

Bandwidth, Modulation and SNR Comparison for Multi-Gigabit Automotive PHY

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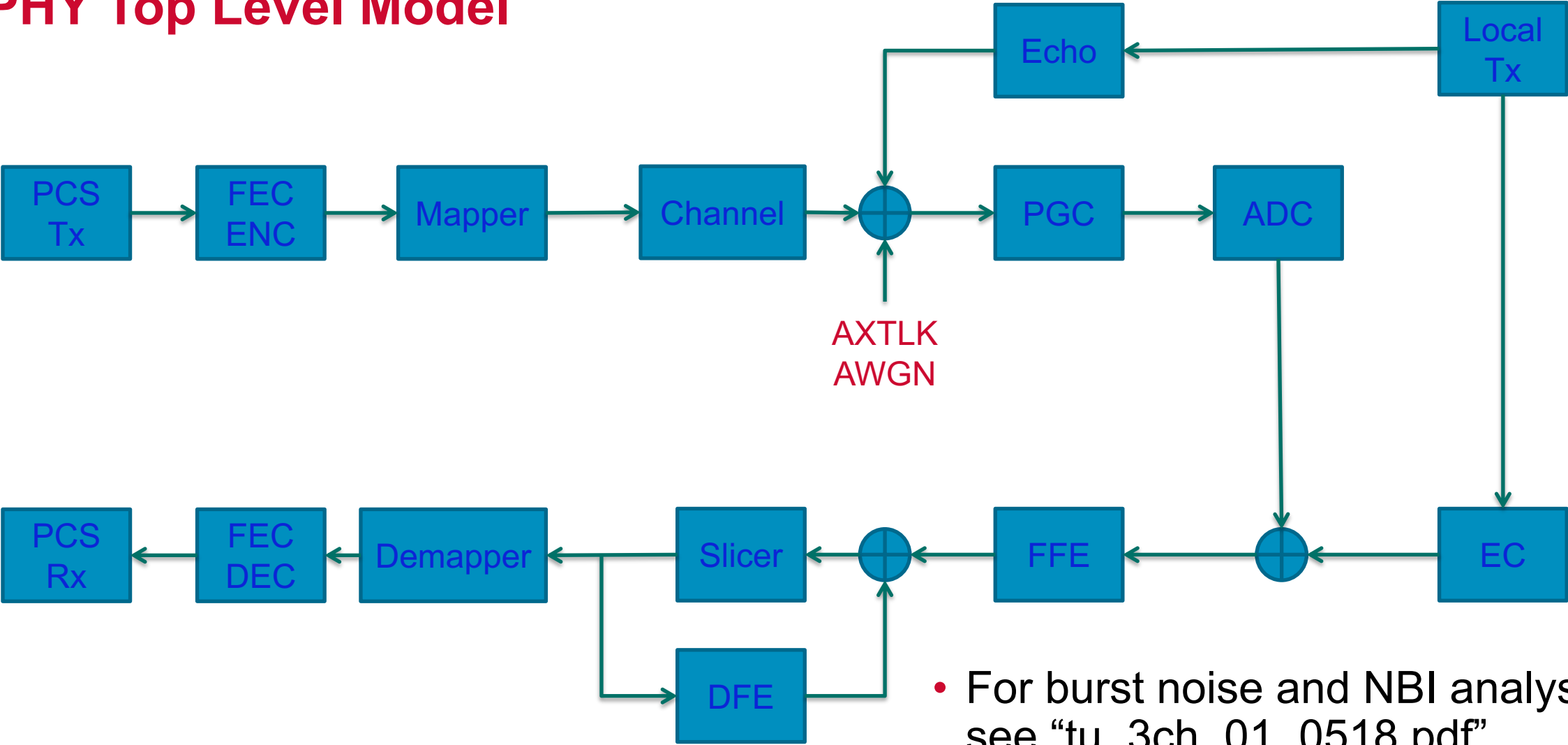
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Overview

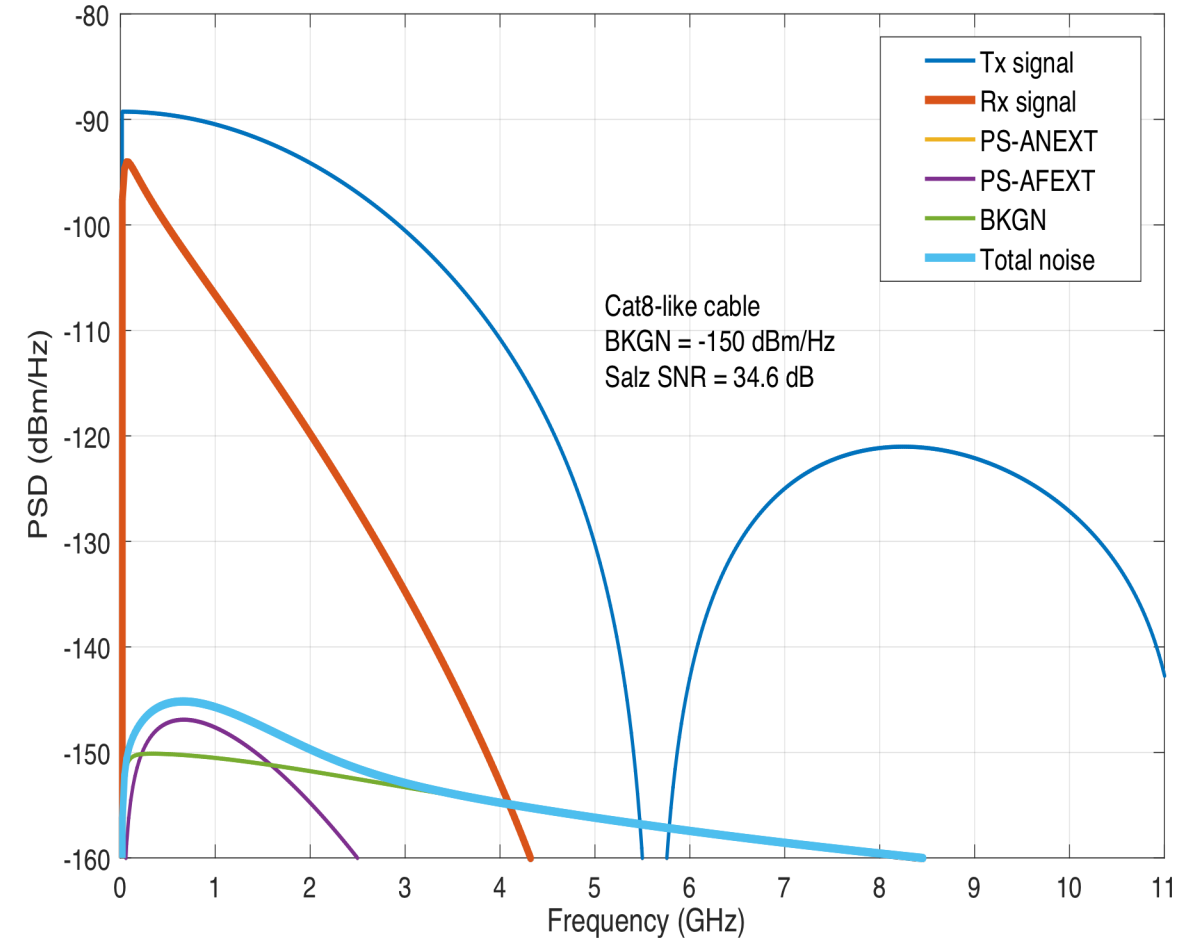
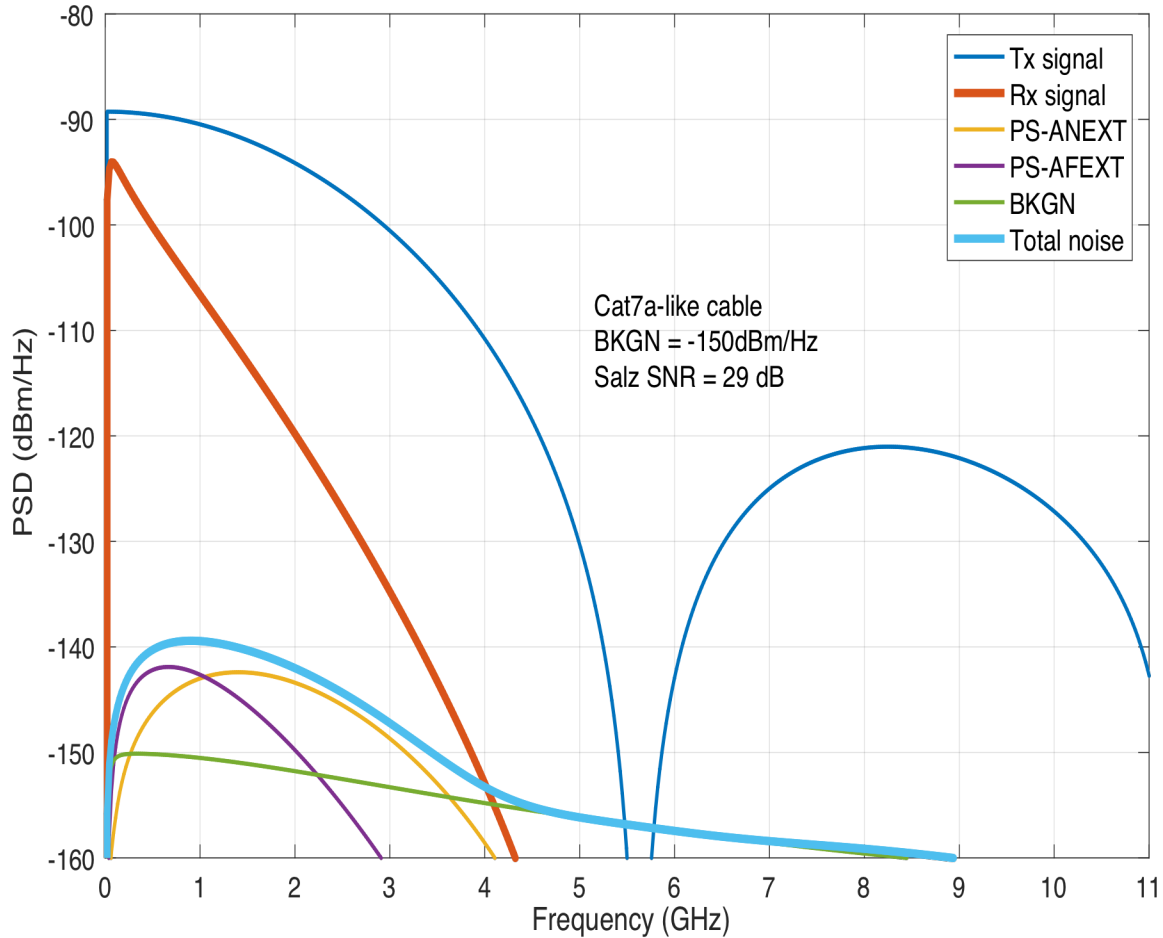
- 10Gb/s over single STP focus
 - 10Gb/s the more challenging problem
 - 2.5G & 5G scaled versions of 10G
- Channel insertion loss specified in P8023ch_D0p2p2
- 2 crosstalk models used
 - Cat7a-like and Cat8-like
 - Bandwidth extended to > 5GHz
- 2 methods used to analyze SNR Margin
 - Margin to Capacity
 - Margin to uncoded SER
- 7 constellations considered (1.5 to 3.5 bits per symbol)

PHY Top Level Model



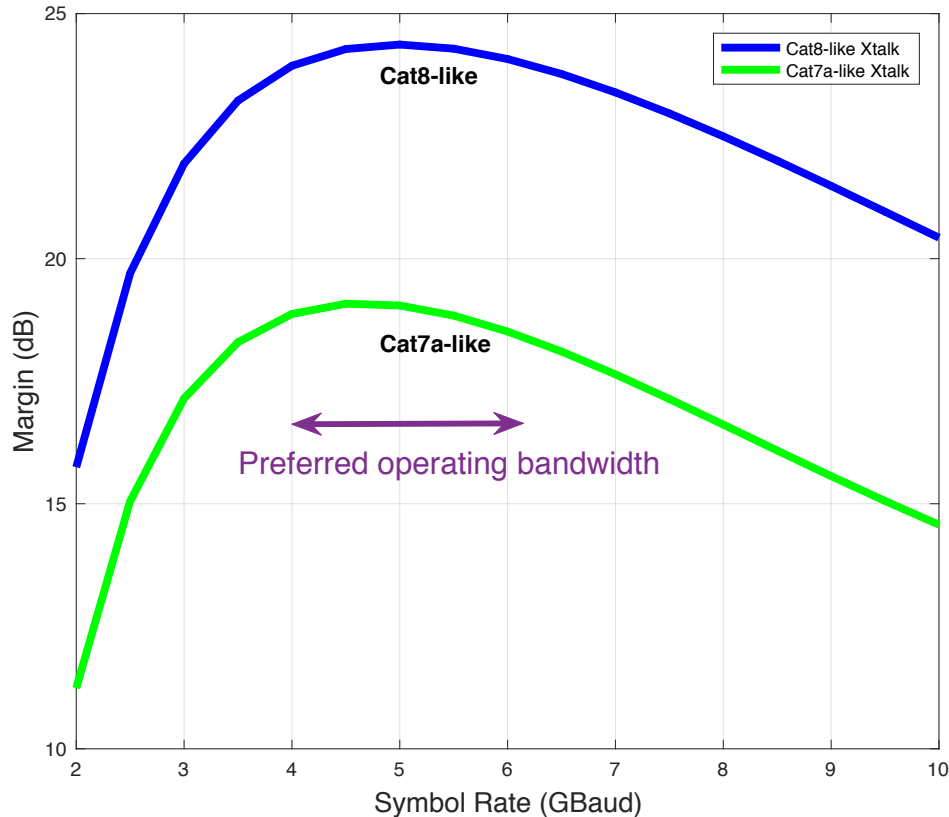
- For burst noise and NBI analysis, see “tu_3ch_01_0518.pdf”

PSD of Signal & Noises: 10Gb/s



- Based on channel insertion loss specified in P8023ch_D0p2p2
- HPF: $f_c = 40MHz$ LPF: $f_c = f_{Nyquist} = Symbol\ Rate/2$

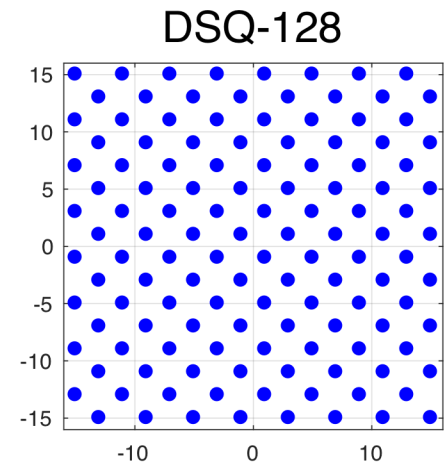
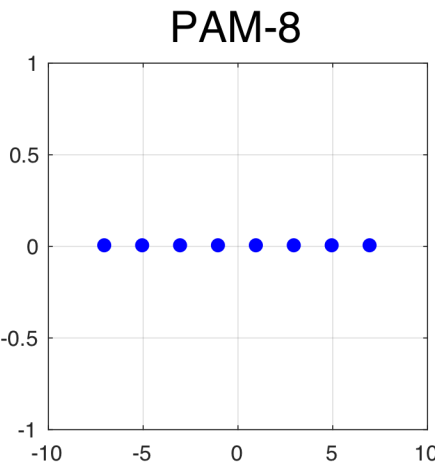
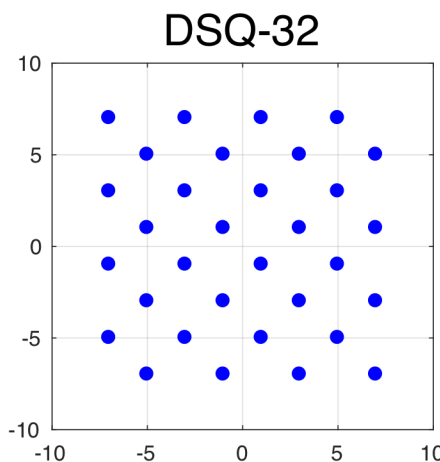
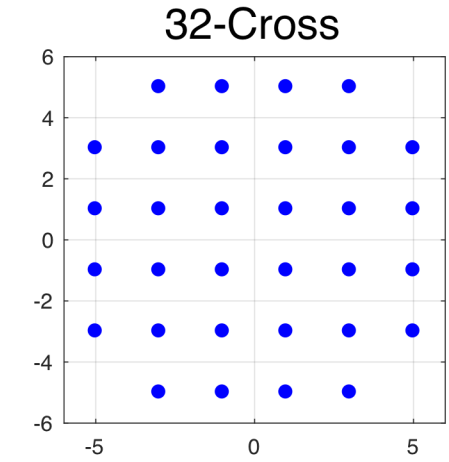
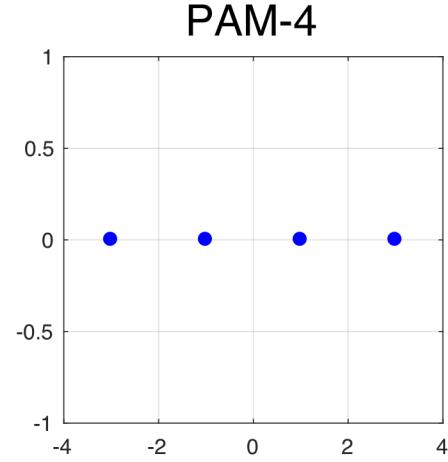
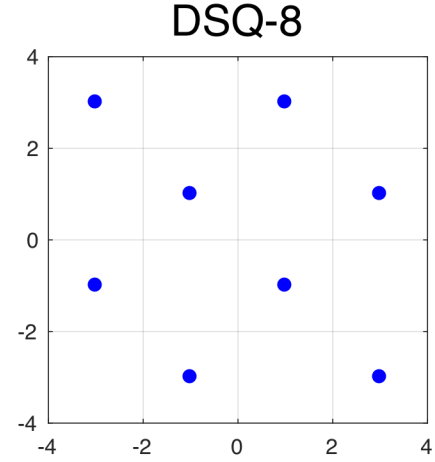
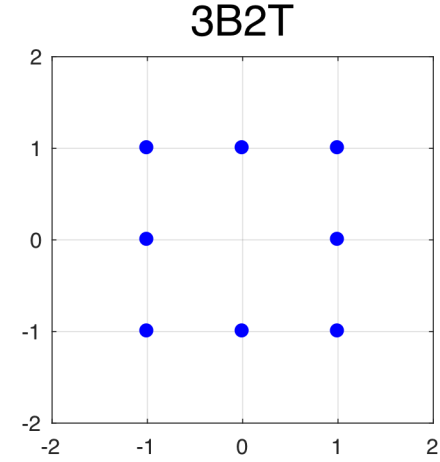
SNR Margin to Capacity



- $C = B \log_2(1 + SNR_{Cap})$
 - $C = 10^{10}$ bits
 - $B = Symbol\ Rate/2$
- $Margin = SNR_{Salz} - SNR_{Cap}$

- Margin relative to bandlimited 10Gb/s AWGN channel
- Highest margin in 4GBaud-6GBaud Symbol Rate (2GHz-3GHz BW) range
- Preferred bandwidth same for Cat7a & Cat8 cable models

Constellations Considered



Modulation	Bits/Sym	Symbol Rate
3B2T	1.5	7500
DSQ-8	1.5	7500
PAM-4	2	5625
32-Cross	2.5	4500
DSQ-32	2.5	4500
PAM-8	3	3750
DSQ-128	3.5	3200

SNR Margin to Uncoded SER

Modulation	Bits/Sym	Symbol Rate (MBaud)	Uncoded SNR @1e-12 SER (dB)	Cat8 Salz SNR (dB)	Cat7a Salz SNR (dB)	Cat8 Margin (dB)	Cat7a Margin (dB)
3B2T	3/2	7500	21.8	30.3	24.4	8.5	2.6
DSQ-8	3/2	7500	21.1	30.3	24.4	9.2	3.3
PAM-4	2/1	5625	24.0	34.6	29.1	10.6	5.1
32-Cross	5/2	4500	27.1	37.5	32.3	10.4	5.2
DSQ-32	5/2	4500	27.3	37.5	32.3	10.2	5.0
PAM-8	3/1	3750	30.4	39.6	34.6	9.2	4.2
DSQ-128	7/2	3200	33.4	41.3	36.5	7.9	3.1

- $Margin = SNR_{Salz} - SNR_{uncoded}$
- Margin relative to 10^{-12} symbol error rate
- Highest SNR margin with 2 or 2.5 bits per symbol

Summary

- Optimize modulation, symbol rate for 10Gb/s over single STP
 - 10Gb/s significantly more difficult
 - 2.5Gb/s, 5Gb/s straightforward scaled modes of 10Gb/s
 - Similar to 2.5G/5G/10GBASE-T
- Cat8-like shielding provides higher margin
- Highest margin at bandwidths of 2GHz to 3GHz
- Margin to capacity consistent with margin to uncoded SER
- Preferred modulation options:
 - PAM-4 (2 bits / symbol)
 - 32-cross (2.5 bits / symbol)
 - DSQ-32 (2.5 bits / symbol)