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25G PON lasers: vendor survey

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Supporters:

- Steven Huang, **Applied Optoelectronics**
- John Johnson, **Broadcom**
- David Li and Qisheng Zhao, **Hisense Broadband**
- Erick Yang and Padman Parayanthal, **Macom**
- Naoki Suzuki, **Mitsubishi**
- Zhigang Gong, **O-Net**
- Barry Colella and Mark Heimbuch, **Source Photonics**
- Tomoyuki Funada, **Sumitomo**

Introduction

- One year ago, Nokia surveyed vendors for performance and cost data on prospective 25G PON devices
  - The results were aggregated and submitted to 802.3ca in harstead_3ca_1a_0716.pdf
- 802.3ca is now close to determining the final power levels for 25G EPON PR30 loss budget (29 dB). Final determinations depend on FEC and TDP decisions, but we are within +/- 1 dB.
- Therefore it is timely to re-survey the vendors, to see if there has been any evolution in component forecasts, in particular on the 25G laser side.
- Changes from last questionnaire:
  - EML + SOA post-amp has been added. Our objective is to avoid SOAs for 25G PON, but the information will be useful.
  - Target date moved to 2021
- The questionnaire was sent to 10 vendors of Laser/EML chips / TO-cans, PON BOSAs / pluggable modules
- Written responses were received from 8 vendors
- Changes from last year's questionnaire are small.

Results

Questionnaire: launch power and ER

25G SMF laser launch power and ER

- What is the maximum AVP_{min} (minimum average power) and minimum ER for an EML and/or DML laser?
- Conditions:
  - NRZ modulation
  - launched from a low-cost PON BOSA with a 45° diplexer
  - over I-temp, EOL
  - for low cost (i.e. high yield) volume deployment in year 2021.
- Except for EML+SOA, minimum targets shown in parentheses- but more would be helpful

Device	Wavelength	Wavelength tolerance	AVP_{min} (dBm)	ER_{min} (dB)
EML	O+ band	+/- 1.5 nm	**(5)**	**(8)**
EML+SOA	O+ band	+/- 1.5 nm		
cooled DML	O- band	+/- 10 nm	**(7)**	**(6)**
uncooled DML	O- band	+/- 10 nm	**(6)**	**(5)**

Launch power and ER: responses

AVPmin (dBm)	number	mean	σ
EML	6	4.6	0.7
EML+SOA	3	8.7	2.0
cooled DML	6	6.5	0.5
uncooled DML	5	4.7	1.0
ER (dB)			
EML	6	7.5	0.8
EML+SOA	3	7.3	1.2
cooled DML	6	5.2	1.0
uncooled DML	5	4.6	0.7

Notes:

- "number" = number of responses
- "mean" = the average value of the responses. When a vendor gave a range for a value, the midpoint of that range was used.
- "σ" = the standard deviation of the responses.

Questionnaire: relative cost

25G SMF laser cost

For the specifications in the previous slide:

What do you estimate will be the cost of a 25G laser in TO-can relative to a 10G EML in TO-can at similar volumes in the year 2021?

Device	Relative cost
10G EML	1
25G EML	
25G EML + SOA	
25G cooled DML	
25G uncooled DML	

Relative cost: responses

Laser cost (TO-can) relative to 10G EML			
	number	mean	σ
25G EML	8	1.8	0.6
25G EML + SOA	5	5.2	3.4
25G cooled DML	8	1.2	0.5
25G uncooled DML	7	0.8	0.3

Notes:
- "number" = number of responses
- "mean" = the average value of the responses. When a vendor gave a range for a value, the midpoint of that range was used.
- "σ" = the standard deviation of the responses.

Discussion

EML: discussion

EML	number	mean	σ
AVPmin (dBm)	7	4.6	0.6
ER (dB)	7	7.6	0.8
Relative cost	8	1.8	0.6
EML+SOA	number	mean	σ
AVPmin (dBm)	3	8.7	2.0
ER (dB)	3	7.3	1.2
Relative cost	5	5.2	3.4

EML

- Note: 4 vendors support 5 dBm AVP_{min} / 8 dB ER.

EML+SOA

- About 4 dB more launch power obtained from an SOA post amp.
- But at ~3x the cost (however note the wide variance on EML+SOA relative cost).

DML: discussion

cooled DML	number	mean	σ
AVPmin (dBm)	6	6.5	0.5
ER (dB)	6	5.2	1.0
Relative cost	8	1.2	0.5

uncooled DML	number	mean	σ
AVPmin (dBm)	5	4.7	1.0
ER (dB)	5	4.6	0.7
Relative cost	7	0.8	0.3

- Based on average responses, the uncooled DML will save 33% from the cooled DML.
- But the uncooled DML has 1.8 dB lower launch power and 0.6 dB lower ER
- This lower performance costs 2.2 dB in OMA.

Recommendations

- 25G OLT
  - **5 dBm AVP_{min} / 8 dB ER** based on EML is a reasonable specification for PR30.
  - EML+SOA can mitigate risk for early implementations.
- 25/10 ONU
  - Will use a high-volume low-cost 10G EPON ONU uncooled DML. The 25/10 ONU solves the 25G PON ONU cost problem for mass deployment.
- 25/25 ONU
  - **6.5 dBm AVP_{min} / 5 dB ER** based on cooled DML is a reasonable specification for PR30. (EML+SOA could be used to mitigate risk for early implementations).
  - The uncooled DML would fall 1.8 dB short on AVP_{min} and 0.4 dB short on ER in 2021. However during the life of 25G PON there will be opportunity to make the necessary improvements.
  - Do not base the PR30 specification on the uncooled laser. For 33% cost savings, this will force ~2 dB more stringent OLT receiver sensitivity that will likely require all OLTs to use SOA+PIN receivers throughout the life of 25G PON.
  - (The PR20 spec can be based on the uncooled DML).


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