



TECHNICAL COLUMNS

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

QAM SIGNALS ON SPECTRUM ANALYZERS

By RON HRANAC

Have you ever looked at a spectrum analyzer display of a quadrature amplitude modulation (QAM) signal and wondered why its displayed amplitude doesn't match its digital channel power?

Consider an upstream cable modem signal at the cable modem termination system's (CMTS's) input connector. You may have the CMTS configured for the default 0 dBmV commanded receive level, and the CMTS reports that value. Yet when you look at the digitally modulated signal's "haystack" on a spectrum analyzer, it appears to be several decibels (dB) low. Or maybe you use a QAM analyzer or cable modem to generate an upstream QAM signal for return path alignment, but when you check the haystack amplitude on a spectrum analyzer, the displayed amplitude doesn't seem right. The same is true in the downstream. QAM channel levels supposedly are set 6 dB below analog TV channel levels, yet on a spectrum analyzer they look a lot lower. What gives?

QAM signals are noise-like, and as such exhibit noise-like behavior when observed on a spectrum analyzer or similar equipment. For instance, when the analyzer's resolution bandwidth (RBW) control is changed, the height of displayed noise and noise-like signals also will change. The wider the analyzer's RBW setting, the higher the noise or noise-like signal appears, and vice-versa.

To illustrate this, Figure 1 shows a 30 MHz continuous wave (CW) carrier with its RF power adjusted to +20 dBmV. The spectrum analyzer is set to 300 kHz RBW, 10 kHz video bandwidth, and averaging turned on to make it easier to place markers. The displayed height of the CW carrier is about +19 dBmV. Figure 2 shows a 3.2 MHz bandwidth 16-QAM signal on the same frequency whose digital channel power - what one would measure with a thermocouple power meter - has been set to +20 dBmV, the same as the CW carrier. But look at its displayed height. The haystack appears about 13 dB lower than the CW carrier, even though the RF power is the same! Switching the QAM signal to 6.4 MHz bandwidth while maintaining the same +20 dBmV digital channel power results in another 3 dB drop in displayed level, as shown in Figure 3. If the analyzer's RBW were changed to 100 kHz, the displayed haystack heights would be even lower, by 4 or 5 dB.

FIGURE 1: CW carrier at +20 dBmV; displayed height is about +19 dBmV.

FIGURE 2: Displayed amplitude of this +20 dBmV 3.2 MHz bandwidth 16-QAM signal is about 13 dB lower than the +20 dBmV CW carrier.

FIGURE 3: When the +20 dBmV 16-QAM signal's bandwidth is increased to 6.4 MHz, its displayed amplitude drops 3 dB relative to the 3.2 MHz signal in Figure 2.

The moral of this story? Use your test equipment's digital channel power function to actually measure QAM signal amplitude. It's easy to be fooled by what one sees on a spectrum analyzer display.

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