Partitioned DC-Balanced (0,6) 16B/18B Transmission Code

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Purpose and Goals

- **Increase coding efficiency** from 80% to 89% as an alternative to scrambling
- Maintain essential features of 8B/10B code:
  - Compact singular *Comma*
  - A few other non-data *control* characters
  - DC-Balance and decent *low frequency* characteristics
  - Partitioned structure for simpler implementation
  - Error Detection
  - Suitable for *Error Correction* feature

Basic Structure

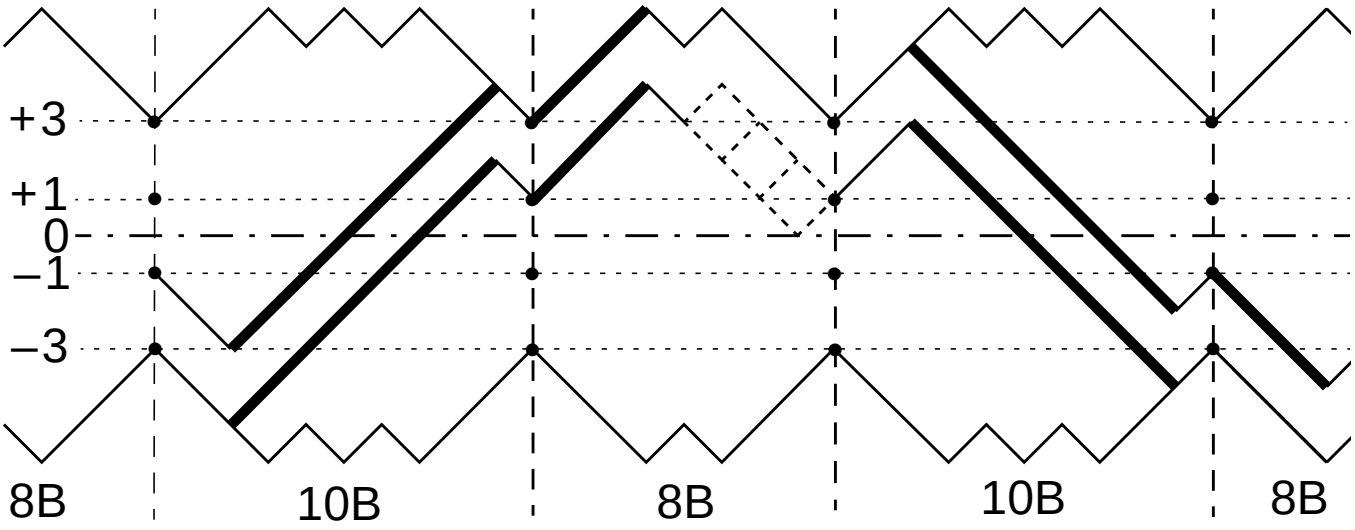
- 16B/18B code is *partitioned* into a 9B/10B code and a 7B/8B code
- Both codes use sets of balanced vectors, and complementary vectors with disparity of ± 2 and ± **4**
- The Running disparity at the 18B, 10B, and 8B boundaries is limited to ± 1 and ± **3**
- The singular non-data 2 byte **comma** sequence:
  - For a *negative* starting disparity, it is '00**<u>1111111</u>**0'**<u>111</u>**0xxxx' where the 4-bit set xxxx can be any single one combined with 3 zeros
  - The comma search can be limited to the 10 bold underlined ones
  - For a *positive* starting disparity, the entire above sequence is complemented.

Transmission Parameters

- Maximum **Run length is 7**, no contiguous runs of 7
- **Low Frequency** Characteristics
  - Maximum Digital Sum Variation is **12**
  - Normalized offset is 87:18 = 4.83 (1.9 for FC code)
  - The low frequency time constants in circuits have to be increased by a *factor of **2.25** ** compared with Fibre Channel code
- Non-data **Control** Characters
  - 10B domain: **5**
  - 8B domain: 0

* Analysis by Dr. J.F. Ewen, IBM Rochester

16B/18B Trellis Envelope, Comma



- **Comma:** 7+3 = 10 bits to check versus 6 for FC code
  - Comma extends over 2 bytes
  - 4 different 2-byte comma sequences available

Implementation

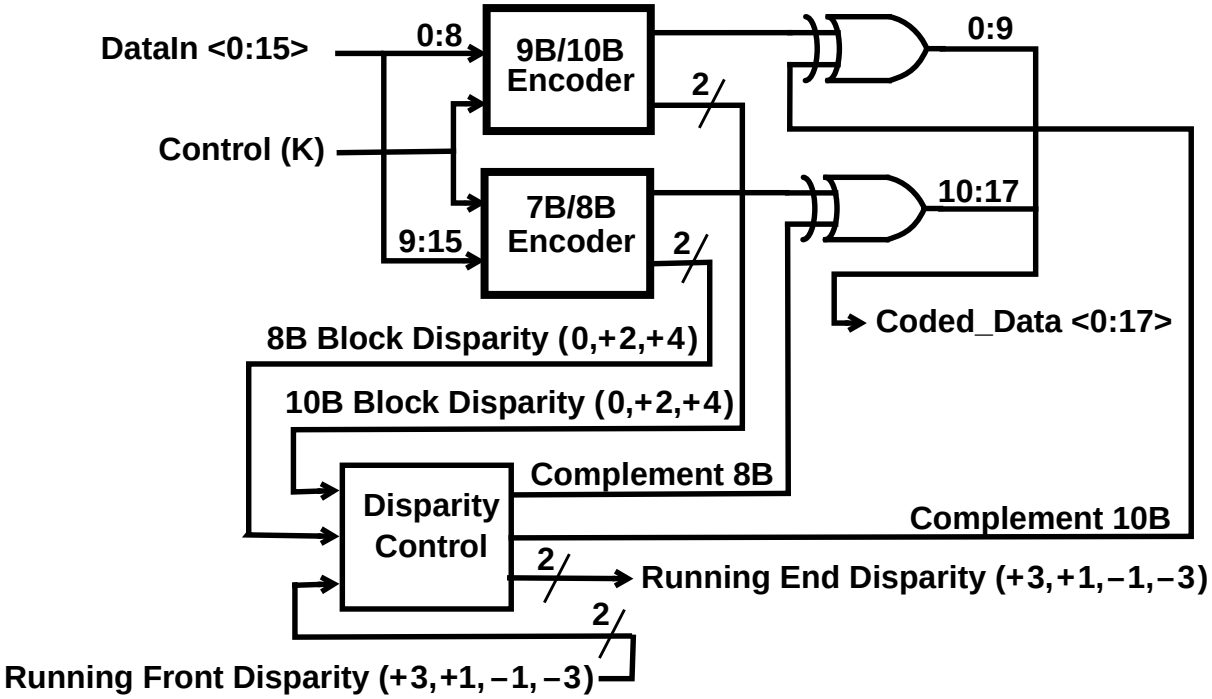
- Implementation approaches similar to FC code are preferred, perhaps supplemented by small tables for some translations which are not readily obtained by parity-type circuits

- The number of required gates for encoding and decoding is higher than for Fibre Channel code

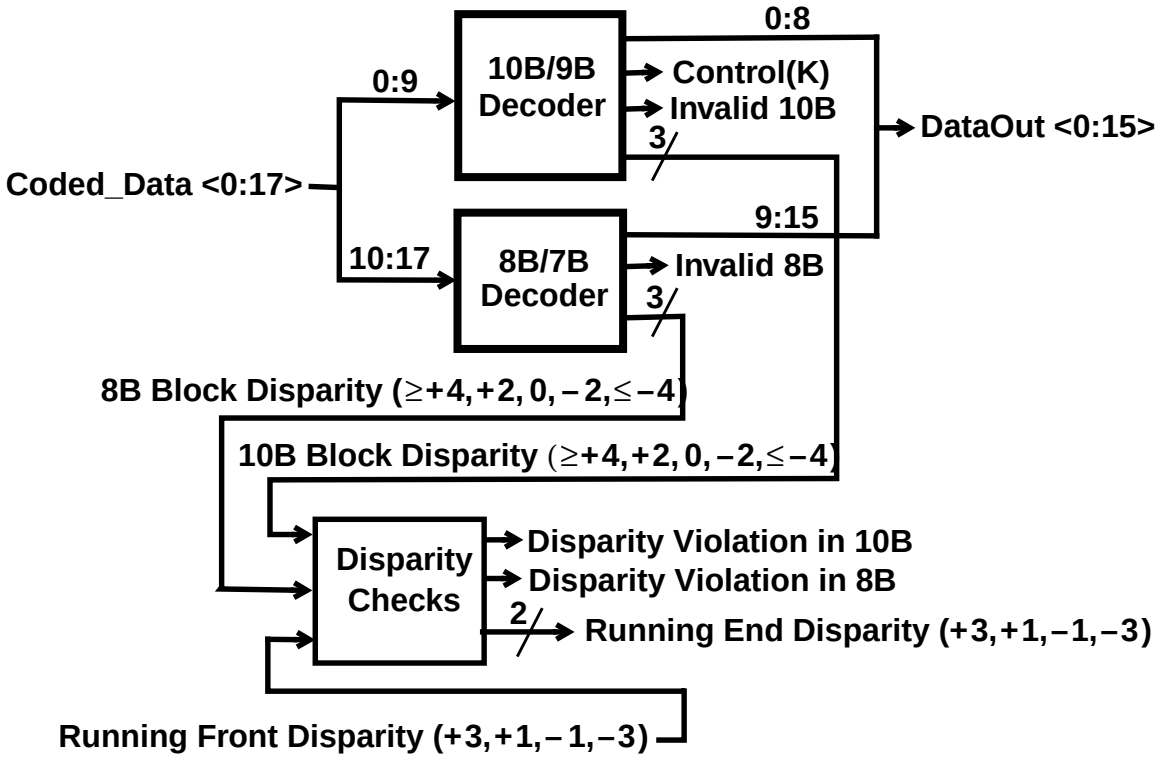
- The disparity control is more complex than for FC code
  - **FC coding**, framing and decoding can comfortably be done at **4-byte intervals** using 0.16 micron lithography CMOS technology. It is more difficult to fit 16B/18B coding and decoding into the same timing structure.

Encoder and Decoder Diagrams

16B/18B Encoder



18B/16B Decoder



Error Correction with 16B/18B Code

- The Error Correction technique developed for the FC code works also with the 16B/18B code if minor modifications are made
  - The 10B and 8B fields are treated as identical, individual blocks
  - The *B-Balanced bits* are redefined to have a value of one if the respective 10B or 8B vector has a *disparity of 0 or* $\pm$ *4,* and a zero value for a disparity of $\pm$ *2*
  - Because of the lesser precision of error locating, the *search range* is extended. It is assumed that an error occurred in the 64-byte range ending with the byte where a disparity error is detected (versus a 16-byte range). This extension requires 4 more parity bits
  - The total number of required parity bits is 21: 9 for vertical parity and 12 for locating the erroneous byte

Conclusion

- A 16B/18B code can be developed to gain better ***coding efficiency***
- The most important features of the FC code are preserved
- The implementation is more complex than the FC code but probably less than a total solution using scrambling