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By **Ron Hranac**, former ***Senior Technology Editor,*** **Access Intelligence** and ***Communications Technology*** **Magazine**

Originally appeared in the **September 2009** issue of *Communications Technology*.

MAKING MER BETTER: PART II

By RON HRANAC

Modulation error ratio (MER), as I noted in August's column, is an important but frequently misunderstood performance metric for the forward and return digital signals carried on our networks.

Many cable operators place a fair amount of emphasis on MER — also called SNR or signal-to-noise ratio — as part of overall network or per-channel health. MER is a useful part of the measurement toolbox of troubleshooting tools. That said, how can one go about ensuring that MER is as high as practical?

Last month I looked at carrier-to-noise ratio (CNR) and RF levels; nonlinear distortions such as composite triple beat (CTB) and composite second order (CSO); and linear distortions — good ol' micro-reflections, amplitude ripple and tilt, and group delay. Keeping all of these under control will go a long way toward maximizing MER. What other major gremlins should be of concern?

"After cleaning the connectors...they observed a 2 to 3 dB improvement in downstream MER."

In-channel ingress

Yes, ingress can degrade MER. You know the drill here. Keep signal leakage down to a dull roar, and forward and return path ingress will be easier to manage.

Most current cable modem termination systems (CMTSs) incorporate ingress cancellation in their upstream receivers, which is quite effective at dealing with in-channel ingress. Still, that shouldn't be an excuse to not work to keep upstream ingress under control. As effective as the CMTS's ingress cancellation is, if in-channel ingress is severe enough even ingress cancellation won't do any good!

One other point: Out-of-channel ingress can still cause problems, among them laser clipping. More on that in a moment. We tend to think of upstream ingress as the undesired signals that for the most part populate the roughly 5 to 15 MHz or so part of the return spectrum, with some occasional ingressors at higher frequencies. Have you ever looked at your upstreams below 5 MHz on a spectrum analyzer? You might be surprised at the nasty stuff that lurks down there, especially AM broadcast radio ingress.

Then there's downstream ingress. Customer premises equipment (CPE) does not include in-channel ingress cancellation. Even if it did, and the ingressor was an over-the-air digital TV signal, ingress cancellation doesn't work with noise or noise-like signals. While the high-power TV broadcasters made the switch to digital, low power TV stations and translators didn't have to, so there may still be a few analog TV channels out there.

And don't forget all of those non-digital over-the-air signals that still exist: two-way radio, pager, ham radio, and other signals that can wreak havoc when your network's shielding integrity has been compromised. My May 2009 column addresses downstream ingress: (www.cable360.net/ct/operations/bestpractices/35443.html).

Bottom line when it comes to ingress: You have to keep the plant tight!

Laser clipping

This occurs when forward or return lasers are overdriven with too much RF. In addition to degrading bit error rate (BER), laser clipping can affect MER. Going the other direction, laser RF input levels that are too low will tank CNR. See last month's CNR discussion about maintaining correct RF levels at the laser inputs.

If you haven't yet done so, I encourage you to also take a look at my July '09 column on upstream CNR (www.cable360.net/ct/operations/testing/36475.html) to see just how much of an impact upstream fiber links have on CNR. If upstream CNR is out of whack, MER will take a hit.

On the subject of lasers and fiber links, a long-time friend and industry colleague recently shared with me an interesting experience that had to do with optical connector cleanliness. The cable company he works for acquired one of JDSU's P5000 series fiber inspection probes (www.jdsu.com), and system personnel began inspecting and cleaning downstream optical connectors as part of an overall program to tweak RF and optical levels, and optimize fiber links. After cleaning the connectors — which can improve optical link CNR and reduce backscatter — they observed 2 to 3 dB improvement in downstream MER. Most of that improvement was attributed to cleaning the optical connectors. That's a pretty significant change!

For more on cleaning optical connections, see "Fiber Connector Cleanliness" in the October 2008 issue of Communications Technology at www.cable360.net/ct/operations/bestpractices/31826.html. Another useful reference is the white paper "Inspection and Cleaning Procedures for Fiber-Optic Connections" available at www.cisco.com/en/US/tech/tk482/tk876/technologies_white_paper09186a0080254eba.shtml.

Common path distortion

Technically a class of nonlinear distortion, CPD is something that I wanted to touch on separately from last month's discussion. CPD, too, can degrade MER. CPD has been around pretty much as long as we've been using the return path, and is a well understood phenomenon. For additional background on CPD, links to acouple different formats of Barry Patel's excellent paper "Characterisation of Common Path Distortions" can be found at http://cable.doit.wisc.edu/cable_resources.html.

We tend to think of nonlinear distortions coming primarily from active devices whose output levels are too high. CPD is interesting in that it's often generated in a diode-like nonlinear junction somewhere in the transmission path that is common to both the forward and return, hence the name common path distortion. The culprit is typically corrosion of some sort, where the corrosion's oxide layer itself — which may be only a few molecules thick — behaves somewhat like a diode.

As you know, diodes are used to make electronic mixer circuits. The presence of a bunch of downstream signals at the diode-like corrosion-based "mixer" results in the generation of various second- and third-order distortions. Many of those distortions appear in the return spectrum. For instance, in an NTSC network, CPD's second order beat clusters may appear every 6 MHz: 6, 12, 18, 24, 30, 36 MHz and so on. Third order distortions may appear 1.25 MHz either side of the 6 MHz-spaced second order distortions. Sometimes only the second order distortions are present, sometimes only the third order distortions, sometimes both, and sometimes CPD manifests itself as an elevated noise floor. Much of the latter may be composite intermodulation noise from the downstream digital channels.

Making CPD fun to track down is that simply climbing a pole or ladder, or opening a pedestal cover may induce enough vibration to temporarily break down the oxide layer that comprises the diode, and the CPD disappears! For awhile, anyway.

One of the first things to check when CPD crops up is downstream RF levels. I have seen situations where downstream amplifier levels that were too high aggravated CPD. Fixing downstream levels won't get rid of the source of CPD, but it may reduce the CPD's amplitude. Next is to track down where the CPD is originating. CPD can be a royal pain to troubleshoot — the divide-and-conquer technique is one way — although tools such as Arcom's Hunter (www.arcomdigital.com) are said to make the job easier.

Cable 101?

As you've seen, maximizing downstream and upstream MER is fairly straightforward, and often involves little more than Cable 101. Some problems, such as transmitted phase noise, incorrect modulation profiles, and even data collisions, can certainly contribute to low reported MER, but the most common causes are typically things we should be making sure are right in the first place.

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