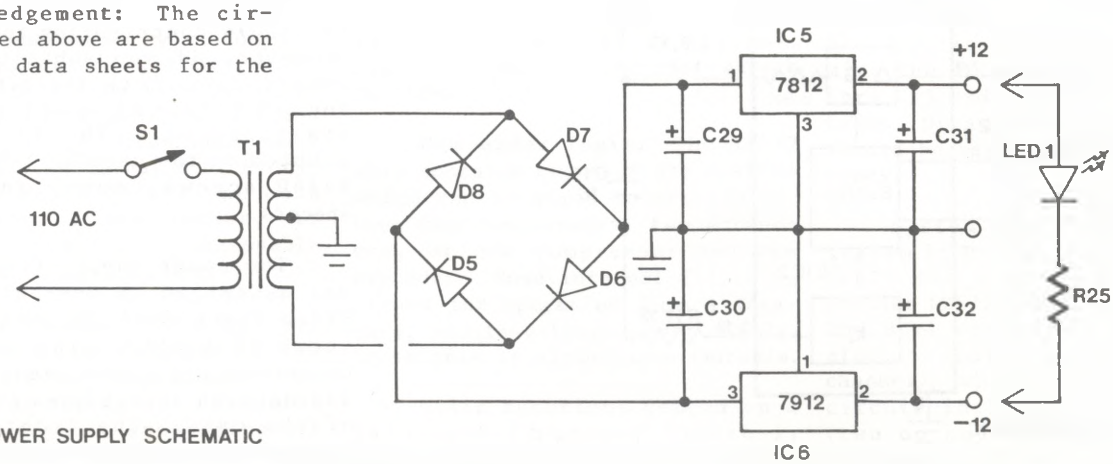
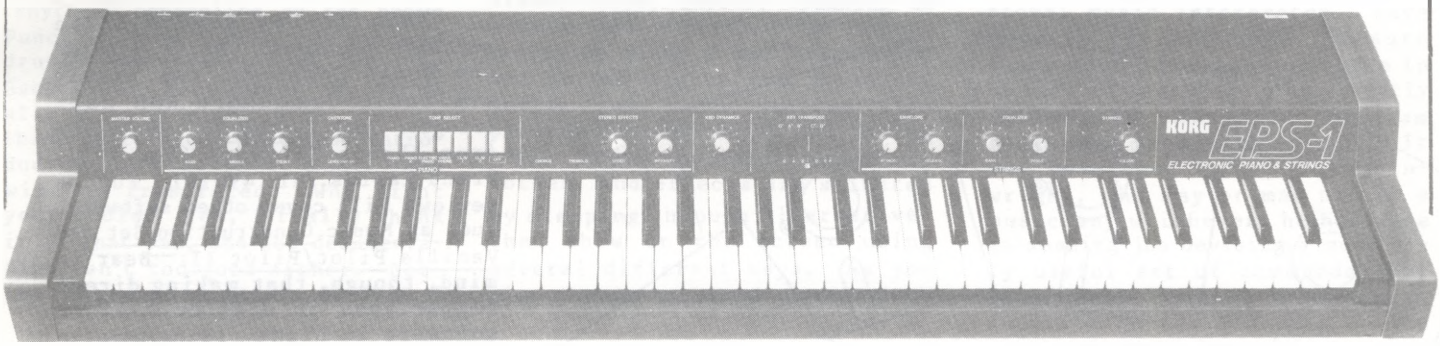


FIG. 4 POWER SUPPLY SCHEMATIC

PRODUCT REVIEW: Korg EPS-1



By: Bill Rhodes

Somebody has finally decided that a string synth/electric piano keyboard should be longer than the normal 54 or so keys found on typical designs: The Korg Electric Piano Strings ensemble (retail price, $1595) features a full 76 note keyboard. Since string (and piano) sounds depend so much on voicing and registration, it seems only natural that a keyboard should exist which accommodates these needs.

As with most electronic pianos, the "acoustic" piano sounds of the EPS-1 are adequate but nothing phenomenal. Besides two "acoustic" type piano sounds on the instrument, there are two "Rhodes" or "Wurlitzer" type settings, and two clavichord/harpsichord type settings. The harpsichord sounds are very nice, but then again, these sounds have always been fairly easy to synthesize. The piano section of the keyboard has a three band equalizer, a separate volume control, a touch sensitivity (dynamics) control, and a "presence" control. This push-pull control voices the piano with different degrees of intensity; thus, the piano can take on a "feathered" (muted) tone, or have more bite. The touch sensitivity works rather well and is adjustable, but of course it is not an exact duplication of the acoustic action of a real piano.

A unique stereo chorus and tremolo circuit controls both the electronic and "acoustic" piano sounds on the EPS-1. The chorus function gives a pleasing dimension to the overall sound of the electronic piano, especially when mixed together with the strings. The tremolo causes the sound of the piano to bounce back and forth between the right and left side of the stereo output and gives a wonderful sense of spaciousness. The EPS-1 also includes a damper pedal; this works the damper of the piano, and can also control the release of the string section.

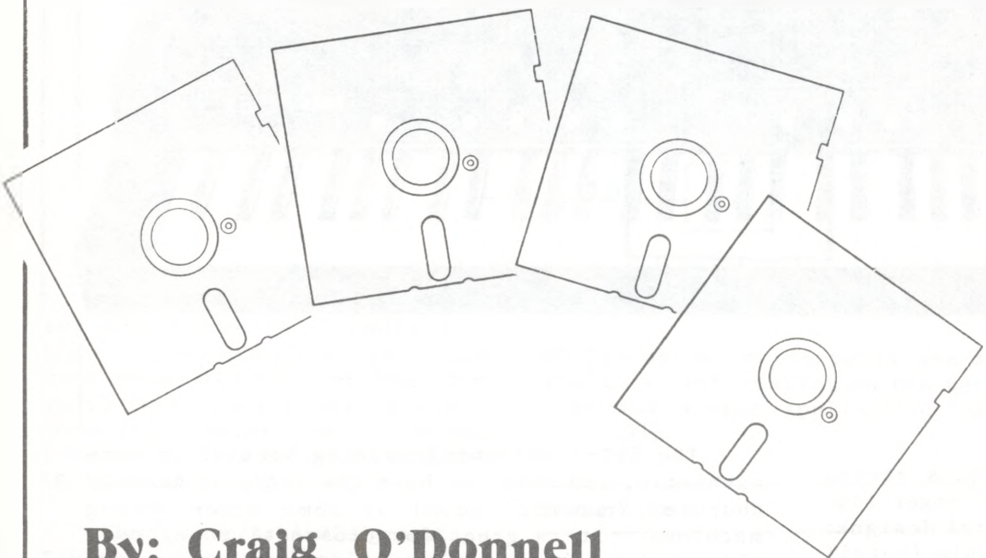
The EPS-1 polyphonic string section is very authentic, and does not have the reedy or heavily chorused "robotic" sound of some other string machines. It is great for classical rock, neoclassical music, or any application requiring a highly "human" sound. There are no registration switches on the EPS-1, but having the longer keyboard helps compensate for this. The overall sound of the strings can be equalized with bass and treble controls; while some people might complain that there is no midrange control, you can always add an outboard parametric if necessary. The EPS-1 also includes attack and release controls; however, there is no de-chorusing control, nor is there an "animation" (chorus intensity) control, so the strings are basically a preset sound. Additionally, the string and piano sections of the instrument include independent volume controls and on-off switches so that you can easily balance these two sections.

The overall sound of the strings*, the ability to voice string parts over a much larger keyboard area, and the stereo abilities of the EPS-1 make it quite an instrument. The top of the keyboard is flat so you can easily stack other instruments on top of it. There is a sliding pitch transpose switch (for those who can't transpose), a nice wood cabinet, and cleats for the AC cord so that any extra length can be taken up (if you've ever tripped over a slack AC cord, this is a feature to appreciate). The price is a little steep, but you are getting good sound for your money. While there seem to be tons of string units available on the market these days, I feel that the EPS-1 is one of the best.

* Listen to "They Fall From The Skies", the third track of my "Key Essentials" album; the strings and harpsichord were recorded using the EPS-1.

Music Software Review

Commodore-64 / CBM-64



By: Craig O'Donnell

How would you like a three-voice minimoog customized with a nine-octave digital sequencer -- for $600? I can't give you the name of a store for that deal, but some home computers -- notably the Commodore 64 (or CBM-64) -- can come close. Atari and Mattel offer music and sound generators in their new computers as well, but so far the CBM-64 seems to have the most flexible features of any synthesizer/home computer combination. For those who are not familiar with this machine, the CBM-64 includes 64k of RAM and a 6510 CPU. The 6510 is Commodore's proprietary 6502 (the same CPU used in the Apple and Franklin computers), and I think the Commodore 64 is 'every byte' as good as the Apple. You can add-on 'smart' disc drives, and unlike the Apple (which requires extra oscillator boards to make meaningful noises), the CBM-64's built-in "Sound Interface Device" (SID) chip lets you make neat sounds right out of the box. Best of all, the CBM-64 is the cheapest 64k home computer that is also suitable for 'serious' applications.

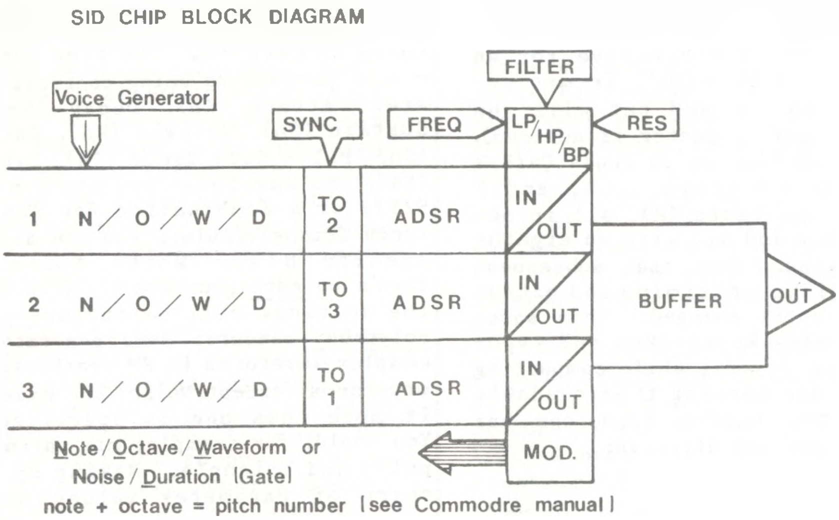
The April '83 issue of Polyphony includes a comprehensive article on the SID chip's capabilities; obtain it and read James Lisowski's well-written description of its operation. While the software reviewed here makes it easy to access the SID chip's functions, knowing what goes on inside makes conceptualizing sounds easier -- much the same way that growing up on modular Moogs and ARPs makes it easier for us pre-digital dinosaurs to program the new breed of machine. Figure 1 is a simplified block diagram of SID's inner workings, along with a minimoog block diagram for comparison.

Unfortunately, Commodore did not provide simple sound commands in the built-in Kernal BASIC, so you need music interpreters (programming tools which work with BASIC or machine language). These let you talk to the computer in simple, musician-oriented commands, rather than having to POKE numeric values into what seems like an endless series of registers. Music interpreters are absolutely necessary to preserve one's musical sanity; it is a useful exercise to try programming some of the sound examples included in the CBM-64's owner's manual some evening just to see how absurd POKEing a raft of values into memory locations can be. Mind you, the native approach can be good for certain 'sound installation' events where a simple idea mutates through randomized values, but to actually realize a serial or trio chamber music composition is pretty close to impossible.

This review covers three software packages: Music Machine and Music Composer, two widely available Commodore ROM cartridges; and Synthy-64, available from Abacus Software (Box 7211, Grand Rapids, MI, 49510). Future reviews will cover other software, such as Music Construction Set and Vanilla Pilot/Pilot II. Bear in mind, though, that making direct comparisons is difficult since software is highly idiosyncratic in nature and is always designed to a specific purpose influenced by its creator's preferences. Comparing software isn't like comparing a Les Paul to a Strat; it's like comparing a trumpet, sax, whistle, and bassoon...all four use the resonating air column principle, but all four yield very different sonic results! Consider your own needs and preferences before buying, and sample whenever possible prior to purchase. Do you want step programming (Synthy-64) or a staff with notes and icons (Music Construction Set)? Do you want a traditional musical syntax (Synthy-64) or an abstract algorithmic approach with randomization and interactive potential (Vanilla Pilot/ Pilot II)? Remember, a raw CBM-64 is potentially all things to all folks; what you feed it affects the results and how much fun you have. If you don't like one composition package's approach, well, heck, try another until you find one that's right.

Surprisingly, I feel the 'stinker' of the batch is Commodore's Music Composer ROM cartridge. Usually ROM cartridges are a good choice because they are almost indestructable and, since they're programmed in machine code instead of BASIC, run very fast. However, the least of its problems is that it thinks its name is MUSIC MAKER, as announced on the screen when you first run it. Music Composer's disastrous menu-driven approach (a menu allows choosing among alternatives that usually lead to further alternatives) is not adequate to SID's demands. Songs are written in clumsy mumbo-jumbo code, save only onto cassette, and your saved songs (programs) cannot be named. The choices of tempo are few, and playback tempos seem approximate and uneven (I found it impossible to get accurate syncopation because the tempo is nowhere close to metronomic). And, a set of "rhythms" controlled by the brown Function keys sends synthesized drum sound reeling back into the Dark Ages. Need that? Worst of all, a tyro might pick this up thinking it would be a good introduction to electronic music, and wind up frustrated. Why fight your tools? Yes, I really think it is that bad, and the documentation isn't too good either. Better options exist at $29.95; I suspect this is a quick fix of something originally developed for the VIC-20 or PET.

A better choice, especially if your kid wants to make sound too, is the Music Machine cartridge ($29.95 list). It gives swift access to a few SID sounds by converting the typewriter keyboard into a piano-like keyboard that uses the "Q" through "(uparrow)" keys, thereby spanning an octave and a fifth. "Q" represents the piano C and "black keys" are in the digits row above the letter row. The program also provides octave-shift and tuning keys. Mode, waveform, number-of-voices, and effects are selected by stepping through alternatives that show on the screen using several different keys. As you play, cute colored notes dash across a musical staff occupying the screen's bottom half. While this program will NOT save compositions or allow three-part playing (except in a drone-like fashion), it's a gass to watch the notes fly by on the monitor! For about $30, then, you can turn your CBM-64 into a Casiotone.



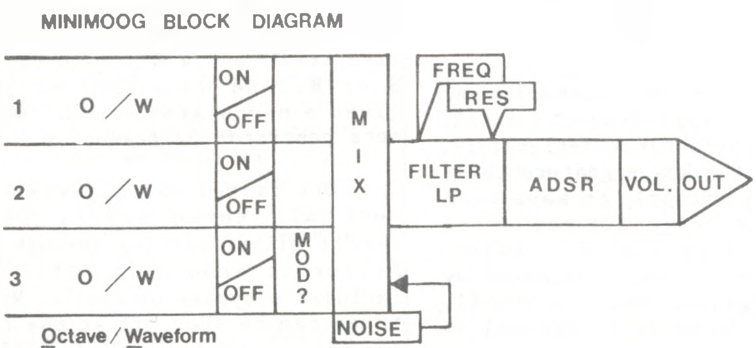


FIG. 1

Abacus Software's Synthy-64 is the only serious-and-professional music interpreter I have seen so far,although I'm sure there must be others out there in hackerland somewhere (the recently introduced "MusiCalc" program looks very promising -- Ed.). It was developed by one Roy Wainwright, who may or may not be a musician; whichever, he has done an amazing job devising a musically useful set of commands that gives full control over every function on the SID chip -- and includes some bonuses as well. Price is $29.95 (cassette) or $32.95 (diskette). Diskette is preferred because storage and housekeeping chores go something like 20 times faster on a disk drive, but if price is a big constraint note that $300-$350 will get you started with a 64, a "Datasette" recorder (cassette storage device), and the cassette version of Synthy-64. Throw in your TV and/or home stereo or portable tape player and you're ready to go. Either version comes with an exhaustive 39-page manual which explains commands, command formats, and takes the novice through a tutorial. Synthy-64's structure seems 'inherently musical' since it considers SID as a three-voice ensemble; thus, it is particularly suited to three-part contrapuntal composition whether tonal, atonal, or serial. SID's exotica can be used within compositions, but your writing will be done in a soundworld of beats-per-minute tempo, repeats nestable to 27 levels, repeat-except-for options, and conventional note values with ties, dots, and double-dots. One concession to swing: a ! gives a triplet time value. However, you cannot randomize parameters or interact with joysticks or input ports.

Full-screen editing makes scoring very simple. A 'score' resembles a program in Fortran or APL; line numbers are followed by mnemonic commands (letters) and parameters (numbers). To edit, you move the cursor about the screen and overwrite any errors or obsolete parts using INSERT and DELETE commands where necessary. Move the cursor to the end of the logical line, hit RETURN, and voila, the score is changed. GOTO and GOSUB commands are used within a score as in BASIC. If several songs are grouped within one 'score' (i.e., program) a certain selection can be called using a simple combination of INPUT and GOTO commands at the beginning of the program. GOTO sends the program to a specified line number, while GOSUB sends the program to and through a subroutine for more data or music. (RETURN then shoots it back to the line number following GOSUB.) Sounds confusing, but it's simple, really. Subroutines can also reset sound parameters in the different voices, change them completely, or supply a repeating chorus; a subroutine might even be a single complex part that comes up over and over again. Wherever you'd like to repeat, use a GOSUB to save scoring time and editing. Usually a logical line will represent one, two, or four bars of music (consistency here means less confusion!) and a subroutine can take as many lines as you want -- even more than the main routine.

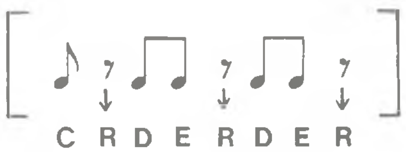
Comments (REMarks) and screen text manipulations can be inserted into the score without affecting the music. You cannot display graphics, but you can announce titles, show lyrics, or similar simple text. Comments lines separate a score into parts for easy reading without affecting playback.

What is an actual song like? Abacus includes sample tunes as the "Music-64" program. They show the agility you might develop, and source listings are included in the manual. One example illustrates the TRACE command, which displays a real-time parameter chart onscreen; the various numbers and letters change as the sound plays. Initially intimidating to watch, the chart sped up my learning process since I saw and heard how different values affect the sound.

Complex pieces must be prescored somehow on paper. You can RUN passages in edit mode to hear them if you enjoy working by ear, but in any case, organization is critical. It's almost impossible to improvise in Synthy-64 commands! Actually, abstract sounds using Sync, Mod, Noise, Filter, and so on can be 'sculpted' in almost-real time, but don't envision playing a synthe-sax with the prolixity of a Charlie Parker or Jimi Hendrix, improvising while the computer 'remembers'; it ain't done here. Go MIDI.

Five preset instrument sounds live at the top of the music memory space, lines 63010 to 63050. Use them as-is or alter them. "Piano" is a default sound on all three sound generators, and until you've grasped the scoring process it's best to stick with the presets. Later on, you can create your own voicings and edit them into a score. Since the five instruments reside on the disk or tape they are never lost. Use them to develop a piece, and when you're satisfied, give your trio different instruments later. This saves a lot of composition time.

Synthy-64 is intended to save time and keystrokes. The whole shebang revolves around a brilliant idea: C4/8 means "play a 'C' in the fourth octave for an eighth-note duration" (tempo defaults to 100 BPM but will run much slower or faster if desired). A program line which reads C4/8 R D E R D E R plays C, D, and E notes, and rests (R), all in octave four and all with an eighth-note value. Note that subsequent notes 'inherit' timing and octave values until changed. This saves many, many keystrokes and typographical errors, while compacting scores and keeping them readable too. The rhythm from the bar above, incidentally, is:



Serialists and chromatic impressionists will love the #/$/%, or sharp/flat/natural designators. SGN#2 sets the key signature to D-major (two sharps), to save even more keystroking. SGN can be set on any sharp or flat key center. Multiple voices are designated by +/-/L (English pound symbol), which are thoughtfully grouped in the top right to speed up scoring. Synthy-64 will scan ahead during polyphonic passages and sound grouped voices as chords, or simultaneities in klangfarbenmelodie. There are ways to ensure that voices stay silent so that you don't have to code hundreds of Rs into a score that alternates between one and more voices. Two chords would score out as: +C4/2 -C3/2 LC2/2 +R -R LR +C -G LD#. This would play three octaves of C, followed by a half-note rest in all three voices, followed by a chromatic C-minor half-note chord. Knowing this much you're ready to go!

The manual is very clear on tricks like repeat, repeat-except-for, and the like, so I will not delve into this further. However, I would like to briefly outline some of the Advanced Features (voice setting, modulation, filtering, portamento) using the manual's own example.

Scoring simplicity is only half the power of the Synthy-64 interpreter. The "@" sign delimits a voice-setting command. The manual refers to these as 'tone generator control commands' and I'll agree that's the accurate thing to call 'em. The tone generator parameters being controlled are: Attack (An), Decay (Dn), Sustain (Sn), Release (Rn), Gate (Gn), Pulse Duty Cycle (Pn), Sync (Yn), and Waveform (Wn, where n = S/T/P or a combination for Sawtooth/Triangle/Pulse; you can also specify N for White Noise). That's on each generator! Most of the settings will be obvious to Polyphony readers; Sync generates complex waveforms in FM synthesis; waveforms (except Noise) are mixed if more than one is specified. You could, for example, mix narrow pulse and triangle. Making up a chart of parameter values and ranges will help a great deal here as you invent sounds. Even without such a chart, though, you should see that -@WN @Q500 @D12 @A0 @S0 @R0 @G1 translates to Noise with fastest Attack ("zero rise time") and a medium Decay, no S or R, and Gate "On" -- this gives a percussion sound. @Q500 sets generator #2 frequency.

One filter setting will affect all three voices since they're either passing through the filter or around it (SID even includes a bypass option!). Voice three can be shut off at the filter and rerouted as a Mod oscillator, just like a minimoog. Vibrato, FM, and Ring Modulation (@Mn) are easily accomplished. The filter has HP, BP, and LP options which can also be combined for oddball slopes. Xn sets the frequency (values are 0 to 15); Yn sets the "Q" (0-15), and Zn sets HP/LP/BP.

When checking out the advanced features (which I'm sure are of the greatest interest to Polyphony readers), the key word is 'play'. Experiment with the examples in the manual, then with your own ideas. See how single parameters can be shifted (you don't have to rewrite the entire tone generator command line). Go crazy!

"Okay," you say, "I'm sold. I'll buy it. Isn't there anything the matter with it?" Well, yes. It is very picky about spacing between commands, and will return error messages if you've put any spaces in the wrong places. When Synthy-64 hits an error, the music stops, the trace chart appears onscreen, and the error message prompts you to take 'corrective measures' (ho-ho-ho). Also, Synthy-64 does not provide sync in or out. It would be helpful if someone devised a hardware/software fix to allow at least sync-out at "n" pulses-per-quarter note. The Abacus folks indicated that they are working to link a pair of 64's to allow stereo three-part music, so sync can be done. Just don't ask your friendly reviewer to explain how!

All the CBM-64 software stands or falls on the 5-pin DIN jack* used to send the audio to hi-fi, tape, or anything but a TV speaker. You won't hear the quality of SID's sounds without it. You will also hear a Casio-like 'graininess', but remember that you're spending $300, not three grand.

In sum, for the bucks the CBM-64 can open a lot of doors for you whether you want to make music, process words, manage money, or play games. I would recommend Synthy-64 for the serious composer and the student or beginner alike. I encourage you to try it out; soon we'll look at more music-making software for our Commodore's helpful SID.

*DIN cable source: J.J. Meshna Inc, 19 Allerton St., Lynn, MA 01904. Tel. 617/595-2275 or write for catalog. $10.00 minimum order.

Vocal Basics

By: Danna Sorensen

As more musicians put together home studios and play all the parts on their compositions, many players are acquiring new skills. Guitarists are learning synthesizer to flesh out their compositions, it seems everybody is learning how to program electronic drum machines, and many musicians are opening up their mouths and singing for the first time.

Singing is a very natural act; just open your mouth and push the air out. But, singing right is a little more complicated. You have to be careful not to abuse your vocal cords, which can be a problem with inexperienced singers. I have seen many prospective singers ruin (or at least very seriously damage) their voices from unintentional misuse of the vocal mechanism. My intention in this article is to clear up a few misconceptions about singing, as well as provide a guideline to further development of the voice for those who want to get into singing on a more serious level.

Getting started. For the beginning singer, the best place to start is with your posture; good posture is the foundation of controlled breathing, and controlled breathing is the foundation of singing. Hold your head comfortably erect, with your shoulders remaining down. Carry your chest comfortably high, but not too high -- certainly not like a soldier's posture. Keep your back straight. You can get into this position by standing against a wall, and making sure that your body contacts the wall from heels to head.

After becoming aware of your posture, it's a good idea to become aware of your breathing. From a sitting position, lean forward and place the forearms on the knees. Take a slow, deep, noiseless breath through the mouth. Expand the waistline around its entire circumference, but do not raise the shoulders. The muscles you are using are the abdominal (stomach), dorsal (back), and costal (rib). Now sit up with back straight and chest high, and repeat the breathing exercise in this position. Stand and place the back of your hands on your ribs and concentrate on moving your hands out and in as you inhale and exhale. Inhale deeply; then exhale slowly with a steady hissing sound for 24 counts. Continue to use abdominal, dorsal, and costal muscles to push the air out, creating a louder and louder hissing sound. Now stand up with back straight, chest high, feet apart, with one foot slightly in front of the other. The weight is on the forward foot. Place hands on ribs, and do the following:

Inhale: inhale deeply, allow the abdominal, dorsal, and costal muscles to expand.

Exhale: contract (pull in) the abdominal, dorsal, and costal muscles. This is your support. Without it you will have a whispering tone quality in your voice instead of a clear full bodied tone.

You should have a feeling of "lift" from the abdomen upward. Do not raise the shoulders.

Your tone should be rounded by the mouth and lips. Lips and tongue should never be tense; the jaw should be loose, and the tongue in a forward position with the tip resting against the back of bottom row of the teeth. If the tongue slips back it will block the flow of air and create too much tension on the throat. Correct tongue positioning will open up the air passage.

Directing vocal energy. You have a soft and hard palate. Put your tongue to the roof of your mouth and go back as far as you can. The soft tissue you feel there is your soft palate. Bring your tongue forward a bit and you can feel a hard lump. This is the hard palate.

Even though we know that the air goes down into your lungs, imagine the air filling up the top is the most closed sound; "AY", as in "ate", is an open sound; "OH", as in "rose", is an open sound; "AH", as in "law", is the most open. All vowels must eventually be modified (by changing to more of an open "AH" sound) as the pitch gets higher. For instance, "EE" almost always has to be modified in the upper range. Singing it straight puts too much tension and stress on your throat, so it closes up and you will not be able to hit the note. (It also takes more push from the abdomen to sing in the upper range.) You modify the sound by dropping the jaw and opening the mouth wider.

Once these concepts are clearly understood and put into practice, the vocal mechanism will begin to work wonders with very little effort. Don't expect miracles overnight: Correct singing is difficult and takes time, but your voice will be stronger and last much longer than if it were untrained.

Caring for the voice. Your voice should be treated properly. Get plenty of rest and exercise, do not scream or belt, and do not talk, sing, or practice when the throat is irritated. To prevent dry throat, drink at least six glasses of water a day. Cough or clear the throat as little as possible -- it is much better to sing the mucous off. If you ever need surgery such as tonsillectomy, or other operations that require a tube down the throat, make sure your doctors know you are a singer and must be careful. Do not overwork the voice; stop when the voice begins to feel fatigued, and do not speak on a pitch higher or lower than the optimum one for you. Many drugs (alcohol, marijuana, amphetamines, coffee, cocaine, etc.) dehydrate you and are bad for the voice. Cigarettes, of course, are also terrible for your voice.

Singing is fun and exciting and well worth the effort. Good luck, and most of all, have fun! In closing, here are some words from the great teacher of acting, Stanislavski:

"Love the art in you, not you in the art. Artists of colors, sounds, chisels, and words choose their art in order to communicate through their works with other people. The inner process must be conveyed to the audience. The most important thing is to build the life of the human spirit."

References for further study:

Monahan, Brent Jeffery, The Art of Singing: a Compendium of Thoughts on Singing, New Jersey and London, 1978. Scarecrow Press.

Pearl Shinn Wormhoudt Building the Voice as an Instrument, (Oskaloosa Iowa, 1981)

Caruso, Enrico, How to Sing, republished in New York, The Opera Box: originally published in London, The John Church Company.

Fuchs, Viktor, The Art of Singing and Voice Technique, London, John Calder (Publishers) Ltd., 1963.

Miller, Richard, English, French, German and Italian Techniques of Singing, New Jersey, The Scare Crow Press.

Functional Lessons In Singing, Evan Trusler and Walter Egret.

Also, Manuel Garcia achieved fame as a teacher and has written some excellent books. Venard and Coffin have done some very in-depth studies as well. Their books are very helpful if you really want to study the voice, and can be found in most libraries.

Build A Just Intonation Generator

By: Vanessa Else

Virtually all of the music we hear is tuned to the even-tempered scale. In fact, this scale is so common that many people forget that alternate scales exist. However, even-tempered tuning is a relatively recent development (it traces back to Bach's time, around 1600). The reason it was developed is that other forms of tuning (such as just intonation), while more physically "precise" (see David Doty's article in the August 1983 Polyphony, pp. 38-42), could not modulate easily from key to key. Over many years, it was discovered that if all the tones of a scale had the same numeric relationship to one another -- not an acoustic relationship to a specific fundamental frequency as is the case with just intonation -- then any tone of that scale could compositionally function as the fundamental at any time. Therefore, even-tempered instruments could modulate to many different keys within the framework of a single piece.

Some acoustic instruments produce a discrete set of frequencies (wind instruments with keypads, fretted string instruments, piano, etc.). Others have a virtually infinite set of playable frequencies between a maximum and minimum point specified by the instruments' size (trombone, timpani, voice, any fretless string instrument, etc.). Since acoustic instruments were the only ones available in Bach's era (yes, some of you may find it hard to imagine but there was a time when AC current flowed not from yonder wall sockets), the even-tempered tuning of the discrete type of instrument locked almost all of Western music into the even-tempered standard.

Luckily, the second type of instruments described above (those not committed to any particular scale) are abundant and diverse enough that you could be playing in just intonation tomorrow. You and your friends can pull out your cellos and violins and start vibrating to the resonant harmonics. Then again, you might want to pull out your electronic just-intoned devices (such as fretless bass and synthesizer) and charge the air with some of those rediscovered resonances. Ahhh, you say your synthesizer only plays in even-tempered tuning? Then, JIG is for you.

"JIG" is an acronym for Just-Intoned-Generator. Based on one of the most commonly known just intoned scales, it is a top octave generator board (available in kit form from PAIA Electronics) that retrofits any 50240-based electronic musical instrument to just intonation, or can form the basis for custom instruments. (The 50240 is an even-tempered top octave divider chip used in many keyboards, including PAIA's Organtua, Stringz & Thingz, the Chord Egg, and Oz. For more information on this chip, see Polyphony 2/76).

The subject of just intonation is becoming a hotter and hotter issue as technology advances and we are therefore better equipped to deal with the complexities of modulation within "pure" tuning systems. By the "purity" of just intoned music, I mean that combinations of notes which have whole number mathematical relationships to each other have fewer discordant qualities (impurities) than combinations of notes whose relationship is defined by an irrational number (as with even-tempered tuning; again, refer to David Doty's article). In other words, playing two or more notes simultaneously (other than octaves) in even-tempered tuning will generate beat frequencies. This is because harmonics are not even-tempered, and the higher note(s) of the interval is likely to beat with an harmonic from the lower note(s). Some intervals produce higher beat frequencies than others; sixths and minor thirds are particularly noticeable. A common example of this even-tempered discrepancy is known to guitarists -- trying to tune a fretted guitar with string harmonics will never be successful, since the acoustically pure overtones are not coherent with the fretted tones.

Western culture's even-tempered system, based on the relationship of an irrational number, cannot avoid creating a multitude of beat frequencies with combinations of one or more notes. As some people theorize, this might be unhealthy to our nervous systems for reasons similar to the problems caused by fluorescent light: the constant optical beating (fluorescent light is a continuous stream of light pulses) is alleged to drain the human body of energy, and has been known on occasion to induce eye infections. Who knows what the nearly imperceptible -- yet unavoidable -- beatings in even-tempered tuning have done to the psyche of Western man? Just intonation just might be a partial antidote to the catastrophic cacaphony of Western culture -- if our music becomes more soothing, perhaps our culture will become more peaceful and cooperative as well.

Circuit Design: Basic math. The just intonation scale is defined by a set of ratios all related to a base, or fundamental, frequency. For example, the note represented by the ratio 3/2 is 1.5 times the fundamental frequency. Our set is a diatonic (12 note) expansion of one of the scales discussed in David's article. The ratios used to derive this scale are:

1/1 16/15 9/8 6/5 5/4 4/3 45/32 3/2 8/5 5/3 9/5 15/8 2/1

The JIG circuit starts with a single, very high frequency clock and sends it through several different frequency dividers; tapping different output points of the circuit provides a correct set of tones. Since there is only one driving clock frequency for the entire block of dividers, we want to find the lowest number by which all these ratios are related in order to keep the clock frequency reasonably low. That number turns out to be the lowest common multiple of the numerators of the above ratios. The lowest common multiple of the numbers 2, 3, 4, 5, 6, 8, 9, 15, 16, and 45 is 720. This is the largest divisor so it generates the lowest note of our scale -- the root, which we'll call **Clo**. Note, however, that the general use of "C" in this article and the accompanying diagrams is irrelevant to the frequency of C in contemporary, United States, standard, even-tempered tuning (= 16.35 Hz, 32.7 Hz, 65.4 Hz, 130.8 Hz, or 261.8 Hz, etc.). In this discussion "C" merely indicates the fundamental frequency, or tonic, of a just scale.

Beyond semantics...since we're dividing the clock by 720, our clock frequency must be 720 times higher than the fundamental of our scale because:

clock freq (divided by) 720 = actual Hz of tone

Therefore if we wanted the scale's fundamental to be 220 Hz (an octave below concert A-440) our clock frequency must be 158.4 kHz (= 720 x 220).

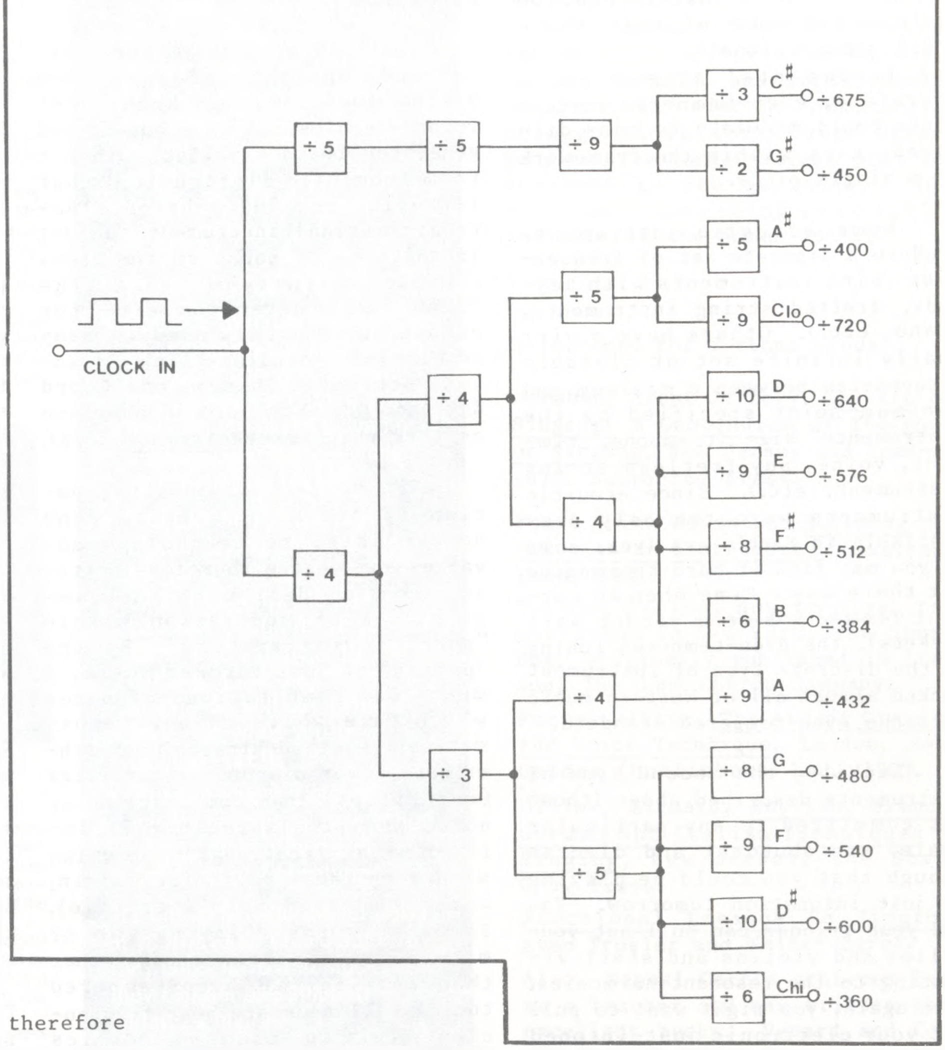
Now that we know the value of the numerator of the transform ratio (the least common multiple) we can figure out the divisors (of the clock frequency) for each of the other eleven tones. Refer to figure 1. Because 720 is the least common multiple of the numerators of the ratios we see that

the given ratio = 720/X

"NOTE"	$[\text{RATIO} \times \frac{1}{720}]^{-1}$	RESULTING DIVISOR	PRIME NUMBER COMPONENTS
C lo	$[1/1 \times 1/720]^{-1}$	720	$5 \times 3^2 \times 2^4$
C♯	$[16/15 \times 1/720]^{-1}$	675	$5^2 \times 3^3$
D	$[9/8 \times 1/720]^{-1}$	640	5×2^7
D♯	$[6/5 \times 1/720]^{-1}$	600	$5^2 \times 3 \times 2^3$
E	$[5/4 \times 1/720]^{-1}$	576	$3^2 \times 2^6$
F	$[4/3 \times 1/720]^{-1}$	540	$5 \times 3^3 \times 2^2$
F♯	$[45/32 \times 1/720]^{-1}$	512	2^9
G	$[3/2 \times 1/720]^{-1}$	480	$5 \times 3 \times 2^5$
G♯	$[8/5 \times 1/720]^{-1}$	450	$5^2 \times 3^2 \times 2$
A	$[5/3 \times 1/720]^{-1}$	432	$3^3 \times 2^4$
A♯	$[9/5 \times 1/720]^{-1}$	400	$5^2 \times 2^4$
B	$[15/18 \times 1/720]^{-1}$	384	3×2^7
C hi	$[2/1 \times 1/720]^{-1}$	360	$5 \times 3^2 \times 2^3$

FIG. 1: BASIC MATH FOR DIVIDER NETWORK

FIG. 2: DIVIDER NETWORK BLOCK DIAGRAM



therefore

X = 720/ratio

where X is the resulting clock divisor required to obtain each note. Once we have our set of divisors, we break them into their prime numeric components which easily translate into a network of dividers (see figure 2).

Since all just scales are not created equal, figure 3 shows the mathematics and block diagram for an alternate, seven-tone Pythagorean scale (described in David Doty's article). There are many different possible scales, so if you fully understand the procedure of using dividers to create scales from a high frequency clock, you will be able to design your own top octave divider derived from your favorite scale. In case you would like to experiment with other just scales, those in figure 4 were also provided by David Doty (note that our JIG scale is the same as #2). His comments were, "I am not certain (these) are the best ones available, although they may well be. The possibilities are enormous and, in any case, what makes a good scale is as much in the hearing as in the numbers. #1 has the lowest numbers of any 7-limit chromatic I have found. #2 is a 5 limit scale with the maximum number of consonant triads. This is what many theorists consider the proper form for a chromatic scale. #3 is OMJ12, the 12 tone version of our (Other Music's) current scale, and the one we would probably prefer on a keyboard. Note that it differs from #1 by only 1 note (D), but that this one note raises the divisor by a factor of 3. #4, the "Inverse Helix" has the lowest divisors of all, but definitely falls into the category of exotic scales; not something that you could substitute for a normal chromatic scale without bizzare results."

"NOTE"	$\lvert RATIO \times \frac{1}{972} \rvert^{-1}$	RESULTING DIVISOR	PRIME NUMBER COMPONENTS
C lo	$\lvert 1/1 \times 1/972 \rvert^{-1}$	972	$3^5 \times 2^2$
D	$\lvert 9/8 \times 1/972 \rvert^{-1}$	864	$3^3 \times 2^5$
E	$\lvert 81/64 \times 1/972 \rvert^{-1}$	768	3×2^8
F	$\lvert 4/3 \times 1/972 \rvert^{-1}$	729	3^6
G	$\lvert 3/2 \times 1/972 \rvert^{-1}$	648	$3^4 \times 2^3$
A	$\lvert 27/16 \times 1/972 \rvert^{-1}$	576	$3^2 \times 2^6$
B	$\lvert 243/128 \times 1/972 \rvert^{-1}$	512	2^9
C hi	$\lvert 2/1 \times 1/972 \rvert^{-1}$	486	$3^5 \times 2$

Common denominator of 9, 81, 4, 3, 27 & 243 = 972

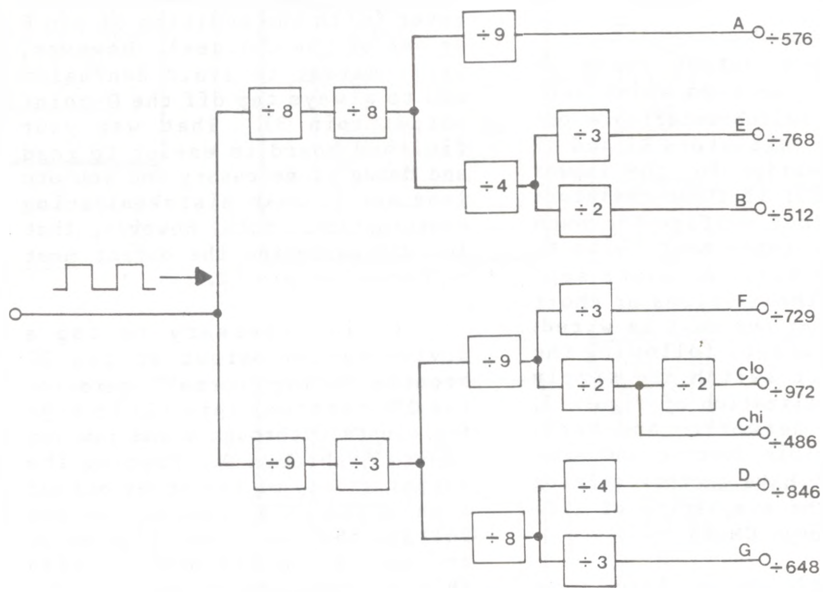


FIG. 3: PROCEDURE FOR ANOTHER JUST SCALE

1

"NOTE"	RATIO	DIVISOR
C lo	1/1	420
C♯	28/27	405
D	10/9	378
D♯	7/6	360
E	5/4	336
F	4/3	315
F♯	7/5	330
G	3/2	280
G♯	14/9	270
A	5/3	252
A♯	7/4	240
B	15/8	224
C hi	2/1	210

2

"NOTE"	RATIO	DIVISOR
C lo	1/1	720
C♯	16/15	675
D	9/8	640
D♯	6/5	600
E	5/4	576
F	4/3	540
F♯	45/32	512
G	3/2	480
G♯	8/5	450
A	5/3	432
A♯	9/5	400
B	15/8	384
C hi	2/1	360

3

"NOTE"	RATIO	DIVISOR
C lo	1/1	1260
C♯	28/27	1215
D	9/8	1120
D♯	7/6	1080
E	5/4	1008
F	4/3	945
F♯	7/5	900
G	3/2	840
G♯	14/9	810
A	5/3	756
A♯	7/4	720
B	15/8	672
C hi	2/1	630

4

"NOTE"	RATIO	DIVISOR
C lo	1/1	48
C♯	12/11	44
D	8/7	42
D♯	6/5	40
E	16/13	39
F	4/3	36
F♯	16/11	33
G	3/2	32
G♯	8/5	30
A	12/7	28
A♯	16/9	27
B	24/13	26
C hi	2/1	24

FIG. 4: SEVERAL JUST SCALES

Circuit design: Circuit description. Refer to the circuit diagram (figure 5), which shows a conglomeration of dividers with a Master Clock. These dividers, as you might suspect by now, are the circuit equivalents of the block diagram we constructed above (figure 2).

We begin with the Master Clock, which is a 4001 (Quad 2-input NOR Gate) CMOS chip configured to provide a pulse wave output with an approximate 50% duty cycle. The 47 pF capacitor assures an extremely high clock frequency. For lower clock output frequencies, use a larger capacitor.

The clock output feeds an octave select section which provides three switch-selectable octave ranges. Resistors R1 and R2 provide protection for the inputs of IC12 and IC3; if these resistors lower the clock voltage too much (all clock voltages must swing to greater than half the power supply), lower their values or short them out after the unit is wired. The divider stages following the octave select switch are simply the exact realization of figure 2, the divider network. And here, folks, with this concise and simple design we have another shining example of the simplicity of life achieved through CMOS!

Now let's delve into some specific points of interest regarding circuit design. Divide-by-two, and divide-by-four can be accomplished with a 4017 (another CMOS IC -- a Synchronous Divide-by-10 counter with 1-of-10 outputs). However, since this chip is more expensive than a 4013 CMOS Dual D Flip-Flop, and each D flip-flop on the chip can perform binary divide, we use 4013s wherever possible.

4017s provide all signal divisions other than 2 or 4. The 4017 has a few operational quirks which I encountered during JIG's development. For normal operation ("normal" for this chip being divide-by-ten division) the clock enable and reset pins (see figure 6) should be at ground. To wire up any divider between 0 and 9 inclusive, the reset pin (#15) should not be grounded but should be connected to the appropriate output pin for the required divide. The counter will advanced one count each clock pulse; therefore, on any count, the decoded output goes positive, while the others remain at ground. This will furnish a pulse output waveform at the pin where you tap the note.

For all divides (other than ten) you can tap the output at any of the points that trigger before the pin to which reset connects. For example, to construct a divide-by-seven module connect pin 6 to the reset (pin 15) and tap the output at pins 1-5, 7 or 10. To construct a divide-by-eight module connect pin 9 to pin 15 and tap the output signal at any of the same places as with the divide-by-seven (with the addition of pin 6 as one of the choices). However, it is safest to avoid confusion and to always tap off the 0-point output (pin 3). That way your finished board is easier to read and debug if necessary and you are less apt to make mistakes during construction. Note, however, that for divide-by-ten the output must be tapped at pin 12.

It is necessary to tap a divide-by-ten output at pin 12 because during "normal" operation the OUT terminal (pin 12) is high for counts 0 through 4 and low for counts 5 through 9. Tapping the output at any of the other output pins produces a constant output voltage that is either high or at ground. The minor problem with this is that when using a divide-by-10 at the final output stage for a note, the resultant waveform is a square wave (the same thing occurs if you have a divide-by-two or divide-by-four final stage for a note.) Uh-oh, we see that we have square waves for some notes and pulse waves for others. Have no fear! If the initial clock frequency is high enough, the output frequencies from our board can be wave-shaped. There is not enough room for us to discuss waveshaping here so I refer you to Don Lancaster's CMOS Cookbook (available through Polymart; see page 34. Look in the Applications Catalog section of Chapter 5, where it discusses the use of D flip-flops to make digital-to-analog converters -- p. 288 in my edition of the book). I wonder, though, how much the harmonic complexity of the varied waveforms supports or detracts from just intonation's sonic uniformity.

Of course, to avoid an output stage square wave we could substitute a 4017 divide-by-ten module with a two-chip configuration of divide-by-two and -five. Also, we could use a 4017 when the final output stage is a divide-by-two or -four to avoid the square wave output problem, but these are solutions which are not warranted because of cost considerations. Besides, this is a terrific opportunity to experiment with waveshaping if you haven't so far. (Editor's note: After playing with JIG, I did not find the blend of three square wave outputs and nine pulse outputs with varied duty cycles objectionable -- in fact, to me the combination sounded more appealing than all square or all pulse waves.)

NOTE: All 16 pin ICs, connect pin 16 to +V.
All 14 pin ICs, connect pin 14 to +V.
Recommended supply voltage = 12 - 15.
Bypass capacitors not shown.

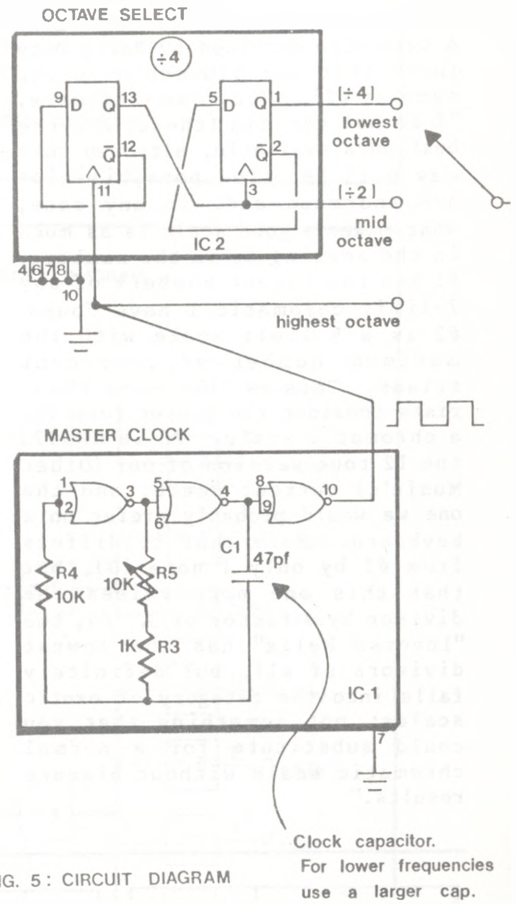
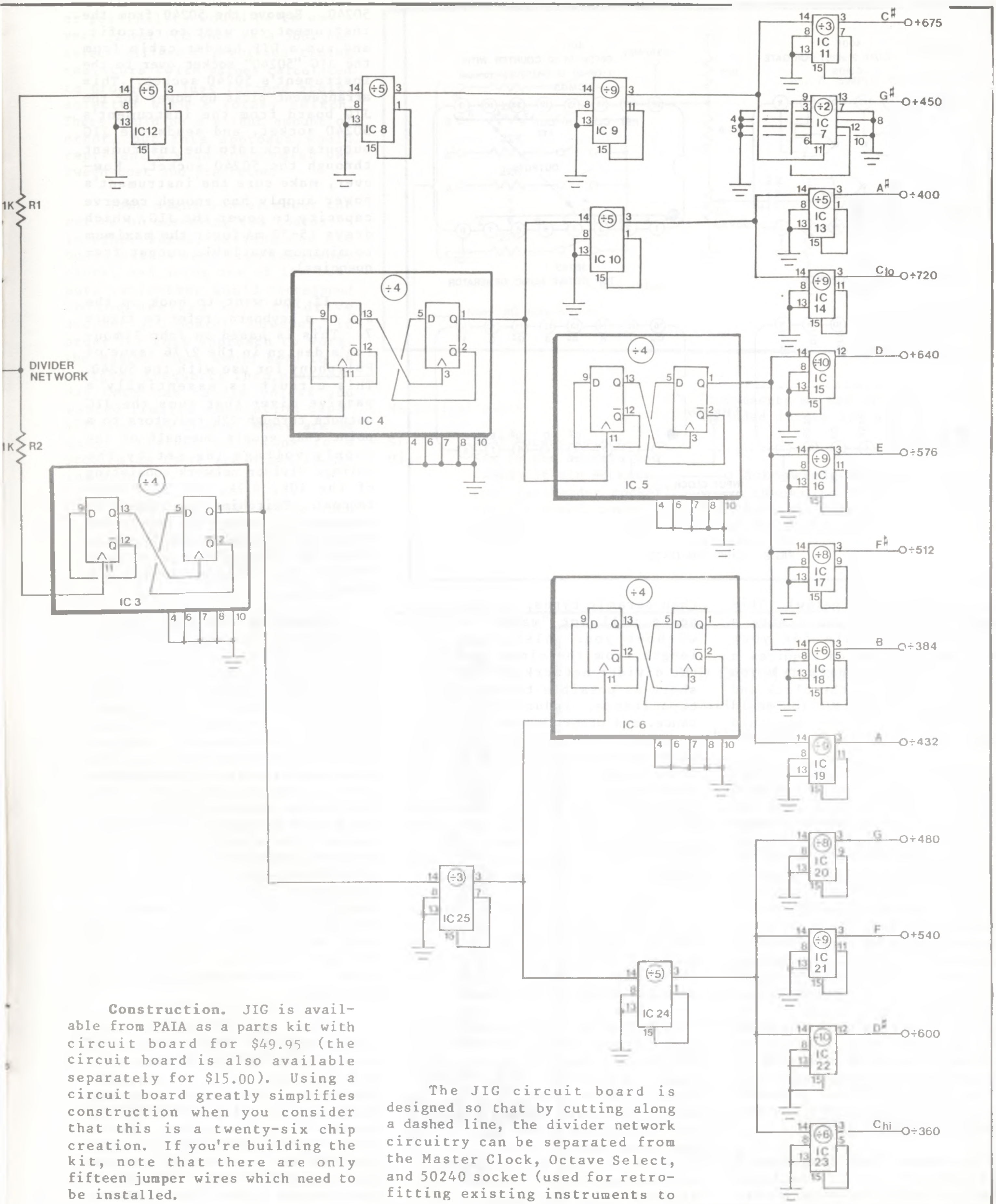


FIG. 5: CIRCUIT DIAGRAM



Construction. JIG is available from PAIA as a parts kit with circuit board for $49.95 (the circuit board is also available separately for $15.00). Using a circuit board greatly simplifies construction when you consider that this is a twenty-six chip creation. If you're building the kit, note that there are only fifteen jumper wires which need to be installed.

The JIG circuit board is designed so that by cutting along a dashed line, the divider network circuitry can be separated from the Master Clock, Octave Select, and 50240 socket (used for retrofitting existing instruments to

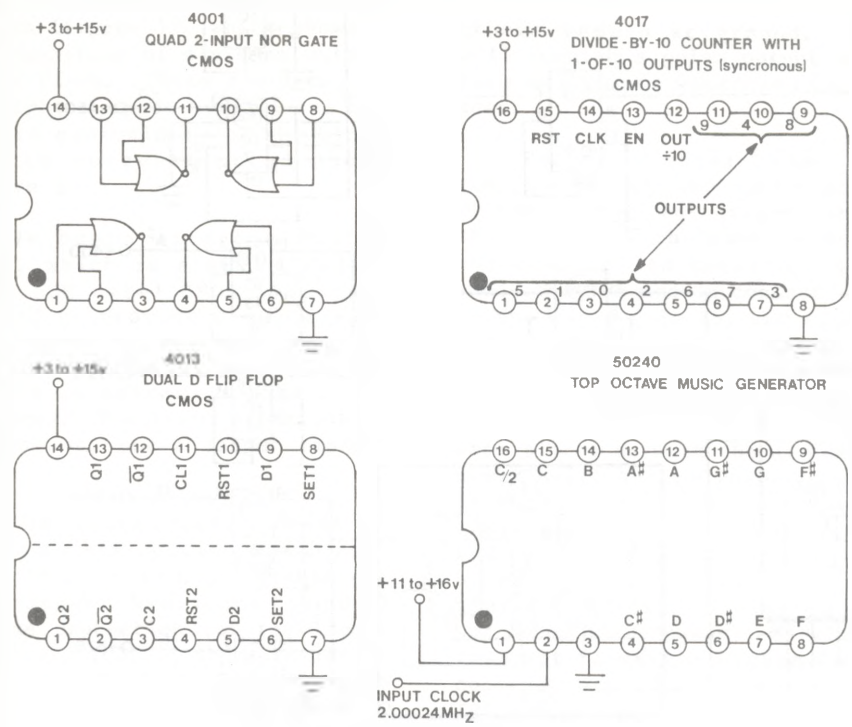


FIG. 6: CHIP PIN-OUTS

just intonation; see below). This means that should you desire a different just scale for your sonic creations (which requires a different divider network) you need not replicate the clock and octave select circuits. You could even insert a switch for rapid change from one scale to another.

Here are a few tips for those of you who are going to build a JIG from scratch. CMOS inputs are particularly susceptible to damage from static electricity; therefore, after you've shuffled across the carpet, be sure to touch a ground connection before working on your circuit. Also, if you're breadboarding the JIG on a socket strip and are going to be connecting wires to holes in the socket strip that connect to CMOS input pins, be sure to provide input protection. Placing a 1k Ohm resistor in series with the CMOS input (in other words, between the place where you keep jumpering to the input and the actual input pin of the chip) provides adequate protection. (Again, refer to Don Lancaster's CMOS Cookbook.)

The Master Clock should use a polystyrene or mica capacitor, either of which is more stable than ceramic types, so that your scale will not "wander around" without you. Also, the wire length from the clock output to the divider network should be as short as possible to avoid stray capacitance, inductance, reactance, and other transmission line problems. Use IC sockets so that in case you create other JIG divider networks, you can swap ICs from an existing JIG board. Of course it would be more convenient to have a complete set of chips for each scale but convenience is an economic luxury not all can afford. Invest in the sockets.

The next question is how to wire up the outputs; this will vary, depending on whether you want to retrofit a 50240-based instrument or build a custom instrument around the JIG.

Retrofitting is pretty simple. If you obtain one of PAIA's JIG boards you will notice that there is a 16 pin socket on the board with a bunch of pads. By wiring the positive supply, ground connections and JIG outputs to the indicated pads (C to C, C# to C#, D to D, etc.), the JIG outputs will appear at this socket configured like the outputs of a 50240. Remove the 50240 from the instrument you want to retrofit, and run a DIP header cable from the JIG "50240" socket over to the instrument's 50240 socket. This arrangement picks up power for the JIG board from the instrument's 50240 socket, and sends the JIG outputs back into the instrument through the 50240 socket. However, make sure the instrument's power supply has enough reserve capacity to power the JIG, which draws 15-30 mA (over the maximum to minimum available output frequencies).

If you want to hook up the JIG to a keyboard, refer to figure 7. This is based on John Simonton's design in the 2/76 issue of Polyphony for use with the 50240. This circuit is essentially a passive mixer that sums the JIG outputs through 22k resistors to a point that equals one-half of the supply voltage (as set by the voltage divider network consisting of the 10k, 4.7k, and 5k resistances). Switching the outputs to the one-half supply voltage point minimizes thumping and popping, since the JIG outputs alternate between the positive supply and ground.

Expanding the JIG. One of the reasons why just intonation fell into disfavor is because it is difficult to modulate to different keys. However, with electronic instruments you can modulate simply by changing the clock frequency, and since all dividers are locked to this frequency, the scale will remain in tune regardless of what key you select. The problem now becomes to calibrate the Master Clock in a just intoned scale. The simplest, and least accurate, solution would be to use a calibrated dial to select the appropriate key. Another solution would be to use a rotary switch to select different preset tuning pots, which would need to be tuned to just intervals. Unfortunately, none of these methods is highly accurate.

Other approaches are possible, however. One option would be to use one of the JIG boards in the feedback loop of a phase-locked loop, and try for frequency multiplication of a relatively low Master Clock frequency. While this hasn't been tried, it seems like the best -- although also the most expensive -- way to create a just intoned Master Clock. Another possibility would be to use a very linear VCO such as a 566, and select different precision timing resistors (with values calculated to produce a just intoned scale) selected with a rotary switch. There would be a slight amount of error, but this approach would represent a good compromise between cost and precision.

Some might wonder about the merits of cascading two boards -- in other words, driving one JIG board with a very high frequency clock, and using one of its outputs (whichever would correspond to the desired key) to drive another JIG board. However, in order for this approach to work, the Master Clock would have to be a higher frequency than present-day CMOS can handle unless you wanted limited modulation capabilities. As always, there are as many different solutions to a problem as there are minds thinking about it.

Since there has been so much interest in the subject of just intonation, we're planning on publishing follow-up articles on applications, alternate scales, and how to create a just intoned/easily modulatable clock; but first, we need you to send in the articles! So if you have any interesting ideas or experiments involving the JIG, write Polyphony at P.O. Box 20305, Oklahoma City, OK 73156.

Parts list

Resistors (5%, 1/4 Watt except as noted)

R1, R2	1k (see text)
R3	1k
R4	10k
R5	10k linear pot

Capacitors (15 or greater working Volts)

Bypass capacitors:

C1	47 pF (polystyrene preferred)
C2-C5	0.01 uF ceramic disc
C6-C9	10 uF electrolytic

Semiconductors

IC1	CD4001 quad NOR gate
IC2-IC7	CD4013 dual D flip-flop
IC8-IC25	CD4017 divide-by-10 counter

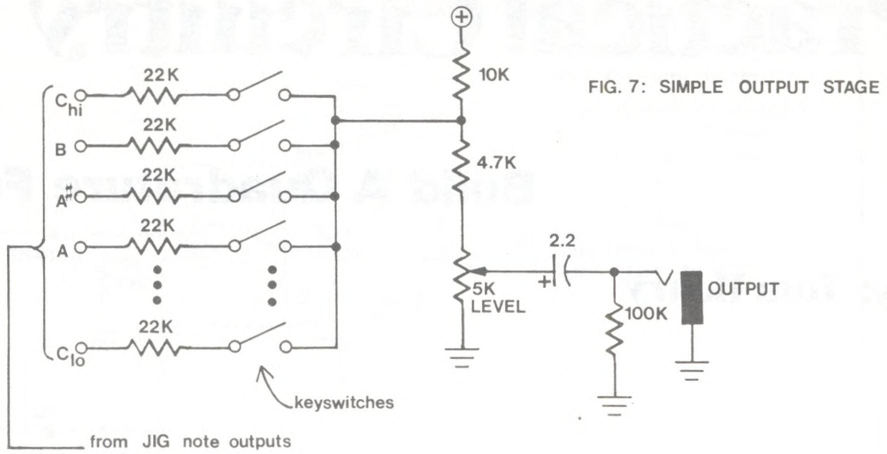


FIG. 7: SIMPLE OUTPUT STAGE

Mechanical parts

S1	SP3T rotary switch
Misc.	Six 14 pin sockets and twenty 16 pin sockets (one for header socket), circuit board, power supply*, wire, solder*, knobs, etc.

(Components marked with * are not included in the JIG parts kit.)

Acknowledgement. I extend many thanks to Craig Anderton. Only with his expertise and assistance could this article have been written.

SUBSCRIBE see page 6

Practical Circuitry

Build A Quadrature Function Generator

By: Tom Henry

What exactly is a quadrature function generator? To answer that, we must first understand the concept of a quadrature oscillator. An oscillator is said to have quadrature outputs if it produces simultaneous sine, cosine, negative sine, and negative cosine outputs. Such an oscillator can be created quite easily by setting a four pole lowpass filter into oscillation, and tapping the required outputs from consecutive stages[1]. If trigonometry alarms you, just consider the outputs to be four sine waves, each one ninety degrees out of phase with the previous output.

Despite the interesting patches possible with a quadrature oscillator, it does have one main drawback: Sine wave oscillators are fairly touchy, and you will often find that the amplitude will change as the frequency is swept over a wide range. In addition, under some conditions the oscillator may fail to oscillate; or, at the other extreme, hard clipping may bring about some undesirable distortion.

That's where the quadrature function generator comes in, since we will throw out the oscillator completely and replace it with a function generator. Oscillators are reactive; they depend on a resonating RC network. Function generators are non-reactive (in the sense that they don't resonate); their timing depends solely on the charging and discharging of a capacitor. With this circuit, the outputs are very stable in amplitude and purity over a very wide range. Finally, one more distinction between oscillators and function generators is that the former generates sinusoidal outputs, while the latter generates triangle waves (or sometimes ramp waves).

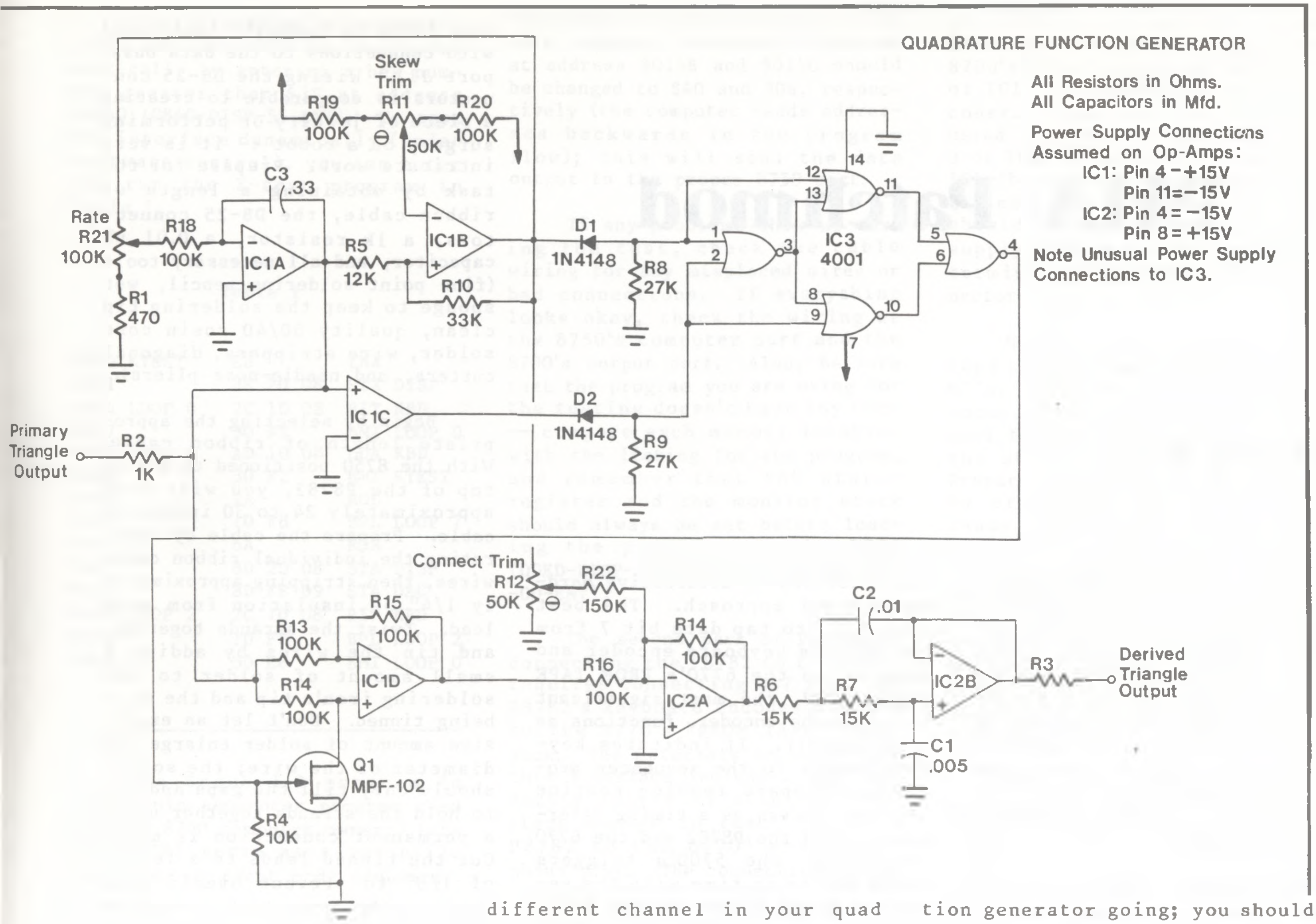
How it works. To fully understand the workings of a quadrature function generator, we must resort to some mathematics. There's hardly room to do that here, so if you're interested in the math behind the circuit, please refer to another article of mine which gives the complete analysis of a quadrature function generator[2]. (Actually, the circuit presented here is more compact and uses fewer parts than the earlier version, but the circuit action is very similar.) But even though we can't go through the mathematics here, we can still get an intuitive feel for how the circuit works. Referring to the schematic, op amps IC1A and IC1B form a Schmitt trigger/integrator function generator, an old friend from way back. C3 sets the basic frequency range, with R21 allowing for an adjustable rate. It is important to note that the output of IC1A is a triangle wave, and the output of IC2B is a square wave. The triangle wave goes directly to the "Primary Triangle Output" via R2. In addition, various line segments of the triangle wave are used in conjunction with Quadrature Function Generator's other circuitry to construct a new triangle wave ninety degrees out of phase with the first -- and that's where the square wave output from IC1B comes in. This output tells the circuit when to grab the various segments needed in the construction of the new triangle wave.

IC3 is configured as an EXCLUSIVE-OR gate; it seemed more cost-effective to use the dirt cheap 4001 quad gate for this, rather than using one gate out of a 4070 EX-OR gate. Note the unusual power supply hookup for this chip. Since this part of the circuit drives the gate of an N-channel FET, we need a swing from negative to ground.

IC1D, Q1, and their associated circuitry comprise a sign changer. This circuit will invert or not invert the input, depending upon the control voltage at the gate of Q1. Once again, see (2) for more details on the function of this sub-circuit.

Note that, so far, all of the op amps have each been 1/4 of a TL084 quad bi-fet op amp package. This particular chip must be used (instead of 741s, for example), since this circuit requires an extremely high slew rate -- we want all of the switching to be as clean as possible. But now we're going to reverse this philosophy and specify as slow an op amp as possible for IC2A and IC2B! IC2A sums together the various line segments to form a new triangle wave which is ninety degrees out of phase with the original. By specifying a low slew rate for this amp, any of the discontinuities in the derived triangle will be masked by the op amp's inability to slew fast enough. Pretty sneaky! In addition, IC2B is set up as a lowpass filter with a cutoff frequency of 1.5 kHz, which also helps smooth out the new triangle output.

Adjusting the trimpots is fairly easy. To simplify the process, temporarily replace C3 with a 0.05 uF capacitor. This will increase the frequency to a more easily observable range. Now monitor the "Derived Triangle Output" on an oscilloscope. While watching the waveform, go back and



forth between trimmers R11 and R12 until the waveform "comes together" and connects to form a smooth triangle wave. This process is quite magical; I think the sight on the scope will really amaze you! If you have a dual channel scope, compare the two waveforms ("Primary" versus "Derived") and confirm that they are indeed ninety degrees out of phase with respect to each other.

To round out the circuit you will probably want to provide inverted versions of the "Primary" and "Derived" triangle outputs. This will give you a total of four outputs, each one ninety degrees out of phase with the previous.

Applications. Well, what shall we use it for? For a start, how about automatic quadraphonic panning: Gang the inputs of four VCAs together, and control each one by a different triangle wave. Send each output of the VCAs to a different channel in your quad system, and the result is circular location modulation. What?!? You don't have a quad system? Then you can still use the quadrature function generator for some neat stereo effects. For a really bizarre sound, try this patch: Gang the inputs of VCAs 1 and 3 and apply a dry signal to these VCAs. VCA 1 should feed the left channel and VCA 3 the right channel. Now gang the inputs of VCA 2 and VCA 4, and apply an echoed signal to these inputs. VCA 2 should mix into the left channel, while VCA 4 mixes into the right. Now really crank up the delay time and feedback and hit some staccato notes -- but don't get seasick!

What?! You say you don't have a stereo rig either? That makes it harder to think up patches, but here's a good one to try. Apply an audio signal to four different flangers, with each one set for a slightly different initial delay time. Then send each flanger output to a VCA, and finally sum the VCAs together into a monaural output. Set the function generator going; you should hear an incredibly dense and lush sound. This is especially good for full-bodied instruments, such as rhythm guitar.

You may think I'm getting ridiculous, but what do you do if you don't have any synthesizer at all? (I'm serious now!) Well, you can create some great Lissajous figures on an oscilloscope screen, or better yet, hook the unit up to your laser art show for a far out display. (What?! No laser? Well...) There's quite a lot this little black box can do.

I've had a real blast designing and building the quadrature function generator. The circuit has a real "that's neat!" aspect to it, and is lots of fun to play with. If you come up with some interesting applications be sure to jot me a line c/o Polyphony.

(Editor's note: Splitting a signal into four filters, whose outputs feed four VCAs controlled by the Quadrature Function Genera-

continued on page 30

PAIA Patchmod

By: Scott Lee

The following describes a set-up used in the PAIA demo studios to synchronize a number of devices together. Although it took several months to come up with this patch, only eight to ten hours were involved in actually performing all required modifications (Patchmod necessitates some custom patch cords and a bit of wiring) and physically patching the units together.

Background: Evolution of a patch. The first step was to connect the P8782's keyboard data output to the Proteus data input so that the two of them could "talk" to each other. This was accomplished by joining their respective I/O ports. But while testing the interface between the two devices, I decided to add some drums in to accompany my jam; so, I got the 6770 Master Synchronizer going and patched a couple of its trigger outputs to the trigger inputs on the 5700 Drum. After setting the 6770 to RUN, I adjusted the 5700 to sound like a kick drum and snare while listening to each channel individually. After tweaking the controls for the desired voicings, I got back to the jamming. While using the P8782 as a sequencer for the 8750, the 5700 droned on, providing an interesting percussive voice to the overall sound.

My next idea was to see about interfacing the P8782 to the 6770. Using the click track option of the sequencer program was one possibility, but this would have required software modifications; so, I devised an alternative hardware-based approach. The best choice is to tap data bit 7 from the P8782's keyboard encoder and send it to the 6770's FROM TAPE input. DB7, the most significant bit from the encoder, functions as a status bit. It indicates keyboard scans to the sequencer program's keyboard reading routine and also serves as a timing reference. With the P8782 and the 6770 connected, the 5700's triggers could now be in time with the sequence being played on the 8750, thus giving me synchronized drums and sequencer; as the 8750 pumped out a transposing bass line, the 5700 kept a steady (but integral) beat, allowing me to try my chops on the other keyboards in the studio. Incidently, since I happened to have the 8750 running through the 6750 Hyperflange + Chorus, I decided it would only be natural to patch one of the trigger outputs from the 6770 to the 6750's LFO sync input. This patch had the best feel to it with the sweep rate set two to three times faster than the tempo of the sequence being played. Another possibility that I didn't try would have been to patch a signal into the control voltage input on the Hyperflange + Chorus; the patch points on the 8750's rear panel would also offer numerous possibilities.

Making the adapter cables. The interface between the P8782 and 8750 ports requires a cable with DB-25 connectors at each end. At the P8782 end, the 8700's DB-25 was re-wired to output port J2 (the P8782 is normally configured with connections to the data buss, port J1). Wiring the DB-25 connectors is comparable to creating a piece of jewelry or performing surgery on a robot -- it is very intricate work. Prepare for the task by obtaining a length of ribbon cable, the DB-25 connectors, a 1k resistor, a 0.01 uF capacitor, and all necessary tools (fine point soldering pencil, wet sponge to keep the soldering tip clean, quality 60/40 rosin core solder, wire strippers, diagonal cutters, and needle-nose pliers).

Begin by selecting the appropriate length of ribbon cable. With the 8750 positioned to sit on top of the P8782, you will need approximately 24 to 30 inches of cable. Prepare the cable by separating the individual ribbon cable wires, then stripping approximately 1/4" of insulation from each lead. Twist the strands together, and tin the wires by adding a small amount of solder to the soldering iron's tip and the wire being tinned. Don't let an excessive amount of solder enlarge the diameter of the wire; the solder should only fill the gaps and act to hold the strands together until a permanent connection is made. Cut the tinned leads to a length of 1/8" to prevent overly long leads at the connector's terminals (if too long, they could short to each other).

Prepare the connector by heating and filling the receptacles (terminals) with solder. Check and double-check the terminal numbers you will be using on each connector as you make each connection (see figure 1); orient the connector the way it will connect with its mate, and get a mental picture of the general location of where the wires will connect. With pre-tinned terminals and wires, it is necessary only to heat the connector terminal and insert the wire, holding both steady until the joint cools. Once all connections are made, you can continue with the other end of the cable. Again, prepare the cable by stripping and tinning the wires and prepare the connector by filling the terminals that will be using with solder (see figure 2). However, before the wires are soldered, install the indicated resistor, capacitor, and jumper wires (figure 3). Finally, connect the wires to the connector terminals.

The interface between the P8782 and the 8750 can be tested statically by entering a hex number greater than $3F at address $0840 (0840-DISP-55-ENT). To test the interface dynamically (under software control), you can enter and run the K-test program in Table 1.

Table 1

```
0000 KTEST    E8          INX
0001          8E 20 08    STX DISP
0004 LOOP 0   2C 10 08    BIT KBD
0007          30 FB       BMI LOOP 0
0009 LOOP 1   AD 10 08    LDA KBD
000C          30 F2       BMI KTEST
000E          2A          ROL
000F          10 F8       BPL LOOP 1
0011          6A          ROR
0012          8D 20 08    STA DISP
0015          8D FF 09    STA DAC
0018 LOOP 2   2C 10 08    BIT KBD
001B          10 FB       BPL LOOP 2
001D          30 E8       BMI LOOP 0
```

The Seque 1.0 program (a monophonic sequencer program used by many 8700 computer owners) lets the P8782 serve as a versatile real-time or event mode sequencer. Note that if you attempt to use this program, the memory locations at address $014B and $014C should be changed to $40 and $08, respectively (the computer reads addresses backwards in the program flow); this will send the data output to the proper 8750 port.

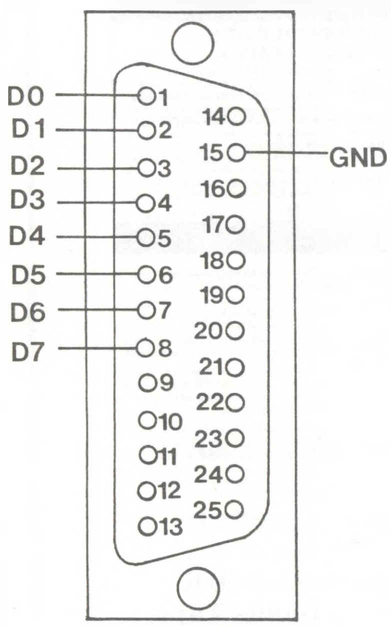
If any problems show up during the test, check the cable wiring for any misplaced wires or bad connections. If everything looks okay, check the wiring at the 8750's computer port and the 8700's output port. Also, be sure that the program you are using for the testing doesn't have any bugs -- compare each memory location with the listing for the program, and remember that the status register and the monitor stack should always be set before loading the programs on the 8700 (00ED-DISP-FF-ENT-00FE-DISP-FF-ENT-00-ENT).

The second part of Patchmod, connecting the P8782 to the 6770, requires connecting DB7 from the P8782's keyboard encoder circuit to the 6770's "FROM TAPE" input jack. The materials necessary for this interface include a two conductor length of shielded wire (long enough to reach from the P8782 to the 6770) and a 1/4" phone plug. The connection to the data bit on the encoder was made between an unused pin on the 8700's DB-25 connector and pin 3 of IC1, the CD4024 IC on the encoder. This wire could be soldered to a trace connecting to pin 3 of IC1, or directly to pin 3 of IC1 (be careful about overheating the chip, though). Another wire should connect from the power supply ground to another unused terminal on the 8700's DB-25 connector.

Now we can prepare the patch cord connecting the P8782 to the 6770. One end of the cable will connect to the DB-25 connector used for the 8750's interface, and the other to a 1/4" phone plug. Prepare the two leads of the cable by stripping and tinning the leads. Again, be careful not to get too much solder on the wires or they will not fit into the receptacles on the DB-25's terminals. Also trim the tinned leads to about 1/8" for the reason given earlier. Solder the two cable leads to the DB-25 terminals that match up with the two wires previously wired to the 8700's DB-25.

The other end of the cable connects to the 1/4" phone plug. Prepare this end by stripping and tinning the wires and sliding the cover for the plug, un-threaded

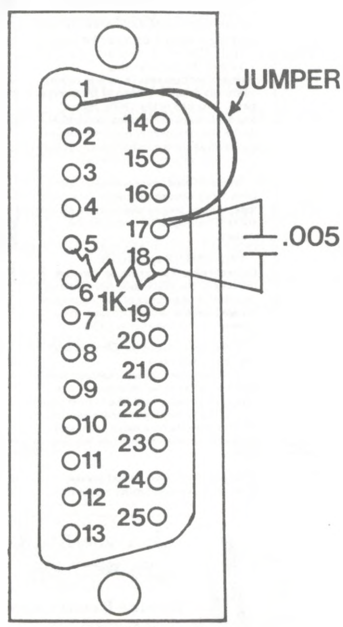
FIG. 1



DB-25 P
(from solder side)

Connector for 8700 Output Port

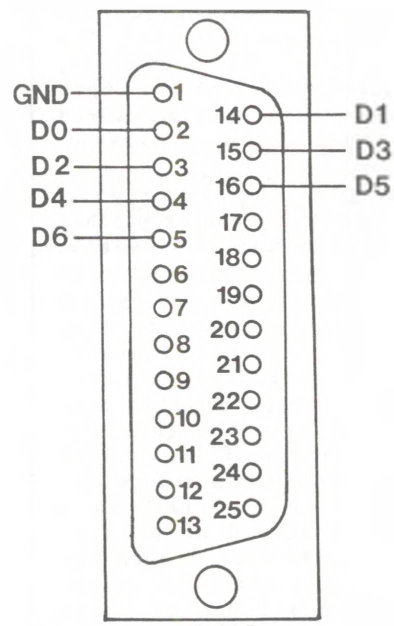
FIG. 3



DB-25 P
(from solder side)

Connector for Proteus Port

FIG. 2



DB-25 P
(from solder side)

Connector for Proteus Port

end first, over the cable. The wire carrying DB7 should be soldered to the "hot", or tip, lug of the plug. The remaining wire, ground, should be soldered to the remaining, or ground, lug of the plug. After the connection has cooled down, bend the tabs at the end of the plug ground around the cable, and screw the cover on to the plug.

The interface between the 6770 and the P8782 can now be tested. Patch the 1/4" phone plug end of the new cable into FROM TAPE on the 6770, plug the DB-25 interface connector into the 8700, and apply power to both units. Since the encoder clock on the P8782 is running constantly, it is not necessary to load a program for testing. On the 6770, set the SENSITIVITY control to minimum, the +5/+10 switch to +5, the INT.-/EXT. switch to EXT., and RUN/STOP to RUN. Now, advance the SENSITIVITY control and you should notice that the LEDs will begin to flash, which indicates the synchronizer is accepting the 8700's data bit as a clock signal. If the LEDs do not flash, the trouble could be in the patch cord, the encoder circuit, or the 6770. The encoder can be checked by loading and running the 8700's K-test program. If this program works correctly, then the encoder is probably functioning properly. If not, unplug the patch cord to the 6700 and try again. This will isolate the trouble to either the encoder or the cable. If the program runs with the cable disconnected, the trouble could be a miswired cable, or perhaps a problem at the input of the 6770 such as a miswired jack, improper solder connection, etc.

And now the rewards... Finally, everything can be patched together and tested as a system. With all the gear running in time and synchronized, you can easily create a multi-layered recording using only one track. (Incidentally, I often record that one track onto a cheapo portable tape recorder and save the tape for future inspiration.) You could also record Patchmod's sounds for an introduction or "fill" in a song to be recorded at a later date. But aside from recording, Patchmod is just plain fun -- and synchronizing a bunch of units together in a rhythmic fashion makes for a more complete sound when jamming or coming up with new ideas. ●

Practical Circuitry

continued from page 27

tor, can make for fascinating timbral changes. Also, for those of you who are into synchro-sonic recording techniques, adding a CMOS switch in parallel with C3, and feeding the switch control terminal with an appropriate trigger pulse, will reset the oscillator at the rate of the trigger. All in all, for those experimenters who don't quite need the sophistication or versatility of John Simonton's "Shepard Function Generator" presented in the February 1982 issue of Polyphony, the Quadrature Function Generator provides a low-cost way to experiment with voltage controlled panning, cross-fading, channel-splitting, and the like.)

NOTES

(1) For example, see J. Patchell, "Build a Voltage-Controlled Quadrature Oscillator", Polyphony, Nov/Dec 1980, pp. 26-27.

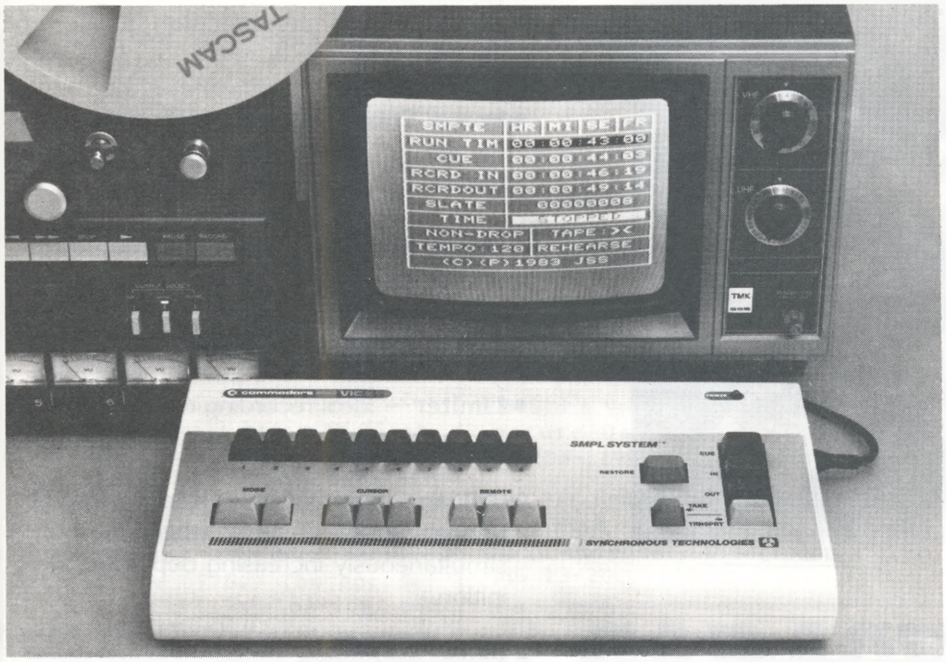
(2) T. Henry, "A Function Generator With 'Quadrature' Triangle Wave Outputs", Electronotes #122, pp. 13-20.

PARTS LIST, QUADRATURE FUNCTION GENERATOR

Resistors (1/4 Watt, 5% tolerance preferred)	
R1	470
R2,R3	1K
R4	10K
R5	12k
R6,R7	15K
R8,R9	27K
R10	33K
R11,R12	50K trim pot
R13-R20	100K
R21	100K potentiometer
R22	150K
Capacitors (15 or greater working Volts)	
C1	0.005 uF, mylar pre ferred
C2	0.01 uF, mylar preferred
C3	0.33 uF, mylar preferred
Semiconductors	
IC1	TL084 quad bi-fet op amp
IC2	1458 dual op amp
IC3	4001 CMOS quad NOR gate
Q1	MPF-102 N-channel FET
D1,D2	1N4148 or equivalent switching diode

CURRENT EVENTS

'Tell Them You Saw It In Polyphony'



Synchronous Technologies has introduced The SMPL system, the first low cost computer based automation system designed specifically for the smaller recording studio. The SMPL System provides in one package a SMPTE Time Code generator, SMPTE Time Code reader, Autolocator, automatic record In/Out insert editing system, Time Code derived metronome, 24 Tick/Beat Drum and synthesizer synchronizing system and recorder remote control.

Designed to be used with lower cost multi-channel cassette or open reel recorders, it simply plugs into the normal remote control jack. Neither tachometer output nor speed control input to the recorder are required.

During rehearsal, Punch In and Punch out points can be set on the fly and saved in the computer's memory to be repeated as many times as necessary before committing to tape. A programmable CUE point provides both looping type return to CUE function at the end of the insert and also provides a known, repeatable starting point for instrument synchronizing signals.

Many benefits result from the system being based on industry standard non-drop format SMPTE Time Code. Unlike simple tone or click-track based instrument synchronizing systems, the SMPL System need not be started from the beginning of the work in process in order for the metronome and synchronizing signals to be in correct time-phase with the music. The work can be started at any arbitrary position and the computer instantly calculates the correct phase of both metronome beat and synchronizing signal.

With the SMPL System, tapes produced in the small studio will transport to larger studios and be compatible with the automatic mix-down and sync-locking equipment found there. Tapes produced on machines with limited channels can be "pyramided" to 24 and 40 track studio machines, allowing the artist to work in his own environment at his own pace and still have access to expensive studio facilities.

Since much of today's commercial music involves electronic digital drums and sequencer controlled polyphonic synthesizers, the SMPTE track can replace numerous tracks which might otherwise be recorded as audio. Not only does this effectively increase the number of tracks available to the musician, it also allows these tracks, which are susceptible to the loss of fidelity which results from ping-ponging and conventional dubbing techniques, to be mixed first generation to the master tape.

SMPL uses the "user bits" in the Time Code to provide an indelible SLATE which becomes part of the control track and can be used as a cross reference for lead and track sheets, billing notes, etc.

The SMPL system lists for $995.00 and is available from major music and pro-audio retailers across the country or direct from Synchronous Technologies, P.O. Box 14467, Oklahoma City, OK 73113 (405) 842-0680.

More delays. RolandCorp US (1022 South La Cienega Blvd., Los Angeles, CA 90035) has introduced the SDE-3000 delay ($1,095 list), with 4.5 seconds of maximum delay and 8 user-programmable presets. The SDE-1000 ($499 list) gives 1.125 seconds of delay and 4 user-programmable presets.

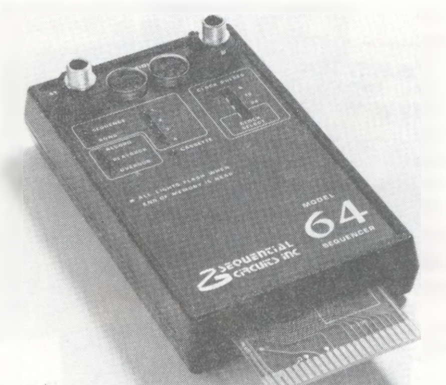
MXR (740 Driving Park Ave., Rochester, NY 14613) has announced the Model 1500 digital delay ($500 list) with 20 kHz bandwidth at its full 1.5 second delay, and 10:1 sweep ratio for wider-range flanging sounds.

ADA (2316 Fourth St., Berkeley, CA 94710) now makes the 2.56i Digital Delay ($799.95 list), which features delays from 0.3 ms to 2.56 seconds at 16 kHz bandwidth, 8:1 sweep range for wide flanging effects, and variable modulation waveform.

Buyer beware! Polyphony has been asked by Korg and Yamaha to advise our readers that some dealers are selling products made by these companies which are not intended for U.S. markets (i.e. incorrect line voltage settings etc.). To recognize legitimate models intended for the U.S. market, check for safety testing approval stickers common to this country (FCC, UL, etc.), and also check the intended line voltage. Any readers who are not sure of the authenticity of a piece of equipment can check with either company for assistance.

Commodore-64 music software. Waveform, Inc. (1912 Bonita Way, Berkeley, CA 94704; tel. 415/841-9866) has introduced MusiCalc 1, available on diskette for $74.95. This program turns the C-64 into a 3-voice synthesizer with fully interactive real-time sequencing, modulation, and transposition. Users can to play along with preprogrammed melodies or create and store their own melodies for later playback.

Sequential Circuits has finally announced their Commodore 64 Midi Sequencer cartridge ($195 list); this plugs into the C-64's memory expansion port and may be used with or without a monitor. Up to 4000 notes can be recorded, as well as velocity, pitch bend, and modulation information (if the synthesizer is so equipped). Digital recording capabilities simulate multi-track recording (overdubbing, duplication, editing, etc.). Sequences can also be transposed, chained, and synced to drum parts.



Drum Update. E-mu (2815 Chanticleer, Santa Cruz, CA 95062) has updated the Drumulator with a new PROM that increases the number of songs from 8 to 64, and also provides a "song write protect" feature to prevent accidental erasure of song steps. Also, five new sets of custom drum sound chips are available for the Drumulator from Digidrums (100 South Ellsworth, Ninth Floor, San Mateo, CA 94401). Each set lists for $250; choices include Electronic Drums #1 and Electronic Drums #2 (Simmons-like sounds), Latin Percussion (12 percussive sounds), African Percussion/Miscellaneous (12 more percussion sounds, all of which are real winners), and Rock Drums. The latter have a lot of ambience-plus-limiting-plus-noise-gating effect a la Led Zeppelin, Phil Collins, etc.

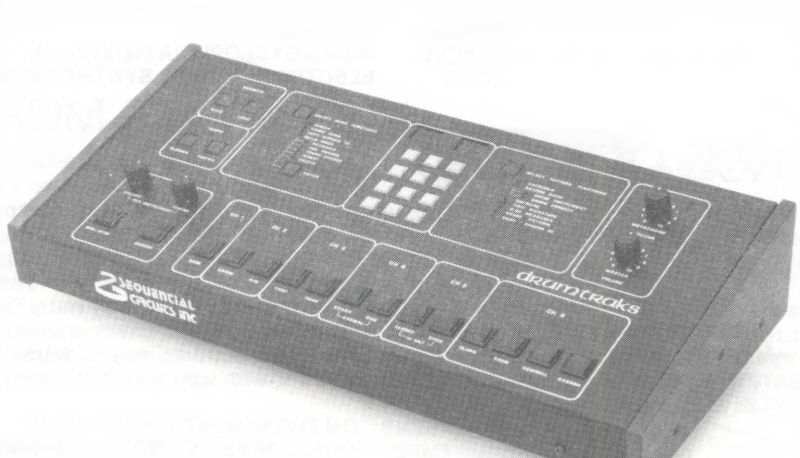
Oberheim Electronics (2250 S. Barrington Avenue, Los Angeles, CA 90064) has introduced an Update Expansion for their DMX digital drum machine. This hardware/software combination allows for over 45 new features including 5000+ event internal programming capacity, 200 sequence patterns, 100 songs, programmable tempo displayed in frames per beat, elapsed time indications for song and sequence, and selective cassette interface for loading single sequences or songs from tape. The update costs $150, including installation at an Oberheim Service Center. Oberheim has also added several new drum sounds to their drum card library, including congas, timbales, cowbell/clave, a complete set of electronic drums, and sound effects. Most voice cards retail for $100.

MXR has introduced a library of optional sounds for their digital Drum Computer. The Drum Library includes four packages of unique drum sounds that replace existing ICs in the Drum Computer: Roto (Roto 1, 2, and 3), Conga (Conga 1 and 2), Percussion I (Bell 1, Bell 2, and Clave), Percussion II (Cabassa, Guiro, and a sharp-attack Kick). MXR is also working on remote footswitch options, external drum programming pads, and trigger output options. New features have also been added to stock drum machines, namely a "Next Song" feature and new handclap sounds. New sounds for the open hi-hat and snare will follow soon.

Also new from MXR is the "Junior" portable sound box, designed to provide popular drum/-percussion sounds, as well as special effects. The first "Junior" features four voices: laser blast, hand claps, shaker, and drum. A switch selects between the voices, while separate controls adjust output level and tempo. The Junior may be triggered by an internal clock or external trigger.

Sequential Circuits has announced Drumtraks, a programmable drum machine that retails for $1295 and includes a MIDI interface. Features include: programmable level and tuning for each of the 13 digitally recorded drum and cymbal sounds; 3300 note memory; 24, 48, or 96 pulses-per-quarter-note clock input; and sync-to-tape.

Keyboard recorder. Sequential Circuits has also introduced the Six-Trak, a combination 6 voice polyphonic synthesizer and sequencer. The latter includes auto correct, programmable track level changes, track duplication, and over 800 note storage capacity. You can stack several voices on one note, or record into the sequencer one voice at a time. Recording less than all six voices leaves other voices free for real-time playing. Six-track also includes a MIDI interface and retails for $1095.



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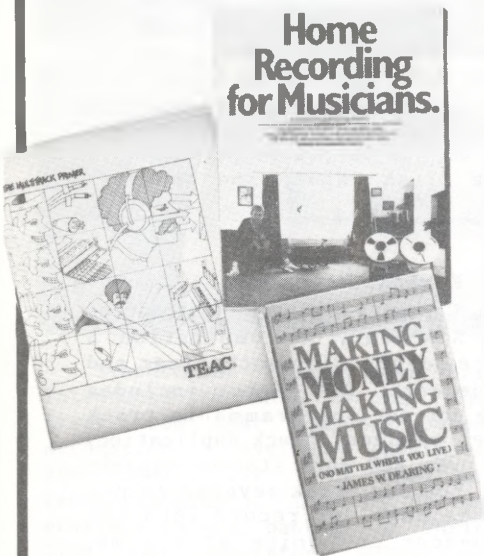

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Often used reference materials to answer the many questions encountered in everyday synthesis. **THE SOURCE** Book of Patching and Programming from Polyphony has over 125 pages of patches in universal flow chart notation; the largest publication of its type.

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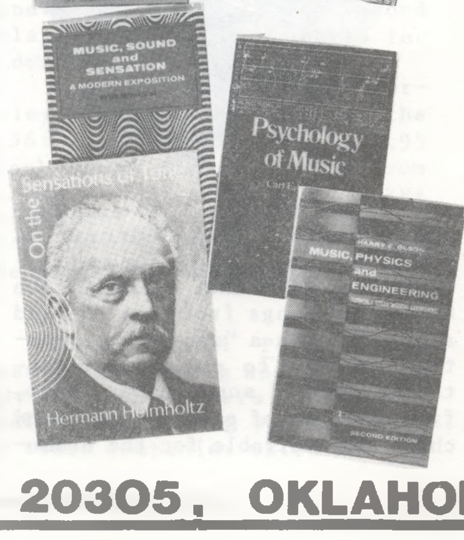

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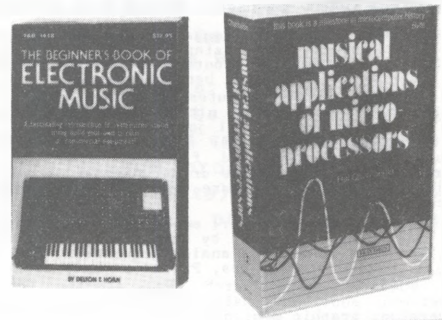

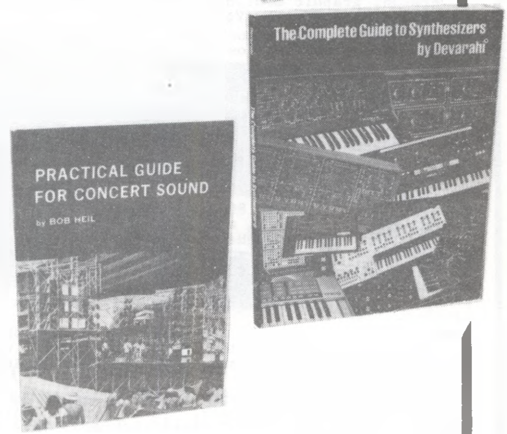

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ELECTRONICS

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- #0301: 7/77: frequency divider project, random tone generator project, normalizing synthesizer controls, eliminating patch cords, computer control of analog modules, Chord Egg modification, adding pitch bending, patches.
- #0303: 2/78: computer controled Gnome, using joysticks, build a bionic trumpet, ultra-VCO modifications, voltage control the Mu-Tron Bi-Phase, oral joystick, patches.
- #0304: April/May 78: Minimoog modifications, non-keyboard module use, phasing and flanging (theory and circuits), memory expansion for programmable drums, digitally addressed transposer project, polyphonic software (with software transient generators), patches, Volume 3 index.
- #0402: Sept/Oct 78: electronic music notation, notes on the recording of "Cords" by Larry Fast, sequencer software - part one, rhythmic control of analog sequencers, touch switch projects, modular vocoder techniques, PET as a music controller, patches.
- #0404: January/March 79: add-ons for vocal F and V converter, shorthand patch notation, more on note to frequency conversion, graphic monitor project, George Russell, super VCA circuit, echo software, Vol. 4 index.
- #0502: July/August 79: hex VCA/mixer project, electronic music schools and studios, modify the Oberheim Expander Module, profile of Ernest Garthwaite, budget microphones, digitizer projects and software, bar graph ICs.
- #0505: January/February 80: Joseph Byrd, Mort Garson, Larry Fast on 'Games', composing for 'live plus tape', using the CA3280, recording vocals, ADSR circuits.
- #0506: March/April 80: Computers in Music: real time audio processing hardware, Powell sequencer system, Max Mathews, advanced STG software, PortaStudio, phase modulation, Volume 5 index.
- #0601: May/June 80: Gary Numan, Microcomputers in Real Time Audio, Build a Digital Audio Delay Line, writing Documentation, Richard Hayman Composer/Performer Home Recording: Applying Harmonizing and Pitch Transposing Techniques by: Craig Anderton.
- #0602: July/August 80: Peter Gabriel, digital VCO project, Dream modules, optimum level settings, dynamic phrasing, patches.
- #0603: Sept/Oct combined with Nov/Dec 80: alternate controllers, add voices to Casio M-10, voltage controlled quadrature oscillator project, cordless patch bay, recording rules, patches.
- #0604: January/February 81: Special Construction Edition; Build: Audio Circuit Breaker, Pulse Width Multiplier, Magnetic Harp, 50 Watt/Channel Stereo Power Amp, Quad Sequential Switch, DOD Mods, patches.
- #0605: March/April 81: Portable Music Issue, reviews of Remco's FX, E-H Mini-synthesizer, Casio's VL-Tone, plus mods for the M-10, GR-500, mini-amp, and the Korg X-911. Introducing; Practical Circuitry and On Location, new columns.
- #0606: May/June 81: Synthesizer: Hardware Mods and Software. Modular Synthesizer Effects. Environmental music. Keyboard assignment for the 8700, new columns; Details, Practical Circuitry, and On Location. Volume 6 index.
- #0701: July/August: Guitar Electronics: Modify; Fender Amp, MXR Phase 100, GR-500. Input/Output Structures, $5 Analog Programmer, Sample and Hold technique, Modular Synthesizer Effects, new column: Applied Synthesis, Marketing Your Records.
- #0702: Sept./Oct.'81: Harald Bode Interview, Live Plus Tape New Technique, Xenharmonics, Kraftwerk Live - Review, Psycho-Acoustic Experiments, Practical Circuitry - Super Controller, Applied synthesis - Brass, Construction Tips For Beginners.
- #0703: Nov./Dec.'81: Dave Rossum interview, Applied Synthesis: Strings,Details: Series-parallel/Sum-Difference. The Sound Gizmo and Pro-One Reviews, Practical Circuitrv: VCO Deluxe.
- #0704 Jan./Feb.'82: Bob Moog interview, Chip Power - STK-050/070, Simple Square Wave Shaper, Tape Timer Ruler, Practical Circuitry: VCAs made simple, Details: Gozinda & Gozouta Revisited, Korg Trident & Casiotone 202 Reviews.
- #0705 Mar./Apr.'82: Electronic Music Math, Analog Delay Clock / Modulation; Frequency Domain Modifiers; Screen-Wave for the TRS-80; Touch Switches Revisited; Practical Circuitry: ADSR the Easy Way; Getting the most out of a Cheapo (Guitar).
- #0706 May/August '82: Anatomy of a Private record, Don Slepian Interview, Understanding Digital Synthesizers: A Digital Filter, Syn-Bow Review, Optical Audio, Profiles of SSM 2033 & 2044, The PAL Filter, Bill Rhodes Applied synthesis: Bells, Pipe Organ, Harpsichord, Electronic piano; The Realistic MG-1 Reviewed.
- #0801 Sept/Oct.'82: Ambience in Electronic Music,Tone Bypass for Fender Amps, 8 Track Reviews, Parametric EQ Tips, Solo/Cut Circuit for TASCAM Model 3, The SSM 2011, Tube Preamp, Snare + Drum Voice Circuit, Triple Pick-up Switcher, Simulated Stereo, When Quality Reocrd Mfg. Counts, Independent Record Mfg. Convention report.
- #0802 February '83: AMS-100 Gate Output, Bus Distribution Modules for Modular Synthesizers, Dynamic Touch Controller, Expanding Envelopes, MXR Limiter Review, New Age Music, An Overview, Synsonics Drum Review, Interface, Practical Circuitry: A Patch Over Scheme for Small Synthesizers, Lab Notes: Shepard Functions.
- #0803 April '83: Sound Interface Device, Build a Bass Pedal System, Dr. Rhythm Mod., Switched Capacitance/Transversal Filters, Voltage Controlled LFO, Rockman & Voyetra Eight Reviews.
- #0804 June '83: MIDI Hardware Fundamentals, What MIDI Means for Musicians, The Vangelis Interview, Creative Recording on a Shoestring Budget, A One Chip ADSR, An Electronic Switch.
- #0805 August '83; Donald Buchla Interview, An Overview of Digital Drums, Exploring Just Intonation, Build a simple Drum Synthesizer, Micro-Drums part I, The Penultimate Compressor, Why Spring Reverb Will Never Die, Gate/Sample & Hold Circuit.
- #0806 October '83 Larry Fast Interview, Basic Film Scoring Math, Foxtex X-15 Review, Build the Hip Bass Drum, Applied Synthesis: Orchestral Voicings Using the Tenth Interval.
- #0901: December '83 John Foxx Interview, Build: a Dual Trigger Delay; Center Channel Reverb. Drum Machine Modifications - PAIA, E-Mu, Roland; Polyphonic Keyboard Reviews, White noise.

CASIO M-10 OWNERS.......

Did you realize that your pride and joy has unseen powers? That there are voices and effects that you can add for the cost of a switch and a piece of wire? This latest booklet from POLYPHONY gives you the info that you need to transform your mini-axe and gives details on adding a "stunt box", computer interfacing and much,,much more.

No. CMOD 16 pages $3.50

SSM 2011 CHIPS

As a special service to readers interested in evaluating this exciting new chip, for a limited time POLYMART offers the SSM 2011 Microphone Preamp/Level Detector IC.
No. 2011 .....$5.75 each plus postage ($1.00)

RACK PANEL SPECIAL!

Easily machined 1/8 inch unfinished aluminum rack panels as low as $3.95 each in quantities of 3 or more. (you may mix sizes for discount prices)

	Quantity 1	3 or more
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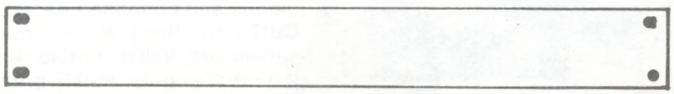

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We cannot invoice; payment must be enclosed with your order. there is a flat $.50 handling fee per order plus postage costs. MasterCharge and Visa are welcome. ($10.00 minimum charge). Foreign orders **must** be paid by certified check or money order in U.S. $ drawn on a U.S. bank (or by charge card). Phone orders welcomed for charge card orders.

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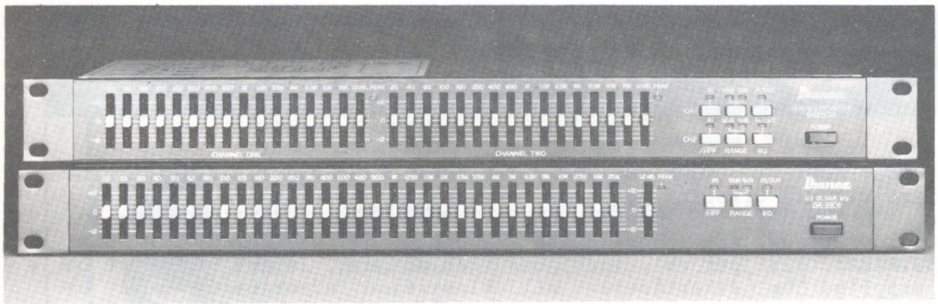
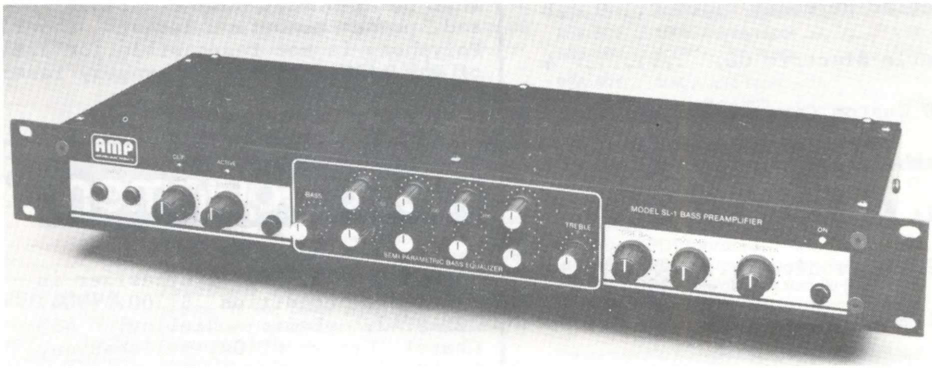


Modular signal processor kits. RODCAR Electronic Sales (9983 Monroe, Dallas, TX 75220) has released a very interesting set of products: signal processing module kits that plug into a motherboard and can form the basis of a custom processing system. Kits (board/parts) include motherboard ($29.95), parametric stage ($24.95), lo-z mic preamp ($24.95), "brilliance" controller to regenerate high frequencies lost through processing ($19.95), summing card ($12.95), and several others (limiter, noise reduction, etc.). A catalog is available from the above address.

Graphic stuff. Ibanez (1716 Winchester Rd., Bensalem, PA 19020) has introduced the GE1502 dual 2/3 octave and GE3101 1/3 octave graphic EQs. Each model retails for $325.



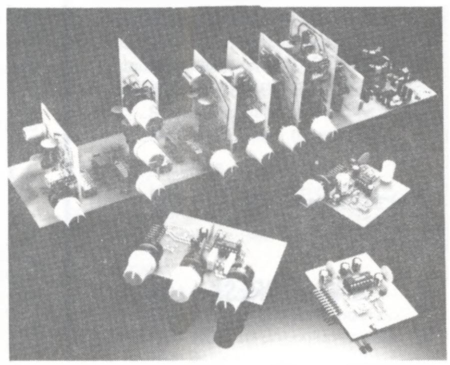
Bassically. AMP (9829 Independence Ave., Chatsworth, CA 91311) has announced the SL-1 bass preamp with integral limiter, bass/treble EQ, four-band semi-parametric equalizer, balanced connectors, and other features suitable for both studio and stage use.

New Korg stuff. The Poly 800 ($795 retail) stores 64 programs, includes six-stage envelope generators and stereo chorus, allows for "layering" (two sounds per note), has a MIDI port, sequencer, and joystick modulation control. The instrument weighs 13 lb. (good for strapping around your neck) and can be AC or battery powered.

The PSS 50 Programmable "Super Section" is basically a preset rhythm machine (with digitally recorded drum and high-hat sounds) plus a chord sequencer with pre-programmed bass lines and various instrument accompaniment patterns. It's designed for practice, live performance, and songwriting.

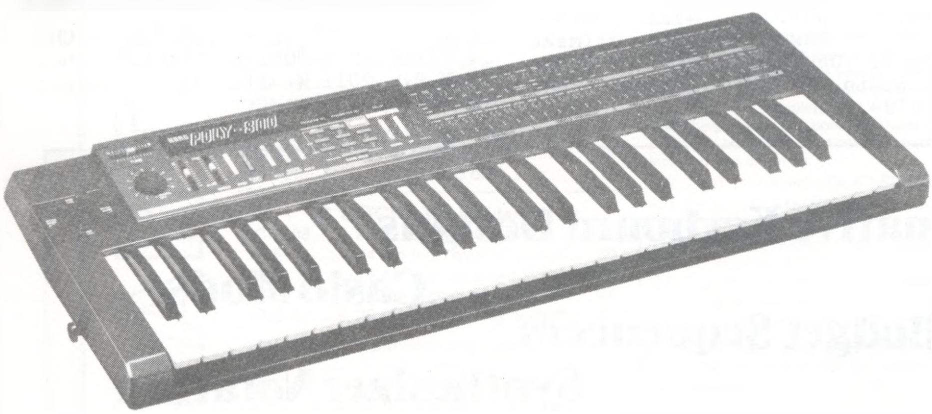
Finally, Analog Delay, Noise Gate, and Phaser modules are now available for the PME-40X effects system.

Kurzweil update. Kurzweil (411 Waverly Oaks Road, Waltham, MA 02154), whose prototype K-250 digital keyboard caused quite a stir at last June's NAMM show, have finalized their production model. Features include 26 resident instrument voices, multi-track performance sequencer, and the ability to store 100 keyboard setups (including splits, doubles, and transpositions). Planned options include ROMs for extra voices, a digitizer for sound sampling, and disk drive for additional storage. Customer deliveries are scheduled for the 2nd quarter of 1984.



CURRENT EVENTS

"Tell Them You Saw It In Polyphony"



AD INDEX

MOVING?

When writing to change the address on your POLYPHONY subscription it is important that you enclose the mailing label. Our computer cannot locate your name on the subscription list without it.

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PUT POLYPHONY TO WORK FOR YOU. Equipment Exchange classified rates for individuals offering goods or services for sale or trade: 25c per word, 20 word ($5.00) minimum charge. Commercial establishments: 50c per word. Prices, zip, phone numbers count as one word each. DISPLAY CLASSIFIED: $15 per col. inch, one inch minumum, camera ready art to be supplied by advertiser. all classified advertising must be prepaid. advertisers using a Post Office Box number for responses must furnish Polyphony Publishing co. with a complete street address and phone number. Readers should respond directly to advertiser. Polyphony is not responsible for claims made in ads, or for the reslts of any transactions. Polyphony reserves the right to edit or refuse any ads submitted.

Music equipment

FOR SALE: ARP 2600 Synthesizer in excellent condition $1300. (904) 222-9242, David Bieling, 415 Chapel Drive #B104, Tallahassee, FL 32304.

Oberheim FVS-4 Polyphonic Module synth. with programmer patches and schematic in excellent condition. $2,250 or best offer. Call or write: Dan D'Angio, 3128 Lanvale Place, Philadelphia, PA 19145, (215) 334-5980

PS-3010 remote poly-keyboard for use with Korg PS-3100, 3200, 3300 synthesizers. with 20 ft. 60 pin connector cable and junction box VGC 300.00 or trade (314) 429-2858.

E-MU EMULATOR 8 voice keyboard. With additional software; user multi-sample, sequence sync, analog interface. Excellent condition (619) 566-3850 or 486-4734 $5,500.

All in perfect condition: PAIA 8782 Encoded Keyboard $85.00, Phlanger $35.00, 4711 Mixer $20.00, EKx modules, (make offers). Doug Chandler, P.O.Box 413, Badin, NC 28009. Phone: (704) 983-4194.

FOR SALE: Korg X-911 Guitar synthesizer, $600 list; Also MS-04 Modulation Pedal list $220.00 will sell both for $275.00 or trade for digital delay unit, Ben Kettlewell, P.O. Box 1205, Provincetown, MA 02657.

Recordings

COMPOSER-X the latest cassette release by Walt Whitney. "a well conceived, excellently produced package of electronic music with strong melodic qualities." Send $5.50 ppd. to Walt Whitney, P.O. Box 2411, Overland, MO 63114

INCIDENTS OUT OF CONTEXT and PRIME NUMBERS: 2 LPs of Original music in just intonation composed and performed by David Doty and Friends. INCIDENTS features Polysynths with acoustic and electro-acoustic instruments; PRIME NUMBERS is gamelan-style percussion. $6.98 each plus $1.00 postage and handling, from OTHER MUSIC, 535 Stevenson St., San Francisco, CA 94103 (CA residents add sales tax)

equipment

CABLE - SATELITE - MICROWAVE - UHF - VIDEO ACCESSORIES. S.A.S.E. 40c. H.M.S. 2011 W. 11th St., Upland,, CA 91786.

NEXT

Alternative Keyboard Designs

Casio Mods

Low Budget Sequencers

Synthesizer Notation

PARTS and KITS from: PGS

LINEARS

TL061.........BiFet .... .72
TL062.........Dual BiFet .... .99
TL064.........Quad BiFet 1.95
TL071.........BiFet .... .65
TL072.........Dual BiFet 1.15
TL074.........Quad BiFet 1.95
NE555.........Timer .... .39
NE570.........Compander 3.80
NE571.........Compander 2.95
NE572.........Compander 4.95
UA741.........Comp. OpAmp .... .29
MC1456.....Low Noise OpAmp .... .90
RC1556......Low Noise OpAmp 1.48
CA3080......OTA .... .94
CA3280......Dual OTA 1.98
RC4136......Quad OpAmp 1.10
RC4739......Dual Low Noise 1.19
NE5532......Dual High Perf 3.70
NE5534......High Performance 2.65

SPECIAL PURPOSE

SAD-1024......Analog Delay 17.50
SAD-4096......Analog Delay 37.50
MK50240.......Top Octave Div. 5.95
SN76477........Sound Generator 3.45

SANYO HYBRID POWER AMPS

STK050......50 Watt Power Amp 19.40
STK070......70 Watt Power Amp 24.20

SSM- SOLID STATE MICRO-TECHNOLOGY

SSM 2010......VCA 7.50
SSM 2011......PreAmp 5.75
SSM 2012......VCA 9.50
SSM 2020......VCA 7.50
SSM 2022......VCA 7.50
SSM 2030......VCO 7.50
SSM 2033......VCO 10.00
SSM 2040......VCF 7.50
SSM 2044......VCF 7.50
SSM 2050......VCTG 7.50
SSM 2056......VCTG 5.75

THERMISTER (Temp. Sensing Resistor)

TSR-Q81....Tel Labs Q81 1k $3.50

OPTO-ISOLATOR

CLM6000....Clairex CLM6000 .... $2.85

CAPACITORS (25 volt)

701-100....... 100 pf polystyrene .... .25
701-180....... 180 pf polystyrene .... .25
701-1000..... 1000 pf polystyrene .... .25
701-2200..... 2200 pf polystyrene .... .25
701-2200..... 3300 pf polystyrene .... .25
701-3900..... 3900 pf polystyrene .... .25

702-005....... .005 uf mylar .... .12
702-01......... .01 uf mylar .... .12
702-05......... .05 uf mylar .... .16
702-1.......... .1 uf mylar .... .21
702-22......... .22 uf mylar .... .33

703-1.0........ 1.0 uf tantalum .... .39
703-3.3........ 3.3 uf tantalum .... .49
703-4.7........ 4.7 uf tantalum .... .59

704-2.2........ 2.2 uf electrolytic .... .21
704-4.7........ 4.7 uf electrolytic .... .21
704-10......... 10 uf electrolytic .... .21
704-100....... 100 uf electrolytic .... .31

705-10......... 10 pf ceramic disk .... .15
705-.01........ .01 uf ceramic disk .... .12
705-.1.......... .1 uf ceramic disk .... .17

IC SOCKETS (soldertail)

IC-S-08....... 8 pin high quality socket .... .27
IC-S-14....... 14 pin high quality socket .... .30
IC-S-16....... 16 pin high quality socket .... .34
IC-S-18....... 18 pin high quality socket .... .40
IC-S-28....... 28 pin hgih quality socket .... .60

IC-C-08....... 8 pin economy socket .... .13
IC-C-14....... 14 pin economy socket .... .15
IC-C-16....... 16 pin economy socket .... .17
IC-C-18....... 18 pin economy socket .... .20
IC-C-28....... 28 pin economy socket .... .40

RESISTORS 5%, 1/4 watt

All EIA values available from 2.0 ohm to 5.1 Meg. Also availble is 10 Meg.

100 each of same value $1.50
50 each of same value .... .98
25 each of same value .... .75
10 each of same value .... .40
5 each of same value .... .25

ASSORTMENTS

10 each of 10 values (100) 3.00
25 each of 10 values (250) 6.50
50 each of 20 values (1000) 16.00

CHORUS/DELAY KIT

This chorus/delay unit, designed by Craig Anderton and featured in Guitar Player magazine, provides flanging, slapback echo, and automatic double tracking effects. The delay range is from 2 ms to 80 ms. Due to the use of compression and expansion techniques, the unit has dead-quiet operation up to about 50 ms and only minimal noise out the full 80 ms. This project kit consists of all electronics, pots, jacks, etc. Also included are the two circuit boards (etched, drilled, and legended) needed for the project. Not included is wire, solder, case, knobs, etc. The Chorus/Delay unit also needs a well regulated bi-polar 15 volt power supply (not included). (A punched and legended rack mount panel will soon be available for this project.)

Order KT-CD777 .... $78.00

"SNARE +" DRUM VOICE KIT

This percussion synthesizer was designed by Thomas Henry and appeared in POLYPHONY magazine. Here's what Craig Anderton had to say about the "SNARE +". "At last - an inexpensive drum voice that has a punchy, full sound. .....All in all, the Snare + delivers a lot of drum sounds, and I would unhesitatingly recommend it to anybody who's tired of the thin sound found in most electronic drum units."

We offer the kit with or without a panel. Kit 3770 contains all electronic parts, switches, jacks, pots, etc, as well well as etched, drilled, and legended circuit board. Kit 3772 includes all this plus a punched and legended rack mount panel (standard 1 3/4 by 19 inches) available in black or blue (both with white legends).

Not included with either kit is wire, solder, mounting hardware, etc. The SNARE + also needs a bi-polar 15 volt power supply (not supplied).

KIT 3770 Basic SNARE + kit $33.95
KIT 3772 SNARE + with rack panel $44.94

THE "CLARIFIER" GUITAR EQ/PREAMP

The "CLARIFIER" is an onboard preamp/EQ module for guitar. This design, by Craig Anderton, was first seen in the pages of GUITAR PLAYER magazine. Here's what the CLARIFIER will do: Replace the guitar's standard passive tone control with a two control, active circuit which provides over 12 db of bass and treble boost and up to 6 db cut.... Buffer your pickups from external loading, giving additional output and improve high freq response.... Add a nominal 6 db of gain to give your signal a bit more punch, as well as improve the signal/noise ratio in multiple effects systems... make your guitar immune to the high freq loss caused by long cable runs.

The CLARIFIER kit is available in two options, both of which include a high quality drilled, legended, and masked circuit board, as well as complete step by step instructions. Kit 2450 contains everything needed for a complete unit.. Kit 2455 contains everything execpt the pots (for those who prefer a particluar brand of potentiometer). Batteries are not included with either kit.

KIT 2450....Complete CLARIFIER kit . $18.95
KIT 2455.....CLARIFIER less controls ..$14.95

TERMS: (Check, Money Order, Cashiers Check - Add .75 if under $10.00)— ($10.00 minimum on C.O.D. (UPS only) add $1.50)— (Mastercard and Visa: $10.00 minimum. You must supply exp. date.)— (Indiana residents add sales tax.)

SHIPPING AND HANDLING: $1.00 plus 5% of purchase. We will credit any amount over our standard rate.

SATISFACTION GUARANTEED!

SIGNAL DIODE

601-60...1N914 (1N4148) signal diode . 5/.35

TRANSISTORS

2N3904.....2N3904 NPN Transistor .... .25
2N3906.....2N2906 PNP Transistor .... .25

POTENTIOMETERS

(3/8 long shaft, 5/16 mounting hole)

854-401......10K Linear taper 1.09
854-501......100K Linear taper 1.09
854-505......500K Linear taper 1.09

855-401......10K Audio taper 1.09
855-501......100K Audio taper 1.09
855-505......500K Audio taper 1.09

856-401......10K Audio taper with on/off switch 1.25

TRIM POTS (vertical mount)

802-251.....250 ohm trimmer .... .40
802-103.....10K trimmer .... .40

MINI TOGGLE SWITCHES

403-20....SPDT (on/on) sub-mini (3A).... 1.20
403-40....DPDT (on/on) sub-mini (3A).... 1.50
405-10....SPST (on/off) bat handle (6A). 1.85

LED's

Please note that the typical DC forward current (I-fwd) of these LED's is less than those offered elsewhere making these LED's ideal for battery circuits or others where current consumption is a factor.

305-201.....Red T-1¾ jumbo diffused (20 ma.) .... .30
305-202.....Green T-1¾ jumbo diffused (30 ma) .... .40
305-203.....Dual T-1¾ jumbo diffused (50 ma) .... .90
305-204.....Tri T-1¾ jumbo diffused (20 ma) 1.50

Note: 305-204 is a three lead, tri-color (green, red, yellow) device. It is essentially two separate LED's in one package. (The yellow is obtained by turning on both green and yellow.)

JACKS and PLUGS

1/4 In. PHONE JACKS

901-101...Mono standard phone jack .... .45
901-103...Mono with n/closed contact .... .52
901-105...Mono encl. jack (open back) .... .55
902-211...Stereo standard phone jack .... .70
902-213...Stereo encl. jack (open back) .... .77

1/8 In. MINI JACKS

903-351...Mono with n/closed contact .... .32
903-353...Mono encl. (open back) .... .26
903-355...Mono enclosed with contact .... .35

RCA JACKS

921-100...RCA jack, chassis mount .... .34
921-200...RCA jack on phenolic mount .... .25
921-300...Dual RCA on phenolic mount .... .43

1/4 In. PHONE PLUGS

911-201...Mono, black phone plug .... .48
911-203...Mono, red phone plug .... .48
911-205...Mono, chrome (metal) plug 1.20
911-211...Stereo, black phone plug .... .65

1/8 In. MINI PLUGS

913-251...Mono, black mini plug .... .38
913-253...Mono, red mini plug .... .38
913-255...Mono, chrome (metal) plug .... .56

SWITCHING JACKS

These are stereo phone jacks that contain an independent switching sywtem that is controlled by the insertion of the plug. Jack 905-301 contains the equivalent of a DPST normally on switch. Jack 905-302 contains the equivent of a DPDT on/on switch making it ideal for switching bi-polar power supplies on and off in effects boxes, etc.

905-301...Stereo jack with SPST switch.. .90
905-302...Stereo jack with DPDT sw. 1.00

PGS ELECTRONICS
Route 25 - Box 304
Terre Haute, IN 47802

UNIVERSAL KEYBOARD CONTROLLERS

PAIA's new series V Keyboard controllers offer enough standard features like pitch and modulation wheels, smooth Pratt-Read action, small size and light weight to make you fall in love with them the first time you lay your hands on one. And there are options available to make these controllers compatible with practically any synthesis system from any manufacturer.

Begin by selecting 37 or 61 note actions. In either configuration the basic unit is a scanning matrix encoder that delivers parallel digital outputs — six bits indicating the key being examined and a strobe bit indicating the up/down status of that key. A jumper selectable eighth line serves a hand-shaking function with a computer if needed. The parallel data appears on a standard DB-25 connector on the rear of the case.

If you're going to be using the keyboard to control lv./Oct. exponential response equipment such as PAIA's EKx series of cards or systems manufactured by Roland, Serge, Synton and others, simply add the low-cost KDAC option. This option provides not only linear control voltage output, but also implements low note priority with retriggering and gives industry standard gate (high logic when any key is down) and trigger (short pulse when new key is presesed) outputs. The digital outputs are not disabled by this addition, in fact they are also expanded because you can now use the 8 digital data lines either as output from the keyboard to a computer or for driving the control voltage output from a computer — completely under software control.

To use the controller with linear response synthesizer modules such as PAIA 4700 or 2700 series equipment, also select the KEX option. This addition generates the exponential control voltage required by this series of equipment and still maintains the outputs outlined earlier. One keyboard can simultaneously control exponential and linear response equipment, and you still have the 8 bit bi-lateral computer port.

EXTRA VALUE

LOW COST

K37 37 note digital keyboard controller $188.00 (4.50)

K-61 61 note digital keyboard controller $289.00 (5.50)

KDAC Digital to Analog Converter Add-on $15.95

KEX Exponential Converter Add-on $15.95

47D SYNTHESIZER PACKAGES—MODULAR VERSATILITY AT LOWEST POSSIBLE PRICES

There is no better place to begin learning about electronic sound production than with a modular synthesizer. Seeing the physical connections between modules and being able to re-route signals by plugging the output of one into the input of another makes clear what functions individual processing and control elements perform in a very physical and obvious way. At the same time, modules are frequently the system of choice of the most advanced synthesists because the versatility of modules can never be matched by an "axe-in-a-box".

These 47D packages are a particularly nice place to start not only because of their low cost, but since they feature our new Series V Keyboard Controllers (see description above) they can serve as the foundation of a system which can grow to be as eclectic as you like with digital, linear or exponential equipment from many different manufacturers.

Modules included with the system are:2-4710 Voltage Controlled Amplifier/Balanced Modulators, 1-4720 Voltage Controlled Oscillator, 1-4730 Multi-Modal Voltage Controlled Filter, 1-4740 ADSR Transient Generator, 1-4750 Control Oscillator/Noise Source, 1-4712 Reverb Module, 1-4771 Power Supply. The modules are housed in a 4761 Wing Cabinet.

Available with either 37 or 61 note keyboard controller, the package prices represent about a 10% savings over separate component prices.

47D37 Synthesizer with 37 note controller $429.00 (9.00)
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