RS-FEC LPI SIGNALING

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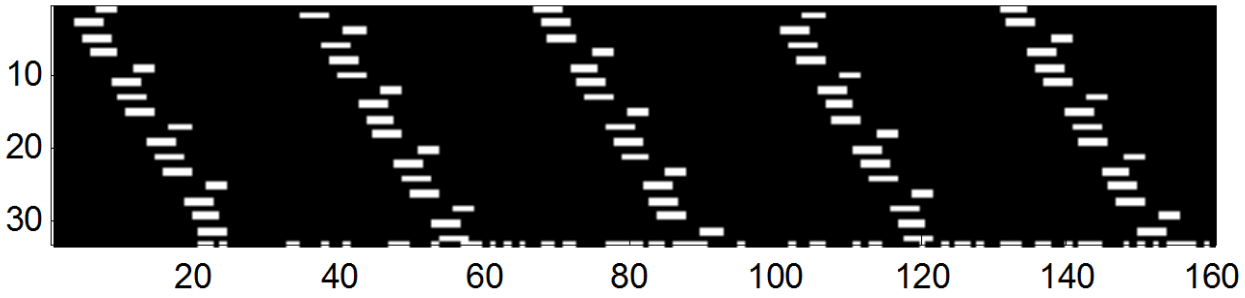
Background

- In D1.0, Clause 108 includes LPI signaling in the RS-FEC as proposed in ran_3by_01a_0315 (comment #129 on D0.1).
- The solution involves sending unscramble data over the channel during WAKE periods.
- As noted in the March meeting, the bit pattern generated by transcoding blocks comprising /I/ or /LI/ characters is unsuitable for the electrical signaling:
  - Especially /I/ blocks, which have long runs of “0” bits
  - Low transition density and strong DC imbalance
- A simple modification is suggested here in order to solve the problem.

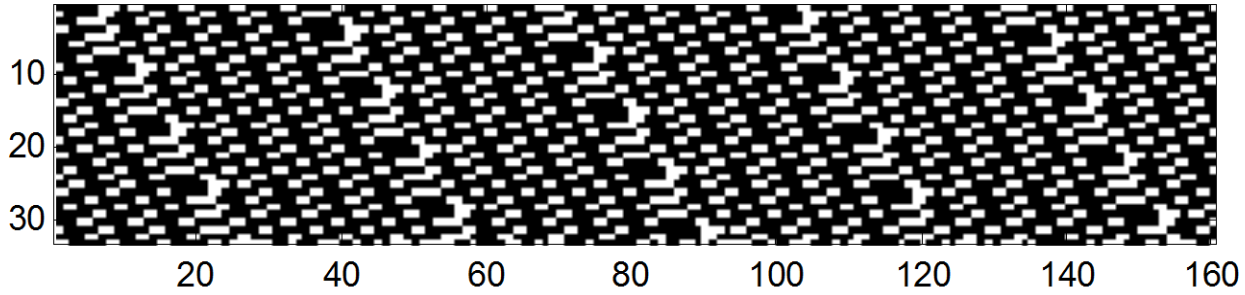
Problem demonstration

- Plot below shows the structure of a codeword comprising only /I/ characters.
  - Most of the bits are zero (black)
  - “1” bits (white) appear only in the block type octets (four ones, except at the beginning of a transcoded block) and the RS-FEC parity field (random bits used in this example). Only ~7% of the bits are “1”.
- For easy visualization, the 5280 bits are shown in chunks of 160 bits from left to right.



Problem demonstration (cont.)

- Plot below shows the structure of a codeword comprising only /LI/ characters in a similar fashion.
  - There are more “1” bits and transitions than in the /I/ case, but pattern is still biased toward 0 (75% of the bits).

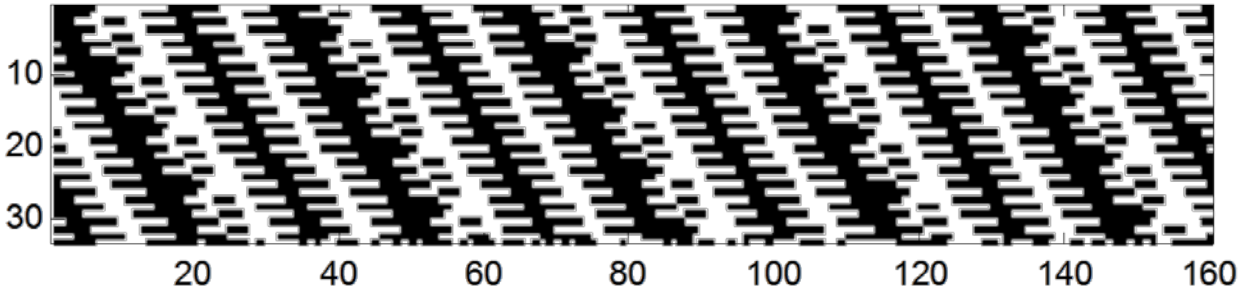


Suggested change

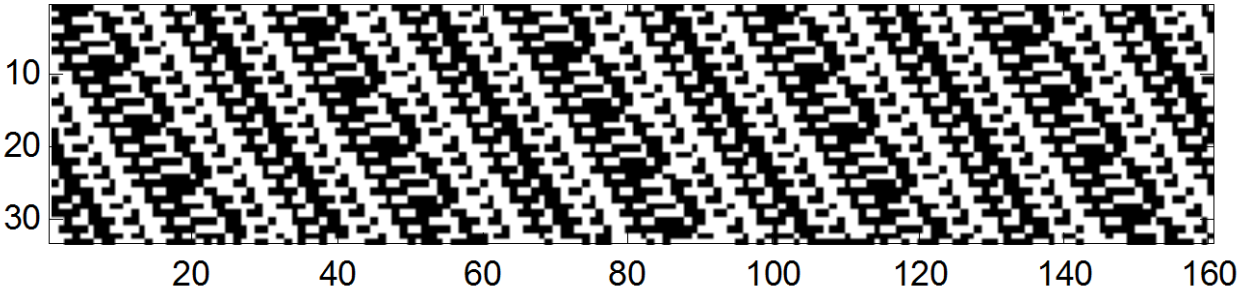
- After the RS-FEC descrambles the PCS blocks, if bypass_scrambler=1, modify each block by inverting every other group of 7 bits (control character) in the 56 bits that hold the payload.
- Example: for block type 0x1e, which is followed by eight 7-bit groups C0..C7 – invert C0, C2, C4 and C6.
- This will keep the pattern easy to synchronize on for the receiver, and will restore DC balance in the two cases of /I/ and /LI/.
- The receiver will reverse this inversion effect on the data sent to the PCS.

Effect of change on codeword contents

- DC balance and transition density are achieved in both cases:
  - Modified “idle” pattern



  - Modified “LI” pattern



Proposed change – details

- In 108.5.2.2, change
  "When scrambler_bypass is true, the descrambled data is passed to the transcoder, rather than the data from the scrambler output“

  to
  "When scrambler_bypass is true, the data passed to the transcoder is created by applying a bitwise exclusive-or with the fixed 64-bit value 0x00FE03F80FE03F80 to each block of descrambled data, rather than using the data from the scrambler output".

- In 108.5.3.6, change
  "When descrambler_bypass is true, the received data is used without descrambling“

  to
  "When descrambler_bypass is true, bitwise exclusive-or with the fixed 64-bit value 0x00FE03F80FE03F80 is applied to each block instead of regular descrambling".

- In 108.5.3.6, change
  "This causes the rate compensation function to use the receive data without descrambling (see 108.5.3.6)“

  to
  "This enables the rate compensation function (see 108.5.3.6) to operate correctly with unscrambled data sent from the remote RS-FEC transmit function (see 108.5.2.2)".