Experimenter's Corner

By Forrest M. Mims

A PROGRAMMABLE TIMER/COUNTER

A FEW years ago, Signetics overwhelmed us all with the introduction of the 555 timer. That chip, as you probably know, is one of the most versatile IC's around, and literally scores of applications for it have been published in POPULAR ELECTRONICS and other magazines.

More recently, Exar capitalized on the 555's popularity by pairing it with a binary counter and putting the whole thing in a 16-pin DIP. They called it the XR-2240 and it is a fully programmable timer/counter with all kinds of fascinating applications. I'm going to describe a few that I've come up with—you will probably think of many others.

With just a few external parts, you can connect the XR-2240 in a free-running mode as shown in Fig. 1. Use anything from 4 to 15 volts for the supply. Current drain is fairly low—about 10 mA for a 9-volt battery. The combination of R and C determines the oscillation period (T = RC) of the XR-2240's internal time base. The binary counter outputs (pins 1 through 8) increase T (or reduce the frequency, depending on how you look at it) by factors of 1, 2, 4, 8, 16, 32, 64, and 128. The result is eight quare waves with harmonically related frequencies from a single RC timing combination. Figure 2 is a scope photo showing six of the counter outputs from an XR-2240 in its free-running mode (R = 1.5 kilohms and C = 0.022 µF). Of course, this is impressive, but you haven't seen anything yet!

You can get some really interesting waveforms by connecting the binary counter outputs together. Some of the possible results are shown in Fig. 3. Exar calls the circuit configuration a binary pattern generator, but I call it a super-deluxe audio "chirper." Just connect a crystal or high-impedance magnetic earphone to the output to hear the chirps. By experimenting with the binary counter output interconnections and installing resistors of various values between some of the outputs, you will be able to obtain a variety of chirps, buzzes, warbles, and other strange sounds. For even more variations, change values of R and C.

If weird-sounding electronic music doesn't interest you, you can always use the pattern generator in more conventional applications. For example, it makes a nifty marker tone generator for a communications system (such as a long-range laser communicator). While a monotone audio oscillator would do the job, it's hard to miss a chirping marker or mistake it for a heterodyne.

Waveform Generator. Another possibility is to use the circuit as a complex waveform generator. I really mean complex, because the XR-2240 can generate all kinds of stepped waveforms. The photo in Fig. 4 shows part of a repetitive, stepped waveform generated by connecting several resistors of different values between the binary counter outputs and the circuit output.

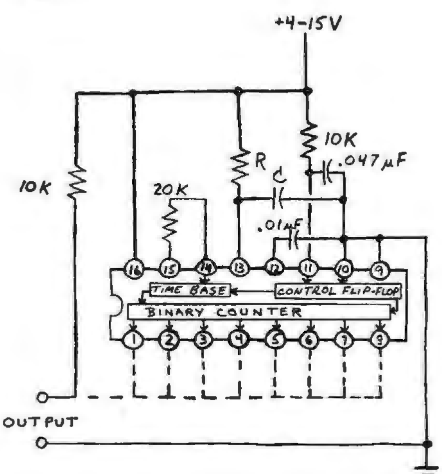

Fig. 1. Schematic of XR-2240 in free-running (astable) mode.

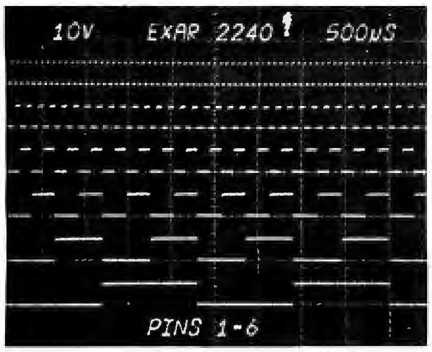

Fig. 2. Output on pins 1 to 6. Scope photos taken with C-59 camera on a Tektronix 7603 scope with 7M13 plug-in readout unit.

If you don't need far-out waveforms like the one in Fig. 4, you can generate more conventional staircases, For a staircase with 256 steps, connect a resistor with a value of about 1000 ohms from pin 8 to the output. Then connect resistors 2, 4, 8, 16, 32, 64, and 128 times that value from pins 7, 6, 5, 4, 3,

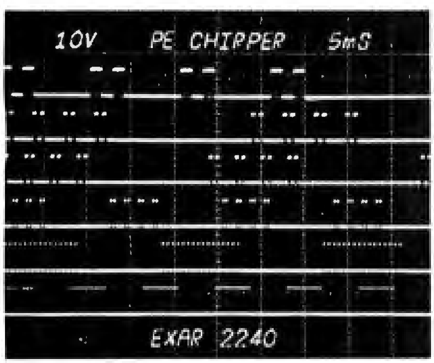

Fig. 3. Six different "chirp" (tone burst) outputs from XR-2240.

2, and 1 (respectively) to the output. You'll have to use precision resistors to get a uniformly spaced staircase. If some values are slightly off, the waveform will be somewhat distorted.

There are lots of other uses for the XR-2240 and they include analog-to-digital conversion, sample-and-hold,

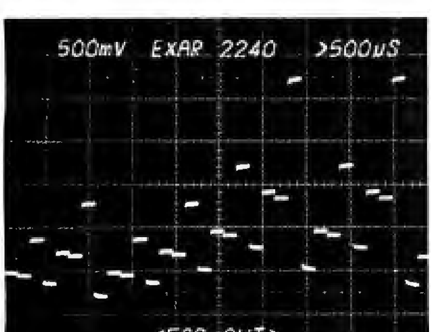

Fig. 4. Complex waveform obtained by connecting resistors to outputs.

harmonic synchronization, and ultra-long "timing" circuits (not true one-shots, but useful nonetheless). The timing properties of the chip are really impressive. For example, the values of R and C in Fig. 1 can be set to provide just one pulse every 10 or 15 minutes. Since pin 8 has a period of 128T, an RC combination which gives a period of 12 minutes would provide an output square wave with a period of 128 × 12 or 1536 minutes. That's more than a whole day. You can get longer delays by connecting more counter outputs to the output bus. The total time delay will equal the sum of the delays available at each counter output pin.

For truly incredible delays of up to 3 years (!), you can cascade two XR-2240's in series. The delays available from the combination can be used to remind you of birthdays and anniversaries, limit your offsprings' phone calls, and dream up assorted science fiction gadgets.

We'll take a closer look at some of the XR-2240 timing applications in a future column. Meanwhile, latch on to a couple of XR-2240's (see the ads in the back of this magazine), and warm up your soldering iron. ◈