25Gb/s Rx and Cable Test Proposals

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Agenda: Effectively this is two presentations

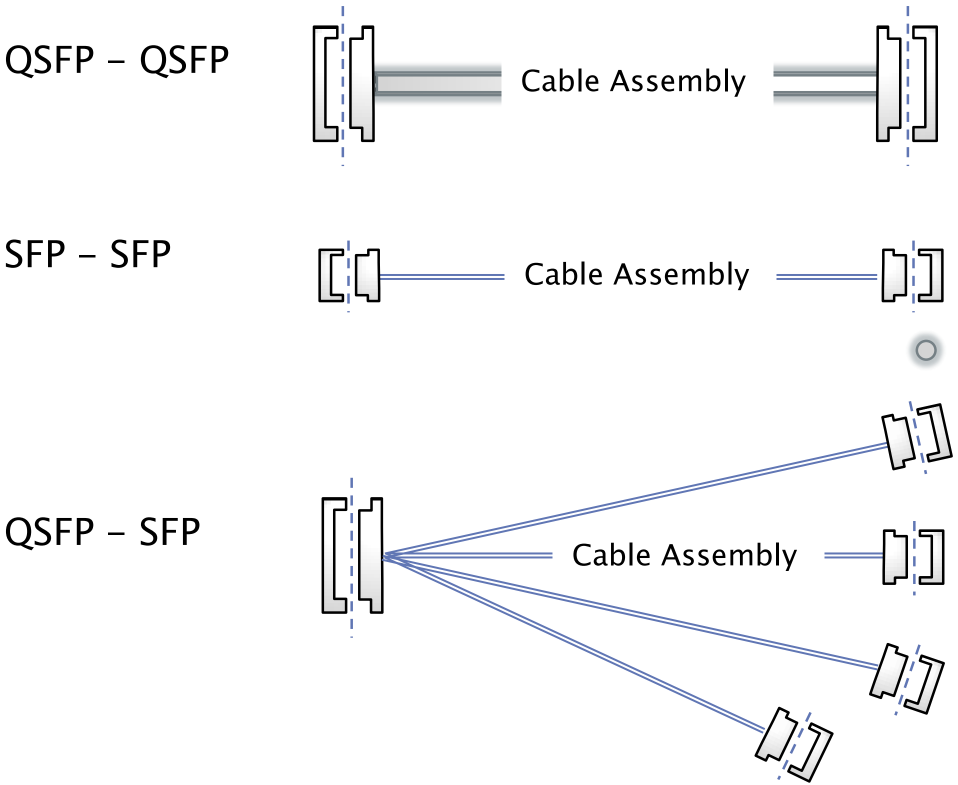
1) Receiver interference tolerance test proposal
   - Similar to 92.8.4.4
   - 3 FEC options presented (baden_25GE_01e_0115)
2) Cable assembly characteristics proposal
   - Similar to 92.10 and more specifically 92.10.7 Cable assembly Channel Operating Margin
   - 3 cables tests each with one of the 3 FEC options

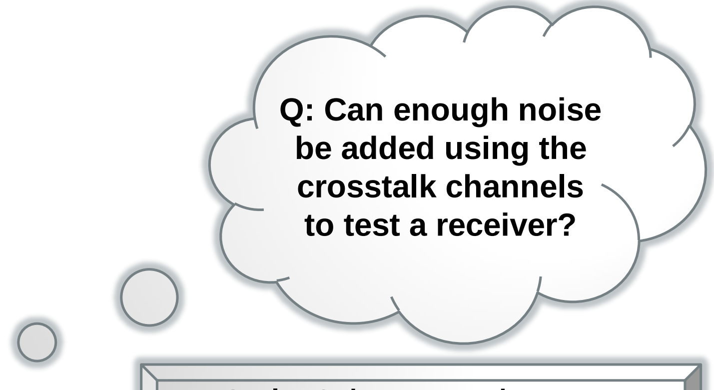
Context

- Gravitating towards one host board loss
- Very little change in Tx sections
  - not covered in this presentation
  - Test board per connector typed required
- Compatibility with 100GBase CR4 switches

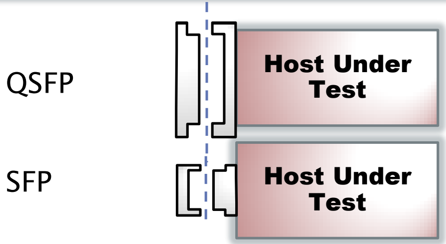
Receiver interference tolerance test proposal

Review: Potential Cable Variants





Only 2 host under test connector options



Host tests should not care what cable is plugged in!

Suggested host receiver types of testing requirements *(if it is supported, we must test)*

- RS FEC Host
  - Use approximately a "5 meter cable (AWG 26)"
- Clause 74 FEC Host
  - Use approximately "3 meter cable (AWG 26)"
- No FEC
  - Use something like a "2 meter cable (AWG 26)"
- Reuse 92.8.4 where possible

Potential Rx Interference Tests

PCS/FEC	Host/w QSFP	Host w/SFP
25G with RS FEC* (RS FEC)	☑	☑
25G with CL74 FEC* (CL74 FEC)	☑	☑
25G without any FEC* (no FEC)	☑	☑

*baden_25GE_01_0115

Desire: <u>One method for all</u>

Proposal is basically an “in principle”

Add Rx Interference tests for CL 74 FEC and no FEC if options are supported

Table 92–8—100GBASE-CR4 interference tolerance parameters

Parameter	Test 1 values	Test 2 values	Units	Test 3 CL 74 FEC	Test 4 No FEC
RS-FEC symbol error ratio[a]	10^{-4}	10^{-4}		10^{-8}	10^{-12}
Fitted insertion loss coefficients	$a_1 = 1.7$ $a_2 = 0.546$ $a_4 = 0.01$	$a_1 = 4.3$ $a_2 = 0.571$ $a_4 = 0.04$	dB/√GHz dB/GHz dB/GHz^2	a_1=3.43 a_2=0.456 a_4=0.032	a_1=2.573 a_2=0.342 a_4=0.024
Applied SJ[b] (peak-to-peak)	0.1	0.1	UI	0.1	0.1
Applied RJ (RMS)	0.01	0.01	UI	0.01	0.01
Even-odd jitter	0.035	0.035	UI	0.035	0.035
COM (max)	3	3	dB	3	3

Lowest loss

~5m

~3m

~2m

Add line for insertion Loss from new contributions

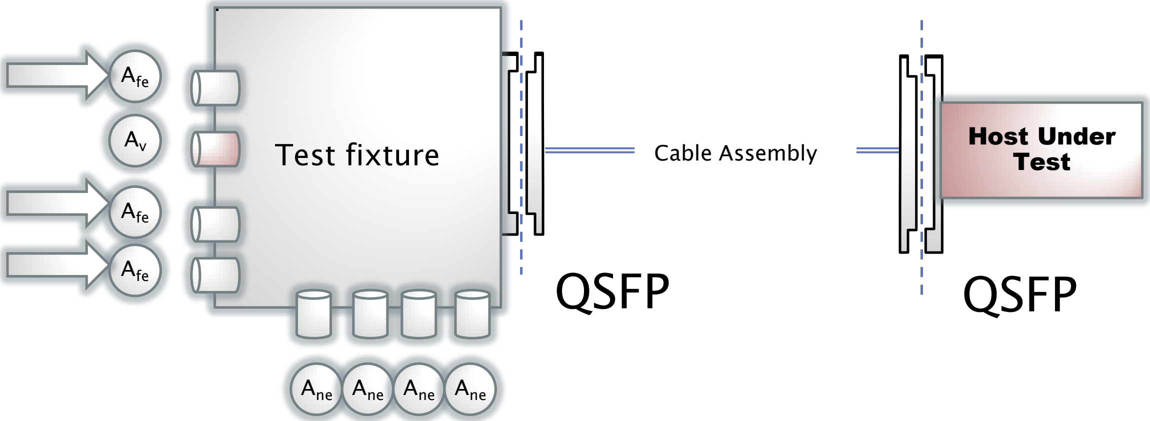
Test 3 data extrapolated from:
http://www.ieee802.org/3/25GSG/public/channel/Amphenol_NDACGJ-0003_QSFP-4SFP_3m_26AWG_APN43140033HXJ.zip
Test 4 data extrapolated from:
http://www.ieee802.org/3/100GCU/public/ChannelData/Molex_11_0516/bugg_02_0511.zip (2m Cable)

One aspect of the CL92 receiver interference tolerance test is to adjust FEXT to COM

92.8.4.4.3 Test channel calibration

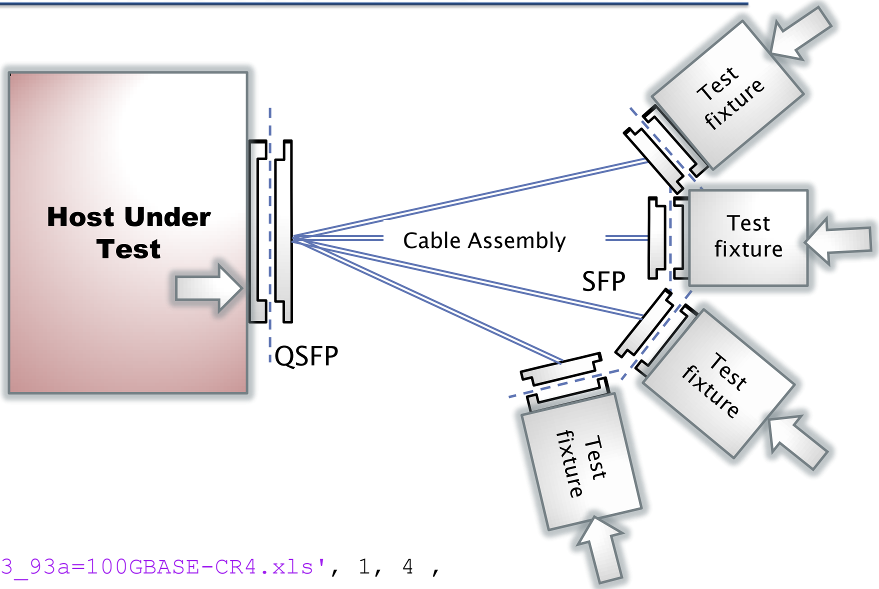
Figure 92–10.

c) The value of the far-end aggressor amplitude A_{fe} is adjusted until the required COM is achieved. The far end aggressors ([3 Tx] in Figure 92–9) peak-to-peak amplitude is set to twice the resulting value for the test.



Crosstalk amplitude get a feel experiment with Clause 74 FEC: … may change with data focused for Rx test

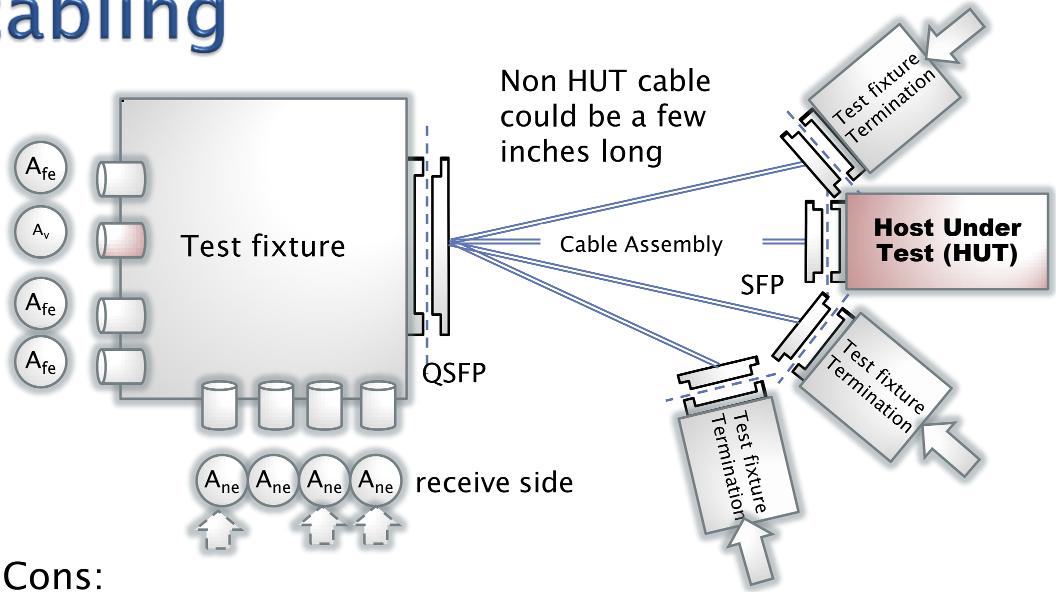
2.6v p-p crosstalk generator voltage seems too large. But 3m cables tested started with 3.76 dB COM

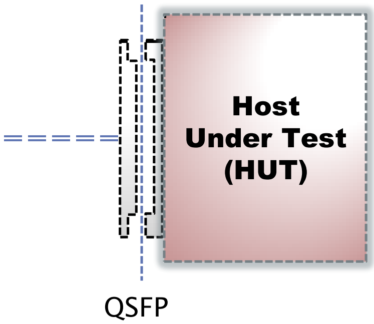



```
measurements_folder = uigetdir('C:\');
COM=100;
X_A=.6 ;
while COM > 3
    X_A=X_A+.1;
    COM_P2TX2_P1RX2=com_ieee8023_93a('config_com_ieee8023_93a=100GBASE-CR4.xls', 1, 4 ,
strcat(measurements_folder,'\P2TX2_P1RX2.s4p'),...
        strcat(measurements_folder,'\P2TX4_P1RX2.s4p'),...
        strcat(measurements_folder,'\P1TX1_P1RX2.s4p'),...
        strcat(measurements_folder,'\P1TX2_P1RX2.s4p'),...
        strcat(measurements_folder,'\P1TX3_P1RX2.s4p'),...
        strcat(measurements_folder,'\P1TX4_P1RX2.s4p'),'param.a_next', num2str(X_A) ,'param.a_fext', num2str(X_A) );
    COM=min(COM_P2TX2_P1RX2{1, 2}.channel_operating_margin_dB,COM_P2TX2_P1RX2{1, 1}.channel_operating_margin_dB);
;
end
```

Matlab code for determining crosstalk amplitude

Option 1: Crosstalk noise adjusted by driving receive side of NEXT or use short non HUT cabling





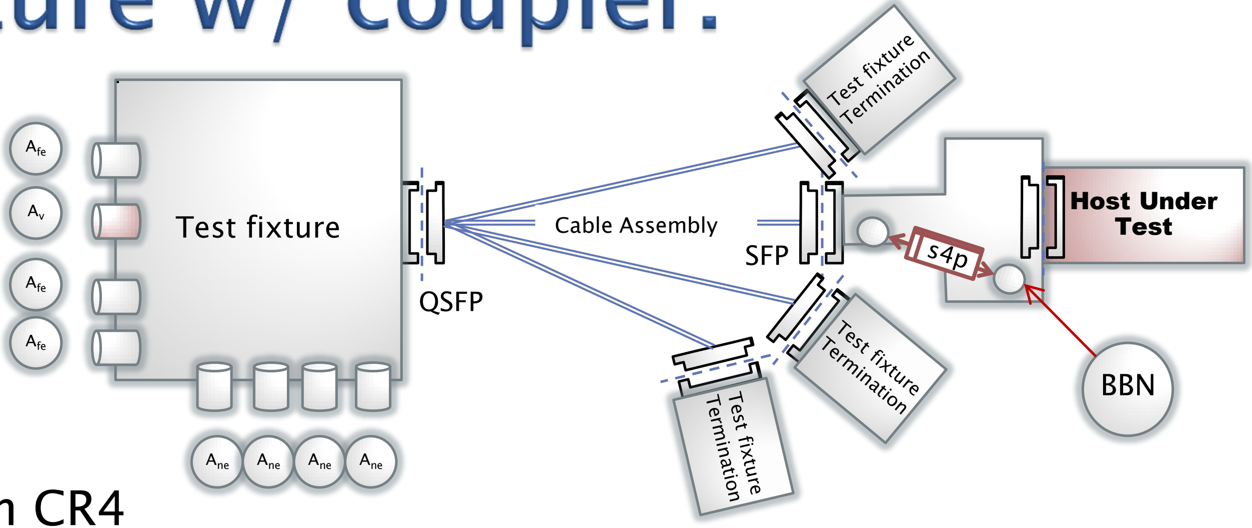
Cons:

- May require too much generator crosstalk voltage
- Non standard cables
- Need to resolve back drive for QSFP host

Pros:

- Closest to CL 92

Option 2: Add broadband noise in test fixture w/ coupler.



Cons:

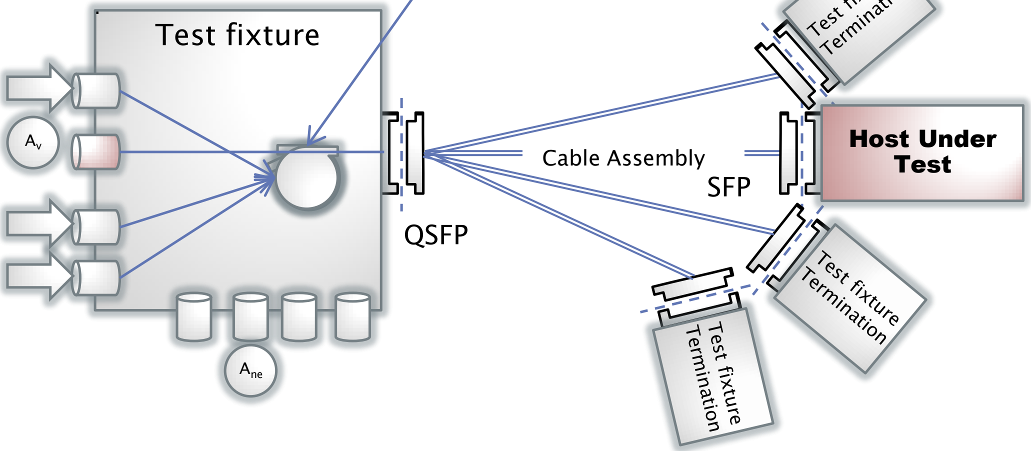
- Different from CR4
- New added Rx host test board
- Some may believe this is not representative of noise in a “real” cabled system

Pros:

- Similar to Rx test in CL 93
- Can use same test for all FEC and connector options

Option 3: Crosstalk noise is increased Rx-Tx coupling

Simulations suggest microstrip coupling from Tx to Rx could work



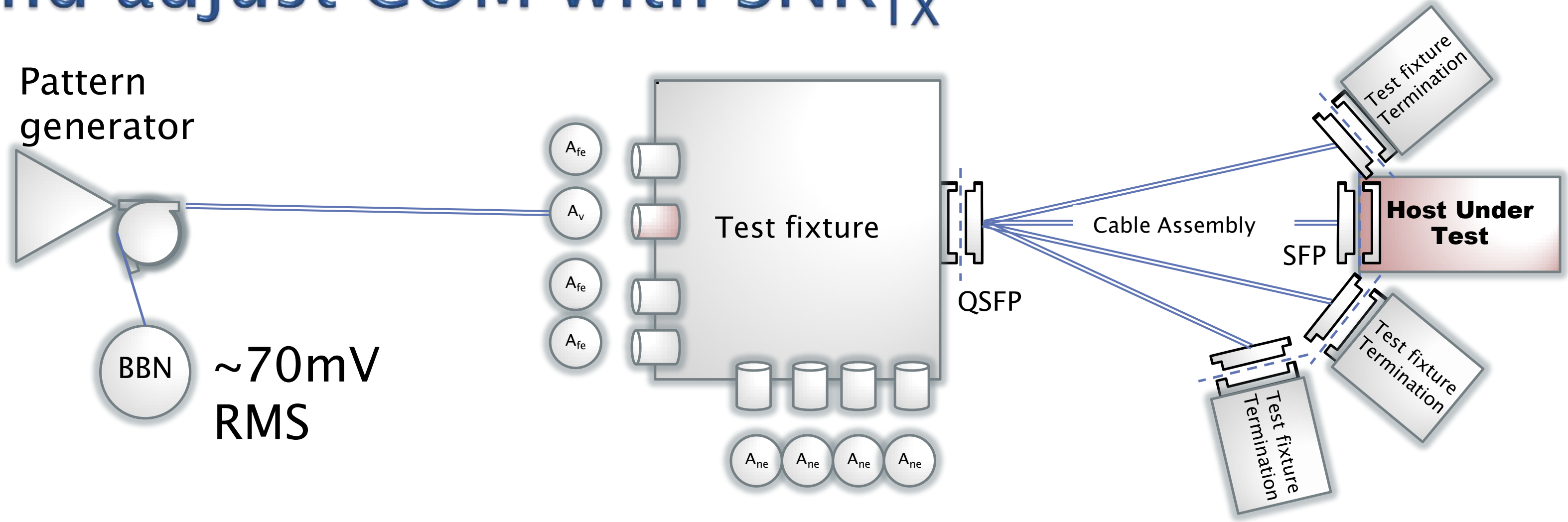
Cons:

- New Rx test fixture boards
- Still may need large aggressor voltage
- Coupling may prove difficult to implement reliably but could be out of scope which may cause objections
- Some may believe this is not representative of noise in a cabled system

Pros:

- Similar to Rx test in cl 92
- Can use same test all FEC and connector options

Option 4: Add broadband noise in transmitter and adjust COM with SNR_{TX}



Cons:
- Different from CR4

Pros:
- Similar to Rx test in CL 93
- Can use same test for all FEC and connector options

Rx Interference Test Proposal

92.8.4.4 Receiver interference tolerance test

The receiver interference tolerance of each lane shall comply with both test1 and test 2 if RS FEC is supported and additional table 3 if CL 74 FEC is supported and test 4 if NO-FEC is supported is using the parameters of Table 92-8 when measured according to the requirements of 9 *2.8.4.4.1 to 92.8.4.4.5*. The cable assembly used in the test channel specified in *92.8.4.4.2* shall meet the cable assembly Channel Operating Margin(COM) specified in *92.10.7*.

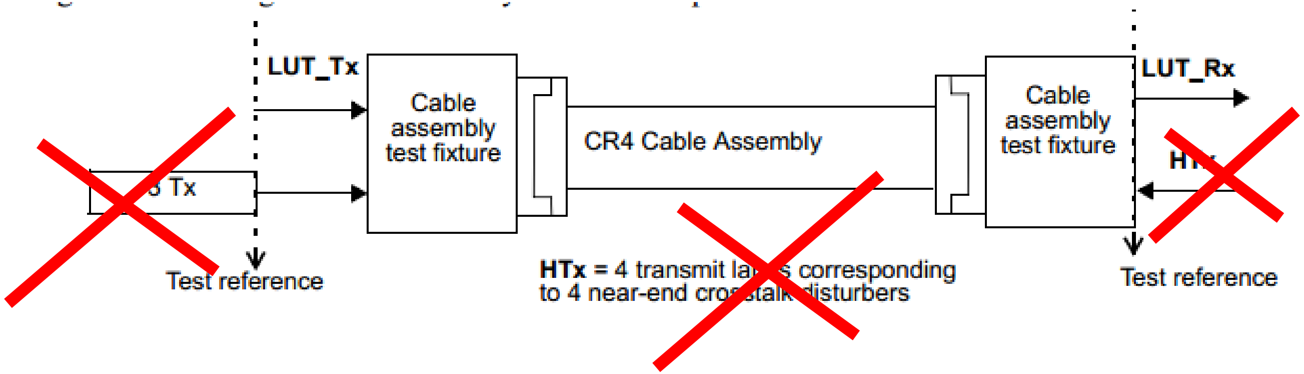


Figure 92–10—Test channel calibration

Adapt 92.8.4.4.3 text after figure 92–10

The fitted insertion loss coefficients of the lane under test (LUT), derived using the fitting procedure in *92.10.2*, shall meet the test values in Table 92–8. It is recommended that the deviation between the insertion loss and the fitted insertion loss be as small as practical and that the fitting parameters be as close as practical to the values given in Table 92–8.

The COM shall be calculated using the method and parameters of 92.10.7 with the following exceptions:

a) The channel signal path is , where is the measured channel between the test references for the LUT in Figure 92–10.

b) The value of transmitter SNR_Tx is adjusted until the required COM is achieved for the test.

c) If the test transmitter presents a high-quality termination, e.g., it is a piece of test equipment, the transmitter device package model S (tp) is omitted from the calculation of . Instead, the voltage transfer function is multiplied by the filter Ht (f) defined by Equation (92–22) where Tr is the 20 to 80% transition time (see 86A.5.3.3) of the signal as measured at TP0a.

d) No aggressors are used for the computation of COM.

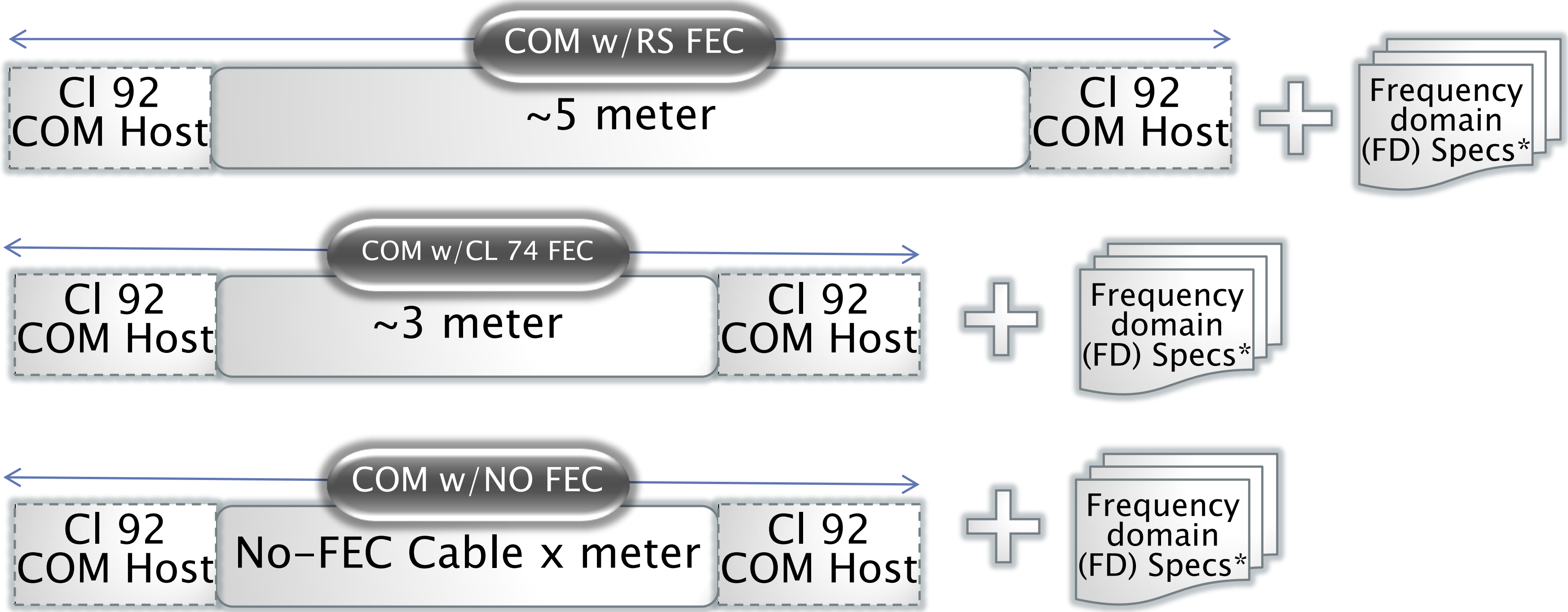
Added to adaptation of 92.8.4.4.4 Pattern generator

The pattern generator shall inject broad band noise on the data signal producing SNR_TX specified b).

Cable assembly
Channel Operating Margin

Cable COM tests

Same COM test method regardless of connector type



*more on next slide

Frequency Domain Specification (Details: TBD)

Use 802.3bj clause 92

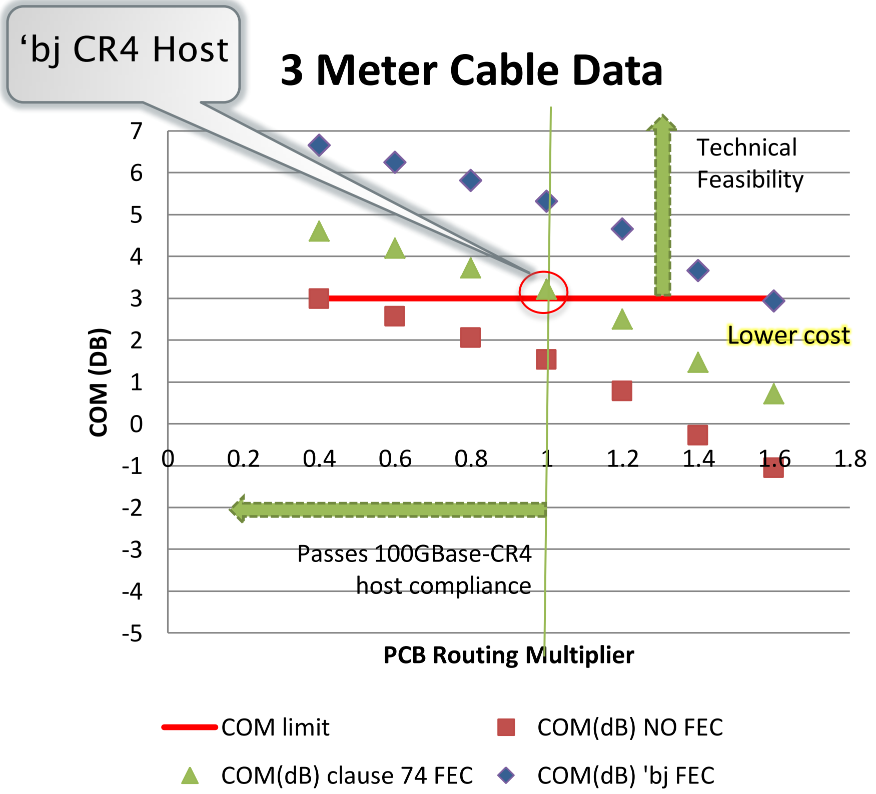
- 92.10 Cable assembly characteristics
- 92.10.1 Characteristic impedance and reference impedance
- 92.10.2 Cable assembly insertion loss
- 92.10.3 Cable assembly differential return loss
- 92.10.4 Differential to common-mode return loss
- 92.10.5 Differential to common-mode conversion loss
- 92.10.6 Common-mode to common-mode return loss

Frame work specifications as in: diminico_120314_25GE_adhoc

What may we say about 5m and 3m cables specs?

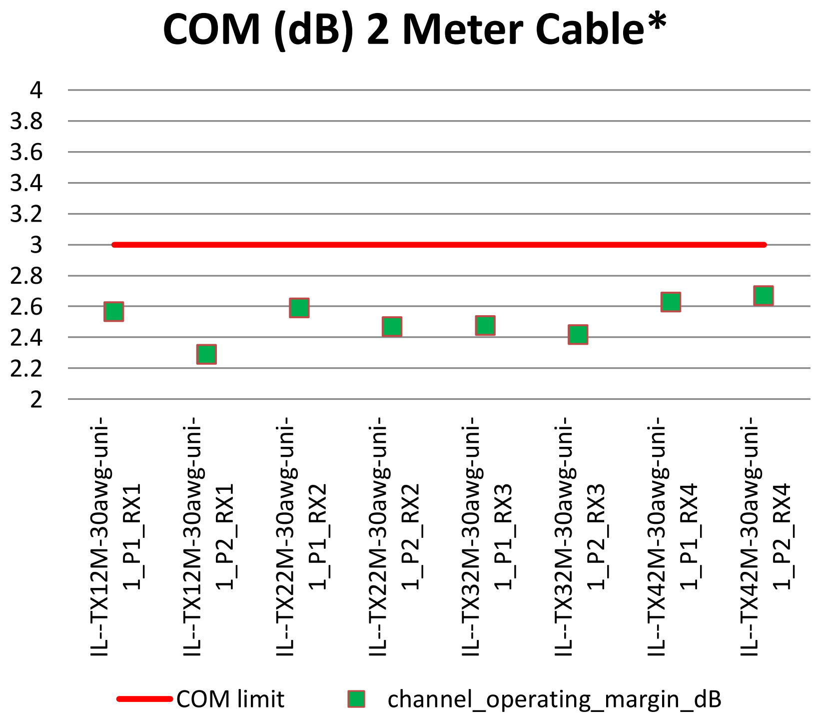
- 5m cable
  - **COM computed with RS FEC and standard ‘bj host board**
  - Support all 100GBase CR4 and related direct attach CAUI
- 3m cable
  - **COM computed with clause 74 FEC and standard ‘bj host board**
  - Support all 100GBase CR4 and related direct attach CAUI
  - Keeps cable manufacturing and reflections controls consistent with 5m cables
- Align with Chris DiMinico’s frequency domain proposals (diminico_120314_25GE_adhoc ff)

Review: Limits of 3 meter cables (mellitz_25GE_01a_0914)



- 3 meter cable just passes COM limit with a standard IEEE802.3 CR4 Clause 92 host board and a Clause 74 FEC.
- The Clause 74 FEC COM was 3.76 dB
- Some newer 3 meter cables have a bit more COM margin

2 meter cables may not pass COM limit with 100GBASE-CR4 Host Loss (13.62dB total @ 12.89GHz)



- No FEC cable posts a challenge because of reflections
- 2m 26 AWG cable may pass no-FEC
  - No data yet
- Recommendation:
  - Electrically specify a no-FEC cable with COM
  - Improve test fixture return loss

matoglu_25GE_01a_1114

	1m 30AWG QSFP-4SFP	2m 30AWG QSFP-4SFP	2 2 Q 4
With FEC	✓	✓	✓
Without FEC	✓	✓ Max7.3dB total host PCB loss	✓ M to P

* http://www.ieee802.org/3/100GCU/public/ChannelData/Molex_11_0516/bugg_02_0511.zip

What may we say about a no-FEC cable

- Would pass COM with no FEC and a standard ‘bj host board (CR4)
- Supports all 100GBase CR4 and related direct attach CAUI
- Electrically compliance regardless of reach
  - Cable reach outside of IEEE scope but it looks like a 2 meter cable requirement is on the horizon (andrewartha_3by_01_0115).

Proposal: Adapt 92.10.7 with the following changes

xx.yy.q Cable assembly Channel Operating Margin

The cable assembly Channel Operating Margin (COM) for each victim signal path (receive lane) is derived from measurements of the cable assembly victim signal path, the respective individual near-end crosstalk paths, and the respective far-end crosstalk paths that can couple into a victim signal path. COM for a 5 meter cable is computed using the procedure in 93A.1 with the Test 1 and Test 2 values in Table 93-8 and the signal paths defined in xx.yy.qq. Test 1 and Test 2 differ in the value of the device package model transmission line length z_p. COM for a 3 meter is the computed the same except the parameter DER_0 in Table 93-8 is set to 1e-8. COM for a no-FEC cable is computed with values in Table 93-9 expect DER_0 is assigned a value of 1e-12 and $b_{max}(n)$ is assigned a value of 0.3. *(as in Table 83D-6 of IEEE802.3bm to prevent error propagation)*

Summary

- More focused data is required to determine Rx Host No FEC table refinement and reach.
- Recommend Rx Interference tests Option 4
- One host board loss
- Single test for each or 3 type of cables
  - No change in host board budgeting
  - Stronger FEC for a given cable type is out of scope
    - However, margin will increase as FEC strength increases
- More data requested for COM passing No-FEC cables
- More data requested for Rx test cases
- Request FD mask proposals for 3m and no-FEC cables