PHY quality criterion
RS-FEC Frame Error Ratio (RFER)
Comment #146 to D1.2

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RS-FEC definition and assumptions

- We have a systematic Reed-Solomon (RS-FEC) encoder:
  - defined over the Galois Field (2^{10}), where the RS symbol size is m=10 bits
  - which takes a message of k = 522 RS symbols length
  - to generate a codeword of n = 544 RS symbols length
  - adding parity of (n-k) = 22 RS symbols length
  - with error correction capability of t = (n-k)/2 = 11 RS symbols per codeword
  - with error detection capability of 2·t = 22 RS symbols per codeword
- Let's assume received PAM symbols do not present autocorrelation and noise is additive and white (e.g. ISI may be fully compensated and noise whiten by a suitable equalizer) and bit mapping is according to 802.3cz D1.2 table 166-5 (i.e. Gray)
  - Bit errors are produced according to Poisson's distribution (statistics sufficiently random)
- Let's assume received PAM symbols are detected one-by-one by minimum distance and bits belonging to codewords are directly extracted from detected symbols (hard-detection)
- Let's assume RS-FEC decoder is the most usual one based on: syndrome computation, error locator polynomial computation (Berlekamp-Massey), error location roots (Chien) and error values computation (Forney).
- Then, under these assumptions, we are able to elaborate equations to calculate several error ratios
- **Note**: *these assumptions are used to derive RFER threshold for PHY quality criterion. However, the receiver may be implemented in different way and error statistics be different. Nevertheless, RFER criterion shall be fulfilled by a compliant 802.3cz PHY to establish a reliable link*

Error ratio equations

- SER_{in}: RS symbol error ratio at the RS decoder input (before decoding)
- SER_{out}: RS symbol error ratio at the RS decoder output (after decoding)
- BER_{in}: bit error ratio at the RS decoder input (before decoding)
- BER_{out}: bit error ratio at the RS decoder output (after decoding)
- $RFER_{out}$: RS frame error ratio at the RS decoder output (after decoding)

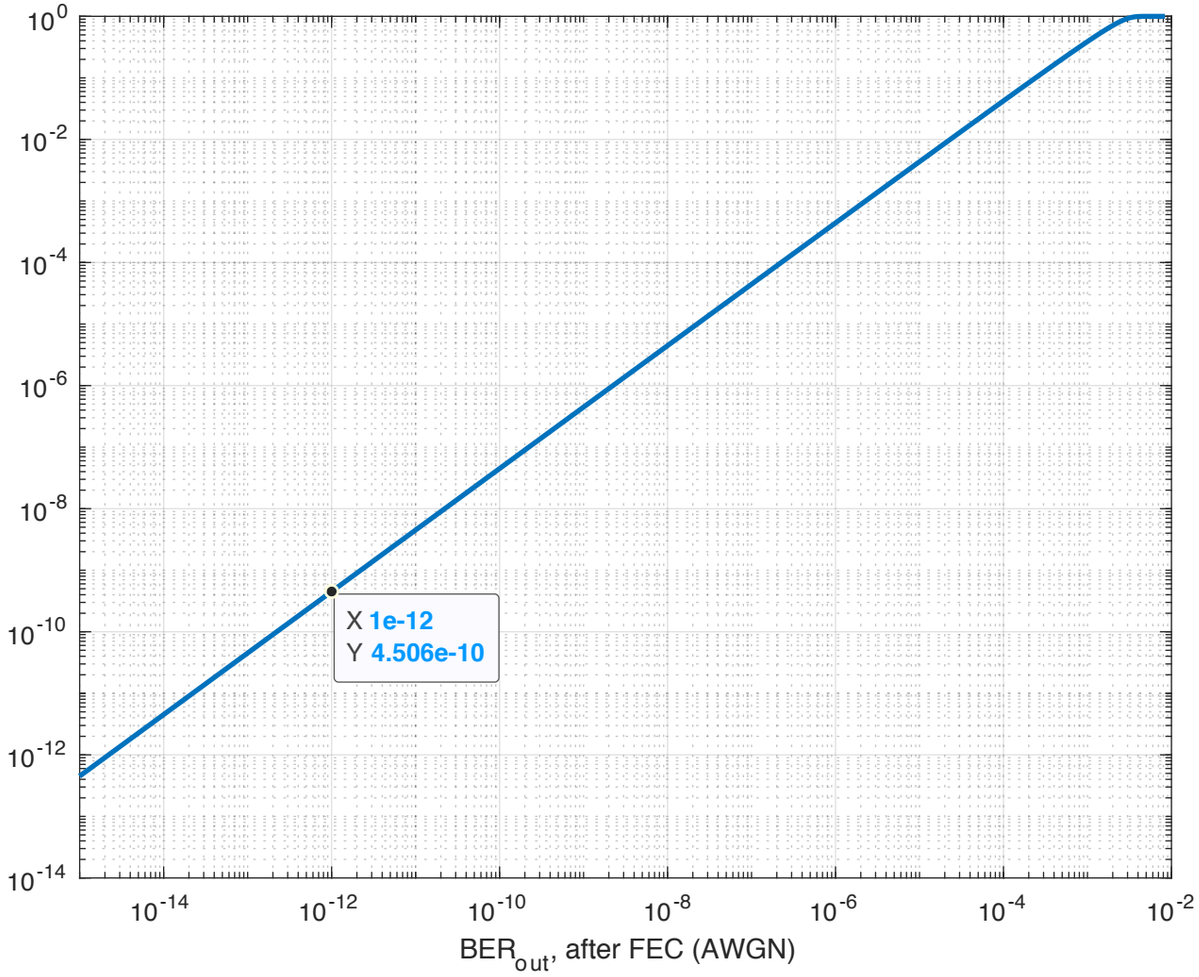
$$SER_{in} = \sum_{i=1}^{m} \binom{m}{i} \cdot BER_{in}^{i} \cdot \left(1 - BER_{in}\right)^{m-i}$$

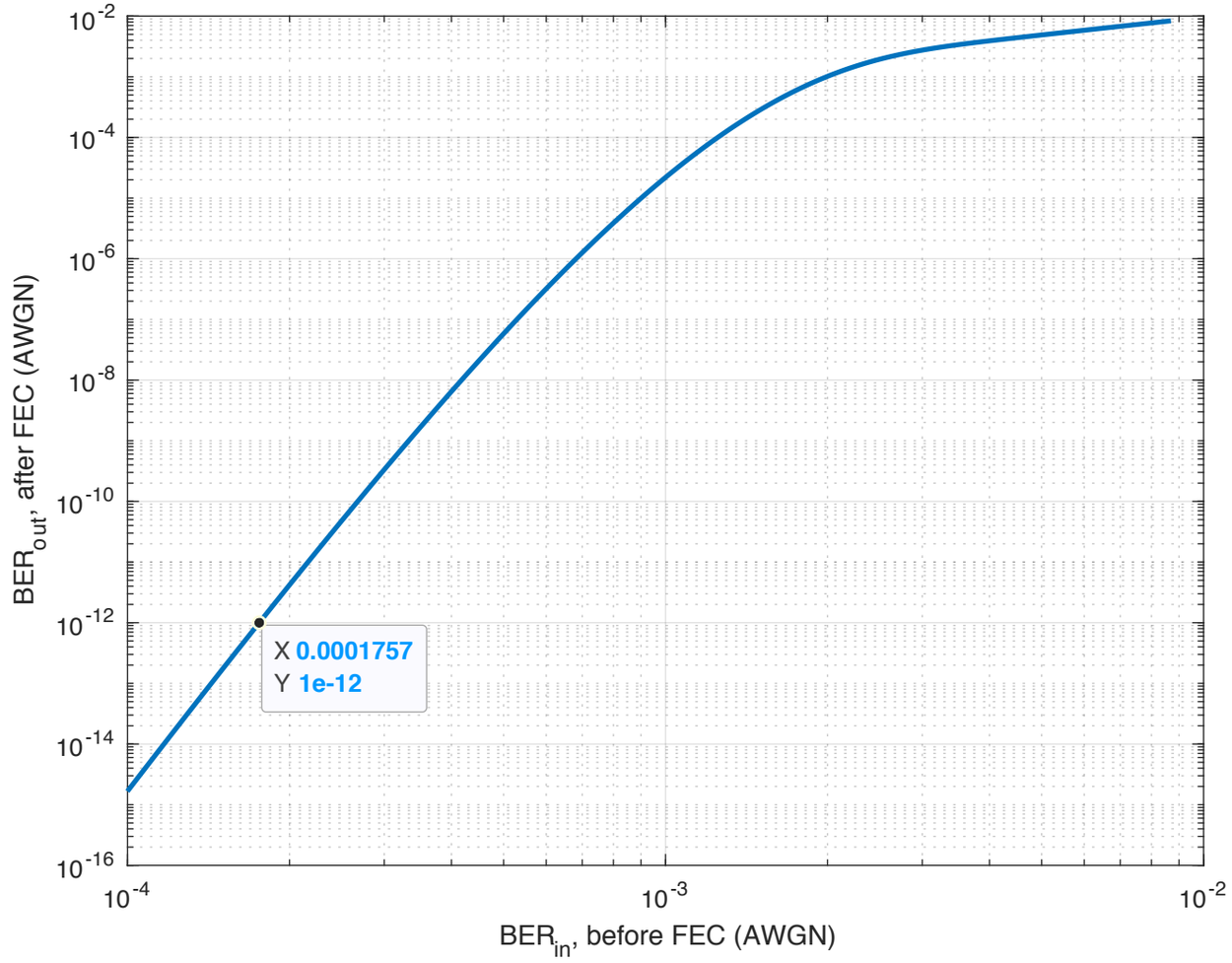
$$SER_{out} = \sum_{i=t+1}^{n} \frac{i}{n} \binom{n}{i} \cdot SER_{in}^{i} \cdot \left(1 - SER_{in}\right)^{n-i}$$

$$RFER_{out} = \sum_{i=t+1}^{n} \binom{n}{i} \cdot SER_{in}^{i} \cdot \left(1 - SER_{in}\right)^{n-i}$$

$$BER_{out} = \frac{SER_{out}}{m}$$

RFER limit





RFER < 4.5×10^{-10}

Thank you