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Summary of Progress on Mixing Segment Specifications in 802.3da

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3/9/2023 – UPDATED 3/14/2023

Updated to remove “MDI” language and clarify it is the PMA attached

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Draft 0.7 Content

FROM JUNE 2022, DIMINICO CONTRIBUTIONS

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Background

Background in diminico_SPMD_01_06152022

Adjustment resulted from online and offline discussions

Adopted in June 2022 (6/29/2022) from diminico_SPMD_02_06292022

Limited clarity on trunk connections & compensation

Draft 0.7 - topology

Trunk – stub

- Other configurations allowed
  - Meaning stars, Y's, etc. ARE allowed
  - Must meet other requirements in 168.7
- Defines stubs with TC (trunk connection), MDI attachment points
  - TC is a single point, only defined on the stub
- Defines 'edge terminations' on trunk
- Figure is an example

168.7 Mixing segment characteristics

10BASE-T1M PHYs are designed to operate over media that meet the requirements specified in this subclause. The 10BASE-T1M mixing segment (1.4.331) is a single balanced pair of conductors that may have more than two MDIs attached

Figure 168–17 shows an example mixing segment with reference points. The mixing segment specificationsin 168.7 are referenced to these designated points and are to be met without the MDI or other loads attached. The mixing segment specifications are based on a trunk-stub configuration. Other configurations may be possible, provided they meet the electrical parameters in this 168.7. The example configuration assumes that the trunk comprises TBD m of 1.02 mm (18 AWG) 100 Ω cabling and the stubs are 100 Ω balanced pairs of conductors up to 30 cm long. The trunk is terminated at each end into 100 Ù, at a point designated the 'edge termination'. One end of the stub is designated the trunk connection (TC) and the other designated the 'MDI attachment point'.

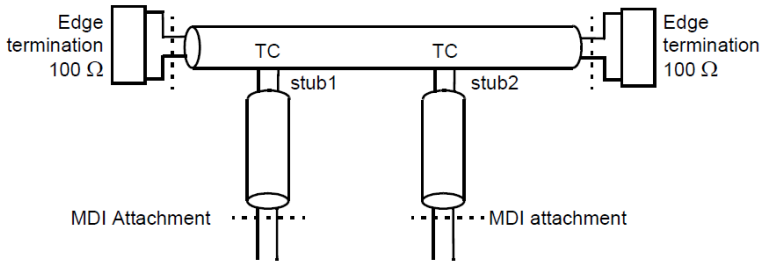

Figure 168–17—Mixing segment and reference points

Source: IEEE P802.3da D0.7

Draft 0.7 – Insertion Loss

IL of trunk specified between edge terminations without MDIs or loads attached

- Are unterminated stubs attached?, If there is compensation at the TC, is that attached?

IL and delay of (separated) stub from TC to MDI attachment point specified

> The mixing segment insertion loss is specified by independently meeting the requirements specified in this section for trunks and stubs. The stub time delay is specified to limit reflective resonances.

Source: IEEE P802.3da D0.7

Draft 0.7 – Return Loss

RL at MDI attachment point without MDI or other loads attached is specified

- If compensation is used, is that attached?

> The mixing segment at any MDI attachment point, without the MDI or other loads attached, shall meet the return loss values determined using Equation (168–6). The reference impedance is 50 Ω.

Source: IEEE P802.3da D0.7

RL at Edge terminations is specified without any MDIs or loads

- Are unterminated stubs attached?, If there is compensation at the TC, is that

> The mixing segment edge terminations, without the MDI or other loads attached, shall meet the return loss values determined using Equation (168–7). The reference impedance is 100 Ω.

Source: IEEE P802.3da D0.7

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RX Model

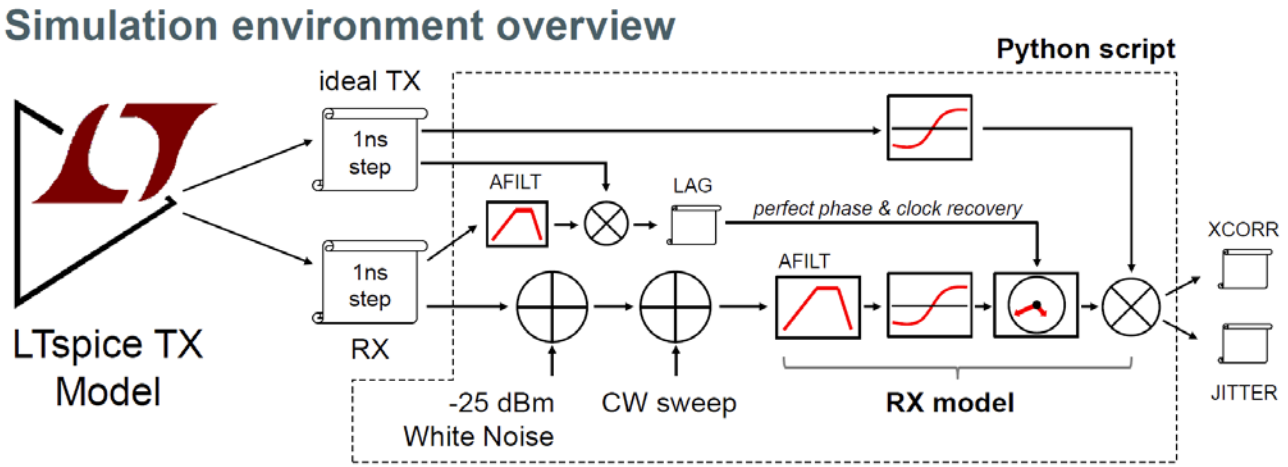
RX Model – July 2022 & after

Correlator receiver model, introduced in
[beruto_3da_20220711_rx_model]

Added to consensus model, w/programmable TX filter
[paul_02_da_09142022]

Follow-on presentations:

- [diminico_SPMD_01_1122]
- [Paul_da_20221207]
- [diminico_SPMD_01_0123]
- [diminico_SPMD_01_0223]



- The simulation purpose is to evaluate how well the proposed metric follows the noise environment compared to the receiver model performance

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Presentation summary

Diminico 11/22 – showed compensated/uncompensated 30 node, 75m topologies working – no proposed specifications

Paul 12/22 – looked for worst-case location to attach a node, found worse than Diminico 11/22, conclusion:

- We are going to need rules about how much a node can reflect
  - Either compensate nodes that have high parasitic capacitance
  - Or design nodes that have low parasitic capacitance (<5pF?)
- Zimmerman 12/22 – showed 10BASE-2 approach to specifying reflections – need more test points

Diminico 1/23

- Confirms Paul sensitivity to node position and reflection
- Considers return loss on equally spaced nodes due to varying impedance segments
  - Measured: No MDI's and No compensation ; Compensation + MDI's attached ; or Compensation + dummy-MDI load attached
    - NOT: MDI without compensation

Diminico 2/23

- Eliminate stubs – specify 'in and out'
- Compensation, when used, in the device MDI connector…

So, where are we?

Latest presentations have no stubs – this suggests

- Delete stub measurement from draft
- Keep trunk IL, RL measurements without MDI's attached and without compensation to measure trunk as a unit
  - This needs to include margin for TC connectors, PHY loading

Need to specify a trunk connection interface

- Connects left & right sides of trunk
- Connects to PMA/PMD of PHY
- Key question: is the TC connector part of the mixing segment, or is it part of the PHY/DTE?

- When PMA/PMD is not attached, acts like an inline connector (prescribed IL, prescribed RL)
  - IL & RL without PMA/PMD should be included in mixing segment
  - Left, right to mixing segment – third port goes to the PMA
  - w/o PMA attached - Left <-> Right path is included in trunk edge-termination IL, RL specifications without MDI attached
    - Insertion loss needs to be minimal
    - Return loss needs to be high
  - Left

Question - does RL measurement sufficiently specify reflections from 'left' and 'right' of TC?

- (we should be able to use the consensus model to do this, no?)
  - Consider a mismatched TC near the far-end of the mixing segment –should that set the overall return loss limit?

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So, where are we?

Latest presentations have no stubs – this suggests

- Delete stub measurement from draft
- Keep trunk IL, RL measurements without MDI's attached and without compensation to measure trunk as a unit
  - This needs to include margin for TC connectors, PHY loading

Need to specify a trunk connection interface (TCI)

- Connects left & right sides of trunk
- Connects to PMA/PMD of PHY
- Key question: is the TC connector part of the mixing segment, or is it part of the PHY/DTE?

TCI has characteristics of both

- When PMA/PMD is not attached, acts like an inline connector (prescribed IL, prescribed RL)
  - IL & RL without PMA/PMD should be included in mixing segment - this likely means no compensation engaged
- When PMA/PMD is attached (or dummy MDI loading), PHY loading increases IL, decreases RL
  - Need an IL budget for this extra loading that allows 30 nodes
  - Need to specify left & right RL to minimize reflections

TCI is the new MDI…. But with 2 media ports and an interface to the PMA….

Inspiration – Clause 10 (10BASE2)

Specification is both on cabling without PMAs and on reflections WITH PMA attached

Meat of signal integrity comes from reflection specs in 10.4.1.1

These equate to return loss at the ports that connect to the mixing segment

Connection between trunk and MAU is specified separately

1.4.394 Medium Attachment Unit (MAU): A device containing an Attachment Unit Interface (AUI), Physical Medium Attachment (PMA), and Medium Dependent Interface (MDI) that is used to connect a repeater or data terminal equipment (DTE) to a transmission medium.

10.4 MAU–medium electrical characteristics

10.4.1 MAU-to-coaxial cable interface

10.4.1.1 Input impedance

The shunt capacitance presented to the coaxial cable by the MAU circuitry (not including the means of attachment to the coaxial cable) is recommended to be not greater than 6 pF. The magnitude of the reflection from a MAU plus the cable connection specified in 10.6.3 shall not be more than that produced by an 8 pF capacitance when measured by both a 25 ns rise time and 25 ns fall time waveform. The resistance presented to the coaxial cable shall be greater than 100 kΩ.

These conditions shall be met in both the power-off and power-on, not-transmitting states.

Source: IEEE Std 802.3-2022

Inspiration – Trunk to MAU

States a possible T connector, but defines connection characteristics

Limits stub length via shunt capacitance

Limits reflection (10.4.1.1 specifies reflection)

Uses qualitative specifications that likely need tightening up ("shall present a low shunt capacitance…", "shall not disturb transmission line characteristics significantly…")

Provides some safety, grounding, and physical specifications that are likely not relevant

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10.6.3 MAU-to-coaxial cable connection

A BNC "T" (plug, receptacle, plug) adaptor provides a means of attaching a MAU to the coaxial cable. The connection shall not disturb the transmission line characteristics of the cable significantly; it shall present a low shunt capacitance, and therefore a negligibly short stub length. This is facilitated by the MAU being located as close to its cable connection as possible; the MAU and connector are normally considered to be one assembly. Long (greater than 4 cm) connections between the coaxial cable and the input of the MAU jeopardize this objective.

Overall system performance is dependent largely on the MAU-to-coaxial cable connection being of low shunt capacitance.

The design of the connection shall meet the electrical requirements contained in 10.4.1.1 and the reliability specified in 10.4.2.3. The use of BNC "T" adaptors and connectors satisfies these requirements. Figure 10–7 shows a MAU-to-coaxial cable attachment.

A means shall be provided to ensure that the connector assembly (that is, BNC "T" plus male connectors) does not make contact with any building metalwork (at ground potential) or any other unintended conductors. An insulating cover should therefore be applied after connection. A possible design is depicted in Figure 10–7. The insulating cover should have these characteristics:

a) It should guard against accidental grounding of the connector assembly.
b) It should allow ease of attachment and detachment of an assembled "T" connector to the MAU without necessitating the removal of section cable connectors (that is, segment integrity is maintained).
c) It should be a simple moulding that attaches firmly to a connector assembly.

Source: IEEE Std 802.3-2022

TCI/MDI specification

TCI connects to left and right trunk pairs and presents both sides as a 4 pin interface to the PMA (MDI plane)

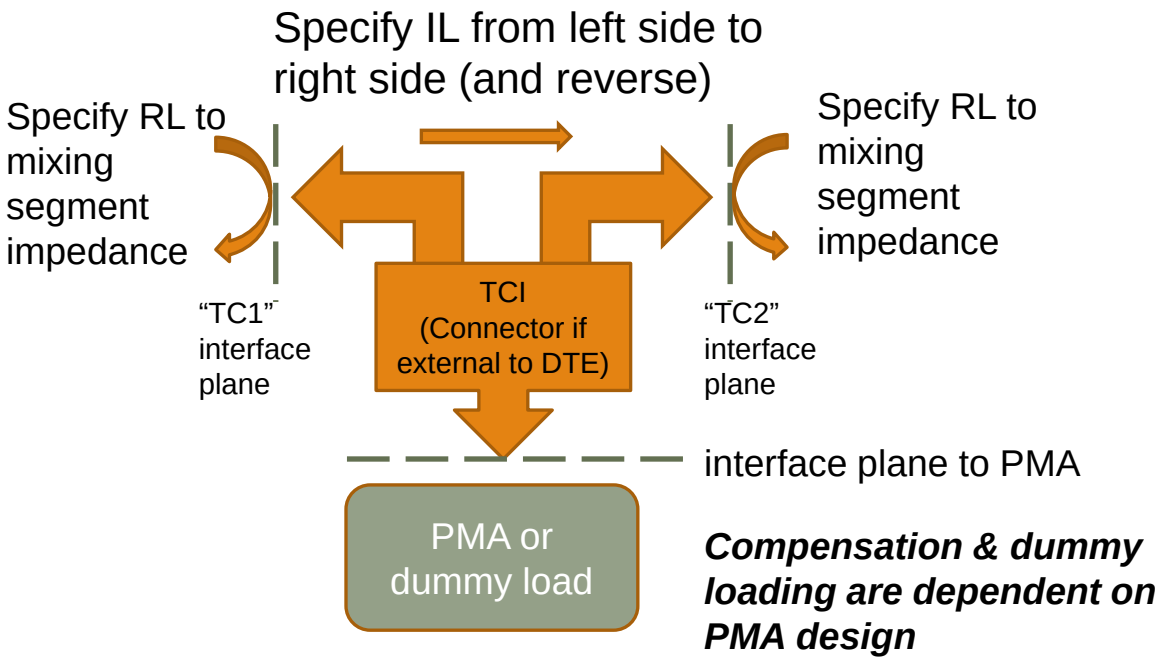
The TCI meets different RL & IL specs depending on whether PMA/loading is or is not attached

When no PMA attached, the TCI maintains continuity between the left and right sides of the mixing segment as part of mixing segment (like an inliner)

When a PMA is attached, the TCI routes continuity of through 4 signal interface (p_left, n_left, p_right, r_right) to the PMA, PMA completes the path from left to right

Normal RL specs associated with the MDI are met at both the left and right side of the TCI – not at a single MDI interface plane

TCI specification contains the left to right side insertion loss when the PMA is attached



Updated to remove "MDI" language and clarify it is the PMA attached

Summary approach

Specify trunk independent of stubs and PMA loading/compensation ← ***ALREADY IN DRAFT***

- PMA loading & compensation belong in the device, because they depend on the device
- Include margin for trunk connectors as 'inline' connectors (unloaded, uncompensated) ← ***NEED NUMBERS (Media dependent)***

TCI replaces MDI – it's different in that it has 2 media ports, so it deserves its own name — ***DRAFT CHANGE***

Will need specification of end-to-end trunk insertion loss with maximum load TCI & PMAs in place — ***DRAFT CHANGE***

- Not specified in clause 147
- Need contribution on what the appropriate insertion loss curve is ← ***NEED NUMBERS (PHY dependent)***
- Need work on budget for reflection magnitude – Consensus model w/RX ← ***NEED NUMBERS (PHY dependent)***

Specify TCI & PMA connection (what we normally think of as MDI) as a unit — ***DRAFT CHANGE – Replaces: MDI return loss***

- Specify left-to-right insertion loss and left, right side return loss with PMA (or compensated loading) in place
- PMA electricals tested with TCI fixture in place, at left and right TCI ports
- Implementers can include compensation can be included here, or can be uncompensated – just needs to meet specs
  - Should probably add descriptive text, but leaves room for development innovation
- Implementers can incorporate wiring and service loops ("stubs") into device provided that TCI specs are met
- Delete mention of stubs and stub length – this is part of the TCI specification

Possible Spec – Trunk Connection Interface

168.7.2a Trunk Connection Interface

The Trunk Connection Interface (TCI) connects the left and right sides of the mixing segment together (trunk port CP1 and tru nk port CP2) and has a third port to attach the PMA at the MDI attachment point (see 168.7). The TCI is part of the mixing segment, and the requirements of 169.7 are met with TCIs in place with or without attached MDIs as specified for the particular specification.

A TCI may be a "T" type connector to provide a mean of connecting the segments of balanced conductors and attaching a PMA to the trunk. The connection is specified so as not to disturb the transmission line characteristics of the trunk conductor significantly, except for the increased insertion loss when loaded with a PMA. TCI's with compensation are expected to be matched to a particular PMA.

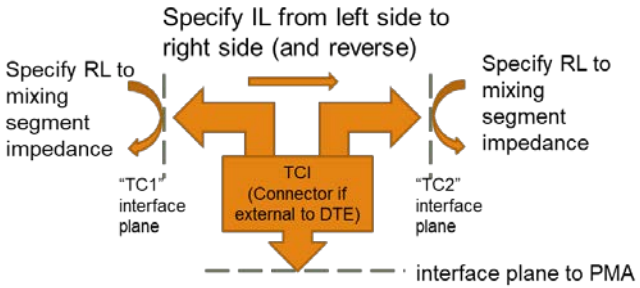
Without a PMA or PMA loading present, the differential insertion loss of the TCI between the trunk ports shall be less than **TBD** dB *(small number)* from 0.3 to 40 MHz, in each direction, measured into 100 ohms.

With the specified PMA or PMA present, the differential insertion loss of the TCI between the trunk ports shall be less than **TBD** dB *(allows for compensation and phy loading – may be an equation)* from 0.3 to 40 MHz, in each direction, measured into 100 ohms.

Without a PMA or PMA load present at the TCI attachment, the return loss of the TCI at port CP1 and CP2 shall be greater than Equation 169-X with the other trunk port terminated in 100 ohms. *(NOTE – this is to allow meeting the unloaded trunk RL spec)*

With a PMA or PMA load present at the TCI attachment, the return loss of the TCI at port CP1 and CP2 shall be greater than Eq uation 169-Y with the other trunk port terminated in 100 ohms. NOTE - this specification replaces the MDI return loss and is measured at the TCI.

The TC adaptor and the PMA attachment may be located within a single assembly, presenting negligible stub length when the PMA attachment is open circuit, and may include compensation engaged when a PMA or PMA load is attached. *(NOTE – should we specify the length of a stub, and if so, how – in cm? In ns delay? – alternatively, as TBD shunt capacitance based on the various studies?)*



TEXT IN BLUE HIGHLIGHT MAY BE BETTER LOCATED IN THE MDI SECTION

Updated to remove "MDI" language and clarify it is the PMA attached

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Discussion? - Thank you