Electrical Parameters for 3m Cable Non-FEC and 4m Cable BASE-R FEC Operation Ref: Comments 86-94

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Two Basic Issues
Ref: Comments 86-94

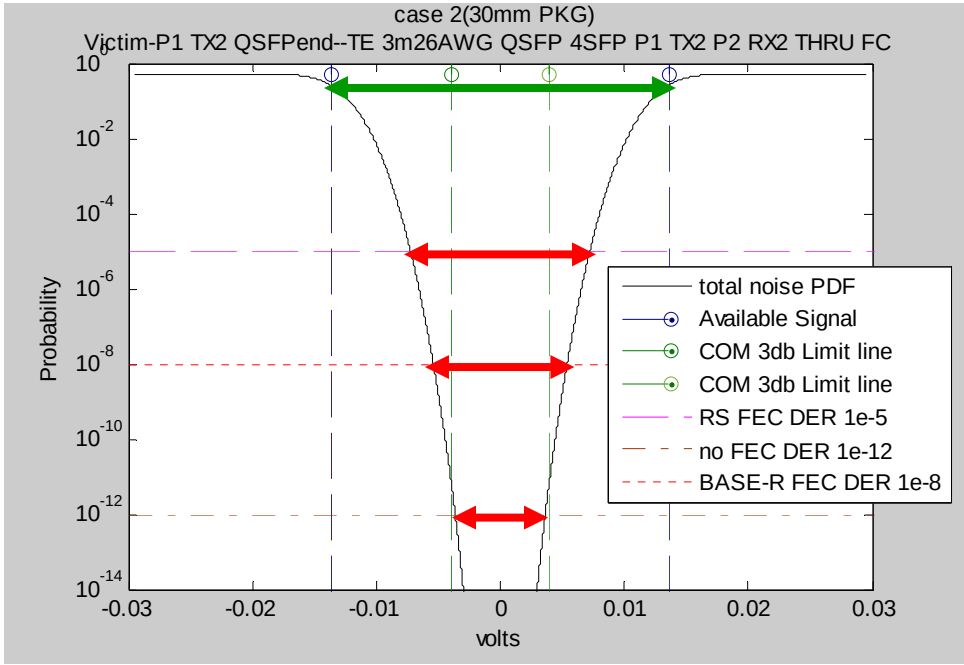
- Very few 3 meter cables pass 3.0dB COM without FEC*
- A fair number of 3 meter cables have large COM margins when operating with the BASE-R FEC*
- Ground rules:
  1. For interoperability reasons the Host and Chip budget remain as in 802.3bj.
  2. Other possible Host/Chip allocations are out of scope

* matoglu_25GE_01a_1114, mellitz_25GE_01_0914, shanbhag_020415_25GE_adhoc_v2

Issue 1: Can some 3m cables pass a COM limit for operation without FEC?

- Is there margin in COM at BER of 1e-12?
- Noise accumulation accelerates in the COM computation as BER decreases
- Issue: Prior ‘bj devices may have already taken this budget. Refer back to ground rule 1… no host/chip budget change.

Bathtub Curve Example



COM eye height vs. cumulative probability

Some Rx devices may incur margin related to COM double counting

- 0.4db COM can be allocated to SNDR and drive voltage
  - SNDR for case 2 reference package (30mm) double counted
    - 2mv sigma_n double counted suggest SNR_TX of 28.4dB should be used in COM for case 2
  - Voltage amplitudes used in COM calculations for case 2 package calculate to be 0.43mV for THRU or FEXT and 0.65 mV for NEXT based on compliance Tx specifications
- 0.1db COM can be allocated to bounding SNDR noise
- See: mellitz_040815_25GE_adhoc for details
- Lower to the COM limit to 2.5dB has about the same affect
- Does this violate rule 1?

Where to change COM limit to 2.5dB for no FEC operation

Test 1 and Test 2 differ in the value of the device package model transmission line length z_p. COM for any channel within the cable assembly shall be greater than or equal to 3 dB for each test.

channel within the cable assembly shall be greater than or equal to 3 dB for the CA-L and CA-S test and 2.5 dB for CA-N test.

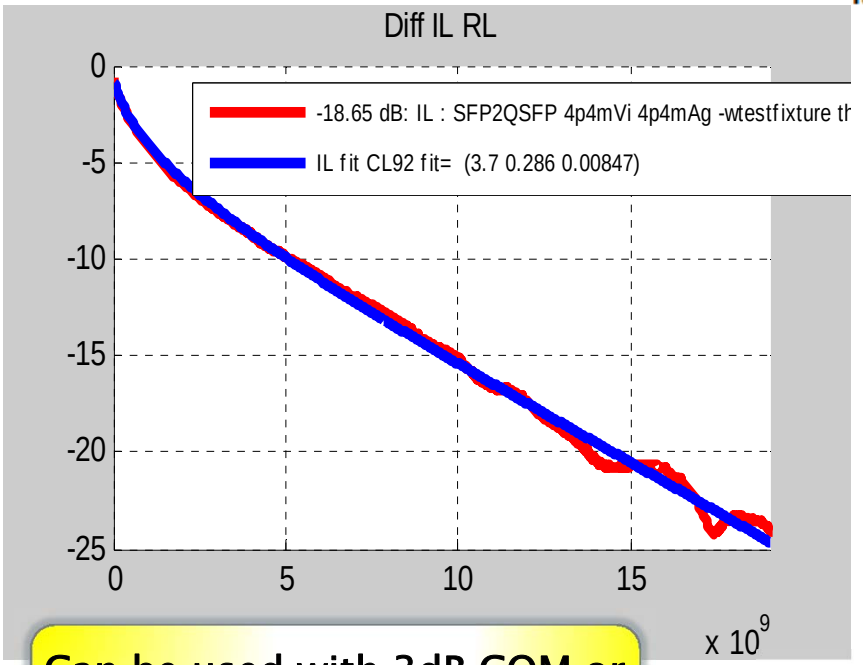
Table 110–10—COM parameter values

Parameter	Symbol	CA-N	CA-S	CA-L	Units
Maximum start frequency	f_{min}	0.05	0.05	0.05	GHz
Maximum frequency step	Δf	0.05	0.01	0.01[a]	GHz
Device package model					
Single-ended device capacitance	C_d	2.5×10^{-4}			nF
Transmission line length, Test 1	z_p	12			mm
Transmission line length, Test 2	z_p	30			mm
Single-ended package capacitance at package-to-board interface	C_p	1.8×10^{-4}			nF
Transmitter differential peak output voltage					
Victim	A_v	0.4			V
Alien far-end aggressor	A_{fe}	0.6			V
Near-end aggressor	A_{ne}	0.6			V
Normalized DFE coefficient magnitude limit, for $n = 1$ to N_b	$b_{max}(n)$	0.5	0.5	1	—
Target detector error ratio	DER_0	10^{-12}	10^{-8}	10^{-5}	—

[a]For cable lengths greater than 4 m, a frequency step (Δf) no larger than 5 MHz is recommended.

110.10.7.1 Channel signal and crosstalk path calculations

Recommendation: Use the following no FEC interference tolerance parameters



Can be used with 3dB COM or 2.5dB COM by adjusting SNDR

Table 110–7—25GBASE-CR and 25GBASE-CR-S interference tolerance parameters, -FEC mode

3.7
0.286
0.00847

	Test 1 (low loss)	Test 2 (high loss)	Units
Test pattern	Scrambled idle or PRBS31		
Bit error ratio required[a]	$< 10^{-12}$		
Fitted insertion loss coefficients a_1 a_2 a_4	 1.7 0.546 0.01	 3 0.29 0.02	 dB/√GHz dB/GHz dB/GHz^2
Approximate fitted loss at 12.89 GHz[b]	14.8	17.57	dB
Applied SJ[c] (peak-to-peak)	0.1		UI
Applied RJ (RMS)	0.01		UI
Even-odd jitter	0.035		UI
COM (max)	3		dB
b_{max} used in COM calculation	0.5		
DER_0 used in COM calculation	10^{-12}		

18.65

[a]The bit error ratio is measured using the PCS errored blocks counter (see 49.2.14.2) or the PMA
l error counter (see 109.4.5.4) as appropriate.
ertion loss between the two test reference points (see Figure 92–10).
SJ frequency >100 MHz, specified at TP0.

New line
DFE4
RSS>0.12

Proposal 2: Change reach for BASE-R FEC operation to 4 meters.

- Select a synthesized 3m cable that compares well to posted Amphenol and TE 26 AWG cables for:
  - IL, RL, ILD, ICR, and COM
  - Plus TDR of test fixture plus cable connector module and cable launch
- Compute COM for synthesized cabled sweep lengths
- Determine cable length just passes the COM limit of 3.0 dB with BASE-R FEC operation

Posted Synthesized Channel File Key

file	Synthesized Cable Length
SFP2QSFP_3p0m.zip	3meters
SFP2QSFP_3p3m.zip	3.3meters
SFP2QSFP_3p4m.zip	3.4meters
SFP2QSFP_3p5m.zip	3.5meters
SFP2QSFP_3p8m.zip	3.8meters
SFP2QSFP_4p0m.zip	4.0meters
SFP2QSFP_4p2m.zip	4.2meters
SFP2QSFP_4p4m.zip	4.4meters

SFP2QSFP_3mVi_3mAg_-wtestfixture_xtalk7

- Aggressor breakout cable length
- Aggressor breakout cable length
- type

NEXT/FEXT file designations

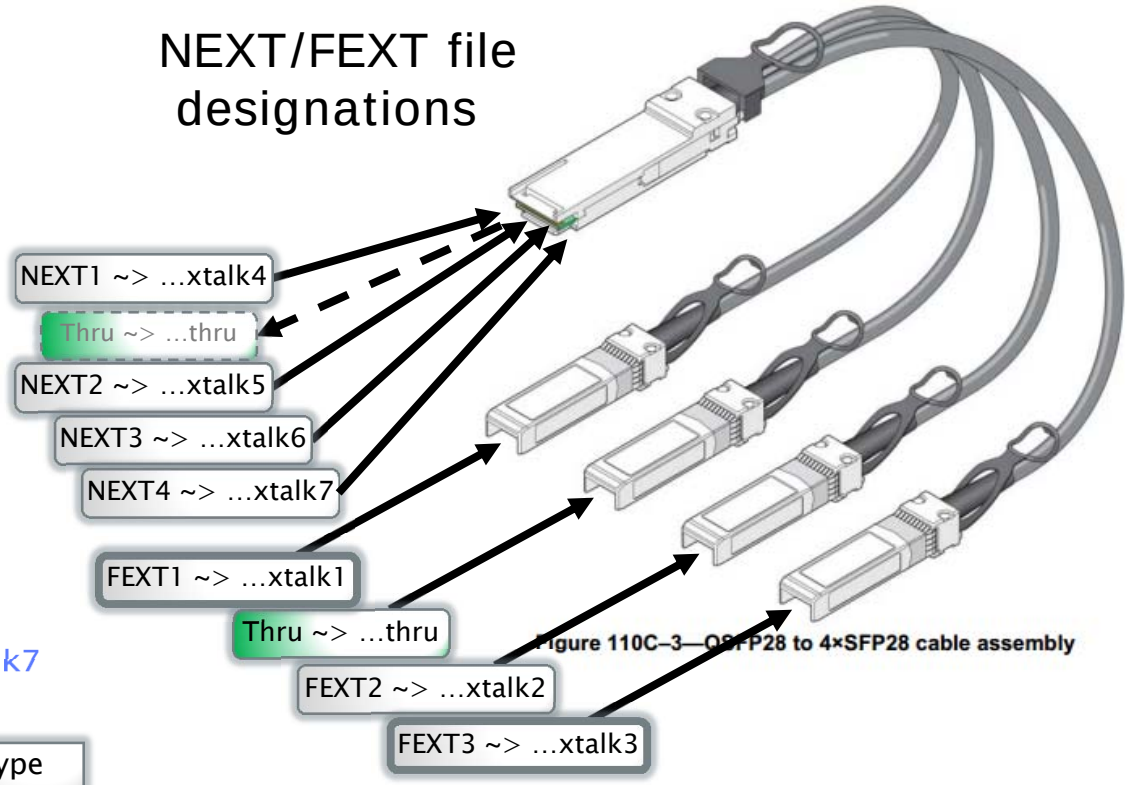
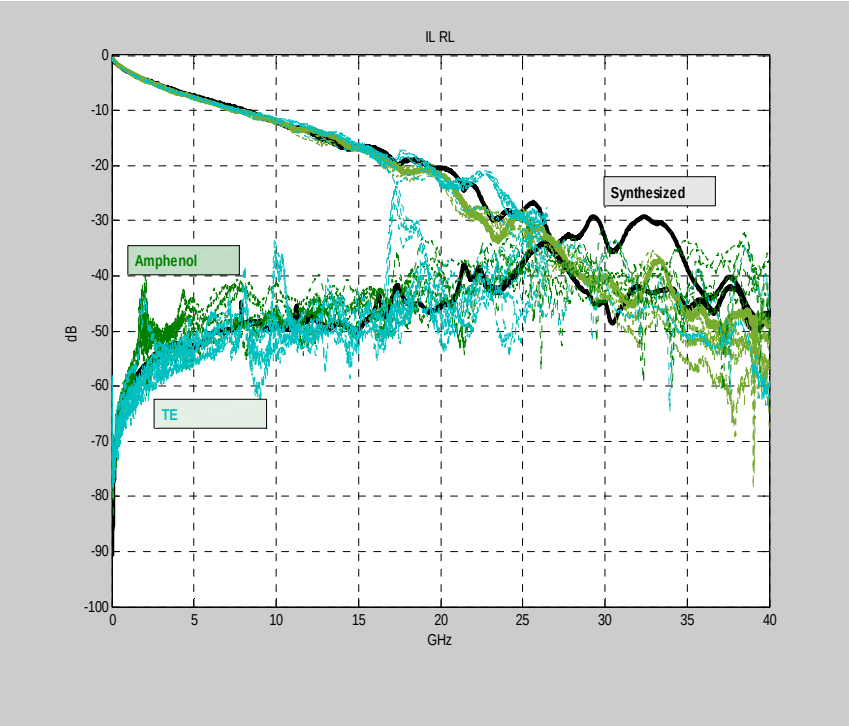
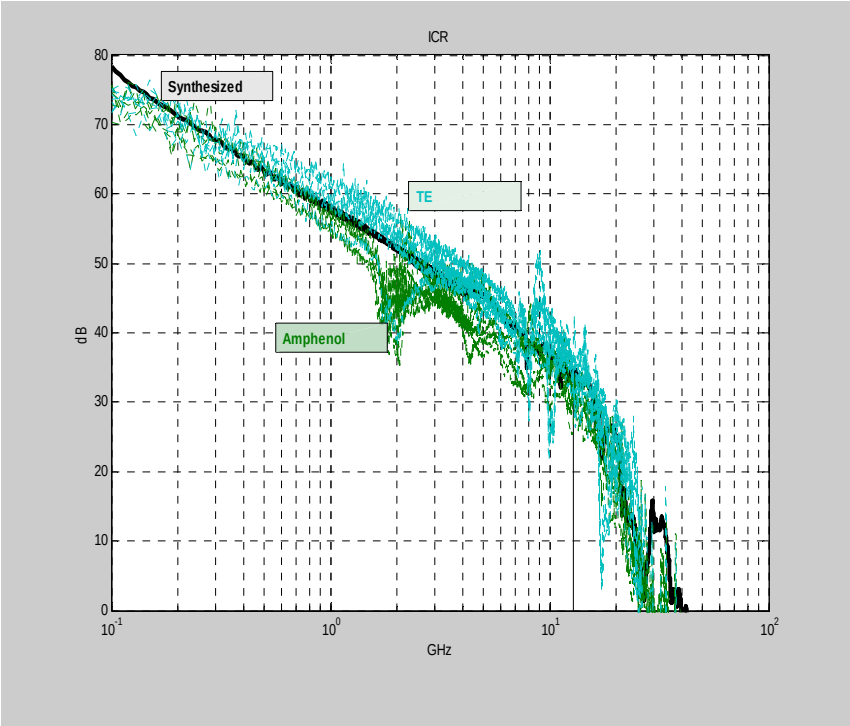


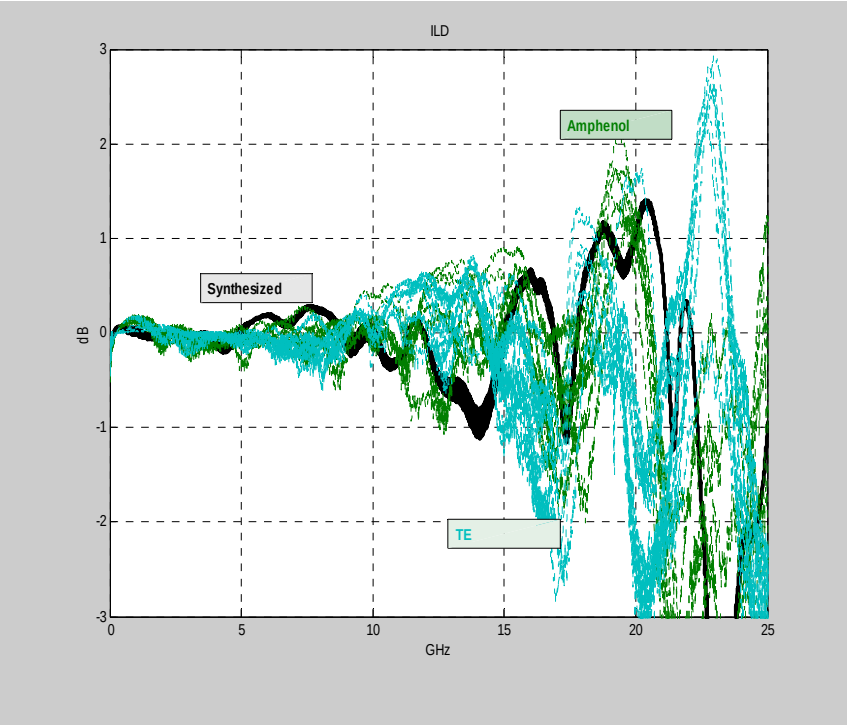
Figure 110C–3—QSFP28 to 4×SFP28 cable assembly

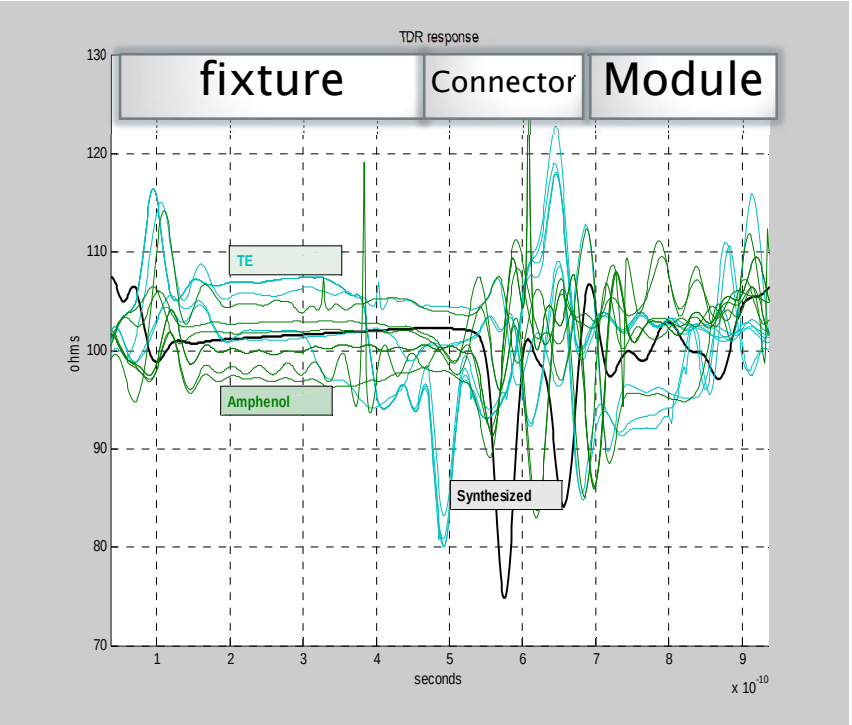
Synthesized 3m cable IL, RL, and ICR is within those for posted 3m cables





Synthesized 3m cable ILD and TDR is within those for posted 3m cables

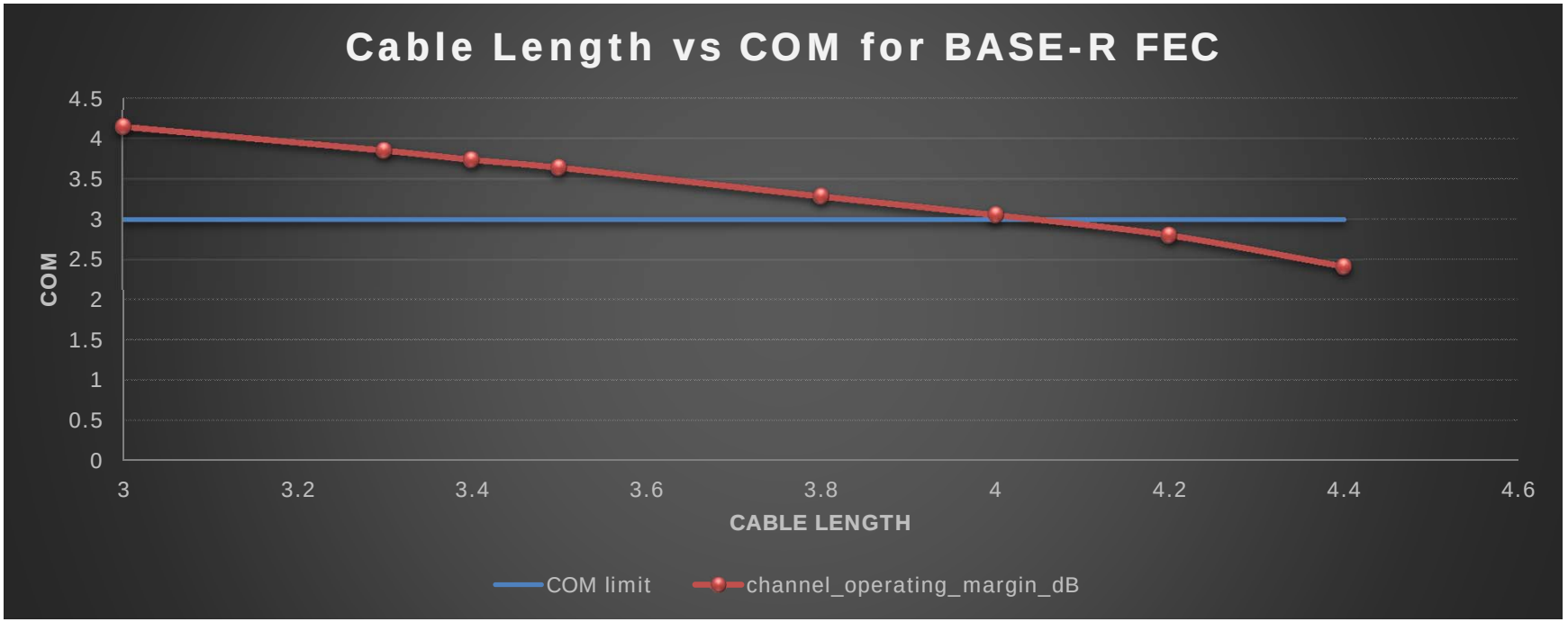




Double check of COM for Synthesized 3m cable

- TE_3m26AWG_QSFP_4SFP_P1_TX2_P2_RX2_THRU
  - COM=4.23dB
- SFP2QSFP_3p0mVi_3p0mAg_-wtestfixture_thru
  - COM=4.12dB
- The 3m synthesized cable starting point to sweep length

Swept results suggest a 4 meter cable may just pass 3.0dB COM for BASE-R FEC operation



Recommendation: Use the following BASE R interference tolerance parameters

Table 110–6—25GBASE-CR and 25GBASE-CR-S interference tolerance parameters, BASE-R FEC mode

Parameter	Test 1 (low loss)	Test 2 (high loss)	Units
Test pattern	Scrambled idle encoded by BASE-R FEC		
BASE-R FEC block error ratio required[a]	$< 4.7\times10^{-10}$		
Fitted insertion loss coefficients a_1 a_2 a_4	 1.7 0.546 0.01	 3.96 0.18 0.03	 dB/√GHz dB/GHz dB/GHz^2
Approximate fitted loss at 12.89 GHz[b]	14.8	21.04	dB
Applied SJ[c] (peak-to-peak)	0.1		UI
Applied RJ (RMS)	0.01		UI
Even-odd jitter	0.035		UI
COM (max)	3		dB
b_{max} used in COM calculation	0.5		
DER_0 used in COM calculation	10^{-8}		

[a]The BASE-R FEC block error ratio is measured using the FEC corrected blocks counter (see 74.8.4.1) and the FEC uncorrected blocks counter (see 74.8.4.2).
[b]Fitted insertion loss between the two test reference points (see Figure 92–10).
[c]Applied SJ frequency >100 MHz, specified at TP0.

3.99
0.663
0.00753

24.12

New line
DFE4
RSS>0.12

Cable insertion loss for BASE-R FEC and no-FEC cables

Table 110–9—Cable assembly characteristics summary

Description	Reference	CA-L	CA-S	CA-N	Unit
Maximum insertion loss at 12.8906 GHz	110.10.2	22.48	16.48	12.98	dB
Minimum insertion loss at 12.8906 GHz	110.10.2		8		dB
Minimum differential return loss at 12.8906 GHz	110.10.3		6		dB
Differential to common-mode return loss			tion (92–28)		dB
Differential					dB
					dB

32

29

19.48

16.48

Table 110A–1—Cable insertion loss budget values at 12.8906 GHz

Parameter	CA-L	CA-S	CA-N	Units
IL_{Chmax}	35	29	25.5	dB
IL_{Camax}	22.48	16.48	12.98	dB
$IL_{Ch0.5m}$	20.52			dB
IL_{Camin}	8			dB
IL_{Host}	9.85			dB
$IL_{MatedTF}$	3.59			dB

changed from comments based on cable mfgr. Inputs

Caveat: No 16.48dB cables have been shown to pass COM.

Where to change lengths

110.10 Cable assembly characteristics

25GBASE-CR cable assemblies are intended as a point-to-point interface between 25GBASE-CR or 25GBASE-CR-S PHYs, using controlled impedance cables. The cable assembly contains insulated conductors terminated in a connector at each end. Since 25GBASE-CR and 25GBASE-CR-S PHYs have two specified MDI connectors, single-lane (SFP28, specified in 110.11.1) and multi-lane (QSFP28, specified in 92.12), there are three possible combinations of the connectors at each end. The possible cable assembly types are described in Annex 110C.

All cable assembly measurements are to be made between TP1 and TP4 with cable assembly test fixtures as specified in Annex 110B. These cable assembly specifications are based upon twinaxial cable characteristics, but other cable types are acceptable if the specifications of this subclause are met.

Three cable assembly types are specified for 25GBASE-CR, with different COM requirements:

a) Cable assembly long (CA-L): Cable assembly that supports links between two PHYs that operate in RS-FEC mode with error correction enabled on both receivers, with cable length up to 5 m.

b) Cable assembly short (CA-S): Cable assembly that supports links between two PHYs that operate in BASE-R FEC mode, with cable length up to 3 m.

c) Cable assembly no-FEC (CA-N): Cable assembly that supports links between two PHYs that operate in no-FEC mode, with cable length up to 2 m.

The COM requirements for the cable assembly types are specified in 110.10.7.

4

3

Trickle down changes

Table 110C–1—Host and cable assembly combinations

Cable assembly form factor	Cable assembly type	Host, first end	Hosts, second end	Reach	FEC modes supported[a]
SFP28 to SFP28 (110C.3.1)	CA-L	One, SFP28 form factor (110C.2.1)	One, SFP28 form factor (110C.2.1)	5 m	RS-FEC
	CA-S			3 m	RS-FEC, BASE-R FEC
	CA-N			2 m	RS-FEC, BASE-R FEC, no FEC
QSFP28 to QSFP28 (110C.3.2)	CA-L	One, QSFP28 form factor (110C.2.2)	One, QSFP28 host factor (110C.2.2)	5 m	RS-FEC
	CA-S			3 m	RS-FEC, BASE-R FEC
	CA-N			2 m	RS-FEC, BASE-R FEC, no FEC
QSFP28 to 4×SFP28 (110C.3.3)	CA-L	One, QSFP28 form factor (110C.2.2)	Four, SFP28 form factor (110C.2.1)	5 m	RS-FEC
	CA-S			3 m	RS-FEC, BASE-R FEC
	CA-N			2 m	RS-FEC, BASE-R FEC, no FEC

[a]FEC mode is selected through Auto-negotiation (Clause 73). See 110.6.

4 m

3 m

4 m

3 m

4 m

3 m

Actions

- Accept changes in slides 6 & 13
  - Supports no-FEC and BASE-R FECR Rx host testing
- Risks and Dilemmas
  - 3 meter cables may still be difficult to pass COM
  - Proliferation of 3 meter cables failing COM may render some compliant hosts inoperable.
  - Lowering COM limit for no-FEC may render some chips inoperable: Violates Rule 1. i.e. no change
- Slide 5,14,15,and 16 suggest a change to
  - A 2.5dB COM limit for no FEC operation
  - Up to a 3 meter cable length for no FEC operation
  - Up to a 4 meter cable length for BASE-R FEC operation
- Suggestion: Straw ballot to determine whether we want to violate rule 1 and accept changes on slides 5,14,15, and 16 as a proposal