Experimental results on 100Base-T1 PHY delays

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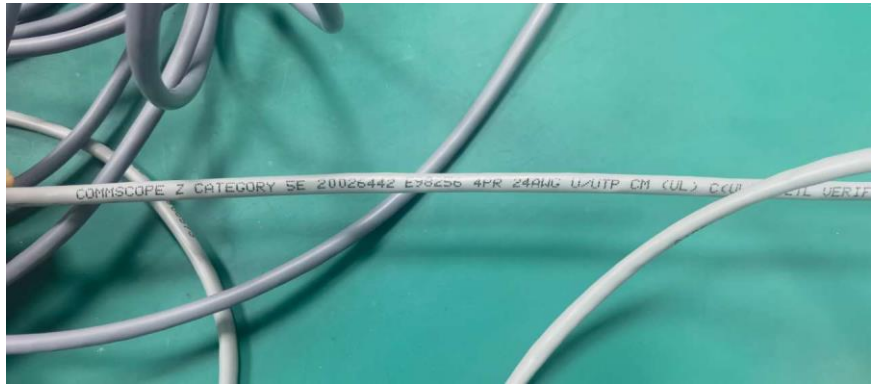
Motivation

- In recent meetings, some companies mentioned there is one important use case of IEEE 802.3dg Task Force which needs to be focused on: Servo motor feedback communication. Such use case requires a link segment up to 100m and has a strict PHY latency requirement (Tx + Rx latency < 1.5us).
- During online and email discussion, one opinion is the existing 100Base-T1 PHY may meet the requirement of servo motor application. Nevertheless, there is currently no experimental results verifying the applicability of 100Base-T1 PHY.
- The intention of this presentation is showing some experimental results of latency and insertion loss performance with 100Base-T1 PHY and AWG 24 cable, so the experts in this group can take a reference, and further discuss the possibility of using 100Base-T1 PHY to cover the motor servo application.

Measurement Setup

- Cable:
  - COMMSCOPE K-S2
  - Cable structure: Category 5E, AWG 24, UTP
- Symbol rate: 66.66 MBd
- Nyquist frequency: 33.33 MHz
- Measurement environment: Normal temperature, only Gaussian noise
- PHY: 100Base-T1
- Transmit Peak Differential Output: 1.677 V



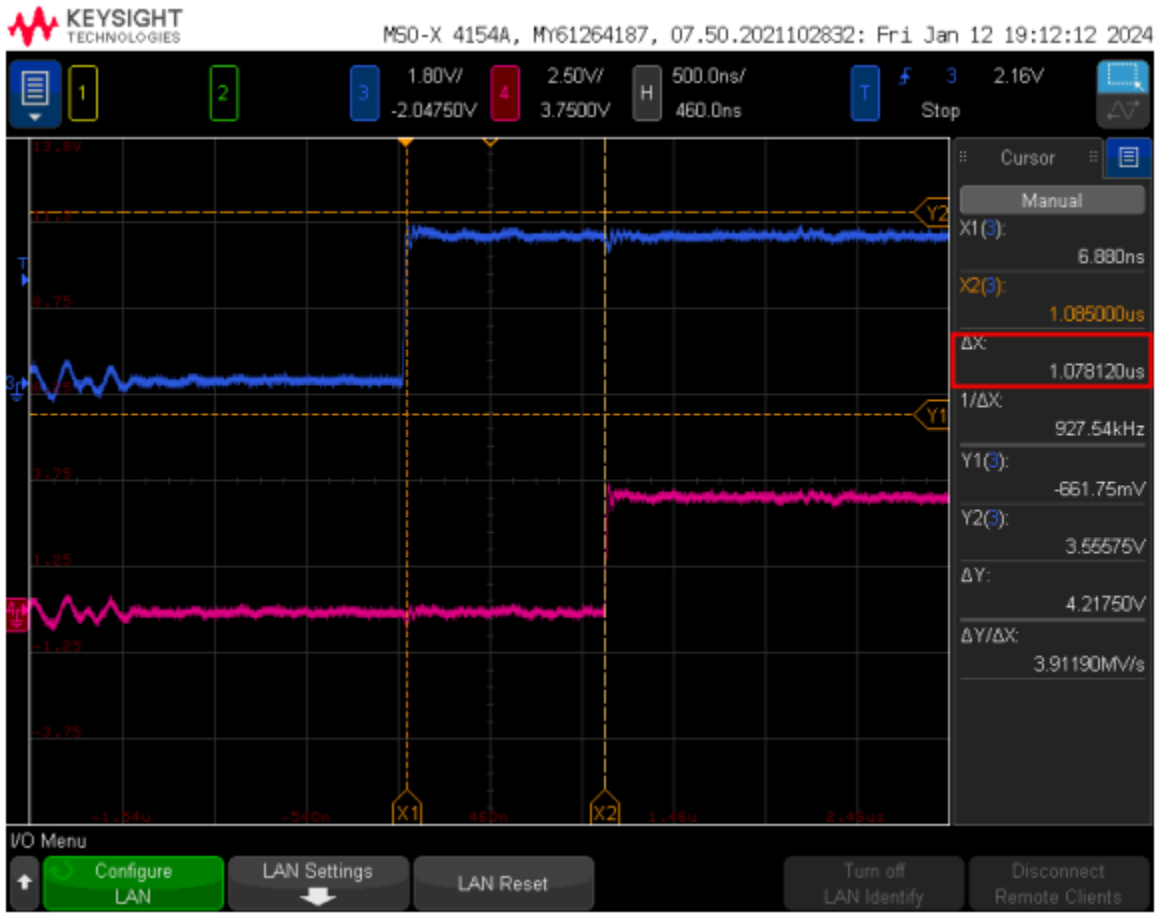
Two different set of measurements were taken:

1. Measure the latency performance over 100m cable without bit error, where two inline connectors are used.
2. Measure the maximum distance it can go without bit error, where three inline connectors are used.

Note: 'Without bit error' here means a BER better than 1e-10.

Measurement Results - Latency

- PHY latency here includes PHY Tx latency + PHY Rx latency + propagation time.
- 2 Inline connectors are used (RJ45 connector), divides the link segment to: 20cm, 100m, 20cm

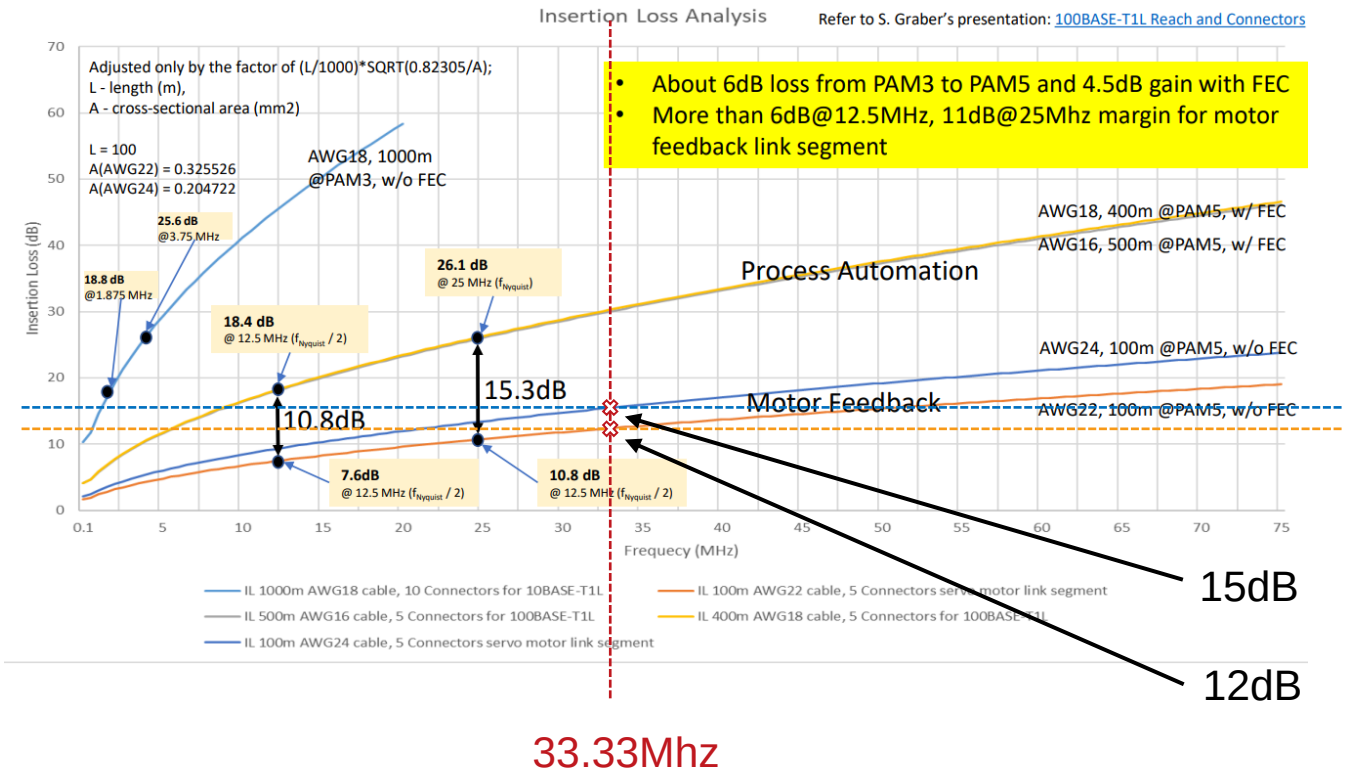


The total latency over 100m cable is measured as 1.08us, which means the pure PHY Tx+Rx latency is around 0.5us. The BER in this case is in the order of 1e-14.

Measurement Results – IL

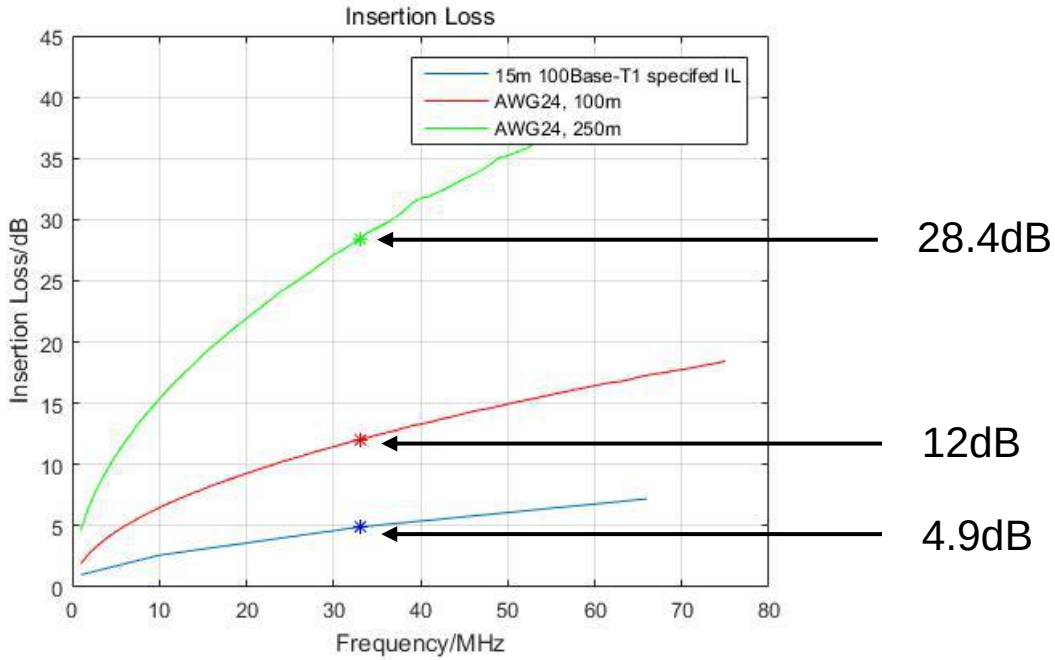
1. The maximum distance the cable can reach without bit error is 250m (It can be longer, but considering the relatively ideal measurement environment, 250m is a safe distance). The worst case BER in this case is 0.12*1e-11
2. 3 Inline connectors are used (RJ45 connector) for the maximum distance, divides the link segment to: 60m, 60m, 60m and 70m

Insertion loss performance over 100m Ref: xu_3dg_01_05252022



33.33Mhz

Insertion loss performance with 100Base-T1



Conclusions

- The latency over a 100m AWG 24 cable with 100Base-T1 PHY is around 1us (0.5us for Tx+Rx latency)
- In industry design, the 100Base-T1 PHY is capable of supporting roughly more than 250m transmission distances without bit error (IL 28.4dB@Nyquist)
- The experimental results might indicate a possibility to use 100Base-T1 PHY to cover the motor servo use case.
- Maybe more experiments needed in future (with PWM noise, STP, …)

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Thank You