Bill & Ed's D1.5 Action items

Bill Powell - Nokia

Receive Sensitivity - 141.7.10,11

- D1.5, p.75, L48, 52
- Current text:

141.7.10 Receive sensitivity

{TBD}

141.7.11 Stressed receiver conformance test

{TBD}

- From 802.3av (10G EPON):

75.7.11 Receive sensitivity

Receiver sensitivity is defined for the random pattern test frame, or test pattern 1, or test pattern 3, and an ideal input signal quality with the specified extinction ratio. The measurement procedure is described in 58.7.10 for 1 Gb/s PHYs and 52.9.8 for 10 Gb/s PHYs. The sensitivity shall be met for the bit error ratio defined in Table 75–6, Table 75–7, or Table 75–11 as appropriate.

75.7.12 Stressed receiver conformance test

Compliance with stressed receiver sensitivity is mandatory for the following PMDs: 10GBASE–PR–D1, 10GBASE–PR–D2, 10GBASE–PR–D3, 10GBASE–PR–U1, 10GBASE–PR–U3, 10/1GBASE–PRX–D3, 10/1GBASE–PRX–U1, 10/1GBASE–PRX–U2, and 10/1GBASE–PRX–U3. The stressed receiver conformance test is intended to screen against receivers with poor frequency response or timing characteristics that could cause errors when combined with a distorted but compliant signal. To be compliant with stressed receiver sensitivity, the receiver shall meet the specified bit error ratio at the power level and signal quality defined in Table 75–6, Table 75–7, or Table 75–11 as appropriate, according to the measurement procedures of 58.7.11 for 1 Gb/s PHYs and 52.9.9 for 10 Gb/s PHYs.

Receive Sensitivity - 141.7.10

- Bill proposed:

  Receiver sensitivity is defined for test patterns in 75.7.3 (10G) and 141.7.2 (25G), and an ideal input signal quality with the specified extinction ratio. The measurement procedure is described in 52.9.8 for 10 Gb/s PHYs and 88.8.9 for 25 Gb/s PHYs. The sensitivity shall be met for the bit error ratio defined in Table 141-15, Table 141-16, Table 141-19, or 141-20 as appropriate.

Proposed RX sensitivity Text

- Umeda-san proposed:

  Receiver sensitivity, which is defined for an ideal input signal for 10 Gb/s PHYs and an input signal with VECP = 0.5 dB for 25 Gb/s PHYs, is informative and compliance is not required. If measured, the test signal should have negligible impairments such as intersymbol interference (ISI), rise/fall times, jitter and RIN. Instead, the normative is stressed receiver sensitivity.

Compliance Req:
- 1G & 10G EPON

Not req.
- 100GBASE-LR/ER

Possibly include here

Stressed receiver conformance test - 141.7.11

Bill proposed:

Compliance with stressed receiver sensitivity is mandatory for the following PMDs: 25GBASE-PQG-D2, 50/25GBASE-PQG-D2, 25GBASE-PQX-D2, 50/25GBASE-PQX-D2, 50/25GBASE-PQG-D2, 50GBASE-PQG-D2, 50/25GBASE-PQX-D2, 50GBASE-PQX-D2, 25/10GBASE-PQG-D2, 50/10GBASE-PQG-D2, 25/10GBASE-PQX-D2, 50/10GBASE-PQX-D2, 25GBASE-PQG-D3, 0/25GBASE-PQG-D3, 25GBASE-PQX-D3, 50/25GBASE-PQX-D3, 50/25GBASE-PQG-D3, 50GBASE-PQG-D3, 50/25GBASE-PQX-D3, 50GBASE-PQX-D3, 25/10GBASE-PQG-D3, 50/10GBASE-PQG-D3, 25/10GBASE-PQX-D3, and 50/10GBASE-PQX-D3. The stressed receiver conformance test is intended to screen against receivers with poor frequency response or timing characteristics that could cause errors when combined with a distorted but compliant signal. To be compliant with stressed receiver sensitivity, the receiver shall meet the specified bit error ratio at the power level and signal quality defined in Table 141-15, Table 141-16, Table 141-19, or 141-20 as appropriate, according to the measurement procedures of 52.9.9 for 10 Gb/s PHYs and 88.8.10 for 25 Gb/s PHYs.

Umeda-san proposed:

Stressed receiver sensitivity shall be within the limits given in Table 141–15, Table 141–16, Table 141–19 and Table 141–20 if measured using the method defined in 87.8.11 with the following exceptions:

a) Added sinusoidal jitter is as specified in Table 88–13 for 25 Gb/s PHYs.

b) The stressed eye J2 Jitter, stressed eye J9 Jitter, and vertical eye closure penalty are as given in Table 141–15, Table 141–16, Table 141–19 and Table 141–20.

c) The test pattern is as given in Table 88–11 for 25 Gb/s PHYs, with the exception of Pattern 5.

d) The reference receiver used to verify the conformance test signal is required to have the bandwidth given in 88.8.8 for 25 Gb/s PHYs.

100GBASE-LR4/ER4 25G Rx sensitivity (for reference)

88.8.9 Receiver sensitivity

Receiver sensitivity, which is defined for an ideal input signal, is informative and compliance is not required. If measured, the test signal should have negligible impairments such as intersymbol interference (ISI), rise/fall times, jitter and RIN. Instead, the normative requirement for receivers is stressed receiver sensitivity.

88.8.10 Stressed receiver sensitivity

Stressed receiver sensitivity shall be within the limits given in Table 88–8 if measured using the method defined in 87.8.11 with the following exceptions:

a) Added sinusoidal jitter is as specified in Table 88–13.
b) The stressed eye J2 Jitter, stressed eye J9 Jitter, and vertical eye closure penalty are as given in Table 88–8.
c) The test pattern is as given in Table 88–11.
d) The reference receiver used to verify the conformance test signal is required to have the bandwidth given in 88.8.8.

Table 88–13—Applied sinusoidal jitter

Frequency range	Sinusoidal jitter, peak-to-peak (UI)
$f < 100$ kHz	Not specified
100 kHz $< f \leq 10$ MHz	$5 \times 10^5 / f$
10 MHz $< f <$ 10 LB[a]	0.05

[a] LB = loop bandwidth; upper frequency bound for added sine jitter should be at least 10 times the loop bandwidth of the receiver being tested.

100GBASE-LR4/ER4 25G Rx sensitivity (for reference)

87.8.11 Stressed receiver sensitivity

Stressed receiver sensitivity shall be within the limits given in Table 87–8 if measured using the method described in 87.8.11.1 and 87.8.11.5 with the conformance test signal at TP3 as described in 87.8.11.2. The BER is required to be met for the lane under test on its own.

For each lane, the stressed receiver sensitivity is defined with the transmit section in operation on all four lanes and with the receive lanes not under test also in operation. Pattern 3 or Pattern 5, or a valid 40GBASE-R signal, is sent from the transmit section of the PMD under test. The signal being transmitted is asynchronous to the received signal.

Laser Timing Parameters - 141.7.13

- D1.5, p.76, L13,15
- Glen's 14 Feb 2019 proposed changes:

Here are updates/thoughts on action items 12-15:

12	Laser timing parameters	141.7.13	55	29	Ed H. Bill P.	Bill still looking
13	Receiver settling time measurements	141.7.14.1	56	49,40	Ed H. Bill P.	Bill still looking
14	Figure 141-3, timing parameters	141.7.13.2	56	41	Glen	Finished, comment submission pending
15	Receiver settling time measurements	141.7.14.2	58	37	Ed H. Bill P.	Bill still looking

Action item #12 is related to TBDs in this text:

141.7.13 Laser on/off timing measurement

T_{on} is defined in 141.7.13.1 and has the value of less than or equal to 128 ns (defined in Table 141–17 and Table 141–18).

A method for measuring $T_{receiver\_settling}$ is illustrated in 141.7.13.2 (informative) and has a value of less than {TBD} ns (defined in Table 141–15 and Table 141–16).

T_{CDR} is defined in {TBD, Clause 142} and has the value of less than {TBD} ns.

T_{off} is defined in 141.7.13.1 and has the value of less than or equal to 128 ns (defined in Table 141–17 and Table 141–18).

Section 141.7.14 (TBD=800ns)

Move to ?

14

First, paragraphs 2 and 3 are out of place here. Only paragraphs 1 and 4 should remain.
The paragraph 2 should be moved to section 141.7.~~17~~ (insert between 141.7.14 and 141.7.14.1 headers). Replace the TBD in this paragraph with 800 ns (based on the contribution from Curtis and Frank that we reviewed today.) I already made this change in Action Item #14 (see below).

Paragraph 3 should be removed from this location.
Bill and Ed need to figure out what to do with the Tcdr definition. Clause 142 talks about what ONU transmits during Tcdr time, but never provides any definition of it or measurement methodology. This is the only remaining gap for AI #12.
If we need to add an illustration of Tcdr measurement to Figure 141-3, let me know.

Laser Timing Parameters - 141.7.13

- Final proposed 141.7.13 text:

141.7.13 Laser on/off timing measurement

Ton is defined in 141.7.13.1 and has the value of less than or equal to 128 ns (defined in Table 141–17 and Table 141–18).

~~A method for measuring Treceiver_settling is illustrated in 141.7.13.2 (informative) and has a value of less than {TBD} ns (defined in Table 141–15 and Table 141–16).~~

~~TCDR is defined in {TBD, Clause 142} and has the value of less than {TBD} ns.~~

Toff is defined in 141.7.13.1 and has the value of less than or equal to 128 ns (defined in Table 141–17 and Table 141–18).

Glen and Bill will work on where and what to include for T_{CDR} between now and the comment deadline/meeting

Receiver settling time meas. - 141.7.14.1

- D1.5, p.77, L39,40
- Glen's 14 Feb 2019 proposed changes:

12	Laser timing parameters	141.7.13	55	29	Ed H. Bill P.	Bill still looking
13	Receiver settling time measurements	141.7.14.1	56	49,40	Ed H. Bill P.	Bill still looking
14	Figure 141-3, timing parameters	141.7.13.2	56	41	Glen	Finished, comment submission pending
15	Receiver settling time measurements	141.7.14.2	58	37	Ed H. Bill P.	Bill still looking

Action Item #13 is related to this text:

141.7.14.1 Definitions

$T_{receiver\_settling}$ is denoted as the elapsed time beginning from the moment that the optical power in the receiver at TP7 reaches the conditions specified in 141.7.11 and ending at the moment that the electrical signal after the PMD at TP8[i] reaches within 15 % of its steady state average power, jitter (see {TBD}). $T_{receiver\_settling}$ is presented in Figure <TBD>. The data transmitted may be any valid 256B/257B symbols (or a specific power synchronization sequence). The optical signal at TP7, at the beginning of the locking, may have any valid 256B/257B pattern, optical power level, jitter, or frequency shift matching the standard specifications.

The "Figure <TBD>" is resolved by action item #14 (see below). The only remaining gap here is to fill the jitter reference "... jitter (see {TBD})." I believe this simply should point to the OLT receiver tables 141-15/16 with Stressed Jitter parameters that Curtis and Frank presented on the call today. I already made this change in Action Item #14 (see below). If you agree with this change, we can close this action item.

- 141.7.14 Receiver settling time measurement (add text below to 141.7.14)
  A method for measuring Treceiver_settling is illustrated in 141.7.13.2 (informative) and has a value of less than ~~{TBD}~~ 800 ns (defined in Table 141–15 and Table 141–16).
- 141.7.14.1 Definitions
  "Figure <TBD>" should be replaced by "Figure 141-3"
  "…steady state average power, jitter (see TBD)" should be replaced by
  "…steady state average power and jitter (see Tables 141-15 and 141-16).
  [Note, these tables include stressed RX sensitivity and stressed eye jitter]

Example - 802.3av Receiver settling time meas.

- 10G EPON (802.3av):

75.7.15 Receiver settling timing measurement

75.7.15.1 Definitions

Denote $T_{receiver\_settling}$ as the time beginning from the time that the optical power in the receiver at TP7 reaches the conditions specified in 75.7.12 and ending at the time that the electrical signal after the PMD at TP8 reaches within 15% of its steady state parameter (average power, jitter) (see Table 75–6 for 10GBASE–PR–D1, 10GBASE–PR–D2, and 10GBASE–PR–D3, and Table 75–7 for 10/1GBASE–PRX–D1, 10/1GBASE–PRX–D2, and 10/1GBASE–PRX–D3). $T_{receiver\_settling}$ is presented in Figure 75–9. The data transmitted may be any valid 64B/66B symbols (or a specific power synchronization sequence). The optical signal at TP7, at the beginning of the locking, may have any valid 64B/66B pattern, optical power level, jitter, or frequency shift matching the standard specifications.

- Tables 75-6 & 75-7 are .3av OLT PMD RX characteristics & include stressed RX sensitivity and stressed eye jitter

Receiver settling time meas. - 141.7.14.2

- D1.5, p.79, L37
- Glen's 14 Feb 2019 proposed changes:

12	Laser timing parameters	141.7.13	55	29	Ed H. Bill P.	Bill still looking
13	Receiver settling time measurements	141.7.14.1	56	49,40	Ed H. Bill P.	Bill still looking
14	Figure 141-3, timing parameters	141.7.13.2	56	41	Glen	Finished, comment submission pending
15	Receiver settling time measurements	141.7.14.2	58	37	Ed H. Bill P.	Bill still looking

Action item #15 is related to this text:

Figure 141–5 illustrates the test setup for measuring the OLT PMD receiver (upstream) $T_{receiver\_settling}$ time. The optical PMD transmitter has well–known parameters, with a fixed known T_{on} time. After T_{on} time the parameters of the reference transmitter, at TP6 and therefore at TP7, reach within 15% of its steady state values as specified in {TBD}.

This TBD should simply reference the ONU Transmit Characteristics tables 141-17 and 141-18.

- We agree

PMA registers for C45 - 142.4.1

- D1.5, p.114, L50
- Current OLT text

142.4.1 Differential Encoder

Differential encoding as shown in Figure 142–18 shall be implemented in the OLT TX PMA for down-stream. Differential encoding is optional to use by setting the control bit in the register, as defined in <Clause 45>.

Editor's Note (to be removed prior to publication): AI for Bill to come up with a proposal for an associated Clause 45 register to control the encoder function.

X_i = Input from OLT PCS FEC encoder
Y_i = Output to OLT PMA

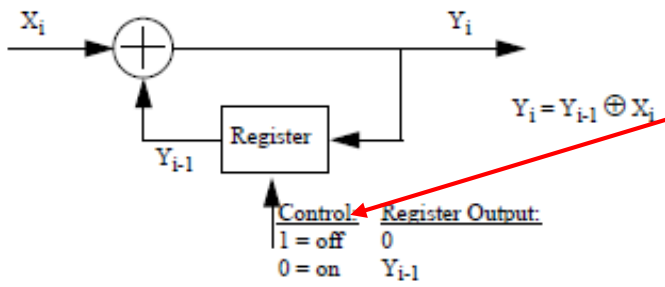

Figure 142–18—Differential encoding

Change to "Clause 45 register 1.29.15"

Remove Note

Change Name to DS_Diff_Enc
0 = off
1 = on

- Proposed changes
  - Map the OLT control bit (DS_Diff_Enc) to Clause 45 - PMA/PMD Control 3 (1.29.15; R/W)
  - Modify Table 45-26a and Fig. 142-18 accordingly
  - Note that only one "lane" needs to be specified as CL45 registers are duplicated for each 25G lane

PMA registers for C45 - 142.4.2

- Current ONU text

Change Name to
DS_Diff_Enc
0 = off
1 = on

142.4.2 Differential Decoder

Differential decoding shall be implemented in the ONU PMA RX function as shown in Figure 142–19. The ONU shall implement automatic detection of RX path differential encoding, and switch in the decoder as appropriate.

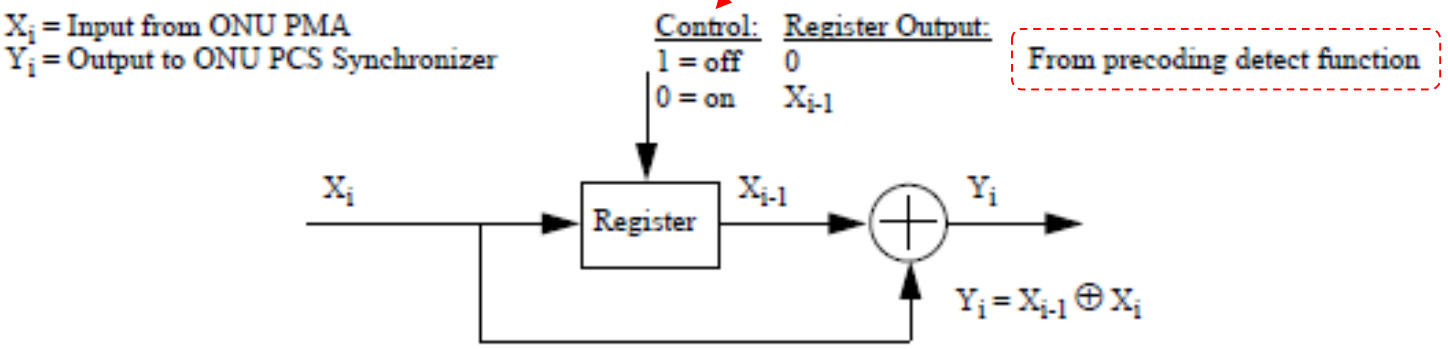

Figure 142–19—Differential decoding

- Proposed changes
  - Map the ONU Diff. Encode detection bit (DS_Diff_Enc) to Clause 45 - PMA/PMD Control 3 (1.29.15; R/W)
  - Modify Table 45-26a and Fig. 142-19 accordingly
  - Add sentence to end of 1st paragraph of 142.4.2: "The DS_Diff_Enc bit is mapped to Clause 45 ONU register 1.29.15. This bit is controlled by a local precoding detection function (outside the scope of this standard)"

C45 - Table 1:29

- Clause 45.2.1.23a changes:

1. **Add new:**
   45.2.1.23a.2 Downstream Differential Encoding (1.29.15)
   Downstream differential encoding is selected using bit 1.29.15. This bit is R/W with the default value of 0 (indicating that the downstream differential encoding is not enabled).

   In the OLT, this bit controls whether downstream differential encoding is selected for the TX PMA output.

   In the ONU, this bit indicates whether the downstream differential decoding is enabled in the ONU RX PMA.

Table 45–26a—PMA/PMD control 3 register bit definitions

Bit(s)	Name	Description	R/W[a]
1.29.15:6	Reserved	Value always 0	RO
1.29.5:0	PMA/PMD type selection	5 4 3 2 1 0 1 1 x x x x = Reserved 1 0 1 x x x = Reserved 1 0 0 1 1 1 = 50GBASE-PQX-U3 1 0 0 1 1 0 = 50GBASE-PQX-U2	R/W

2. Modify the current first row of Table 45-26a and add a new row above that one as follows:

Bits	Name	Description	R/W
1.29.15	DS_Diff_Enc	Downstream differential encoding	R/W
1.29.14:6	Reserved	Value always 0	RO

Backup

Receive Sensitivity - 1G EPON

- From 802.3ah (1G EPON):

60.9.10 Receive sensitivity measurement

Receiver sensitivity is defined for the random pattern test frame and an ideal input signal quality with the specified extinction ratio. The measurement procedure is described in 58.7.10. The sensitivity shall be met for the bit error ratio defined in Table 60–5, Table 60–8, Table 60–11, or Table 60–13 as appropriate.

60.9.11 Stressed receive conformance test

The stressed receiver conformance test is intended to screen against receivers with poor frequency response or timing characteristics which could cause errors when combined with a distorted but compliant signal at TP3. Modal (MMF) or chromatic (SMF) dispersion can cause distortion. The conformance test signal uses the random pattern test frame and is conditioned by applying deterministic jitter and intersymbol interference. If the option for stressed receiver compliance is chosen, the receiver shall meet the specified bit error ratio at the power level and signal quality defined in Table 60–5, Table 60–8, Table 60–11, and Table 60–13 as appropriate, according to the measurement procedures of 58.7.11.

25G EPON test patterns (for reference)

141.7 Definitions of optical parameters and measurement methods

The following subclauses describe definitive patterns and test procedures for Nx25G-EPON PMDs. Implementers using alternative verification methods should ensure adequate correlation and allow adequate margin such that specifications are met by reference to the definitive methods. All optical measurements, except TDP and $RIN_{15}OMA$ shall be made through a short patch cable between 2 m and 5 m in length.

141.7.1 Insertion loss

Insertion loss for SMF fiber optic cabling (channel) is defined at the wavelengths specified in Table 141–11 and Table 141–12, depending on the particular PMD. A suitable test method is described in ITU–T G.650.1.

141.7.2 Test patterns

The test patterns used in this clause shall be the same as those used for 100GBASE-LR4, as described in 88.8.1 and shown in Table 88-10, with the exception of Pattern 5. Table 88–11 shows the test patterns to be used in each measurement, unless otherwise specified, and also lists references to the subclauses in which each parameter is defined.

141.7.3 Wavelength and spectral width measurement

The center wavelength and spectral width (RMS) shall meet the specifications when measured according to TIA-455-127-A under modulated conditions using an appropriate PRBS or a valid Nx25G-EPON signal, or another representative test pattern.

NOTE—The allowable range of central wavelengths is narrower than the operating wavelength range by the actual RMS spectral width at each extreme.

141.7.4 Optical power measurements

Optical power shall meet specifications according to the methods specified in ANSI/EIA-455-95. A measurement may be made with the port transmitting any valid Nx25G-EPON signal.

141.7.5 Extinction ratio measurements

The extinction ratio shall meet the specifications when measured according to IEC 61820-2-2 with the port transmitting a valid Nx25G-EPON signal, and with minimal back reflections into the transmitter, lower than –20 dB. The test receiver has the frequency response as specified for the transmitter optical waveform measurement.

100GBASE-LR4/ER4 25G Rx test patterns (for reference)

141.7 Definitions of optical parameters and measurement methods

The following subclauses describe definitive patterns and test procedures for Nx25G-EPON PMDs. Implementers using alternative verification methods should ensure adequate correlation and allow adequate margin such that specifications are met by reference to the definitive methods. All optical measurements, except TDP and $RIN_{15}OMA$ shall be made through a short patch cable between 2 m and 5 m in length.

141.7.1 Insertion loss

Insertion loss for SMF fiber optic cabling (channel) is defined at the wavelengths specified in Table 141–11 and Table 141–12, depending on the particular PMD. A suitable test method is described in ITU–T G.650.1.

141.7.2 Test patterns

The test patterns used in this clause shall be the same as those used for 100GBASE-LR4, as described in 88.8.1 and shown in Table 88-10, with the exception of Pattern 5. Table 88–11 shows the test patterns to be used in each measurement, unless otherwise specified, and also lists references to the subclauses in which each parameter is defined.

141.7.3 Wavelength and spectral width measurement

The center wavelength and spectral width (RMS) shall meet the specifications when measured according to TIA-455-127-A under modulated conditions using an appropriate PRBS or a valid Nx25G-EPON signal, or another representative test pattern.

NOTE—The allowable range of central wavelengths is narrower than the operating wavelength range by the actual RMS spectral width at each extreme.

141.7.4 Optical power measurements

Optical power shall meet specifications according to the methods specified in ANSI/EIA-455-95. A measurement may be made with the port transmitting any valid Nx25G-EPON signal.

141.7.5 Extinction ratio measurements

The extinction ratio shall meet the specifications when measured according to IEC 61820-2-2 with the port transmitting a valid Nx25G-EPON signal, and with minimal back reflections into the transmitter, lower than –20 dB. The test receiver has the frequency response as specified for the transmitter optical waveform measurement.