802.3ck D1.4
Annex 162B – Test Fixtures
FOM_{ILD} Comments

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Comments Mated Test Fixture FOM_{ILD}

1. FOM_{ILD} comments #111, #97, #104 and #107 propose values
   - > Comments 111, 97 and 104, propose 0.18 dB
   - > Comment 107 proposes 0.18 dB with Tt=9.6 ps
   - > Comment #41 requests a value

2. FOM_{ILD} Comment 130 proposes deletion

Cl 162B SC 162B.1.3.1 P 262 L 36 # 130
Comment Type TR
(addressing TBD)
"FOMILD shall be less than (TBD) dB"
The importance of this parameter for quality of test fixtures in the context of this project has not been presented. ERL likely covers what FOMILD originally intended to cover.
The specification should be deleted without loss of technical completeness.
SuggestedRemedy
Delete the quoted sentence.
PROPOSED ACCEPT IN PRINCIPLE.
Resolve using the response to comment#111.

Proposals

- **Proposal A.**
  - **FOM_{ILD} 162B.1.3.1 – P262, L36, replace TBD with 0.18**
  - **Change T_t=7.5 ps to 8.5 ps**

The FOM_{ILD} is calculated according to 93A.4 with f_b=53.125 GHz, T_t=7.5 ps, and f_r=0.75 × f_b. The fitted insertion loss and insertion loss deviation are computed over the range f_{min}=0.05 GHz to f_{max}=40 GHz. FOM_{ILD} shall be less than **(**TBD**)** dB.

- **Proposal B.**
  - **Remove FOM_{ILD} with editorial license**

The FOM_{ILD} is calculated according to 93A.4 with f_b=53.125 GHz, T_t=7.5 ps, and f_r=0.75 × f_b. The fitted insertion loss and insertion loss deviation are computed over the range f_{min}=0.05 GHz to f_{max}=40 GHz. FOM_{ILD} shall be less than **(**TBD**)** dB.

Straw Poll:
I support
Proposal A: FOM_{ILD}: replace TBD with 0.18 dB, change *Tt*=7.5 ps to 8.5 ps
Proposal B: Remove FOM_{ILD} with editorial license

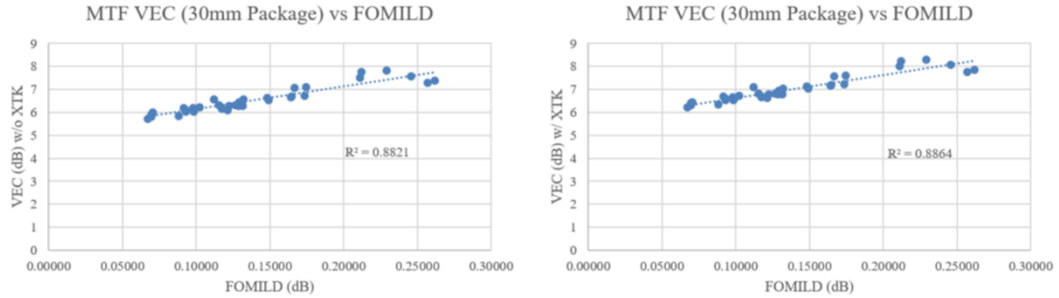
Proposal (A) Mated Test Fixture FOM_{ILD}

- **162B.1.3.1 – P262, L36, TBD = 0.18, T_t=8.5 ps**
- **Update PICs.**

The FOM_{ILD} is calculated according to 93A.4 with f_b=53.125 GHz, T_t=7.5 ps, and f_r=0.75 × f_b. The fitted insertion loss and insertion loss deviation are computed over the range f_{min}=0.05 GHz to f_{max}=40 GHz. FOM_{ILD} shall be less than (TBD) dB.

MTF FOMILD Requirement

Replacing the TBD



- Adding maximum crosstalk to the MTF results in ~ +0.5dB VEC
- VEC and FOMILD are well correlated and VEC<7.5dB results in and FOMILD<0.187dB
- Recommend setting the MTF FOMILD requirement to 0.18dB for D1p5 release
  - Can be adjusted in future drafts if VEC requirements change or more MTF data becomes available

Slide 11 https://www.ieee802.org/3/ck/public/adhoc/jan13_21/kocsis_3ck_adhoc_01_011321.pdf

Proposal (A) Mated Test Fixture FOM_{ILD}

- **FOM_{ILD} is an electrical specification related to <u>electrical properties</u> of MTF.**
- **802.3ck has 6 host receptacles and plugs to consider (MTF).**
- **Comment#85 was resolved with the module output transition time (min) to 8.5 ps**
- **For 50G – MTF FOM_{ILD} Tt=9.6ps, C2M (120E) Module Output @ TP4 Transition time (min, 20% to 80%) = 9.5ps (min)**
- **<u>Proposal (A) MTF FOM_{ILD} = 0.18 dB, Tt=8.5 ps</u>**

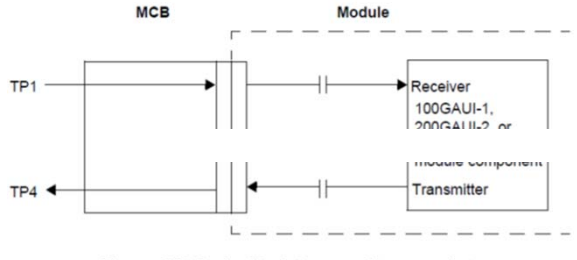


Figure 120G–4—Module compliance points

Source IEEE *Draft* P802.3ck/D1.4
10th December 2020

$$ILD(f) = IL(f) - IL_{fitted}(f)$$

$$FOM_{ILD} = \left[\frac{1}{N}\sum_{n} W(f_n) ILD^2(f_n)\right]^{1/2}$$

$$W(f_n) = \mathrm{sinc}^2(f_n/f_b)\left[\frac{1}{1+(f_n/f_t)^4}\right]\left[\frac{1}{1+(f_n/f_r)^8}\right]$$

fb= signaling rate.
<u>ft=3 dB transmit filter bandwidth inversely proportional to the 20% to 80% rise and fall time Tt.</u>
The constant of proportionality is 0.2365
fr =is the 3 dB reference receiver bandwidth.

Source: IEEE Std 802.3bj-2014

Proposal (B) Delete MTF FOM_{ILD}

> **Comment 130 proposes deletion**

Cl 162B SC 162B.1.3.1 P 262 L 36 # 130
Comment Type TR
(addressing TBD)
"FOMILD shall be less than (TBD) dB"
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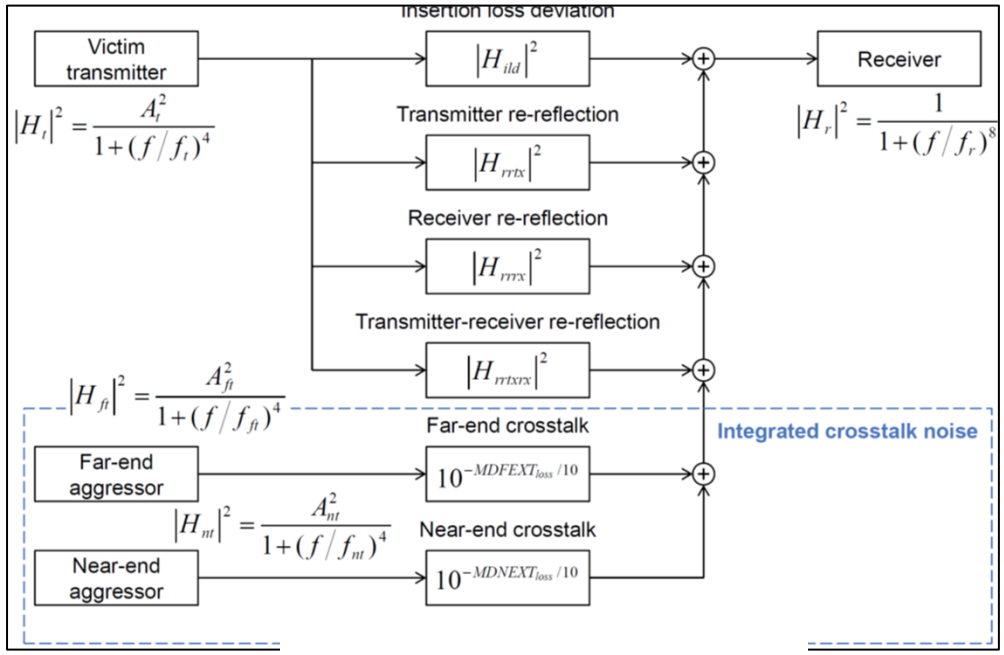
Proposal (B) Delete MTF FOM_{ILD}



Source: moore_01_0311.pdf

93A.4 Insertion loss deviation

$$ILD(f) = IL(f) - IL_{fitted}(f)$$

$$FOM_{ILD} = \left[\frac{1}{N}\sum_n W(f_n) ILD^2(f_n)\right]^{1/2}$$

$$W(f_n) = \mathrm{sinc}^2(f_n/f_b)\left[\frac{1}{1+(f_n/f_t)^4}\right]\left[\frac{1}{1+(f_n/f_r)^8}\right]$$

Source: IEEE Std 802.3bj-2014

fb= signaling rate.
ft=3 dB transmit filter bandwidth inversely proportional to the 20% to 80% rise and fall time Tt. The constant of proportionality is 0.2365
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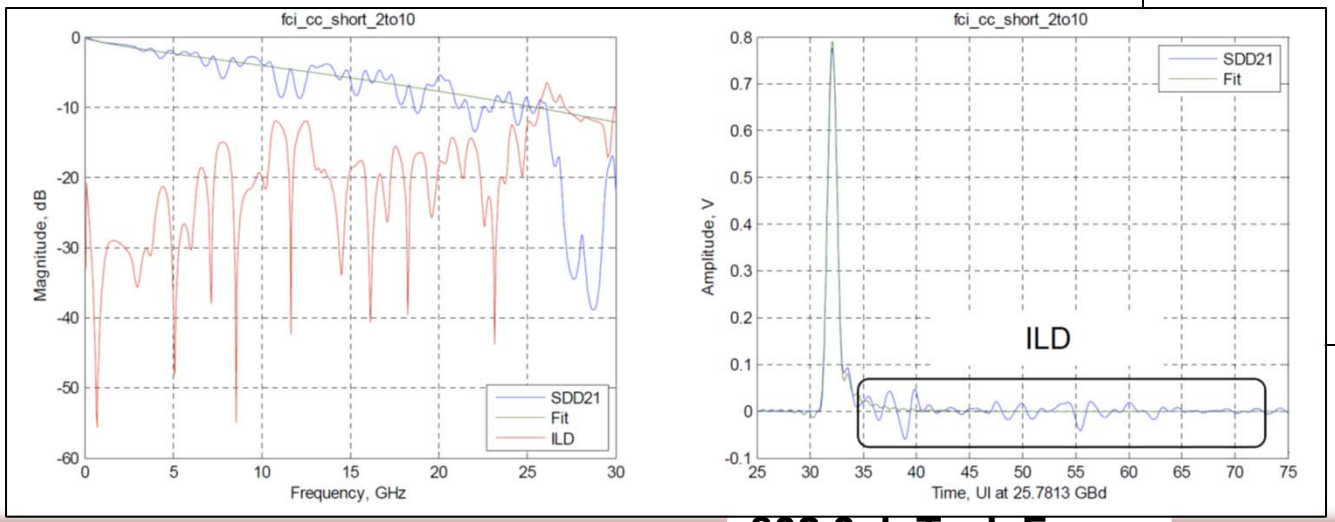


Proposal (B) Delete MTF FOM_{ILD}

Transfer function of the assembled link

- The transfer function from the transmitter input to the receiver output is the following

$$H_{21} = \frac{s_{21}^{(t)} s_{21} s_{21}^{(r)}}{1 - s_{22}s_{11}^{(r)} - s_{11}s_{22}^{(t)} + s_{11}^{(r)}s_{22}^{(t)}\Delta S} \qquad \Delta S = s_{11}s_{22} - s_{21}s_{12}$$
$$s_{21} = s_{12}$$

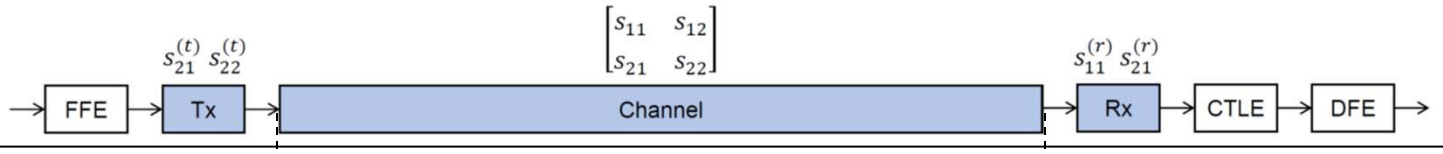
- Note that $1/(1-x) \cong 1 + x + x^2 + \cdots$ for $|x| < 1$

$$H_{21} \cong s_{21}^{(t)} s_{21} s_{21}^{(r)} \left(1 + s_{22}s_{11}^{(r)} + s_{11}s_{22}^{(t)} + s_{21}s_{21}s_{11}^{(r)}s_{22}^{(t)}\right)$$

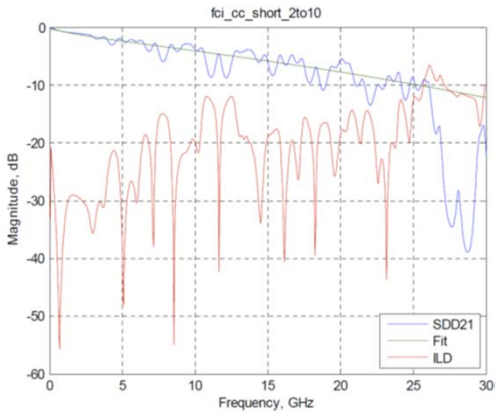
Rx-Tx re-reflection
Tx re-reflection
Rx re-reflection

- Constraints on s_{11}, s_{22}, $s_{11}^{(r)}$, and $s_{22}^{(t)}$, e.g., ERL, are imposed to limit the re-reflection terms

Source: healey_3ck_01a_0120.pdf



MTF ERL limits re-reflection terms (ILD)

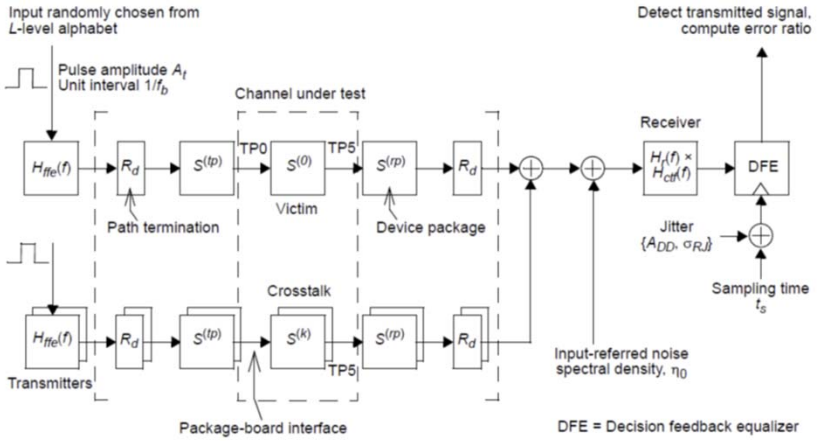


- **MTF ERL limits re-reflection terms in insertion loss (ILD)**

Supplemental

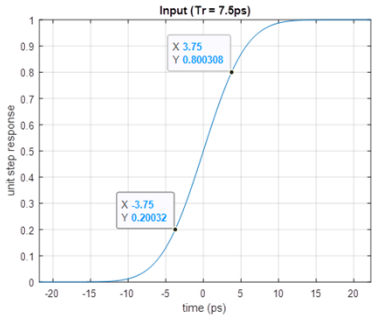
Proposal (A) Mated Test Fixture FOM_{ILD}

- 162B.1.3.1 – P262, L36, TBD = 0.18 dB, T_t=8.5 ps
- Update PICs.

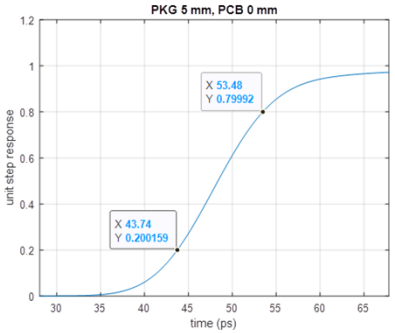


Tr COM = 7.5 ps

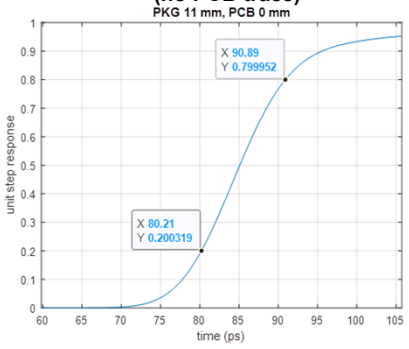
7.5ps input step (Gaussian input pulse)



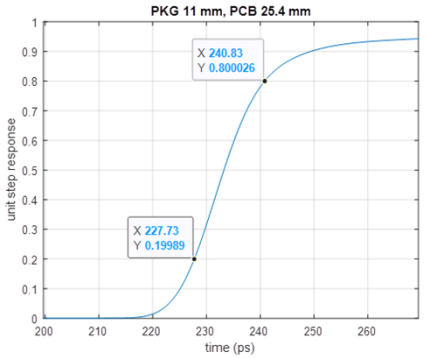
9.74ps after 5mm PKG trace (*no* PCB trace)



10.68ps after 11mm PKG trace (no PCB trace)



13.10ps after 11mm PKG trace and 25.4mm PCB trace

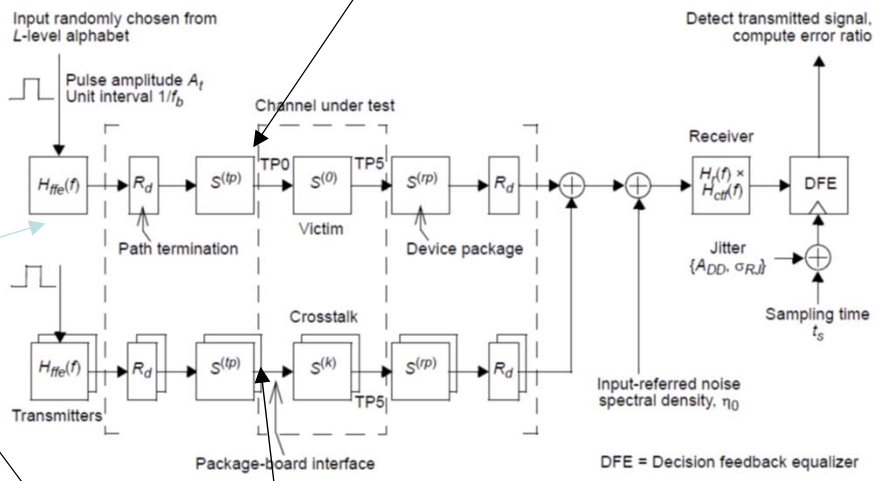


Analysis contributed by Yasuo Hidaka: Using COM device and PKG/PCB model parameters in P802.3ck D1.4.

Rise time

T_t FOM_{ILD}

Tr COM = 7.5 ps



T_t ICN

162.11.7 Cable assembly Channel Operating Margin

The cable assembly Channel Operating Margin (COM) for each lane is derived from measurements of the cable assembly signal, near-end crosstalk and far-end crosstalk paths. COM is computed using the path calculations defined in 162.11.7.1 and the procedure in 93A.1, where T_r is 7.5 ps for $H_r(f)$ as used in Equation (93A–19). The specific paths used depend on cable assembly form factor (see Annex 162D), as described in 162.11.7.2.

$$H_r(f) = \exp(-(\pi f T_r / 1.6832)^2) \qquad (93A–46)$$

94.3.12.1 Test fixture

The test fixture of Figure 94–10 or its equivalent is required for measuring the transmitter specifications described in 94.3.12.

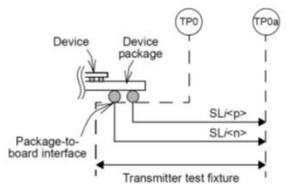
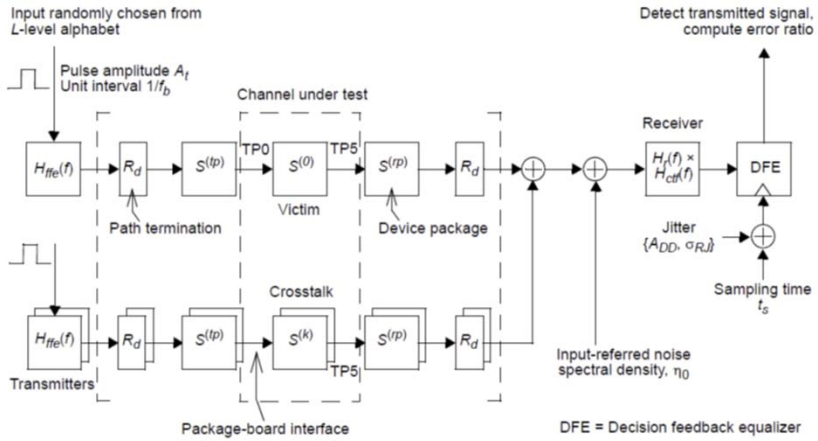


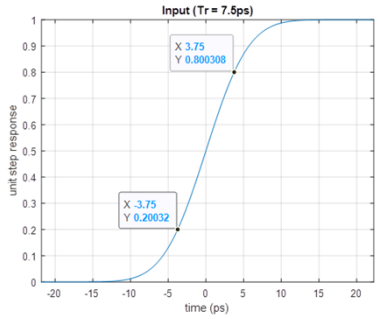
Figure 94–10—Transmitter test fixture and test points

Rise time

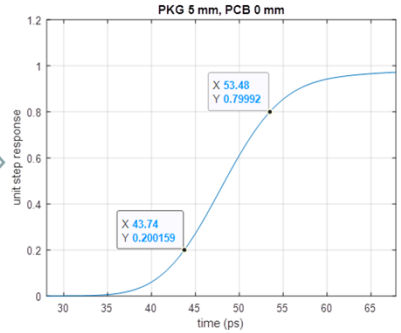
Tr COM = 7.5 ps



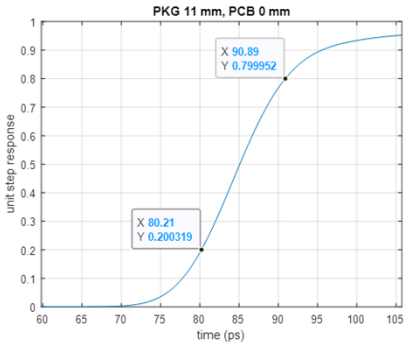
7.5ps input step (Gaussian input pulse)



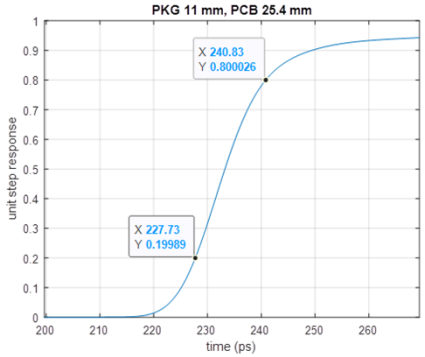
9.74ps after 5mm PKG trace (no PCB trace)



10.68ps after 11mm PKG trace (no PCB trace)



13.10ps after 11mm PKG trace and 25.4mm PCB trace



Analysis contributed by Yasuo Hidaka: Using COM device and PKG/PCB model parameters in P802.3ck D1.4.

Rise time

Rise time – 12G.3.1.4 supplemental

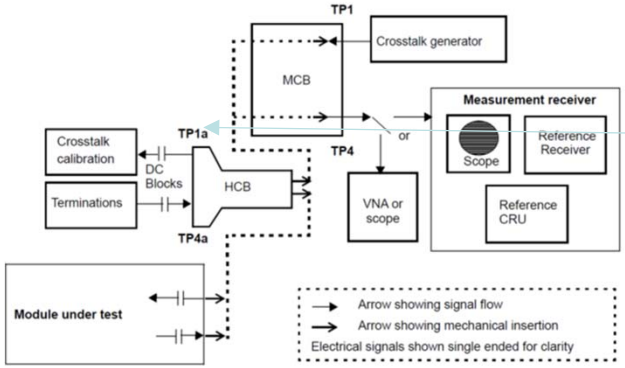


Figure 120G–7—Example module output test configuration

Table 120G–1—Host output characteristics at TP1a

Transition time (min, 20% to 80%)	120G.3.1.4	7.5	ps

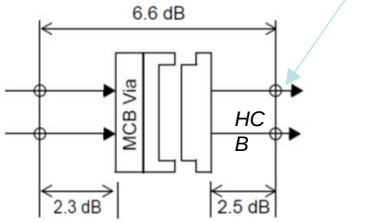


Table 120G–3—Module output characteristics (at TP4)

Transition time (min, 20% to 80%)	120G.3.1.4	7.5	ps

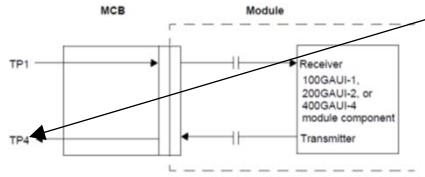


Figure 120G–4—Module compliance points

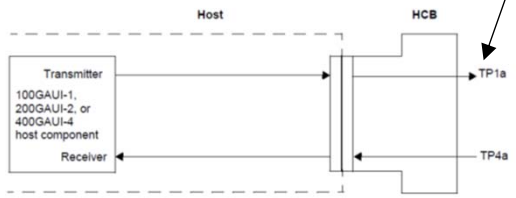


Figure 120G–3—Host compliance points