

100GBASE-KP4 Training Frame Update for Draft 1.2

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Supporters and Contributors

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Training Pattern Update

- Applies to comments #163, 147, 149, 148
- Reviewed in 100GBASE-KP4 transmitter characteristics ad hoc on 24 October, 2012
 - Attendees:
 - Matt Brown, Charles Moore, Megha Shanbhag, Piers Dawe, Rick Rabinovich, Wheling Cheng, Adee Ran, Kent Lusted, Beth Kochuparambil, Mohammad Kermani, Vasu Parthasarathy, Rich Mellitz, Will Bliss, Zhongfang Wang, Beth Kochuparambil, Stephen Alie, Mike Dudek, Walter Katz

100GBASE-KP4 Training Frame Update Goals

- Use full-state pinning termination in Draft 1.2
 - 1 PAM4 symbol (termination) with bits taken from known PRBS sequence
 - 45 PAM4 symbols precoded
- Enable locking on termination PRBS during training
 - Essential for data decoding
- Make training frame same size as PMA frame
 - Simplifies implementation
 - Use PAO for EEE ALERT frame only
- Maintain spectrally rich, DC balanced and uncorrelated lane sequences

100GBASE-KP4 Precoding changes from D1.2

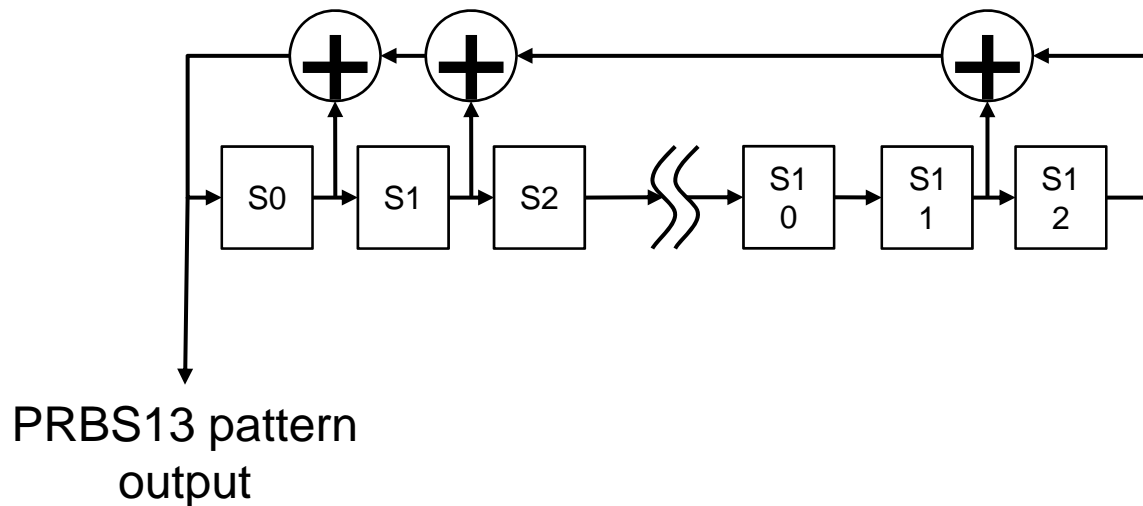
- Training frame word (TFW) is still 46 UI
 - Now TFW is same size as D1.2 termination block
 - In D1.1, 1 TFW = 2 TB46
- TFW is now created from 92 bits of PRBS13 at a time (instead of 45 bits at a time in D1.1)
 - Gray coding results in 46 bit-pairs
 - First bit-pair is used for initializing the precoder state
 - As per 94.2.2.6
 - The remaining 45 bit-pairs fed through the precoder
 - As per 94.2.2.6

Training Frame size changes from D1.2

- Propose to increase training pattern length to 338 TFWs
 - Requires $338 \times 92 = 31096$ bits from PRBS13
 - PRBS13 full cycle is 8191 bits
 - Use 3 full cycles + 4th cycle truncated to 6523 bits
 - Bits from 2nd and 4th cycles are inverted
- Added to marker and control channel (10 TFW together), the new training frame is 348 TFWs, which is equal to the PMA frame size

PRBS generator change

- Modified Fibonacci polynomial: $G(x)=1+x+x^2+x^{12}+x^{13}$
 - Old one was $G(x)=1+x+x^2+x^{11}+x^{13}$
 - Required to enable creating 4 DC balanced, quasi-white, non-correlated sequences



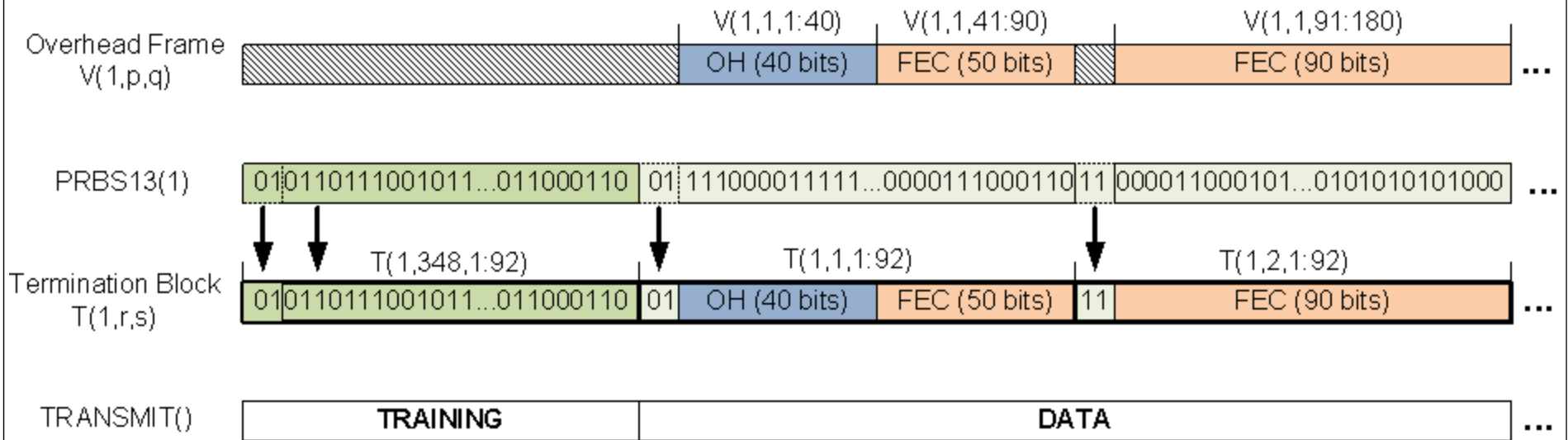
Initial outputs

- The *initial outputs* of the PRBS13 generator, right after the control channel transmission, shall be different for each of the PMD lanes, as follows (LSB transmitted first)
 - PMD lane 0: 0xCD92
 - PMD lane 1: 0x2AFB
 - PMD lane 2: 0xC3D3
 - PMD lane 3: 0xE2F6
- Generator is re-seeded to same values at the beginning of every training frame pattern

Transition from training to data

- Training frame is always aligned with the PMA frame; last training frame is immediately followed by 40-bit overhead of data
 - No need for PAO field in training (only in EEE alert)
 - Countdown field still used to signal transition
 - 40-bit overhead must start with a termination symbol to be consistent
 - Bit-inversion of PRBS13 is removed (present in 2nd and 4th PRBS cycle)
- PRBS13 is re-seeded at the beginning of each training sequence during training mode, but keeps running freely in data mode
 - Termination bits get synced during training
 - PRBS always advances 92 bits per TFW in training and by 92 bits per term block in data mode
 - Do not reseed first PMA frame after training ends
 - Do not reseed in data mode at start of each PMA frame

Training to Data Transition



- Notes:
 - PRBS13 bit inversion ends with transition to data mode

Blue = first TFW
Green = second TFW

Initial sequences

Lane	Output of	Contents of first 2 TFWs (from left to right)
L0	PRBS	01001001101100111100010101011000010010011101111001110100000111010011011101001110011001010111 00011111110101110110111111010001011011111010011110110010101100111001001110000111100001101011
	Gray code	1031320220111130103121231210012102121023131112 0122211213222101132233123203320231023012301332
	Precoder	1301200200101031003201123322233220110021032320 0111101103333223211121021130331123112233001211
L1	PRBS	11011111010101000000100100110110011110001010101100001001001110111100111010000011101001101110 1001110011001010111000111111010111011011111101000101101111101001111011001010110011100100111
	Gray code	2122111000310213123033320031023220233002331323 3120203323022233232122330321221022131113120312
	Precoder	2333232222100230112212113123112022030002123021 3200221203111121120111213023332202301012331233
L2	PRBS	1100101111000011110111011101100110011001110001110001100001100111000001100110000001110 00110110000110001010110001100100111010101000110010010000111001111011101010110011001001010101
	Gray code	2032200223232320202023023020020023230020200023 0213013033201310233330203100231232333202031111
	Precoder	2211131112033022002203112200022203300022000021 0230012212001231121213312313301120303311301010
L3	PRBS	0110111101000111101111101011001101111110001111011010111011110010000101100010110010101111000 100101101011110010100101100010011111000010101101011001001111110001010111101001000101111100
	Gray code	1322101232233202122302213323220301130320332230 3113322033113031220033211310222011132331011220
	Precoder	1202310211121133202133321203331223213022120213 3230333121012210200030232100202232302123101113

ALERT Frame

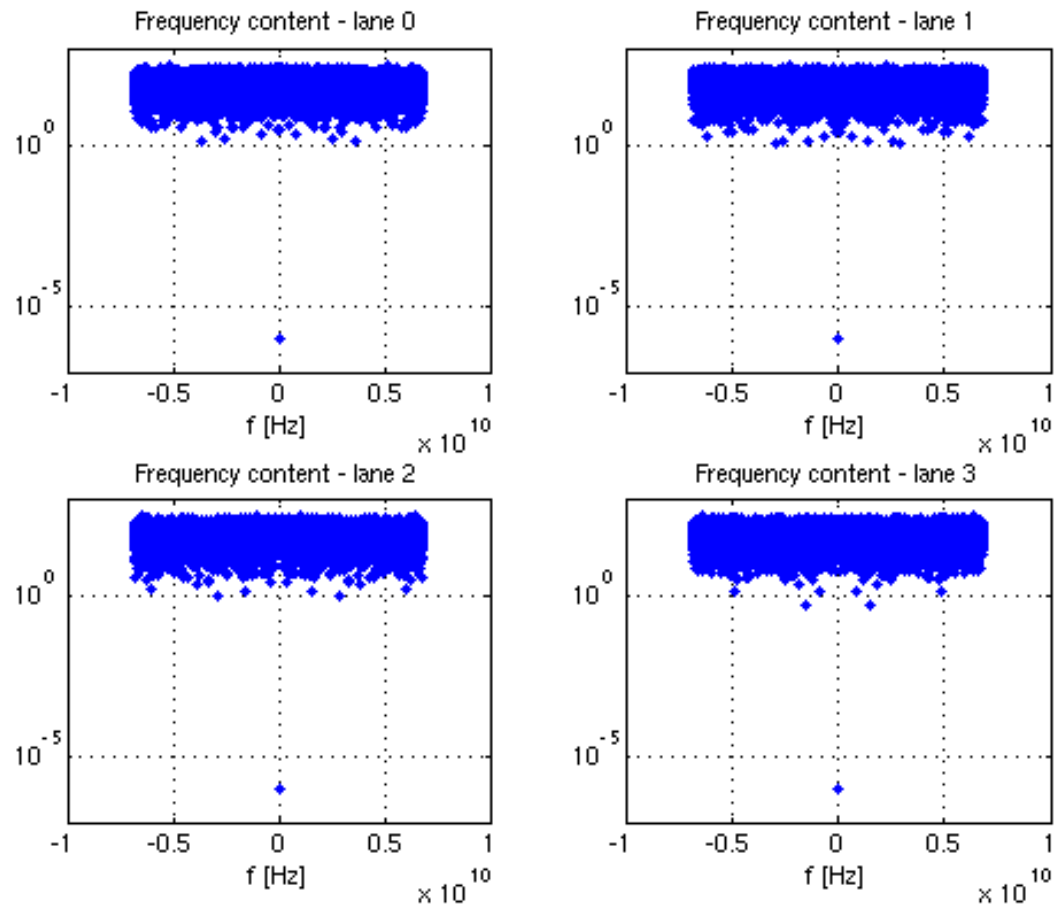
- Update ALERT frame as outlined in this document:
 - Keep the short frame length of 58 TFW in Draft 1.2
 - 1 TFW = 1 TB92
 - Use the aforementioned PRBS13 generator, polynomial, seeds, etc.

Training pattern features

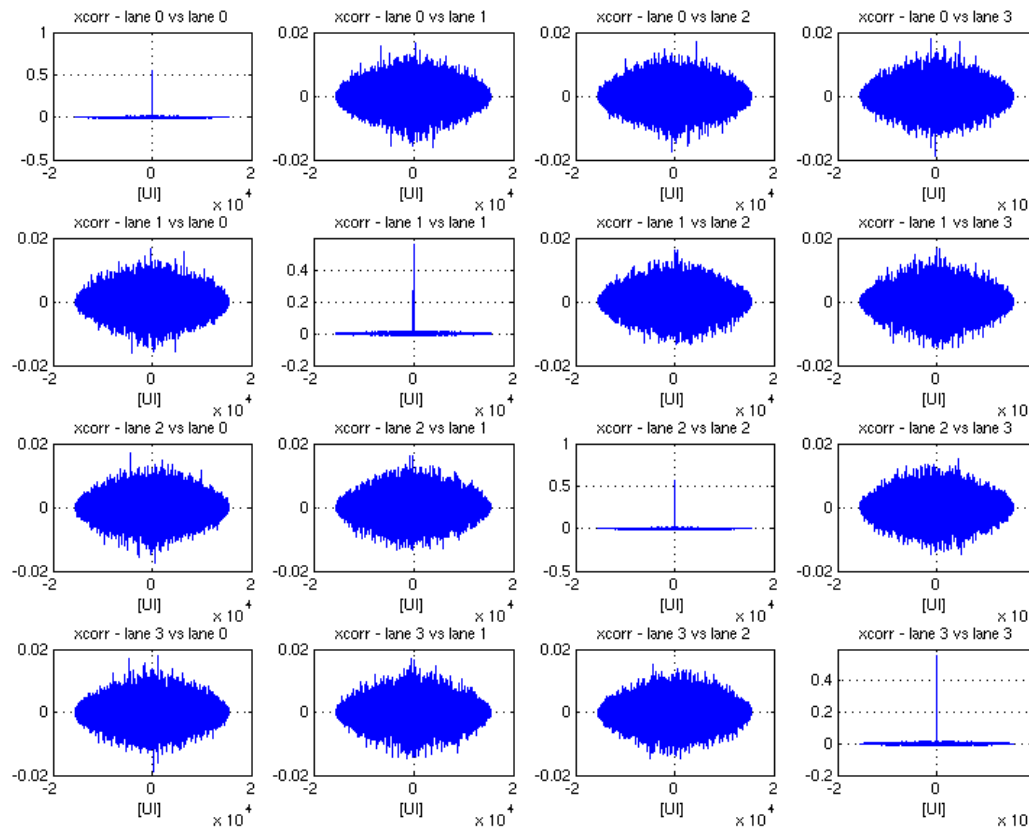
- The resulting training sequences are DC balanced, quasi-white and have low correlation between lanes
- Distribution of voltage levels is nearly uniform
- Distribution of transitions between level is nearly uniform

BACKUP

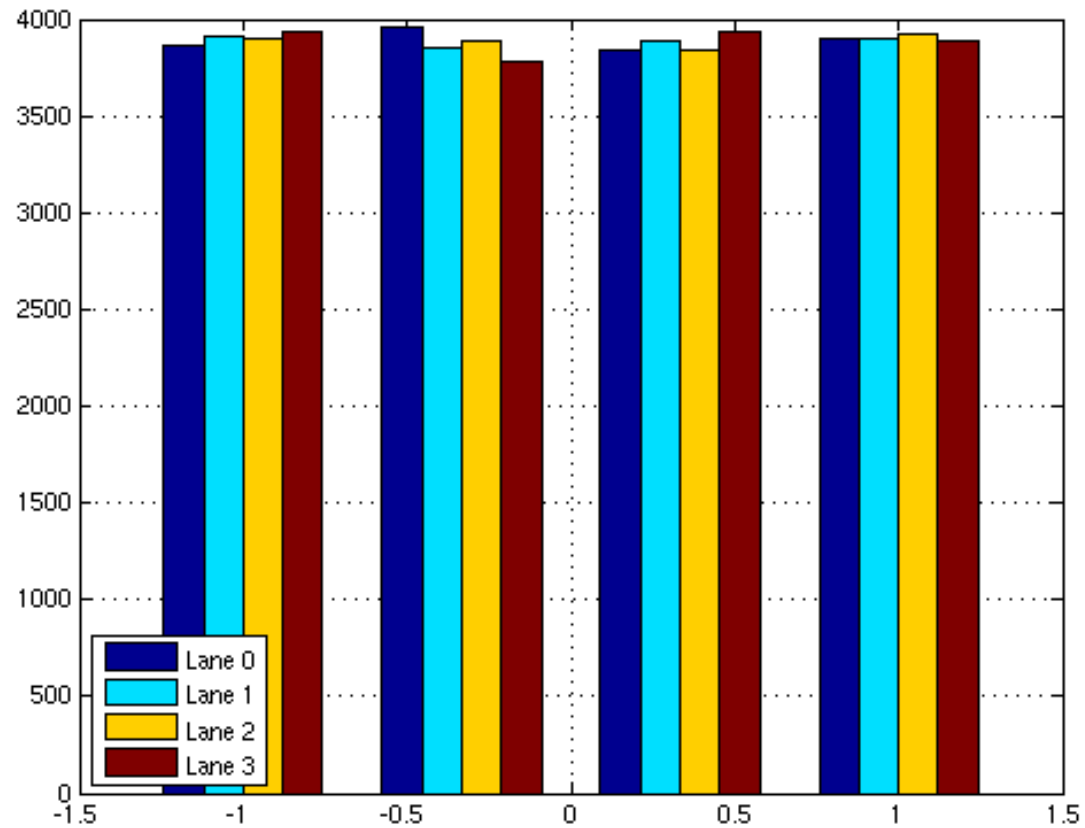
Patterns are quasi-white and DC balanced



Low correlation between lanes

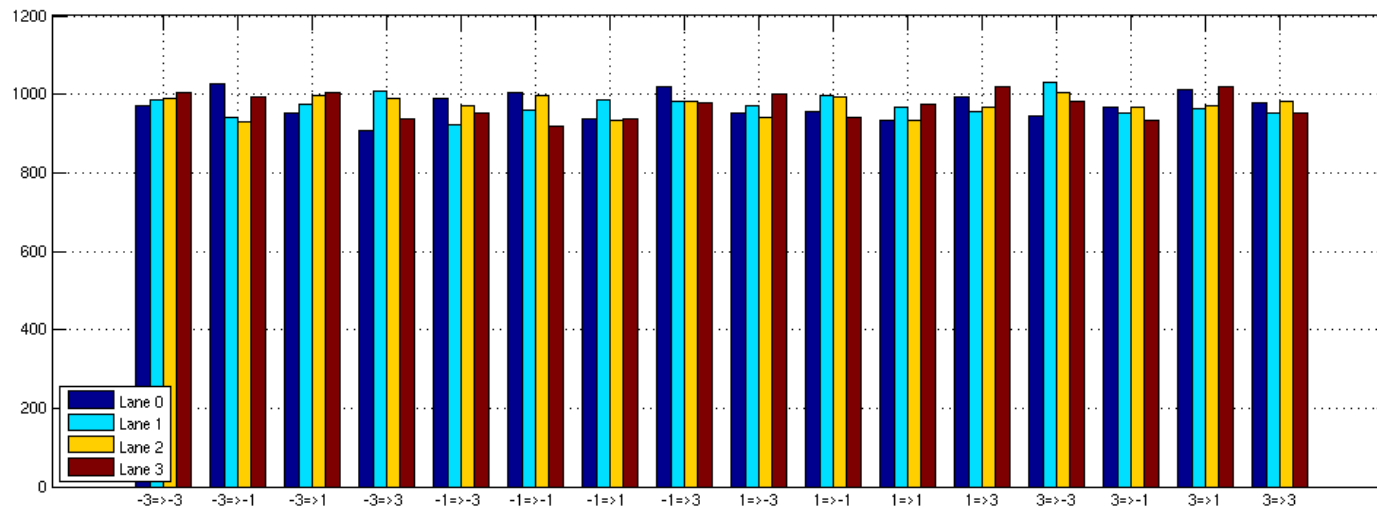


Level distribution



PRBS pattern portion only

Transition distribution



PRBS pattern portion only