802.3dj Annex 174A histogram bin 16 definition
In support of comment R2-142

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Introduction

Comment R2-142 identified an error in Annex 174A’s equations calculating the error mask based on the error histogram measurement

The original suggested resolution was to change the equation and all associated values to correct the error.

- The editorial team expressed concern that this was too wide of a scope at this stage in the process

Rather than modifying the equation, the suggested resolution is to identify the difference in a note, clarifying that the calculated values are sufficiently accurate for use as a block error mask.

Background: test block error histogram

Each test block of 544/p test symbols is checked and its number of errored symbols is counted.

- The block is tallied into the bin for that count: 0, 1, 2, ... 15.
- Blocks with 16 or more errored symbols all fall into one final bin.

Dividing each bin count by the number of blocks gives $Hm^{(i)}(k)$, the histogram.

- Bins 0-15 are point probabilities; bin 16 is the accumulated tail.

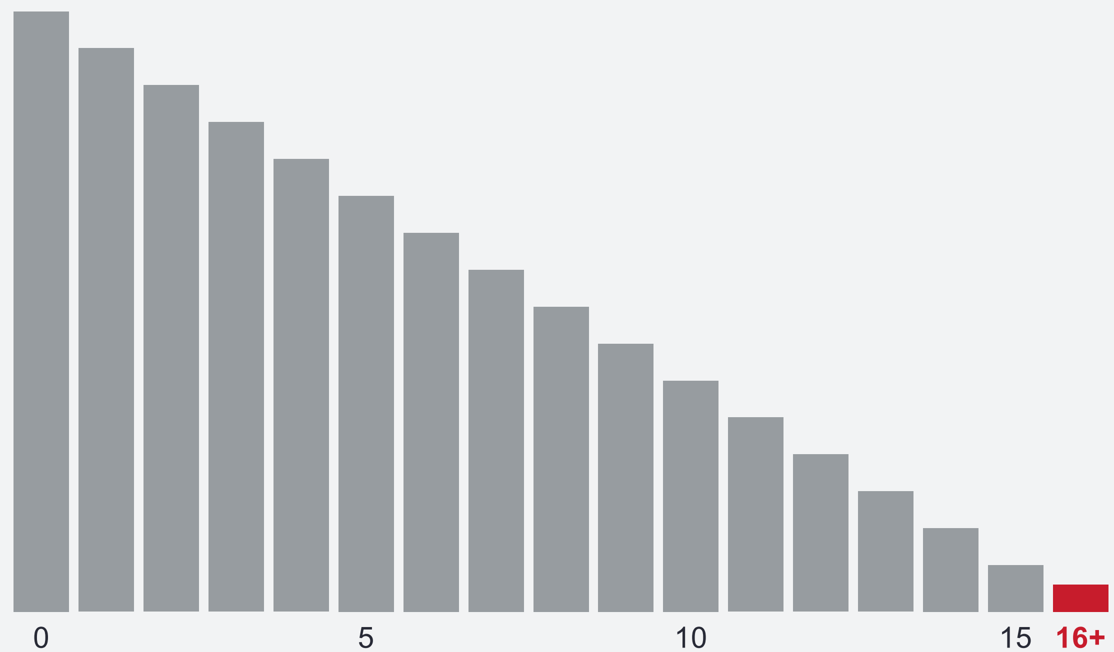
Relation to RS(544,514,10)

A test block relates to an RS(544,514,10) codeword: 544 ten-bit symbols with 30 parity symbols, up to 15 symbol errors are correctable.

Bins 0-15 are codewords the FEC decoder corrects; bin 16 is exactly the uncorrectable case, 16 or more symbol errors.

Bin 16 is therefore the codeword (block) error probability the BLER limits of 174A.5/174A.6 are written against.

Probability of a test block having k errored symbols



Bins 0-15: exactly k errors

Bin 16: 16 or more errors, accumulated into one tail bin

The inconsistency: definition versus equation

DEFINITION — 174A.9.3

$Hm(i)(16) = P(k \geq 16)$

Bin 16 is a tail: 16 or more test-symbol errors in a block; bins 0–15 are exactly k.

The 174A.9.2 counters agree — test_block_error_bin_i_16p counts blocks with 16 or more errors.

EQUATION (174A–5)

$Hmax(16) = P(k = 16)$

A single binomial term C(n, k) × RSSER^k × (1 – RSSER)^(n–k), n = 544/p.

At k = 16 it returns exactly 16 errors — no summation over k = 16 to n is applied.

174A.9.5 pass criterion: Hm(i)(k) < Hmax(k) for all k > 0 — the limit mask does not match the histogram it is measured against.

The difference between the tail and the point probability, at the maximum BER specified in this annex is ~9%

Internally inconsistent, and not measurable

INTERNALLY INCONSISTENT

Same bin, two treatments

174A.9.4 treats bin 16 correctly as a tail, summing the k ≥ 16 terms in the convolution hconv[Hx, Hy].

174A.9.6 and 174A.9.7 build He(k) from Equation (174A–5); the reported BLER is He(16), compared against the codeword error ratio limit of 174A.5 or 174A.6.

The same bin is handled one way in the convolution and another way in the mask.

AS DEFINED AND COUNTED

The FEC decoder cannot report exactly 16

A block error is an uncorrectable codeword — 16 or more symbol errors.

A PMA test block counter could in principle bin exactly 16, but the counters of 174A.9.2 are defined as 16-or-more (test_block_error_bin_i_16p).

An RS-FEC decoder cannot report exactly 16 at all: beyond its correction capability it only flags the codeword as uncorrected. 174A.11.2's FEC_uncorrected_cw_counter counts codewords with more than 15 symbol errors, and 174A.11.3 sets Hm(16) from that counter.

Every form of bin 16 defined in this annex — PMA test block counters and PCS FEC counters alike — is a 16-or-more quantity, and the FEC counter cannot be anything else.

Only Equation (174A–5) treats bin 16 as exactly 16, so the limit is the one term in the method with no measurable counterpart.

Why this does not invalidate the test

The probability of exactly 16 errors is always less than the probability of 16 or more errors.

Hmax(16) is therefore understated relative to a rigorous tail-based limit, and the reported BLER is likewise understated.

The mask is tighter, not looser — the error is in the conservative direction.

- A lane that should fail cannot pass because of this discrepancy; at worst a compliant lane is held to a slightly stricter limit.

At the BER values specified in this annex the two quantities are close, because the binomial terms above k = 16 fall off rapidly.

- For example, p=1 in Table 180-20, receiver error max — ~6% different.
    - 3.6E-13 for exactly 16 test symbol errors
    - 3.8E-13 for 16+ symbol errors
- The difference grows to ~9% at the maximum BER specified in this annex.

Proposed remedy

Retain Equation (174A–5) and the related tables unchanged.

Add the following NOTE to 174A.9.5:

- *NOTE—Equation 174A-5 calculates Hmax(16) as the probability of exactly 16 test-symbol errors, rather than the probability of 16 or more test-symbol errors specified for bin 16 in 174A.9.3. For the BER values specified in this annex, the exact-16 value is a sufficiently accurate and conservative approximation to the 16-or-more value.*

Minimal editorial impact: one NOTE, no changes to equations, tables, or test procedures.

Removes the error for implementers reading 174A.9.3, 174A.9.5, and 174A.9.6 together.