Micro-Reflection Limit Proposal

Contribution to IEEE 802.3cy

Ragnar Jonsson (Marvell) & Hossein Sedarat (Ethernovia)

March 30, 2021

Introduction

There have been several presentations on limiting micro-reflections:

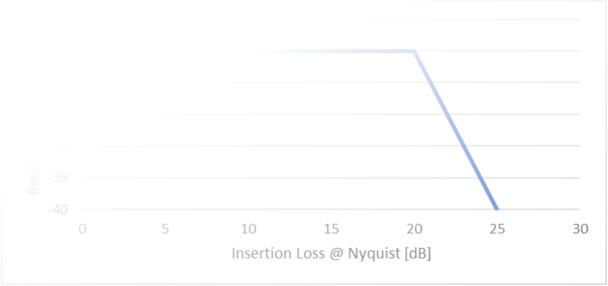
- jonsson_3cy_01a_0720
- sedarat_3cy_01_0920
- jonsson_3cy_01a_10_14_20
- sedarat_3cy_02_10_14_20
- sedarat_3cy_02_1120
- jonsson_3cy_01_12_08_20
- sedarat_3cy_01_03_23_21

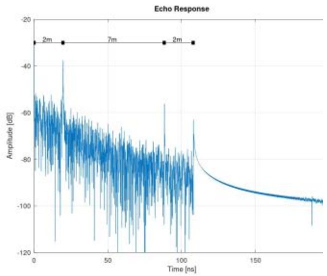
Specific text for calculating the micro-reflection limits was proposed in

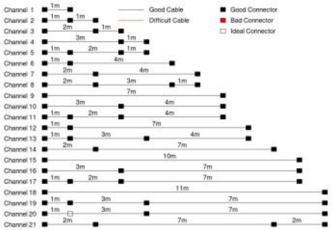
- jonsson_3cy_01_03_16_21 and
- jonsson_3cy_01_03_23_21

The text in this contribution has minor edits for clarity, but should be technically identical to the text in

- jonsson_3cy_01_03_23_21







Micro-Reflection Limit Text

#1 of 6

xxx.1 Echo Tail and Residual Echo Metrics

This subclause defines metrics to limit Noise from echo outside of major discontinuities in a link segment. Such echo that is beyond the required capability of the PHY to cancel the echo is referred to as residual echo. These metrics are determined using the following procedure using the parameters in Table 1:

Table 1

Parameter	Parameter Value	Parameter Description
Δf	TBD	The sample frequency spacing for the frequency domain transfer function measurements
N	TBD	Number of sampling points to use for the time domain representation of the echo impulse response
N_{seg}	TBD	Number of samples in each segment
$N_{discard}$	TBD	Number of largest segments to discard

Micro-Reflection Limit Text

#2 of 6

Step 1. The frequency domain transfer function for the differential mode channel echo, S_{11}, is measured at the link segment side of the MDI, e.g., the plug if the cable is terminated in a plug, with the far end terminated in 100Ω resistance. This measurement is performed for both ends of the link segment and provides the magnitude and phase of the transfer function, measured with frequency spacing Δf. The measured signal can be represented as a complex sequence E_k:

(Equation xxx-1)

$$E_k = S_{11}(k\Delta f)$$

or

$$E_k = S_{22}(k\Delta f)$$

Micro-Reflection Limit Text

#3 of 6

Step 2. The frequency domain transfer function is converted to time domain impulse response with sampling interval, T, according to the following method:

Step 2a. The phase of E_k is adjusted to make the values at DC and Nyquist frequencies real. The adjustment is done by dropping any imaginary component at DC and applying linear phase adjustment to E_k, corresponding to fractional delay of the time domain signal, and is given by:

(Equation xxx-2)

$$H_k = E_k e^{-jk\theta}$$

$$H_0 = \mathrm{real}(E_0)$$

where

$$\theta = \frac{\mathrm{angle}\left(E_{K_N}\right)}{K_N}$$

$$K_N = \frac{N}{2}$$

Step 2b. The impulse response of the signal is computed by applying Hermitian symmetric extension of the signal above the Nyquist frequency, as in Equation xxx-3:

(Equation xxx-3)

$$H_k = \mathrm{conj}\left(H_{K_N - k}\right), \qquad \text{for } k \in \{K_N + 1, \ldots, 2K_N - 1\}$$

and then computing the inverse Fourier transform according to:

(Equation xxx-4)

$$h_n = \frac{1}{K_N} \sum_{k=0}^{2K_N - 1} H_k e^{j\frac{2\pi}{2K_N}kn}$$

Micro-Reflection Limit Text

#4 of 6

Step 3. The first *N/2* samples of the echo impulse response, h_n, are split into segments with N_{seg} samples in each segment. The sum of the squares for each segment is computed by adding the squared impulse response in each segment

(Equation xxx-5)

$$P_r = \sum_{k=rN_{seg}}^{(r+1)N_{seg}-1} h_k^2$$

Step 4 The *k* largest P_r values are excluded from the calculations by setting their value to zero in the residual echo value

(Equation xxx-6)

$$RE_r(k) = \begin{cases} 0 & \text{if } P_r \text{ is one of } k \text{ largest } P_r \text{ values} \\ P_r & \text{for all other } r \end{cases}$$

Micro-Reflection Limit Text

#5 of 6

Step 5 The residual echo metric, REM, is calculated as the sum of all the residual echo values, after discarding the *k* largest P_k values:

(Equation xxx-8)

$$REM(k) = 10\log_{10}\left(\sum_{r} RE_r(k)\right) \quad \text{(dB)}$$

Step 6 The echo tail metric, ETM, is calculated as the sum of all the residual echo values after a reference value *k*

(Equation xxx-7)

$$ETM(k) = 10\log_{10}\left(\sum_{r \geq k} RE_r(N_{discard})\right) \quad \text{(dB)}$$

Micro-Reflection Limit Text

#6 of 6

xxx.2 Limit on Residual Echo Metric

The REM value of each end of the link segment, defined by the calculation described in Section xxx.1, shall comply with Equation xxx-9:

(Equation xxx-9)

$$REM(N_{discard}) \leq \min(REMmax, -IL(f_c) - REMoffset) \quad (dB)$$

where f_c is TBD, *REMmax* is TBD and *REMoffset* is TBD.

xxx.3 Limit on Echo Tail Metric

The ETM value of each end of the link segment, defined by the calculation described in Section 1, shall comply with Equation xxx-10:

(Equation xxx-10)

$$ETM(k) \leq \min\left(ETMmax, -IL(f_c) - ETMoffset(k)\right) \quad for\ k\ \in TBD$$

where f_c is TBD, *ETMmax* is TBD and *ETMoffset(k)* is TBD.

Straw Poll Question

- I would support incorporating the material on Micro Reflection Limits in Slides 3 through 8 as a baseline.

- Y:
- N:

Conclusion

The micro-reflection limit text has been updated based on comments received on earlier text, but no technical changes from previous text

We propose to adopt the text in slides 3 to 8 as baseline text in 802.3cy