EVM Measurement Methodology for correlation for EVM TQM

Approved by

IEEE P802.3cw Task Force

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Proposed Test Plan for 400GBASE-ZR Standardization Work
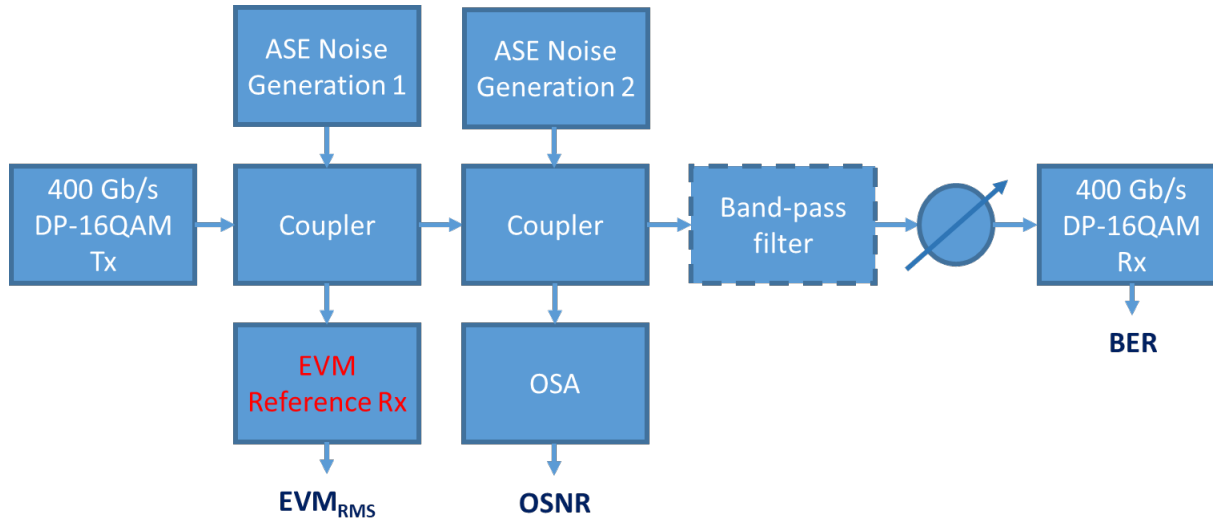
Measurements setups

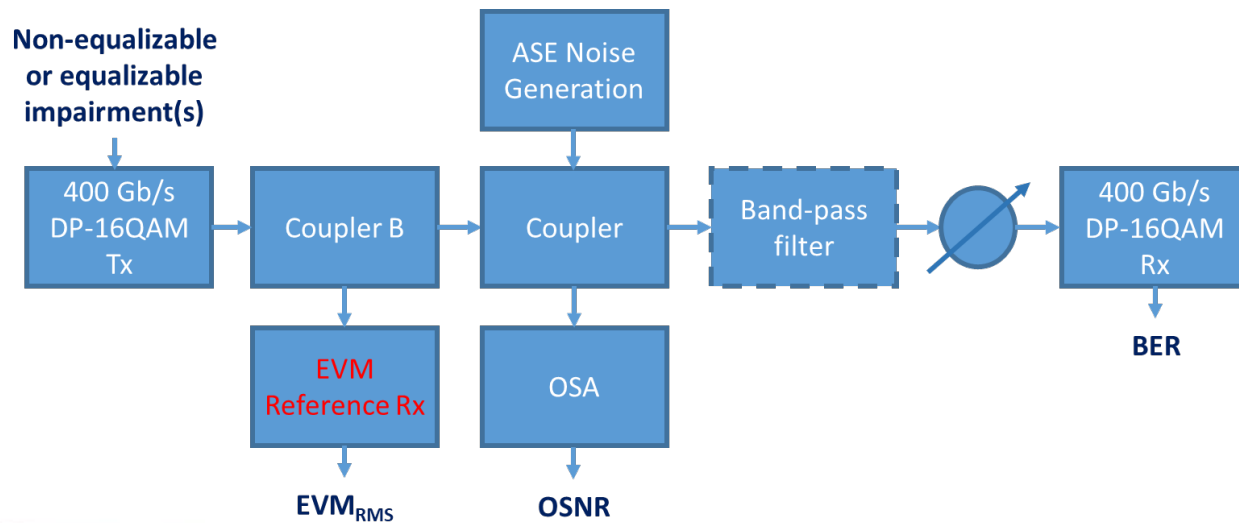Fig. 1 Measurement setup for OSNR penalty vs EVM for non-equalizable noise like impairment.

Fig. 2 Measurement setup for OSNR penalty vs EVM for non-equalizable (circle-like noise) or equalizable impairment(s).

The measurement setup in Fig. 1 (for noise like impairment) and the one in Fig. 2 (for non-equalizable or equalizable impairments) should be used to test if the following parameters can be covered by EVM:

- I-Q offset;
- Quadrature error;
- I-Q imbalance;
- I-Q skew;
- Non-linearities;
- non-equalizable impairment like circle-like noise (zero mean noise with fix magnitude and incremental phase) as shown in _anslow_3cn_01_181025_;
- non-equalizable noise like impairment;

Test setup conditions include:

- Relative Tx Polarization power imbalance. Maximum limit – 1.5 dB.

Measurements should be taken at a constant optical input power to the DP-16QAM receiver and EVM Reference Rx. Note - Needs further input & discussion. Suggest to add statement to detailed steps in slides 7-10.

For this exercise, it is assumed that the Test DP-16QAM Transmitter and the DP-16QAM Receiver are from the same implementer. Testing from multiple implementations to confirm observed trends across implementations would be preferred.

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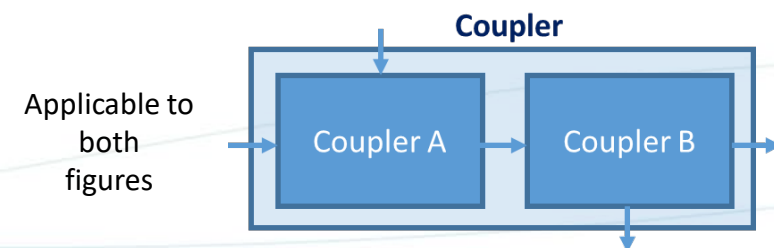
EVM Reference Rx
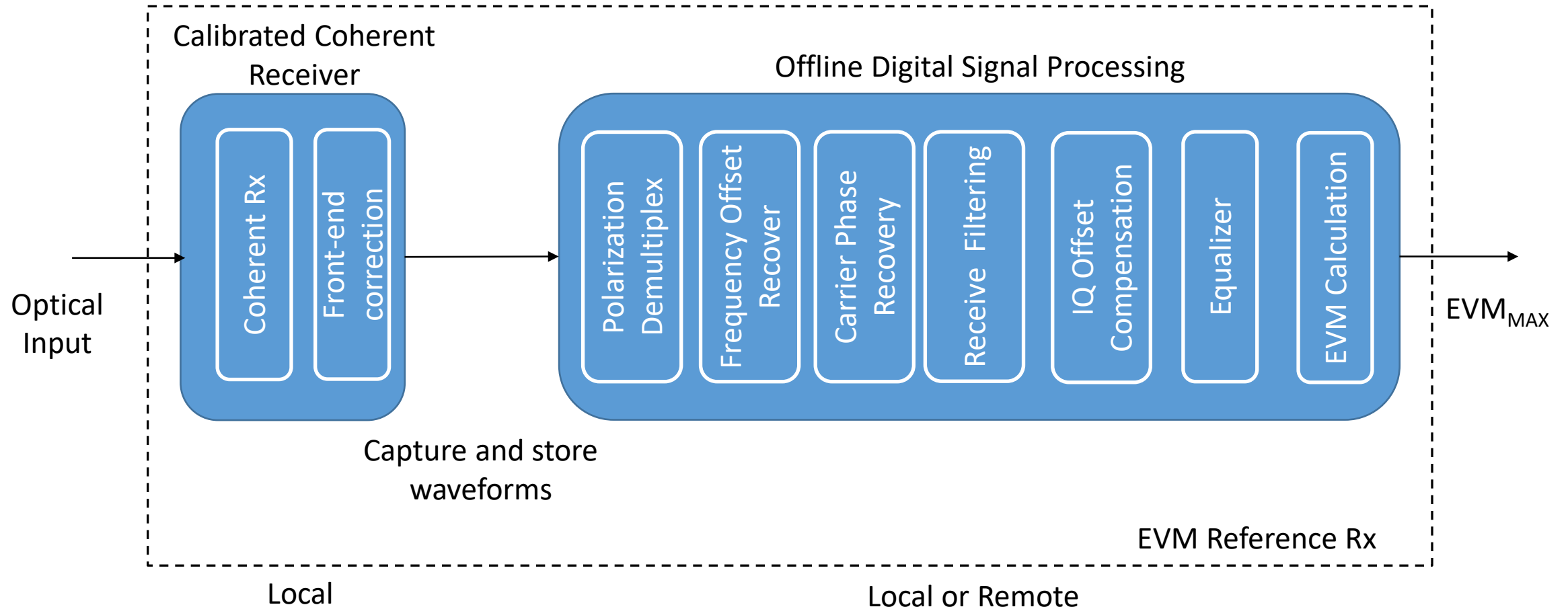
- Calibrated coherent receiver: always "local" to transmitter under test
- Offline digital signal processing: can be either "local" or "remote" to transmitter under test

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Measurements based on setup in Fig. 1

If measuring non-equalizable noise-like impairment using the setup in Fig. 1 the following steps are used:

1) OSNR Penalty Testing
   1. Without ASE noise generation 1, adjust the ASE noise generation 2, to get the considered pre-FEC BER of 1.25e-2; the OSNR value is measured ($OSNR_0$). Capture the optical waveform at the output of the Calibrated Coherent Receiver, which will be used to calculate EVM_{MAX0}
   2. OSNR Penalty - The OSNR Penalty Testing should cover at least 0-2.4dB OSNR penalty and should consists of at least 7 points. Each point should be obtained tuning the impairment under consideration such to get a point-to-point variation of not more than 0.4dB OSNR penalty.
      a) Introducing ASE noise generation 1, the pre-FEC BER is changed (not 1.25e-2 anymore). Capture the optical waveform at the output of the Calibrated Coherent Receiver.
      b) Adjust the ASE noise generation 2, to set pre-FEC BER at 1.25e-2 again, then turn-off ASE noise generation 1 and then the second OSNR value is measured ($OSNR_1$), the OSNR penalty is ($OSNR_1$-$OSNR_0$).
   3. Change the ASE noise generation 1 and repeat step 2. Capture the optical waveform at the output of the Calibrated Coherent Receiver and measure the OSNR value as noted.

2) EVM Analysis

   a) For each optical waveform captured, EVM_{MAX} is calculated with "Digital Signal Processing" as per current IEEE P802.3cw draft

   b) The curve of OSNR penalty versus EVM_{MAX} is obtained.
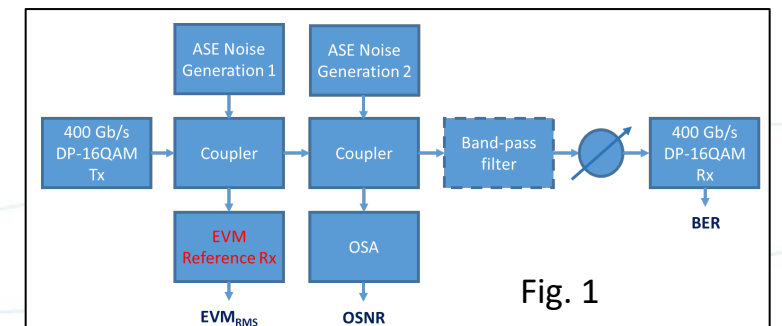
Fig. 1

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Measurements based on setup in Fig. 2

It is preferred that measurements are obtained independently for each parameter, i.e as the effect of varying one parameter is being measured the other parameters remain unchanged.

Using IQ offset as an example the procedure is:

1) OSNR Penalty Testing

   1) Adjust the ASE noise generation, to get the considered pre-FEC BER of 1.25e-2; OSNR value is measured ($OSNR_0$). Capture the optical waveform at the output of the Calibrated Coherent Receiver, which will be used to calculate EVM_{MAX0}

   2) OSNR Penalty - The OSNR Penalty Testing should cover at least 0-2.4dB OSNR penalty and should consists of at least 7 points. Each point should be obtained tuning the impairment under consideration such to get a point-to-point variation of not more than 0.4dB OSNR penalty.

      a) Modify the transmitter to give a certain value of IQ offset and Capture the optical waveform at the output of the Calibrated Coherent Receiver.

      b) The pre-FEC BER is changed (not 1.25e-2 anymore), Adjust the ASE noise generation, to set pre-FEC BER at 1.25e-2 again, then the second OSNR value is measured ($OSNR_1$), the OSNR penalty is ($OSNR_1$-$OSNR_0$).

   3) Modify the transmitter to give a certain value of IQ offset and repeat the b) part of step 2). Capture the optical waveform at the output of the Calibrated Coherent Receiver and measure the OSNR value as noted.

2) EVM Analysis

   1) For each optical waveform captured, EVM_{MAX} is calculated with "Digital Signal Pro

   2) The curve of OSNR penalty versus EVM_{MAX} is obtained.
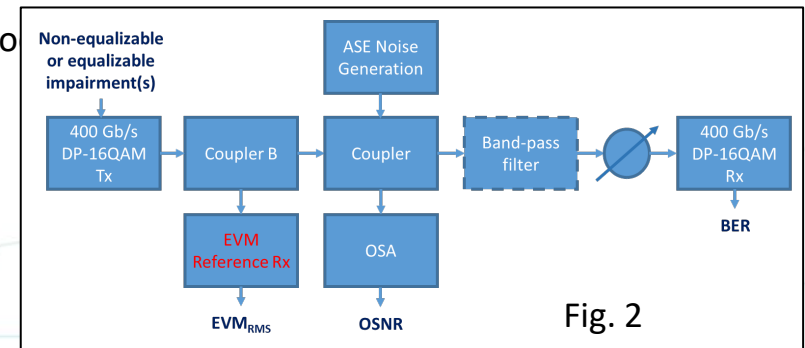
Fig. 2

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Evaluate Suitability of EVM_{MAX} metric for DP-16QAM

Step 1:

1) Generate OSNR penalty versus EVM_{MAX} plots containing noise like impairments and deterministic impairments (as example circular impairment) using the setups as shown in Fig. 1 and Fig. 2. The two plots should lie on top of each other.

2) Introduce a 3rd line for an individual impairment like IQ offset, quadrature error, IQ imbalance (just one impairment at the time) which shows OSNR penalty vs <u>uncompensated</u> EVM_{MAX}.

3) Then check if the 3rd line for the particular impairment is very close to the other two lines. If this is the case we do not need to treat it as separate impairment and we would not need to compensate for it in the EVM calculation.

4) In case the 3rd line is sufficiently different to the other two lines then we will need to compensate for it (as it has happened for IQ-offset for 100 Gb/s DP-DQPSK transmitters).

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Evaluate Suitability of EVM_{MAX} metric for DP-16QAM

Step 2 (to be addressed after step 1 is completed).

Check the OSNR penalty for combination of impairments that remain compensated by the compensated EVM metric after step 1:

1) Generate OSNR penalty versus "compensated impairment(s)" plot(s) and define a suitable limit for the individual impairment. P802.3cw would need to discuss how to define those limits based on what the performance impact and current transmitter capability is.

2) Apply the combination of individual impairments with the limit defined in 1) and measure the associated OSNR penalty.

3) Establish whether the measured OSNR penalty is acceptable. In case it is not acceptable we need to re-define the limit for the individual impairment (back to 1)).