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

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Summary

- 10Gb/s over single STP focus

- 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)

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PSD of Signal & Noises: 10Gb/s

Cat7a-like cable
BKGN = -150dBm/Hz
Salz SNR = 29 dB

Cat8-like cable
BKGN = -150 dBm/Hz
Salz SNR = 34.6 dB
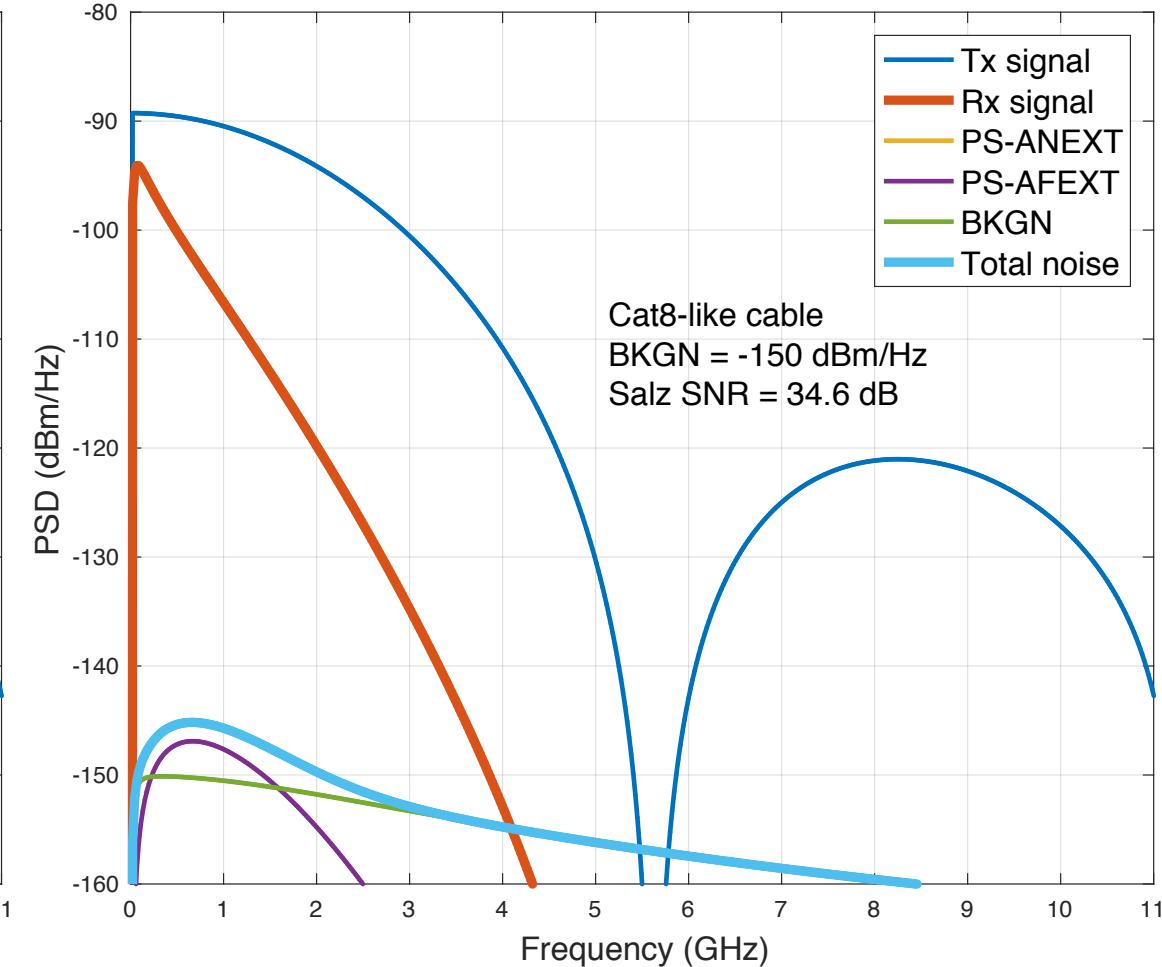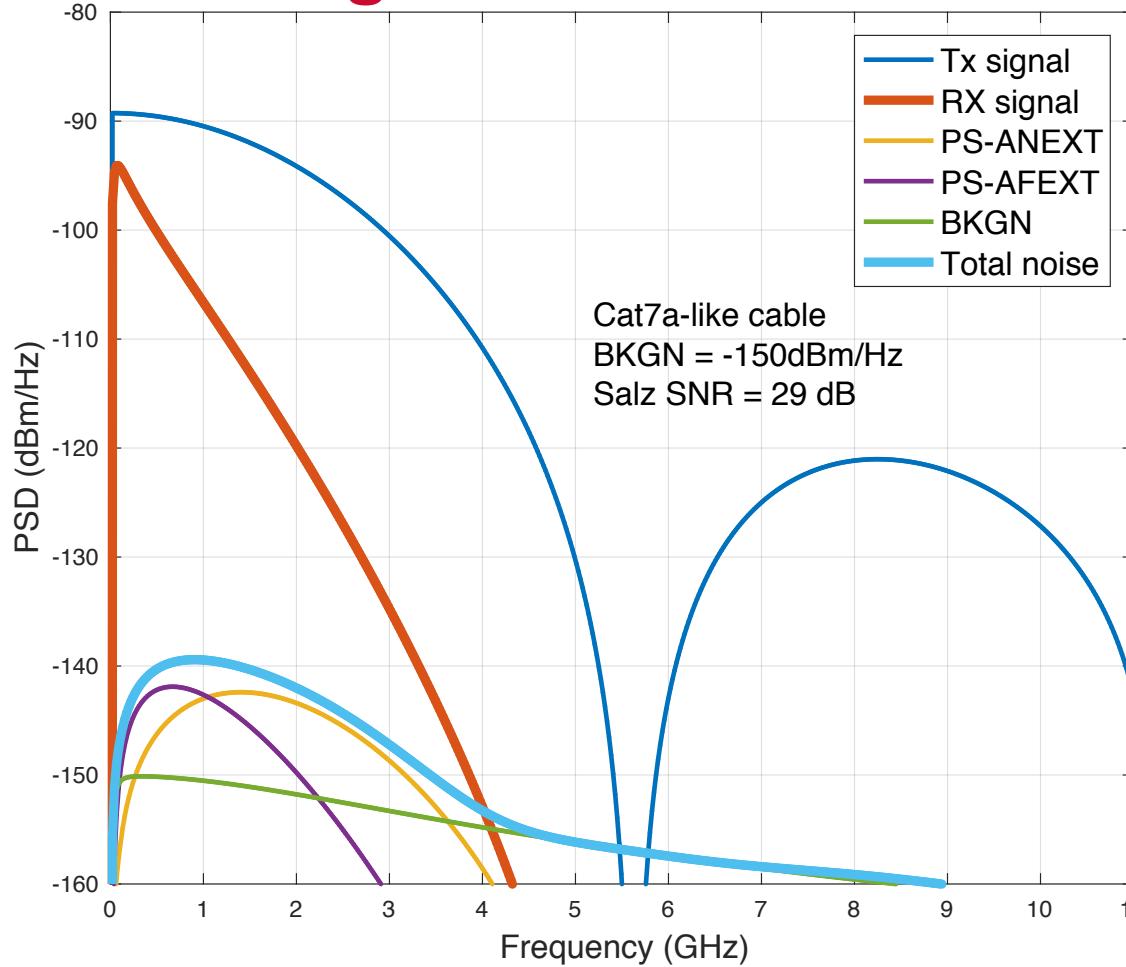
- Based on channel insertion loss specified in P8023ch_D0p2p2

- HPF: $f_c = 40 MHz$ LPF: $f_c = f_{Nyquist} = Symbol\ Rate/2$

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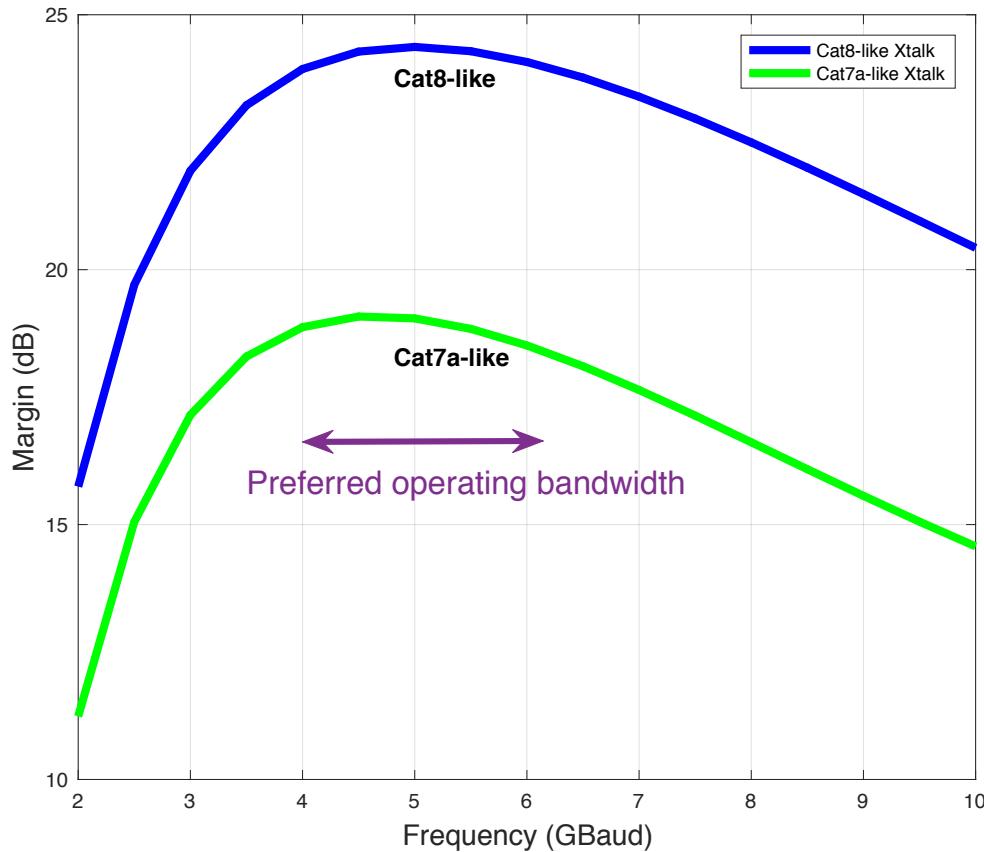
- $C = B \ log_2(1 + SNR_{Cap})$
  - $C = 10^{10} \ bits$
  - $B = Symbol \ Rate/2$

- $Margin = SNR_{Cap} - SNR_{Salz}$

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

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Constellations Considered

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PHY Top Level Model

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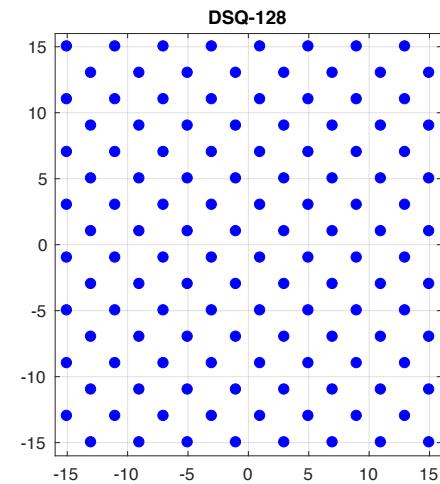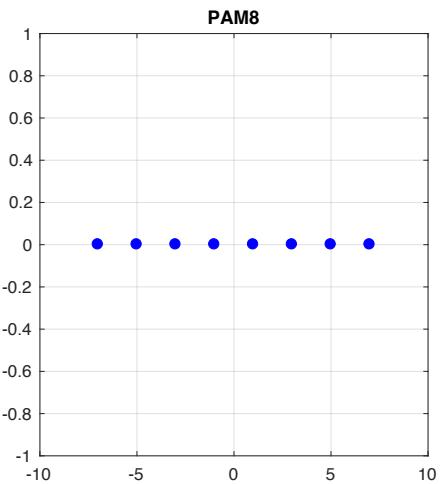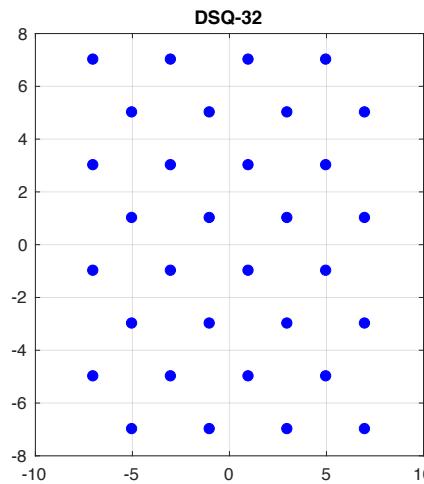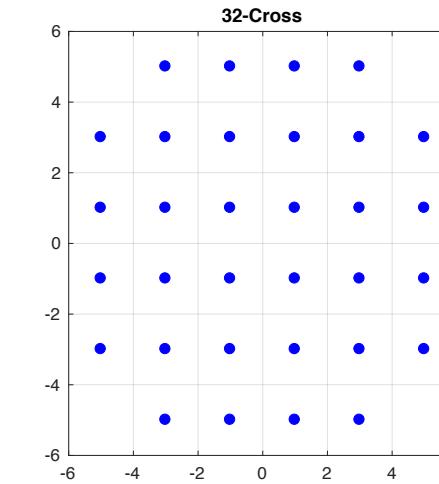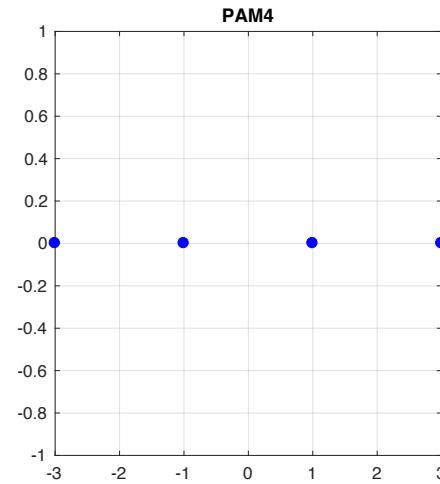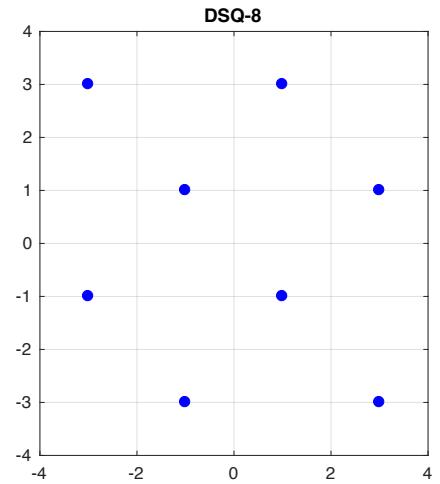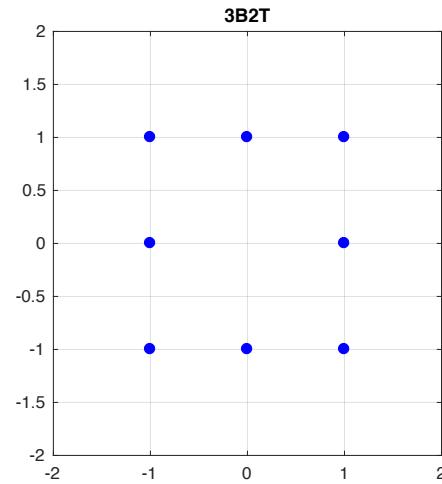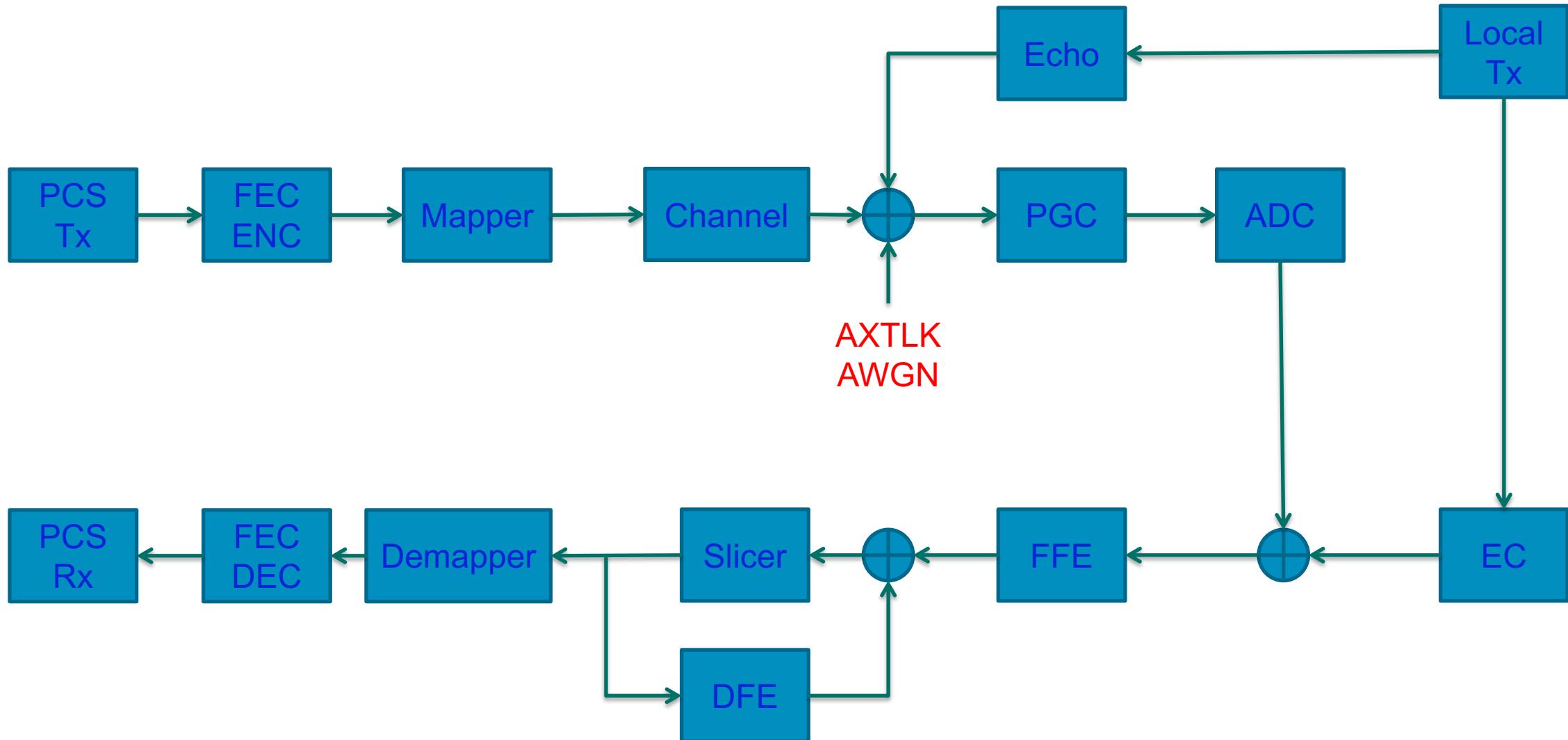
SNR Margin to Uncoded SER

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

- $Margin = SNR_{Salz} - SNR_{uncoded}$
- Highest SNR margin with 2 or 2.5 bits per symbol

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Summary

- Focus on 10Gb/s over single STP
  - 2.5Gb/s, 5Gb/s scaled modes of 10Gb/s
- 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 include
  - PAM-4 (2 bits / symbol)
  - 32-cross (2.5 bits / symbol)
  - DSQ-32 (2.5 bits / symbol)

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