MB810 Implementation for HARI

IEEE P802.3ae Plenary Meeting
March 6-10, 2000
Hyatt Regency, Albuquerque, NM

ChanGoo Lee*, Tae Kyu Kang*, Hyeong Ho Lee*, and Dae Young Kim**,

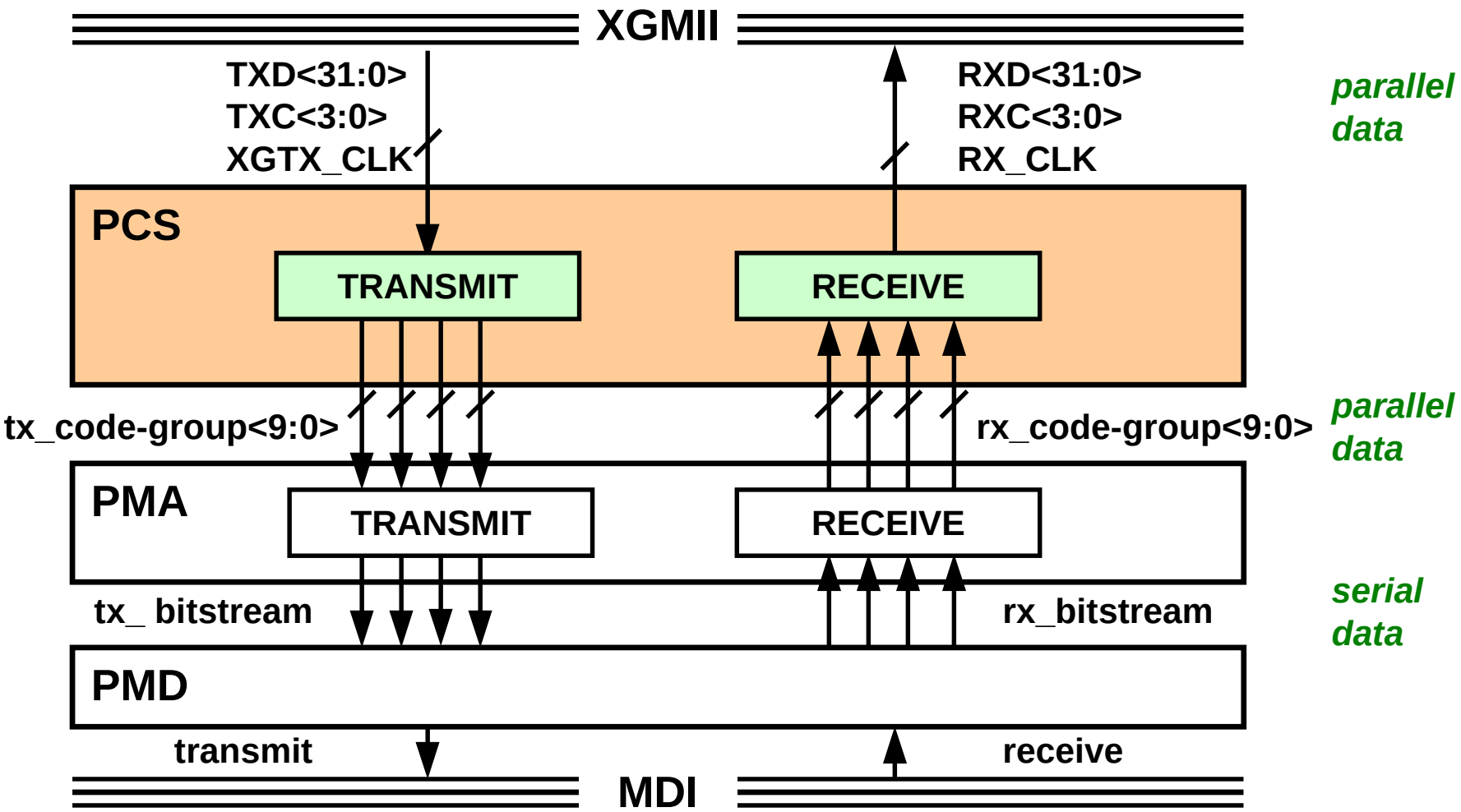
***ETRI, **CNU in Korea | e-mail : cglee@etri.re.kr**

http://ccl.cnu.ac.kr/LineCoding/

Goals of this Presentation

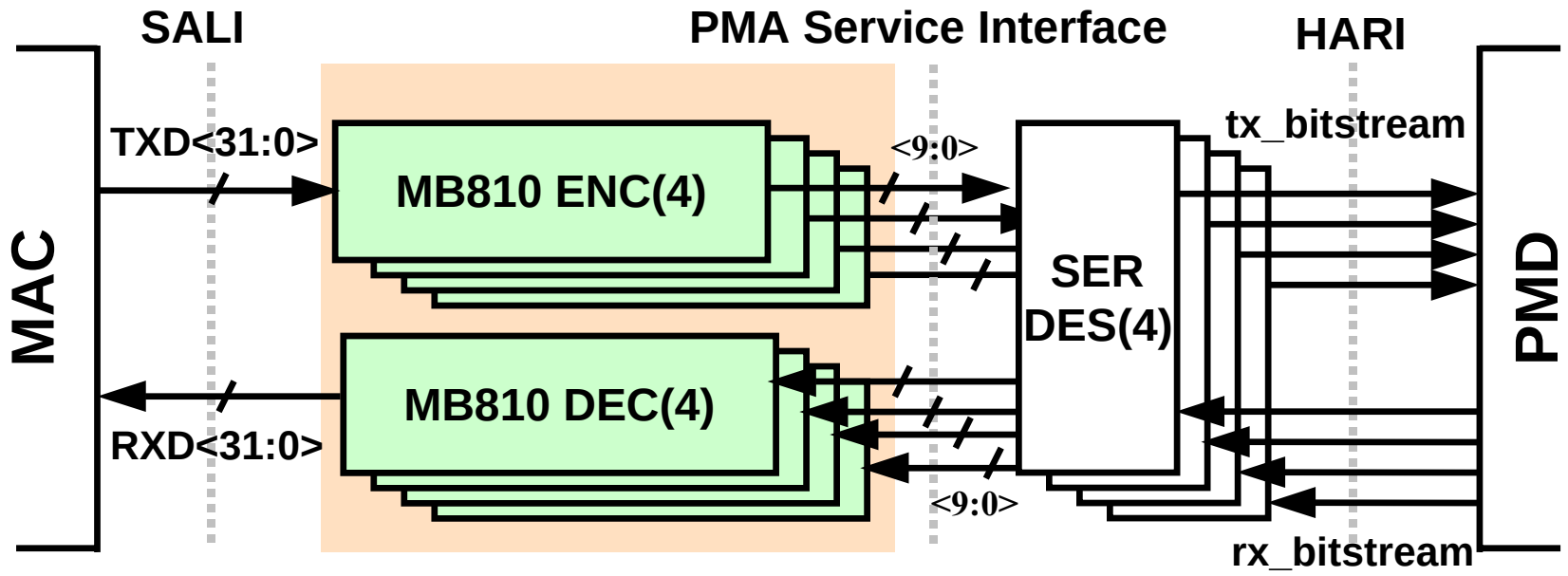
- Demonstrate MB810 as a HARI coding alternative.
- Get reminded that MB810 shares similar characteristics with 8B/10B but consumes half the bandwidth.
  - To the effect of less emission and longer distance.
- Suggest adoption of both MB810 and 8B/10B as dual-mode coding schemes for XGXS (and possibly also for PCS).

Physical Layer Functional Block Diagram

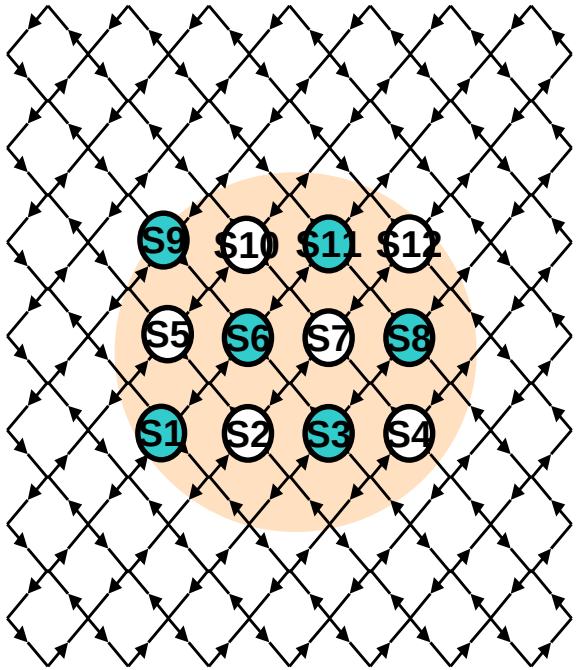


Architecture for HARI Interface

- Four MB810 ENDECs are required for HARI interface.
- MB810 ENDEC sits between the same SALI and HARI interfaces as 8B/10B ENDEC does.



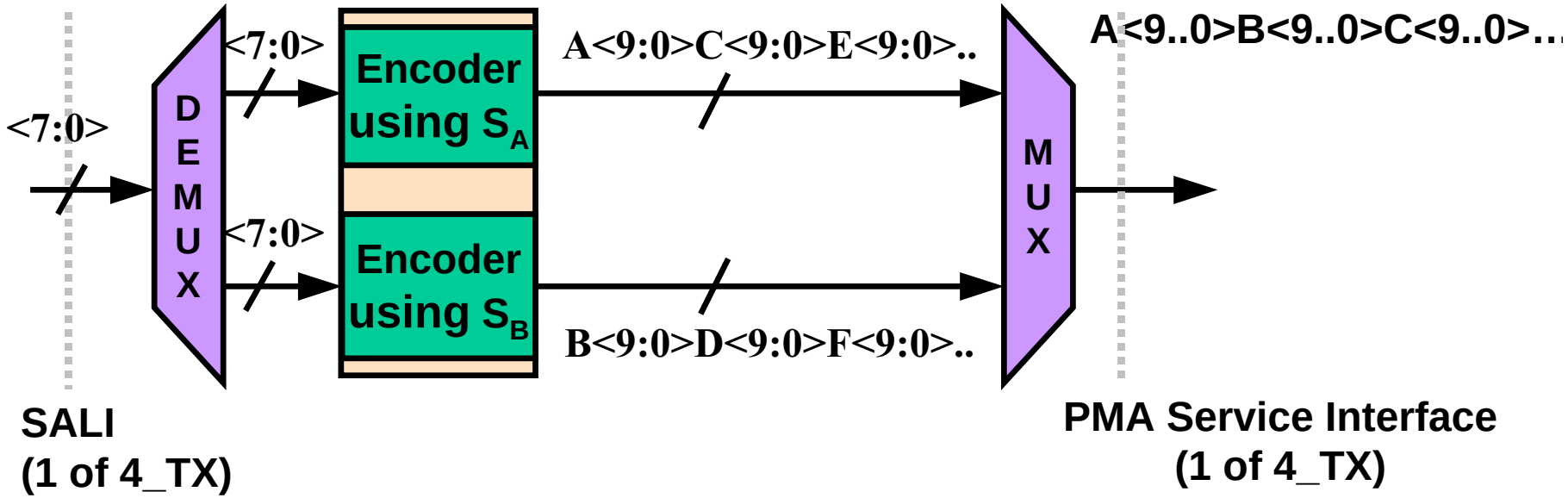
MB810 Encoding Property



- MB810 has 12 encoding states.
- When a codeword starts at an encoding state, it is allowed to terminate only at one of 6 encoding states.
- Using this property, encoding states are grouped into two, each of which composing of 6 states:
  - Group Sα = (S1, S3, S6, S8, S9, S11)
  - Group Sβ= (S2, S4, S5, S7, S10, S12)

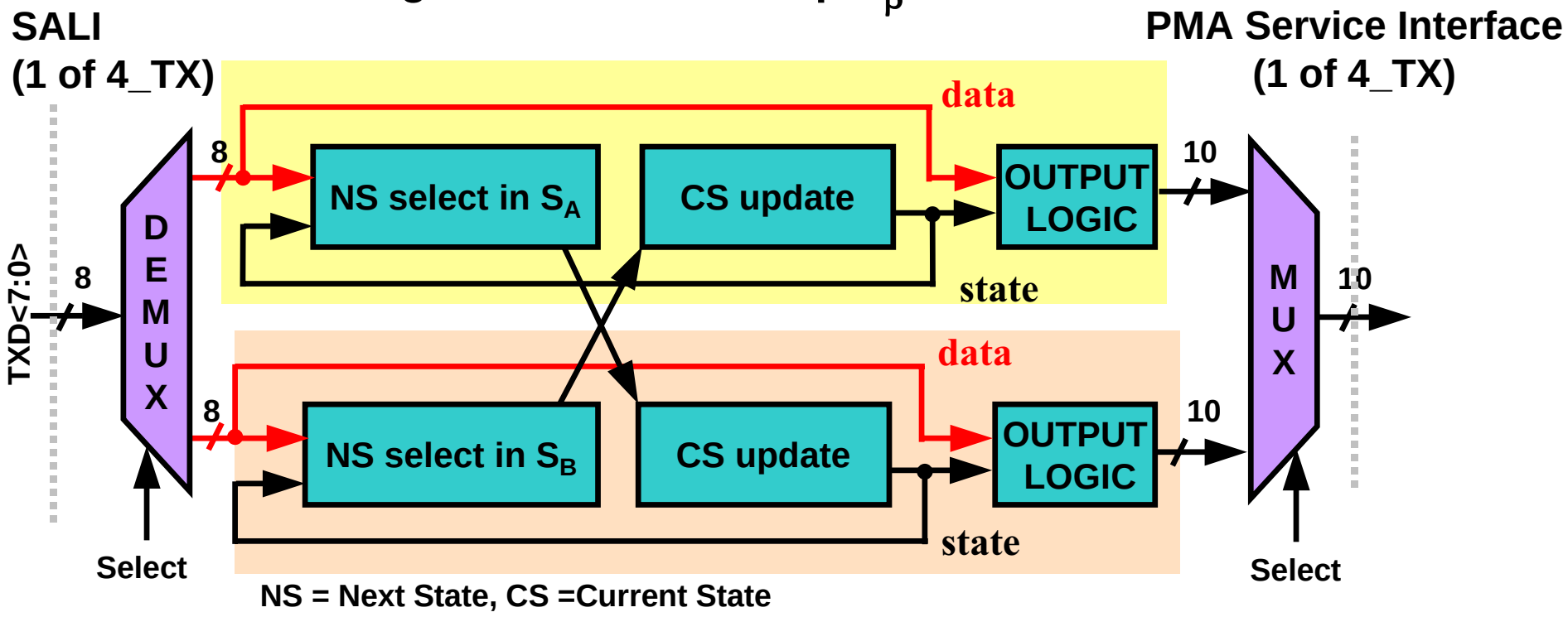
A half the complexity in MB810 Encoder

- Serial output codeword stream A<9..0>B<9..0>C<9..0>D<9..0>…, is generated by word multiplexing with output codeword from two groups, for example, A is generated by an encoder using Sα, B is generated by an encoder using Sβ, C an encoder using Sα, and so on.
- An encoder can encode two input data streams.

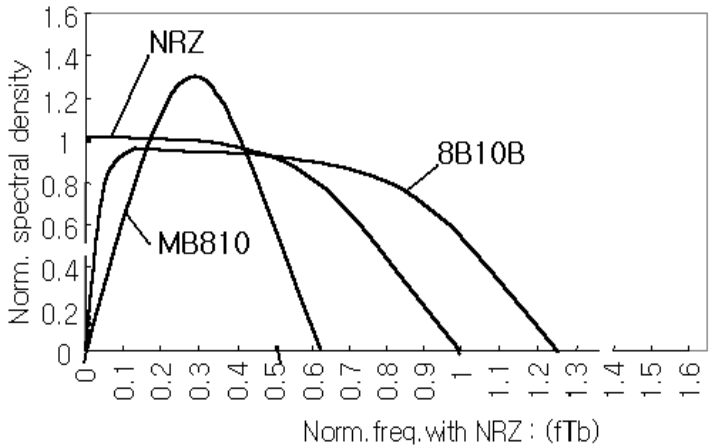


MB810 ENC Implementation

- Data transferred from MAC at 156.25MHz rising edge are encoded using the states in Group S_α
- Data transferred from MAC at 156.25MHz falling edge are encoded using the states in Group S_β

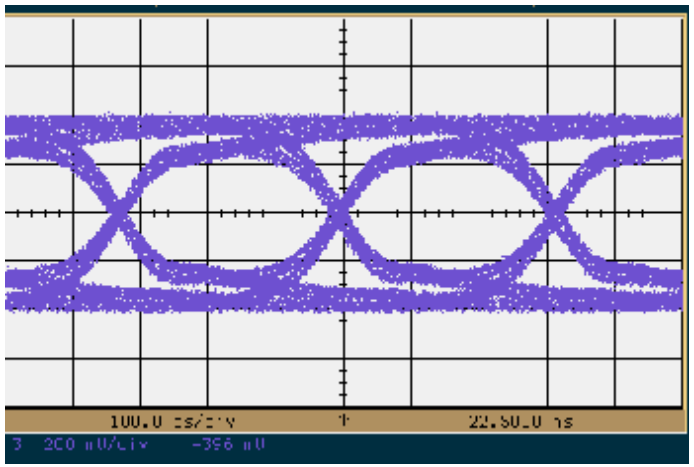


Transmission Test in HARI



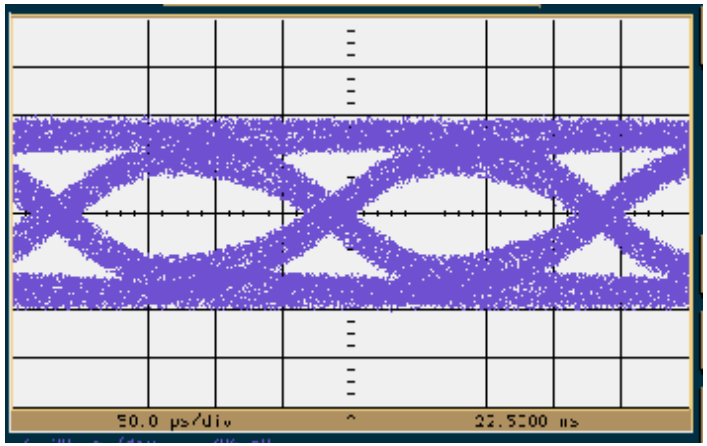
MB810 is a minimum (Nyqyust) bandwidth code; less noise, less emission, less jitter, longer distance.

Eye in FR-4 PCB Transmission



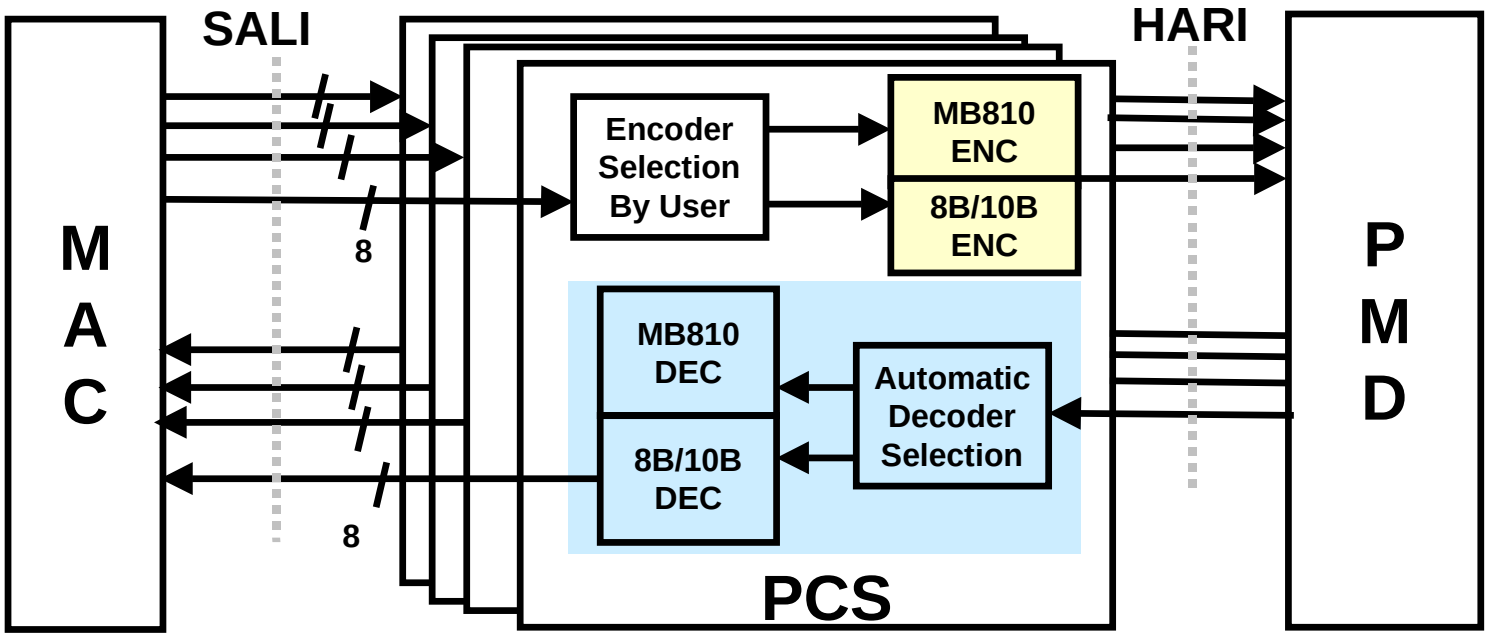
3.125Gb/s

t: 0.8mm
Microstrip
50 Ohm
Length: 24”



5.0Gb/s

MB810 and 8B/10B Coding in PCS



- At PCS reception, the decoder is selected automatically by Idle data pattern [7].
- According to the application, the encoding sheme can be selected by the user.
- Adoption of MB810 together with 8B/10B in PCS is free from system architecture .

Reminder to Why Block Coding

- Hard and tight bound on run length
  - Self-clocking, Relaxation on RX PLL design
- Absolute freedom from zero/low freq power
  - No dc wander, No need for dc restoration ckt at RX
- Reframing fast, immediate, robust
- Multi-purpose control codes
  - Deskew, Management, etc.
- Error monitoring capability, inherent
- Deterministic, predictable performance
  - Less burden on, especially, analog circuits.

Why is Only Half the Bandwidth Enough for MB810?

- **Finiteness of ASV Guarantees This [Ref:1,3]**

  ASV = max | … - y_{-1} + y_0 - y_1 + y_2 - y_3 + … |

- **A Finite ASV Tends, in the Statistical Sense, To:**

  Suppress **{ … 0 1 0 1 0 1 … }** **;f_0 ~ 1/2T**

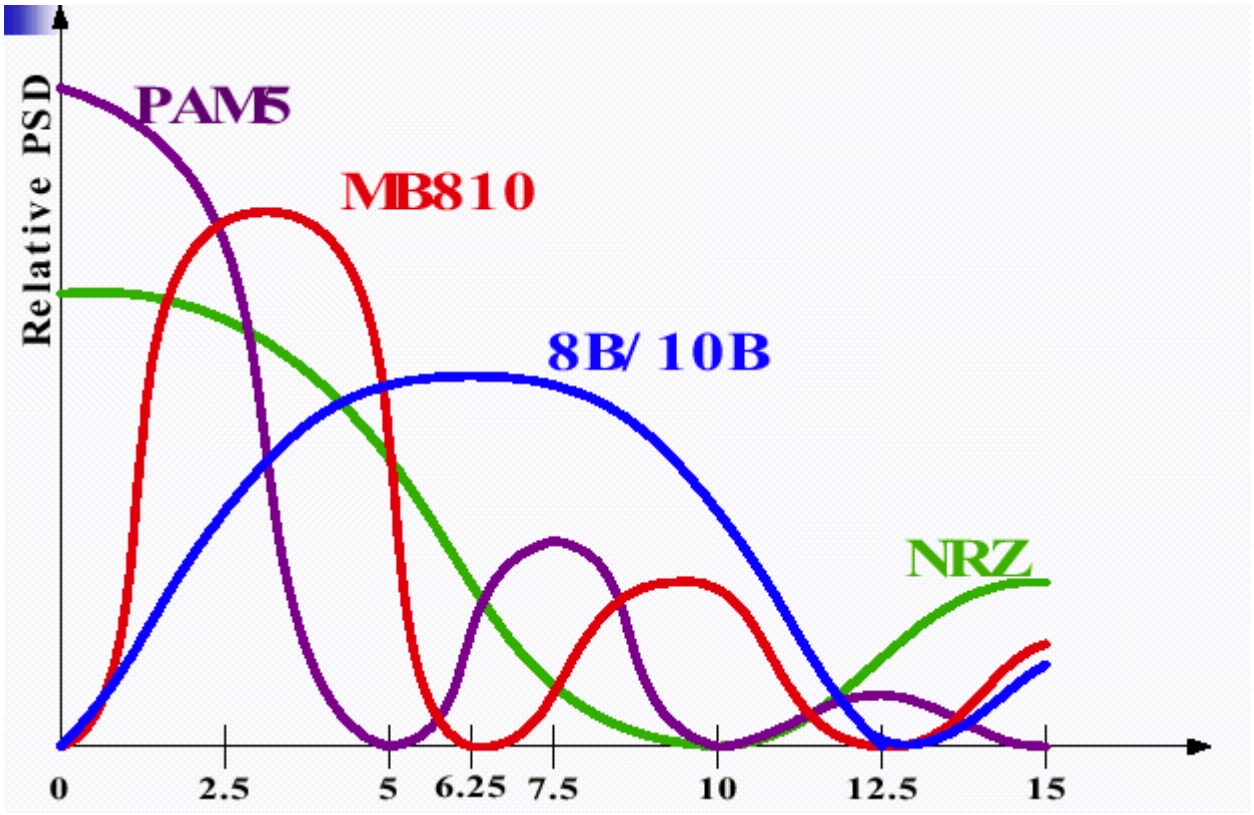
  = { … -(-1) +(+1) -(-1) +(+1) - … }

  Enhance **{ … 0 0 1 1 0 0 1 1 … }** **;f_0 ~ 1/4T**

  = {… -(-1) +(-1) -(+1) +(+1) -(-1) +(-1) - …}

- **Evidence ---> See Power Spectrum**

Spectrum

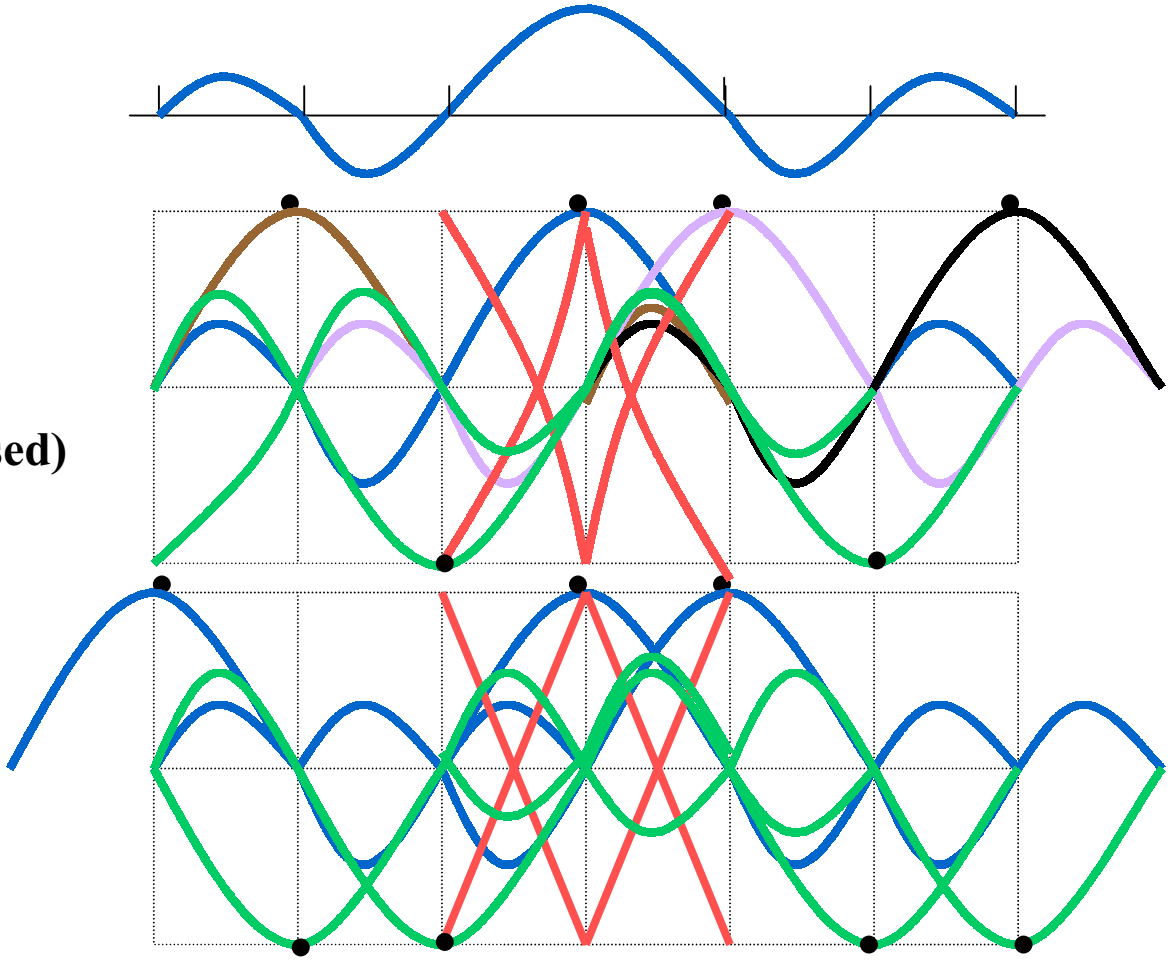


Why Wider Eyes for the Same T_C

Single Pulse

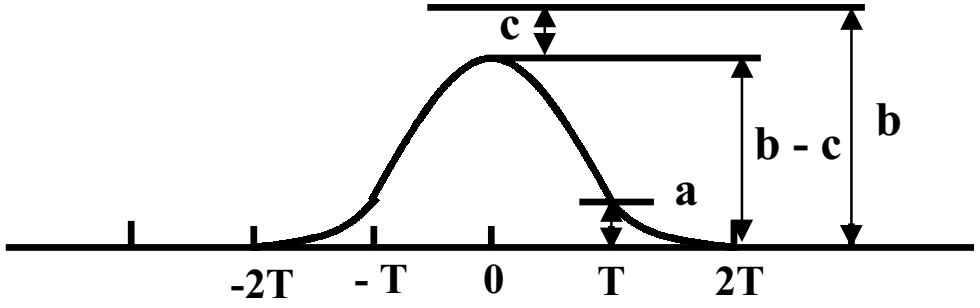
ASV = Infinite
('0101' Unsuppressed)

ASV =Finite
('0011' Enhanced)

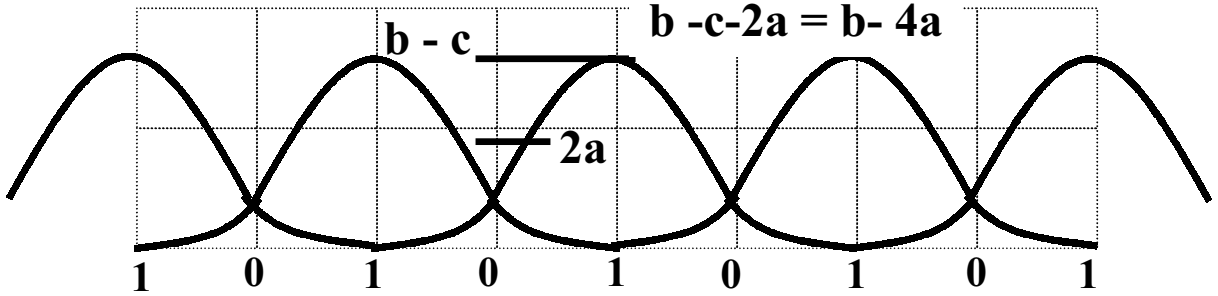


Case of Typical Optical Pulse

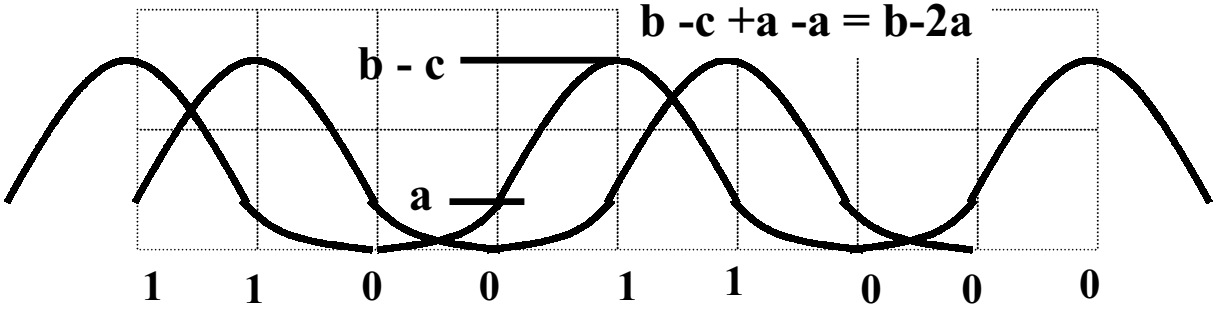
Single Pulse



ASV = Infinite
('0101' Unsuppressed)



ASV =1
('0011' Enhanced)



Conclusion

- MB810 can be considered as an alternative HARI coding.
- Being a minimum (Nyquist) bandwidth code, MB810 offers better performance; less jitter, longer distance, less emission.
- We believe in block coding. If 8B/10B is faced with a bandwidth problem, MB810 could be a relief.
- For user discretion, a dual mode block coding, 8B/10B plus MB810, is suggested.
- With less bandwidth, MB810 can also be applied successfully to fibers; e.g., VCSEL over MMF/SMF.

References

[1] ChanGoo Lee, Dae Young Kim, Hae Won Jung, and Hyeong Ho Lee, "A new line code MB810 for 10 GbE," *IEEE 802.3 HSSG plenary meeting*, Montreal,Canada, July 6-7, 1999.

[2] ChanGoo Lee, Dae Young Kim, Chun Sik Shin,Hae Won Jung, and Hyeong Ho Lee, "Performance and Implementation Updates to MB810," *IEEE 802.3 HSSG Interim meeting*, York, UK, Sept. 27-29, 1999.

[3] ChanGoo Lee, Dae Young Kim, Chun Sik Shin, Hae Won Jung, and Hyeong Ho Lee, "White paper on the MB810 Line Code for 10GbE," *IEEE 802.3 HSSG Interim meeting*, York, UK, Sept. 27-29, 1999.

[4] ChanGoo Lee, Dae Young Kim, Kyung Gyu Chun, Hae Won Jung, and Hyeong Ho Lee, "Jitter Consideration of MB810," *IEEE 802.3 HSSG Plenary meeting*, Kauai, Hawaii, Nov. 9-10, 1999.

[5] Dae Young Kim, Tae Kyu Kang, Sang Seob Song, Moo Jung Chu, Sang Soo Lee, and Hyeong Ho Lee, "MB810 Applications for HARI Interface," *IEEE 802.3 HSSG Interim meeting*, Dallas Texas, Jan. 18-20, 2000.

[6] Dae Young Kim, Tae Kyu Kang, Sang Seob Song, Moo Jung Chu, Sang Soo Lee, and Hyeong Ho Lee, "MB810 Applications for HARI Interface," *IEEE 802.3 HSSG Interim meeting*, Dallas Texas, Jan. 18-20, 2000.

[7] ChanGoo Lee, Yong Woo Chae, Dae Young Kim, Hae Won Jung, and Hyeong Ho Lee, "Considerations on MB810 Decoder for 10 GbE," *IEEE 802.3 HSSG Interim meeting*, Dallas Texas, Jan. 18-20, 2000.

[8] Heyung Sub Lee, ChanGoo Lee, Dae Young Kim, and Hyeong Ho Lee, "MB810 Encoding Method with Control Codes," *IEEE 802.3 HSSG Interim meeting*, Dallas Texas, Jan. 18-20, 2000.

References(Con't)

[9] Han Chul Do, ChanGoo Lee, and Hyeong Ho Lee, "Error Detectability of MB810," *IEEE 802.3 HSSG Interim meeting*, Dallas Texas, Jan. 18-20, 2000.

[10] C. G. Lee, D. I. Lee, and D. Y. Kim, "An evaluation for high speed optical line code: Minimum Bandwidth (MB) Line code MB34," *proc. of ICT'98*, vol. 1, pp. 81-85, Porto Carras, Greece, June 1998.

[11] D. Y. Kim, and J. -k. Kim, "A condition for stable minimum-bandwidth line codes," *IEEE Trans. Commun.*, vol. COM-33, no. 2, pp. 152-157, Feb. 1985.

[12] D. Y. Kim, J. I. Baek, J. -k. Kim, S. K. Hyun, and Y. K. Park, "Run-Length-Limited Variants of Duobinary and Modified Duobinary," *IEEE Trans. on Commun.*, vol. COM-33, no. 2, pp. 142-150, Feb. 1987.

[13] D. Y. Kim, "Lower-bound eye widths of minimum-bandwidth systems," *IEEE Trans. on Commun.*, vol. 43, no. 2/3/4, pp. 1235-1249, Feb./Mar./Apr. 1995.

[14] ChanGoo Lee, Jae Il Cho, Chulhyung Zchung, Jeong Hoon Ko, and Dae Young Kim, "A Test Results of Minimum-Bandwidth Line Code MB34 in 10Gbps Optical Transmission System," *Proc. of ICICS'97*, pp. 1148-1152, Singapore, Sept. 1997

[15] ChanGoo Lee, Dae Young Kim, Byungjun Ahn, Hae Won Jung, and Hyeong Ho Lee, Chu Hwan Yim, "A LINE CODE FOR HIGH-CAPACITY OPTICAL TRANSMISSION SYSTEMS: MB810," Accepted by ISS2000.

[16] ChanGoo Lee, Dae Young Kim, Jung Whan Kim, Hae Won Jung, and Hyeong Ho Lee, "A new Line Code for 10-Gigabit Ethernet: MB810," Accepted by ICC2000.

[17] J.H.Kim, "A study on designing line codes of minimum bandwidth," Ph.D. *Dissertation*, CNU, Taejon, 1992.