

Proposed Set Of Three 10 Gigabit Ethernet PMDs & Related Specifications

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Purpose

- To propose a set of three PMD implementations that meet all the distance objectives of P802.3ae.
- The set consists of :
 - WWDM at 1310 nm
 - Serial at 1310 nm
 - Serial at 1550 nm
- Target specifications for these three PMDs are described
- There will be separate presentations on other PMD cases

Figure 38-1 (equivalent for WWDM)

- This is the same for WWDM on a per lane basis

802.3z Figure 38-1 shows PMA, PMD, Fiber Optic Cabling (channel) and four test points



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Table 38-6 (equivalent for WWDM)

Operating range for 10000BASE-LX WWDM over each optical fiber type

Fiber type	Modal BW @ 1300 nm (min. overfilled launch) (MHz*km)	Minimum range (meters)
62.5 um MMF	500	2-300
50 um MMF	400	2-240
50 um MMF	500	2-300
10 um SMF	N/A	2-10,000

Table 38-7 (equivalent for WWDM)

10000BASE-LX WWDM transmit characteristics

Description	62.5 um MMF, 50 um MMF, 10 um SMF	Unit
Transmitter type	Longwave Laser	
Signaling speed per lane (range)	3.125 +/- 100 ppm	GBd
Wavelength (range), four lanes	1270-1355	nm
Lane center wavelengths	1275.7, 1300.2, 1324.7, 1349.2	nm
Lane separation	+/- 5.7 24.5	nm
Trise/Tfall (max. 20-80% response time)	100	ps
Side-mode suppression ratio (SMSR), (min)	0.0	dB
RMS spectral width (max)	0.62	nm
Average launch power, four lanes (max)	3.5	dBm
Average launch power, per lane (max)	-2.5	dBm
Average launch power, per lane (min)	-7.5	dBm
Avg. launch power of OFF transmitter, per lane (max)	-30	dBm
Extinction ratio, (min)	7	dB
RIN (max)	-120	dB/Hz

Table 38-8 (equivalent for WWDM)

10000BASE-LX WWDM receive characteristics

Description	62.5 um MMF 50 um MMF	10 um SMF	Unit
Signaling speed per lane (range)	3.125 +/- 100 ppm		GBd
Wavelength (range), four lanes	1270 to 1355		nm
Lane center wavelengths	1275.7, 1300.2, 1324.7, 1349.2 +/- 5.7		nm
Lane separation	24.5		nm
Average receive power, four lanes (max)	3.5		dBm
Average receive power, per lane (max)	-2.5		dBm
Return loss (min)	12		dB
Receive electrical 3 dB upper cutoff frequency (max)	3750		MHz
Receive sensitivity	-15.5	-16.5	dBm
Stressed receive sensitivity	-10.3	-15.0	dBm
Vertical eye closure penalty	3.60	0.74	dB

Table 38-9 (equivalent for WWDM)

Worst case 10000BASE-LX WWDM link power budget and penalties

Parameter	62.5 um MMF	50 um MMF		10 um SMF	Unit
Modal bandwidth as measured at 1300 nm, (min, overfilled launch)	500	400	500	N/A	MHz*k m
Link power budget	8.0	8.0	8.0	9.0	dB
Operating distance	300	240	300	10,000	m
Lane insertion loss	2.46	2.37	2.46	7.14	dB
Link power penalties	4.63	5.13	5.13	1.82	dB
Unallocated margin in link power budget	0.91	0.50	0.41	0.04	dB

Note 1: MMF parameters are calculated with link model having DCD_DJ = 25.0 ps

Note 2: SMF parameters are calculated with link model having DCD_DJ = 20.5 ps

Table 38-10 (equivalent for WWDM)

10000BASE-LX WWDM jitter budget

Compliance point	Total jitter		Deterministic jitter	
	UI	ps	UI	ps
TP1	0.240	76.8	0.100	32.0
TP1 to TP2	0.284	90.9	0.100	32.0
TP2	0.431	138.0	0.200	64.0
TP2 to TP3	0.170	54.4	0.050	16.0
TP3	0.510	163.4	0.250	80.0
TP3 to TP4	0.332	106.2	0.212	67.8
TP4	0.749	239.6	0.462	147.8

Figure 38-1 (equivalent for serial SMF links)

- Almost the same as in 802.3z
- The mode conditioning patch cord does not apply
- TP1 and TP4 are not likely to be physically accessible interfaces

(802.3z Figure 38-1 shows PMA, PMD, Fiber Optic Cabling (channel) and four test points)



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Table 38-6 (equivalent for Serial SMF links)

Operating range for serial links using 10 um SMF links with two source types

Fiber type	Source Type	Target range (meters)
10 um SMF	1310 nm Laser	2-10,000
	1550 nm Modulator	2-40,000

Note 1. Operating ranges are targets because the attenuation of the outside plant is not guaranteed by standards.

Note 2. Shortest 1550 nm links may require an attenuator to avoid over-driving the receiver.

Table 38-7 (equivalent for Serial SMF links)

Transmit characteristics for serial 10 um SMF links

Description	Value		Unit
	Single longitudinal mode laser	Modulator	
Transmitter type	Single longitudinal mode laser	Modulator	
Signaling speed (range)	10.3125 +/- 100 ppm		GBd
Wavelength (range),	1290-1330*	1530-1565	nm
Trise/Tfall (max. 20-80% response time)	40	33	ps
Side-mode suppression ratio (SMSR), (min)	30.0*	30.0*	dB
RMS spectral width (max)	0.40*	0.034*	nm
Average launch power, (max)	1.0	+2	dBm
Average launch power, (min)	-4.0	-2	dBm
Avg. launch power of OFF transmitter, (max)	-30		dBm
Extinction ratio, (min)	6*	8*	dB
RIN (max)	-130	-140	dB/Hz

❖ Notes on following slide

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Table 38-7 (continued)

- Note 1: Change to Optical Modulated Amplitude (OMA) specification is proposed (actually OMA is a power).
- Note2: The 1310 nm link spectral characteristics are being review to possibly accommodate 1300 nm VCSELs.
- Note 3: The low spectral width of 1550 nm link is a temporary representation, a placeholder, for further work to be done regarding dispersion accommodation.
- Note 4: The 1310 nm case uses directly modulated laser where low extinction ratio helps the laser speed. The 1550 nm case uses a modulator which can deliver high extinction ratio. 8 dB is near the ITU/SONET specification.
- Note 5: SMSR reduction may improve cost effectiveness. This is currently under review.

Table 38-8 (equivalent for Serial SMF links)

Receive characteristics for serial 10 um SMF links

Description	Value		Unit
Signaling speed (range)	10.3125 +/- 100 ppm		GBd
Wavelength (range)	1290-1330	1530-1565	nm
Average receive power, (max)	1.0	-8.0	dBm
Receive sensitivity	-14.0	-20.0*	dBm
Return loss (min)	12		dB
Stressed receive sensitivity	-11.45	-15.41	dBm
Vertical eye closure penalty	1.71	2.72	dB

*Note: This is too optimistic. Further design work needed.

Table 38-9 (equivalent for Serial SMF links)

Worst case 10000BASE-LX Serial 10 um SMF link power budget and penalties

Parameter	1310 nm transmitter	1550 nm transmitter	Unit
Link power budget	10.0	18.0	dB
Operating distance	10	40	km
Link insertion loss	7.04	13.0	dB
Link power penalties	2.27	3.36	dB
Unallocated margin in link power budget	0.69	1.64	dB

Note 1: Table parameters are calculated with link model having DCD_DJ = 8.0 ps

Table 38-10 (equivalent for Serial SMF links)

10000BASE-LX serial SMF link jitter budget

Compliance point	Total jitter		Deterministic jitter	
	UI	ps	UI	ps
TP1	0.240	23.3	0.100	9.7
TP1 to TP2	0.284	27.5	0.100	9.7
TP2	0.431	41.8	0.200	19.4
TP2 to TP3	0.170	16.5	0.050	4.8
TP3	0.510	49.5	0.250	24.2
TP3 to TP4	0.332	32.2	0.212	20.6
TP4	0.749	72.6	0.462	44.8

Further Work

- WWDM specifications are stable.
- Serial link specification issues (indicated by *)
 - Operating ranges are targets due to unspecified fiber loss
 - Optical modulated amplitude (OMA) may replace extinction ratio (ER)
 - SMSR reduction will be reviewed to explore performance/cost trade-off
 - Serial jitter budgets will benefit from optimization work
- Additional 1550 nm 40 km link specifications issues
 - Spectral width and receive sensitivity will be reconsidered
 - Increasing the link length beyond 40 km will need OC-192 optical engineering. Shortest links require an attenuator.
 - It is likely that the 40 km specification can be achieved without using optical amplifiers or avalanche photodiodes.