



Correction to 1000BASE-T1 PHY $8N/(8N+1)$ Encoder Equations

IEEE 802.3bp - Interim Meeting - May 2014

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Objective

- ▶ **Correct equation error in $8N/(8N+1)$ encoder that was adopted during March 2014 meeting**

Motion #6: Move that 1000BASE-T1 PHY encoder use the $8N/(8N+1)$ block as described in Lo_3bp_02_0314.pdf slide 18 (Formal Encoder Definition) and the Clause 55 scrambler (as shown on slide 15 of same). The final integer value of N ranging from 1 to 16 inclusive will be decided by the 802.3bp task force at a later date.

M: William Lo S: Mehmet Tazebay

Y: 30 N: 0 A: 3

MOTION PASSES (Technical $\geq 75\%$)

The Equation Error

▶ Previous

- $\text{NEXT}(p)[4] = \text{Bitwise AND of TC}[p:N-1]$
- $\text{NEXT}(n+1)[4] - \text{if OR}(n) = 1 \text{ AND TC}[n-1] = 1$

▶ Corrected

- $\text{NEXT}(p)[4] = 0 \text{ if Bitwise SUM of TC}[p:N-1] = 1, \text{ else } 1$
- $\text{NEXT}(n)[4] - \text{if OR}(n) = 1 \text{ AND TC}[n-1] = 1$

▶ Corrected equations simulated against brute force byte placement for all 2^N permutations

Formal Encoder Definition (5 bit pointer) [corrected]

Define:

- N = number of GMII bytes encoded into block
- Bytes numbered $n = 0, 1, 2, \dots, N-1$. Byte 0 is the first one presented on GMII.
- $TC[n] = 0$ if byte n is data byte on GMII, 1 if byte n is control byte on GMII
- $TC[-1] = 1$ by definition
- $TD[n][0:7] = \text{GMII byte } n \text{ TXD}[0:7]$ if $TC[n] = 0$
- $TD[n][5:7] = 010 - \text{IPG}, 101 - \text{LPI}, 001 - \text{TX Error}$ if $TC[n] = 1$. $TD[n][0:4]$ is undefined.
- $B[0:8N]$ is the $8N+1$ block. Bit 0 transmitted first.
- $OR(p) = \text{Bitwise OR of } TC[p:N-1]$
- $NEXT(p)[0:3] = \text{bit position of lowest bit in } TC[p:N-1] \text{ that is a 1. Bit 3 is MSB.}$
- $NEXT(p)[4] = 0$ if Bitwise SUM of $TC[p:N-1] = 1$, else 1

▶ $B[0] = OR(0)$

▶ $B[8n+1:8n+4] =$

- $TD[n][0:3] - \text{if } OR(n) = 0$
- $NEXT(n)[0:3] - \text{if } OR(n) = 1 \text{ AND } TC[n-1] = 1$
- $TD[n-1][3:6] - \text{if } OR(n) = 1 \text{ AND } TC[n-1] = 0$

▶ $B[8n+5] =$

- $TD[n][4] - \text{if } OR(n) = 0$
- $NEXT(n)[4] - \text{if } OR(n) = 1 \text{ AND } TC[n-1] = 1$
- $TD[n-1][7] - \text{if } OR(n) = 1 \text{ AND } TC[n-1] = 0$

▶ $B[8n+6:8n+8] =$

- $TD[n][5:7] - \text{if } OR(n) = 0$
- $TD[n][5:7] - \text{if } OR(n) = 1 \text{ AND } TC[n] = 1$
- $TD[n][0:2] - \text{if } OR(n) = 1 \text{ AND } TC[n] = 0$

Motion

Move that 1000BASE-T1 PHY encoder use the $8N/(8N+1)$ block as described in Lo_3bp_01_0514.pdf slide 4 (Formal Encoder Definition). This replaces the one previously adopted (Lo_3bp_02_0314.pdf slide 18). The final integer value of N ranging from 1 to 16 inclusive will be decided by the 802.3bp task force at a later date.

The adoption of Clause 55 scrambler referenced in Lo_3bp_02_0314.pdf slide 15 is unaffected.

M: William Lo S:

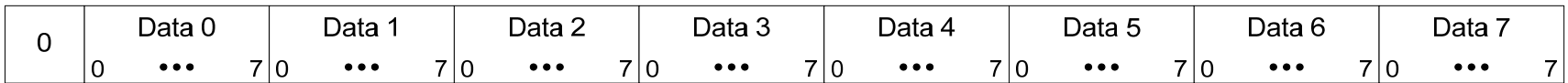
Y: N: A:

MOTION (Technical $\geq 75\%$)

BACKUP

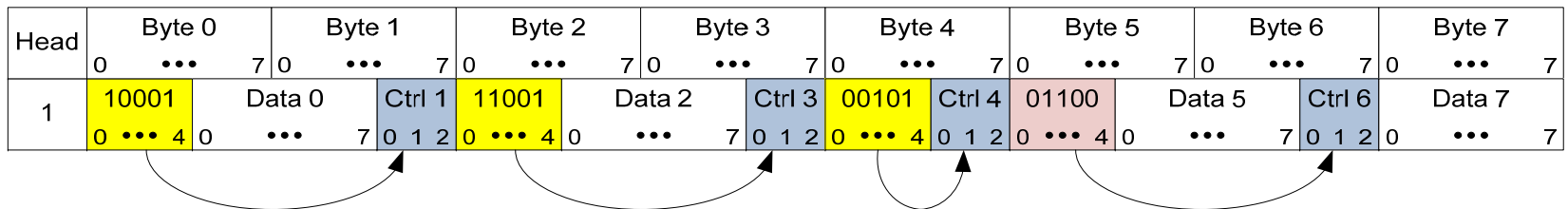
A more flexible way of 64/65 encoding

- ▶ Instead of using fixed block types, use pointers instead
- ▶ No change if all bytes are data bytes – same as before



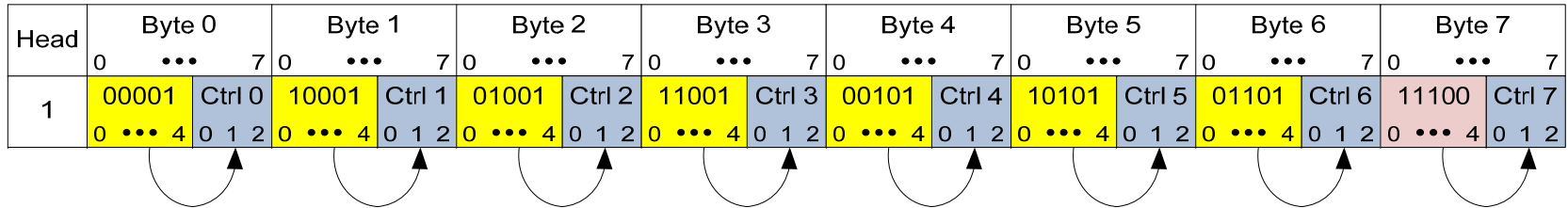
Control Block Encoding

- ▶ If byte is control byte use 5 bit pointer + 3 bit control code
- ▶ If byte is data use 8 bit data
- ▶ Bit 0 to 3 of pointer points to next byte that is a control symbol
- ▶ Bit 4 of pointer indicates whether the next control symbol is the final control symbol of the block
 - 0 = final one, 1 = more control symbols
- ▶ Example: D/C/D/C/C/D/C/D

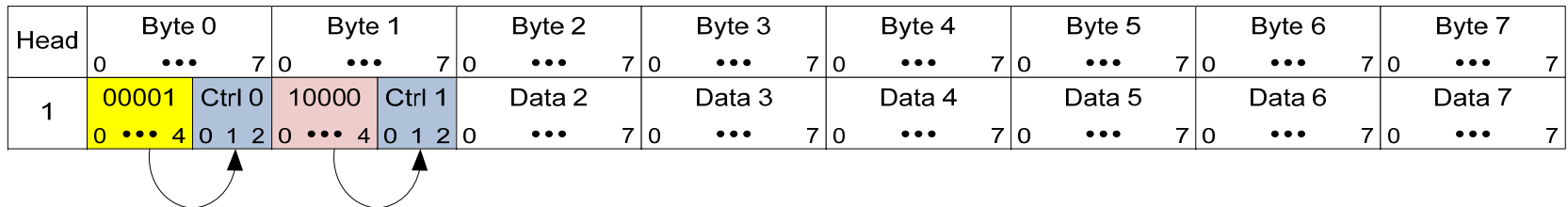


More Examples

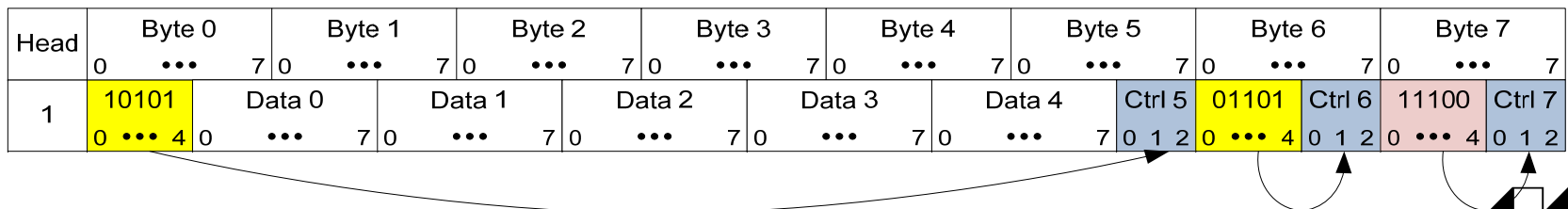
▶ All control codes



▶ Start of packet on byte 2



▶ End of packet on byte 4



GMII Control Code Mapping

▶ 3 bit control code

Control Code[0:2]	GMII Transmit	GMII Receive
001	Transmit Error Propagation	Data Reception Error
010	Normal Inter-Frame	Normal Inter-Frame
101	Assert Low Power Idle	Assert Low Power Idle
else	Reserved	Reserved

- ▶ **Note that 10G start and terminate control symbols are not needed**
 - 1G MAC does not use start or terminate symbols

No Change To Clause 55 Scrambling

▶ Master

- $G(x) = 1 + x^{39} + x^{58}$

▶ Slave

- $G(x) = 1 + x^{19} + x^{58}$