R_{peak} specifications

(comments #143, #200, #232, #360)

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Introduction

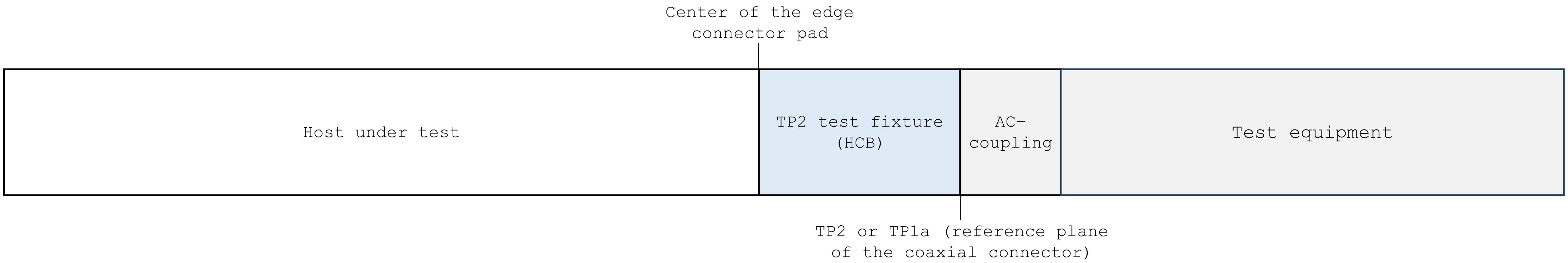
- Multiple comments have observed that the current R_{peak} limits in the draft need to be updated
- It is proposed that the R_{peak} limits be based on the values produced by the models used for the calculation of Channel Operating Margin (COM)
- This would ensure that implementations are consistent with the calculations used to evaluate cable assemblies and the chip-to-module COM reference model

Host transmitter signal measurements

179B.2.1 TP2 or TP3 test fixture insertion loss

The TP2 or TP3 test fixture reference insertion loss is defined as the insertion loss between the reference plane of the coaxial connector and the center of the edge connector pad. The reference insertion loss is defined by Equation (179B–1) and illustrated by Figure 179B–1. The effects of differences between the insertion loss of an actual test fixture and the reference insertion loss are to be accounted for in the measurements.

- TP2 test fixture (HCB) is included in host transmitter signal measurements
- Assume TP2 test fixture loss is corrected to the reference loss



179.9.4 Transmitter characteristics

The transmitter on each lane shall meet the specifications at TP2 given in Table 179–7 and detailed in the referenced subclauses.

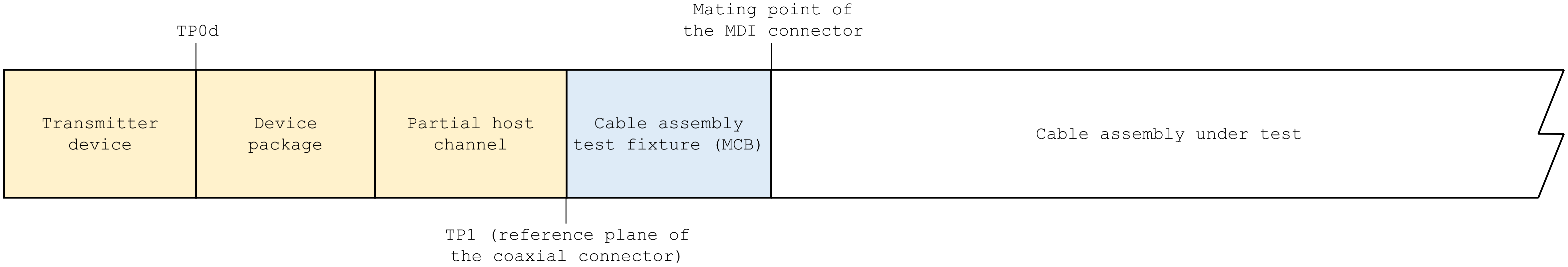
Unless specified otherwise, transmitter signal measurements are made for each lane separately using a fourth-order Bessel-Thomson low-pass response with a 3 dB bandwidth of 60 GHz, with AC-coupled connection from TP2 to 50 Ω single-ended loads in the test equipment.

Cable assembly evaluation

179B.3.1 Cable assembly test fixture insertion loss

The cable assembly test fixture reference insertion loss is defined as the insertion loss between the reference plane of the coaxial connector and the mating point of the MDI connector. The reference insertion loss is defined by Equation (179B–2) and illustrated by Figure 179B–1. The effects of differences between the insertion loss of an actual test fixture and the reference insertion loss are to be accounted for in the measurements.

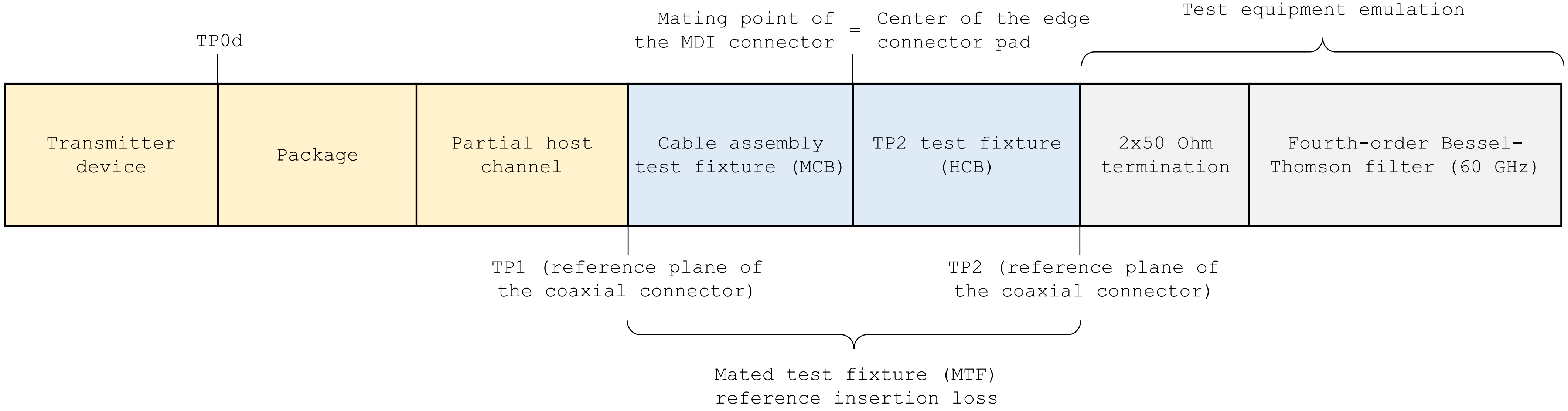
- Cable assembly test fixture(s) are included in cable assembly measurements
- Assume cable assembly test fixture loss is corrected to the reference loss



- Cable assembly COM is computed using equation-based models of a host transmitter device, device package, and a partial host channel
- The cable assembly test fixture becomes part of the host model
- Note that the transmitter device model includes the device termination model and the input rise time filter

Model of the host used for cable assembly evaluation

- Requirements for the host transmitter signal should be consistent with the conditions under which cable assemblies are evaluated and the chip-to-module reference model
- Assuming test fixture losses is corrected to the reference losses, transmitter signal requirements can be derived from a model based on the COM equation-based host components and the reference mated test fixture (MTF) insertion loss



179B.4.2 Mated test fixtures insertion loss

HCB reference insertion loss

NOTE—The reference insertion loss of the mated test fixture is equal to the sum of Equation (179B–1) and Equation (179B–2).

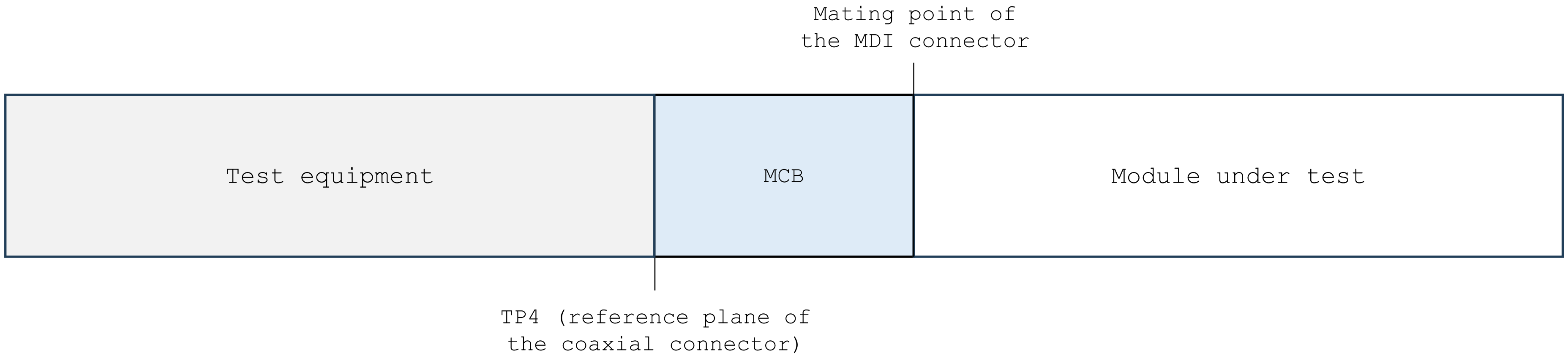
MCB reference insertion loss

Module transmitter signal requirements

179B.3.1 Cable assembly test fixture insertion loss

The cable assembly test fixture reference insertion loss is defined as the insertion loss between the reference plane of the coaxial connector and the mating point of the MDI connector. The reference insertion loss is defined by Equation (179B–2) and illustrated by Figure 179B–1. The effects of differences between the insertion loss of an actual test fixture and the reference insertion loss are to be accounted for in the measurements.

- MCB is identical to the cable assembly test fixture with the same reference insertion loss
- Assume MCB loss is corrected to the reference loss
- Note that AC-coupling is within the module under test

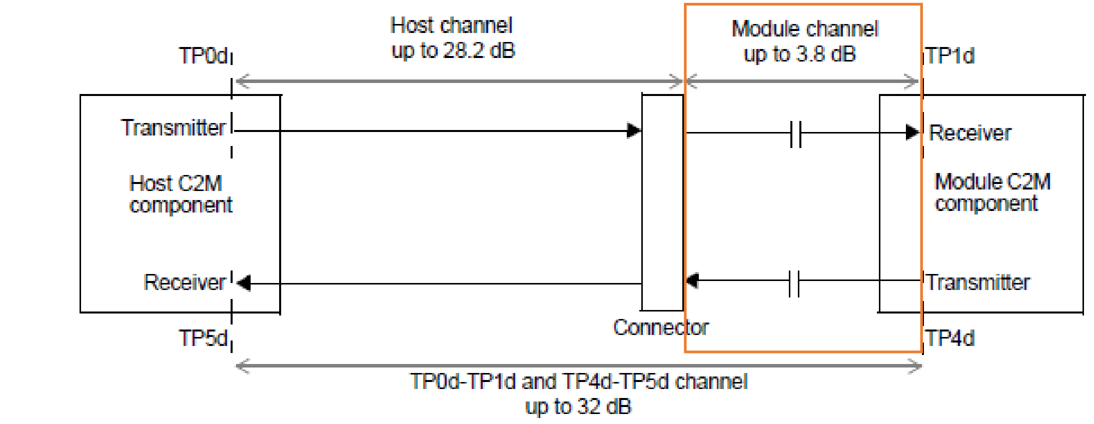


176D.6.5 Module output characteristics

Unless specified otherwise, module output signal measurements are made for each lane separately using a fourth-order Bessel-Thomson low-pass response with a 3 dB bandwidth of 60 GHz, with DC-coupled connection from TP4 to 50 Ω single-ended loads in the test equipment.

Module channel loss

- COM reference model is used to calibrate the test channel for interference/jitter tolerance tests
- Assumes the module channel consists of HCB and a device package model
- This is inconsistent with the reference insertion loss budget illustrated in Figure 176D-6
- Assume module channel loss is consistent with the model used for test channel calibration



NOTE—For loss budgeting purposes, the connector is considered part of the host.

Figure 176D–6—Reference insertion loss budget at 53.125 GHz

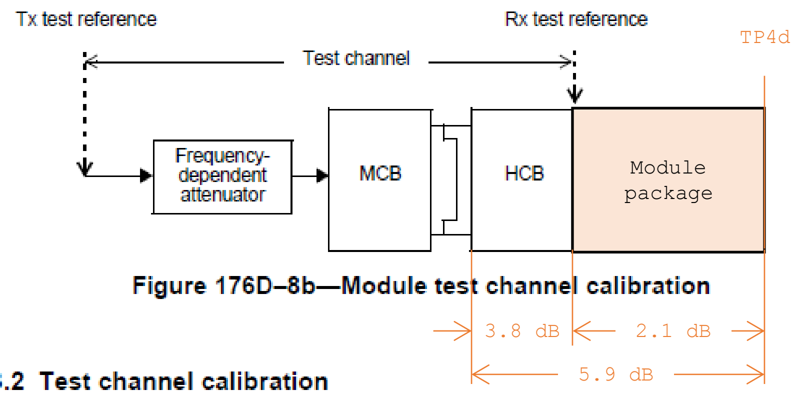


Figure 176D–8b—Module test channel calibration

176D.8.13.2 Test channel calibration

The COM of the test channel is calculated using the method defined in Annex 178A and the parameters of 176D.7.2, with the following considerations:

a) For the host test, the test channel is measured between the Tx and Rx test references shown in Figure 176D–7b, and COM is calculated using the partial host channel, device package, and device termination models in Table 176D–6 for the receiver S-parameter model.

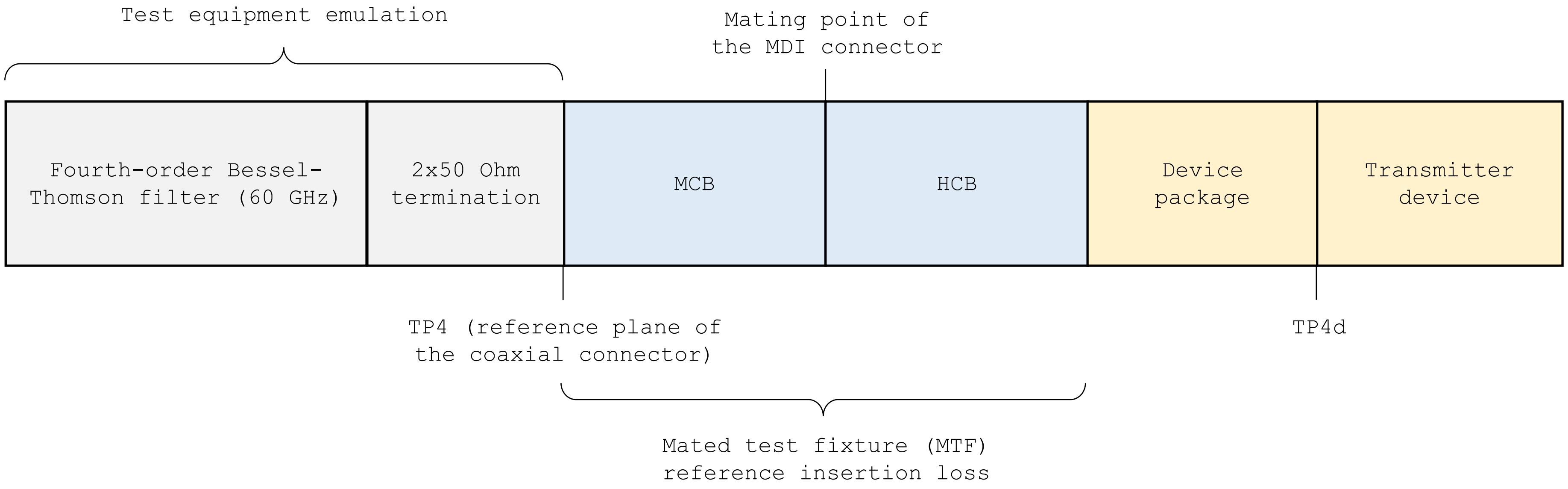
b) For the module test, the test channel is measured between the Tx and Rx test references shown in Figure 176D–8b, and COM is calculated using the module device package and device termination models in Table 176D–6 for the receiver S-parameter model. Calculation is performed for both case 1 and case 2 of the package transmission line 1 length, and the value of COM is taken as the lower of the two calculated values.

Table 176D–6—Host and module model parameters *(continued)*

Parameter	Symbol	Value	Units
Device package model, module			
Transmission line parameter γ_0	γ_0	5×10^{-4}	1/mm
Transmission line parameter a_1	a_1	8.9×10^{-4}	$ns^{1/2}$/mm
Transmission line parameter a_2	a_2	2×10^{-4}	ns/mm
Transmission line parameter τ	τ	6.141×10^{-3}	ns/mm
Transmission line 1 length, case 1	$z_p^{(1)}$	4	mm
Transmission line 1 length, case 2	$z_p^{(1)}$	10	mm
Transmission line 1 characteristic impedance	$Z_c^{(1)}$	87.5	Ω
Transmission line 2 length	$z_p^{(2)}$	1.8	mm
Transmission line 2 characteristic impedance	$Z_c^{(2)}$	92.5	Ω
Single-ended package capacitance at package-to-board interface	C_p	40×10^{-6}	nF

Model of module transmitter used in COM reference model

- Requirements for the module transmitter signal should be consistent with the COM reference model
- Assuming the MCB loss is corrected to the reference loss, module transmitter signal requirements can be derived from a model based on the COM transmitter device model and the reference mated test fixture (MTF) insertion loss



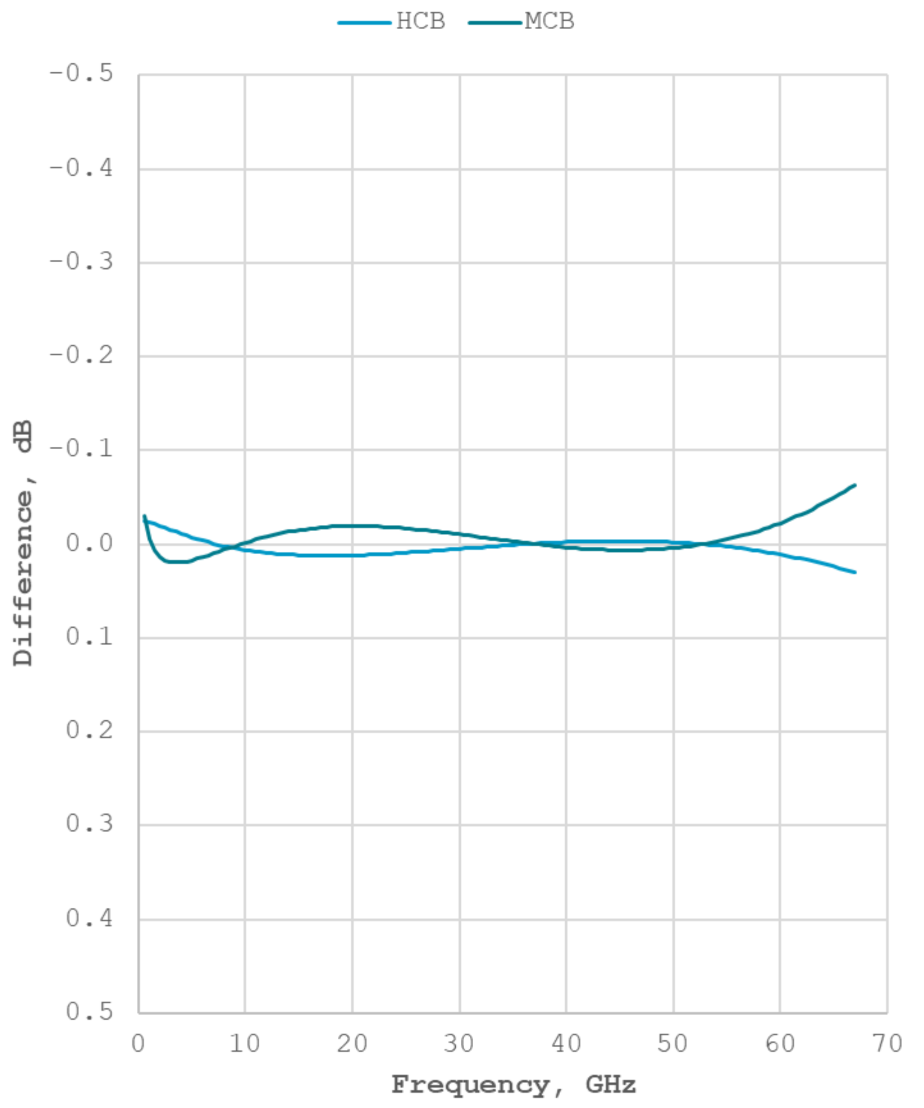
- Again, note that the transmitter device model includes the device termination model and the input rise time filter

Simplification of test fixture reference insertion loss

$$IL_{ref}(f) = b_0 + b_{0.5}\sqrt{f} + b_1 f + b_{1.5} f^{1.5} + b_2 f^2$$

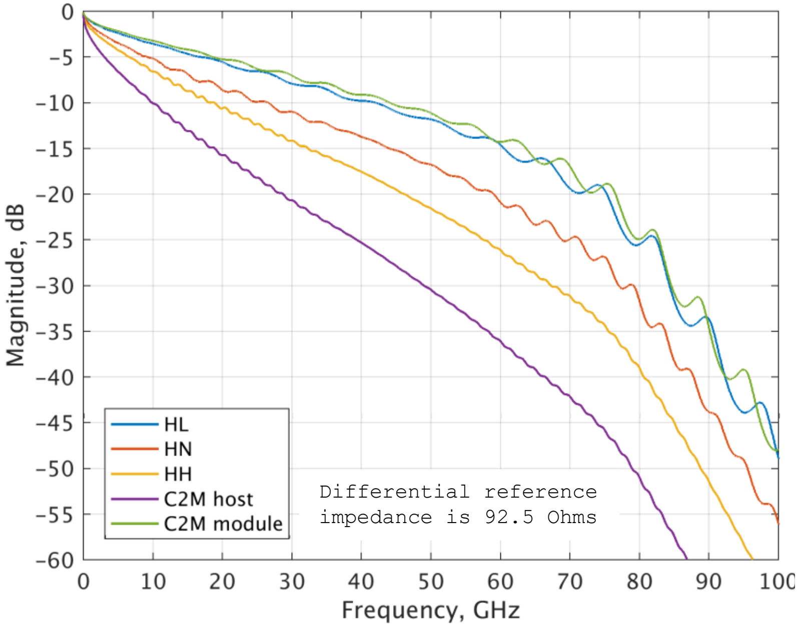
- Draft 2.2 specifies reference insertion loss using an equation with the form shown above
- These equations include a $f^{1.5}$ term and negative polynomial coefficients
- The $f^{1.5}$ term can be removed and coefficients constrained to positive values
- The resulting equations are practically identical to the originals and are more amenable to a physical interpretation
- It is straightforward to determine a causal phase from the re-fit equations for use in time-domain modeling

Coefficient	Draft 2.2		Re-fit	
	HCB	MCB	HCB	MCB
b_0	-0.015	-0.0269	0	1.097E-01
$b_{0.5}$	0.28	0.5829	3.073E-01	3.729E-01
b_1	0.03495	-0.0841	1.172E-02	1.031E-02
$b_{1.5}$	-0.00495	0.016		
b_2	0.00065	0	3.321E-04	9.123E-04

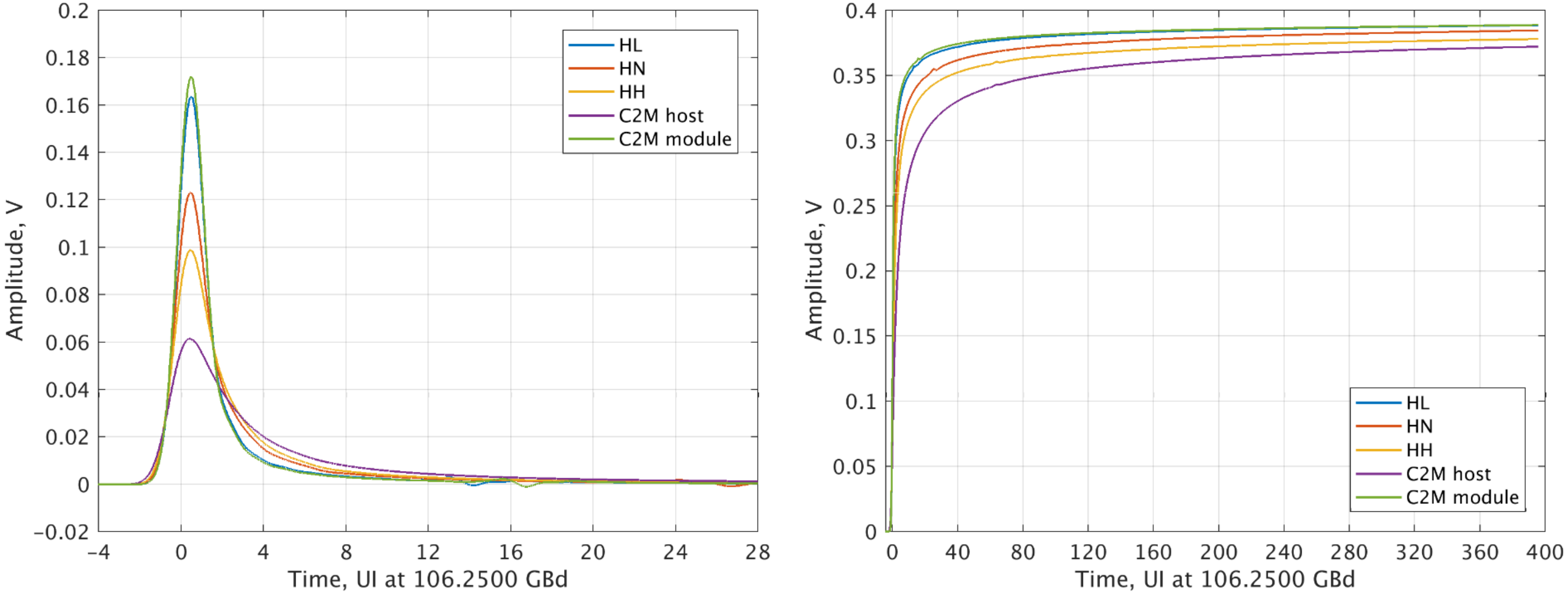


Summary of results

TP0d-to-TPx insertion loss



Pulse response



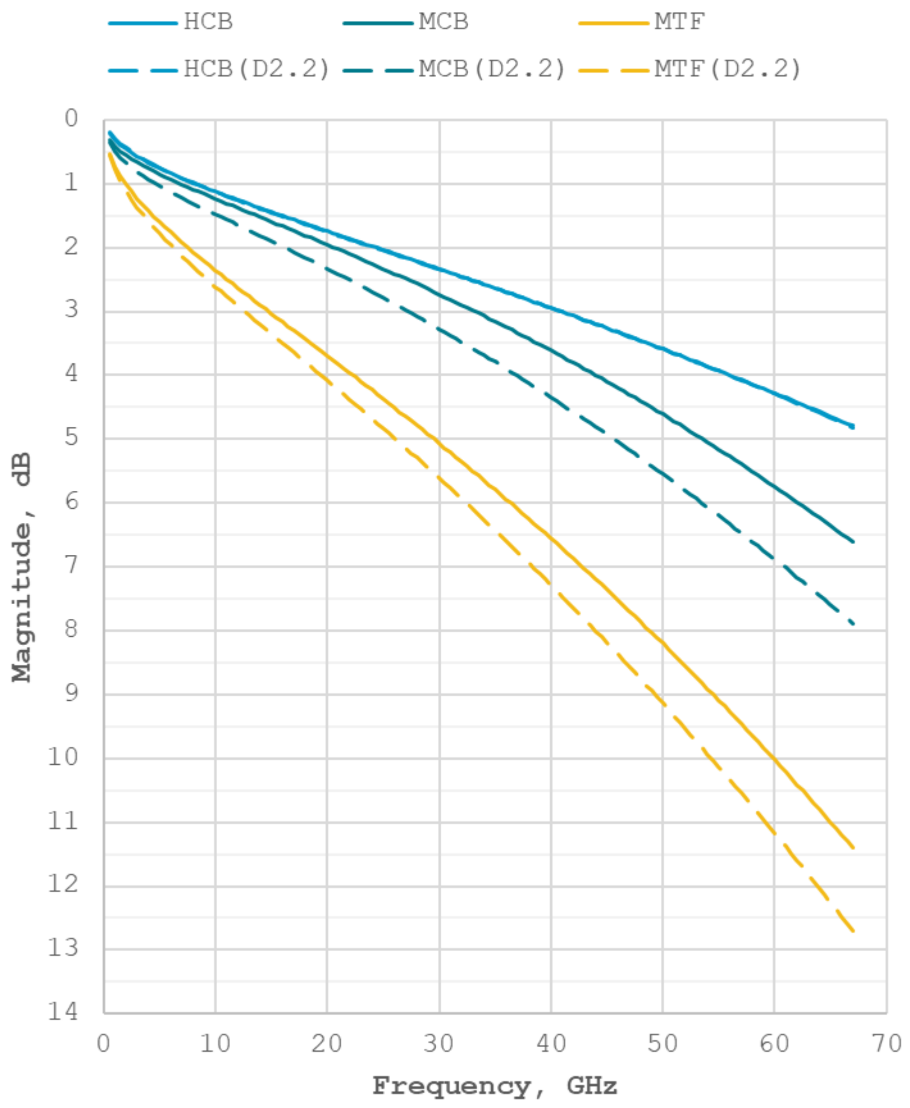
Case	Package		Partial host	Mated test fixture	TP0-to-TPx IL, dB [2]		p_{max}, V	v_f, V	R_{peak}
	Class	Length, mm	Length, mm [1]	IL, dB	Calculated	Target			
HL	A	8	22	9.75	12.78	12.75	0.162	0.388	0.418
HN	B	15	83	9.75	17.75	17.75	0.122	0.384	0.318
HH	B	45	74	9.75	22.79	22.75	0.098	0.378	0.259
C2M host	B	45	260	9.75	32.03	32	0.061	0.372	0.164
C2M module	A	10	n/a	9.75	11.82	n/a	0.171	0.388	0.441

[1] Partial host channel trace lengths needed to be increased relative to the values in draft 2.2 to reach target insertion loss values.
[2] TPx represents either TP2 for Clause 179 hosts (HL, HN, HH), TP1a for Annex 176D hosts (C2M host), or TP4 for Annex 176D modules (C2M module).

Comment #232

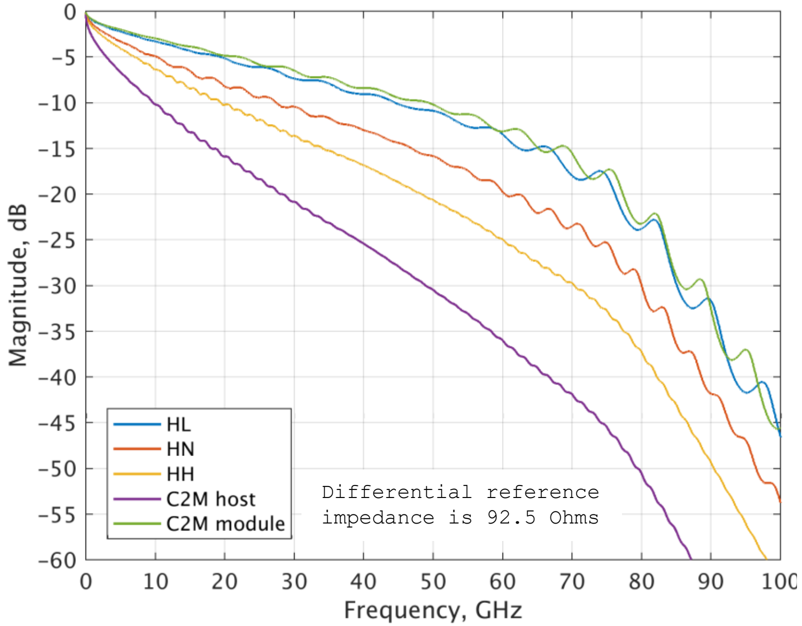
- Comment #232 suggests a reallocation of the loss budget to account for reductions to connector (and via) loss
- It proposes to reduce the cable assembly test fixture (MCB) and Clause 179 host loss allocations by 1 dB
- A new cable assembly test fixture reference insertion loss is defined by scaling the original equation
- The mated test fixture reference insertion loss is still the sum of the individual test fixture reference insertion losses

Coefficient	Draft 2.2 re-fit		MCB loss reduced by 1 dB	
	HCB	MCB	HCB	MCB
b_0	0	1.097e-01	0	9.12e-02
$b_{0.5}$	3.073e-01	3.729e-01	3.073e-01	3.102e-01
b_1	1.172e-02	1.031e-02	1.172e-02	8.578e-03
b_2	3.321e-04	9.123e-04	3.321e-04	7.59e-04

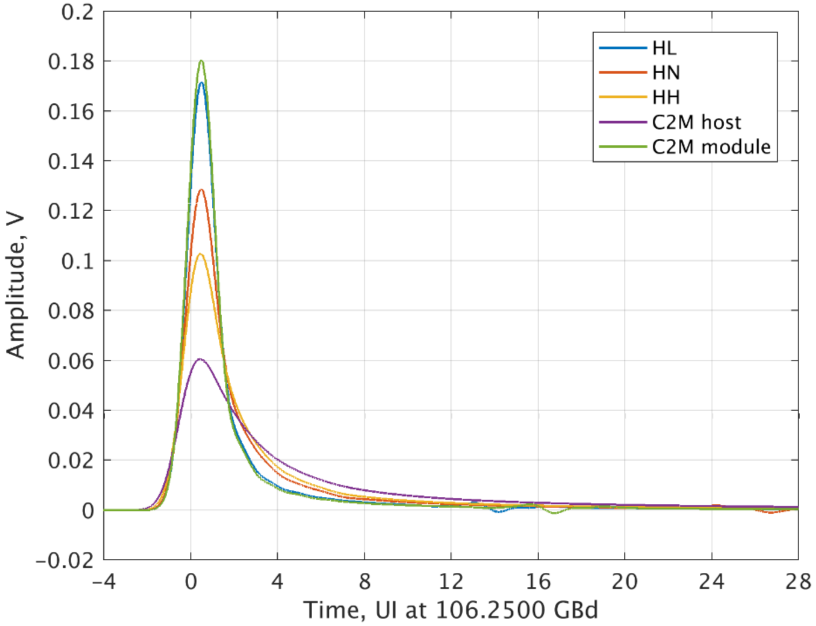


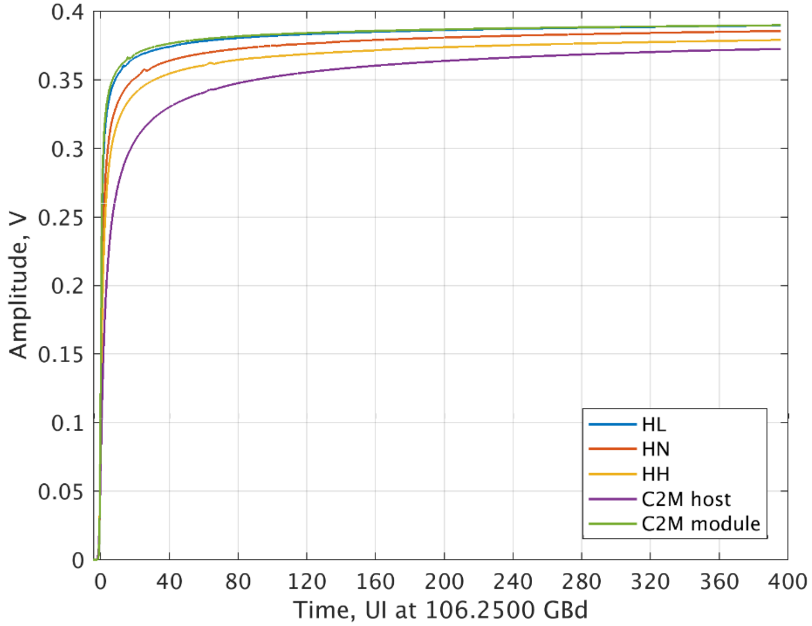
Results with loss budgets modified per comment #232

TP0d-to-TPx insertion loss



Pulse response





Case	Package		Partial host	Mated test fixture	TP0-to-TPx IL, dB [2]		p_{max}, V	v_f, V	R_{peak}
	Class	Length, mm	Length, mm [1]	IL, dB	Calculated	Target			
HL	A	8	22	8.75	11.78	11.75	0.171	0.389	0.44
HN	B	15	83	8.75	16.75	16.75	0.128	0.385	0.332
HH	B	45	74	8.75	21.8	21.75	0.102	0.379	0.269
C2M host	B	45	280	8.75	32.02	32	0.06	0.372	0.161
C2M module	A	10	n/a	8.75	10.82	n/a	0.179	0.389	0.46

[1] Partial host channel trace lengths needed to be increased relative to the values in draft 2.2 to reach target insertion loss values.
[2] TPx represents either TP2 for Clause 179 hosts (HL, HN, HH), TP1a for Annex 176D hosts (C2M host), or TP4 for Annex 176D modules (C2M module).

Summary and recommendations

- R_{peak} values produced by the models used to compute cable assembly COM, and used in the chip-to-module COM reference model, were computed
- These values should be used as the basis for R_{peak} limits for hosts and modules
- If these limits are found to be difficult to meet in practice, then it may be necessary to revisit the host (or module) model used for COM
- It was shown that the partial host channel trace lengths should be adjusted for the host channel model to agree with the budgeted loss values
- It was shown that the steady-state voltage limits are not being met by the models
- The lower end of the v_f limit should be adjusted accordingly
- Values were computed with and without the loss adjustments suggested in comment #232
- It was shown that the reference insertion loss polynomials could be simplified with no meaningful change to the loss values
- These simplifications should be considered for the next draft
- There appears to be a discrepancy between the module reference insertion loss and the interference/jitter tolerance test channel calibration procedure

Summary of proposed changes

Case	Draft 2.2			No change to loss budgets			Comment #232 accepted		
	Partial host z_p, mm	v_f, V	R_{peak}	Partial host z_p, mm	v_f, V	R_{peak}	Partial host z_p, mm	v_f, V	R_{peak}
HL	9	0.4	0.456	22	0.388	0.418	22	0.389	0.44
HN	70	0.4	0.345	83	0.384	0.318	83	0.385	0.332
HH	60	0.4	0.234	74	0.378	0.259	74	0.379	0.269
C2M host	250	0.4	0.123	260	0.372	0.164	280	0.372	0.161
C2M module	n/a	0.4	0.456	n/a	0.388	0.441	n/a	0.389	0.46