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shaping tomorrow with you

Return Loss of Test Channel for Rx ITT in Clause 136 (#72)

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Background

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- For Clause 93 (100GBASE-KR4), return loss of test channel for Rx ITT was specified to meet EQ (93-2)
  - EQ (93-2) is return loss of test fixture, that is rather good
  - With good return loss of test channel, broadband noise is always injected
  - Overstress of broadband noise may have contributed to ample margin of interoperability for existing 25G NRZ SerDes specs
- I proposed to do the same for Annex 120D and Clause 137
  - The proposal was already adopted in P802.3bs
- A feedback in June 14th Ad Hoc was that cable PHY should be specified independently from backplane PHY
  - Even if the same SerDes devices will be used for both of PHYs
- This presentation focuses on Rx ITT for cable PHYs

Clause 92 (100GBASE-CR4)

- Requirements for the test channel quality
  - The cable assembly meets the cable assembly COM in 92.10.7.
    - Specified in 92.8.4.4 and 92.8.4.4.2
  - ILD (insertion loss deviation) is recommended to be as small as practical.
    - Specified in 92.8.4.4.3
  - IL fitting parameters are recommended to be close to values in Table 92-8.
    - Specified in 92.8.4.4.3
  - (No need to meet the cable assembly characteristics in 92.10 (e.g. RL)) ???

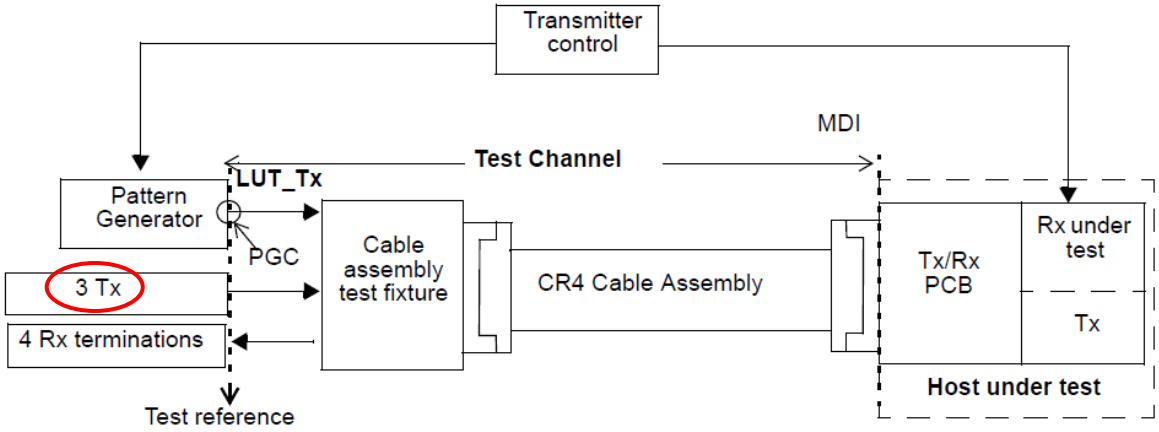
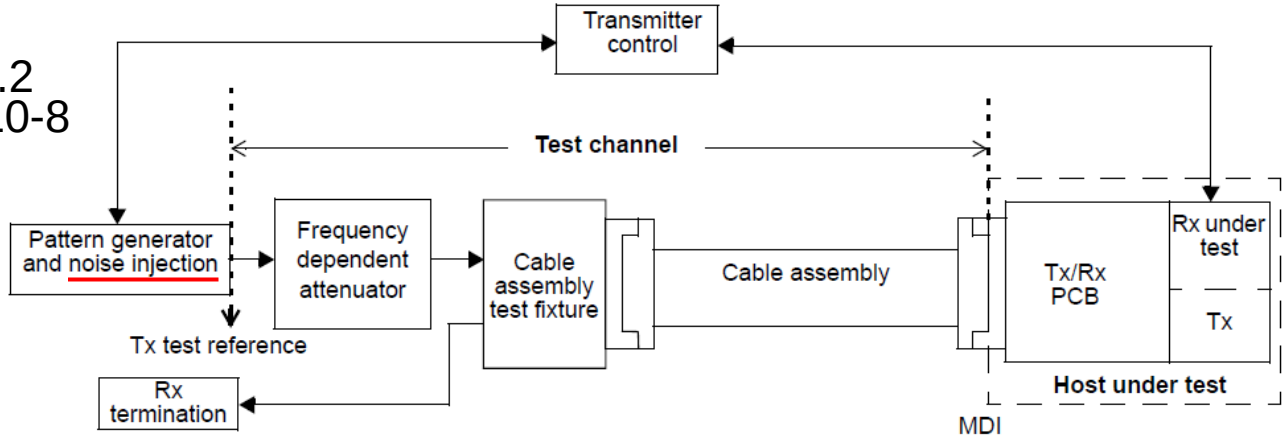


Figure 92–9—Interference tolerance test setup

- 3 far-end TXs are used as the noise source for calibration
  - Broadband noise was *not* used in Rx ITT in Clause 92

Clause 110 (25GBASE-CR)

- Requirements for the test channel quality
  - The cable assembly meets the cable assembly COM in 110.10.7.
    - Specified in 110.8.4.2
  - The cable assembly meets the cable assembly requirements in 110.10
    - Specified in 110.8.4.2.2
    - 110.10.3 refers to 92.10.3 cable assembly differential return loss, EQ 92-27
  - The cable assembly *test fixture* meets the requirements in Annex 110B.1
    - Specified in 110.8.4.2.3
    - 110B.1.3.2 refers to 92.11.3.2 mated test fixture differential return loss, EQ 92-38
  - Insertion loss
    - Specified in 110.8.4.2 and Table 110-6~110-8



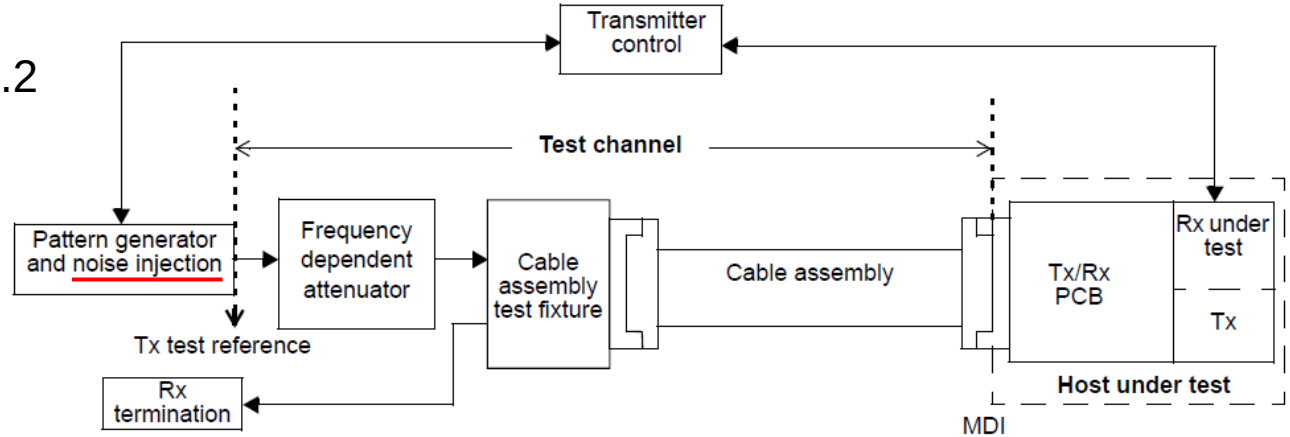
NOTE—The MDI of the host under test is not included in the test channel.

Figure 110–3a—Interference tolerance test setup

- Broadband noise is added to the signal before the Tx test reference

Clause 136 (50GBASE-CR, etc) in D2.0

- Requirements for the test channel quality
  - The cable assembly meets the cable assembly COM in 136.11.7.
    - Specified in 136.9.4.2
  - The cable assembly meets the cable assembly requirements in 136.11
    - Specified in 136.9.4.2.2
    - 136.11.3 refers to 92.10.3 cable assembly differential return loss, EQ 92-27
  - The cable assembly *test fixture* meets the requirements in Annex 136B
    - Specified in 136.9.4.2.2
    - 136B.1.1.2 refers to 92.11.3.2 mated test fixture differential return loss, EQ 92-38
  - Insertion loss
    - Specified in 136.9.4.2 and Table 136-13



NOTE—The MDI of the host under test is not included in the test channel.

Figure 110–3a—Interference tolerance test setup

- Broadband noise is added to the signal before the Tx test reference

Test Channel seems too loose

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- Quality of test channel is just same as channel
  - The cable assembly in the test channel is required to meet just
    - The cable assembly COM
    - The cable assembly requirements (e.g. differential return loss, EQ 92-27)
  - In Clause 92, ILD was recommended to be as small as possible
    - However, this recommendation was removed in Clause 110 and 136
- Only test fixture is restricted more tightly than channel
  - E.g. mated test fixture meets the differential return loss, EQ 92-38
- We should tighten test channel in the same way as backplane
  - We may specify its return loss as the test fixture grade by EQ 92-38
    - Same as backplane PHYs which also use return loss of test fixture (EQ 93-2)
  - Need to check feasibility

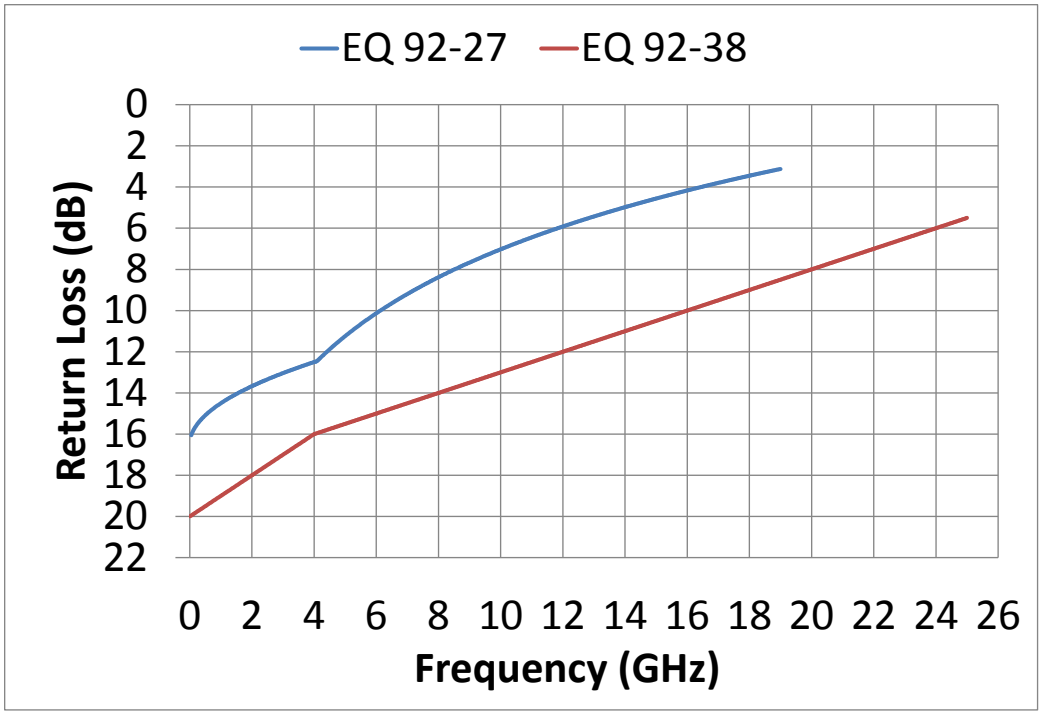
EQ 92-27 vs EQ 92-38

- EQ 92-27 : cable assembly differential return loss

$$Return\_Loss(f) \geq \begin{cases} 16.5 - 2\sqrt{f} & 0.05 \leq f < 4.1 \\ 10.66 - 14\log_{10}(f/5.5) & 4.1 \leq f \leq 19 \end{cases}$$

- EQ 92-38 : mated test fixture differential return loss

$$Return\_Loss(f) \geq \begin{cases} 20 - f & 0.01 \leq f < 4 \\ 18 - 0.5f & 4 \leq f \leq 25 \end{cases}$$



Test Data for Feasibility Study

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- Molex zQSFP to zQSFP cable data
  - Measured between TP1 and TP4 using MCBs at both ends
  - Contribution to 50G and NGOATH Study Group by Chris Roth (Molex)
  - http://www.ieee802.org/3/50G/public/channel/index.html

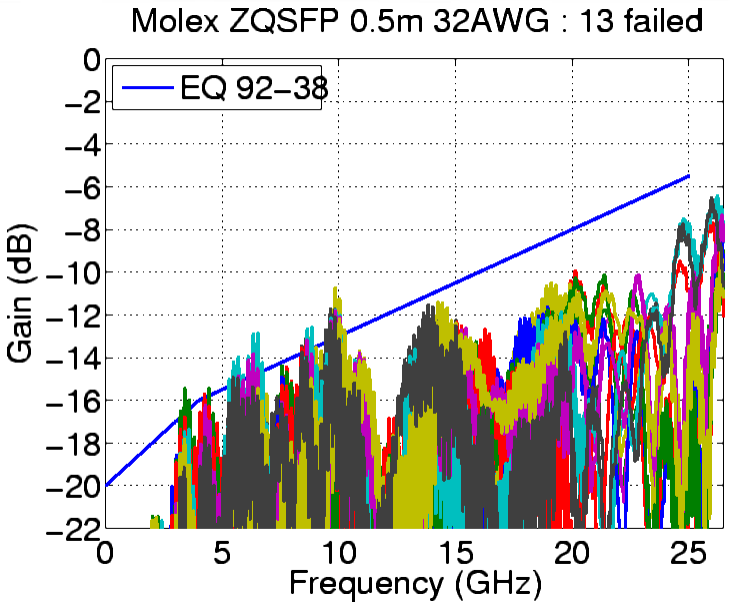
- 5 cable types (8 THRU channels for each cable type)

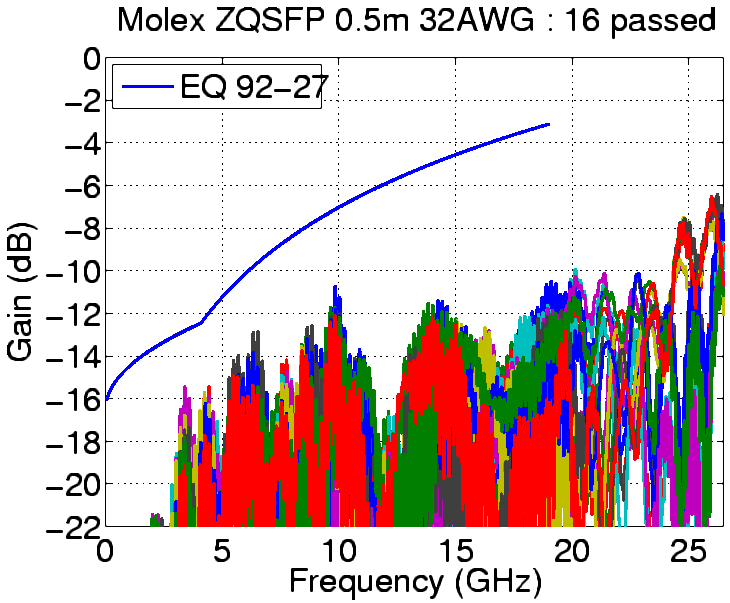
Type		Insertion Loss at 13.28GHz (dB)			Relevant Rx ITT Test Column in Table 136-13
		min	typ	max	
A	0.5 meter 32 AWG	8.2360	8.4142	8.7035	Test 1 (8-10dB)
B	1 meter 30 AWG	9.9715	10.2465	10.5423	N/A
C	1 meter 26 AWG	7.9745	8.2035	8.3921	Test 1 (8-10dB)
D	2 meter 26 AWG	11.1135	11.3041	11.5613	N/A
E	3 meter 26 AWG	14.3190	14.4033	14.5195	Test 2 (14.06-16.06dB)

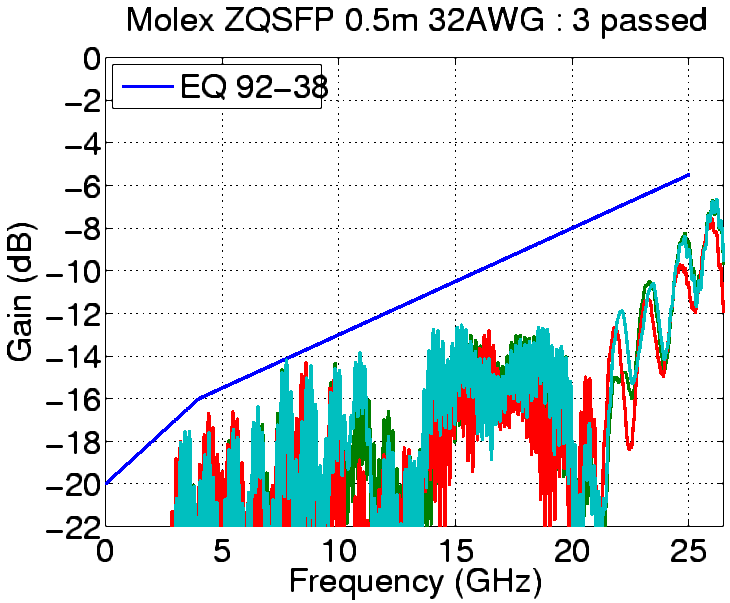
- Checked all 16 ports for each cable type
  - Checked both of S11dd and S22dd for each of all 8 THRU channels

Type A: 0.5 meter 32 AWG

- EQ 92-27 (graph below)
  - 0 failed, 16 passed
- EQ 92-38 (graphs on right)
  - 13 failed, 3 passed
    - Worst violation 2.3248 dB

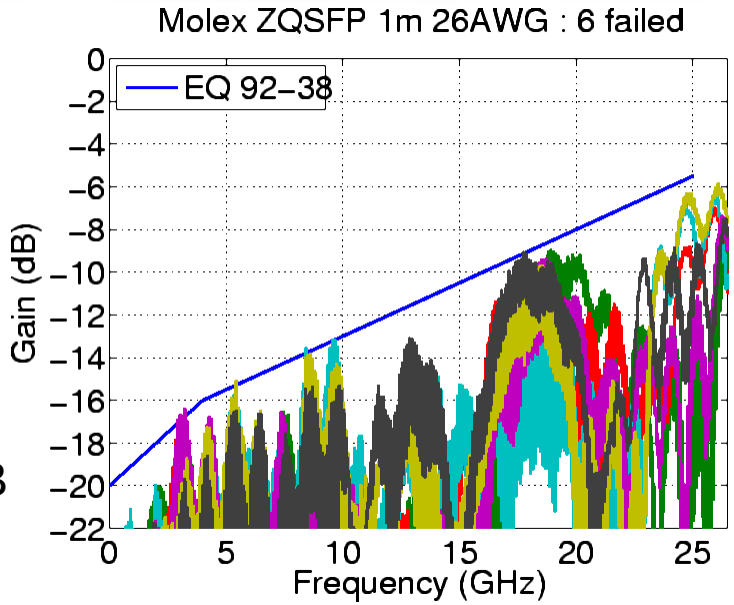


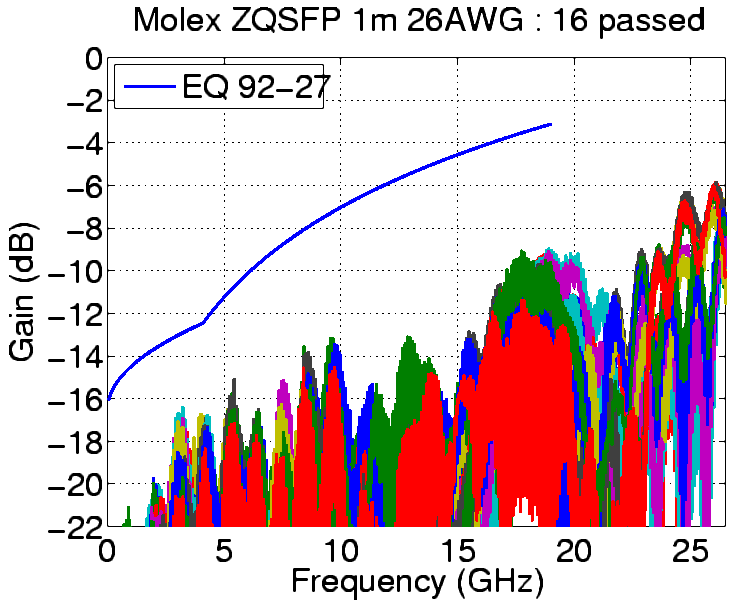


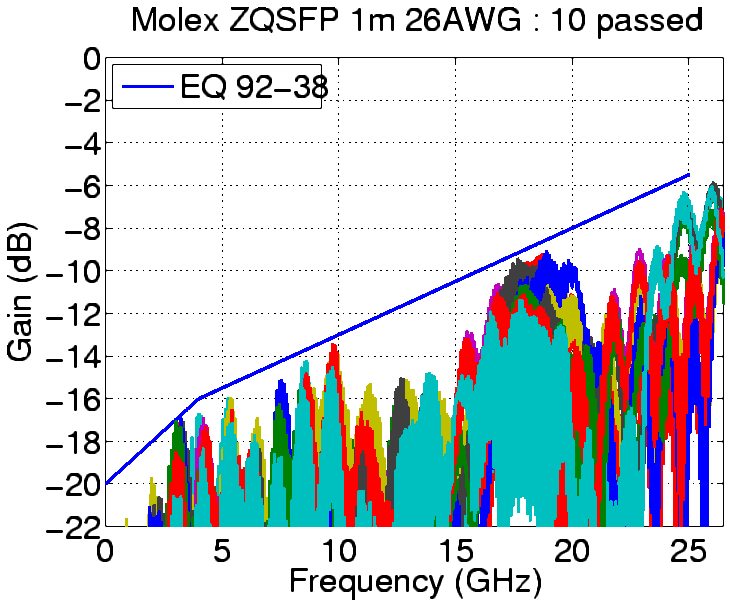


Type C: 1 meter 26 AWG

- EQ 92-27 (graph below)
  - 0 failed, 16 passed
- EQ 92-38 (graphs on right)
  - 6 (barely) failed, 10 passed
    - Worst violation 0.3715dB
    - Violation 0.2410dB, 0.2005dB, 0.0962dB in the other three 4-lane bundles

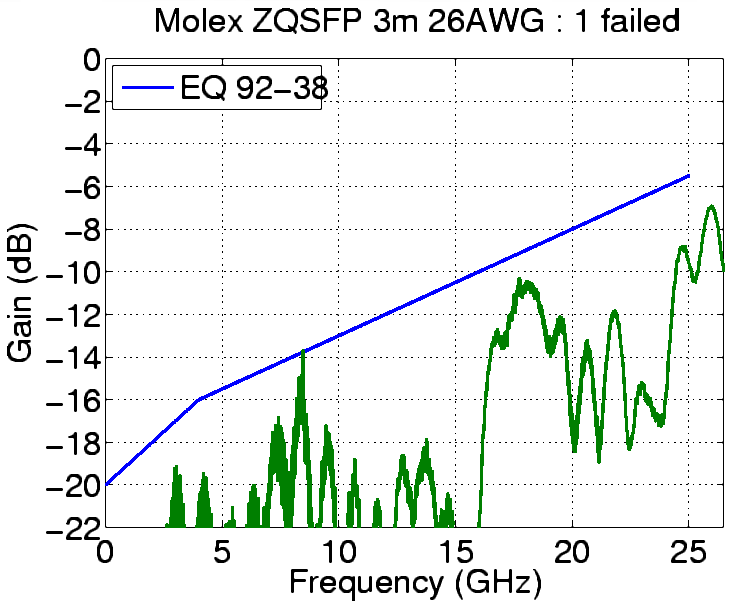


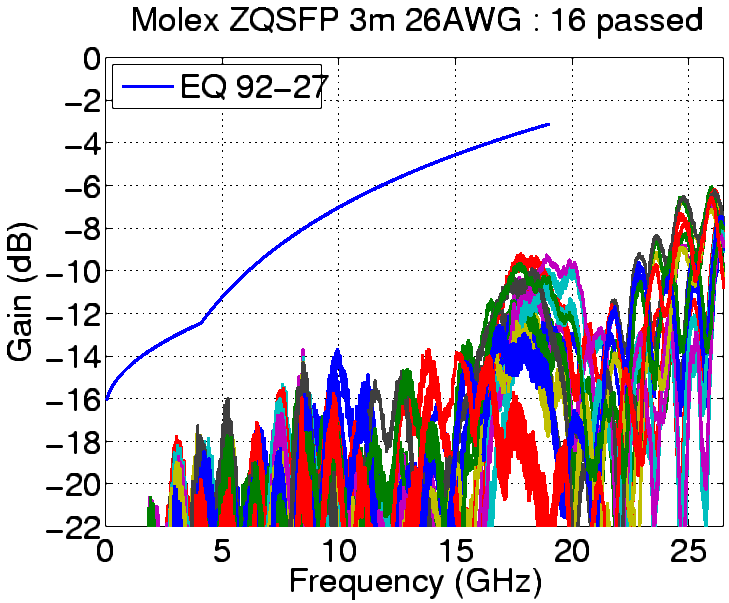


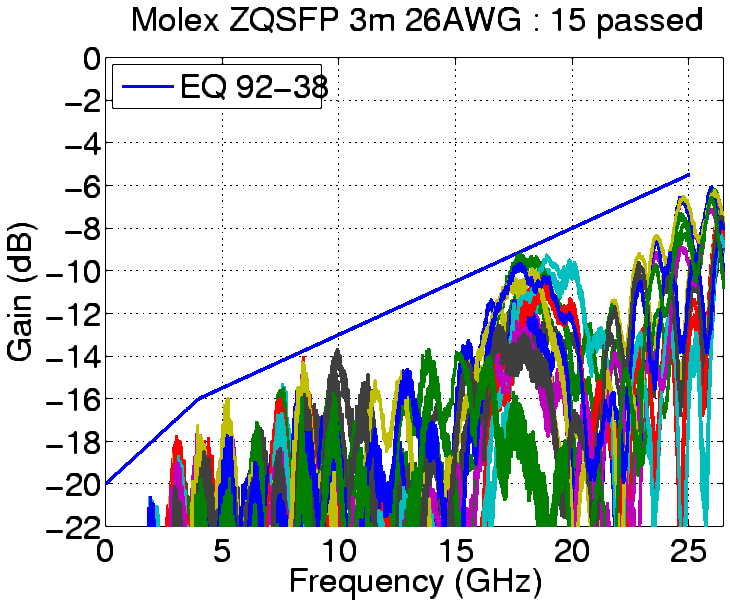


Type E: 3 meter 26 AWG

- EQ 92-27 (graph below)
  - 0 failed, 16 passed
- EQ 92-38 (graphs on right)
  - 1 barely failed, 15 passed
    - Worst violation 0.0649 dB
      - Just at one data point







Summary

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- Prior cable PHYs did not specify return loss of test channel for Rx ITT tighter than channel
  - In Clause 92, insertion loss deviation was recommended to be as small as possible, but not any more in Clause 110 or Clause 136 D2.0
- However, good test channel for Rx ITT is important for cable PHYs regarding to interoperability between channel and Rx for the same scenario as backplane PHYs
  - This has been explained in hidaka_061417_3cd_02_adhoc-v2.pdf and my several former presentations in the context of backplane PHYs
- It is feasible to tighten return loss of test channel by EQ 92-38
  - Results of Type-E indicate that there is no problem for Test 2
  - Results of Type-C indicate that it may be critical or a little hard for Test 1
    - It should be OK if we relax the equation by 0.1dB for Test 1

My proposal

- Specify the differential return loss of the test channel at Rx test reference including the cable assembly by Equation (92-38)

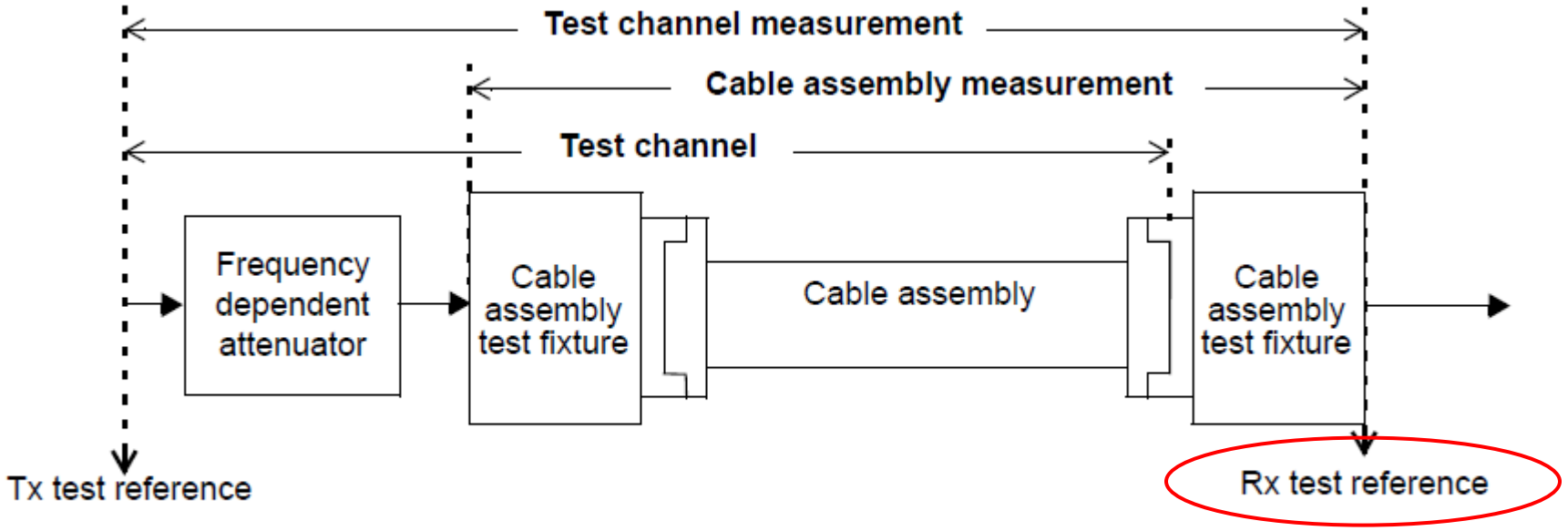

Figure 110–3b—Test channel calibration

- Optionally, we may relax the equation by 0.1dB for Test 1.
  - However, we should not relax for Test 2
    - Because Test 2 is more critical than Test 1 regarding to interoperability.

Follow-up Discussions at Ad Hoc Call

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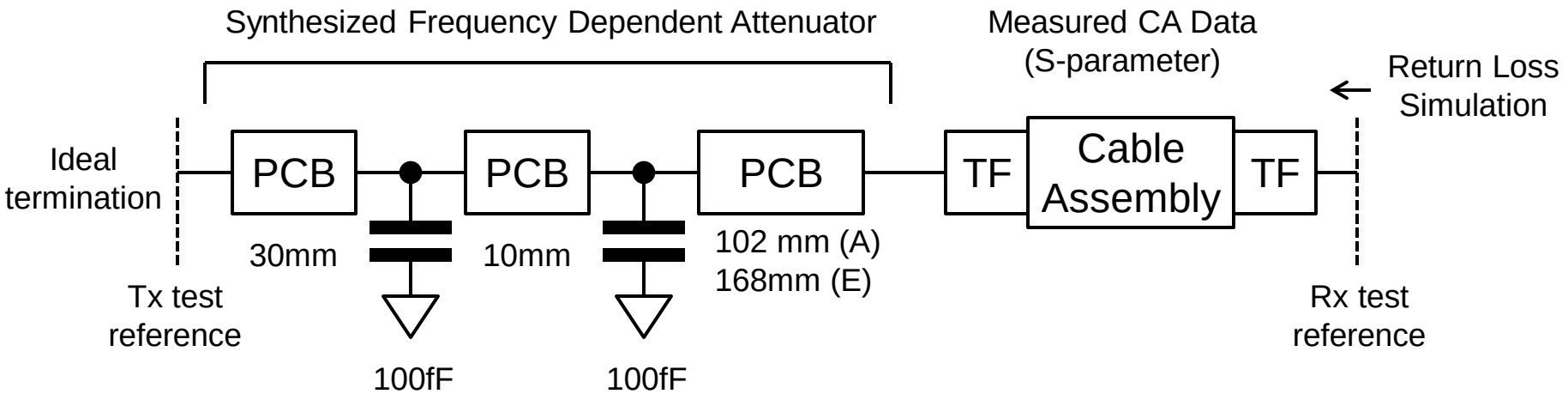
- Some more margin may be needed
  - I asked opinions from experts of cable assemblies
    - “The data is fairly typical of that particular cable design, but we can definitely make better or worse cables depending on material choices and a few different design options.”
    - “They are old data. We can do better now. We have no problem of this equation.”
    - “The idea is understandable, but we need to check more data.”

- Some realistic reflection may be needed in test channel
  - We may add intentional reflection to the frequency dependent attenuator
    - Evaluated the effect of reflection in the frequency dependent attenuator on the return loss at Rx test reference
  - We may add RSS_DFE4 to Table 136-13

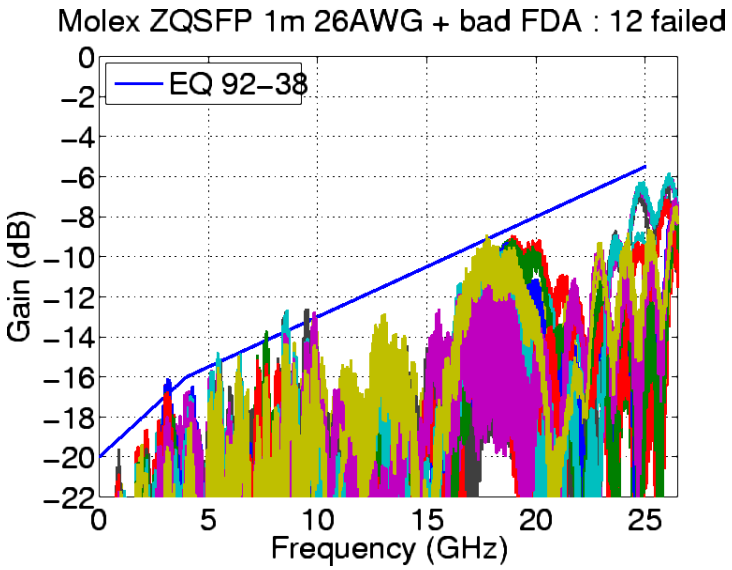
RL Sim with Frequency Dependent Attenuator

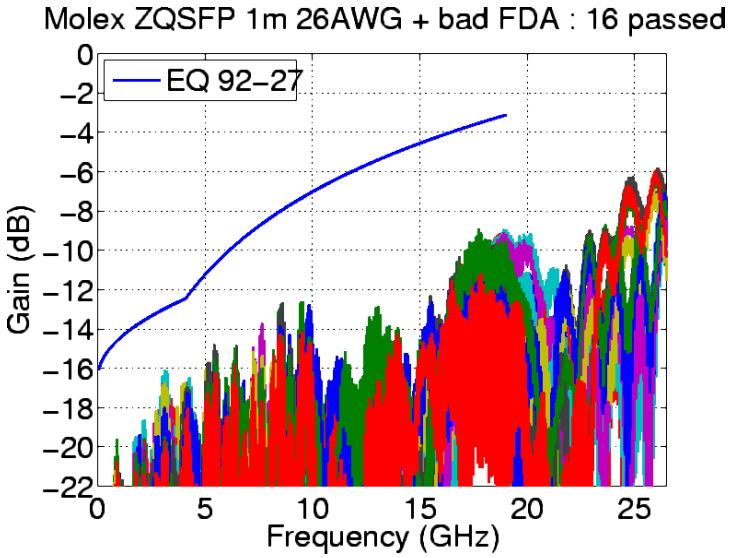


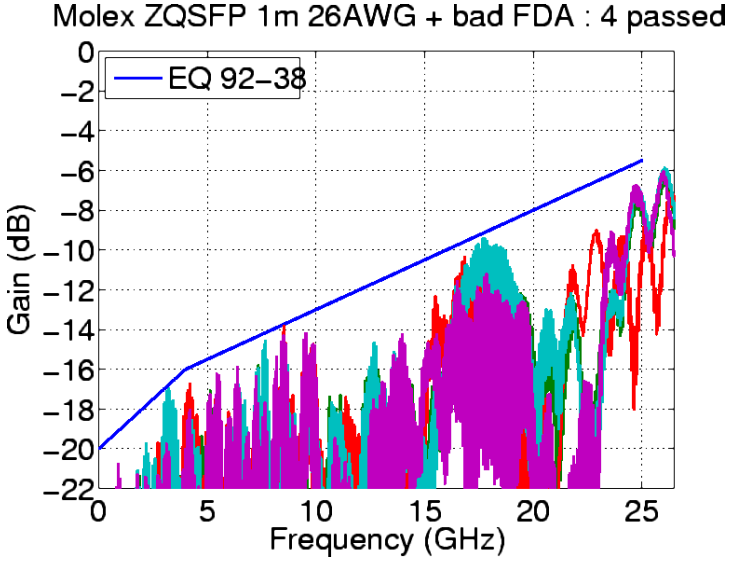
Type		Cable Assembly + TF IL at 13.28GHz (dB)			Test Channel (incl. FDA) IL at 13.28GHz (dB)			Test Column in Table 136-13
		min	typ	max	min	typ	max	
C	1 meter 26 AWG	7.97	8.20	8.39	14.19	14.43	14.58	Test 1 (Low loss)
E	3 meter 26 AWG	14.32	14.40	14.52	23.40	23.48	23.61	Test 2 (High loss)

Type C: FDA + 1 meter 26 AWG

- EQ 92-27 (graph below)
  - 0 failed, 16 passed
- EQ 92-38 (graphs on right)
  - 12 failed, 4 passed
    - Worst violation 1.00dB
    - Violation 0.92dB, 0.74dB, 0.62dB in the other three 4-lane bundles

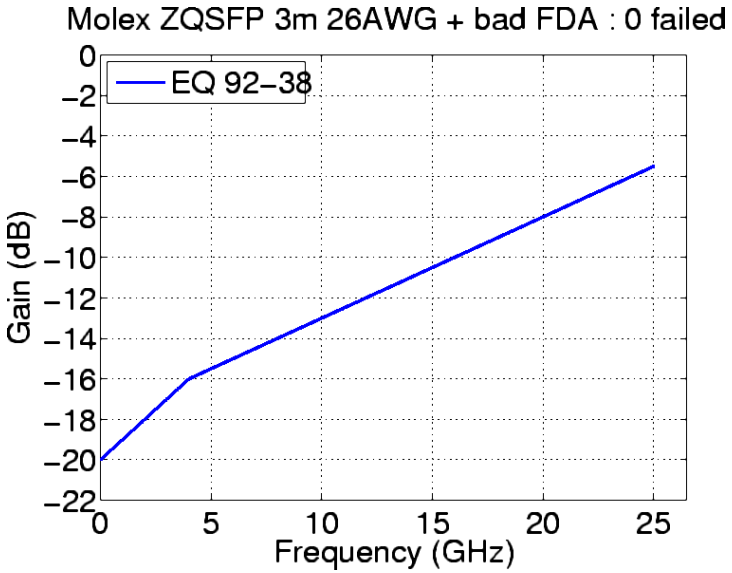


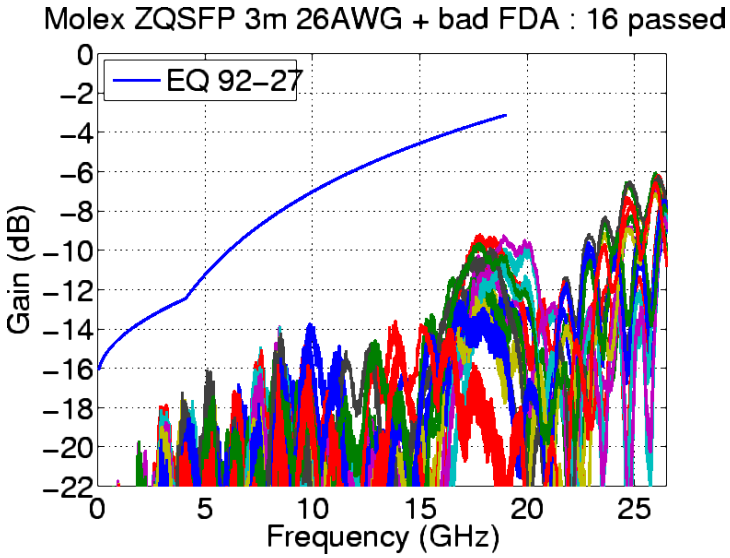


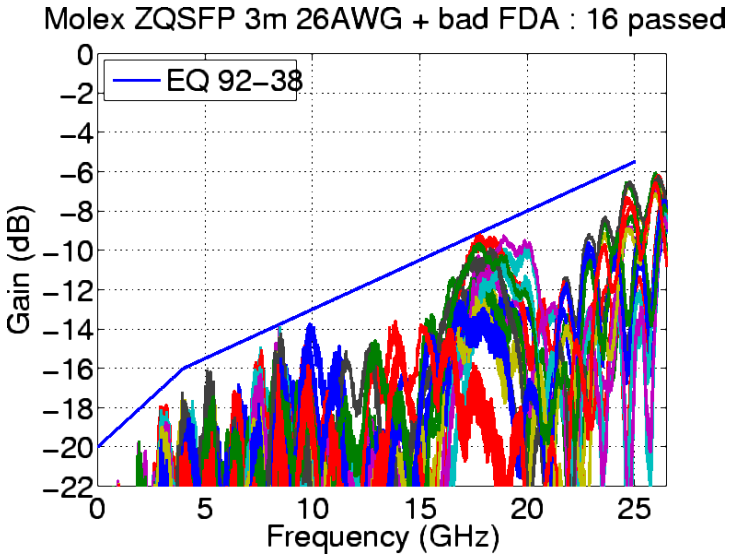


Type E: FDA + 3 meter 26 AWG

- EQ 92-27 (graph below)
  - 0 failed, 16 passed
- EQ 92-38 (graphs on right)
  - All 16 passed
    - Worst margin 0.10 dB







Moving Forward

- For now, add tentative RL spec of test channel of Rx ITT
  - For test 1
    - Equation relaxed from EQ 92-38 by 1dB for entire frequency
  - For test 2
    - Same equation as EQ 92-38
- Update the equation in a later revision, if necessary

- Add RSS_DFE4 to Table 136-13 for now (or in a later revision)
  - Min 0.05 for both of test 1 and test 2 in the same way as Clause 137

  - I have simulation results of RSS_DFE4 which show
    - I will report them in Ad Hoc call

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Thank you