Tx Function to Rx Function AdHoc Channel Considerations

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Scope

- This Ad Hoc was chartered at the April 2019 Interim with primary focus to consider Tx Function to Rx Function channel characteristics and possible refinements to the alien crosstalk specifications.
- Ad Hoc will generate content for 802.3ch informative annex addressing channel characteristics and possible refinements to the alien crosstalk specifications.

Purpose

- TX-RX Channel considerations

Link Segment (2.5/5/10 Gb/s) – 2.5/5/10GBASE-T1

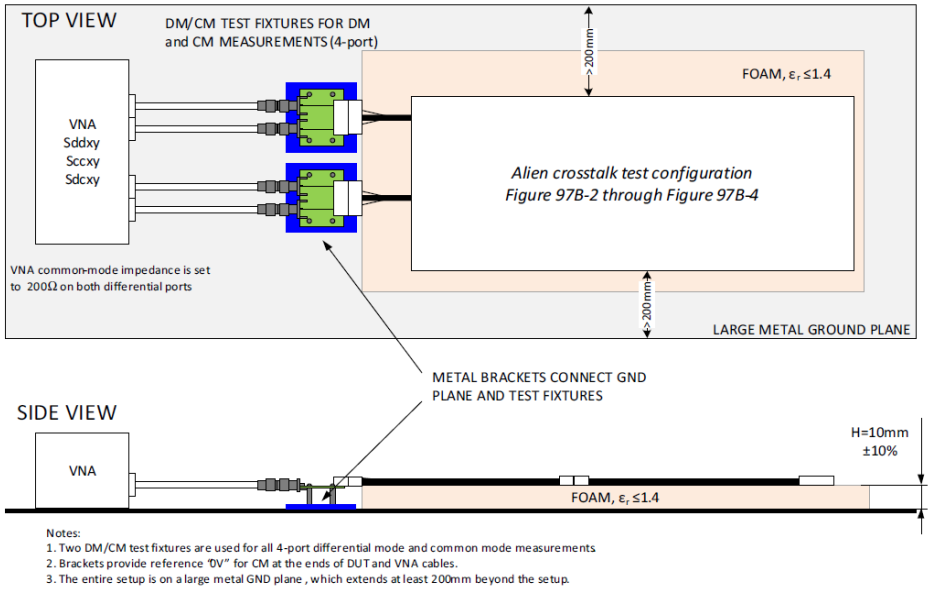
- Link transmission parameters (up to at least 15 m)
  - Frequency range specified
    - Characteristic impedance
    - Insertion loss - 1 MHz ≤ f ≤ S*fmax MHz
    - Return loss
      - 2.5GBASE-T1 - 1 MHz ≤ f ≤ 1000 MHz
      - 5GBASE-T1 - 1 MHz ≤ f ≤ 2000 MHz – RL mag limit is specified in relationship to IL@1.5 GHz
      - 10GBASE-T1 - 1 MHz ≤ f ≤ 4000 MHz – RL mag limit is specified in relationship to IL@3 GHz
    - Coupling Attenuation - 1 MHz ≤ f ≤ 5500 MHz
    - Shielding Effectiveness - 30 MHz ≤ f ≤ S*fmax MHz
    - Maximum Link Delay - 2 MHz ≤ f ≤ S*fmax MHz

- For 2.5GBASE-T1, 5GBASE-T1, and 10GBASE-T1, the maximum applicable frequency for the Link Segments specifications is 4000 MHz × S. For 2.5GBASE-T1, S = 0.25; for 5GBASE-T1, S = 0.5; and for 10GBASE-T1, S = 1.

Coupling Between Link Segment– 2.5/5/10GBASE-T1

- Alien crosstalk noise
- To ensure the total alien NEXT loss and alien FEXT loss coupled between link segments is limited, power sum alien near-end crosstalk (PSANEXT) loss and power sum alien attenuation to crosstalk ratio far-end (PSAACR-F) is specified. The test methodologies are specified in Annex 97B.

Annex 97B Test Methodologies



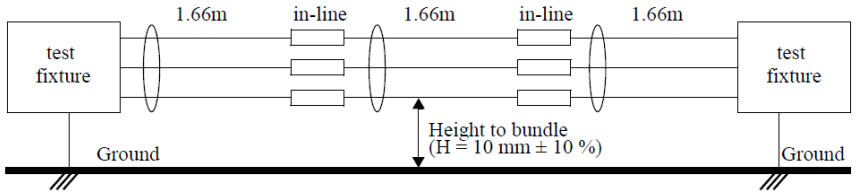


Figure 97B–2—Use Case 1 test configuration

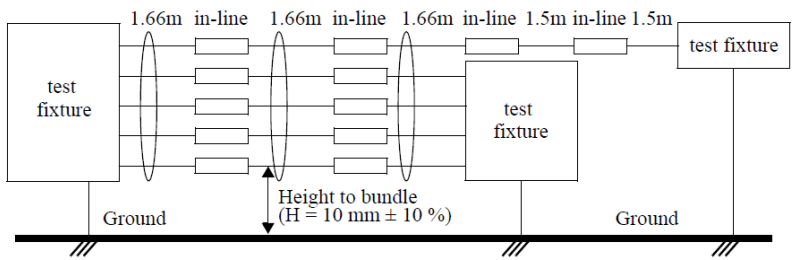


Figure 97B–3—Use Case 2 test configuration

Alien Crosstalk Noise Rejection

149.5.3.2 Alien crosstalk noise rejection

This specification is provided to verify the receiver's tolerance to alien crosstalk noise. The test is performed with a noise source consisting of a signal generator with Gaussian distribution, bandwidths and magnitudes shown in Table 149–16. The receive DUT is connected to the noise source through a directional coupler, as shown in Figure 149–41, with a link segment as defined in 149.7. The BER is expected to be less than 10^{-12}, and to satisfy this specification the frame loss ratio is less than 10^{-9} for 125-octet packets measured at MAC/PLS service interface.

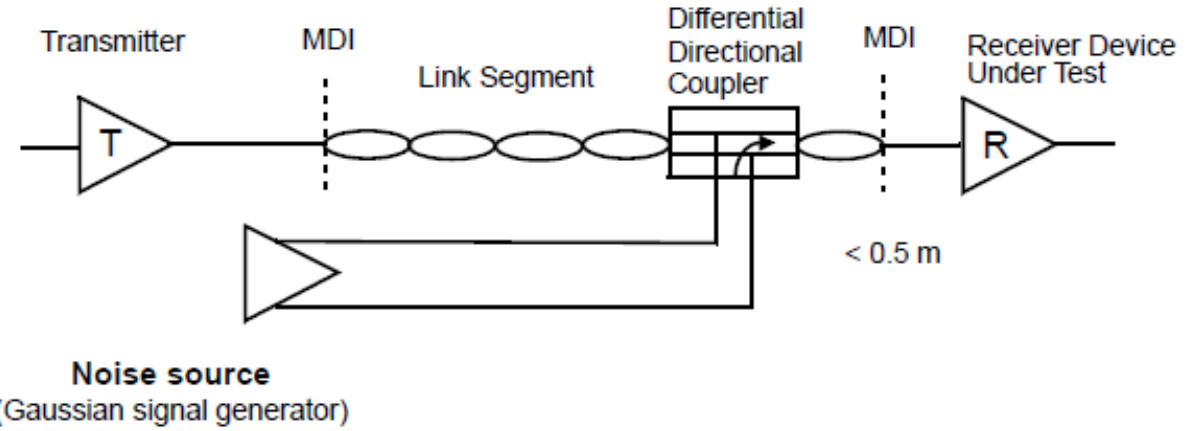
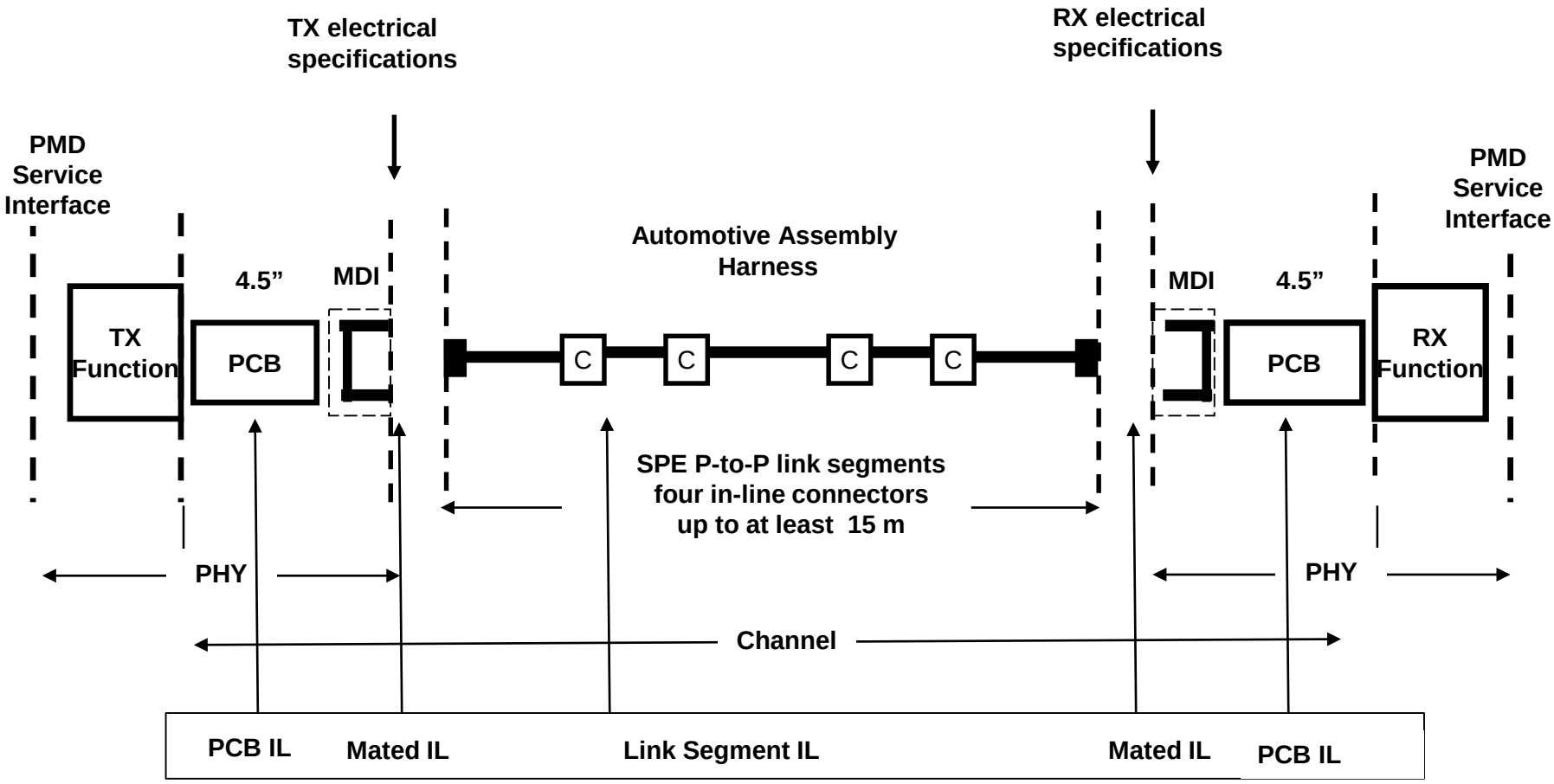


Table 149–16—Alien crosstalk noise source

PHY type	Noise Bandwidth (MHz)	Added Noise at MDI (dBm/Hz)
10GBASE-T1	3500	–152
5GBASE-T1	1750	–149
2.5GBASE-T1	875	–146

Channel Insertion Loss Budget



Link Segment	MDI	PCB FR408 (db/in)	PCB 370HR (db/in)	channel FR408	channel 370HR
14.398	0.084	0.856	1.039	16.278	16.644
20.560	0.119	1.314	1.681	23.426	24.159
29.869	0.168	2.066	2.799	34.336	35.802

Source IL: Kadry_Channel Inseriton Loss_5-17-2019_RevA.pdf

MDI – Medium Dependent Interface- RL

- **802.3ch 2.5/5/10GBASE-T1 - MDI connector**
  - **The mechanical interface to the shielded balanced cabling is a 2-pin connector with a shield.**
- **802.3ch 2.5/5/10GBASE-T1 - MDI connector**
  - **Return Loss**
  - **MDI coupling attenuation (place holder)**

$$MDI\_Return\_Loss(f) \le \begin{cases} 20 - 20\left(\log_{10}\frac{10}{f}\right) & 1 \le f < 10 \\ 20 & 10 \le f \le 500 \\ 12 - 10\log_{10}(f/3000) & 500 \le f \le 3000 \\ 12 - 20\log_{10}(f/3000) & 3000 \le f \le 4000 \end{cases} \quad \text{(dB)}$$

where

f is the frequency in MHz.

For 2.5GBASE-T1, 5GBASE-T1, and 10GBASE-T1, the maximum applicable frequency for the MDI return loss is 4000 × *S* MHz. See Table 149–1 for definition of *S*.

MDI/TX/RX electrical specifications

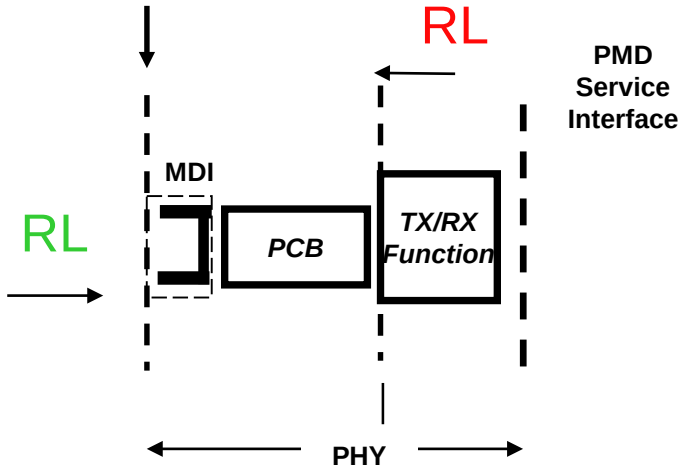
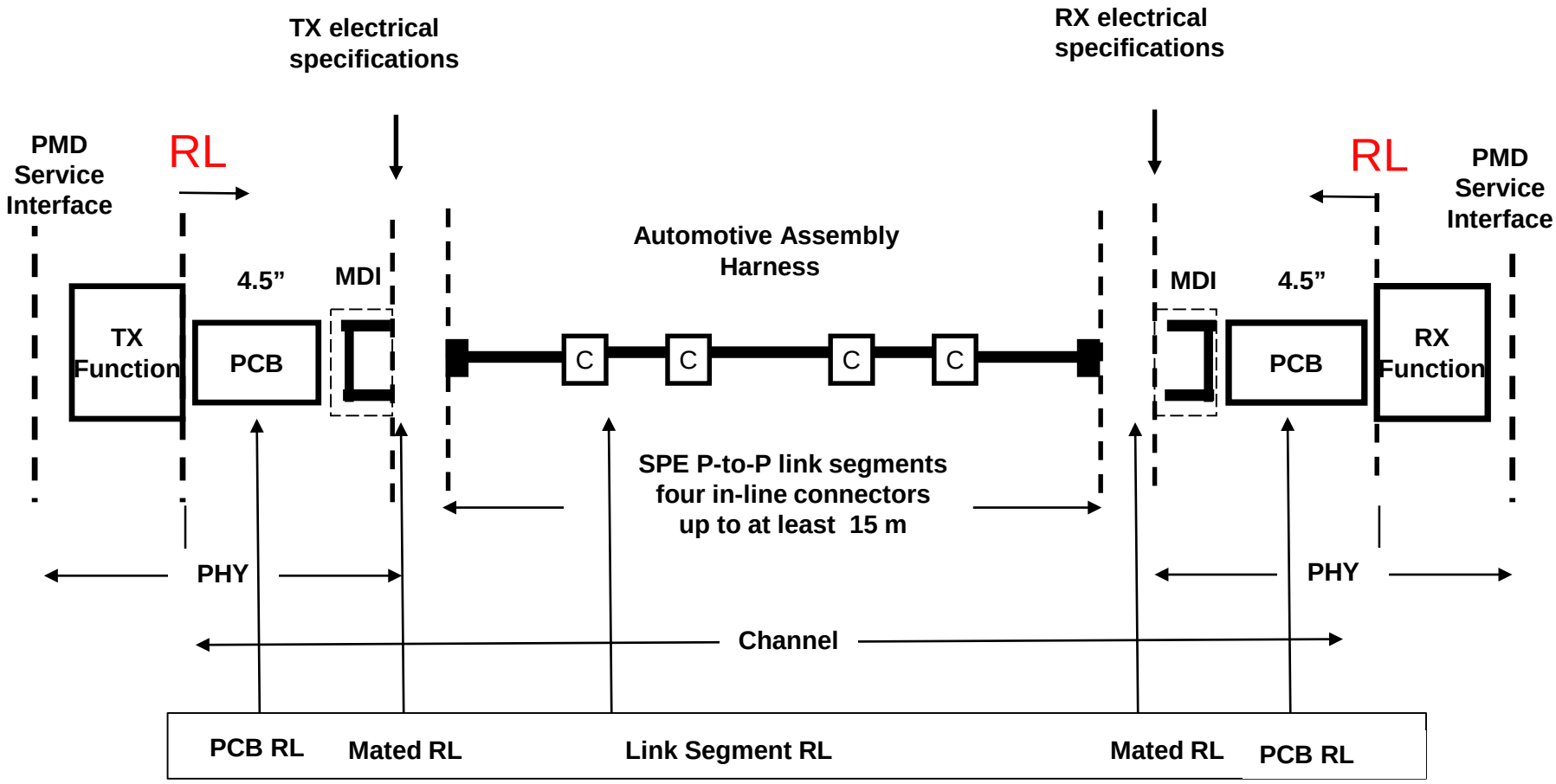


Table 149–1—Scaling parameter

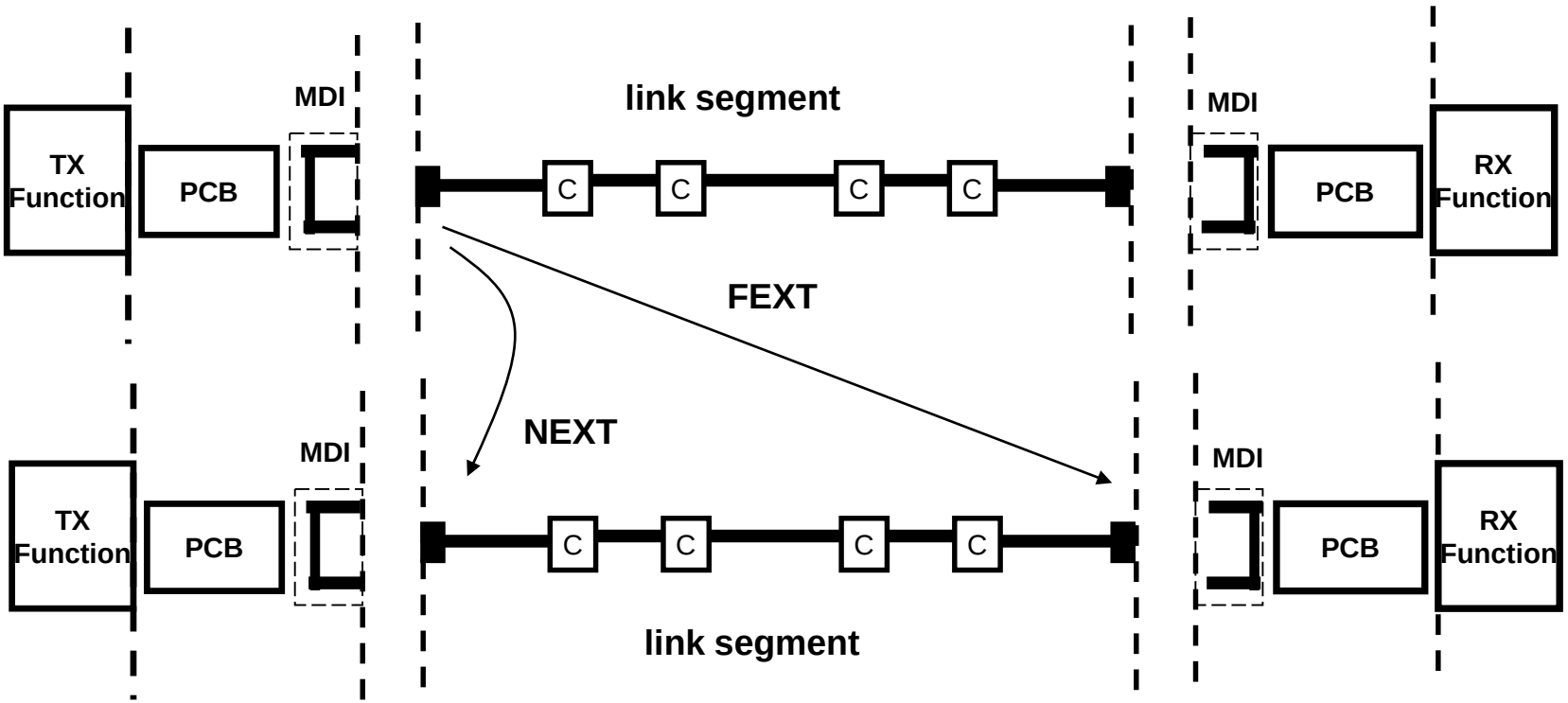
PHY type	*S*
10GBASE-T1	1
5GBASE-T1	0.5
2.5GBASE-T1	0.25

MDI = *PHY is coupled to the cabling at the MDI.*
= MDI requirements: mechanical (to ensure complete compatibility) and electrical.

Channel Return Loss



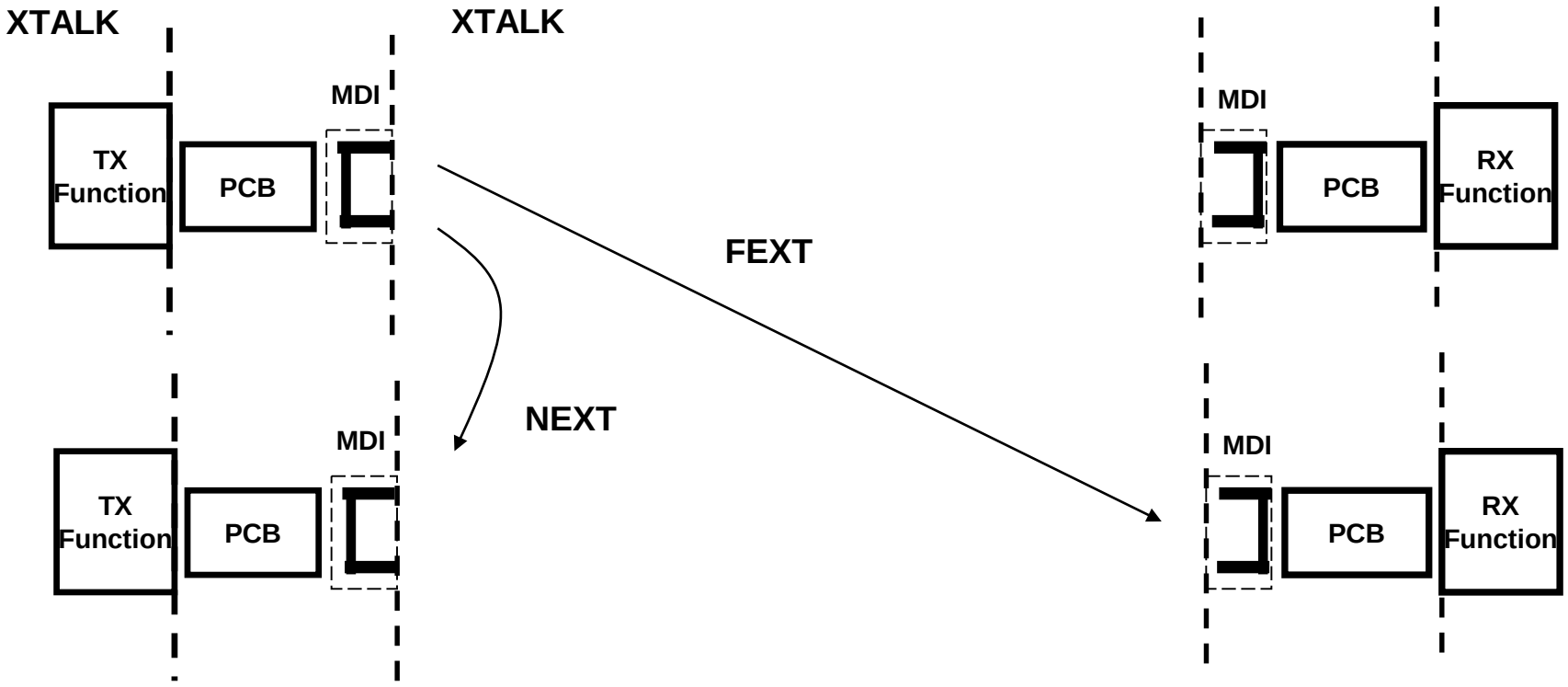
Coupling Between Link Segment– 2.5/5/10GBASE-T1



Source IL: Kadry_Channel Inseriton Loss_5-17-2019_RevA.pdf

XTALK - MDI – Medium Dependent Interface

- **802.3ch 2.5/5/10GBASE-T1 - MDI connector**
  - **Return Loss**
  - **MDI coupling attenuation (place holder)**



IEEE Std 802.3™-2015 - MDI

- 1.4.269 Medium Dependent Interface (MDI): The mechanical and electrical or optical interface between the transmission medium and the MAU (e.g., 10BASE-T) or the PHY (e.g., 1000BASE-T) and also between the transmission medium and any associated (optional per IEEE Std 802.3, Clause 33) Powered Device (PD) or Endpoint Power Sourcing Equipment (PSE).

- 1.1.3.2 Compatibility interfaces: The following important compatibility interfaces are defined within what is architecturally the Physical Layer.

  a) *Medium Dependent Interfaces (MDI).* To communicate in a compatible manner, all stations shall adhere rigidly to the exact specification of physical media signals defined in the appropriate clauses in this standard, and to the procedures that define correct behavior of a station. The medium-independent aspects of the LLC sublayer and the MAC sublayer should not be taken as detracting from this point; communication in an Ethernet Local Area Network requires complete compatibility at the Physical Medium interface (that is, the physical cable interface).

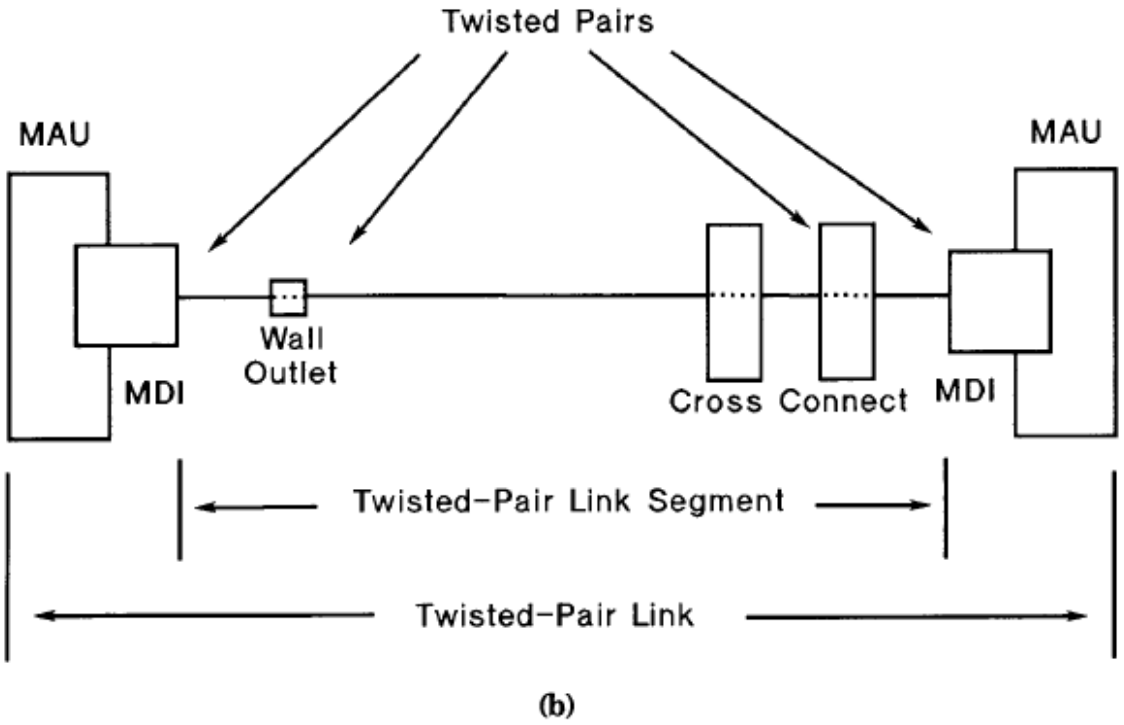
- PMD is coupled to the cabling at the MDI.

- MDI requirements: mechanical (to ensure complete compatibility) and electrical.

Link Segment

1.4.242 link segment: The point-to-point full-duplex medium connection between two and only two Medium Dependent Interfaces (MDIs).

- **Example 10BASE-T**



(b)

Figure 14–2—Twisted-pair link