802.3cb PMD and Channel

SEAGATE

Anthony Calbone 3/14/2016

Overview

- The presentation introduces a single link segment for each 2.5 Gb/s and 5 Gb/s for 802.3cb
- This link segment is described for two different reference models, a “backplane reference model" and a “storage reference model”.
  - The backplane reference model described in this presentation is based on 802.3bj
  - The storage reference model is new to 802.3 due to an asymmetric loss model
- The link segments budgets are derived from existing electrical data from SAS storage systems.

- Notes from previous meetings:
  - It was noted that the test point nomenclature needs work. I am keeping it the same until we decide on new nomenclature.

Test Point Definitions

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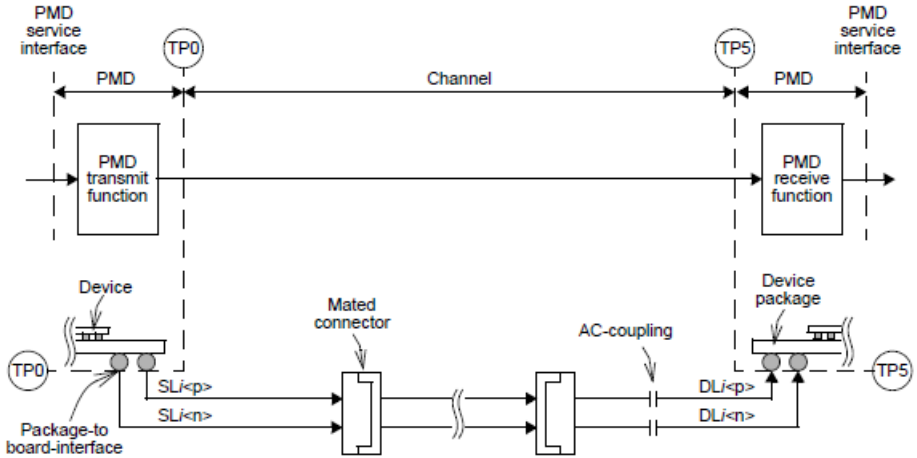
Backplane Reference Model Test Points

- Use 802.3bj as a reference to define ball-to-ball loss
- The is a closed and/or proprietary environment in which the only loss budget is ball-to-ball
- Test points used here are TP0, TP0a, TP5, and TP5a



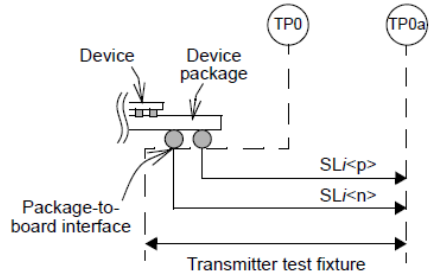


Figure 93–5—Transmitter test fixture and test points

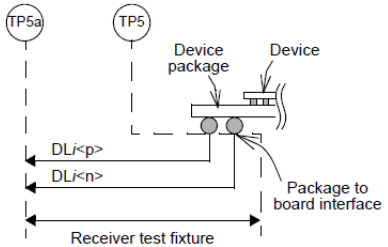
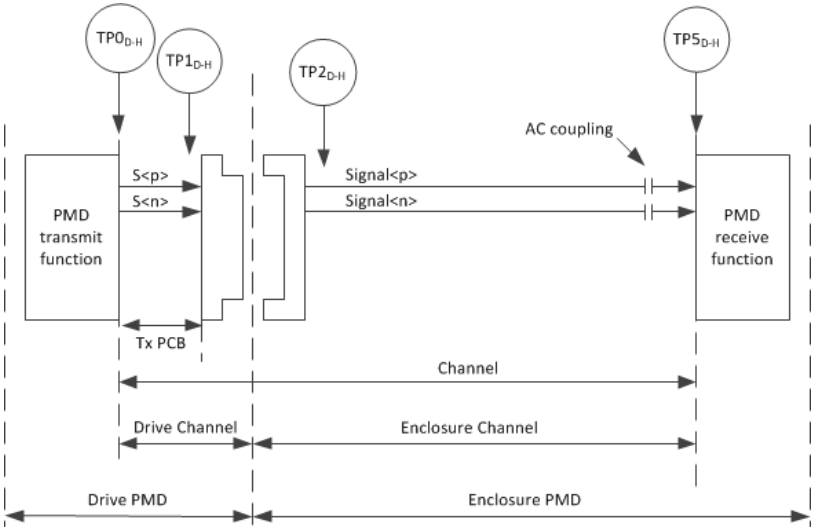


Figure 93–10—Receiver test fixture and test points

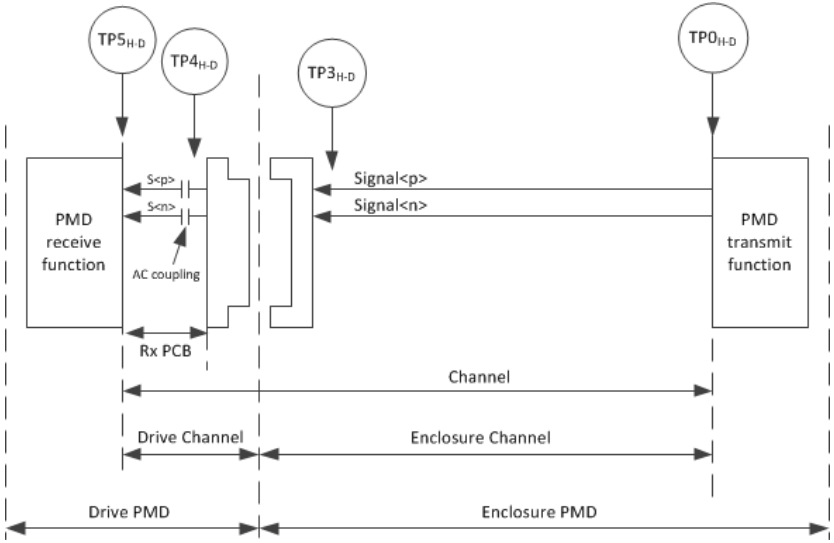
Storage Reference Model Test Points – Drive to Host

- For the storage application, it's important to budget the drive loss since it's an external component.
- The rest of the "box" is vender specific and can be any combination of cable and backplane
- This model is asymmetric, which is the reason there are two separate figures (the second one is on the next page)



Test Points	Descriptions
$TP0_{D-H}$ to $TP5_{D-H}$	The channel including the drive transmitter differential controlled impedance printed circuit board insertion loss and the enclosure insertion loss.
$TP0_{D-H}$ to $TP1_{D-H}$	The drive transmitter traces
$TP0_{D-H}$ to $TP2_{D-H}$	The mated connector pair has been included in the drive transmitter specifications.
$TP1_{D-H}$ to $TP5_{D-H}$	Enclosure channel with mated connector pair included.

Storage Reference Model Test Points – Host to Drive



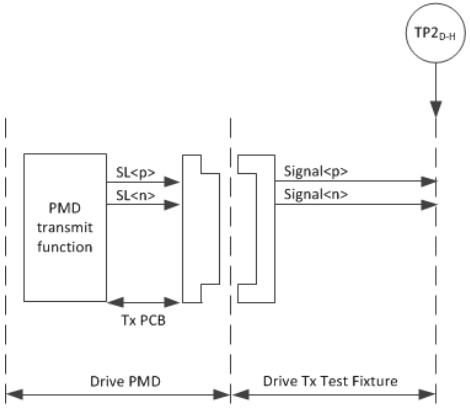
Test Points	Descriptions
$TP0_{H-D}$ to $TP5_{H-D}$	The channel including the drive receiver differential controlled impedance printed circuit board insertion loss and the enclosure insertion loss.
$TP4_{H-D}$ to $TP5_{H-D}$	The drive receiver traces
$TP3_{H-D}$ to $TP5_{H-D}$	The mated connector pair has been included in the drive reciever specifications.
$TP0_{H-D}$ to $TP4_{H-D}$	Enclosure channel with mated connector pair included.

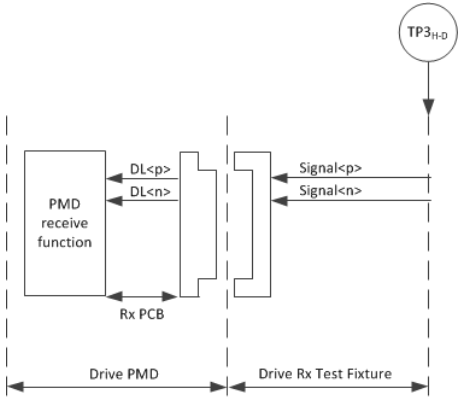
Storage Model – Compliance Measurement Locations

- There was much discussion at the January interim meeting regarding measurements of a storage system
- There are two use cases to consider with the enclosure
  - **Enclosure design:** There needs to be a reasonable way for an enclosure designer to determine compliance, or have some indication of compliance in an informative annex. This would need to be done pre-fabrication of the system.
  - **Assembled enclosure:** Some test points that would be available in simulation or in a design-for-test scenario will not be available in a production system. There needs to be a way to determine compliance at measureable test points.
- The drive compliance measurement locations are done after the mated connector and are more straight forward since there will be an open eye at this test point

Storage Model – Drive Measurement Locations

- The wording below is for brainstorming and does not imply adoption by the working group
- $TP2_{D\text{-}H}$
  - Drive transmitter compliance is measured through a test fixture to provide a measureable test point
- $TP3_{H\text{-}D}$
  - Drive receiver compliance is measured through a test fixture to provide a measureable test point (not all, but measurements such as return loss)
- Need wording similar to 802.3bj referencing the test fixture specification
  - Example wording is shown in the table below

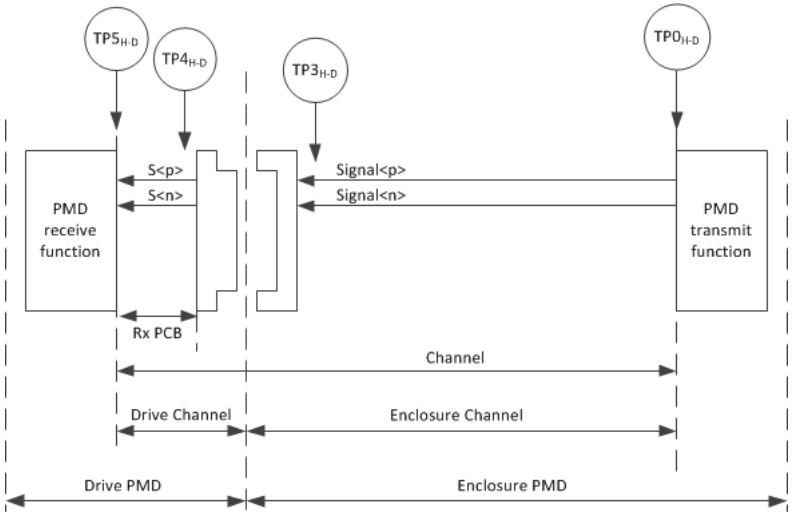




Test Points	Descriptions
$TP2_{D\text{-}H}$	Transmitter measurements of the drive are made at $TP2_{D\text{-}H}$.
$TP3_{H\text{-}D}$	Reciever measurements of the drive are made at $TP3_{H\text{-}D}$.

Storage Model – Drive Measurement Locations Cont'd

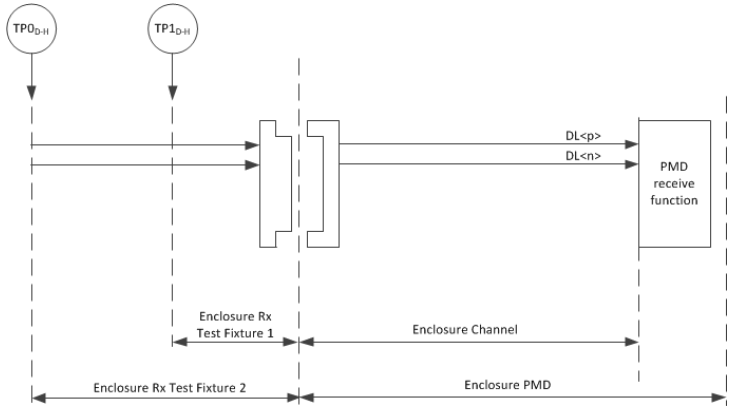
- $TP4_{H\text{-}D}$
  - Drive receiver tolerance testing is calibrated here. The calibration routine may "extend" the test point to $TP5_{H\text{-}D}$.
  - The idea is that the test is calibrated at $TP4_{H\text{-}D}$ to ensure the drive can operate with the delivered signal at the external interface.
- Need wording similar to 802.3bj referencing the test fixture specification
  - Example wording is shown in the table below

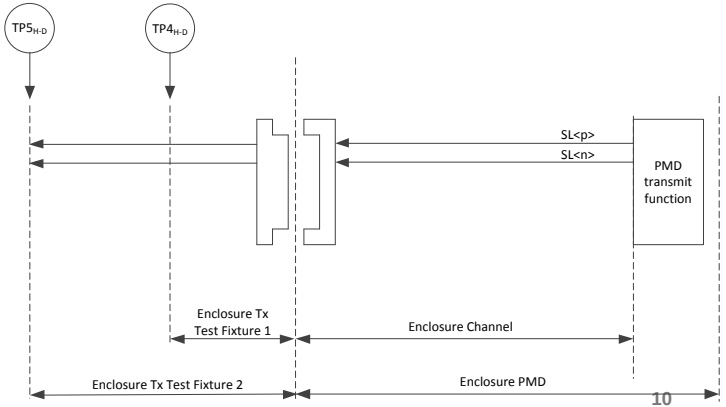


Test Points	Descriptions
$TP4_{H\text{-}D}$	Drive Rx tolerance test is calibrated at $TP4_{H\text{-}D}$.

Storage Model – Enclosure Measurement Locations

- The wording below is for brainstorming and does not imply adoption by the working group
- Test Fixture 1 would provide a low insertion method of measuring the enclosure
- Test Fixture 2 would provide a worst case drive loss to extend the measurement point to $TP0_{D-H}$ and $TP5_{H-D}$
- $TP4_{H-D}$ and/or $TP5_{H-D}$
  - Enclosure transmitter compliance is measured through a test fixture to provide a measureable test point.
- $TP1_{D-H}$
  - Enclosure receiver compliance is measured through a test fixture to provide a measureable test point (not all, but measurements such as return loss)
- Need wording similar to 802.3bj referencing the test fixture specification
  - Example wording is shown in the table below

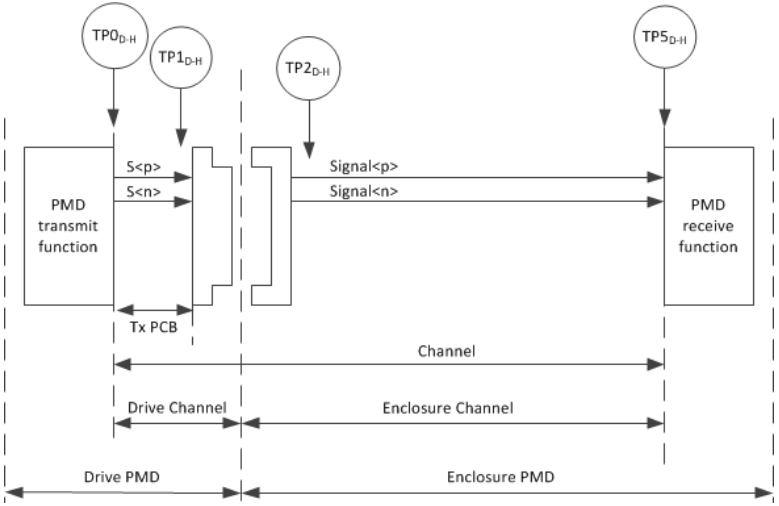




Test Points	Descriptions
$TP4_{H-D}$ and\or $TP5_{H-D}$	Transmitter measurements of enclosure are made here.
$TP1_{D-H}$	Receiver measurements of enclosure are made at $TP1_{D-H}$.

Storage Model – Enclosure Measurement Locations Cont'd

- $TP0_{D\text{-}H}$ and/or $TP1_{D\text{-}H}$
  - Enclosure receiver tolerance testing is calibrated here.
  - The idea is that the test is calibrated such that compliance testing ensures the enclosure can operate with the delivered signal at the external interface.
- Need wording similar to 802.3bj referencing the test fixture specification
  - Example wording is shown in the table below



Test Points	Descriptions
$TP0_{D\text{-}H}$ and\or $TP1_{D\text{-}H}$	Enclosure Rx tolerance test is calibrated here.

Storage Model – Enclosure Measurement Locations Cont'd

- Concerns relate to having both measureable test points on an assembled enclosure, in addition to having the ability to predict compliance in the design phase and a design-for-test enclosure build
- Design phase:
  - Potentially use COM with $TP0_{D\text{-}H}$ and $TP5_{D\text{-}H}$ during the enclosure design phase and a targeted design-for-test build
  - These test points can be made available in these situations
  - Can use the COM requirements for the Backplane reference model
- Assembled phase:
  - Discussions included the possibility of using COM on the "delivered signal" measured at $TP4_{H\text{-}D}$ or $TP5_{H\text{-}D}$ to determine compliance of an assembled enclosure transmitter. This would require the ability to use COM on a signal that has been measured with a scope.
  - Potentially using COM in combination with other measurements such as Rj with a clock-like pattern could be used

5 Gb/s Insertion Loss Budgets

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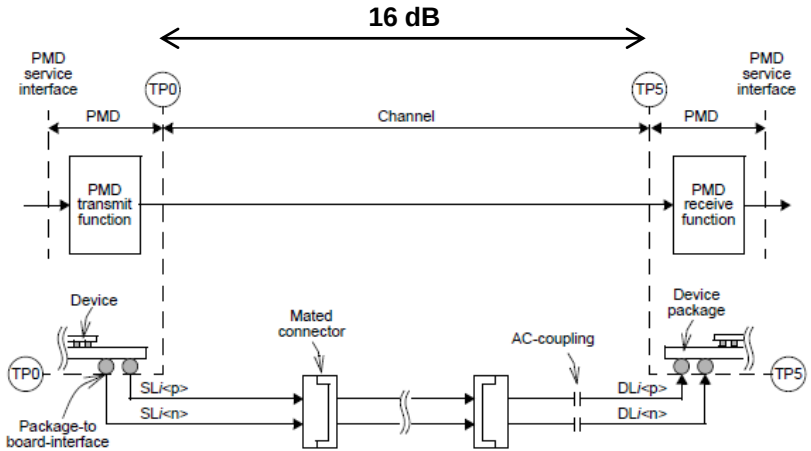
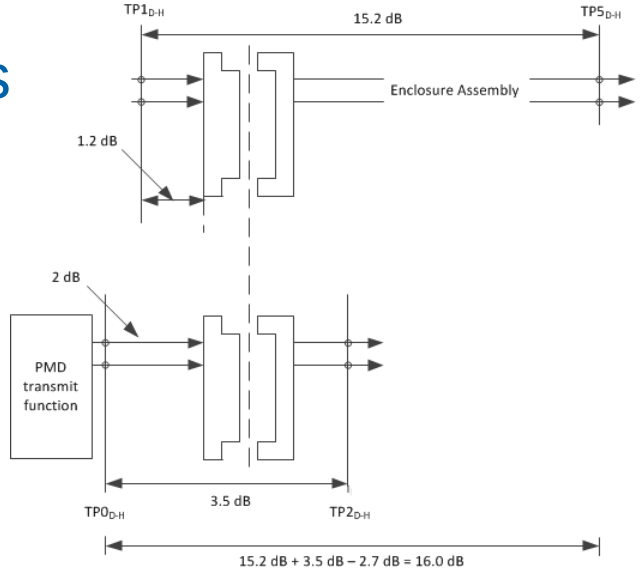
Backplane Reference Model for 5 Gb/s – Ball-to-Ball Loss

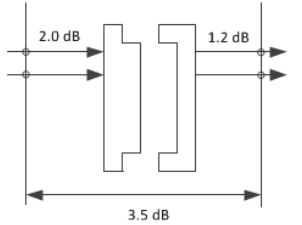
- All loss numbers are in reference to 2.578 GHz
- 16 dB of ball-to-ball loss from TP0 to TP5
- Mapping from 6G SAS
  - Removed 0.61 dB from the die-to-die SAS spec for this ball-to-ball to account for package loss spec as a starting point.
  - This number may need to be refined based on package loss requirements and COM results.
- Need insertion loss numbers between TP0 and TP0a, as well as TP5 and TP5a



Storage Reference Model Loss for 5 Gb/s

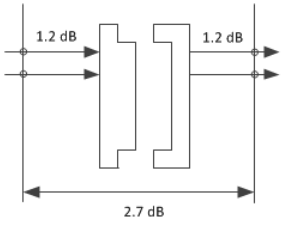
- TP0 to TP5 has same 16 dB ball-to-ball loss as the backplane reference model
  - Enclosure: 14 dB (storage enclosure without the drive)
  - Drive: 2 dB
- Only showing one direction
- Mapping from 6G SAS
  - Assume 0.75 dB for the zero-length test load fixture
- Test fixture assumptions to arrive at 1.2 dB
  - 2.5 in of trace using material with 0.2 dB of loss per inch
  - 1 m of SMA cable
  - If enclosure test fixture 2 is needed, this 1.2 dB value would need to be increased to 2 dB to represent the worst case drive loss.





Mated connector assembly and test point test fixture using enclosure test fixture 2

NOTE – The connector insertion loss is 0.3 dB for the mated test fixture.



Mated connector assembly and test point test fixture using enclosure test fixture 1

NOTE – The connector insertion loss is 0.3 dB for the mated test fixture.

2.5Gb/s Insertion Loss Budgets

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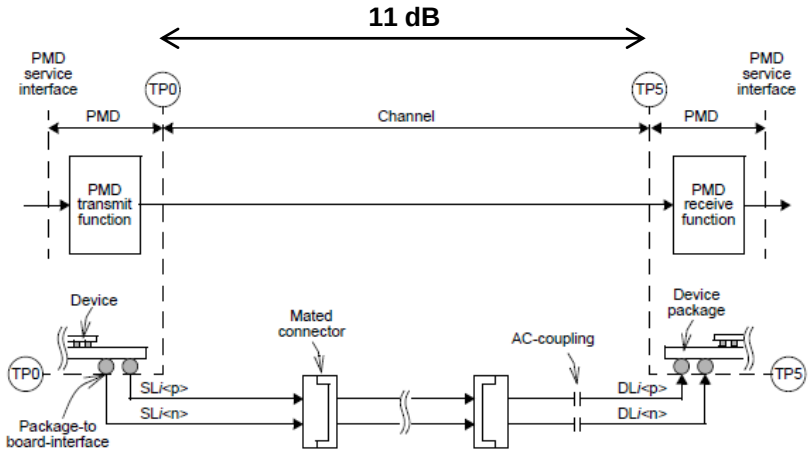
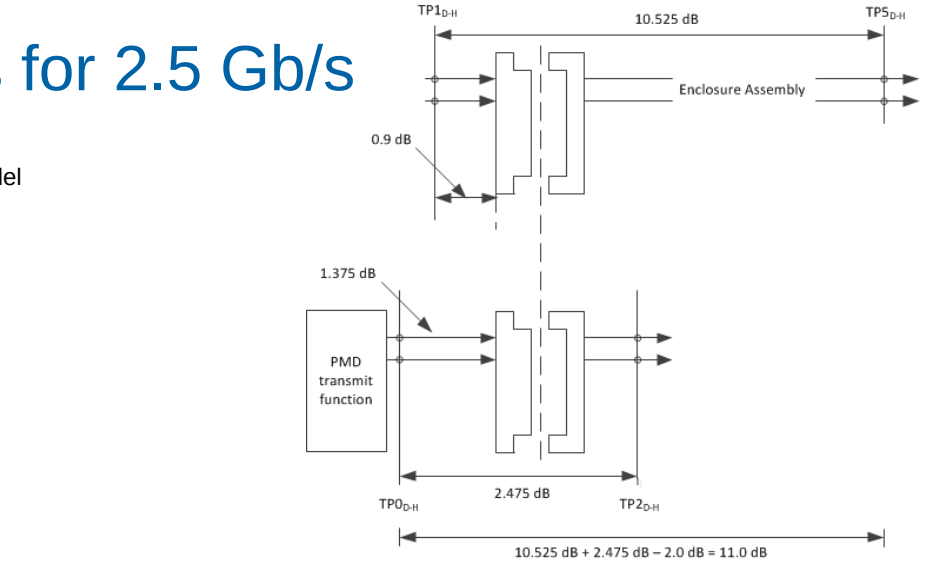
Backplane Reference Model for 2.5 Gb/s – Ball-to-Ball Loss

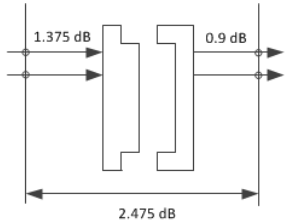
- All loss numbers are in reference to 1.5625 GHz
- 11 dB of ball-to-ball loss from TP0 to TP5
- Mapping from 6G SAS
  - Removed 0.38 dB from the die-to-die SAS spec for this ball-to-ball to account for package loss spec as a starting point.
  - This number may need to be refined based on package loss requirements and COM results.
- Need insertion loss numbers between TP0 and TP0a, as well as TP5 and TP5a



Storage Reference Model Loss for 2.5 Gb/s

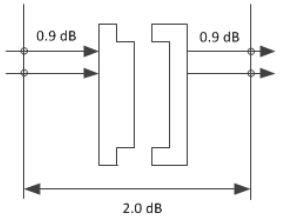
- TP0 to TP5 has same 11 dB ball-to-ball loss as the backplane reference model
  - Enclosure: 9.625 dB (storage enclosure without the drive)
  - Drive: 1.375 dB
- Only showing one direction





Mated connector assembly and test point test fixture using enclosure test fixture 2

NOTE – The connector insertion loss is 0.2 dB for the mated test fixture.



Mated connector assembly and test point test fixture using enclosure test fixture 1

NOTE – The connector insertion loss is 0.2 dB for the mated test fixture.