Originally appeared in the **May 2012** issue of *Communications Technology*.

UNDERSTANDING REAL-WORLD MER MEASUREMENTS (PART 2)

By RON HRANAC

The lab-and-field tests discussed in my 1Q12 column (for more information, click here) produced some interesting results. First, different makes/models of test equipment do, indeed, report different equalized modulation error ratio (MER) values on the same signal under identical conditions. Those instruments that also support unequalized MER measurements reported different unequalized MER values, too.

The variations from instrument to instrument when measuring a given signal under identical conditions ranged from as little as a few tenths of a dB to more than 12 dB. That latter number is no typo – in some cases, we saw more than 12 dB reported MER difference among the various pieces of test equipment.

For instance, in Test Configuration #1, in which the instruments were connected directly to the output of a quadrature amplitude modulation (QAM) modulator through a variable attenuator, the seven analyzers reported equalized MER values ranging from 33.5 dB to 45.0 dB at 0 dBmV input.

During the lab tests, comparison MER measurements were made with and without fixed-value in-line attenuators installed on the ends of the interconnecting cables (output of signal source, input to variable attenuator, output of variable attenuator and test equipment input). This was done to determine if the return loss of the interconnected devices had any significant impact on the reported MER. Observed differences ranged from no change to a worst-case scenario of about 0.9 dB, depending on the specific test equipment. That is, some but not all instruments reported slightly higher MER with the fixed-value attenuators than without.

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The vintage of the equipment also was important, with the first-generation QAM analyzer always providing lower – usually much lower – reported MER than all of the newer analyzers. There was even a slight difference between the latest-generation model of one of the analyzers and its immediate predecessor, with the newest model consistently reporting about 1 dB higher MER than the earlier version. In general, our testing found that later analyzer models outperform earlier models, regardless of manufacturer.

Measurement conditions clearly affect the reported MER value. Low RF input level (e.g., -10 dBmV) in every case produced lower reported MER than did higher RF input levels (0 dBmV and +10 dBmV). Some instruments used in the testing produced slightly lower reported MER when adjacent channels were present compared to the lack of adjacent channels, likely related to receiver selectivity performance.

In an ideal additive white Gaussian noise (AWGN) channel with no other impairments, and assuming a perfect transmitter and receiver, carrier-to-noise ratio (CNR) and equalized MER would be equal. While it’s not possible to have a completely impairment-free channel or a perfect transmitter or receiver, one lab test had the CNR set to a nominal 35 dB. The same impairments from the signal source, combiner, optical link and amplifier cascade were present at the input to each piece of test equipment.

Illustrating variations in receiver implementation loss, adaptive equalizer performance, etc., the reported equalized MER values ranged from a low of 30.1 dB to a high of 35.3 dB. The latter value exceeded the CNR slightly (MER can't be higher than CNR), attributed to normal test-equipment measurement inaccuracy.

As noted in Part 1, most cable operators specify worst-case MER at ends-of-line and other locations. Here is an important takeaway from our lab and field tests: By itself, a specified MER value is relatively meaningless unless several important factors related to the measurement also are specified. So what are those factors, and what can be done to help ensure more consistent and meaningful MER measurements? Here are some recommendations:

The type of measurement – equalized or unequalized – must be stated when defining MER performance metrics. It’s normal for unequalized MER to be a few dB lower than an equalized MER measurement on a given signal, but I have seen 10 dB or more difference when significant in-channel linear distortions were present. Note that one cannot simply add a fixed correction factor to an unequalized MER value to obtain an equalized MER value for the signal in question.

When measuring and comparing MER, the same make/model of test equipment always should be used for more consistent measurement results.

When measuring MER throughout a cable network, attempt to ensure approximately the same nominal signal level at the test equipment or device input, preferably somewhere in the 0 dBmV to +10 dBmV range. Our tests showed that input levels around -10 dBmV always produced lower reported MER than did higher input levels.

Check with the test-equipment or device manufacturer to determine the maximum recommended total signal power, and ensure that the total signal power at the equipment or device input does not exceed that value. Overdriving the test equipment or device may cause erroneous or inconsistent MER readings.

If excessive reverse tilt at the test equipment or device input is a concern, a subscriber drop equalizer, generally available from trap and filter manufacturers, should be used to flatten the signal amplitudes across the spectrum prior to the MER measurement.

When measuring MER, ensure that the CNR at the point of measurement meets or exceeds the SCTE-40 and/or DOCSIS stated minimum values. In the downstream, the SCTE-40 minimum CNR is 27 dB for 64-QAM and 33 dB for 256-QAM. The DOCSIS assumed downstream minimum CNR is 35 dB for both constellations. My personal preference is the latter.

If possible, capture the QAM constellation as part of the MER measurement. If there are significant discrepancies in reported MER values, having access to the constellation enhances the ability to identify and troubleshoot problems. Likewise, if there are suspected issues with the measurement equipment’s approach to computing MER, the constellation will be helpful in isolating the issues.

Improving and maintaining high MER in an operating cable network often involves little more than ensuring proper headend, and forward path and return path alignment; identifying and troubleshooting such problems as nonlinear and linear distortions; keeping leakage and ingress down to a dull roar; and adhering to top-notch installation and maintenance practices.

Some problems like transmitter and receiver phase noise, incorrect modulation profiles and even data collisions can certainly contribute to low reported MER, but the most common causes typically are the things that should be done correctly in the first place. Think cable 101.

For a deeper dive into what can be done to get and keep MER as high as possible, see my August 2009 and September 2009 columns, “ Making MER Better: Part 1 ” (click here) and “ Making MER Better: Part 2 ” (click here).

The full technical workshop paper, which includes all of the lab and field-test data, is on the 2011 Cable-Tec Expo proceedings CD-ROM, available from SCTE.

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