LED WALL ART......VISUAL ENVIRONMENT MACHINE

By: Craig Anderton

I love electronic toys. Blinky light boxes, random music generators, surf synthesizers, Chord Eggs ... these are the things that keep electronics continuously entertaining for me. One day a few months ago I got tired of doing semi-meaningful circuits, and decided to come up with a toy... this project is the result.

What does it do? Well, it's hard to describe something visual on paper, but I'll do my best.

Imagine a line of 8 LEDs, arranged as in figure 1. Now, imagine them firing sequentially so that first #0 lights, then #1, then #2, and so on until you hit #7, at which point the sequence repeats. Many light displays in stores and on theatre marquees use this type of sequential light toy to attract attention; these high wattage circuits require a klunky mechanical stepping relay. The way we implement our low power circuit is to drive each LED directly from the output of a 4028 CMOS 1-of-8 decoder, which when driven with a binary signal decodes that binary signal into an appropriate output. By driving the decoder with a binary counter, and driving the counter with a clock, we obtain a flashing sequence of 8 LEDs.

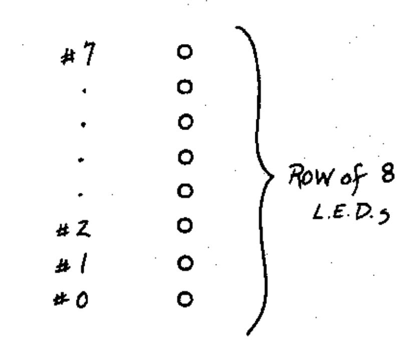

FIGURE 1

Now, imagine another line of 8 LEDs (along with the required counter/decoder circuitry) added next to the first in parallel, identical to the first line except that the LEDs move at half the speed. Then, add another line of 8 LEDs and have those move at half the speed of the second line. Get the picture? We now have this regular but continuously variable flashing sequence of lights, which sits there and looks kind of neat. But this is just the beginning. First of all, you don't have to mount the LEDs in straight lines; one good configuration is three concentric circles of LEDs, with the inside circle going fastest and the outside circle going slowest (this resembles those old 50's representations of atoms). Or, you can just spread the 24 total LEDs (driven by the 3 decoders) around randomly and let them flash in any old way ... or wire one line to go in the opposite direction of another line ... we could go on. Figure 2 shows the block diagram for all this stuff we've been talking about.

Now, let's go a little farther and make the clock voltage controlled, so we can play games with the flash or sequencing rate. For control voltage sources, we'll add a couple of options indicated on the block diagram: a triangle wave low frequency oscillator (LFO) and an audio signal interface. By setting the LFO for a very long period and injecting it into the clock control input, the rate of the flashing LEDs becomes continuously variable ... from so slow you can easily see each individual change, to so fast the LEDs blur into one continuous pattern. R-18 controls the top speed of the flash-

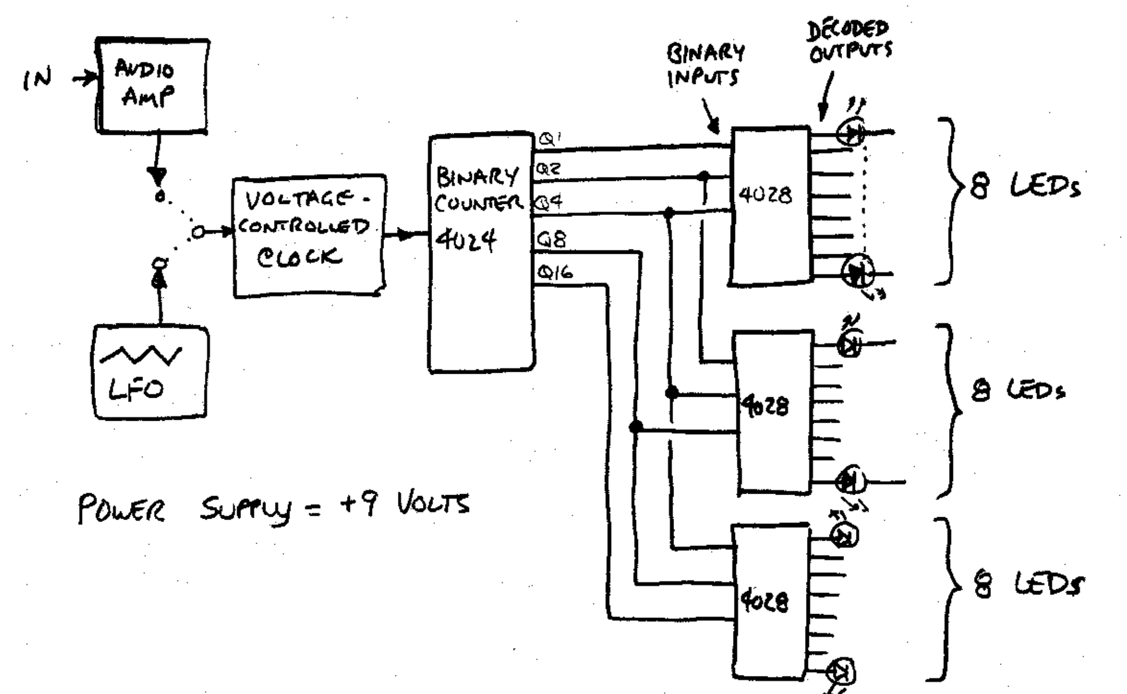

FIGURE 2: BLOCK DIAGRAM

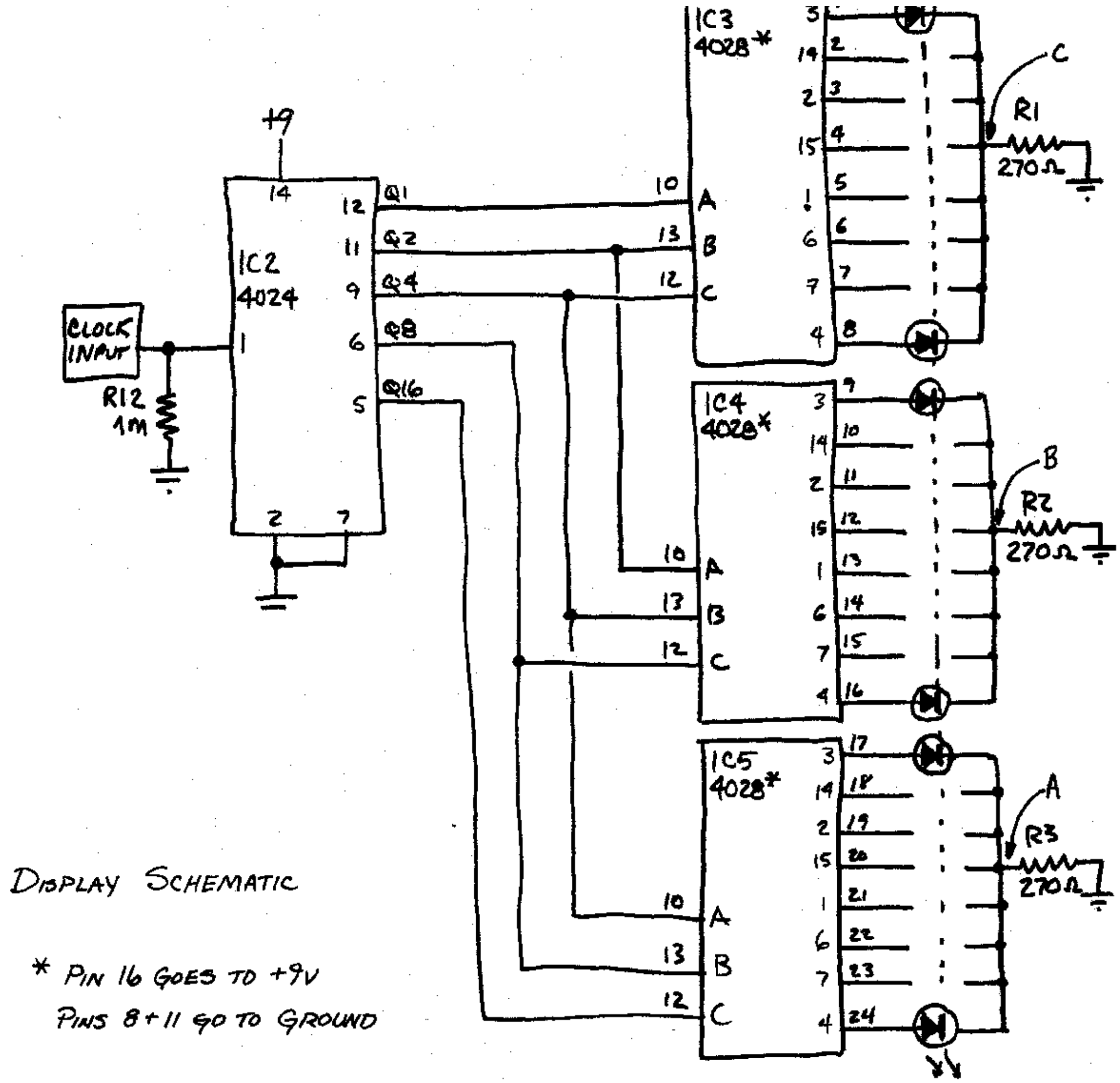

FIGURE 4

ing in this mode. If you want a pattern that changes with the time of day, you can parallel a photoresistor along with R-11. The brighter the light, the faster it goes.

There is yet another option, though, that offers many possibilities: the audio interface. It takes an audio signal and acts like a pseudo envelope follower, allowing audio signals to control the clock. With the parts values shown on the schematic, it is very sensitive. By connecting the amp out to the clock control input and connecting a microphone to amp in, the pattern will change speeds in accordance with the loudness of your voice. A guitar pickup can also drive the audio interface directly. As before, R-18 limits the top speed of the flashing.

This circuit is also useable with hi-fi and musical instrument speakers, and makes a different and interesting kind of color organ. For this application, you should probably add an attenuator at the input of the amp in as shown in figure 3.

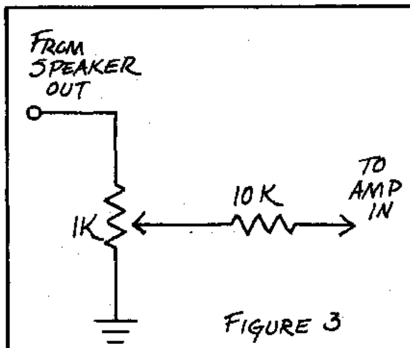

FIGURE 3

This will prevent strong signals from saturating the amp and causing the display to alternate between fast or slow, with no in between speeds. By turning the attenuator down so that peaks of the music give the fastest flash speed, you obtain the nicest effects. This attenuator and R-18 interact to a certain extent; but a little bit of practice, keeping the preceding in mind, will allow you to obtain a wide variety of display reactions to music and sound. Because of the extreme sensitivity of the amp, you can easily insert lossy, passive filters to give separate hi, lo, and mid range outputs to 3 separate LED wall art units, and still have enough drive for the audio interface. A tip: one of my favorite patterns is having three straight lines of LEDs arranged vertically, but with the thing equally bizarre.

DESIGN ANALYSIS

The heart of this design is a CMOS IC, the 4028, which is a one of eight decoder. When presented with a 3 bit binary input, the IC selects an appropriate output and makes it go high. For example, with binary 000 presented to the 3 control inputs (A, B, and C), the first output location goes high, with all others remaining low; with binary 001 the next output goes high, and so on until binary 111 makes the 7th location go high. The output of the IC is capable of driving LEDs directly, which helps keep down the component count. (See figure 4).

In this circuit, we use three 4028s, which means that we have decoded outputs for three sets of 8 LEDs, or a total of 24 LEDs. At any given moment, only one LED out of the set of 8 is illuminated; with the three sets, therefore, at any given moment we have 3 LEDs illuminated. This keeps the current consumption under 40 mA, which minimizes power supply requirements.

We get the binary inputs to these 1 of 8 decoders by using a clock to drive a 4024 binary counter and tapping from appropriate outputs of the 4024. Every time a clock pulse occurs, the binary number presented to IC-3 from IC-2's outputs increases by one; so, with every clock pulse, a different LED lights up at the output of IC-3. Now, we could drive all the 4028s with this same set of binary lines; but then all the LEDs would change at exactly the same rate. Since the 4024 has multiple outputs available, we can take advantage of that and tap off a different set of lines for IC-4. In this circuit IC-4 runs at half the speed of IC-3, so that a different LED lights up at IC-4's output for every two clock pulses. Similarly, we drive IC-5 at half the speed of IC-4, so it in turn requires 4 clock pulses to light up the next LED in the string of LEDs connected to IC-5's outputs.

In this basic form, our little circuit makes a pleasing piece of kinetic art. However, it's nice to add some variations to this basic theme; here is where we get into IC-1, the quad op-amp. Op amp A is a straight square wave oscillator that produces clock pulses, except that it is voltage controllable by putting a transistor in the current path that charges the timing capacitor. Thus, by changing the control voltage present at the base of the transistor, we can change the speed of the clock and hence the rate at which the various LEDs flash.... instead of

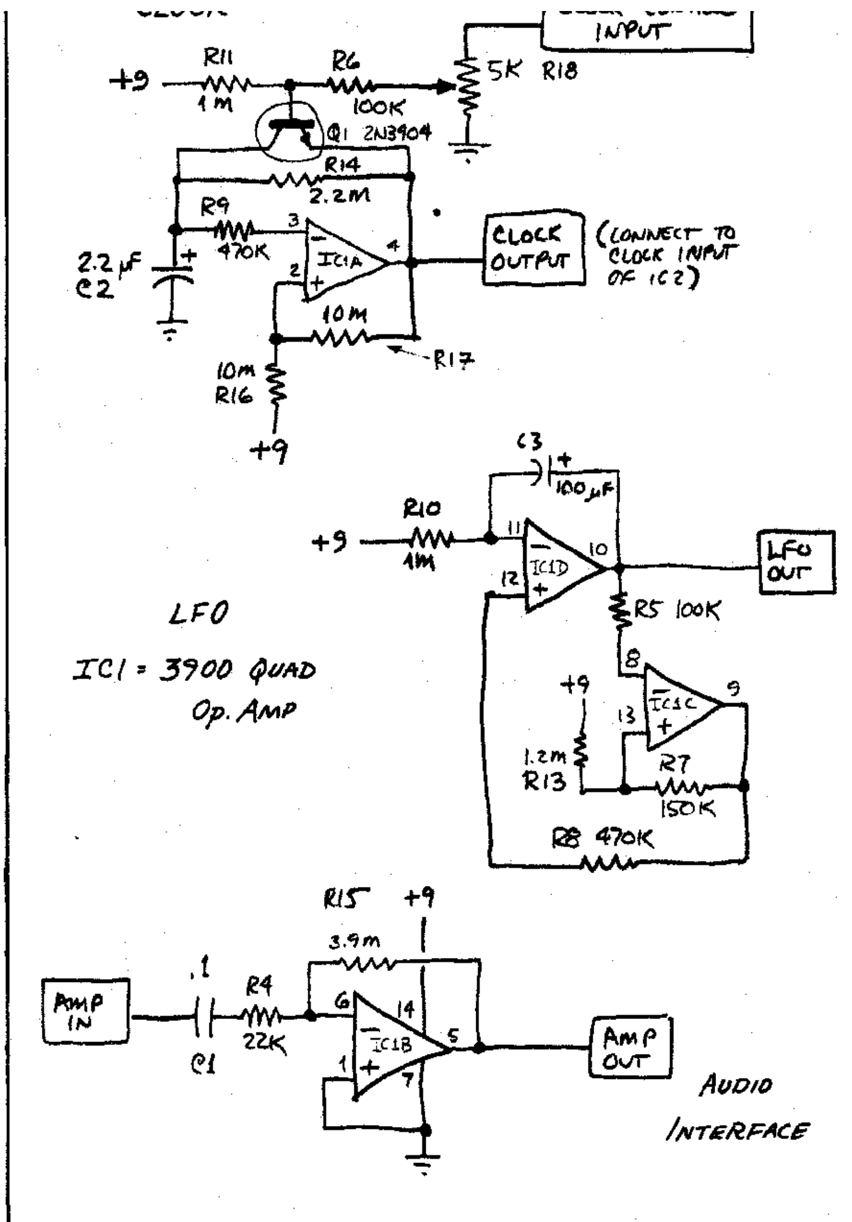

Fig. 5: Controller Schematics

PARTS LIST

R-1	270 ohm
R-2	270 ohm
R-3	270 ohm
R-4	22K
R-5	100K
R-6	100K
R-7	150K
R-8	470K
R-9	470K
R-10 ...	1 meg
R-11 ...	1 meg
R-12 ...	1 meg
R-13 ...	1.2 meg
R-14 ...	2.2 meg
R-15 ...	3.9 meg
R-16 ...	10 meg
R-17 ...	10 meg
R-18 ...	5K
C-1	.1 mf.
C-2	2.2 mf.
C-3	100 mf.
Q-1	2N3904
IC-1 ...	3900
IC-2 ...	4024
IC-3 ...	4028
IC-4 ...	4028
IC-5 ...	4028

24 Light Emitting Diodes

Printed Circuit Board available for this project ...No. BL-1... $6.95 ppd.
From: PAIA Electronics, Inc.
Box 14359, Oklahoma City, OK 73114

that make the overall effect more interesting. (See figure 5).

IC-1C and IC-1D form a low frequency waveform control oscillator, with a very long time period determined by timing capacitor C-3. When we connect "LFO out" to the "clock control input" of the voltage controlled clock, there is a slow, smooth variation of the clock speed from very slow to very fast in a periodic fashion.

R-18 sets the amplitude of the control input. Thus, the peak of the triangle can correspond to maximum speed of the display. Although R-18's setting is not highly critical, spend some time playing with it to discover your favorite setting.

Our final option takes advantage of the left over op amp in IC-1. We use op amp B as an amp with gobs of gain. By connecting "amp out" to the "clock control input", we can vary the speed of the LEDs by varying the audio signal presented to "amp in".

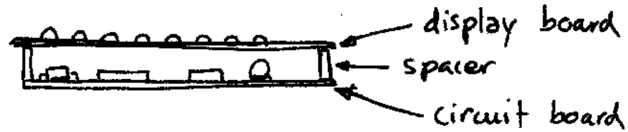

FIGURE 6: MOUNTING

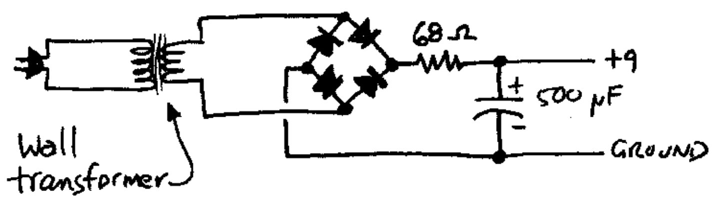

FIGURE 7: POWER SUPPLY

CONSTRUCTION NOTES

Most any method of construction is suitable, although either perf board or a printed circuit board makes for a neater project. To make things easier, a printed circuit board with parts placement designators is available. (See parts list)

First, mount and solder all components. Once that's done, it's time to join the board with a suitable display for the LEDs. One approach is to connect the board to a like-sized piece of perf board via angle brackets. This makes for easy construction and access to optional features; the completed unit also stands up nicely on a desk or table. Another possibility is a sandwich type of construction, with a piece of perf board holding the LEDs mounted directly above the board with spacers (see figure 6). This makes a compact arrangement for wall hanging applications. And of course, you can let yourself go and stick the LEDs into a wooden structure or piece of plexiglass, perhaps covered with a red theater gel or piece of red plastic to accent the redness of the LEDs.

The separate electronics / LED board setup gives maximum flexibility for choosing your display pattern, although it takes a bit of time to connect 24 wires to the anodes of 24 different LEDs. Be patient and you won't have any problems.

POWER SUPPLY... ... AND MODIFICATIONS

This project is designed to run from a 9v. power supply, although it can handle 12 volts too. Figure 7 shows a typical power supply: the transformer can be the wall type used for clocks, and the resistor serves as a voltage dropping resistor to get the voltage down to 9 volts. Depending upon your specific transformer, you may need to experiment with this a little.

When running from a 12 volt supply, you may need to adjust bias resistor R-11; I have found that 2.2 Meg seems just about right for 12 volt operation. If you want to get fancy, use a 5 or 10 M potentiometer for R-11. Set it by first disconnecting any voltage control inputs; start with the pot at maximum resistance, then slowly decrease until the speed of the LEDs just begins to pick up. Back off until the LEDs are going at the slowest speed possible --- that's the setting. You may also want to trim R-13 using the same procedure for operation at voltages other than 9v. I should emphasize that these adjustments are for the perfectionists in the crowd, and using the fixed resistors specified should give equivalent results for a relatively stable supply. These changes will only be required if the power supply is drastically unregulated or not 9 volts.

One final application before finishing up ... you can use the outputs of the 4028s to drive a saturated transistor and reed relay, which can control low voltage incandescent bulbs or trigger a more powerful relay. With this, you can have an interesting stage type display that generates far less RFI and garbage than dimmer based light games.

So, there you have enough info to start experimenting with your own wall art and LED games. Since you're dealing with something artistic, do a good job on the display; I favor LEDs mounted in plexiglass, myself. If you come up with any really exotic displays... how about sending a photo or description off to Polyphony?

Editor's note:

Light Emitting diodes are available in colors other than the standard red. Although not quite as common, green and yellow LEDs are available and would make for an interesting, mixed color display. The mixed color LEDs are packaged by Fairchild Technology Kits and are available from a number of mail order parts supply firms.

My personal suggestion for a display board is one made of foil faced poster board. This material is available from most artist's supply houses and comes faced with a choice of silver, gold, copper or bronze. It adds a very classy touch.

- Linda Kay Brumfield -

LETTERS!

...continued from page 4

issue of Polyphony. However, I thought I would run his letter to see if any of you were interested in his proposed "custom music printing" service. As he said, it would be mandatory that a universally accepted high level music language be established. After we read his article on existing music languages, perhaps we can pool all our ideas and arrive at a workable solution.

- Marvin Jones -