Note to P802.3bn Editors/Task Force: the RxMER value to be stored per subcarrier needs to be an 8 bit unsigned integer with a value of 0 to 255. This value represents increments of 0.25 dB steps from 0 db (value 0x00) to 63.50 dB (value 0xFE). The value 0xFF is defined to mean that the RxMER cannot be measured for that subcarrier as explained in the text below. If this draft text is approved, this also includes the adding of an 8-bit RxMER value type or the modification of existing/anticipated RxMER value type per subcarrier).

Note to P802.3bn Editors: This is a new subsection to be placed under CL 100, CNU receiver functional requirements. Suggest adding as a new subsection: 100.2.11.3 (replacing anything else that was there).

101.2.11.3 Receive modulation error ratio requirements

The CNU receiver shall provide measurements of the downstream Receive Modulation Error Ratio (RxMER) for each subcarrier in all enabled channels.

The CNU measures the RxMER using scattered pilots and PHY Link preamble symbols. Note that if a scattered pilot falls on top of a continuous pilot, it is still considered as a scattered pilot for these measurements. RxMER here is defined as the ratio of the average power of the ideal QAM constellation to the average error-vector power. The error vector is the difference between the equalized received pilot or preamble value and the known correct pilot value or preamble value. As a defining test case, for an ideal AWGN channel, an OFDM channel containing a mix of QAM constellations, with data-subcarrier CNR = 35 dB CNR on the QAM subcarriers, will yield an RxMER measurement of nominally 35 dB averaged over all subcarrier locations. If some subcarriers (such as exclusion bands) cannot be measured by the CNU, the CNU indicates that condition in the measurement data for those subcarriers as a value of 0xFF.

RxMER may be more clearly defined in mathematical notation in accordance with Figure 100-X-1, which shows an ideal transmit and receive model, with no intent to imply an implementation. Let p represent the pilot or PHY Link preamble symbol before transmit IDFT, H presents the channel coefficient for a given subcarrier frequency, n represents noise, $y = H*p + n$ is the unequalized received symbol after receive FFT. The receiver computes G as an estimate of H, and computes the equalized received symbol as $r = y / G$. Using the known modulation value of the pilot or preamble symbol p, the receiver computes the equalized error vector as $e = r – p$. All the above quantities are complex scalars for a given subcarrier. To compute RxMER, the receiver computes E as the time average of $|e|^2$ (squared absolute value) over many visits of the pilot to the given subcarrier (or PHY Link preamble symbol as applicable), and $E\_dB = 10*\log_{10}(E)$. Let S_dB be the average power of the ideal QAM data subcarrier constellation (not including pilots) expressed in dB. The CNU reports $RxMER\_dB = S\_dB – E\_dB$. The CNU shall be capable of providing measurements of RxMER for all active subcarrier locations for each OFDM downstream channel, using pilots and PHY Link preamble symbols.
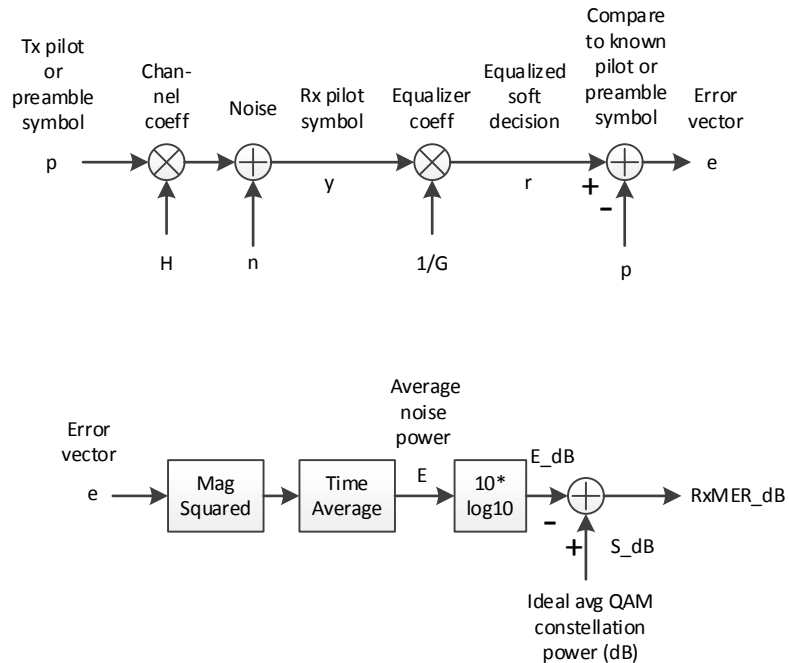
Figure 100-X-1 - Computation of Received Modulation Error Ratio (RxMER) for a given subcarrier

Conditions for performance requirements for downstream RxMER measurements are defined in subsection 100.3.2.

P802.3bn Editor's note: Suggest inserting this as new subsection as 100.3.2

100.3.2 CNU receive modulation error ratio testing

Performance requirements for downstream RxMER measurements are defined under the following specified conditions:

- Channel center frequency is fixed.

- Channel loading consists of a single OFDM channel with no other signals.

- The OFDM channel being measured has a fixed configuration with a 192 MHz channel bandwidth with 190 MHz modulated spectrum and no excluded subcarriers other than at band edges.

- The channel is flat without impairments other than AWGN.

- AWGN level is set to two values giving data-subcarrier CNR = 30 dB and 35 dB at the MDI (F connector) of the CNU across all data subcarriers in the OFDM channel.

- Signal level is fixed at a nominal receive level of 6 dBmV per 6 MHz.

- A minimum warm-up time of 30 minutes occurs before measurements are made.

- Each measurement consists of the frequency average across all subcarriers of the reported time-averaged individual subcarrier RxMER values as defined above. Frequency averaging is performed by external computation.

- An ensemble of M frequency-averaged RxMER measurements (M large enough for reliable statistics, i.e. such that the result lies within a given confidence interval) are taken in succession (e.g., over a period of up

to 10 minutes) at both CNR values. The mean, RxMER_mean in dB, and standard deviation, RxMER_std in dB, are computed over the M measurements at both CNR values. The statistical computations are performed directly on the dB values.

The CNU shall provide RxMER measurements with RxMER_std ≤ 0.5 dB under the above specified conditions.

Define delta_RxMER = (RxMER_mean at CNR_data_subcarrier = 35 dB) - (RxMER_mean at CNR_data_subcarrier = 30 dB). The CNU shall provide RxMER measurements such that 4 dB ≤ delta_RxMER ≤ 6 dB under the above specified conditions.

P802.3bn Editor's note: Suggest adding this new subsection as 100.2.10.3.

100.2.10.3 CLT upstream receive modulation error ratio requirements

This item provides measurements of the upstream receive modulation error ratio (RxMER) for each subcarrier. The CLT measures the RxMER using an upstream probe. The probes used for RxMER measurement are typically distinct from the probes used for pre-equalization adjustment. For the purposes of this measurement, RxMER is defined as the ratio of the average power of the ideal BPSK constellation to the average error-vector power. The error vector is the difference between the equalized received probe value and the known correct probe value.

The CLT shall be capable of providing measurements of RxMER for all active subcarriers for any single specified CNU in a specified OFDMA upstream channel, using probe symbols.   A sufficient number of upstream probe symbols should be used for a reliable estimate of RxMER. An ensemble of M frequency-averaged RxMER measurements (M large enough for reliable statistics, i.e. such that the result lies within a desired confidence interval) would be sufficient for a given level of confidence in the estimate.