DRAWING BOARD

Let's see what's involved in descrambling a SSAVI signal.

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Fooling around with the simple video stuff we've been building is a nice alternative to hanging around on street corners, but it's not really all that terrific if your ultimate goal is to figure out what to do with the junk that shows up on certain channels on your TV. Suppressed sync is the Model-T version of video scrambling, and you can bet your bottom dollar that things have gotten a lot more complicated. Enter the digital age.

Since the suppressed-sync scrambling system was so simple, it wasn't long before people with only moderate electronic skills figured out what was being done and how to beat it. Even the simple stuff we put together over the last couple of months could—with some minor additions—do the job. As the cable business grew, so did the complexity of their scrambling methods.

As I told you when we first started out on this trip into cable video land, ripping the video signal apart is easy—putting it back together successfully is something else entirely. The amount of messing up that's done to the standard video signal is directly proportional to the cost. More intense scrambling is more expensive. Cable operators have to balance their degree of security against the cost of the equipment. Also, the larger the customer base, the less expensive the scrambling system has to be. In New York City (and other large areas), the cable companies have a lot of subscribers, each of whom needs a cable box. The more boxes the cable company has to buy (they don't make them themselves), the more money it has to keep tied up in its inventory.

The old suppressed-sync system was a one-way deal. If you got a box that could descramble one channel, it could descramble any channel. Which channels would be unscrambled was determined by one of the wafers on the channel selector dial. A position would be either jumped or open, which was a major cable company headache for two reasons. The first was that they had to open the boxes and solder or cut traces to configure the box for a given customer. The second was that some enterprising people realized what was going on, opened up their cable boxes, and reconfigured it themselves.

The only way the cable companies could guard against that was to use screws with oddball shaped heads to hold the box together. When that didn't work, they started using screws that had a left-hand thread. But enough history.

What the cable companies needed was a way to talk to each of the boxes individually, while they were in customer's homes. Making such addressable boxes also meant that several scrambling methods could be used; the boxes could be told which method was in use at any one time. Since that information could be sent to the box during the vertical blanking interval (while the beam was off the screen), the cable operator could change the scrambling method from field to field—up to sixty times a second. The boxes could also keep a serial number in an EPROM or some other storage device, which meant that boxes could be addressed individually and the descrambling circuitry could be turned on and off for separate channels from the main cable company office. The cable companies loved it.

Understanding that kind of stuff is a bit more difficult than the old suppressed-sync system, but if you take the pieces one at a time, it all gets cut down to manageable, bite-sized chunks. Although the cable company's scrambling delivery system became much more sophisticated, it was still faced with the same cost restrictions when it had to decide which of the available scrambling techniques to use.

One of the most popular choices was the so called SSAVI system. That's an acronym for Sync Suppression Active Video Inversion. It allows the video to be delivered to your doorstep in one of four flavors:

- Suppressed horizontal sync and normal video (Fig. 1).
- Suppressed horizontal sync and inverted video (Fig. 2).
- Normal sync and suppressed video (Fig. 3).
- Normal sync and normal video (we can forget this one).

Before we get into the nitty gritty of the SSAVI system, there are a

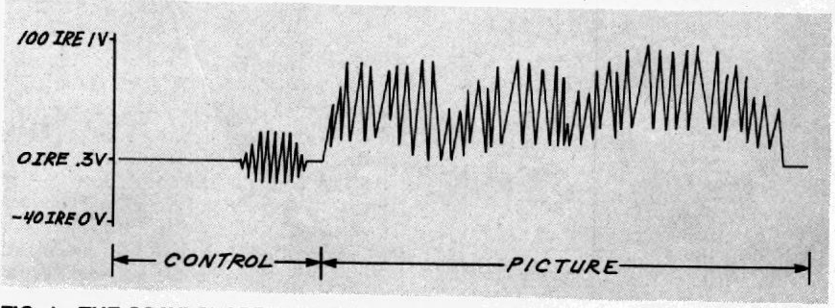

FIG. 1—THE SSAVI SYSTEM can deliver video with suppressed horizontal sync and normal video.

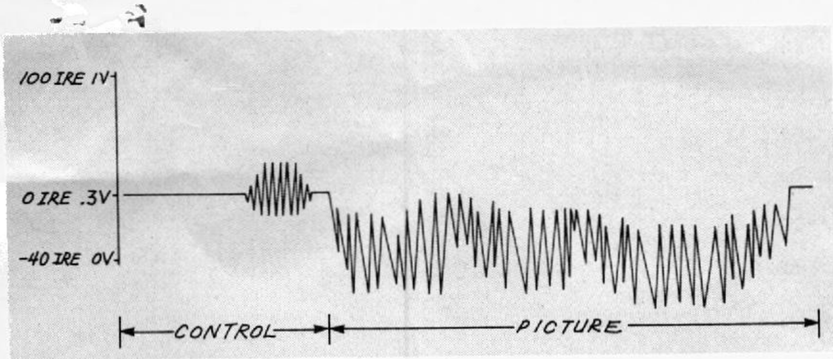

FIG. 2—SUPPRESSED HORIZONTAL SYNC and inverted video is also possible with the SSAVI system.

few basic things you should know, because they tell you some interesting things about how the system works.

The first is that horizontal sync is never inverted—even if the picture is inverted. This means that any circuit designed to descramble it has to separate the two basic parts of the video line (control and picture first). We have to be able to turn the picture right side up (if needed) without inverting the control section as well.

The SSAVI system seems even more complex when you realize that the job of separating control and picture has to be done on lines that might very well have no horizontal sync pulse that can be used as a reference mark. In the older suppressed-sync system, the sync could be recovered from the gating signal that was buried in the audio; with the SSAVI system, there's nothing like that available.

The key to regenerating the video signal is based on the fact that all aspects of it are tied together in a strict mathematical relationship. If you can locate one part of the signal, you can determine where everything else has to be.

The broad picture for a descrambler, therefore, is to design a circuit that can identify one part of the signal, and then use the repetition of that signal as a reference for restoring the rest of the video. You should realize by now that we're talking about a phase-locked loop, or PLL. Even if the identifiable component of the video occurs only once a field (or even once a frame), that's still often enough to control the frequency of a voltage-controlled oscillator, or VCO, and lock the PLL to the received video.

This isn't as strange as it might seem. In a normal video signal, the reference for color is the burst signal that follows horizontal sync. The colorburst signal lasts only a bit longer than 2 microseconds, but it's used as a reference for the whole video line, which is about 63 microseconds long. As far as color correction is concerned, that means there's no real reference signal available for more than 95% of the line! The color phase for the rest of the

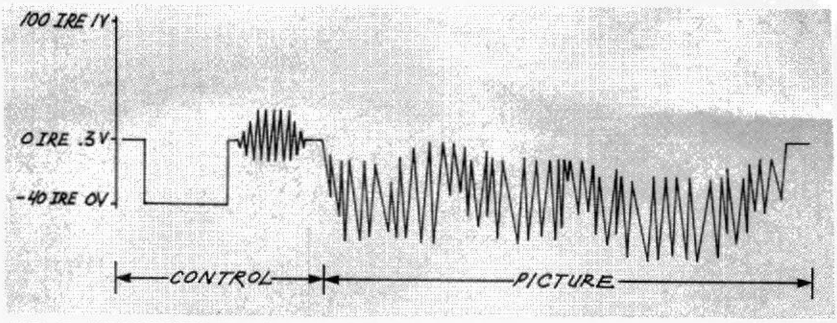

FIG. 3—HERE'S WHAT NORMAL SYNC and suppressed video look like.

line is based on the stand-alone 3.58-MHz generator that's a normal part of the TV set.

Building a SSAVI descrambler isn't as easy as building one to take care of suppressed sync, but it's not as difficult as you might think. Before we start to work out the details of the circuitry, we have to draw up a comprehensive list of exactly what we want the circuit to do. A circuit designed to descramble the SSAVI system needs the following basic features:

- A means of knowing if the picture will be normal or inverted.
- The ability to generate horizontal sync pulses.
- A way to identify a definite point in the received video.
- A circuit to place horizontal sync pulses at the right point.

Some SSAVI systems also play games with the audio, but the methods used to hide the audio have been around for a long time. The audio is usually buried on a subcarrier that's related, in some mathematical way, to the IF component of the TV signal. We'll get into that briefly when we take care of restoring the picture.

Although we'll be working out the details of the circuitry next time, you should already have some ideas of what it has to be like. The SSAVI system uses digital signals for security and access rights—the stuff that cable executives lie awake all night thinking about (instead of less-important things such as improving picture quality, increasing channel services, and widening the audio bandwidth. Because the first step in handling SSAVI scrambled signals is to locate a known point in the signal, we'll be using counters and other standard digital logic to keep track of where everything is supposed to be. That's right people, most of the guts of a SSAVI descrambler are made of the same standard digital stuff we've been using in this column since the beginning.

In the future we'll take apart a typical frame of SSAVI-encoded video and see how we can put it back together again correctly. It's not as complicated as you think and, to tell you the truth, I wouldn't be a bit surprised if a bunch of you readers beat me to it. In the meantime, to help you appreciate what's involved in scrambling a video signal, next month we'll work on some circuitry that will scramble a perfectly good video signal. **R-E**