

Extended EPON PMD Specifications

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1. Introduction

At IEEE 802.3 ExEPON January meeting, new power budget classes (PX30, PX40 and PRX40, PR40) have been proposed in the ZTE and Finisar joint contribution (ExEPON_1201_li_2.pdf). In order to discuss more detail PMD parameters for these new power budget classes, we believe a baseline document with detailed PMD parameter tables is needed, containing specific proposals for the new power budget classes, PX30, PX40, PRX40, and PR40.

This document is a baseline proposal to the IEEE P802.3bk Task Force and if accepted, it is expected to help develop the first version of the draft.

There are two sections in the document. Section 2 defines the power budget class and their name mapping, while Section 3 has four sub-sections, each discussing the detail optical transmit and receive specifications for PX30, PX40, PRX40, and PR40.

2. Power Budget Classes

This section defines the new power budget classes. Each power budget is further identified with a numeric representation of its class, as follows:

- PX30: symmetric-rate (1/1G) power budget, supporting the loss budget of 29 dB;
- PX40: symmetric-rate (1/1G) power budget, supporting the loss budget of 33 dB;
- PRX40: asymmetric-rate (10/1G) power budget, supporting the loss budget of 33 dB;
- PR40: symmetric-rate (10/10G) power budget, supporting the loss budget of 33 dB;

2.1 Power budgets

This section proposes primary attributes for all of the new power budgets, following the terminology specified in IEEE Std 802.3av, Table 75-1.

Table 1: PX30 and PX40 power budgets

Description	PX30-U	PX30-D	PX40-U	PX40-D	Unit
Fiber type	IEC 60793-2 B1.1, B1.3 SMF ITU-T G.652, G.657 SMF				
Number of fibers	1				
Nominal line rates	1.25	1.25	1.25	1.25	GBd
Nominal transmit wavelength	1310	1490	1310	1490	nm
Nominal wavelength tolerance	±50	±10	±20	±10	nm
Transmit direction	Upstream	Downstream	Upstream	Downstream	
Nominal Distance	20		20		km
Maximum channel insertion loss	29	29	33	33	dB
Minimum channel insertion loss	15	15	15	15	dB

Table 2: PRX40 and PR40 power budgets

Description	PRX40-U	PRX40-D	PR40-U	PR40-D	Unit
Fiber type	IEC 60793-2 B1.1, B1.3 SMF ITU-T G.652, G.657 SMF				
Number of fibers	1				
Nominal line rates	1.25	10.3125	10.3125	10.3125	GBd
Nominal transmit wavelength	1310	1577	1270	1577	nm
Nominal wavelength tolerance	±20	-2,+3	±10	-2,+3	nm
Transmit direction	Upstream	Downstream	Upstream	Downstream	
Nominal Distance	20		20		km
Maximum channel insertion loss	33	33	33	33	dB
Minimum channel insertion loss	18	18	18	18	dB

2.2 Mapping of PMDs to power budget

This section proposes mapping of PMD types to be specified by IEEE P802.3bk Task Force and the power budgets defined in Table 1 and 2. The definition format follows closely the format used in IEEE Std 802.3av, Table 75-2.

Table 3: PMD power budget mapping

Description		OLT PMDs			
		1000BASE-PX30-D	1000BASE-PX40-D	10/1GBASE-PRX40-D	10GBASE-PR40-D
ONU PMDs	1000BASE-PX30-U	PX30	N/A	N/A	N/A
	1000BASE-PX40-U	N/A	PX40	N/A	N/A
	10/1GBASE-PRX40-U	N/A	N/A	PRX40	N/A
	10GBASE-PR40-U	N/A	N/A	N/A	PR40

3. Extended EPON PMD specification

This section provides detailed PMD to MDI optical specifications for new PMDS supporting the PX30, PX40, PRX40 and PR40 power budgets.

3.1 PX30 PMD characteristics

This sub-section focused on PX30 PMD characteristics. There are two tables, Table 4 describes the transmitter optical specifications; Table 5 describes the receiver optical specifications.

Table 4: 1000BASE-PX30-D and 1000BASE-PX30-U transmit characteristics

Description	1000BASE-PX30-D	1000BASE-PX30-U	Unit
Signaling speed(range)	1.25±100 ppm	See Table 75-9, 10/1GBASE-PRX-U3 column	GBd
Wavelength (range)	1480 to 1500		nm
RMS spectral width (max)	See Table 75-10 in 802.3av		nm
Average launch power(max)	+7		dBm
Average launch power(min)	+3		dBm
Average launch power of OFF transmitter (max)	-39		dBm
Extinction ratio (min)	6		dB
RIN ₁₅ OMA (max)	-115		dB/Hz
Launch OMA (min)	3.78		dBm
Transmitter eye mask definition(X1,X2,Y1,Y2,Y3)	{0.22,0.375,0.20,0.20, 0.30}		UI
Ton (max)	N.A.		ns
Toff(max)	N.A.		ns
Optical return loss tolerance (max)	15		dB
Optical return loss ODN (min)	20		dB
Transmitter reflectance (max)	-10		dB
Transmitter and dispersion penalty (max)	1.0		dB
Decision timing offset for transmitter and dispersion penalty (min)	±0.10	UI	

Table 5: 1000BASE-PX30-D and 1000BASE-PX30-U receive characteristics

Description	1000BASE-PX30-D	1000BASE-PX30-U	Unit
Signaling speed (range)	See Table 75-7, 10/1GBASE-PRX-D3 column	1.25±100 ppm	GBd
Wavelength (range)		1480 to 1500	nm
Bit error ratio (max)		10 ⁻¹²	
Average receive power (max)		-8	dBm
Damaged threshold Damage threshold (max)		+4	dBm
Receive sensitivity (max)		-27	dBm
Receive sensitivity OMA (max)		-26.2	dBm
Signal detect threshold (min)		-44	dBm
Receive reflectance (max)		-12	dB
Stressed receive sensitivity (max)		TBD	dBm
Stressed receive sensitivity OMA (max)		TBD	dBm
Vertical eye-closure penalty (min)		1.5	dB
Treceiver-setting (max)		N.A.	ns
Stressed eye jitter (min)		0.25	UI pk to pk
Jitter corner frequency		637	kHz
Sinusoidal jitter limits for stressed receiver conformance test (min,max)		0.05,0.15	UI

3.2 PX40 PMD characteristics

This sub-section focuses on PX40 PMD characteristics. There are two tables, Table 6 describes the transmitter optical specifications; Table 7 describes the receiver optical specifications.

Table 6: 1000BASE-PX40-D and 1000BASE-PX40-U transmit characteristics

Description	1000BASE-PX40-D	1000BASE-PX40-U	Unit
Signaling speed(range)	1.25±100 ppm	1.25±100 ppm	GBd
Wavelength (range)	1480 to 1500	1290 to 1330	nm
Side Mode Suppression (min)	30	30	dB
Average launch power(max)	+7	+7	dBm
Average launch power(min)	+4	+2	dBm
Average launch power of OFF transmitter (max)	-45	-45	dBm
Extinction ratio (min)	6	6	dB
RIN ₁₅ OMA (max)	-115	-115	dB/Hz
Launch OMA (min)	4.78	2.78	dBm
Transmitter eye mask definition(X1,X2,Y1,Y2,Y3)	{0.22,0.375,0.20,0.20,0.30}	{0.22,0.375,0.20,0.20,0.30}	UI
Ton (max)	N.A.	512	ns
Toff(max)	N.A.	512	ns
Optical return loss tolerance (max)	15	15	dB
Optical return loss ODN (min)	20	20	dB
Transmitter reflectance (max)	-10	-10	dB
Transmitter and dispersion penalty (max)	1.0	1.0	dB
Decision timing offset for transmitter and dispersion penalty (min)	±0.1	±0.125	UI

Table 7: 1000BASE-PX40-D and 1000BASE-PX40-U receive characteristics

Description	1000BASE-PX40-D	1000BASE-PX40-U	Unit
Signaling speed (range)	1.25±100 ppm	1.25±100 ppm	GBd
Wavelength (range)	1260 to 1360	1480 to 1500	nm
Bit error ratio (max)	10^{-12}		
Average receive power (max)	-8	-8	dBm
Damaged threshold Damage threshold (max)	-3	-3	dBm
Receive sensitivity (max)	-32	-30	dBm
Receive sensitivity OMA (max)	-31.2	-29.2	dBm
Signal detect threshold (min)	-45	-44	dBm
Receive reflectance (max)	-12	-12	dB
Stressed receive sensitivity (max)	TBD	TBD	dBm
Stressed receive sensitivity OMA (max)	TBD	TBD	dBm
Vertical eye-closure penalty (min)	2.2	1.5	dB
Receiver-setting (max)	400	N.A.	ns

Stressed eye jitter (min)	0.28	0.25	UI pk to pk
Jitter corner frequency	637	637	kHz
Sinusoidal jitter limits for stressed receiver conformance test (min,max)	0.05,0.15	0.05,0.15	UI

3.3 PRX40 PMD characteristics

This sub-section focuses on PRX40 PMD characteristics. There are two tables, Table 8 describes the transmitter optical specifications; Table 9 describes the receiver optical specifications.

Table 8: 10/1GBASE-PRX40-D and 10/1GBASE-PRX40-U transmit characteristics

Description	10/1GBASE-PRX40-D	10/1GBASE-PRX40-U	Unit
Signaling speed(range)	10.3125±100 ppm	1.25±100 ppm	GBd
Wavelength (range)	1575 to 1580	1290 to 1330	nm
Side Mode Suppression Ratio (min)	30	30	dB
Average launch power(max)	+9	+7	dBm
Average launch power(min)	+5	+2	dBm
Average launch power of OFF transmitter (max)	-39	-45	dBm
Extinction ratio (min)	6	6	dB
RIN ₁₅ OMA (max)	-128	-115	dB/H z
Launch OMA (min)	5.78	2.78	dBm
Transmitter eye mask definition (X1,X2,X3,Y1,Y2,Y3) / (X1,X2,,Y1,Y2,Y3)	{0.25,0.40,0.45,0.250, 28,0.40}	{0.22,0.375,0.20,0.20, 0.30}	UI
Ton (max)	N.A.	512	ns
Toff(max)	N.A.	512	ns
Optical return loss tolerance (max)	15	15	dB
Transmitter reflectance (max)	-10	-10	dB
Transmitter and dispersion penalty (max)	1.5	1.0	dB
Decision timing offset for transmitter and dispersion penalty (min)	±0.05	±0.125	UI

Table 9: 10/1GBASE-PRX40-D and 10/1GBASE-PRX40-U receive characteristics

Description	10/1GBASE-PRX40-D	10/1GBASE-PRX40-U	Unit
Signaling speed (range)	1.25±100 ppm	10.3125±100 ppm	GBd
Wavelength (range)	1260 to 1360	1575 to 1580	nm
Bit error ratio (max)	10 ⁻¹²	10 ⁻³	
Average receive power (max)	-11	-9	dBm
Damage threshold Damage threshold (max)	-5	-5	dBm

Receive sensitivity (max)	-32	-29.5	dBm
Receive sensitivity OMA (max)	-31.2	-28.7	dBm
Signal detect threshold (min)	-45	-44	dBm
Receive reflectance (max)	-12	-12	dB
Stressed receive sensitivity (max)	TBD	TBD	dBm
Stressed receive sensitivity OMA (max)	TBD	TBD	dBm
Vertical eye-closure penalty (min)	1.4	1.5	dB
Receiver-setting (max)	400	N/A	ns
Stressed eye jitter (min)	0.28	0.3	UI pk to pk
Jitter corner frequency	637	4000	kHz
Sinusoidal jitter limits for stressed receiver conformance test (min,max)	(0.05,0.15)	(0.05,0.15)	UI

3.4 PR40 PMD characteristics

This sub-section focuses on PR40 PMD characteristics. There are two tables, Table 10 describes the transmitter optical specifications; Table 11 describes the receiver optical specifications.

Table 10: 10GBASE-PR40-D and 10GBASE-PR40-U transmit characteristics

Description	10GBASE-PR40-D	10GBASE-PR40-U	Unit
Signaling speed(range)	10.3125±100 ppm	10.3125±100 ppm	GBd
Wavelength (range)	1575 to 1580	1260 to 1280	nm
Side Mode Suppression Ratio (min)	30	30	nm
Average launch power(max)	+9	+10	dBm
Average launch power(min)	+5	+6	dBm
Average launch power of OFF transmitter (max)	-39	-45	dBm
Extinction ratio (min)	6	6	dB
RIN ₁₅ OMA (max)	-128	-128	dB/Hz
Launch OMA (min)	5.78	6.78	dBm
Transmitter eye mask definition(X1,X2,X3,Y1,Y2,Y3)	(0.25,0.40,0.45,0.25,0.28,0.40)	(0.25,0.40,0.45,0.25,0.28,0.40)	UI
Ton (max)	N.A.	512	ns
Toff(max)	N.A.	512	ns
Optical return loss tolerance (max)	15	15	dB
Transmitter reflectance (max)	-10	-10	dB
Transmitter and dispersion penalty (max)	1.5	2	dB
Decision timing offset for transmitter and dispersion penalty (min)	±0.05	±0.0625	UI

Table 11: 10GBASE-PR40-D and 10GBASE-PR40-U receive characteristics

Description	10GBASE-PR40-D	10GBASE-PR40-U	Unit
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Signaling speed (range)	10.3125±100 ppm	10.3125±100 ppm	GBd
Wavelength (range)	1260 to 1280	1575 to 1580	nm
Bit error ratio (max)	10^{-3}		
Average receive power (max)	-9	-9	dBm
Damaged threshold Damage threshold (max)	-5	-5	dBm
Receive sensitivity (max)	-29	-29.5	dBm
Receive sensitivity OMA (max)	-28.2	-28.7	dBm
Signal detect threshold (min)	-45	-44	dBm
Receive reflectance (max)	-12	-12	dBm
Stressed receive sensitivity (max)	TBD	TBD	dB
Stressed receive sensitivity OMA (max)	TBD	TBD	dBm
Vertical eye-closure penalty (min)	2.99	1.5	dB
Treceiver-setting (max)	800	N/A	ns
Stressed eye jitter (min)	0.3	0.3	UI pk to pk
Jitter corner frequency	4	4	MHz
Sinusoidal jitter limits for stressed receiver conformance test (min,max)	(0.05,0.15)	(0.05,0.15)	UI

4. Conclusions

This document, intended to become a baseline proposal for PX30, PX40, PRX40 and PR40 power budgets and specific OLT and ONU PMDs for these power budgets, where parameters for individual PMDs are derived from contribution ExEPON_1201_li_2.pdf, presented at IEEE 802.3 ExEPON January meeting.

We suggest that this document is adopted as a baseline proposal for further development and serves as a base for creation of the first version of the draft for P802.3bk Task Force.