Proposed EVM text for 156.9.10

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IEEE P802.3cw Task Force, 23 August 2021

EVM Ad Hoc

Interim Teleconference Meeting

156.9.10 Error vector magnitude (EVM)

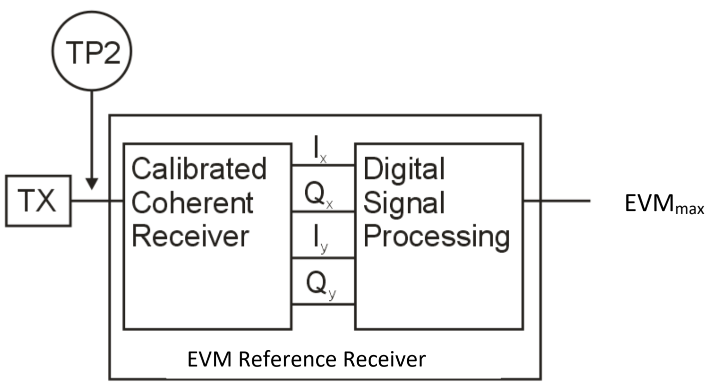
The error vector magnitude shall be within the limits given in Table 156-6 if measured using the methods specified in 156.9.10.1 and 156.9.10.2.

EVM is a metric to define the quality of a 400 Gb/s DP-16QAM transmitter.

The components of the conformance test setup to verify EVM are described in 156.9.10.1.

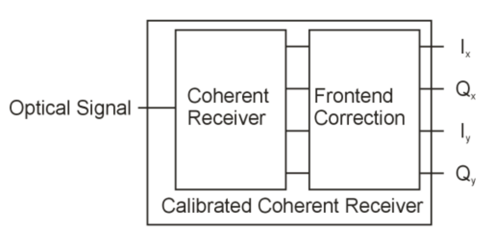
EVM_{max} in this specification is the RMS addition of the EVM values of the sampled symbols for each polarization divided by the maximum amplitude of the theoretical constellation. EVM is defined in 156.9.10.1.2.6.

156.9.10.1 EVM conformance test setup



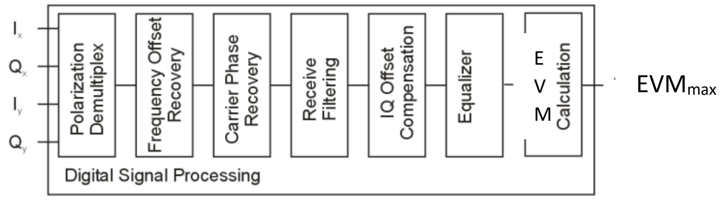
A block diagram for the EVM conformance test is shown in figure 156-7. Connect the 400 Gb/s DP-16QAM transmitter and calibrated coherent receiver using a single-mode fiber patch cord between 2 m and 5 m in length. The conformance test setup consists of the functional blocks described in 156.9.10.1.1 through 156.9.10.1.8. The EVM reference receiver is used for the measurement of EVM_{max}.

156.9.10.1.1 Calibrated Coherent Receiver



The coherent receiver generates four digitized data streams representing the baseband of two orthogonal polarizations of the optical input signal. The frontend correction removes impairments of the realized hardware implementation of the coherent receiver. The coherent receiver should have a bandwidth of at least TBD GHz. The ENOB and sampling rate of the digitizers should be at least TBD bits and TBD(1) times the symbol rate.

156.9.10.1.2 Offline Digital Signal Processing



The offline digital signal processing generates the transmitter quality metric from the four digitized data streams representing the baseband of two orthogonal polarizations of the optical input signal. This processing is done in multiple steps described in the following.

156.9.10.1.2.1 Polarization Alignment

To recover the transmitted signal the 4 received digital signals must be demultiplexed into two sets of complex IQ signals representative of the two polarizations sent out by the transmitter. To do that a block of TBD samples of the digitized signal is used and only a rotation using a complex valued 2x2 matrix is applied to the signal.

156.9.10.1.2.2 Frequency Offset Recovery

The frequency difference between the transmit laser and the local oscillator used to generate the signals in the coherent receiver is estimated and compensated on a fixed block length of TBD symbols.

156.9.10.1.2.3 Receive Filtering

The signal is filtered using a TBD filter with TBD roll-off.

156.9.10.1.2.4 IQ Offset Compensation

The IQ Offset is estimated and compensated on a fixed block length of TBD symbols.

156.9.10.1.2.5 Equalizer

The signal is equalized using an FIR filter with TBD TBD taps. The coefficients of the equalizer are searched that minimize the EVM_{max} value using the signal with additive white gaussian noise considering the Receiver OSNR(min). (add editor’s note: the first TBD is the number of taps and the second TBD is the type of tap being either real or complex)

156.9.10.1.2.6 EVM Calculation

Find the peak vector normalization scaling factor from Equation (156 - 1).

(156 - 1)

$$\alpha = \sqrt{\frac{max_{0 \le k < K}(I_{ref}(k)^2 + Q_{ref}(k)^2)^2}{\frac{1}{K}\sum_{k=0}^{K-1}(I_{ref}(k)^2 + Q_{ref}(k)^2)}}$$

Normalize the sample pairs I_d and Q_d in each of the polarizations using the average power multiplied by the peak vector constellation scaling factor from Equation (156 - 2).

(156 - 2)

$$\alpha_{peak} = \alpha\sqrt{\frac{1}{N}\sum_{\eta=0}^{N-1}(I_\delta(\eta)^2 + Q_\delta(\eta)^2)}$$

Find the nearest constellation pair $I_{ref}(h)$ and $Q_{ref}(h)$ for each normalized sample pair I_d and Q_d in each of the polarizations.

Calculate the error vector magnitude for each normalized sample pair I_d and Q_d in each of the polarizations from Equation (156 - 3)**Error! Reference source not found.**.

(156 - 3)

$$\mathrm{EVM}(n) = \sqrt{(I_\delta(\eta) - I_{ref}(\eta))^2 + (Q_\delta(\eta) - Q_{ref}(\eta))^2}$$

where h is the symbol number within the block starting at 0.

Using all the N samples from the x-polarization calculate $EVM_{max,x}$ from Equation (156-4).

(156 - 4)

$$EVM_{max,x} = \sqrt{\frac{1}{N}\sum_{\eta=0}^{N-1} EVM(\eta)^2}$$

Using all the N samples from the y-polarization and calculate $EVM_{max,y}$ from Equation (156 - 5).

(156 - 5)

$$EVM_{max,y} = \sqrt{\frac{1}{N}\sum_{\eta=0}^{N-1} EVM(\eta)^2}$$

Then calculate EVM_{max} in percent from Equation (156 - 6)**Error! Reference source not found.**.

(156 - 6)

$$EVM_{max} = \sqrt{\frac{(EVM^2_{max,x} + EVM^2_{max,y})}{2}} \times 100\%$$