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# **10GBASE-T**

## **Immunity to Pulse Interference**

### **DSQ vs 12PAM**

**(Isolated Pulse Analysis)**

**IEEE P802.3an Task Force**  
**San Francisco, July 2005**  
**A. Vareljian, KeyEye**

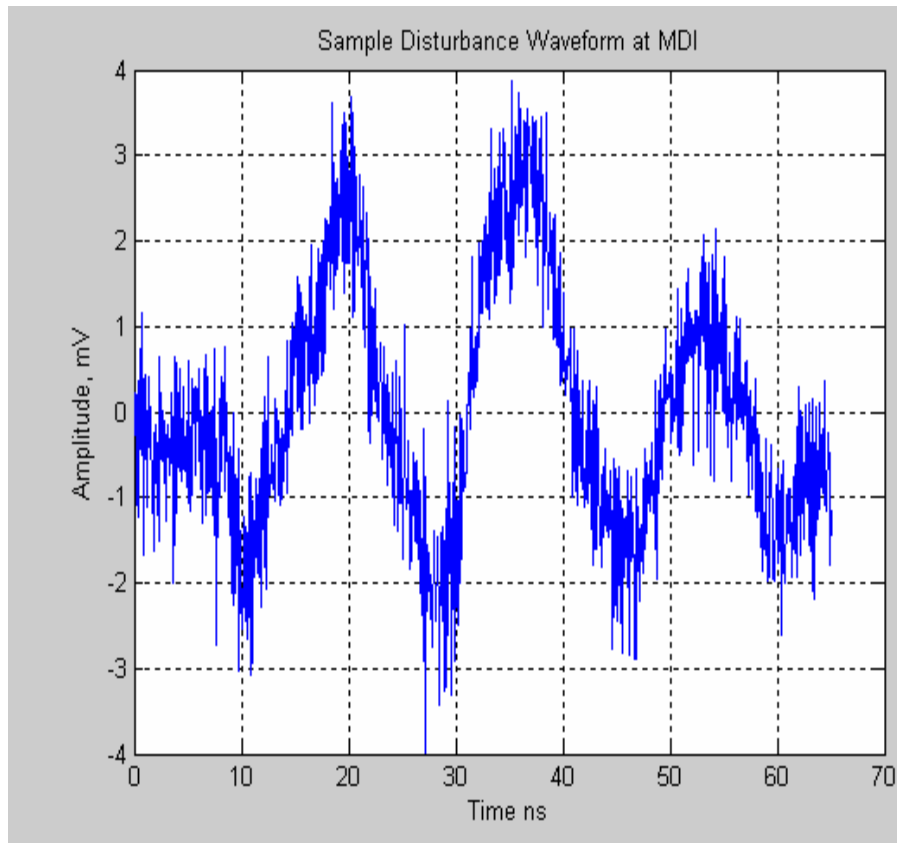
# INTRODUCTION

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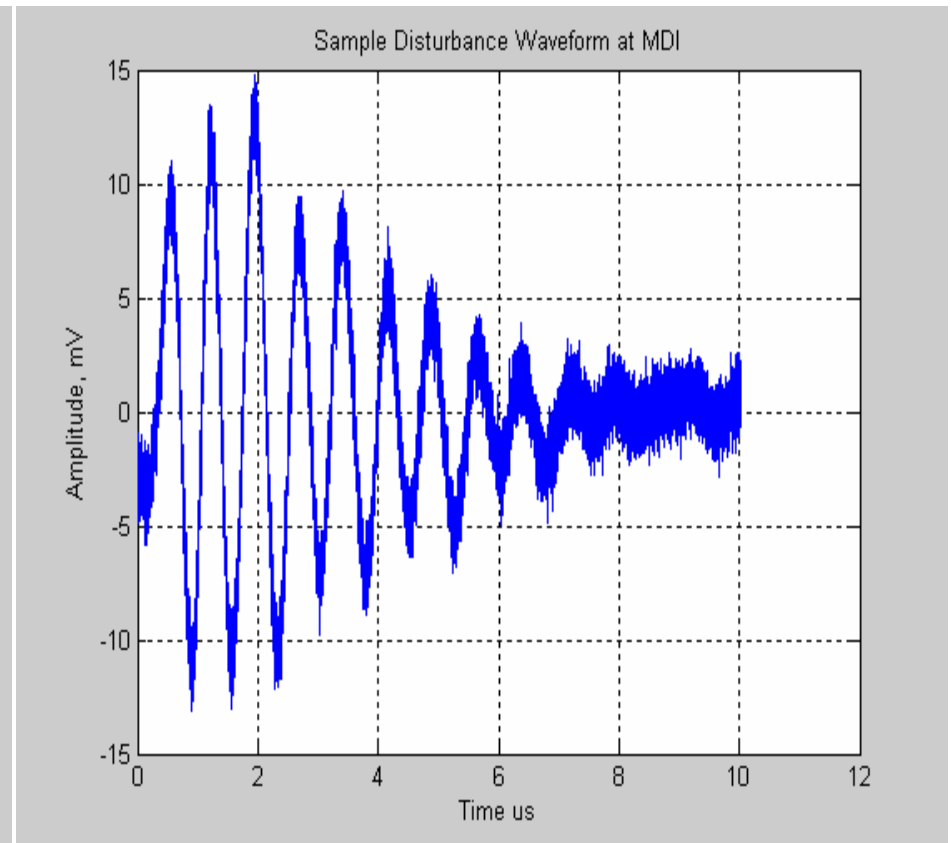
- **10GBASE-T System Intrinsic Noise Budget is Less than  $\sim 650\mu\text{U}$  → This is a very Sensitive System**
  - **Under such conditions UTP Environmental Disturbance – NOT Necessarily Gaussian – May Become a Limiting Factor**
  - **An Isolated Pulse Analysis for DSQ and 12PAM is Presented**
  - **Other Types of Potential Interference Sources over UTP need a Study**
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## Some Lab Captured Disturbance Waveforms @ MDI

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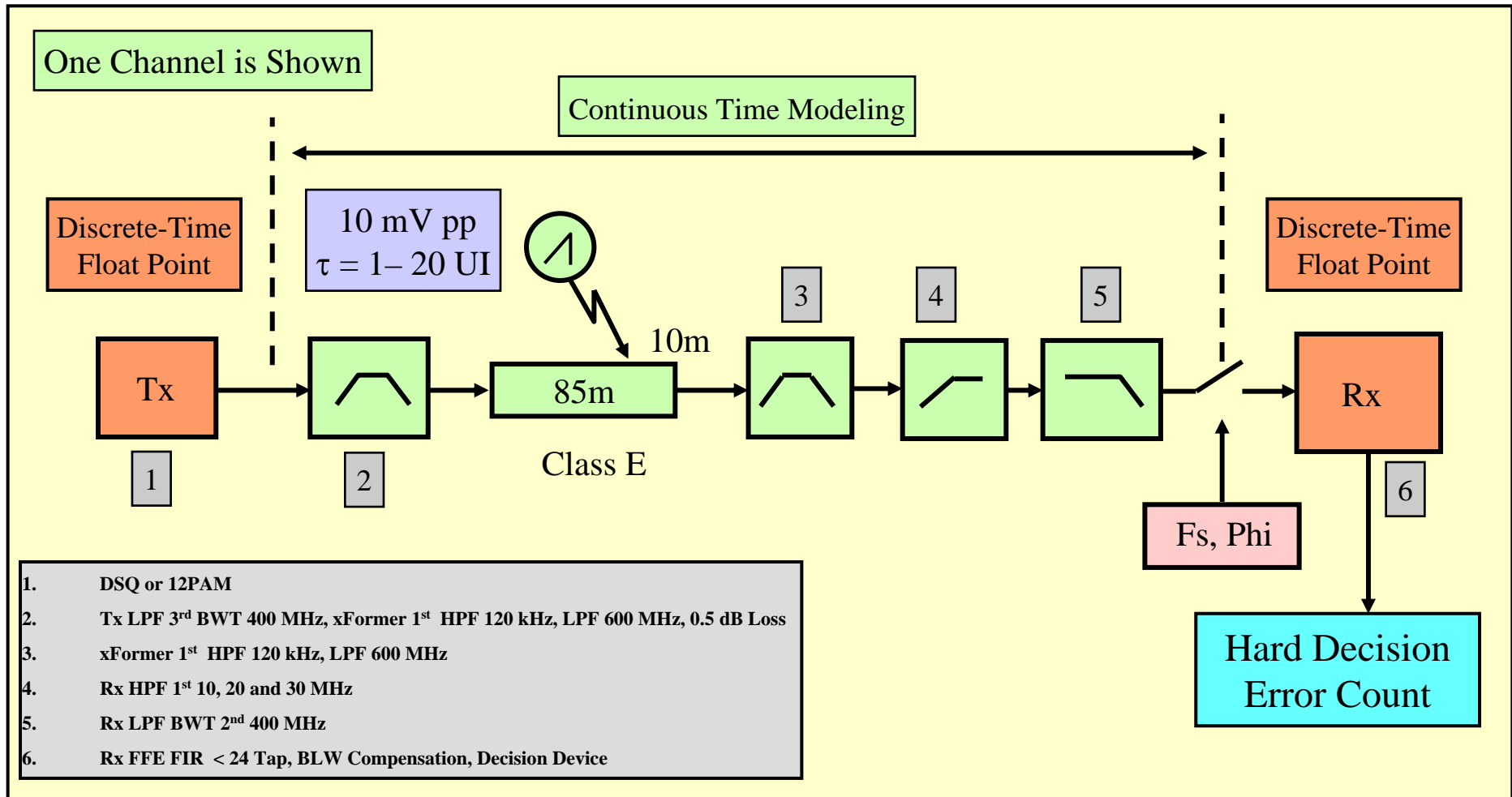


“Short”– Excursion Period in the range of 15 ns (12 UI)



“Long” – Excursion Period in the range of 0.7 us (560 UI)

# DSQ vs 12PAM Isolated Pulse Immunity Study

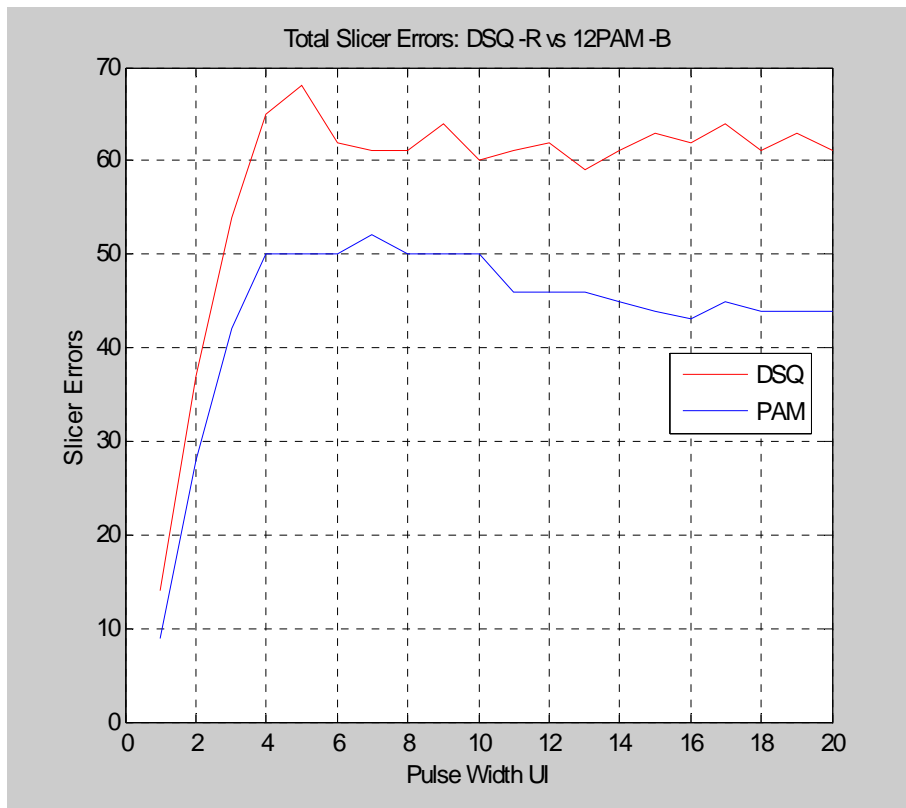


## Key System Observations

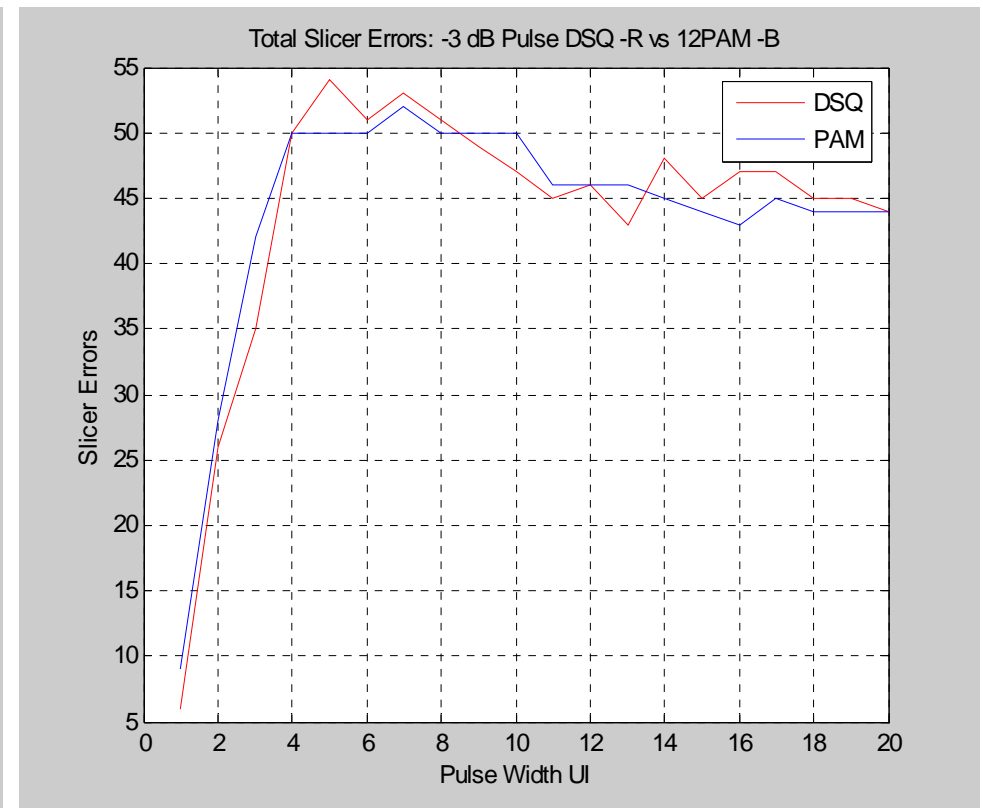
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- **4-D Data Analysis Performed: For a Positive and Negative Going 10 mV Pulse @ Two Non-overlapping Time Locations**
- **Injected Pulse sees approximately 10m of Class E**
- **Configuration Tailored Exclusively for the Comparative Immunity Analysis in DSQ and 12PAM Systems**
- **PWR, Transmitter, Channel, Receiver Structure, MMSE-Opt. EQ → All Same in Both DSQ and 12PAM Based Systems**
- **No Other Sources of Noise – Background, xTalk...**
- **Sum of Hard Decision Errors is used as a Sys Quality Metric**

# DSQ and 12PAM Hard Decision Errors vs Pulse Width

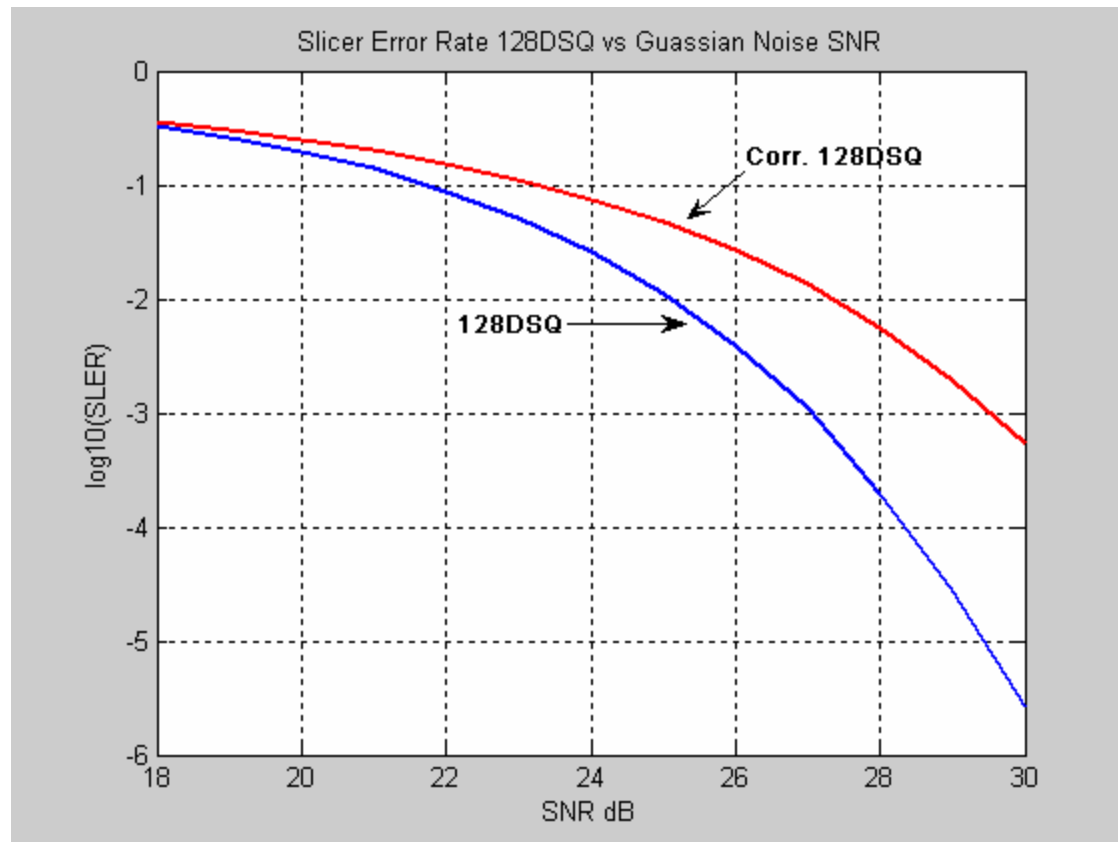


Up to 40% more errors occurred in DSQ vs 12PAM  
Under the same disturbance conditions > 4 UI



Number of DSQ generated errors is roughly equated with  
12PAM when disturbance amplitude is reduced by 3 dB

## DSQ SER vs Correlated Noise in 2-D



If noise were correlated in 2-D space, the DSQ would lose 3 dB of SNR

# Conclusion

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- **Based on Isolated Pulse Disturbance Analysis the DSQ Based System has Shown ~3 dB Higher Susceptibility than a 12PAM Equivalent**
- **Given the Noise Budget of 10GBASE-T vs Stray Voltage Levels Observed in UTP Environment, Revisiting of the Modulation Scheme along with LDPC Coverage of all Transmitted Bits would be Highly Recommended**
- **Need More Comprehensive Characterization of the Channel Impulsive Noise Environment**