

Availability of 10G Transmitters, Receivers and Amplifiers

High Split Ratio Ad Hoc - Task 3

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Introduction

□ This presentation focuses on showing current availability of optical 10G devices such as transmitters, receivers and optical amplifiers

□ Questionnaire

- Available OLT Tx output power (1550 nm)**
- Available ONT Tx output power (1310 nm)**
- Available Rx sensitivity (1310 ~ 1550 nm)**
- Available output power with optical booster amplifier (1550 nm)**
- Available gain of optical preamplifier (1310nm)**

Availability of 10G Transmitters

- ❑ 1550nm lasers are mainly EML, the minimum output power is available at -3 ~ +1 dBm
- ❑ 1310nm lasers are both EML and DML, the minimum output power is at -5 ~ +2 dBm
- ❑ 1490nm lasers are currently not available on the market

Vendor	Wavelength (nm)	Type	Pout (dBm)			Wavelength (nm)	Type	Pout (dBm)			
			min	typ	max			min	typ	max	
A	1530 ~ 1565 (‘C’ band)	EML	0.0	1.0		1260 ~ 1360 (‘O’ band)	DML	-3.0			
B		EML	-2.5								
		EML	-3.0		-1.0						
		EML	0.0		2.5						
		EML	0.5		4.0						
		EML	0.0		2.0						
C		EML	-1.0		2.0			EML	-5.0		
		EML	0.0		4.0			EML	0.0		
D								EML	2.0		
D		EML	1.0								
E		EML	-2.0		2.0						
F		EML	-1.0	0.5	2.0						
G		EML	0.0								
H		EML	-1.0					DML	-3.0		
I		EML	-1.0		2.0			EML	-4.0		
								EML	-5.5		

Availability of 10G Receivers

- ❑ 10G receiver sensitivity is typically
 - < -18 dBm for pin PD with TIA and
 - < -26 dBm for APD with TIA, respectively

Vendor	Type	Overload (dBm)		Sensitivity (dBm)	
		min	typ	typ	max
A	PIN			-20.5	-19.0
		2.0		-19.0	-18.0
		1.0	3.0	-19.0	-18.0
		0.0	2.0	-21.0	-20.0
		1.0	2.0	-19.5	-18.5
			3.0	-17.0	
			3.0	-18.0	
B				-	-18.0
C				-	-20.0
D				-	-17.0
E				-	-17.0
A	APD			-28.5	-27.0
B		-4.0	-2.0	-	-27.0
		-4.0	-2.0	-26.0	-25.5
		-4.0	-2.0	-	-25.0
		-4.0	-2.0	-27.0	-25.0
C				-	-27.0
D				-	-27.0
E	-7.0	-5.0	-27.0	-26.0	

Availability of SOAs

- ❑ Off the shelf in the spectral band of 1550 nm and 1310 nm
- ❑ Saturation power is > 11 dBm typically, and 14 dBm maximum
- ❑ Gain is > 10 dB typically, and 22 dB maximum

Vendor	Wavelength (nm)	Gain (dB)			3dB Saturation Power (dBm)		NF (dB)
		min	typ	max	min	typ	typ
A	1310		14.0			11.0	8.0
B		18.0	22.0			10.0	7.0
C		13.0	16.0		10.0		7.0
		10.0			8.0		6.0
		16.0			8.0	6.0	
A	1550		14.0			13.0	7.0
		4.0		8.0		13.0	7.0
B		10.0	13.0		12.0	14.0	8.0
C		12.0	15.0			10.0	9.0
		18.0	20.0			10.0	9.0
D		20.0			10.0	11.0	6.0
		10.0			10.0	11.0	6.0
		15.0			12.0	13.0	6.0
E	10.0		16.0	14.0		6.5	

Availability of EDFAs (1550 nm)

- ❑ Single channel EDFA, only in 1550nm band
- ❑ Typical output power is > 12 dBm, and maximum is 27 dBm
- ❑ Typical gain is > 13 dB, and 30 dB maximum
- ❑ Even though compact, EDFA modules are much bigger than SOA
- ❑ PDFA for O band (1260 ~ 1360 nm) and TDFAs for S band (1460 ~ 1530 nm) are not widely used

Vendor	Wavelength (nm)	Output power (dBm)			Gain (dB)			NF (dB)	Note
		min	typ	max	min	typ	max	typ	
A	1530 ~ 1560 (‘C’ band)			20.0		25.0		5.0	BA
				3.0	13.0		30.0	5.0	PA
				15.0		20.0		5.2	PA
B		10.0				25.0		5.0	PA
		15.0				25.0		6.2	PA
C		12.0						5.2	BA
		14.0						6.0	BA
		15.0						6.0	PA
D				17.0		24.0		6.0	PA
E		15.0						6.5	BA, LA
		27.0						6.5	BA, LA
F		14.0						6.5	BA, LA
	17.0						6.5	BA, LA	
	19.0						6.5	BA, LA	
	22.0						6.5	BA, LA	

Summary – Available Parameters

Questionnaire		Wavelength	Power / Sensitivity	Gain / Loss
Minimum OLT Tx power	EML	1550 nm	1 dBm	-
Minimum ONT Tx power	EML	1310 nm	2 dBm	-
	DML		-3 dBm	-
Maximum Rx sensitivity	PIN	1310/1550 nm	-18 dBm	-
	APD		-26 dBm	-
Available output power with OA	SOA	1550 nm	11 ~ 14 dBm	10 ~ 22 dB
	EDFA		12 ~ 27 dBm	13 ~ 30 dB
Available gain with OA	SOA	1310nm	-	10 ~ 22 dB

Comparison of PMD Configurations

PMD Configurations

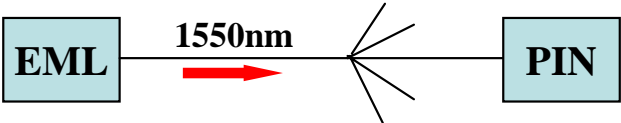
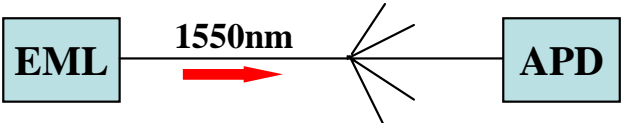
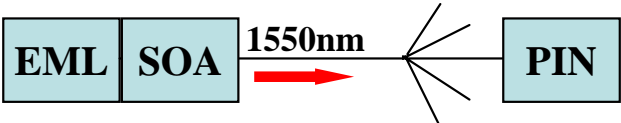
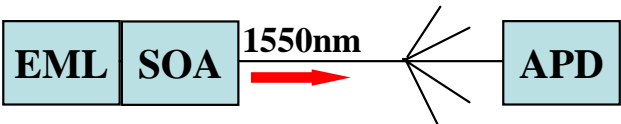
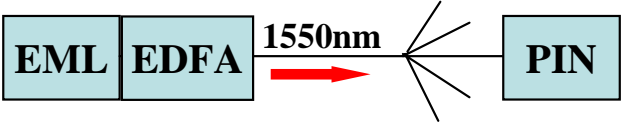
❑ Assumptions about PMD parameters

- Limitation of Tx output power due to SBS: 17 dBm (w/ frequency dithering)
- Optical preamplifier gain: 10 dB
- FEC gain: 4 dB

❑ Assumptions about optic costs

- EML TOSA is 10 times more expensive than pin PD ROSA
- Uncooled DML TOSA is 2 times more expensive than pin PD ROSA
- APD ROSA is 3 times more expensive than pin PD ROSA
- SOA is 20 times more expensive than pin PD ROSA
- EDFA is 40 times more expensive than pin PD ROSA

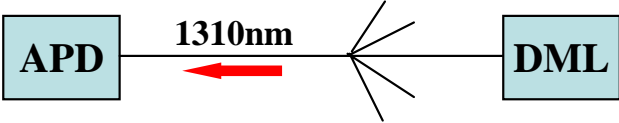
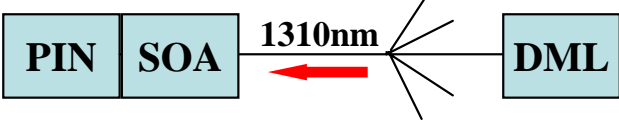
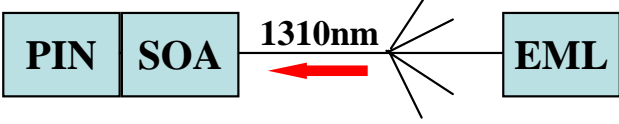
PMD Configurations – 10G Downstream

#	Configuration	Tx Power [dBm]	Rx Sen. [dBm]	FEC Gain [dB]	Power Budget [dB]	Split Ratio & Dist.	Relative Optic Cost per Subscriber
D1		1	-18	(4)	19 (23)	1:16 10km	1X
D2		1	-26	(4)	27 (31)	1:32 20km	2.0X
D3 ²⁾		11	-18	(4)	29 (33)	1:64 10km	0.9X
D4 ²⁾		11	-26	(4)	37 (41)	1:128 20km	2X
D5 ²⁾		17 ¹⁾	-18	(4)	35 (39)	1:128 10km	0.9X

1) Tx output power limitation due to SBS with frequency dithering

2) May require an optical band pass filter at Tx

PMD Configurations – 10G Upstream

#	Configuration	Tx Power [dBm]	Rx Sen. [dBm]	FEC Gain [dB]	Power Budget [dB]	Split Ratio	Relative Optic Cost per Subscriber
U1		-3	-26	(4)	23 (27)	1:16 20km	1X (1.3X) ²⁾
U2		-3	-28	(4)	25 (29)	1:32 10km	1.2X (1.6X) ²⁾
U3 ¹⁾		2	-28	(4)	30 (34)	1:64 10km	4.7X (6.4X)

1) May require an optical band pass filter

2) Compared to D1 of 10G downstream