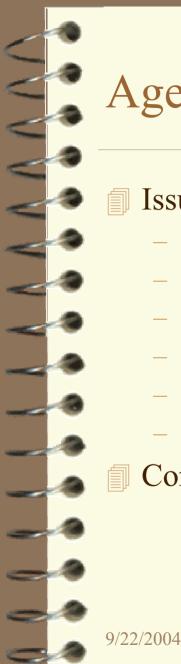


Issues with the PAM12 proposal and derivatives

IEEE 802.3an Task Force September 2004

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Supporters: Ze'ev Roth – Mysticom Joseph Babanezhad – Plato Networks Sim Narasimha – Ample Communications Anand Injeti – Krypton Systems Prof. X. Wang, Raju Hormis – Columbia University Ignacio Berenguer – Cambridge MIT Institute



Agenda



Issues presented in the reflector

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

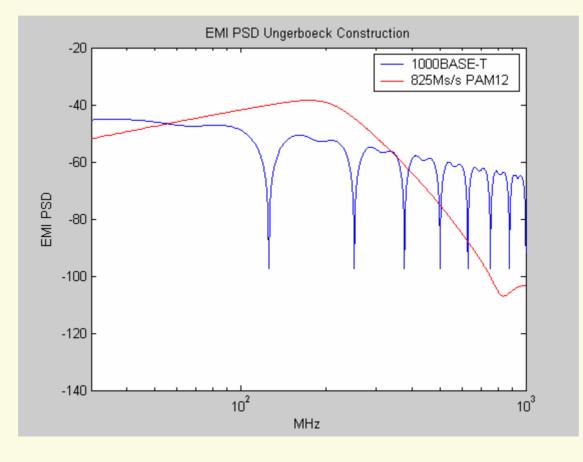
Conclusions

Emissions Penalty over 1G



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

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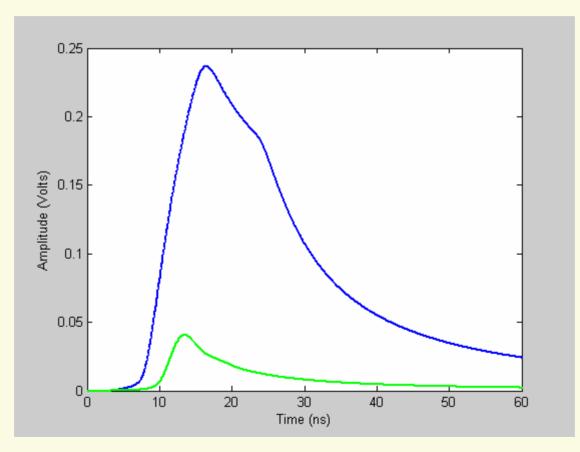


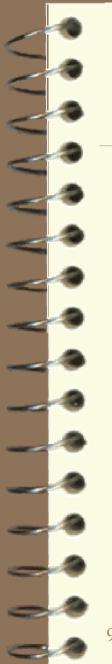
Susceptibility Penalty over 1G



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

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1. Total EMI Penalty



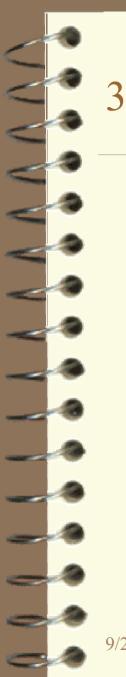
Total EMI Penalty of PAM12 over 1000BASE-T

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 : ??



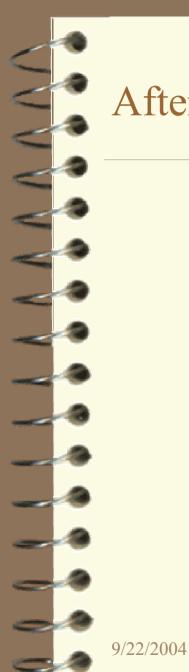
3. Inefficient Constellation



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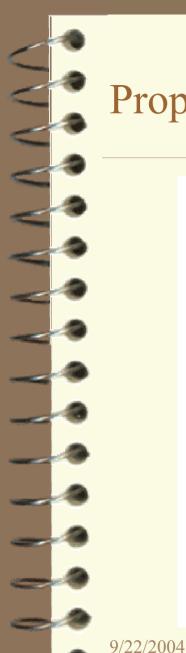
Issues with PAM12 and derivatives



After THP

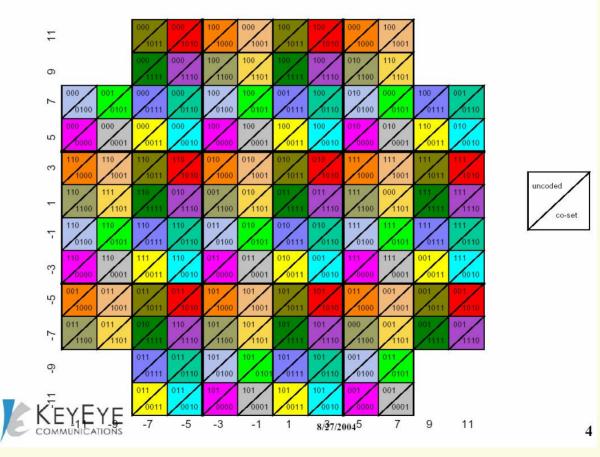


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Proposed Cross Constellation





Issues with PAM12 and derivatives



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Cross Constellation after THP



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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

LDPC frame

P

NEC Teranetics Framing and Control (cont') 52833bits=112 bits for frame alignment 112 bits for +(65x10x80)bits 65B code frame alignment PHYctrl/pad +(9*79+10)bits PHYctrl/pad =(833+768)x33 bits LDPC payload 64B/65B encoding 9 65B 3r10 65B x10 9 65B 65B x10 65B 65B 658 x10 ×10 padding 833 bits 768 bits 191 bits 833 bits 768 bits 191 bits coded uncoded check coded uncoded check 1792bits 1792x33bits=4224x14bits 12PAM 4216 x 4D-12PAM symbol mapping 8 x 4D-12PAM LDPC sync symbol 4224 symbol clock Overwrite 4216 symbol clock

 alignment symbol
 4216 × 4D-12PAM symbol

 8 x 4D-2PAM Frame alignment symbol
 4224 = 12

 A -7 -7 7 -7 -7 7 7
 "Power of C 7 - 7 7 -7 -7 7

 B -7 77 7 -7 7 -7 7
 "Power of C 7 - 7 7 -7 7

 D 7 7 7 -7 7 -7 7
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4224 = 128*33 =(2^7)*33 symbol clock "Power of 2"(128=2^7) block facilitates use of frequency domain processing.

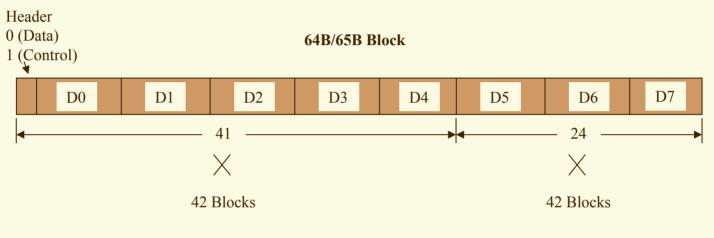
24

Framing Requirement for Double Square Constellation and Derivatives are ??

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Compare Framing in PAM8





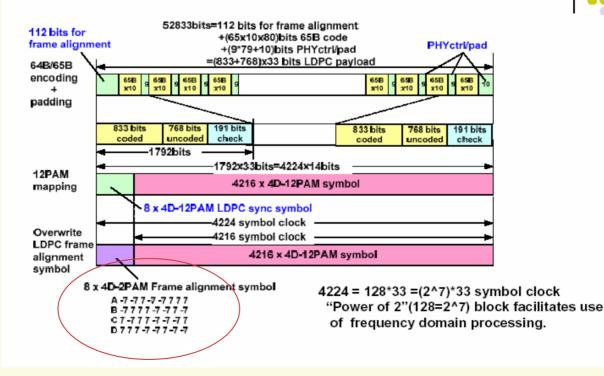
+1 Back Channel Bit = 1723 Information bits for (2048,1723) RS-LDPC Code +16 Parity bits for RS(60,44,5) Code = 1024 Uncoded Information bits for 1024 PAM8 symbols

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5. Fixed Patterns

From tellado_1_0704.pdf, page 24

Teranetics Framing and Control (cont')



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Issues with PAM12 and derivatives

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NEC

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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.

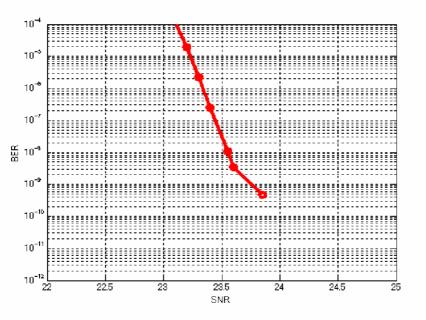
Fixed Patterns are ?? In Double Square Constellation and Derivatives.

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

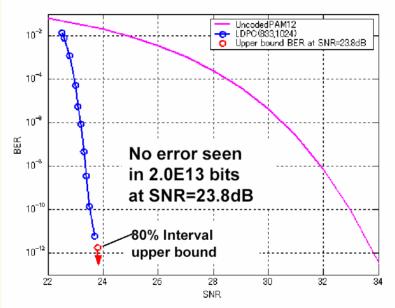
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6. Risky LDPC code (contd.)



From seki_1_0704.pdf

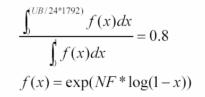
LDPC(833,1024) Performance



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



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

P802.3an July '04 Plenary

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Issues with PAM12 and derivatives

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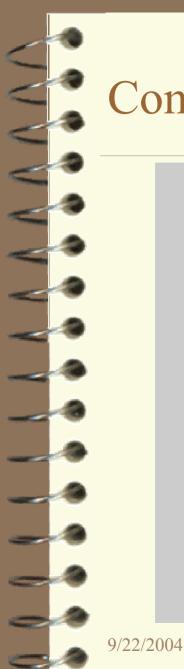
6. Risky LDPC Code (Contd.)



- 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 ~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?

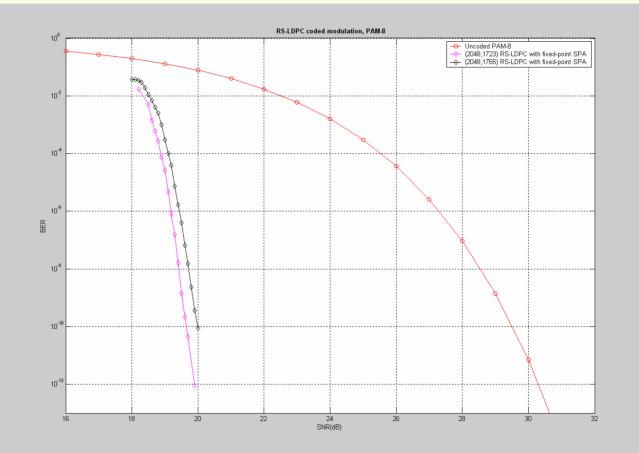
LDPC code(s) used in Double Square Constellation and Derivatives are ??

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Compare (2048,1723) code





Issues with PAM12 and derivatives

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?