



Issues with the PAM12 proposal and derivatives

IEEE 802.3an Task Force

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Agenda



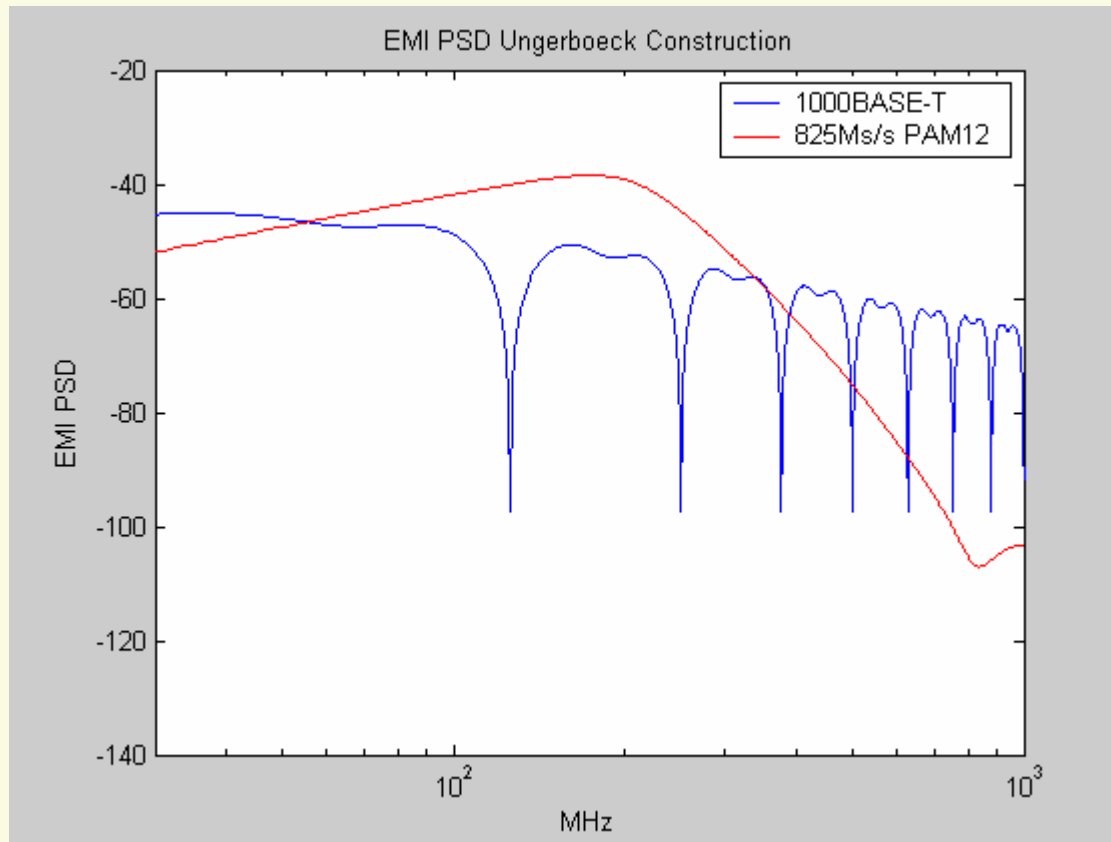
Issues presented in the reflector

- Total EMI Penalty
- AFE Distortion Requirement
- Inefficient Constellation
- Complex Framing
- Fixed Patterns
- Risky LDPC Code

Conclusions

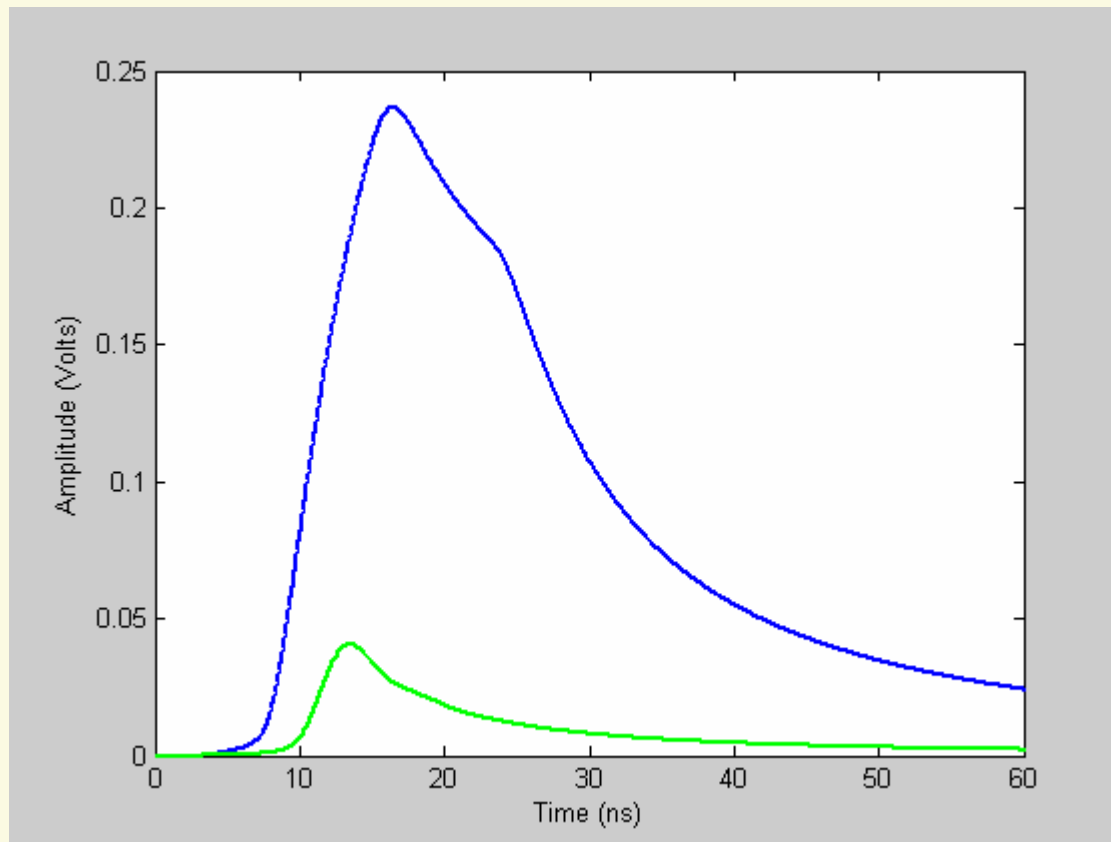
Emissions Penalty over 1G

EMI PSD peak is **6.6dB** higher than that of 1G



Susceptibility Penalty over 1G

Susceptibility penalty is **15.3dB** over 1G after 100m cabling



1. Total EMI Penalty



☰ Total EMI Penalty of PAM12 over 1000BASE-T

Penalty	PAM12 (powell_1_0704.pdf)	PAM8 (for comparison)	Double Square Constellation
Emissions	6.6dB	4.2dB	
Susceptibility	15.3dB	13.2dB	
Total EMI Penalty	21.9dB	17.4dB	
SNR Penalty for TF	2.5dB	0.5dB	

2. Analog Front End Distortion Requirement

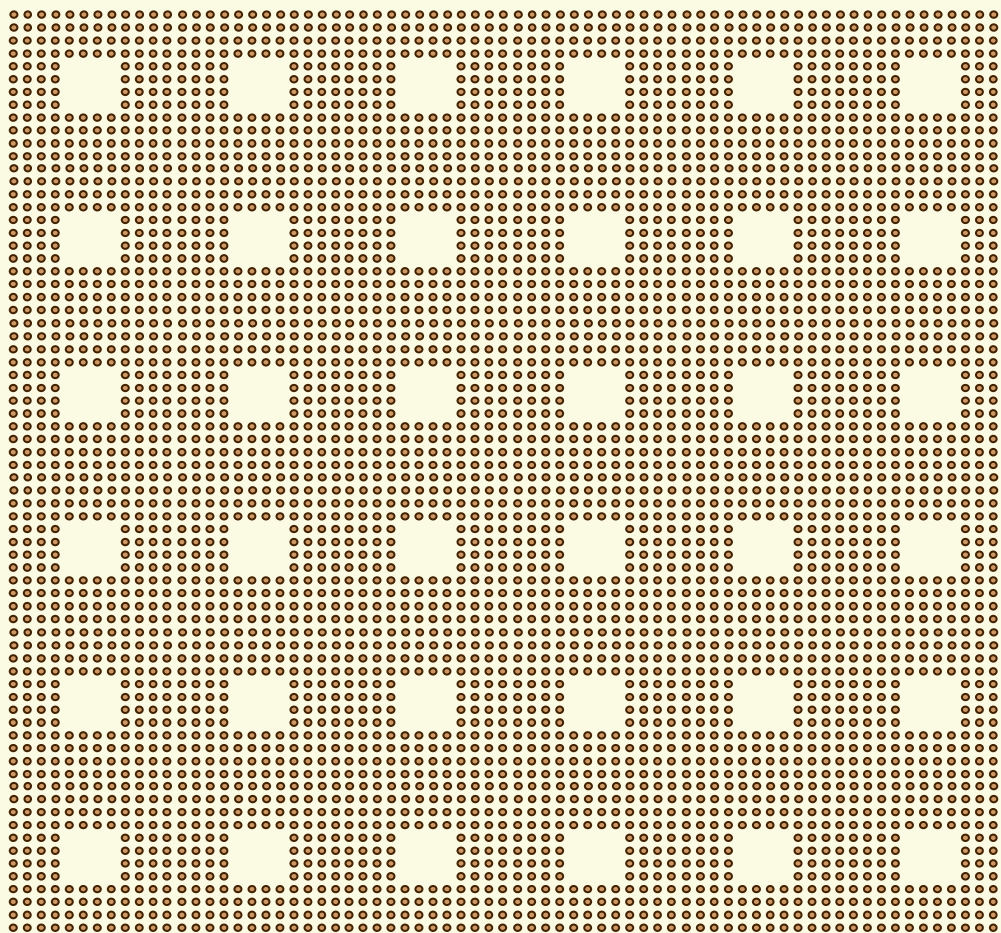
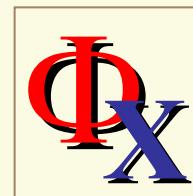


- ❏ SNR Required at the input of the LDPC decoder for PAM12 is **23.8dB** for 1E-12 BER
- ❏ SNR Required at the input of the LDPC decoder for PAM8 is **19.9dB** for 1E-12 BER
- ❏ If implementation budget is proportionally allocated, then the Analog Front End distortion requirements would be **3.9dB** higher for PAM12 than for PAM8.
- ❏ Analog Front End Distortion Requirement for Double Square Constellation and derivatives are : ??

3. Inefficient Constellation



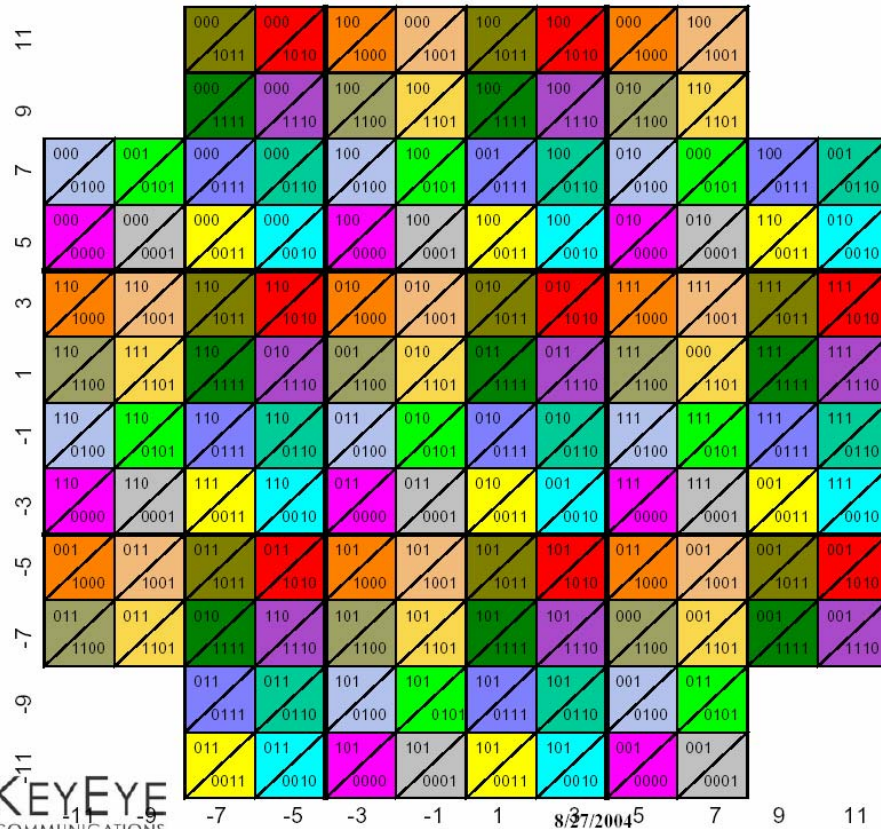
After THP



9/22/2004

Issues with PAM12 and derivatives

Proposed Cross Constellation

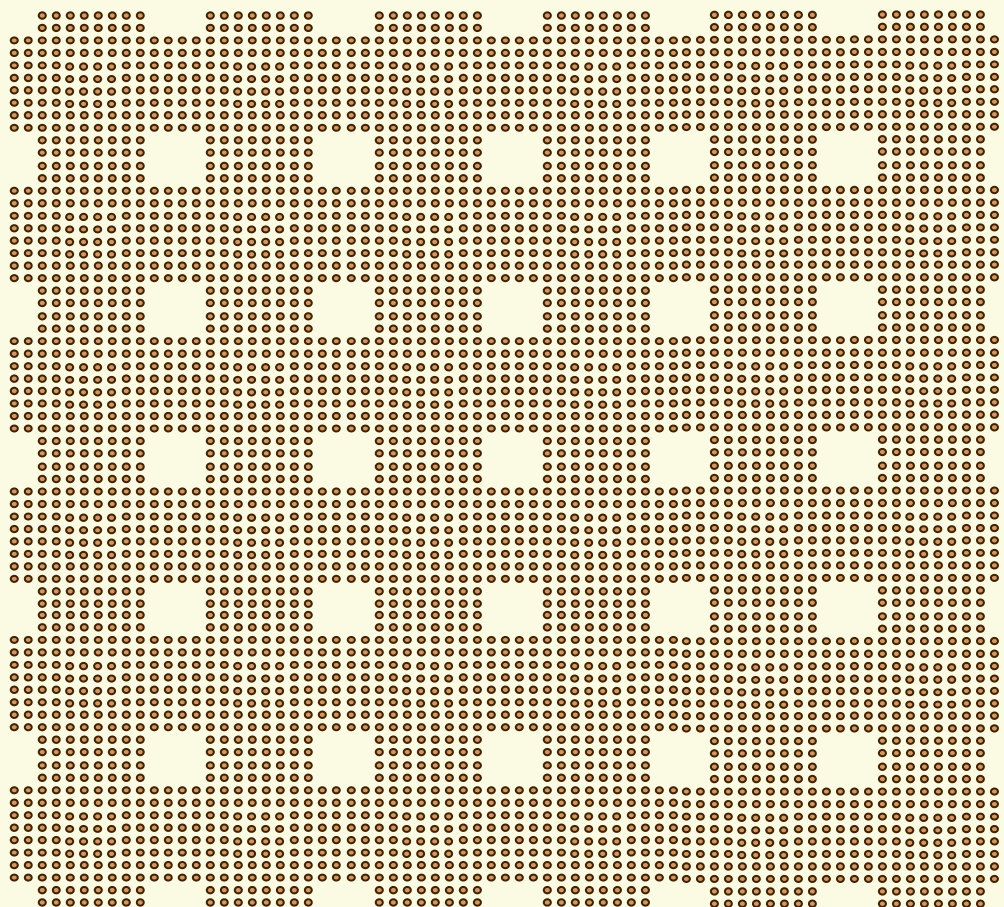
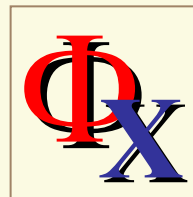


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Cross Constellation after THP



3. Inefficient Constellation



- ☞ At least 1.1dB loss in SNR margin due to holes in the constellation
- ☞ 0.4dB to 0.7dB variation in transmit PSD power as a function of the THP coefficients, depending on the constellation chosen.
- ☞ 2-Dimensional Log Likelihood Ratio calculations for 4 coded bits at a time in LDPC decoder which involves 2-pair statistics and adds dependencies in the Tanner graph that can affect performance of the decoder.
- ☞ 2(Multi)-dimensional Log Likelihood Ratio calculations for Double Square constellation and derivatives are : ??

4. Complex Framing

From tellado_1_0704.pdf, page 24

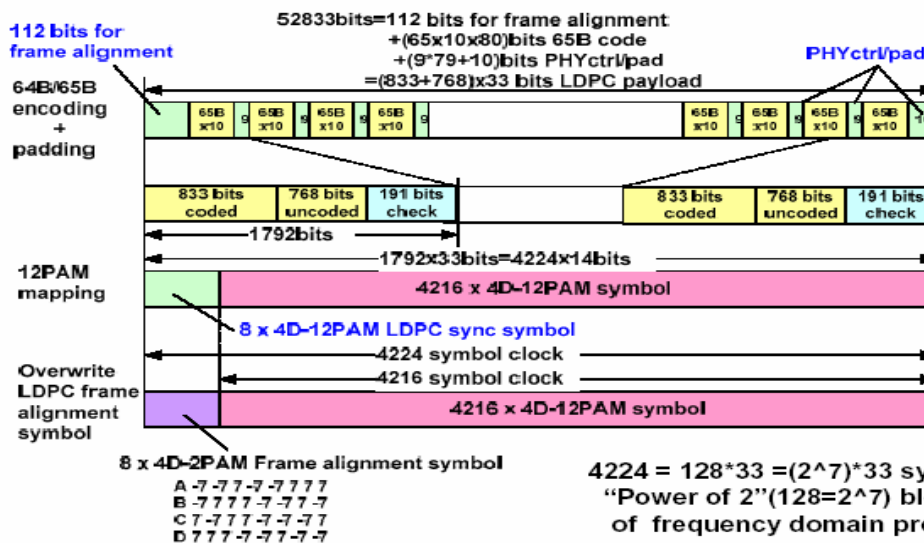


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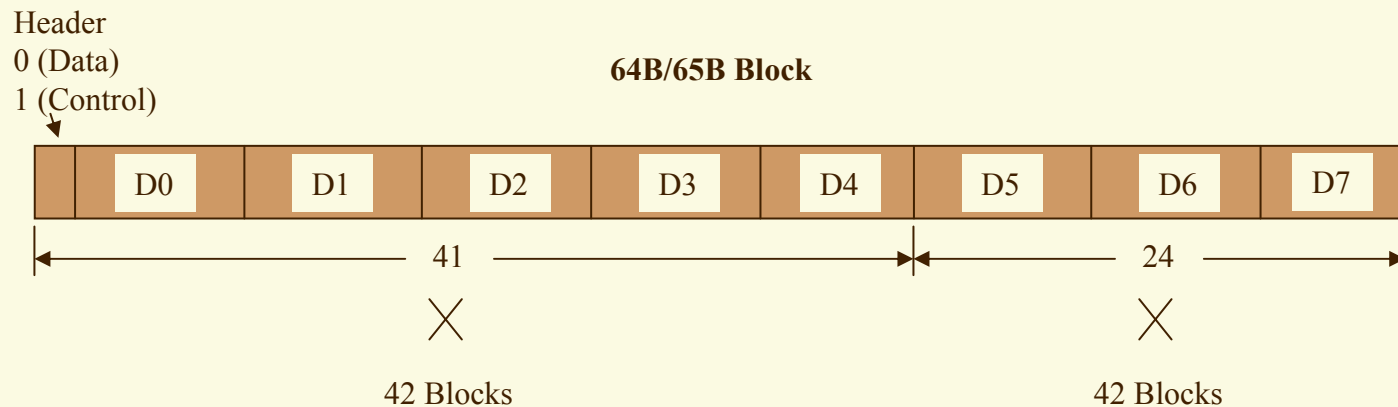
Framing and Control (cont')



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Framing Requirement for Double Square Constellation and Derivatives are ??

Compare Framing in PAM8

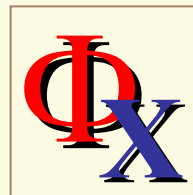


+1 Back Channel Bit = 1723
Information bits for (2048,1723)
RS-LDPC Code

+16 Parity bits for RS(60,44,5)
Code = 1024 Uncoded
Information bits for 1024 PAM8
symbols

5. Fixed Patterns

From tellado_1_0704.pdf, page 24

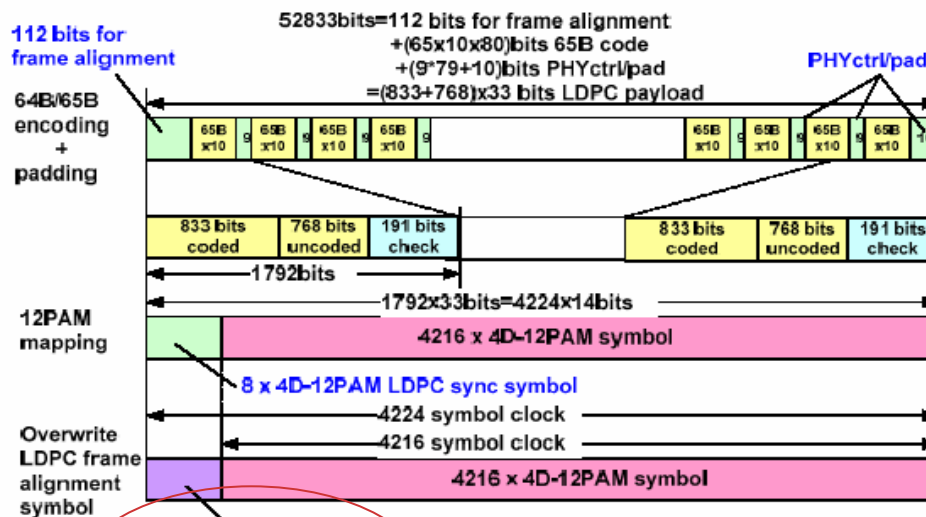


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Framing and Control (cont')



8 x 4D-2PAM Frame alignment symbol

- A -7-77-7-7777
- B -7777-7-77-7
- C 7-777-7-7-77
- D 777-7-77-7-7

4224 = 128*33 = (2⁷)*33 symbol clock
 "Power of 2"(128=2⁷) block facilitates use of frequency domain processing.

5. Fixed Patterns



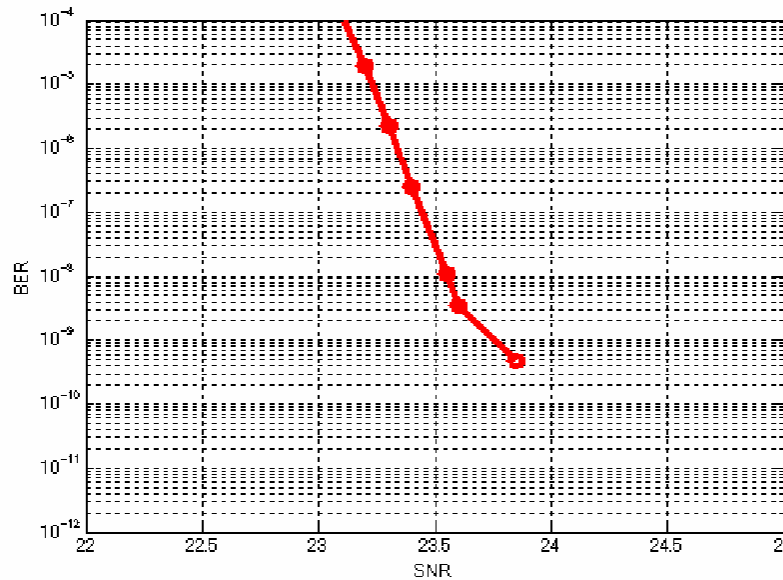
- ☞ Like preamble/SFD in Ethernet packets
- ☞ However, Ethernet packets are of variable length and have variable IPG – therefore, preamble/SFD serve a purpose.
- ☞ Frames in the PAM12 proposal are of fixed length and have ZERO IPG – therefore, fixed patterns occur at predictable points in data stream and serve NO purpose.
- ☞ Fixed Patterns are ?? In Double Square Constellation and Derivatives.

6. Risky LDPC code

From seki_1_0704.pdf



LDPC(845,1024) Performance



Has a BER slope change at unacceptable BER

P802.3an July '04 Plenary

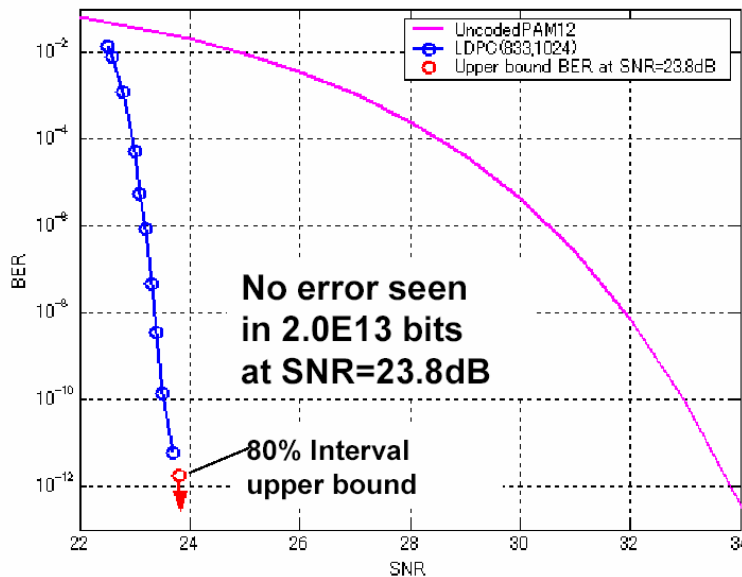
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6. Risky LDPC code (contd.)

From seki_1_0704.pdf



LDPC(833,1024) Performance



Average number of error bits per error blocks = 24.0

$$FER = BER / 24.0 * 1792$$

UB: UB: upper bound BER with 80% confidence

NF: The number of Frame = 2.0E13/1792

f(x) : The probability of error free at x FER

$$\frac{\int_0^{(UB/24*1792)} f(x) dx}{\int_0^1 f(x) dx} = 0.8$$

$$f(x) = \exp(NF * \log(1-x))$$

- No error floor observed up to 1E-12 BER
- Required SNR=23.8dB for 1E-12 BER

6. Risky LDPC Code (Contd.)

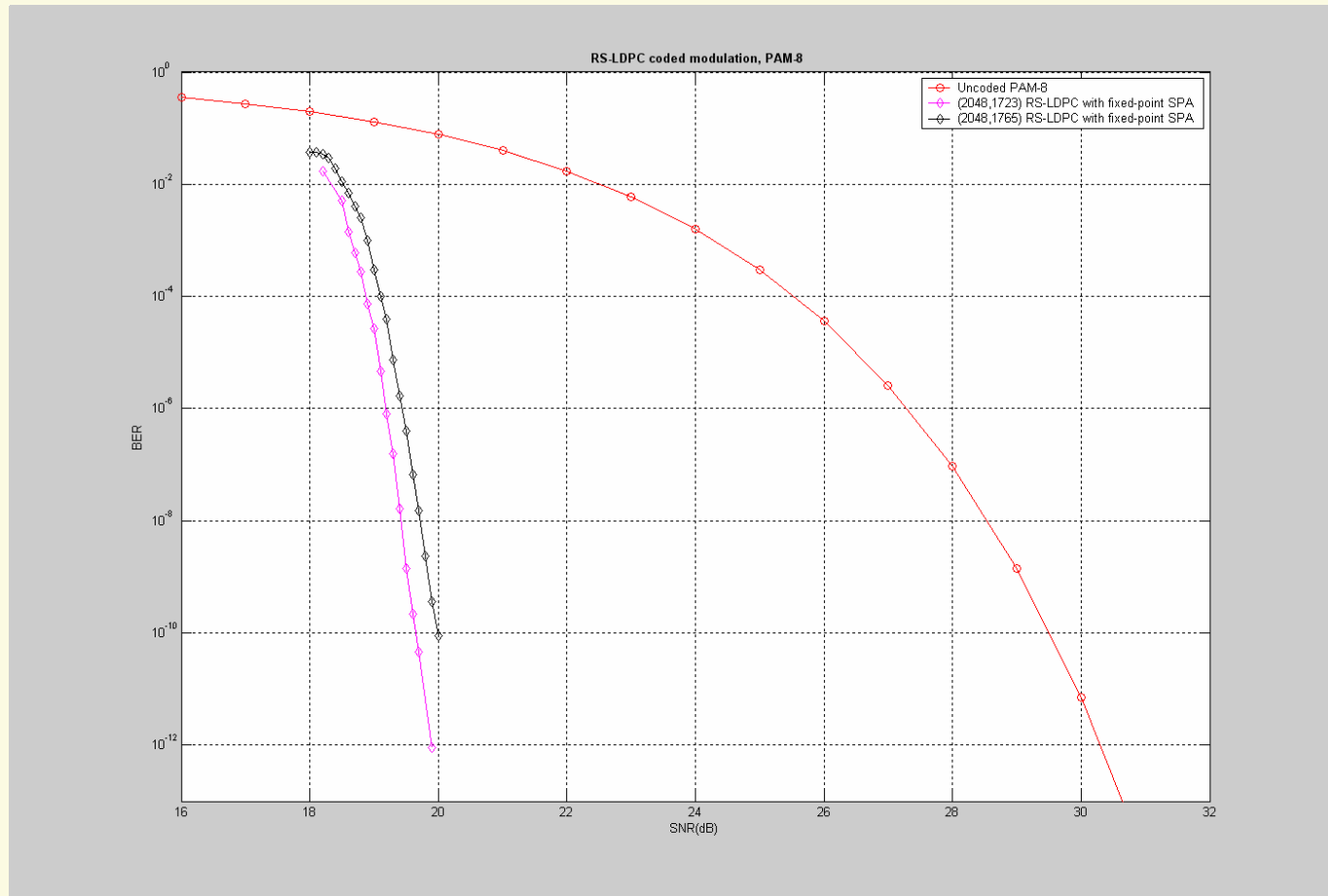


- ☞ However, (1024,833) code is obtained from (1024,845) code by adding 64 rows to its parity check matrix.
 - Of the 64 rows added, 52 rows are dependent rows since the number of information bits only decreased by 12.
 - 12 rows are new checks, augmenting the original 179 parity checks

- ☞ 179 parity checks cause BER slope change at $\sim 1E-10$ BER and result in bad code that was thrown away in `seki_1_0704.pdf`
 - How robust would the code be if we add 12 parity check equations to these 179 parity check equations?

- ☞ LDPC code(s) used in Double Square Constellation and Derivatives are ??

Compare (2048,1723) code



Conclusions



Six issues with PAM12 proposal in powell_1_0704.pdf

- ☞ Total EMI penalty of 21.9dB over 1000BASE-T
- ☞ 3.9dB higher SNR (i.e., AFE distortion requirement)
- ☞ Inefficient “donut” constellation
- ☞ Complex framing
- ☞ Fixed Patterns
- ☞ Risky LDPC code

What are the (new) issues with the Double Square constellation and derivatives?