802.3dj D1.3 Comment Resolution Optical Track

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Introduction

- This slide package was assembled by the 802.3dj editorial team to provide background and detailed resolutions to aid in comment resolution.
- Specifically, these slides are for the various optical track comments.

Use of reference receiver Comment #333

Cl **180** SC **180.9.10** P **432** L **35** # 333

Ran, Adee Cisco

Comment Type **TR** *Comment Status* **X**

Transmitter transition time measurement is defined with good detail, but it is unclear whether the reference equalizer is to be used in the measurement or not (this will likely affect the result).

Note that for RINxxOMA (180.9.11) it is specified explicitly that the noise is measured before the reference equalizer. I assume this should apply to the transition time too.

SuggestedRemedy

Specify whether the reference equalizer is to be used or not.

Implement similarly in other optical PMD clauses as necessary, with editorial license.

Proposed Response *Response Status* **O**

The comment draws attention to the fact that in 180.9.11 RINxxOMA the reference equalizer is explicitly mentioned and is excluded from the measurement while in 180.9.10 the reference equalizer is not explicitly stated and unclear if it should be included or excluded from the measurement.
The commenter is requesting that the draft be consistent among the relevant subclauses when the reference equalizer is to be included or excluded from measurement.

Use of reference receiver Comment #333

180.9.11 Relative intensity noise ($RIN_{xx}OMA$)

$RIN_{xx}OMA$ of each lane, with "xx" referring to the value for optical return loss tolerance in Table 180–7, shall be within the limit given in Table 180–7 when measured using the test pattern and sampling range specified for OMA_{outer} measurement in 180.9.4, but with applied xx dB optical return loss and the reference receiver specified for TDECQ measurement in 180.9.5. The noise is measured before the reference equalizer.

$RIN_{xx}OMA$ is calculated as defined in Equation (180–1):

$$RIN_{xx}OMA = 10\log_{10}\left[\frac{(N_3 + N_0)^2}{OMA_{outer}{}^2 B}\right] \quad (180\text{–}1)$$

180.9.10 Transmitter transition time

The transmitter transition time of each lane shall be within the limit given in Table 180–7 if measured using a test pattern specified for transmitter transition time in Table 180–17.

Transmitter transition time is defined as the slower of the time interval of the transition from 20% of OMA_{outer} to 80% of OMA_{outer}, or from 80% of OMA_{outer} to 20% of OMA_{outer}, for the rising and falling edges respectively, as measured through an O/E converter and oscilloscope with response defined as follows. The combined response of the O/E converter and oscilloscope has a 3 dB bandwidth of approximately 53.125 GHz with a fourth-order Bessel-Thomson response to at least 1.3 × 106.25 GHz. At frequencies above 1.3 × 106.25 GHz, the response should not exceed –20 dB. Compensation may be made for any deviation from an ideal fourth-order Bessel-Thomson response.

The 0% level and the 100% level are P_0 and P_3 as defined by the OMA_{outer} measurement procedure (see 180.9.4), with the exception that the square wave test pattern may be used. When the SSPRQ pattern is used, the rising edge used for the measurement is that within the 00000333333 symbol sequence, and the falling edge is that within the 33333000000 symbol sequence.

Use of reference receiver Comment #333

When the editorial team was developing a response it was noticed that the reference receiver is not clearly defined in 121.8.5.

121.8.5 Transmitter and dispersion eye closure for PAM4 (TDECQ)

The TDECQ and TDECQ – 10log$_{10}$(C_{eq}) of each lane shall be within the limits given in Table 121–6 if measured using the methods specified in 121.8.5.1, 121.8.5.2, and 121.8.5.3.

TDECQ is a measure of each optical transmitter's vertical eye closure when transmitted through a worst case optical channel (specified in 121.8.5.2), as measured through an optical to electrical converter (O/E) and oscilloscope with the combined frequency response given in 121.8.5.1, and equalized with the reference equalizer (as described in 121.8.5.4). The reference receiver and equalizer may be implemented in software or may be part of an oscilloscope.

- While the wording is a bit awkward, it's clear that the reference receiver is distinct from the reference equalizer, **and does not contain it**.
- This is reinforced in 121.8.5.1, Figure 121-4, which shows the reference equalizer separate from the O/E and calibrated oscilloscope that form the reference receiver.
- It's unfortunate that the text in 121.8.5.1 doesn't repeat the term, reference receiver, which is a source of some of the current confusion.
- Another source of confusion comes from the fact that the reference equalizer is typically implemented in the oscilloscope but is not defined as part of the reference receiver.

The state of polarization of the back reflection is adjusted to create the greatest RIN. Each optical lane is tested with the optical channel described in 121.8.5.2. The combination of the O/E converter and the oscilloscope has a 3 dB bandwidth of approximately 13.28125 GHz with a fourth-order Bessel-Thomson response to at least 1.5 × 26.5625 GHz, and at frequencies above 1.5 × 26.5625 GHz, the response should not exceed –24 dB. Compensation may be made for any deviation from an ideal fourth-order Bessel-Thomson response.

The test pattern (specified in Table 121–10) is transmitted repetitively by the optical lane under test and the oscilloscope is set up to capture the complete pattern for TDECQ analysis as described in 121.8.5.3. The clock recovery unit (CRU) has a corner frequency of 4 MHz and a slope of 20 dB/decade. The CRU can be implemented in hardware or software depending on oscilloscope technology.

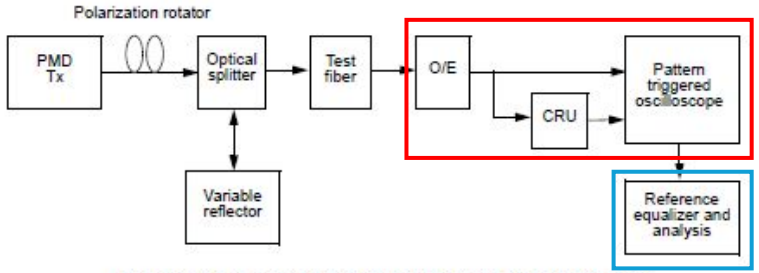

Figure 121–4—TDECQ conformance test block diagram

Use of reference receiver
Comment #333

To respond to the comment and enhance the clarity of the draft, changes are proposed to 180.9.x.

180.9.5.

180.9.5 Transmitter and dispersion eye closure for PAM4 (TDECQ)

The TDECQ of each lane shall be within the limits given in Table 180–7 if measured using the methods specified in 121.8.5.1, 121.8.5.3, and 180.9.5.1, with the following exceptions:

— The signaling rate of the test pattern generator is as given in Table 180–7 and uses the test pattern specified for TDECQ in Table 180–17.

— The reference equalizer is a 15-tap, T-spaced, feed-forward equalizer (FFE), where T is the symbol period, with equalizer coefficient constraints as shown in Table 180–18.

— The combination of the O/E converter and the oscilloscope has a 3 dB bandwidth of approximately 53.125 GHz with a fourth-order Bessel-Thomson response to at least 1.3 × 106.25 GHz, and at frequencies above 1.3 × 106.25 GHz, the response should not exceed –20 dB. Compensation may be made for any deviation from an ideal fourth-order Bessel-Thomson response.

- 180.9.5 points back to 121.8.5.1 and 181.8.5.3 as the basis for the TDECQ conformance test setup, with exceptions listed for the higher symbol rate in P802.3dj.
- 121.9.5 provides a clear definition of the term reference equalizer, but not for the term reference receiver.
- This text can be improved by adding the term reference receiver to the third bullet item.
- It's suggested to swap the order of the second and third bullets to put the reference receiver before the reference equalizer in the list of exceptions.

Use of reference receiver
Comment #333

Proposed updates to 180.9.5.

180.9.5 Transmitter and dispersion eye closure for PAM4 (TDECQ)

The TDECQ of each lane shall be within the limits given in Table 180–7 if measured using the methods specified in 121.8.5.1, 121.8.5.3, and 180.9.5.1, with the following exceptions:
— The signaling rate of the test pattern generator is as given in Table 180–7 and uses the test pattern specified for TDECQ in Table 180–17.
— The reference receiver, comprised of the combination of the O/E converter and the oscilloscope, has a 3 dB bandwidth of approximately 53.125 GHz with a fourth-order Bessel-Thomson response to at least 1.3 × 106.25 GHz, and at frequencies above 1.3 × 106.25 GHz, the response should not exceed –20 dB. Compensation may be made for any deviation from an ideal fourth-order Bessel-Thomson response.
— The reference equalizer is a 15-tap, T-spaced, feed-forward equalizer (FFE), where T is the symbol period, with equalizer coefficient constraints as shown in Table 180–18. The reference equalizer may be implemented in the oscilloscope, but it is not considered part of the reference receiver.

Use of reference receiver
Comment #333

180.9.4 - There is no mention of how the OMAouter waveform is measured.
There is a definition of how OMAouter is measured for TDECQ calculation in 121.8.5.3, but there is no indication if the same is to be used in 121.8.4 for OMAouter in general.

180.9.4 Outer Optical Modulation Amplitude (OMA_{outer})

The OMA_{outer} of each lane shall be within the limit given in Table 180–7. The OMA_{outer} is measured using a test pattern specified for OMA_{outer} in Table 180–17 as the difference between the average optical launch power level P_3, measured over the central 2 UI of a run of 7 threes, and the average optical launch power level P_0, measured over the central 2 UI of a run of 6 zeros, as shown in Figure 180–11.

121.8.5.3 TDECQ measurement method

The standard deviation of the noise of the O/E and oscilloscope combination, σ_5, is determined with no optical input signal and the same settings as used to capture the histograms described below.

OMA_{outer} is measured according to 121.8.4 on the equalized signal.

Proposed updates to 180.9.4, assuming it's the same as used for TDECQ calculation (for CRG discussion).

The OMA_{outer} of each lane shall be within the limit given in Table 180–7. The OMA_{outer} is measured using a test pattern specified for OMA_{outer} in Table 180–17 as the difference between the average optical launch power level P_3, measured over the central 2 UI of a run of 7 threes, and the average optical launch power level P_0, measured over the central 2 UI of a run of 6 zeros, as shown in Figure 180–11. OMAouter is measured using waveforms captured at the output of the reference receiver and reference equalizer defined in 180.9.5.

Use of reference receiver
Comment #333

180.9.7

180.9.7 Transmitter overshoot and undershoot

The overshoot and undershoot of each lane shall be within the limit given in Table 180–7 if measured using a test pattern specified for overshoot and undershoot in Table 180–17.

Overshoot and undershoot are measured using the waveforms captured for the TDECQ test (see 180.9.5) and the waveform captured for the TECQ test (see 180.9.6), but without the reference equalizer being applied in either case.

Proposed updates to 180.9.7

Overshoot and undershoot are measured using the waveforms captured for the TDECQ test (see 180.9.5) and the waveform captured for the TECQ test (see 180.9.6), at the output of the reference receiver defined in 180.9.5 and before the reference equalizer.

180.9.8

180.9.8 Transmitter power excursion

The transmitter power excursion of each lane shall be within the limit given in Table 180–7 if measured using a test pattern specified for transmitter power excursion in Table 180–17.

Transmitter power excursion is measured using the waveforms captured for the TECQ test (see 180.9.6), but without the reference equalizer being applied.

Proposed updates to 180.9.8

Transmitter power excursion is measured using the waveforms captured for the TECQ test (see 180.9.6), at the output of the reference receiver defined in 180.9.5 and before the reference equalizer.

Use of reference receiver Comment #333

180.9.9

180.9.9 Extinction ratio

The extinction ratio of each lane shall be within the limit given in Table 180–7 if measured using a test pattern specified for extinction ratio in Table 180–17. The extinction ratio of a PAM4 optical signal is defined as the ratio of the average optical launch power level P_3, measured over the central 2 UI of a run of 7 threes, and the average optical launch power level P_0, measured over the central 2 UI of a run of 6 zeros, as shown in Figure 180–11.

Proposed updates to 180.9.9 (same as 180.9.4)

The extinction ratio of a PAM4 optical signal is defined as the ratio of the average optical launch power level P_3, measured over the central 2 UI of a run of 7 threes, and the average optical launch power level P_0, measured over the central 2 UI of a run of 6 zeros, as shown in Figure 180–11. Extinction ratio is measured using waveforms captured at the output of the reference receiver and reference equalizer defined in 180.9.5.

180.9.10

180.9.10 Transmitter transition time

The transmitter transition time of each lane shall be within the limit given in Table 180–7 if measured using a test pattern specified for transmitter transition time in Table 180–17.

Transmitter transition time is defined as the slower of the time interval of the transition from 20% of OMA_{outer} to 80% of OMA_{outer}, or from 80% of OMA_{outer} to 20% of OMA_{outer}, for the rising and falling edges respectively, as measured through an O/E converter and oscilloscope with response defined as follows. The combined response of the O/E converter and oscilloscope has a 3 dB bandwidth of approximately 53.125 GHz with a fourth-order Bessel-Thomson response to at least 1.3 × 106.25 GHz. At frequencies above 1.3 × 106.25 GHz, the response should not exceed –20 dB. Compensation may be made for any deviation from an ideal fourth-order Bessel-Thomson response.

Proposed updates to 180.9.10

Transmitter transition time is defined as the slower of the time interval of the transition from 20% of OMA_{outer} to 80% of OMA_{outer}, or from 80% of OMA_{outer} to 20% of OMA_{outer}, for the rising and falling edges respectively. Transmitter transition time is measured using waveforms captured at the output of the reference receiver defined in 180.9.5 and before the reference equalizer.

Use of reference receiver Comment #333

180.9.11

180.9.11 Relative intensity noise ($RIN_{xx}OMA$)

$RIN_{xx}OMA$ of each lane, with "xx" referring to the value for optical return loss tolerance in Table 180–7, shall be within the limit given in Table 180–7 when measured using the test pattern and sampling range specified for OMA_{outer} measurement in 180.9.4, but with applied xx dB optical return loss and the reference receiver specified for TDECQ measurement in 180.9.5. The noise is measured before the reference equalizer.

Proposed updates to 180.9.11

RINxxOMA of each lane, with "xx" referring to the value for optical return loss tolerance in Table 180–7, shall be within the limit given in Table 180–7 when measured using the test pattern and sampling range specified for OMAouter measurement in 180.9.4, but with applied xx dB optical return loss and the reference receiver specified for TDECQ measurement in 180.9.5. The noise is measured at the output of the reference receiver defined in 180.9.5 and before the reference equalizer.

Implement the same changes in 181.9.x, 182.9.x and 183.9.x with editorial license.