MMF Pulse Response and the Impact on EDC

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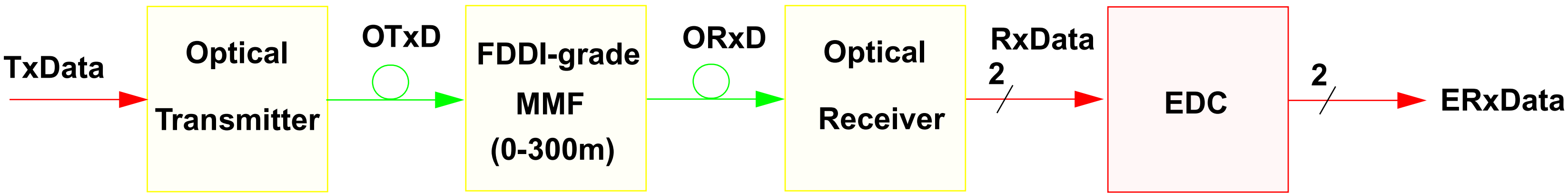
1. Outline

- System Level View using Electronic Dispersion Compensation (EDC)
- Simulation and Test Methodology
- MMF Pulse Response Analysis

  - Normalized Pulse Response Group1
  - Normalized Pulse Response Group 2
  - Normalized Pulse Response Group 3
- Estimated Relative Complexity for EDC Implementation
- Summary

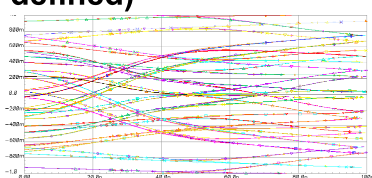
2. System Level View using Electronic Dispersion Compensation (EDC)



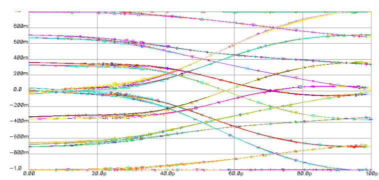
- Optical Transmitter and FDDI-grade MMF are analysed based on pulse response

  - TxData and OTxD can be evaluated using existing methodologies
  - ORxD will require additional parameters for evaluation

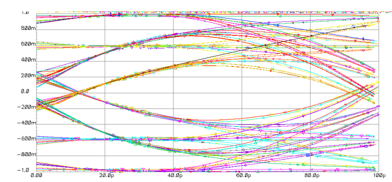
- Optical Receiver will require additional parameters for evaluation (most cases an eye opening for RxData can not be defined)



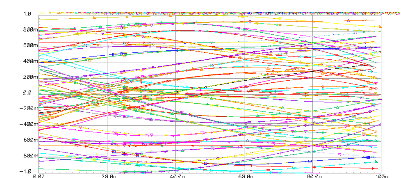
MMF1_1



MMF1_2



MMF2_1



MMF2_2

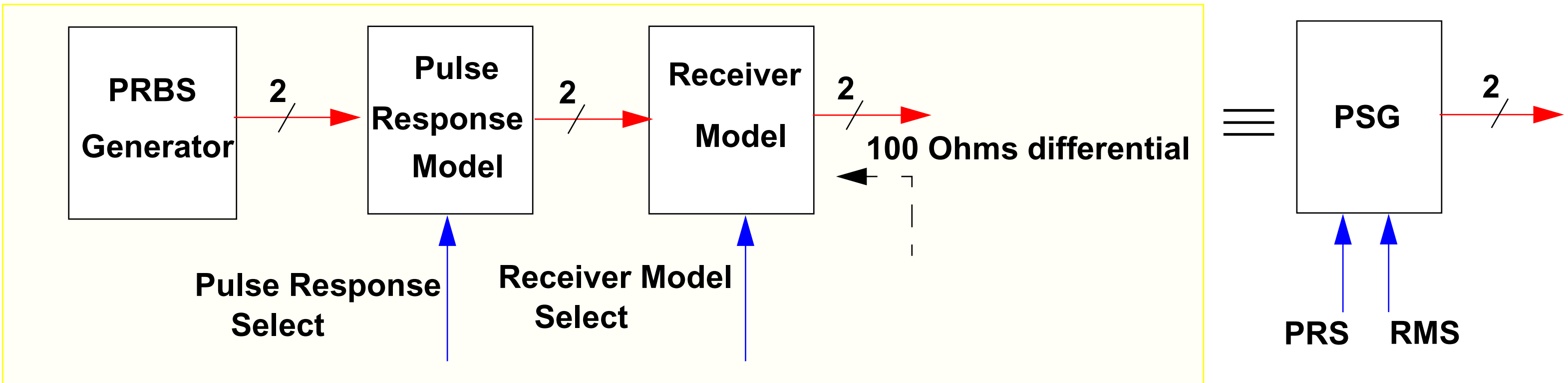
- EDC design and performance will be impacted by all other system components

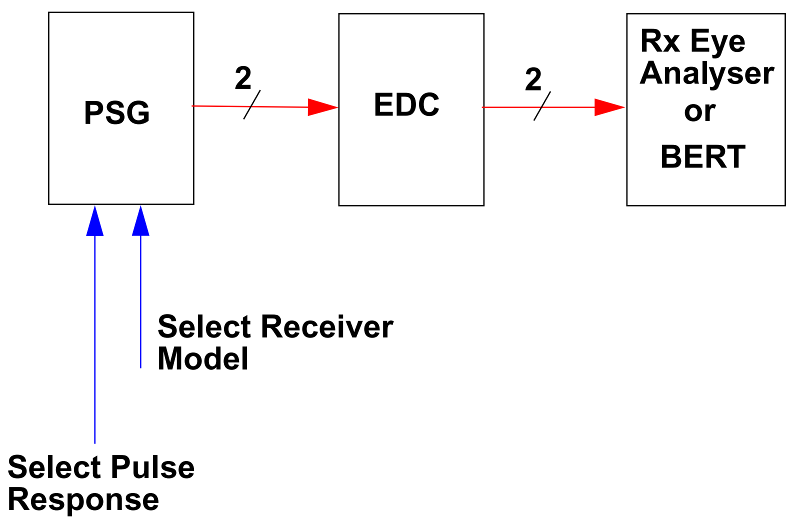
  - FDDI-grade MMF pulse response
  - Optical receiver noise
  - Optical receiver bandwidth and group delay ripple
  - Optical receiver linearity

- FDDI-grade MMF pulse response and the impact on EDC complexity will be analysed in this contribution.

3. Simulation and Test Methodology

Programmable Signal Generator (PSG) for EDC simulation and test



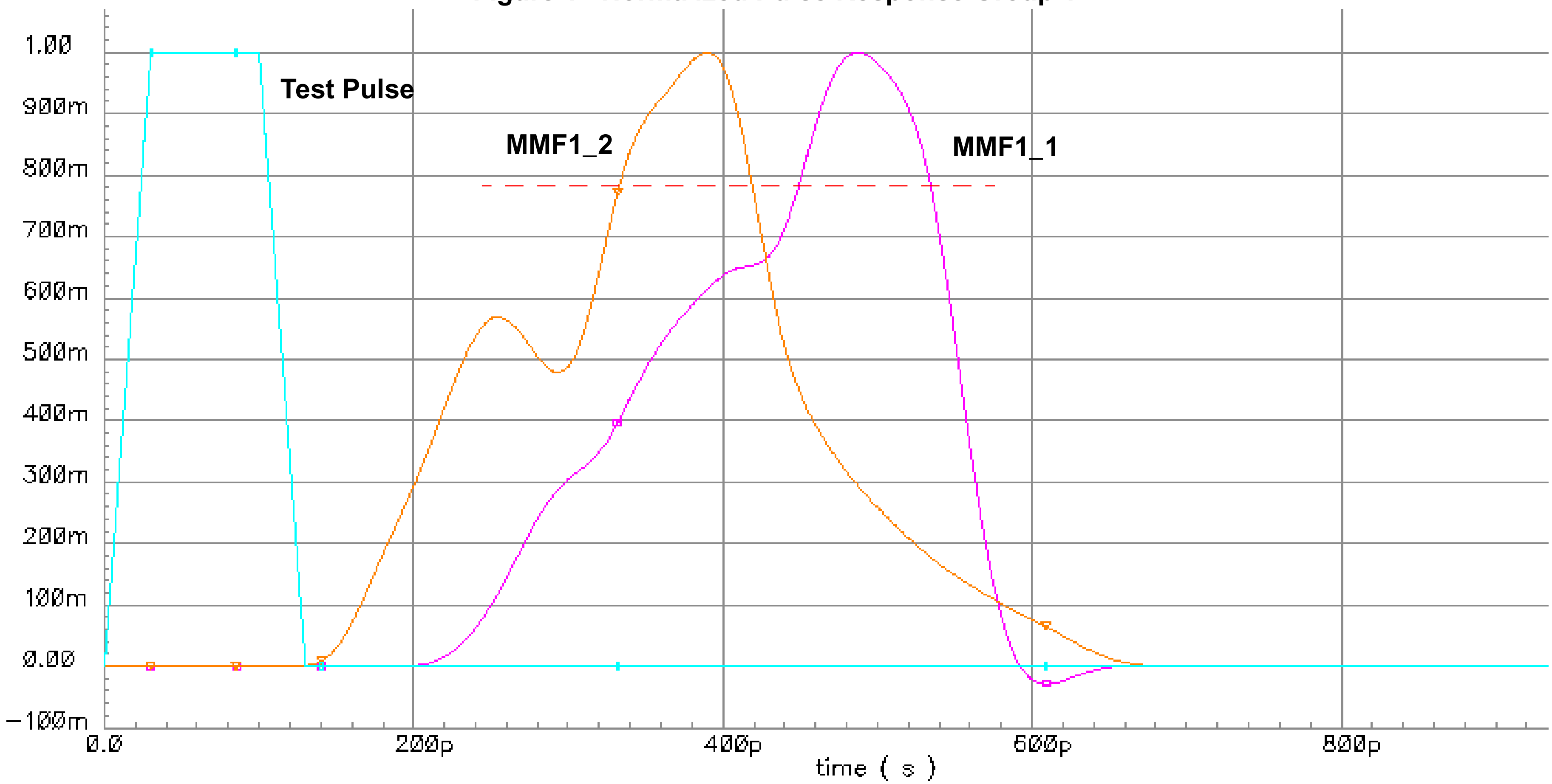


- Pulse response models are defined based on the type of pulse distortion and power distribution. The worst cases will be used for simulation and compliance testing (MMF and EDC).

- Receiver models are defined based on
  - bandwidth (-3 dB electrical)
  - group delay ripple
  - electrical SNR
  - linearity (THD)

4. MMF Pulse Response (1)

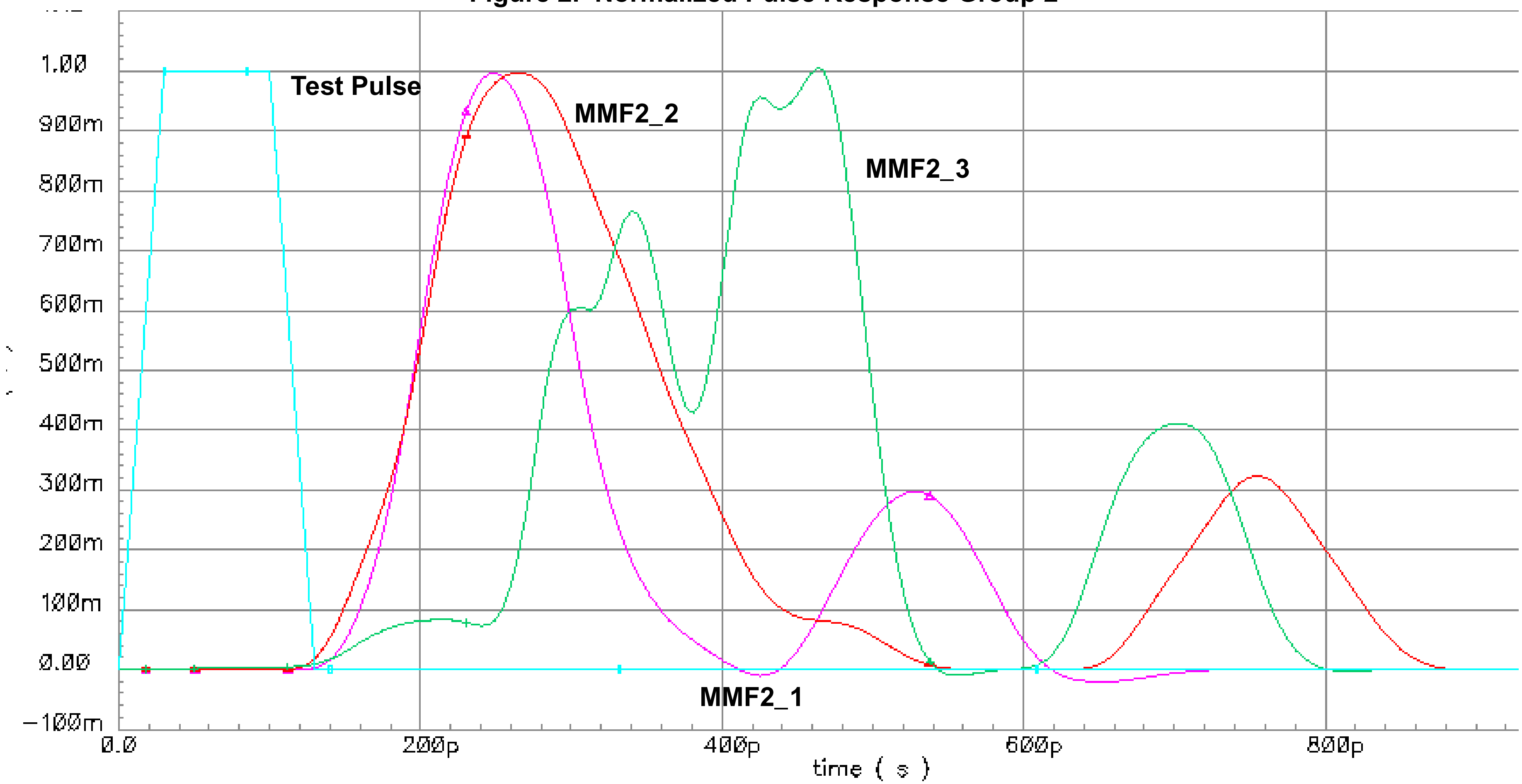
Figure 1. Normalized Pulse Response Group 1



- Test pulse width 100 ps, rise and fall times 30 ps,
- Pulse width increased up to 500 ps (400 ps for MMF1_1),
- One main pulse (the spacing of a parasitic pulse relative to the main pulse is less than pulse width, and much lower power),
- A simple equalization solution consists of an adaptive slicing level (very sensitive to noise and receiver nonlinearities).

5. MMF Pulse Response (2)

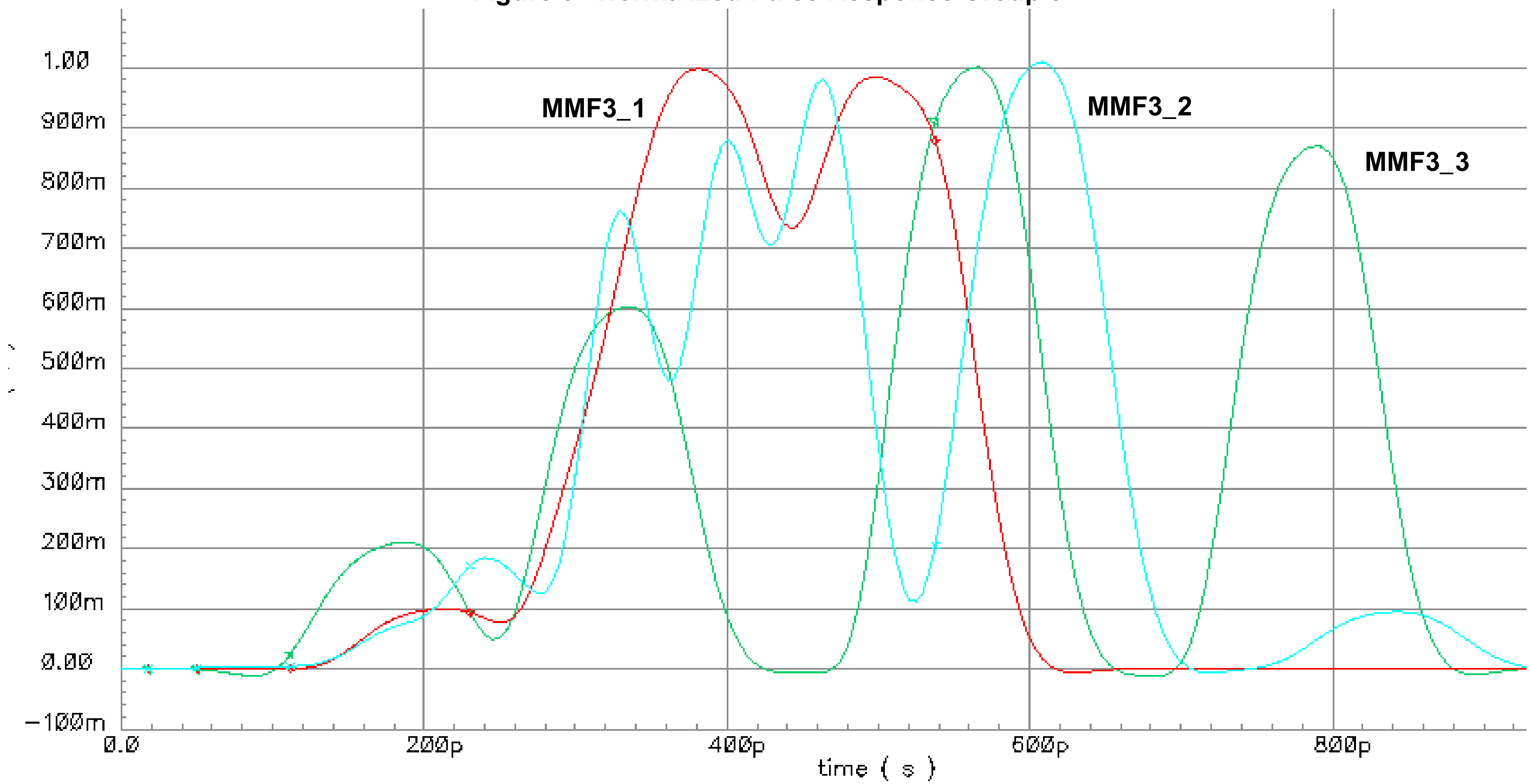
Figure 2. Normalized Pulse Response Group 2



- Test pulse width 100 ps, rise and fall times 30 ps,
- Pulse width increased up to 500 ps (150 ps for MMF2_1, 200 ps for MMF2_2),
- One main pulse (the spacing of a parasitic pulse relative to the main pulse is more than one pulse width, and much lower power),
- The equalization will require several stages of FFE and DFE

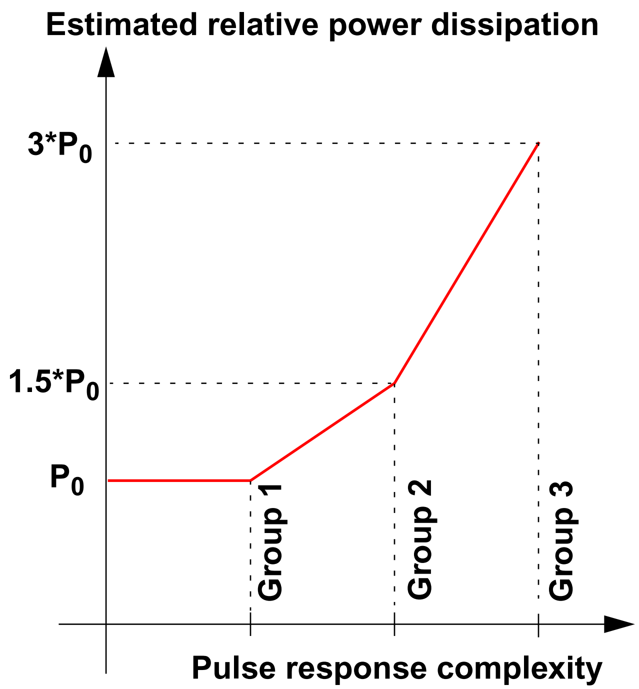
6. MMF Pulse Response (3)

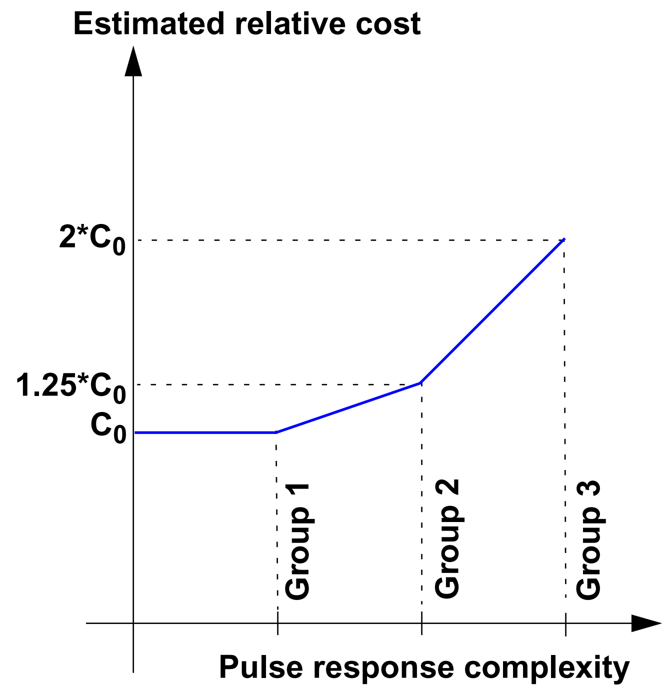
Figure 3. Normalized Pulse Response Group 3



- Test pulse width 100 ps, rise and fall times 30 ps,
- Pulse width increased up to 300 ps (MMF3_1) with two or more equal power pulses
- The spacing of a parasitic pulses (MMF3_2 and MMF3_3) relative to the main pulse is more than one pulse width, and the power levels are very close,
- The equalization will require many stages of FFE and DFE and a unique solution may not be found, depending on pulse separation in time relative to the bit time (MMF3_3).

7. Estimated Relative Complexity for EDC Implementation





- Any EDC implementation will require a number of I/O's, a minimum of monitoring and test access points, and a management interface that are included in the base numbers for power dissipation (P_0) and cost (C_0, including the die, the package and the basic functionality test cost).

- The increase in relative power dissipation and cost for Group 2 type pulse response, are much smaller than for Group 3 type pulse responses.

8. Summary

- A test and simulation methodology, based on MMF pulse response model and receiver model, will allow for FDDI-grade MMF and EDC compliance test and characterization.
- The possible FDDI-grade MMF pulse responses have been divided into three groups, based on the pulse width, the number pulses including the relative power and time spacing.

  Note: The pulse response characterization and how we group the possible pulse responses, is required in order to define, simulate and test a solution. I have made an attempt to group the possible pulse responses, to evaluate if a solution exists for a specific group, and in this case how complex (relative power dissipation and relative cost) the solution is.

- Some complex pulse responses may not have a unique solution, independent of the complexity of the EDC type.
- The relative power dissipation has a significant increase for more complex pulse responses.
- The estimated relative cost increase for more complex pulse responses is less critical. The relative cost increase due to test hardware complexity was not included.