



TECHNICAL COLUMNS

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MORE ON CABLE MODEM UPSTREAM SIGNAL LEVELS

By **RON HRANAC**

A couple weeks after I wrote last month's column, Cisco's John Downey took a look at the manuscript and suggested a few things to add to what was said. Since the May issue was well on its way through the editing and production process by then—and CT's editors give me a limited amount of space each month—I suggested that we collaborate on a second installment to cover the additional material. Here 'tis.

Specs

The default upstream receive level is 0 dBmV for most cable modem termination systems (CMTSs), but the DOCSIS Radio Frequency Interface Specification states, "the intended received power in each carrier **MUST** be within the values shown." The accompanying table shows a summary of the CMTS upstream input signal level values and the corresponding channel bandwidth.

In practice, it's unlikely that one could expect to have problem-free operation outside of a lab environment if the CMTS upstream input were set to, say, +20 dBmV for a 3.2 MHz bandwidth channel. Even though DOCSIS cable modems are supposed to support a wide range of upstream transmit levels (+8 to +58 dBmV for QPSK; +8 to +55 dBmV for 8-QAM and 16-QAM; +8 to +54 dBmV for 32-QAM and 64-QAM; and a maximum of +53 dBmV for S-CDMA applications with all modulation types), typical cable network design and operation pretty much preclude taking advantage of high CMTS input levels. The default value of 0 dBmV is about ideal for most cable networks.

Levels too high

As noted in last month's column, awhile back I ran across a problem where a cable operator had configured the CMTS upstream level to +8 dBmV. Actual input levels varied as much as 3 dB to 5 dB (recall that a CMTS can keep received upstream levels within about a 1 dB window when everything is ideal), largely because some of the modems were transmitting at their maximum output level and simply couldn't reach the CMTS at the desired +8 dBmV. This made it next to impossible to measure the upstream levels using a spectrum analyzer in zero span mode, although the CMTS could still measure the received levels with no problem. It would have been better to change the CMTS's upstream input level back to the default 0 dBmV and then troubleshoot those modems transmitting at or near their maximum output. Doing so would reduce CMTS input level variations to less than 1 dB; yield a relatively constant upstream carrier-to-noise ratio (CNR) among the different modems at the CMTS upstream port; and eliminate the problem with measuring levels with the analyzer in zero span.

CMTS measurements

To aid the troubleshooting process, the CMTS can show which modems are transmitting at their maximum upstream level. Check with your CMTS vendor for the specific command to get this information. In the vast majority of cases, you'll find the problem to be in the subscriber drop, although occasionally the culprit may be in the feeder (bad tap, misaligned reverse amp, etc.). As well, the CMTS has a default range of acceptable upstream receive levels relative to the desired receive level. That is, as long as modems are



received in, say, a 4 dB window at or below the set value—for example, 0 dBmV to -4 dBmV—then the modems will stay online. For the situation just discussed, the cable operator had changed the default value to a larger setting. Here, too, you should check with your CMTS vendor to see what the default window is and how to change it.

The CMTS measures each modem's upstream signal during station maintenance bursts—it actually measures the burst's preamble—and uses that information when commanding the modems to adjust their transmit level as necessary to achieve the desired CMTS input level. This process can get a little interesting if a cable modem vendor implements the preambles differently for QPSK vs. 16-QAM. For instance, changing the station maintenance burst to 16-QAM might make the cable modem appear to transmit 3 dB higher and subsequently achieve 3 dB better upstream signal-to-noise ratio (SNR). Even this may be subjective, since the CMTS's reported upstream SNR is an average of all modems on a given upstream port. Note that some CMTSs can also report per-modem upstream SNR, but in either case the reported SNR is really modulation error ratio (MER). As usual, I digress.

Modem measurements

The signal level reporting capability of cable modems could easily be plus or minus a few decibels. The reported level information is certainly useful for tracking trends, but a \$35 cable modem can't be expected to have the same accuracy as a \$20,000 spectrum analyzer's digital channel power measurement function. Some cable modems report their transmit level based on long bursts even though levels are controlled using station maintenance bursts. Using a mixed modulation profile may lead to questionable results, too. It might be a good idea to take a handful of the modems used in your system and compare the reported upstream transmit level and downstream receive level values against measurements made with recently calibrated test equipment.

The DOCSIS Radio Frequency Interface Specification also states, "The maximum total input power to the upstream demodulator MUST NOT exceed 35 dBmV in the 5-42 MHz frequency range of operation." CMTSs have pretty robust upstream receiver circuits, but keeping total power—the combined power of all desired and undesired signals (ingress, impulse noise and other junk included)—less than +35 dBmV at the upstream port is a good idea. Don't forget to look below 5 MHz and above 42 MHz for out-of-band signals that may be contributing to the total received power, even though the DOCSIS total power parameter pertains to just the 5-42 MHz spectrum. John and I have seen instances of frequencies as low as the AM broadcast band (0.5 to 1.7 MHz) causing interference, especially to upstream lasers.

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