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Return Loss of Test Channel for Rx Interference Tolerance Test (Rx ITT)

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Abstract

- For Clause 93, return loss of test channel for Rx ITT was specified in 93.8.2.3 (not in Annex 93C) 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
- For Annex 120D and Clause 137, we should also specify return loss of test channel for Rx ITT
  - Using EQ (93-2)

RL of Test Channel for Rx ITT in Clause 93

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- The return loss of the test setup in Figure 93C-4 measured at TP5 replica meets the requirements of Equation (93-2).
  - Not a ‘shall’ statement

93.8.2.3 Receiver interference tolerance

The receiver interference tolerance test setup and method are defined in Annex 93C. The receiver on each lane shall meet the RS-FEC symbol error ratio requirement with the channel defined for each test listed in Table 93–6. The parameter RSS_DFE4 is a figure of merit for the test channel that is defined in 93A.2.

The following considerations apply to the interference tolerance test. The test transmitter meets the specifications in 93.8.1 as measured at TP0a (see Figure 93C–3). The test transmitter is constrained such that for any transmit equalizer setting the differential peak-to-peak voltage (see 93.8.1.3) is less than or equal to 800 mV and the pre- and post-cursor equalization ratios (see 93.8.1.5.5) are less than or equal to 1.54 and 4, respectively. The lowest frequency f_{NSD1} for constraints on the noise spectral density is 1 GHz. The return loss of the test setup in Figure 93C–4 measured at TP5 replica meets the requirements of Equation (93–2).

The values of the parameters required for the calculation of Channel Operating Margin (COM) are given in Table 93–8 with the following exceptions. The COM parameter σ_{RJ} is set to the measured value of effective random jitter (see 92.8.3.8.2), the COM parameter A_{DD} is set to half the measured value of effective bounded uncorrelated jitter (see 93.8.1.7), and the COM parameter SNR_{TX} is set to the value of SNDR measured at TP0a (see 93.8.1.6). Tests 1 and 2 are for the case when error correction is bypassed in the RS-FEC sublayer (see 91.5.3.3) and for these cases COM is computed with a DER_0 value of 10^{-12}. The test pattern to be used is any valid PCS output (such as scrambled idle), which is subsequently encoded by the RS-FEC sublayer.

A test system with a fourth-order Bessel-Thomson low-pass response with 33 GHz 3 dB bandwidth is to be used for measurement of the signal applied by the pattern generator and for measurements of the broadband noise.

Equation (93-2) given in 93.8.1.1 Transmit test fixture

The differential return loss of the test fixture, in dB, shall meet Equation (93–2) where f is the frequency in GHz.

$$RL_d(f) \geq \begin{cases} 20 - f & 0.05 \leq f \leq 5 \\ 15 & 5 < f \leq 13 \\ 20.57 - 0.4286f & 13 < f \leq 25 \end{cases} \text{ dB} \qquad (93\text{–}2)$$

The return loss limit is illustrated by Figure 93–4.

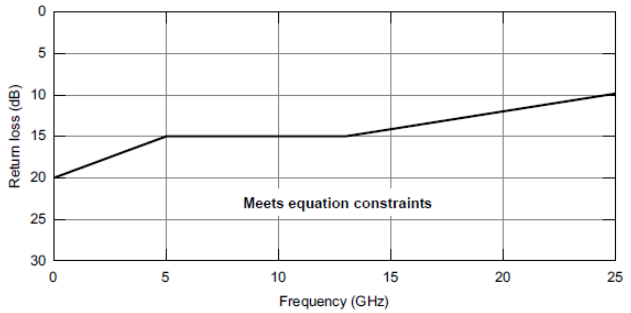

Figure 93–4—Test fixture differential return loss limit

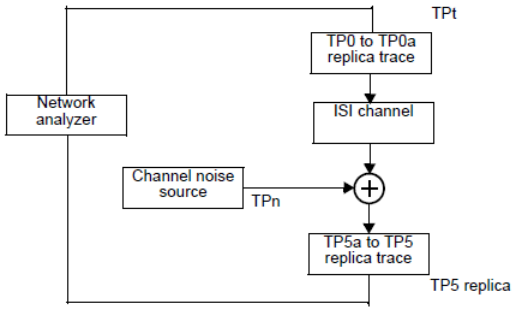

Figure 93C–4—Interference tolerance channel s-parameter test setup

If RL of Test Channel for Rx ITT is met

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- A good test channel is always used for Rx ITT
- Certain amount of broadband noise (BBN) is always injected
- BBN may be more stressful than real channel noise
  - BBN (a.k.a. white noise, Gaussian noise, unbounded noise) has *infinite* range of noise-amplitude distribution
  - Real channel noise (e.g. reflection and crosstalk) has *limited* range of noise-amplitude distribution
- Overstress of BBN may improve margin for interoperability
  - In fact, this overstress may have contributed to the ample margin of interoperability of existing 25G NRZ SerDes

Rx ITT defined in Clause 93.8.2.3 & Annex 93C

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- Clause 93.8.2.3 Receiver interference tolerance
  - Outline description
    - Refer to Annex 93C for detail description of setup and method
  - Defines parameters specific to Clause 93
  - Defines return loss of test channel
- Annex 93C Receiver interference tolerance (normative)
  - Detail description of setup and method
  - Does not define parameters specific to any particular clause
  - Does not define return loss of test channel

Other Old Clauses which invoke Rx ITT

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- RL of test channel is defined in the following clauses:
  - Annex 83D (CAUI-4)
    - By reference from 83D.3.3.1 to 93.8.2.3
  - Clause 111 (25GBASE-KR)
    - By reference from 111.8.3.1 to 93.8.2.3
- RL of test channel seems not defined in the following clauses:
  - Clause 92 (100GBASE-CR4)
    - Insertion loss deviation is recommended to be as small as practical
      - In 92.8.4.4.3
  - Clause 94 (100GBASE-KP4)
  - Clause 110 (25GBASE-CR)
- RL of test channel being not defined for copper cable PHYs
  - This is OK, because the same SerDes will be used for backplane PHYs

New Clauses which invoke Rx ITT

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- RL of test channel is defined in the following NRZ clauses:
  - Annex 120B (200GAUI-8 C2C and 400GAUI-16 C2C)
    - By reference from 120B.3.2 to 83D.3.3, then to 93.8.2.3
  - Annex 135B (LAUI-2 C2C)
    - By reference from 135B.3.2 to 83D.3.3, then to 93.8.2.3
  - Annex 135D (100GAUI-4 C2C)
    - By reference from 135D.3.2 to 120B.3.2, then to 83D.3.3, then to 93.8.2.3
- RL of test channel seems not defined in the following clauses:
  - Annex 120D (200GAUI-4 C2C and 400GAUI-8 C2C)
  - Clause 136 (50GBASE-CR, 100GBASE-CR2, 200GBASE-CR4)
  - Clause 137 (50GBASE-KR, 100GBASE-KR2, 200GBASE-KR4)
  - Annex 135F (50GAUI-1 C2C and 100GAUI-2 C2C)
- We should clearly define it for Annex 120D and Clause 137

Overstress of BBN may be reduced for PAM4

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- The fact of ample margin of 25G NRZ SerDes indicates that overstress of BBN may be too much and too pessimistic
- However, overstress of BBN may be reduced for PAM4, because overall margin for PAM4 is much lower than NRZ
  - In particular, it may be even reduced for CL137, because DER0 is raised to 1E-4 from 1E-5 (or lower)
    - Overstress of BBN may be less significant with DER0 at 1E-4 than 1E-5
- Since amount of overstress of BBN is not clear for PAM4, we should start with EQ (93-2) to define return loss of test channel
- Later, we may tighten or relax return loss of test channel, or equivalently we may decrease or increase Rx ITT COM value

Impact of Defining Return Loss of Test Channel

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- Impact of defining return loss of test channel for 50G PAM4 is expected to be small for SerDes vendors who are already following 93.8.2.3 for 25G NRZ SerDes

My Proposal

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- Since we had defined return loss of test channel for Rx ITT in 25G NRZ backplane PHY and C2C AUI, we should do the same for 50G PAM4 backplane PHY and C2C AUI
- In Annex 120D and Clause 137
  - Define return loss of test channel for Rx ITT to meet EQ (93-2)
  - No change to COM value of Rx ITT (for now)
    - Later, we may tighten or relax return loss of test channel or COM value
- Annex 135F will automatically follow Annex 120D
- Clause 136 is OK as it is
  - The same SerDes will be characterized for Clause 137

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Thank you