EDC Performance Evaluation
A Test Procedure Proposal

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Scope

- To align several simulation procedures devoted to qualify the functionality of Electronic Dispersion Compensator (EDC) systems

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Purpose of EDC

- EDC architecture must be capable to improve system power budget and link length in the Multi-Mode Fiber (MMF) transmission against several impairments which impact during long term operation.

- EDC is to partially mitigate the pulse distortion providing a sort of pulse reshaping and consequently eye opening.

MMF Characteristics

- Pulse dispersion of MMF is mainly due to Modal Dispersion (MD).

- MMF performance is affected by
  - refractive index profile
  - launching conditions of transmitter.

- The impulse response of a given MMF sample can spread over an almost infinite number of different pulse profiles.

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Offset Launch

- The Offset-Launching (OSL) solves the problem of central dip by means of disregarding the central part of the core section
- The OSL approach although rises the sensitivity of the transmitted pulse respect to core-cladding boundary conditions and related environmental effects.

Evaluation Procedure

- The following procedure will give a unified method to be used for both simulation and measurements of the Electronic Dispersion Compensator under evaluation over MMF link.

Defining References

- This EDC evaluation procedure can be used both for MMF link simulation and measurements.
- The transmitter and the receiver under test must be clearly specified.
- They must not be general abstract models, instead they must represent a reference situation for real MMF systems.

Defining References

- The EDC performance must be evaluated by comparison of the transmission system performance *with and without* EDC, but mostly important, assuming a common reference receiver and transmitter pair.
- Transmitter and receiver parameters, like noise power spectral density, linearity, extinction ratio, jitter, RIN…can be specified according to standard mask and prescriptions.

Procedure Outline

1. BTB Ref BER Test
   – Reference optic without EDC
2. BTB EDC BER Test
   – Reference optic with EDC
3. MMF BER Test
   – MMF link length L_1 with reference optic
4. MMF EDC BER Test
   – MMF link length L_1 with reference optic and EDC

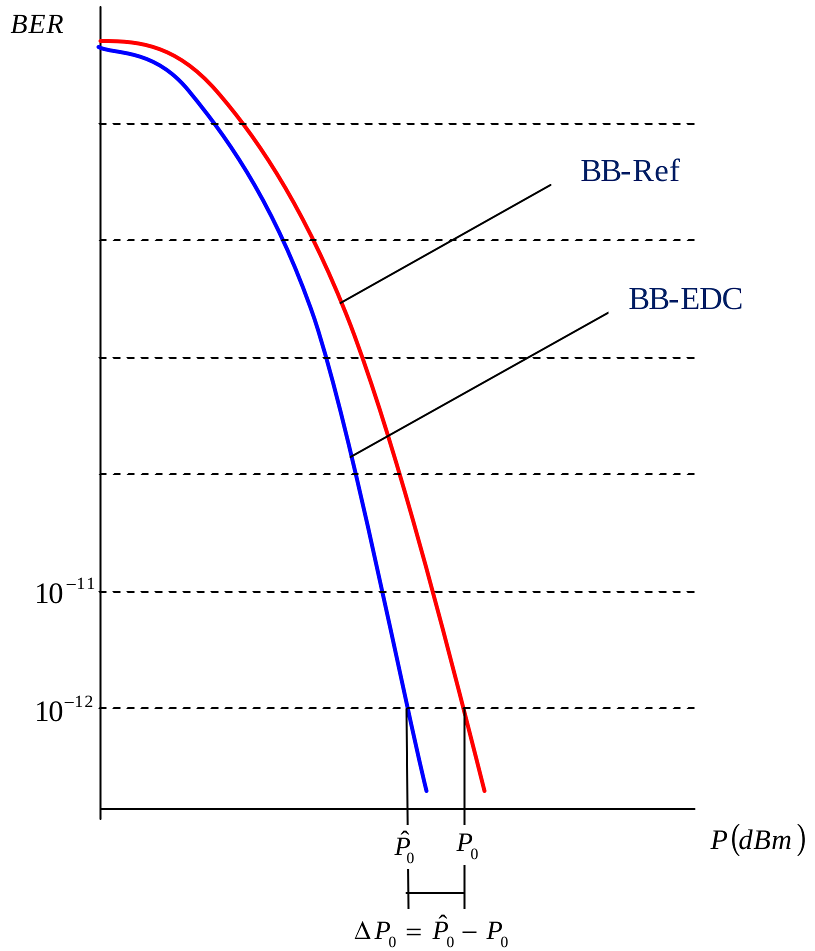
1 - BTB Ref BER Test

- With the reference sub-system as above let us perform first the BER performance test (simulating it or measuring it) in the Back-to-Back (BB) condition, without optical fiber but including optical attenuators.
- Once the BTB-Ref BER test has been completed, let us mark the sensitivity corresponding to some reference error rate, like BER=10^{-12}.

2 - BTB EDC BER Test

- After the BB-Ref test has been completed, the EDC can be included in the reference receiver module following the ROSA section and a second BB-EDC test must be performed.
- Using the same reference error rate as before, BER=10^{-12}, let us mark the sensitivity $\hat{P}_0(dBm)$ and take the difference $\Delta P_0 = \hat{P}_0 - P_0$

2 - BTB EDC BER Test



3 - MMF BER Test

- Assuming the MMF fiber impulse response is known for every given fiber link length, let us perform now the BER test including the fiber response between the transmitter and the receiver of the reference sub-system, *but without the EDC*.
- If available, let us take the input optical power level corresponding to a BER=10^{-12} and mark it as P_1 .

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4 - MMF EDC BER Test

- Insert the EDC after the ROSA and let us repeat the same BER test as before including the fiber link length L1.
- If available, let us take the input optical power level corresponding to a BER=10^{-12} and mark it as $\hat{P}_1$. Let us take the difference $\Delta P_1 = \hat{P}_1 - P_0$.
- After N repeated BER tests, we have collected N+1 optical power differences ΔP_k , $k = 0,1,2,\ldots,N$ where $k = 0$ corresponds to BB-EDC condition.

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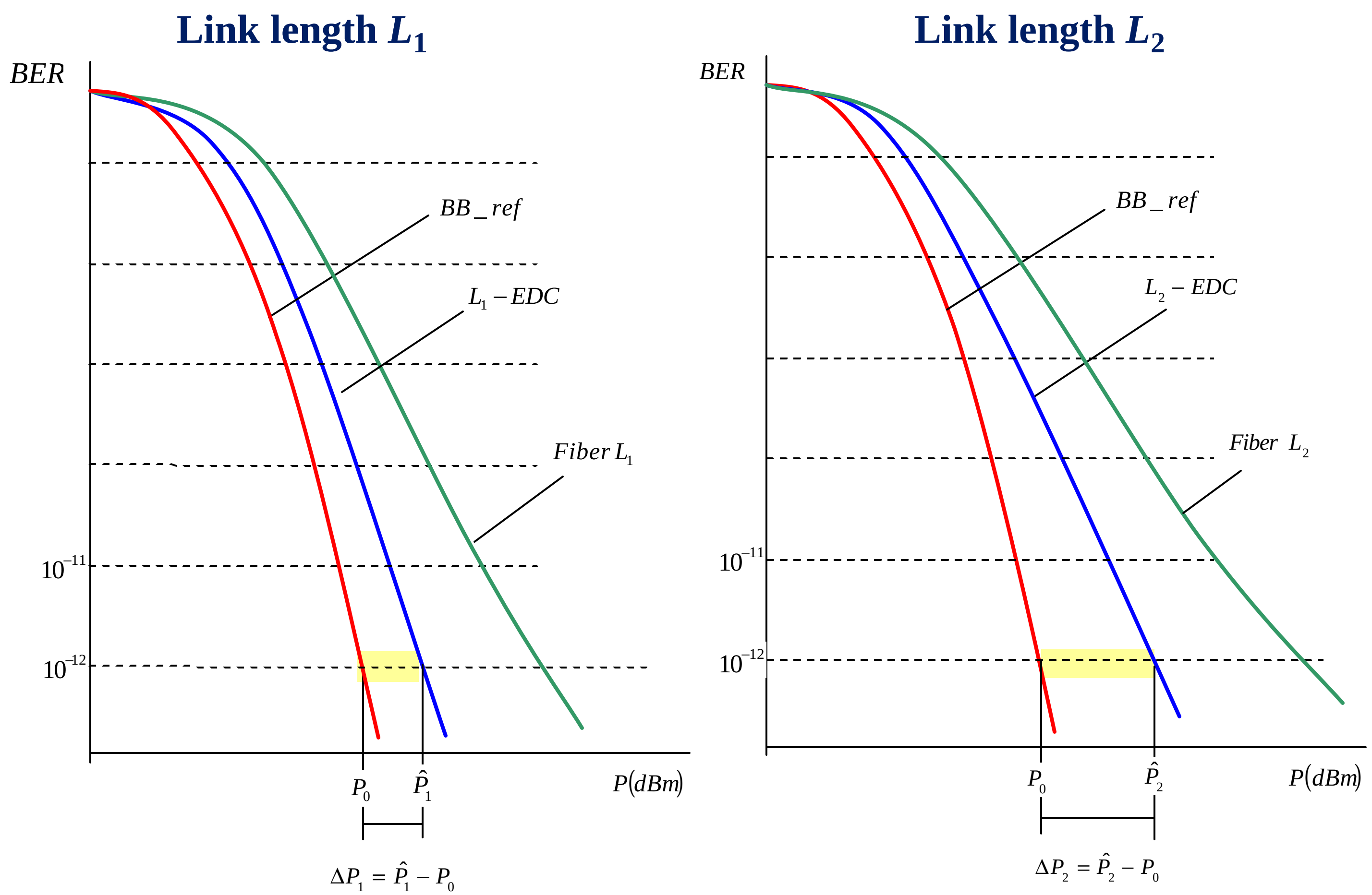
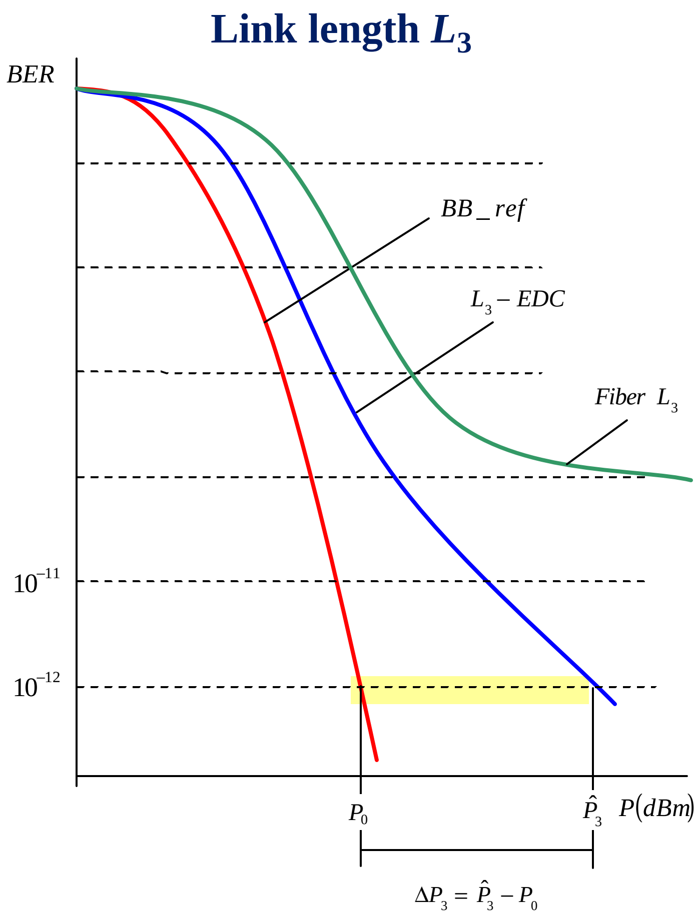
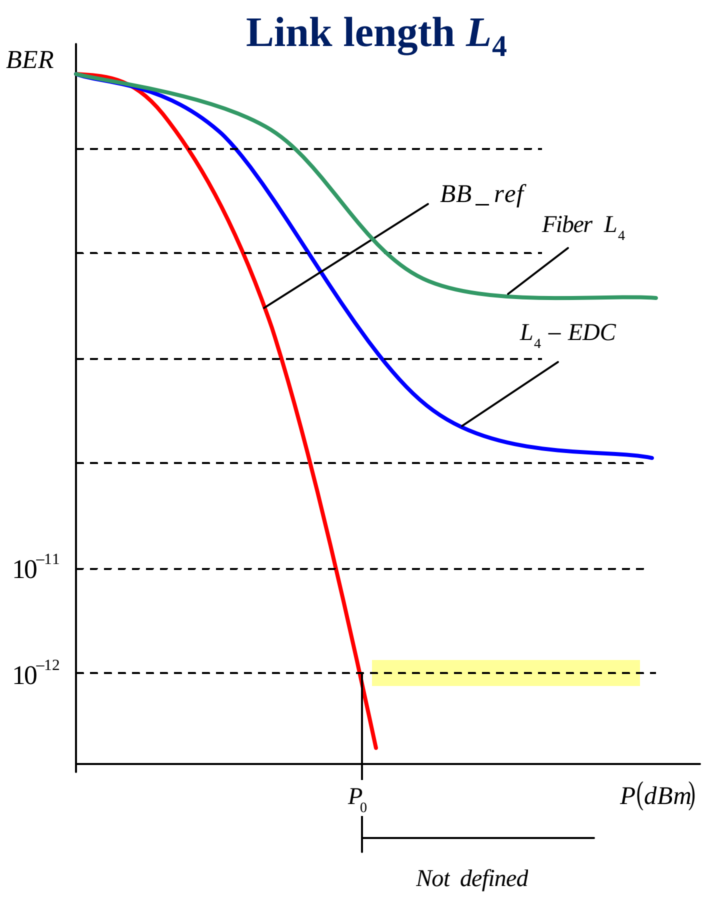
BER Results



Link length L_1
BER
BB_ref
$L_1 - EDC$
$Fiber\ L_1$
10^{-11}
10^{-12}
P_0
$\hat{P}_1$
$P(dBm)$
$\Delta P_1 = \hat{P}_1 - P_0$
Link length L_2
BER
BB_ref
$L_2 - EDC$
$Fiber\ L_2$
10^{-11}
10^{-12}
P_0
$\hat{P}_2$
$P(dBm)$
$\Delta P_2 = \hat{P}_2 - P_0$

BER Results





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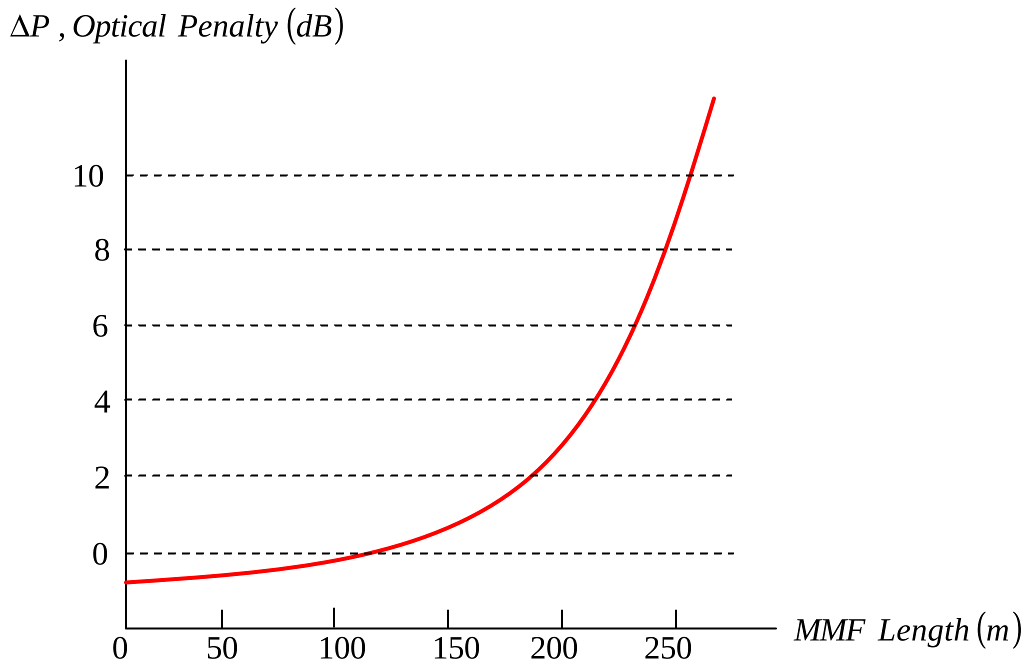
EDC Evaluation Summary

- The final plot gives a quantitative criterion for evaluating the performances of EDC based optical receiver over MMF link.



Conclusions

- The proposed evaluation procedure for EDC based optical receiver serves as a common reference test in order to align compensation performances through different EDC architectures and technologies.
- The optical transmission system is not a digital system and it cannot be evaluated assuming only digital interfaces and tool characteristics of conventional DSP.

Conclusions

- In order to have quantitative link length extension or improved link margin, it is not sufficient to evaluate EDC performance just in terms of eye closure reduction.
- Since EDC works between optical front-end and clock recovery, its frequency response during adaptive equalization changes the noise bandwidth of the whole optical receiver and this affects signal to noise ratio and related BER performances.