

DRAWING BOARD

Let's explore the mysteries of video scrambling.

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I've been looking around for a source for prewired LED matrices to use in our home-made oscilloscope but, so far at least, I haven't had a whole lot of luck. A few places had them but they were fairly expensive and, to make matters even worse, there were minimum quantities and minimum orders. The problem is that the minimums for each order are usually more than you or I would normally spend on electronic parts over the next six months.

I can't believe that some supplier somewhere out there doesn't have a barrel or two full of those things hanging around. If anyone out there knows of a source for an LED matrix, please drop me a note and let me know about it so I can share it with everyone. I'll put it in the column and post the address as a message on the E-Mail section of the RE-BBS (516-293-2283), as well. (It's hard to get on the bulletin board because it's always in use, but a bit of perseverance will win out.)

I'm still waiting to hear from any of you out there who have done something terrific and ingenious with the scope we designed over the last few months. The contest is still on, and the prizes are still waiting for a few winners.

On a different subject entirely, I've been getting lots and lots of mail about video in general and scrambled video in particular. For some reason a lot of you really get enraged because some cable companies insist on scrambling certain premium channels. Before we go any further on this, let me tell you that I don't see anything wrong with it. Now, wait a minute—before you write me off as a stooge of the cable industry, let me finish.

The cable companies have every right to scramble whatever they

want, although the rumors that some companies are scrambling everything they transmit—including the standard VHF channels—is going much, much too far. Premium stations and the pay-per-view shows are okay to scramble. What's not okay are some of the regulations that a lot of the cable companies insist are their God-given right to impose on you.

To begin with, hitting you with an extra fee for putting in another outlet is ridiculous. Some years ago the phone company did the same thing—anyone who added an extension phone on his own was risking life imprisonment or, even worse, being regarded as a not-nice person in the eyes of Ma Bell. That all went out the window years ago, and I think it's only a matter of time before the same thing happens in the cable-TV business. And, as far as I am concerned, the sooner the better.

The most annoying part of the cable system is the whole business of sending me scrambled signals, *and then telling me I can't do anything with them!* As I said, if the cable companies don't want me to get a particular channel (because I'm not paying for it, or some other perfectly legitimate reason), then don't send it to me. Trap it out of the line before the cable comes into my home. The additional cost of the traps has to be offset by the reduced cost of the cable box needed for the system, and the cost of installation should be the same because anyone with an opposable thumb and finger can put a trap on the line.

I agree that the signal coming into my home is the property of the cable company but, and this is important, at a certain time the real ownership of the signal becomes less clear. When the RF has been reduced to baseband video and has

spent lots of milliseconds running around the inside of my TV set, I think things are a bit different and the cable companies' original claim of ownership is a lot weaker. And if I worked out a way to record scrambled signals and then descrambled them on playback, what then?

If I built a box that scrambled some of the channels currently sent to me in the clear, the cable company would look at me in a funny way, but I really doubt they'd care one way of the other.

Now that you know how I feel about this stuff, I'd like to show you how to descramble signals, but I can't because there are several ways that signals can be scrambled. It's sad but true that being able to descramble one system is no guarantee that you can descramble any other system.

The scrambling methods can be broken into two basic categories. The method you have in your home depends on the kind of cable service you have, how it's sent to you, and the economics of your viewing region. That last reason is important because the cable companies have to pay for the decoder boxes; the more sophisticated the way the signal is scrambled, the more the box costs. A cable company that has its franchise in a large city with lots of customers needs lots of boxes, and that translates into some serious numbers for the purchase of the boxes. And don't forget that the more extensive the scrambling method, the more expensive the equipment needed to scramble the signal in the first place.

Taking apart the video signal and turning it upside down and inside out is pretty simple, but putting it back together correctly is a different matter altogether. And the FCC

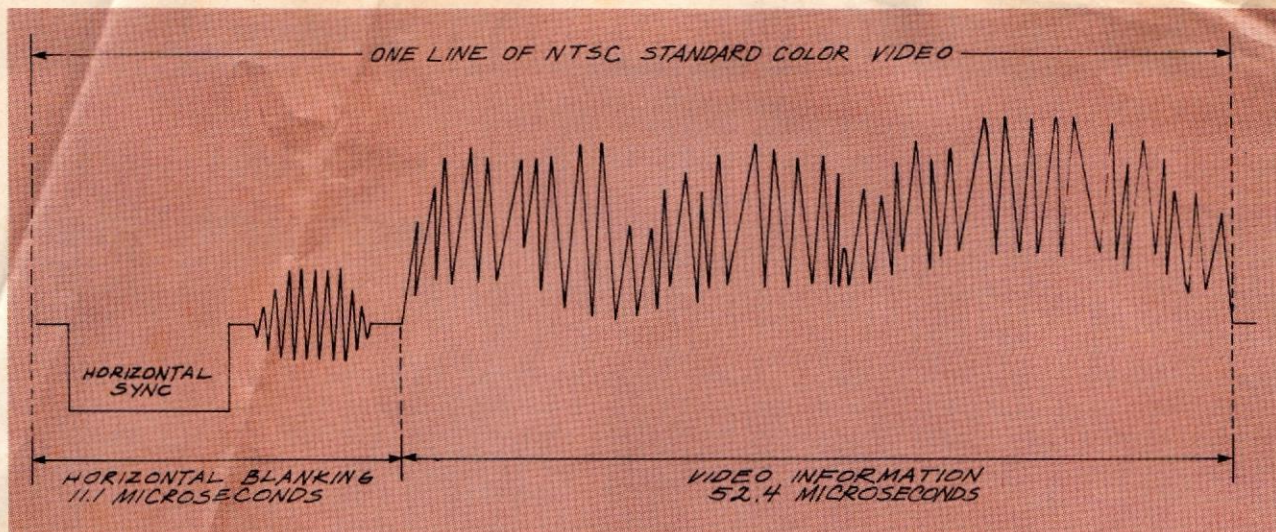


FIG. 1—THE MOST COMMON APPROACH to scrambling video involves manipulating the information in the horizontal interval. For example, without a sync pulse, the TV's horizontal circuitry will freewheel.

keeps a careful watch on how close the reconstituted signal comes to real video. If the new signal is too messy, the FCC will give it a big thumbs down.

The most common approach to scrambling video involves manipulating the information in the horizontal interval. In the beginning, every cable company used the same method—they suppressed the horizontal sync pulse, which meant that the TV had no idea where each line of video started and ended. The sync pulse can be seen in the video waveform shown in Fig. 1. Without a sync pulse, the TV's horizontal circuitry will freewheel and you'll most likely see the horizontal weaving down near the center of your screen rather than being located discreetly off to the side. That also means that the TV won't see the transmitted burst signal in the right place, and the colors will be off as well.

To descramble the video, a decoding signal was sent, buried in the audio. It would restore the sync pulse at the proper time and for the proper interval. I don't want to spend a lot of time on this because there's as much chance of seeing this as there is of seeing a mastodon. Once upon a time they were everywhere, but they're long gone today.

The best way to get a good handle on the whole business of video

scrambling is to get into the theory and the circuitry needed to turn the theory into practice. I have to stress at this point that you're not going to get much out of this unless you understand how video works in the first place. Some time ago I did a series of columns on this subject. I strongly suggest that you get your hands on them, read them, and then keep them handy for reference. I'll assume that you understand the basics of a clear video signal as we go through the methods that are often used to mess it up.

Every scrambling method depends on altering some or all of the control pulses that are included in the definition of the standard video waveform. That means that the most basic operation of any scrambling/unsrambling system is the separation of the control information from the picture information. That isn't such a complex job because the NTSC standard was devised with a strictly mathematical timing relationship between every individual part of the signal. Therefore, looking at a video signal is somewhat like reading a street map—if you know exactly where you are, you automatically know where everything else is. Or, in the case of scrambled video, just where everything else is supposed to be.

Splitting the sync signal from the video waveform is, as I said, a very common job. After all, every TV

does exactly that over and over as long as it's turned on. Most semiconductor manufacturers with lines of video IC's have several sync-separator chips in their catalogs, although it's usually hard to buy them in single quantities from suppliers. And they're not the cheapest IC's around either. I wonder if that means anything.

Over the next several installations we'll be looking at various scrambling methods commonly used by the cable companies. I'll go through the theory and show you how you can find out what your cable company is shipping to the back of your TV set. And yes, we'll be looking at the circuitry needed to descramble the signals—practical examples with component values.

I'll be using standard IC's that meet all our usual criteria of price (low) and availability (everywhere), but this is one area where you're really going to need an oscilloscope. If you're serious about electronics you should have one of these things anyway, because they're just about the most basic and essential piece of test equipment you can own.

When we get together next time we'll start things out by building some stuff that will scramble a standard video signal. That may seem a bit strange, but remember that the first step in defeating an enemy is to learn to think like he does. **R-E**