Technical feasibility for 25G CR copper PMD

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25G CR copper cables

- Two goals – (1) cable length 3m minimum, (2) avoid FEC and its latency.
- Two types of cables –
  - (1) Long cables.
    … all electrical specs exactly same as 100G CR4, will use 25G RS-FEC.
    … optimized for cable lengths upto 5m.
  - (2) Short cables.
    … reduced cable loss, without FEC.
    … optimized for cable lengths upto 3m.
- 25G RS-FEC
  - 25G “single lane” version of 100G KR4 RS-FEC (Clause 91).
  - For PCS and FEC encoding formats, see “ gustlin_081214_25GE_adhoc.pdf ”
  - RS-FEC can be optional for copper cables (avoids latency of 250ns).
  - RS-FEC selection can be done by Auto Neg protocol.
  - RS-FEC can be optional for 25G KR (backplane) – long and short channels.
  - RS-FEC will be mandatory for 25G SR (MMF).

25G CR – Link block diagram

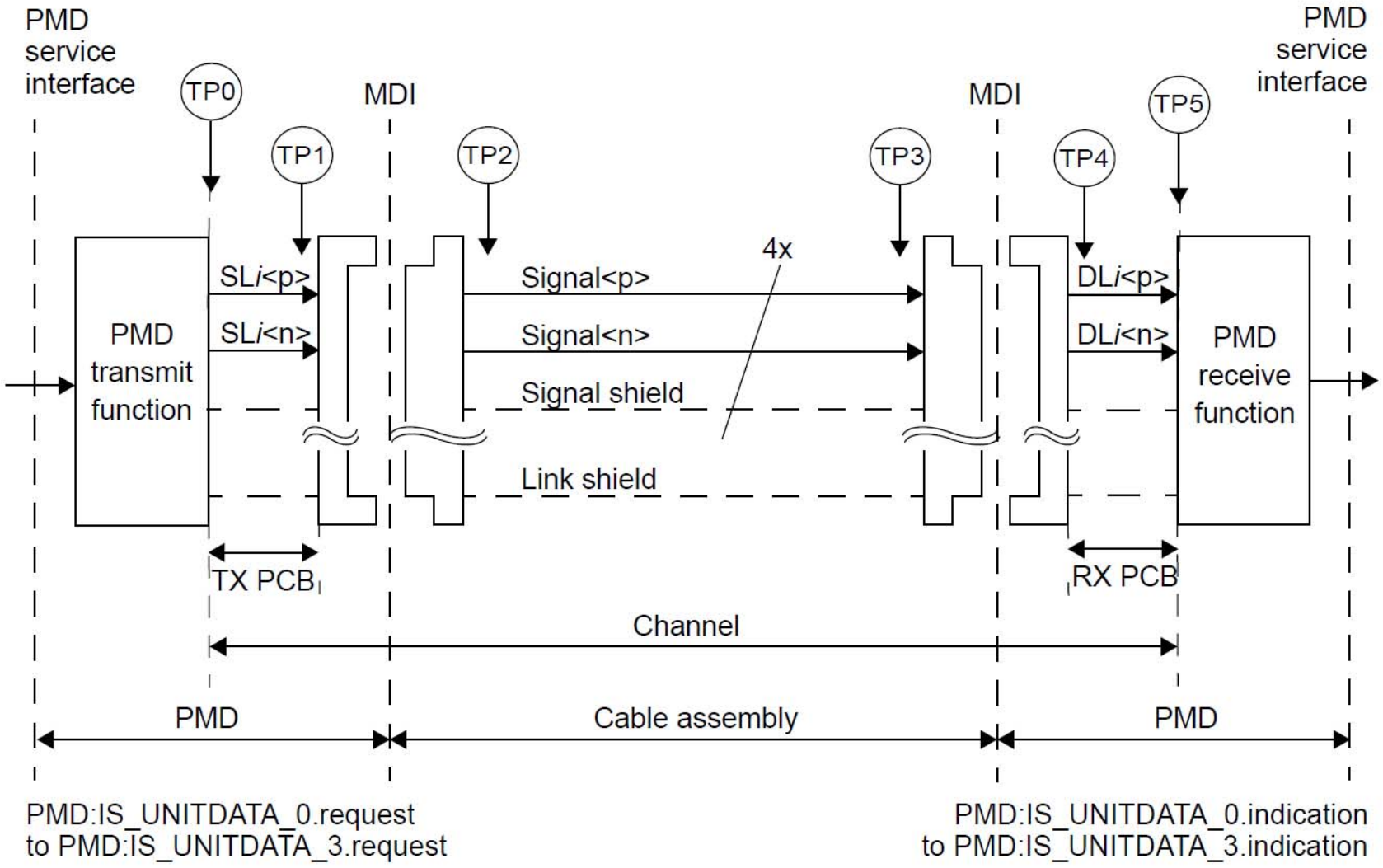
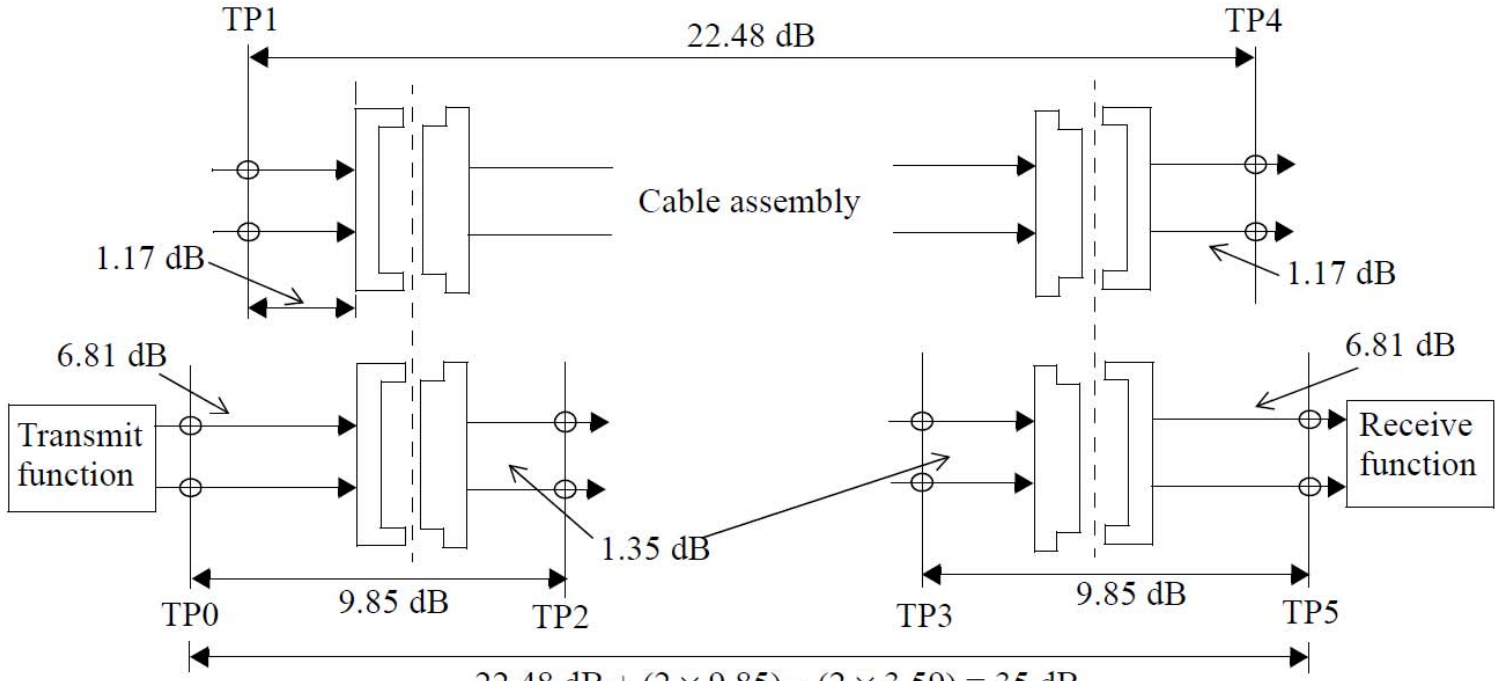
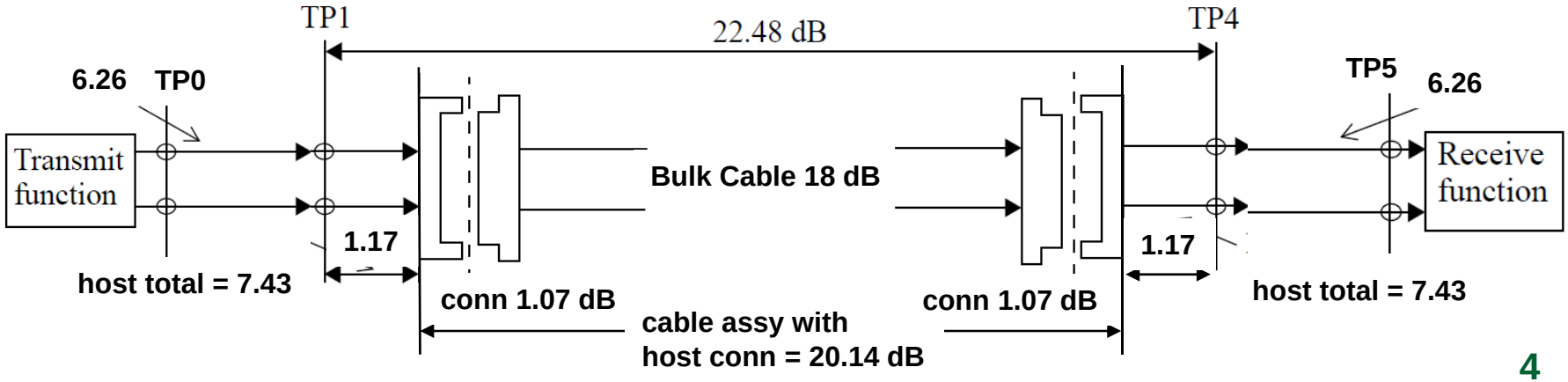


Figure 92–2—100GBASE-CR4 link (one direction is illustrated)

25G CR – Loss Budget (same as 100G CR4)





25G CR – Loss Budget, “long” cables

- Loss Budget – long cables, 35 dB (exactly same as 100G CR4).
  - host channel = 7.43 dB. … 6” trace length on mid loss PCB.
  - cable assembly (compliance test) = 22.48 dB.
  - cable assembly (with host connector) = 20.14 dB.
  - host connector = 1.07 dB x 2 = 2.14 dB.
  - Bulk Cable = 18 dB.
  - Cable length / gauge examples that can meet this.

    3m cable @ 5.5 dB/m @ 30 AWG = 16.5 dB.

    5m cable @ 3.5 dB/m @ 26 AWG = 17.5 dB. ← optimum diameter.

    6m cable @ 3.0 dB/m @ 24 AWG = 18 dB.

    7m cable @ 2.5 dB/m @ 22 AWG = 17.5 dB. ← maximum diameter.

25G CR – Loss Budget, “short” cables

- Possible Loss Budget – short cables, 30 dB (reduced cable loss).
  - host channel = 7.43 dB. … 6” trace length on mid loss PCB.
  - cable assembly (compliance test) = 16.48 dB.
  - cable assembly (with host connector) = 14.14 dB.
  - host connector = 1.07 dB x 2 = 2.14 dB.
  - Bulk Cable = 12 dB.
  - Cable length / gauge examples that can meet this.

    2m cable @ 5.5 dB/m @ 30 AWG = 10.5 dB.

    3m cable @ 3.5 dB/m @ 26 AWG = 10.5 dB. ← optimum diameter.

    4m cable @ 3.0 dB/m @ 24 AWG = 12 dB.

    5m cable @ 2.5 dB/m @ 22 AWG = 12.5 dB. ← maximum diameter.

- MTTFPA needs to be analysed.
  - Concern of MTTFPA from DFE burst errors, for operating without FEC.
  - Option (1) – use COM procedure to verify if BER and MTTFPA is acceptable.
  - Option (2) – use 10G KR FEC to correct DFE burst errors (latency 82 ns).

    (coding gain ~2 dB, is less than one meter additional cable length).

FEC selection

- Auto Negotiation and Link Training for 25G CR and KR.
  - RS-FEC selection can be done by Auto Neg protocol.
  - Host port configured in “short cable” mode (SCM) or “long cable” mode (LCM), based on which PHY can advertise availability of RS-FEC (Y or N).
  - also need to specify Link Training protocol for 25G CR and KR.

	Cable type	Server Port (FEC = Y / N)	Switch Port (FEC = Y / N)	RS-FEC selection by AN
(1)	25G CR short cable	SCM (N)	SCM (N)	N
(2)	25G CR short cable	SCM (N)	LCM (Y)	N
(3)	25G CR short cable	LCM (Y)	SCM (N)	N
(4)	25G CR short cable	LCM (Y)	LCM (Y)	Y
(5)	25G CR long cable	LCM (Y)	LCM (Y)	Y

Other related topics

- Host electrical connectors (MDI)
  - need to consider 2 connectors in 25G CR channel model.
  - SFP28, and QSFP28 (for 4x25G breakout).
- 2 types of RX tolerance test needed for host –

  (1) Short cables (no FEC) @ BER ~ e-12.

  (2) Long cables (with RS-FEC) @ BER ~ e-5.
- 25G C2M electrical interface (XXVAUI)
  - 25G chip to module (C2M) needed for SR (MMF) PMD and AOC cables.
  - “single lane” version of 100G CAUI-4 C2M electrical spec (Clause 83E).
  - chip to chip (C2C) not needed. (eg: use CEI-25G-MR).

What we can leverage from 100G CR4

	Spec or Function	100G CR4	25G CR
(1)	PCS encoding	Clause 82	Based on 10G PCS (CL 49) or 40G PCS (CL 82). eg: gustlin_081214_25GE_adhoc.pdf
(2)	RS-FEC encoding	Clause 91	Single lane version of Clause 91. eg: gustlin_081214_25GE_adhoc.pdf
(3)	Auto Negotiation	Clause 73	Updated to include 25G CR and optional RS-FEC.
(4)	Link Training	Clause 92	Single lane version of Clause 92.
(5)	Link block diagram and test points	Clause 92.7	Exactly same.
(6)	Host TX, RX compliance tests	Clause 92.8	Exactly same, add RX test for "No FEC" mode.
(7)	Cable assembly compliance tests	Clause 92.10	Exactly same for "long cable", add test for "short cable", including COM.
(8)	Test fixtures	Clause 92.11	Exactly same.
(9)	Host connector (MDI)	92.12	keep QSFP28, add SFP28.
(10)	Channel loss budget and allocations	Annex 92A	Exactly same for "long cable", add section for "short cable".
(11)	Host TX, RX chip electrical spec	Annex 92A	Exactly same.

Thank You !