Effect of pattern length on apparent peak-to-peak voltage

Piers Dawe

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Introduction

- Comment 137
- The apparent peak-to-peak differential output voltage of the host depends on the pattern used, because the host channel and HCB have loss and the signal is under-emphasised where observed. Also it is better to **have a spec that relates consistently to voltage swing at the IC**, so there is no need to set up the swing port by port.
- **PRBS9 is too short** for consistent measurements across different host losses.
- Define suitable patterns for peak-to-peak differential voltage: any of PRBS15, PRBS31, scrambled idle, RF, any other 100GBASE-R signal (FEC encoded or not).

- Subclause: 83E.3.1.2 Signal levels
- Page 166, Line 42

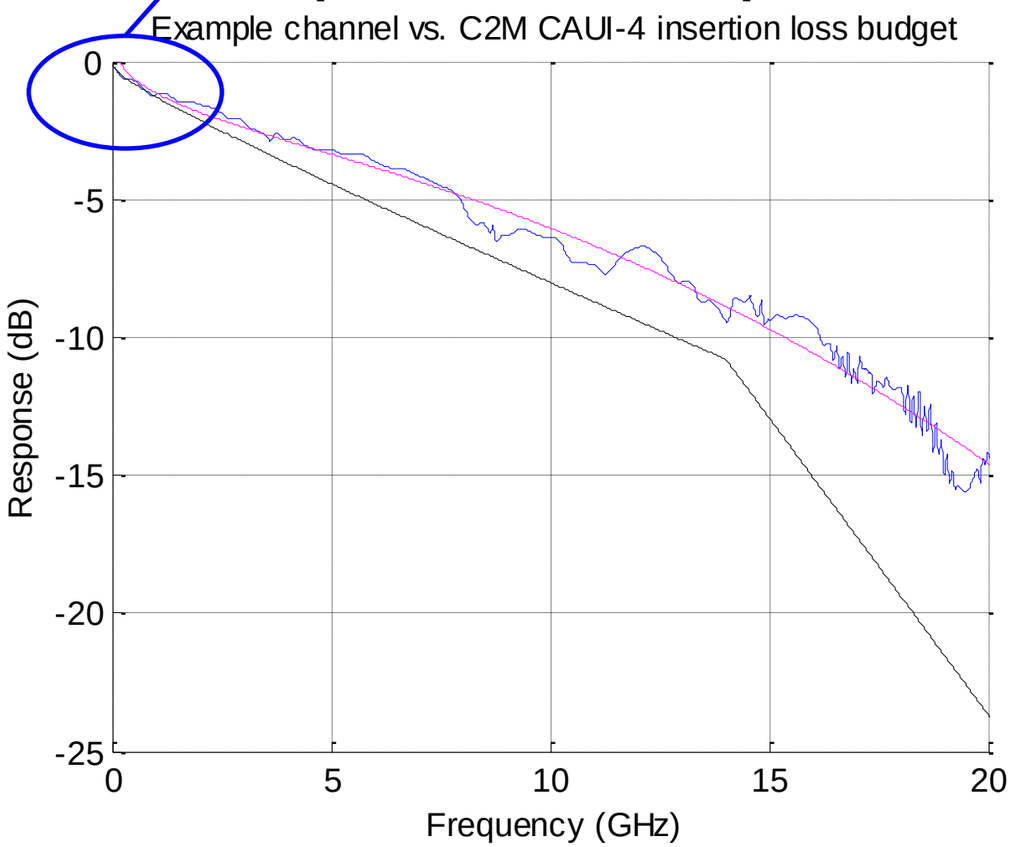
- For OIF members, this issue was presented in oif2013.320.00
  - For CEI-28G-VSR, OIF chose PRBS31

Problem statement

- We want to control the true peak-to-peak voltage in use, to avoid any overload or nonlinear reflection issues
- I believe the intention of spec is 900 mV in service (scrambled user data)
- OIF's CEI, including CEI-28G-VSR, defines peak-to-peak voltage with PRBS31
- With PRBS9, for a lossy channel, the signal doesn't have long enough to stabilise
  - We won't find the true peak-to-peak voltage
  - The error depends on host channel and package loss
  - The error can be around 5% for a reference high loss host
  - We don't know and can't control the host loss in the spec: implementers can exceed the recommended loss if they meet the specs at the test points
- This presentation investigates the effect of pattern length so that the peak-to-peak output voltage spec can be made unambiguous, useful to protect the receiver, and consistent (not channel dependent) for the transmitter IC

Channel simulated: host to module

Curved response at low frequencies



Blue Simulated channel

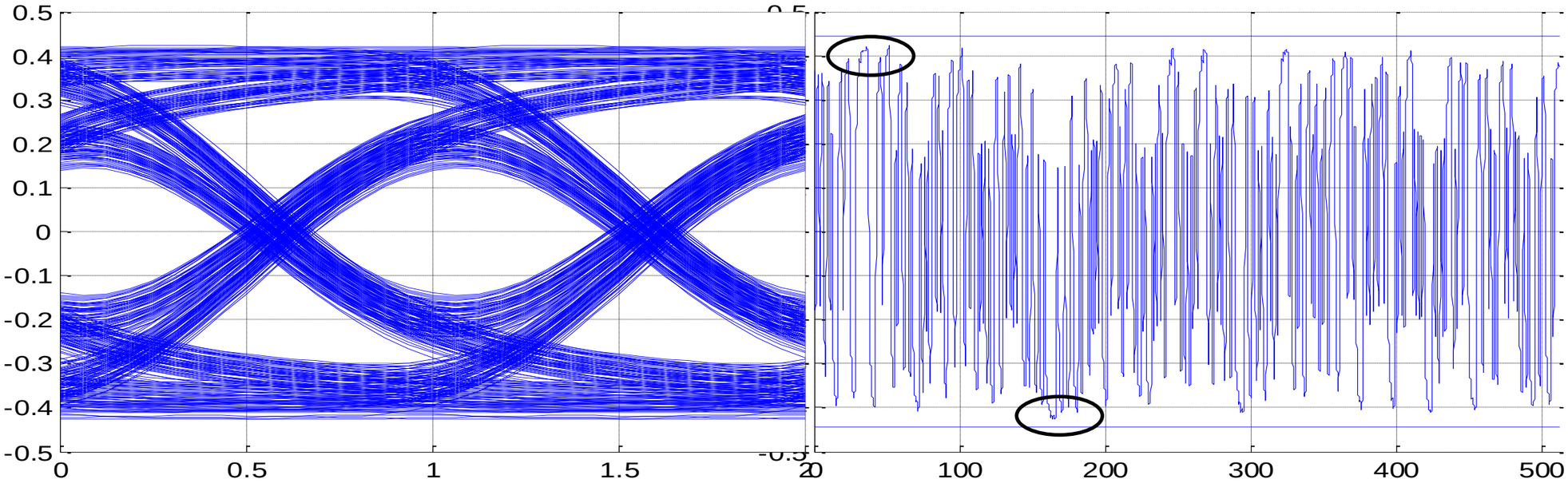
Magenta Fitted response

Black C2M CAUI-4 recommended minimum SDD21

- Signalling rate 28 GBd
- Channel is Sdd21 of oif2010_407 *
  - This is not worst case
  - Should include IC package response
  - Minimum SDD21 is only a recommendation; implementers will try for more loss
- DC response of this channel is 0.987 or -0.12 dB

* There is an equivalent channel "Host to Module Link" in the P802.3bj channel data web page

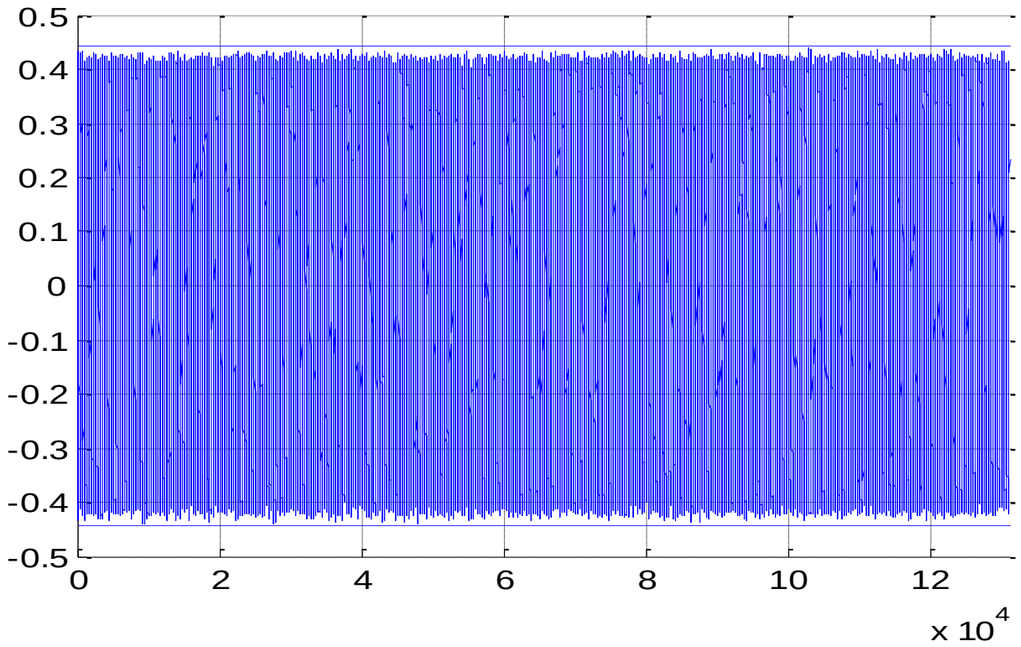
PRBS9



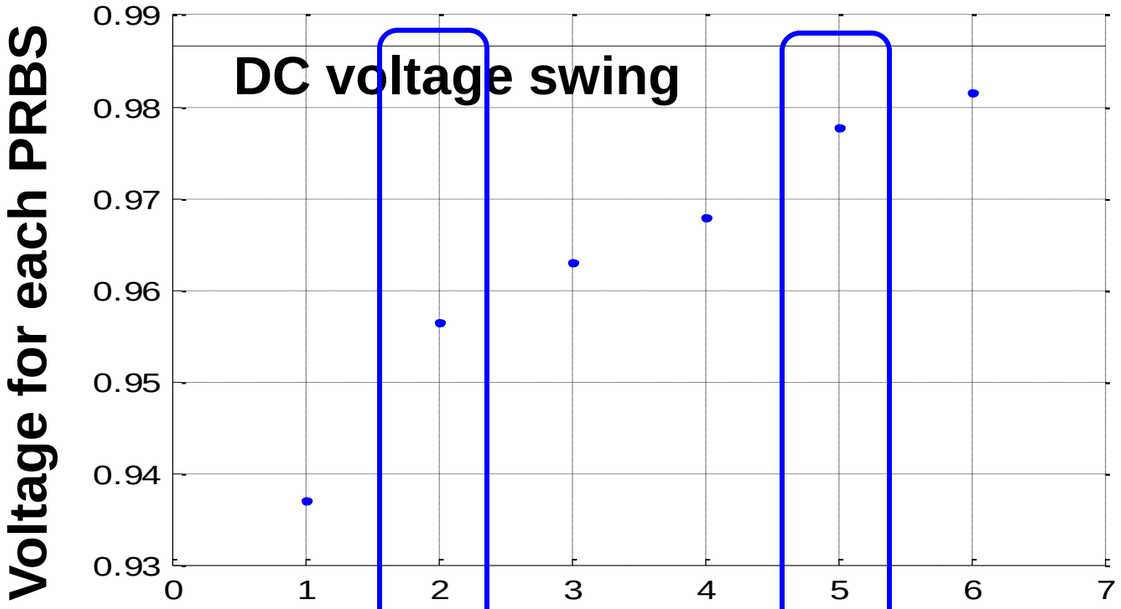
- We want to control the true peak-to-peak voltage in use, to avoid any overload or nonlinear reflection issues
- With PRBS9, signal doesn't have long enough to stabilise
- We don't find the true peak-to-peak voltage
- The error depends on host channel and package loss, which we don't know

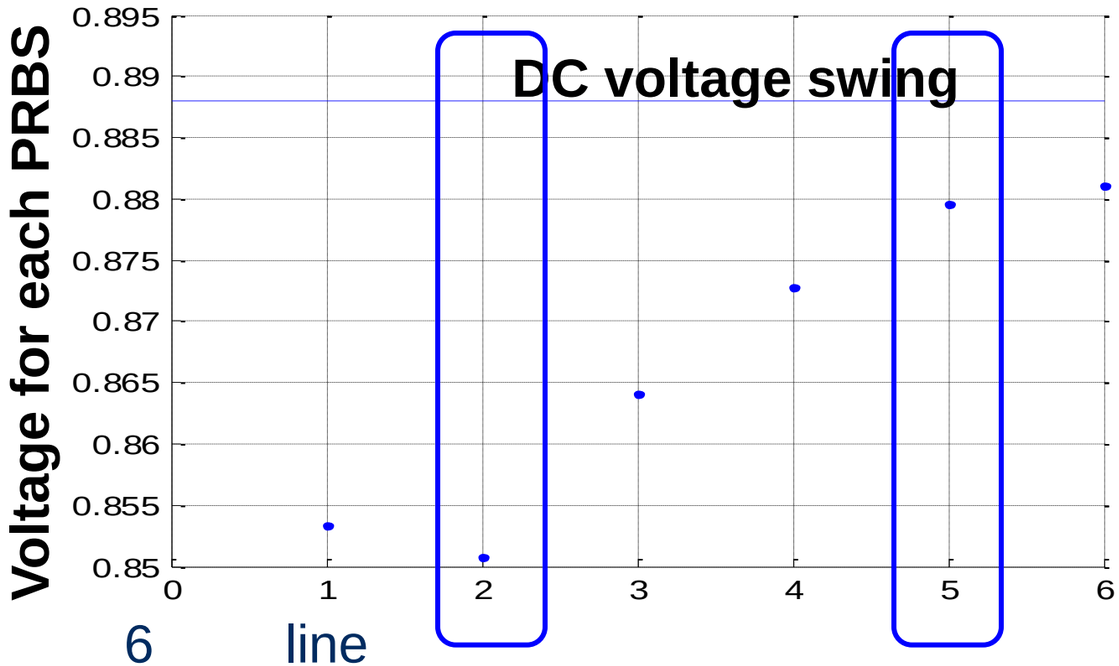
PRBS17

- Getting better...



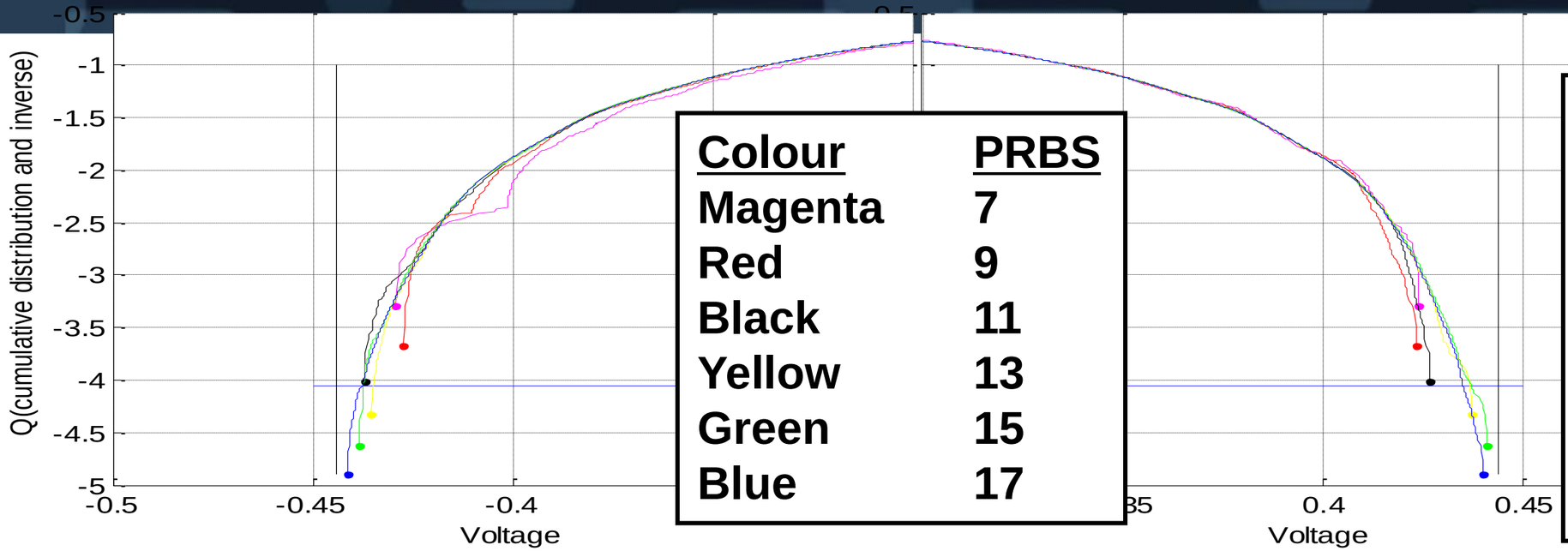
Peak-to-peak voltage depends on pattern





- Index on graph 1 2 2 4 5 6 line
  PRBS 7 9 11 13 15 17 Estimate of true peak-to-peak voltage from DC response
- Left and right input signals differ
- Left: 25.78125 GBd Right: 28 GBd
- 3% to 4% error with PRBS9 in these cases
- Host IC package loss and any more host channel loss will increase this – maybe 5%
- Going to PRBS15 reduces this to about 1%

Is the peak-peak voltage clearly defined?



Colour	PRBS
Magenta	7
Red	9
Black	11
Yellow	13
Green	15
Blue	17

Horizontal lines: 2.5e-5 each (high and low)
Vertical lines: asymptote for a very long scrambled sequence

- PRBS7 to PRBS11 are too short to find the in-service peak-to-peak voltage with user data not a test pattern
  - Note the "PRBS end effects": the extremes of the curves are rough
- In this case, PRBS13, 15 and 17 give very similar results
- Measuring to the usual mask hit ratio of 5e-5 would give consistent results from a quick measurement with PRBS15 or longer (e.g. PRBS31)
  - More practical than original pk-pk on PRBS31
  - More accurate than PRBS9

Module to host

- Here there is less frequency-dependent loss from traces but there is baseline wander from the required AC coupling in the module
  - If we use a long pattern e.g. PRBS31 we should define our "peak-to-peak" at a particular probability to avoid measuring unimportant low-probability tails
  - If we use a medium pattern e.g. PRBS15 we should define our "peak-to-peak" at a particular probability to avoid "PRBS end effects"

Options

1. Use PRBS15
   - This gets us to about 1% of the right result
     - If needed, reduce the host differential voltage pk-pk by about 1% from 900 mV to 890 mV
   - Can live without defining a probability on the CDF to guard against patterning effects, but still useful to deal consistently with the effects of noise in the measurement, and see next slide
     - Example: from all but 2.5e-5 of samples above to all but 2.5e-5 of samples below
     - If needed, reduce the host differential voltage pk-pk by about 2.2% from 900 mV to 880 mV
       - Assuming near maximum recommended host loss
       - ICs in low loss hosts would have to avoid the last 10 mV of amplitude
       - Those channels would not need high amplitude anyway

Simple

Simple, practical, consistent, very similar result to PRBS31

2. Use PRBS31 or compliant Ethernet signal, define the probability
   - Example: from all but 2.5e-5 of samples above to all but 2.5e-5 of samples below
   - If needed, reduce the host differential voltage pk-pk by about 2.2% from 900 mV to 880 mV
     - ICs in low loss hosts would have to avoid the last 20 mV of amplitude

Simple, practical, consistent

3. Use PRBS9, but define the probability
   - Still a good thing to define the probability to deal consistently with the effects of noise
   - Reduce the host differential voltage pk-pk by about 5.6% from 900 mV to 850 mV
   - ICs in low loss hosts would have to avoid the last 50 mV of amplitude

This buys out the error rather than measuring the right thing

- With the right probability, all these measurements are reasonably quick because they don't need pattern lock. However, PRBS9 and PRBS15 can be measured with pattern lock if desired

Conclusion

- For measurement accuracy and relevance, define suitable patterns for peak-to-peak differential voltage: any of PRBS15, PRBS31, scrambled idle, RF, any other 100GBASE-R signal (FEC encoded or not).
- For measurement consistency, define peak-to-peak voltage by all but 5e-5 of the samples

Thank You