# 10GBASE-T
Immunity to Pulse Interference
DSQ vs 12PAM
(Isolated Pulse Analysis)

IEEE P802.3an Task Force

San Francisco, July 2005

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# INTRODUCTION

➢ **10GBASE-T System Intrinsic Noise Budget is Less than ~650µU ➔ 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**

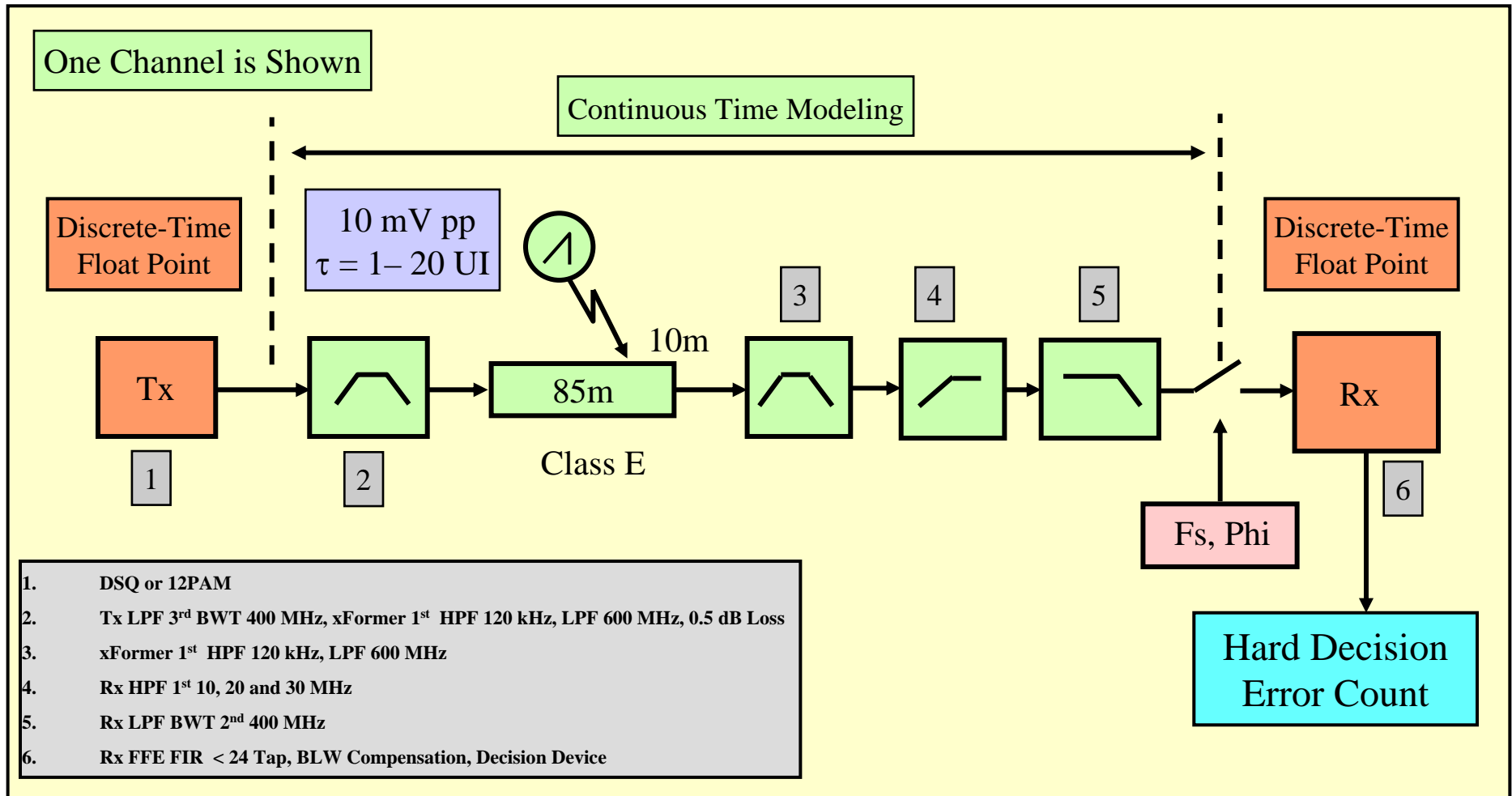# Some Lab Captured Disturbance Waveforms @ MDI
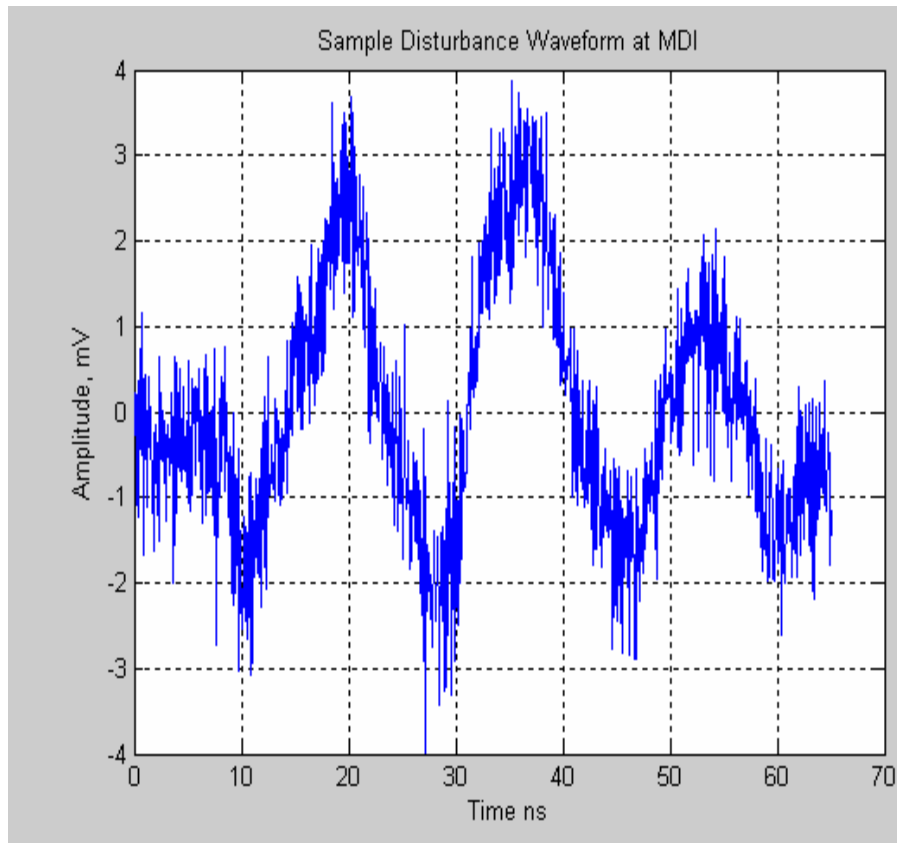
"Short"– Excursion Period in the range of 15 ns (12 UI)
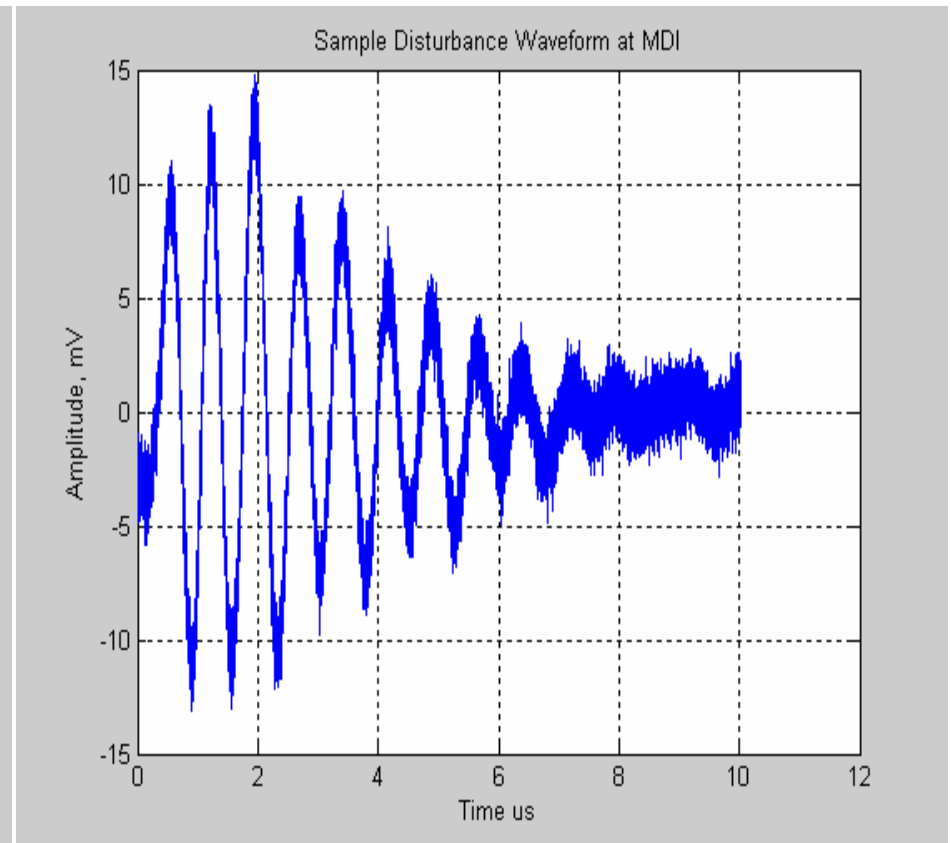
"Long" – Excursion Period in the range of 0.7 us (560 UI)

DSQ vs 12PAM Isolated Pulse Immunity Study

One Channel is Shown

Continuous Time Modeling

Discrete-Time Float Point

10 mV pp
$\tau = 1 - 20$ UI

Discrete-Time Float Point

3　　4　　5

10m

Tx

85m

Rx

Class E

1　　2

Fs, Phi

6

1.　　DSQ or 12PAM

2.　　Tx LPF 3rd BWT 400 MHz, xFormer 1st HPF 120 kHz, LPF 600 MHz, 0.5 dB Loss

3.　　xFormer 1st HPF 120 kHz, LPF 600 MHz

4.　　Rx HPF 1st 10, 20 and 30 MHz

5.　　Rx LPF BWT 2nd 400 MHz

6.　　Rx FFE FIR < 24 Tap, BLW Compensation, Decision Device

Hard Decision Error Count

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Key System Observations

- ➢ **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**

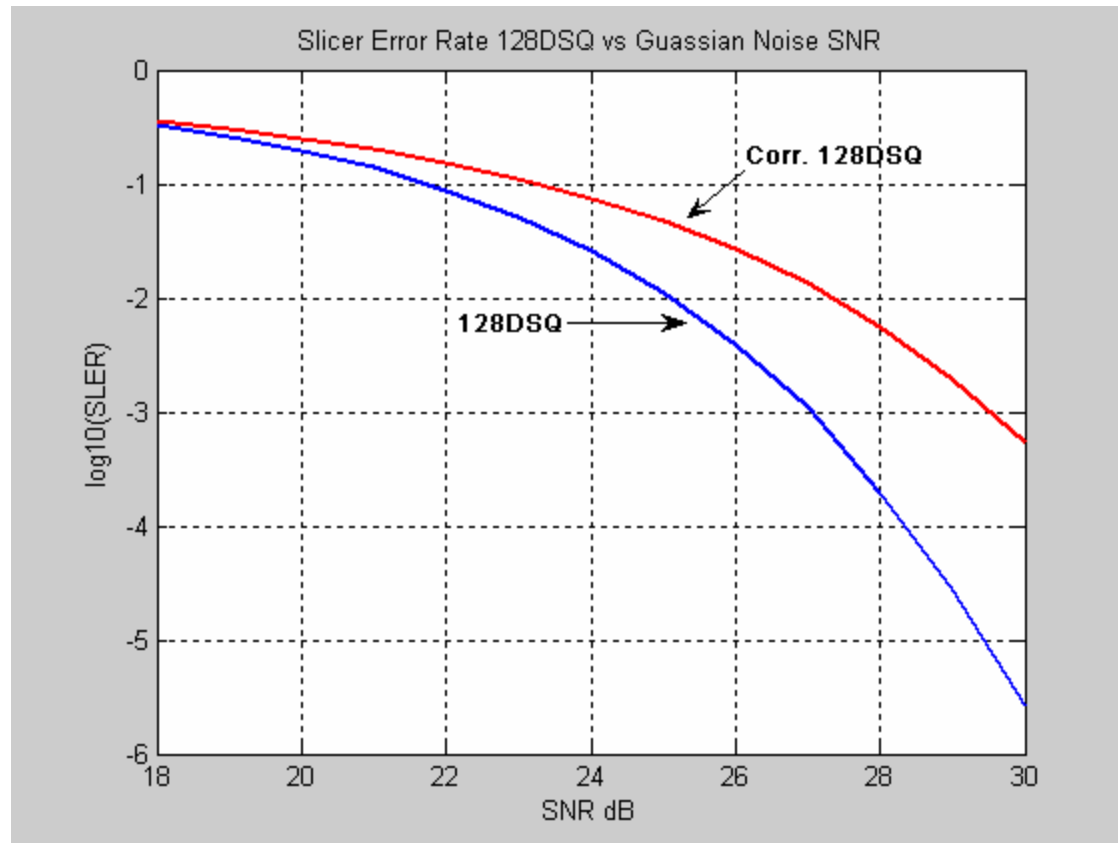# DSQ and 12PAM Hard Decision Errors vs Pulse Width
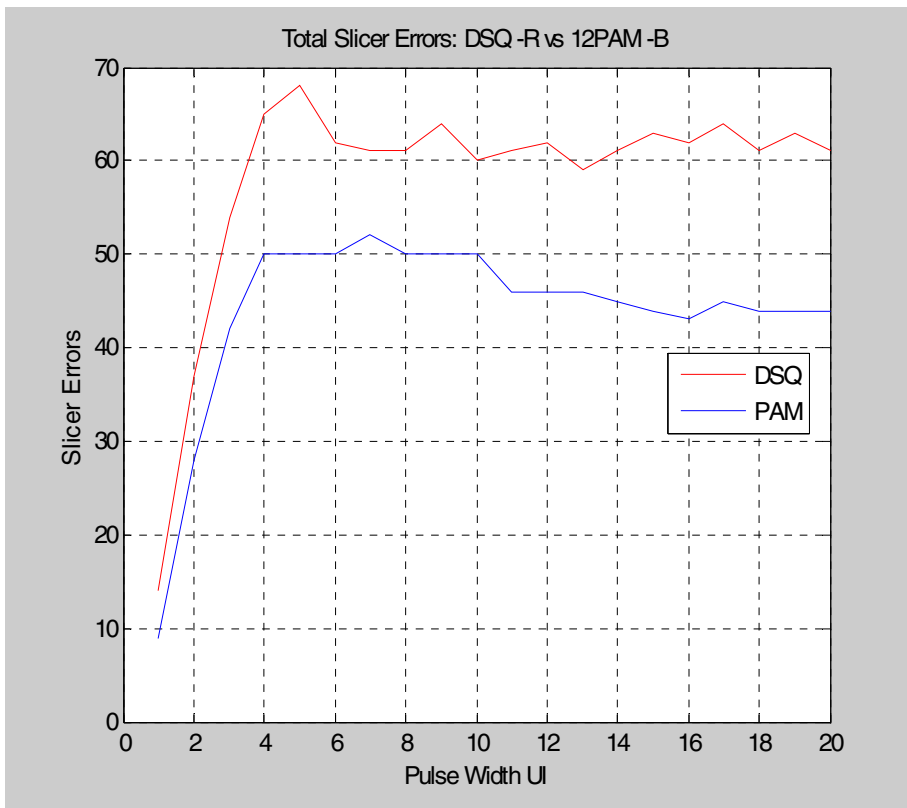
Up to 40% more errors occurred in DSQ vs 12PAM
Under the same disturbance conditions > 4 UI
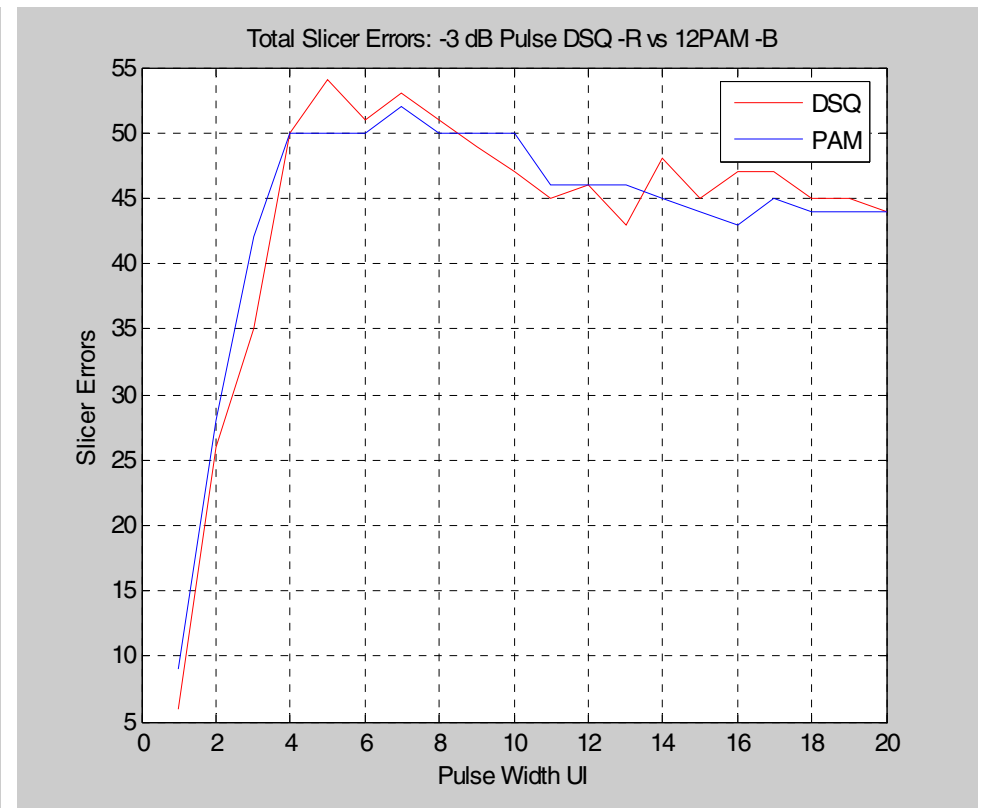
Number of DSQ generated errors is roughly equated with
12PAM when disturbance amplitude is reduced by 3 dB

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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

➢ **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**

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Recommendations

- **Form a subtask group to study**
    - channel impulse noise,
    - noise susceptibility of DSQ128,
    - potential solutions,
    - and report back to 802.3an on findings of the subtask group

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