Alternative optical Tx eye-mask for 10GBASE-R modules (Clause 52)

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Proposal

- Add an alternative optical transmitter eye-mask test for 10GBASE-R optical modules, to allow the use of a statistical eye mask test, with appropriately revised eye-mask coordinates and a maximum ratio of $5x10^{-5}$ hits per sample.

Why: The optical Tx eye-mask test issue 1

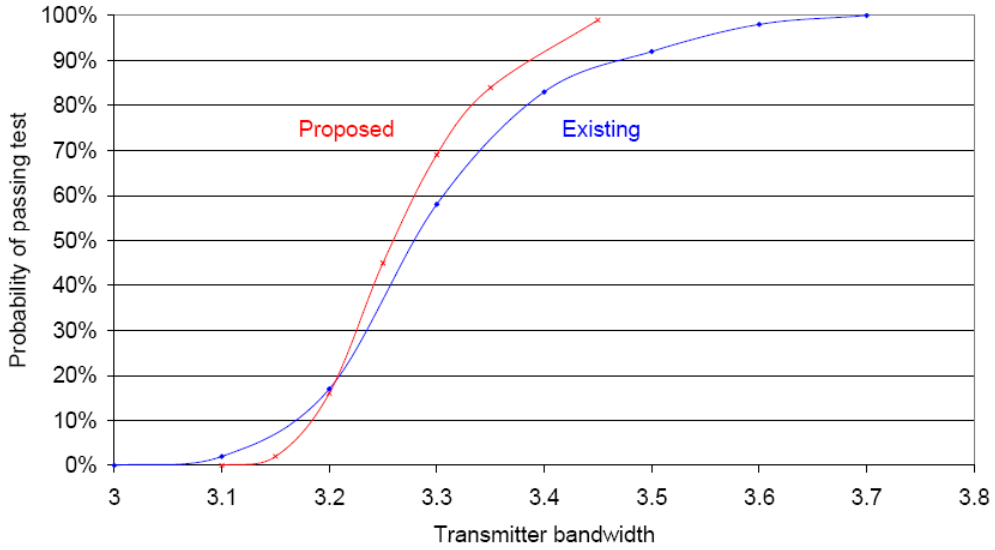
- The current optical transmitter eye-mask test for 10GBASE-R optical transmitters is commonly implemented as a zero hit eye-mask test.
- A zero hit eye-mask test has a several drawbacks
  - Eye mask margin is determined by a single rare event – poor repeatability
    - Eye-mask measurements by different parties are difficult to correlate
  - Larger numbers of samples make the test even less repeatable !
- The single hit criterion causes a large range in device performance between all-passing and all-failing. Failing good devices adds cost.

Statistical eye mask approach

- Statistical eye-mask tests allow a maximum (non-zero) ratio of mask hits to samples taken. They were adopted in recent standards 802.3aq and 802.3ba.
  - They are better than zero hit eye-mask tests:
    - More accurate and repeatable
    - Faster and lower test cost for similar quality of test
    - Eye-mask margin measurements are largely independent of number of samples (provide number of samples >> hit ratio)
- Anticipated benefits to 10GBASE-R community:
  - Better discrimination between 'good' and 'bad' transmitters
    - See simulation work in Pete Anslow presentation '10GBASE-S/L/E eye mask', and measurements reported in this presentation http://www.ieee802.org//3/maint/email/pdf9albvcMFYq.pdf
  - Better consistency between module maker and module user tests
  - Lower module test cost

Eye-mask test methods compared

- Modeling – Pete Anslow presentation
  http://www.ieee802.org//3/maint/email/pdf9albvcMFYq.pdf

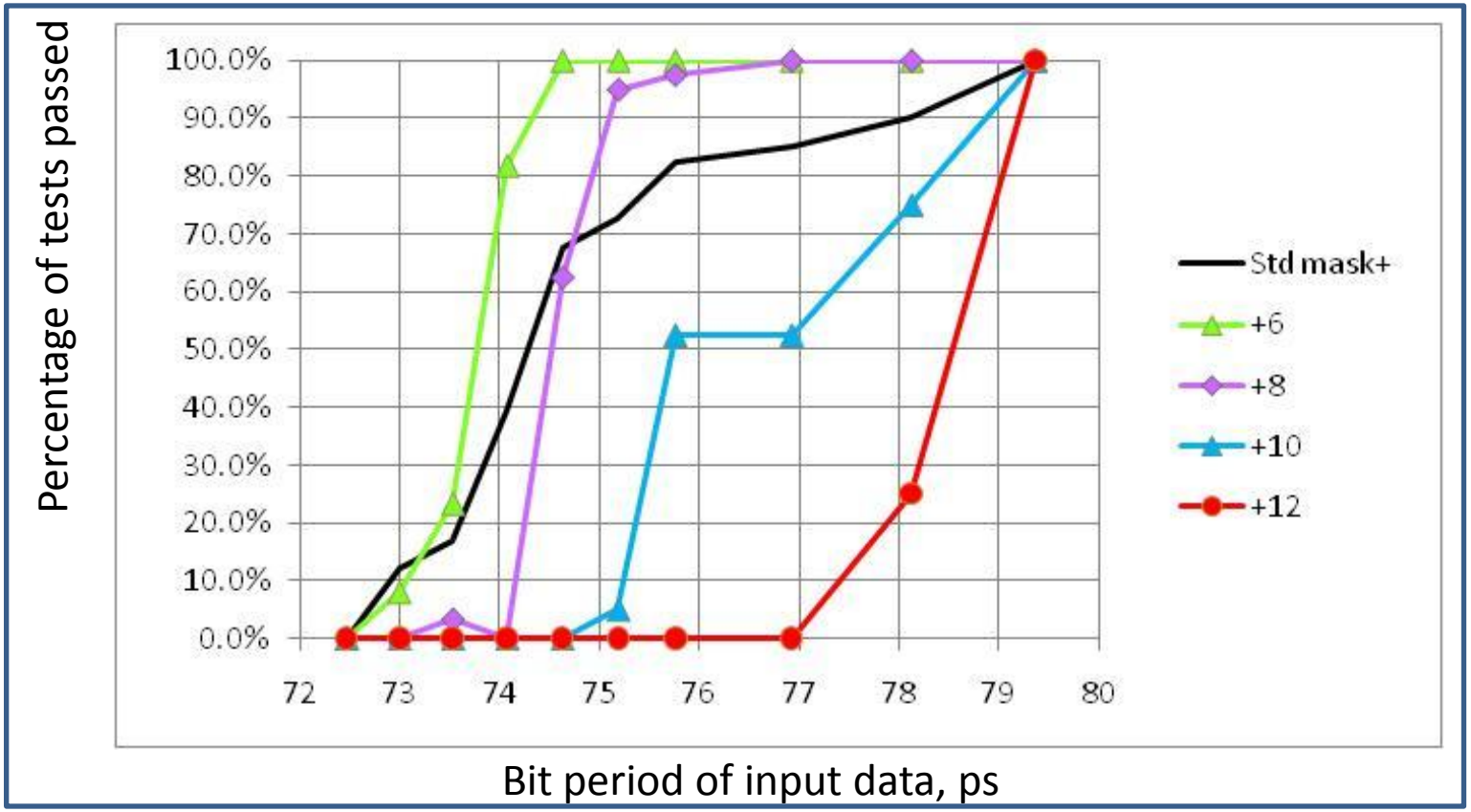


- Measurements – following slides

Measurements

- A comparison of pass/fail rates for transmitter eye mask tests was made:
  - the 10GBASE-R standard zero-hit eye mask from clause 52
    and
  - a set of test eye masks scaled from the clause 52 mask coordinates, with max hit ratio of 5e-5
    - + 6%, +8%, +10%, +12%
- A total of approx 1800 mask measurements were made using a typical SFP+ 10G SR compliant module. 500,000 samples / UI were taken, allowing up to 25 hits in the mask area for a hit ratio $\leq 5 \times 10^{-5}$
- In order to produce a marginal transmitter eye, the input data rate to the module was increased to between 12.8 GHz and 13.8 GHz. The resulting transmit eye has greater jitter and ISI. Eye mask coordinates were scaled with bit rate and eye height, per standard procedure.

Measurement results



- The eye mask coordinates and the measured results for the +6% eye mask agree very closely with the simulations in Pete Anslow's '10GBASE-S/L/E eye mask': the clause 52 eye mask and the +6% eye mask have ~15% pass rate at the same input data bit period.
- All the hit ratio masks have significantly steeper slopes (better discrimination between good and bad transmitters) than the 0 hit eye mask

Conclusions

- A comparison of the clause 52 optical transmitter eye mask test and a set of scaled eye masks with max hit ratio of $5x10^{-5}$ has been made. The hit ratio eye masks all show better discrimination between good and bad transmitters.
- The measured results for the +6% mask confirm the simulations in Pete Anslow's '10GBASE-S/L/E eye mask'.

- An alternative eye mask test is proposed which allows up to 5x10-5 hits, with eye mask coordinates:

X1	X2	X3	Y1	Y2	Y3
0.235	0.395	0.45	0.235	0.265	0.4

Proposed changes to Clause 52

- Add a row to each of tables 52-7, 52-12, 52-16

Alternative transmitter eye mask definition {X1, X2, X3, Y1, Y2, Y3} Hit ratio $5x10^{-5}$ per sample	0.235, 0.395, 0.45, 0.235, 0.265, 0.4	

- Add notes to the transmitter eye mask definition in each of tables 52-7, 52-12, 52-16: “Either transmitter eye mask test may be used. The alternative hit ratio transmitter eye-mask test method is described in 86.8.3.2. ”

Back up

Illustration of test eye-masks

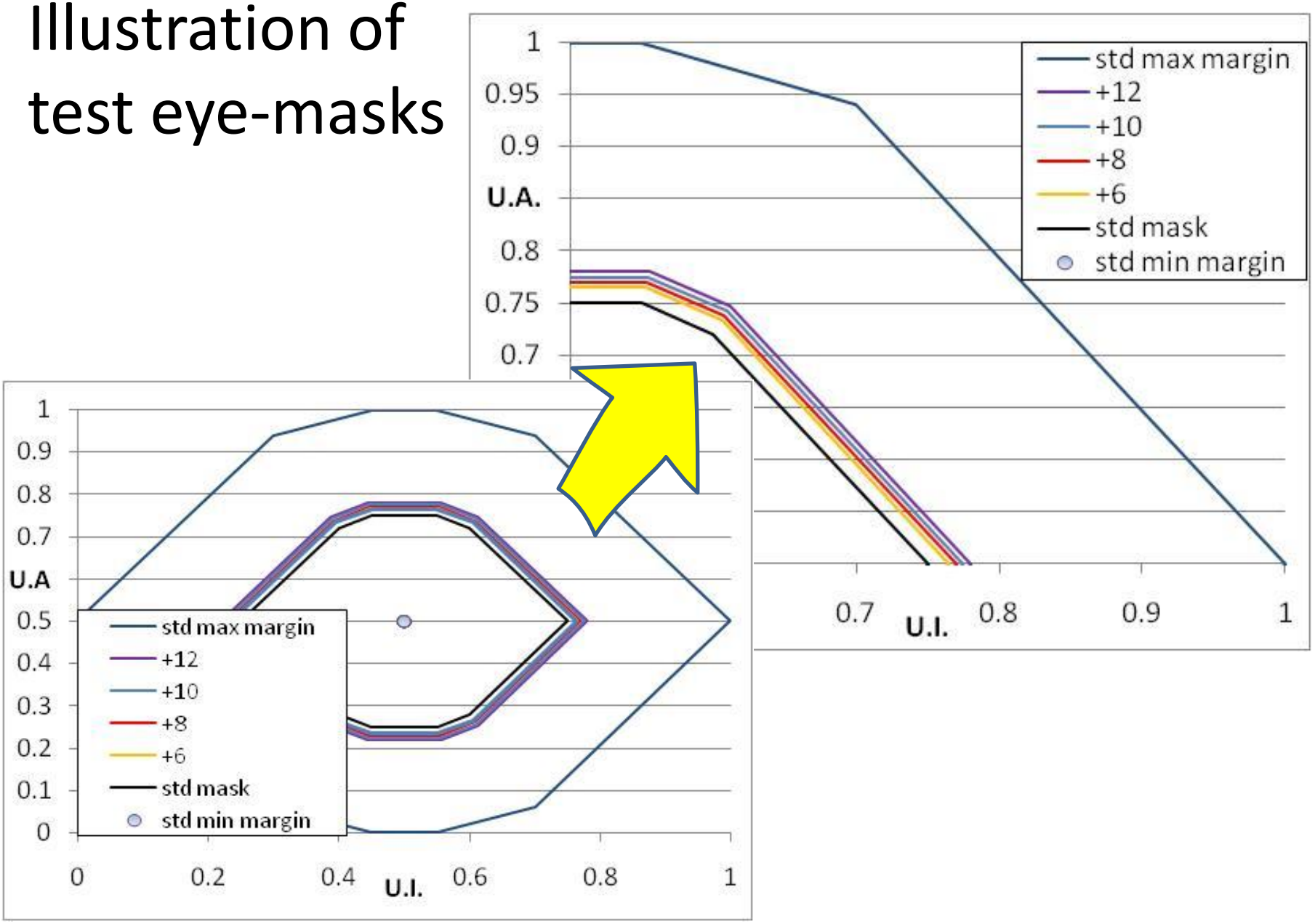


Table of eye mask co-ordinates used in measurements

Eye mask	X1	X2	X3	Y1	Y2	Y3	Hits allowed
Clause 52	0.25	0.4	0.45	0.25	0.28	0.4	0
+6 %	0.235	0.394	0.447	0.235	0.267	0.4	5×10^{-5}
+8 %	0.23	0.392	0.446	0.23	0.262	0.4	5×10^{-5}
+10 %	0.225	0.39	0.445	0.225	0.258	0.4	5×10^{-5}
+12 %	0.22	0.388	0.444	0.22	0.254	0.4	5×10^{-5}

Note: the +6% mask coordinates are almost identical to the alternative eye mask coordinates proposed in '10GBASE-S/L/E eye mask' by Pete Anslow:

Proposed alternative eye mask:

{X1, X2, X3, Y1, Y2, Y3} = {0.235, 0.395, 0.45, 0.235, 0.265, 0.4} with 5×10^{-5} hits allowed