TECHNICAL COLUMNS

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WHEN DIGITAL REALLY IS ANALOG AND OTHER THINGS YOU MAY KNOW

By RON HRANAC

Did you know the “digital” signals we carry on our cable networks aren’t “digital?” They’re analog!

Our networks can’t carry baseband digital data — for the purists, a length of coaxial cable can, but that digital data won’t make it past the first active — so we have to convert the digital data we want to transmit to and from subscribers into analog RF signals. The latter is done using a modulation process called quadrature amplitude modulation (QAM), which results in a double-sideband, suppressed-carrier analog RF signal. The digital information to be transmitted is represented by variations in the RF signal’s phase and amplitude. There are no zeros and ones per se in what we call “digital” signals.

“Did you know the broadband sweep gear used to align and maintain outside plants only shows half of the measured frequency response?”

While we’re on the subject of digital, I’m occasionally asked about whether or not cable operators should do some sort of proof-of-performance tests on digital signals, and when is the FCC going to require digital proofs? The answer to the first question is, in most cases, yes. What about the second question? Did you know the FCC has required digital signals on most cable networks to meet certain specs, and that this requirement has been on the books for several years? §76.640(b)(1)(i) is where you’ll find the rules for digital signals.

(1) Digital cable systems with an activated channel capacity of 750 MHz or greater shall comply with the following technical standards and requirements:

(i) SCTE 40 2003 (formerly DVS 313): “Digital Cable Network Interface Standard” (incorporated by reference, see §76.602), provided however that with respect to Table B.11, the Phase Noise requirement shall be −86 dB/Hz, and also provided that the “transit delay for most distant customer” requirement in Table B.3 is not mandatory.

Yep, digital signals in most systems are supposed to comply with the technical parameters in SCTE-40 (www.scte.org/documents/pdf/standards/ANSI_SCTE%2040%202004.pdf).

What’s not in Part 76 of the FCC Rules is the how to behind ensuring those digital signals comply with SCTE-40. The good news is that several digital measurement procedures are described in “Recommended Practices for Measurements on Cable Television Systems, 3rd Ed.,” also available from SCTE. If you have a modern combination QAM analyzer/spectrum analyzer, most of the required measurements can be performed fairly easily using that kind of test equipment.

Did you know that such distortions as composite triple beat (CTB), composite second order (CSO) and common path distortion (CPD) don’t go away in an all- or mostly digital network? Rather than clusters of discrete beats that occur in a network carrying large numbers of analog TV channels, the digital distortions are noise-like! Those noise-like distortion products are known as composite intermodulation noise (CIN), composite intermodulation distortion (CID) or intermodulation noise (IMN) — none of which should be confused with thermal noise.

Confusion does occur, though. We know that raising RF levels in the plant improves the carrier-to-noise ratio (CNR). But in a system with a lot of digital signals, did you know raising levels improves CNR to a point, then the noise floor starts to increase and the CNR gets worse? That seems counterintuitive, but the now-elevated noise floor no longer is just noise. It's a combination of thermal noise and the previously mentioned noise-like distortions. When characterizing plant performance in the presence of CIN, the term "carrier-to-composite noise (CCN) ratio" commonly is used. Indeed, CCN is a much more appropriate measurement metric than is CNR under these circumstances, because there is no practical way to differentiate thermal noise from CIN.

As more and more cable networks carry larger numbers of digital signals, the issue of signal leakage compliance comes up. I wrote about this in my February 2009 column, and follow-up articles appeared in the March 2009 and issues of Communications Technology

Comcast's Ray Thomas and I co-authored a paper that was presented during last year's Cable-Tec Expo technical workshops. A copy of our paper and our PowerPoint slides can be found on the proceedings' CD-ROM; contact SCTE for details. Our technical workshop highlighted the results of extensive field tests that characterized leakage from all-digital networks. Did you know leaking digital signals can cause harmful interference to over-the-air services under the right conditions? And did you know that currently available leakage detectors can't be used to measure leaking digital signals? The good news is that manufacturers are working on digital-compatible leakage-detector technology. But until that equipment is available in production, the only way to comply with the FCC's existing leakage rules is to use an analog TV channel or continuous wave (CW) carrier when measuring leakage.

The migration to larger numbers of digital signals presents another complication. Did you know most older amplifier automatic gain control (AGC) circuits don't play nicely with a digital signal on the AGC pilot frequency? Those AGC circuits originally were designed for analog TV channels or CW carriers, and not for noise-like digital signals. Most amplifiers manufactured during the last few years have digital-compatible AGC, but hundreds of thousands (or more!) of older amps do not. In most instances, it will be necessary to use an analog TV channel or CW carrier on the AGC pilot frequency if you want those older amps' AGC to work properly.

Did you know the broadband sweep gear we use to align and maintain our outside plants only shows half of the measured frequency response? Before you accuse me of running low on caffeine, understand that "frequency response" is a complex quantity that has two components: magnitude- or amplitude-versus-frequency, and phase-versus-frequency. The display of a sweep receiver shows us amplitude-versus-frequency, but not phase-versus-frequency.

Ideally, amplitude-versus-frequency should be flat, and phase should change in proportion to frequency. When amplitude-versus-frequency is not flat, we see amplitude ripple ("standing waves"), amplitude tilt or some combination of the two. When phase-versus-frequency is out of whack, we have group delay.

Did you know that what are sometimes called "sunspot outages" have nothing to do with sunspots? Those outages actually are solar transit outages, which are twice-yearly satellite reception outages that happen when the sun lines up with geostationary satellites. The sun emits electromagnetic radiation across a wide range of frequencies, including those used by communications satellites. When the sun is directly behind a satellite from the perspective of a given earth station, the RF energy from the sun is strong enough to exceed the desired signal(s) from that satellite. Solar-transit outages occur for a few minutes on each of several days near the spring and autumn equinoxes

Finally, did you know that when we measure the RF level of analog TV channel visual carriers, we don't measure peak power? We measure peak envelope power (PEP), which is the average power of one cycle during the modulation crest. A visual carrier's modulation crest occurs during sync pulses.

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