DRAWING BOARD

ROBERT GROSSBLATT

Making the 4089 do useful things

ONE OF THE NICEST THINGS ABOUT DEsigning logic circuits is that they're, well, so logical. All you need do is figure out what you want the circuit to do, work out a flow chart or block diagram of the unit, find the parts, and that's that.

Well, to be truthful about it, there's a bit more to it than that (as we all know), but the creative work can all be done on paper. Once the circuit has been breadboarded, there are always certain minor technical problems to be taken care of—like the unit doesn't work. But that's circuit *hacking*, not circuit *design*.

Anybody who's been following our discussion on rate multipliers and has breadboarded the circuit we worked out last time, should've found the 4089 to be really simple to use.

In our last discussion of rate multipliers, we left out part of the circuit—the display—because, as previously stated, you can use any counter arrangement that you're familiar with. All you need is a circuit that's able to count and display the number of digits you expect to see in your answer.

This month we'll add the display circuitry and also take a look at what must be done to make our circuit do useful things. We'll begin our discussion with the display circuit.

The display

Before we get into our discussion, here's a little advice that can save you plenty of trouble in the long run. One of the best habits to get into when designing is to keep a notebook containing schematics of often-used circuits. (The "Designer's Notebook" is a good example of the type of circuits you should keep handy.) Remember Grossblatt's 15th law: *Never trust your memory!*

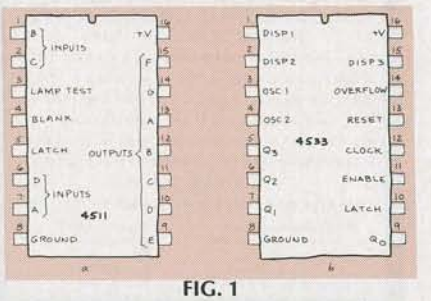


FIG. 1

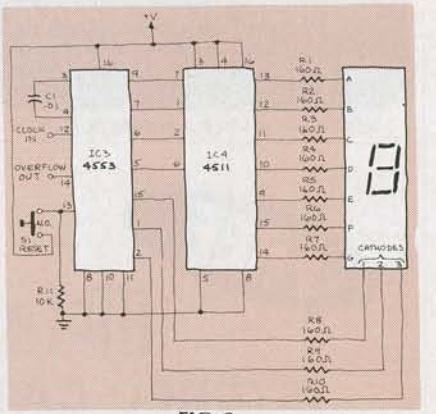


FIG. 2

A counter-display combination is used almost as often as a clock circuit and, therefore, is a natural addition to your files. With that out of the way, let's get to it!

In the example we used for the circuit last time around, we were multiplying 14 times 67. That means we'll need 3 digits (to display 938). Since we'll be counting three digits and using CMOS logic, the 4553 decade counter/multiplexer is a good choice. We will couple it to a standard 4511 decoder driver.

Figure 1 shows the pinouts for both those IC's. You should be familiar with the 4511 (Fig.1-a) since we used it to drive the displays in the keyboard encoder we designed about a year or so ago (February, March, and April, 1983). It's a "plain vanilla" decoder/driver for common-cathode displays.

The 4553 (Fig. 1-b) is a mainstream device that has all the circuitry needed to count up to 999 on board, as well as the multiplexing logic to directly handle three digits. The IC also contains three cascaded synchronous-counters whose outputs time-share pins 5, 6, 7, and 9.

The individual digits are turned on by using the three DISPLAY-ENABLE pins (1, 2, and 15). The RESET, LATCH-ENABLE, and CHIP-ENABLE pins are self explanatory (they're the same as similar controls found on other IC's). Pins 3 and 4 are the external-world connections for the timing capacitor used by the on-board, low-frequency multiplexing oscillator.

Although you may find the 4553 a bit on the expensive side—usually about three or four dollars by mail order—it's a good choice because takes the place of a whole handful of IC's. The savings in board complexity, power consumption, and bench time make it more than worth the extra cost.

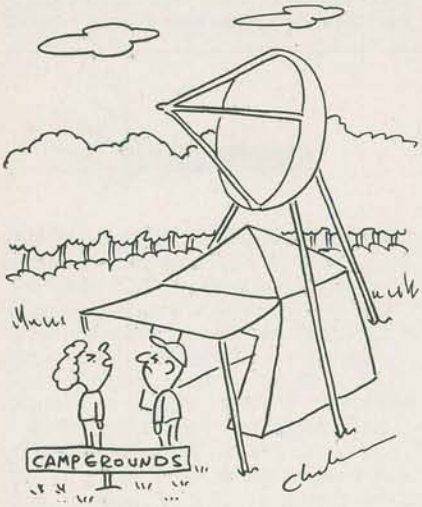
Figure 2 is the schematic for the display portion of the rate-multiplier demonstration circuit we started last month. Because the parts count is low, designing a printed circuit board for it is a snap. (You should be able to fit everything on a small, single-sided board.)

By coupling the circuit in Fig. 2 to the one we worked out last month, you'll have yourself a complete demonstrator for a rate multiplier. Admittedly, last month's circuit isn't the most useful circuit in the world, since it's hard-wired to multiply two particular numbers together. But we'll talk about how to make it a little more versatile in a little bit.

We've already seen how easy it is to do multiplication, but what about division? Well, believe it or not, adapting our circuit to do division is simple. But first, let's go through a quick run down on the theory behind doing multiplication. The rate multiplier takes an input clock and gives us two different kinds of outputs—the base rate and the multiplied rate.

The relation between the two is controlled by a 4-bit word (number) presented to the IC's data or weighted inputs. The multiplied rate will be equal to the product of the base rate and the binary word. As mentioned in previous discussions, doing multiplication is really just successive addition. We keep track of the base-rate pulses and count the multiplied-rate pulses.

When we continue, we will take a look at what steps we have to follow to get the device to perform division. **R-E**



"People will think we came here to watch television."