100G-BASE-WDM4 optical budget constraints

Contributors

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Introduction

- One of P802.3bm adopted objectives :
  "Define a 100 Gb/s PHY for operation up to at least 500 m of SMF"

- 100G-BASE-WDM4 PMD has been proposed
  vlasov_01a_1112_optx

  - 4ch CWDM, Uncooled, Retimed
  - Single die DFB laser array
  - Channel insertion loss up to 3.5dB
  - Link reach up to 2km

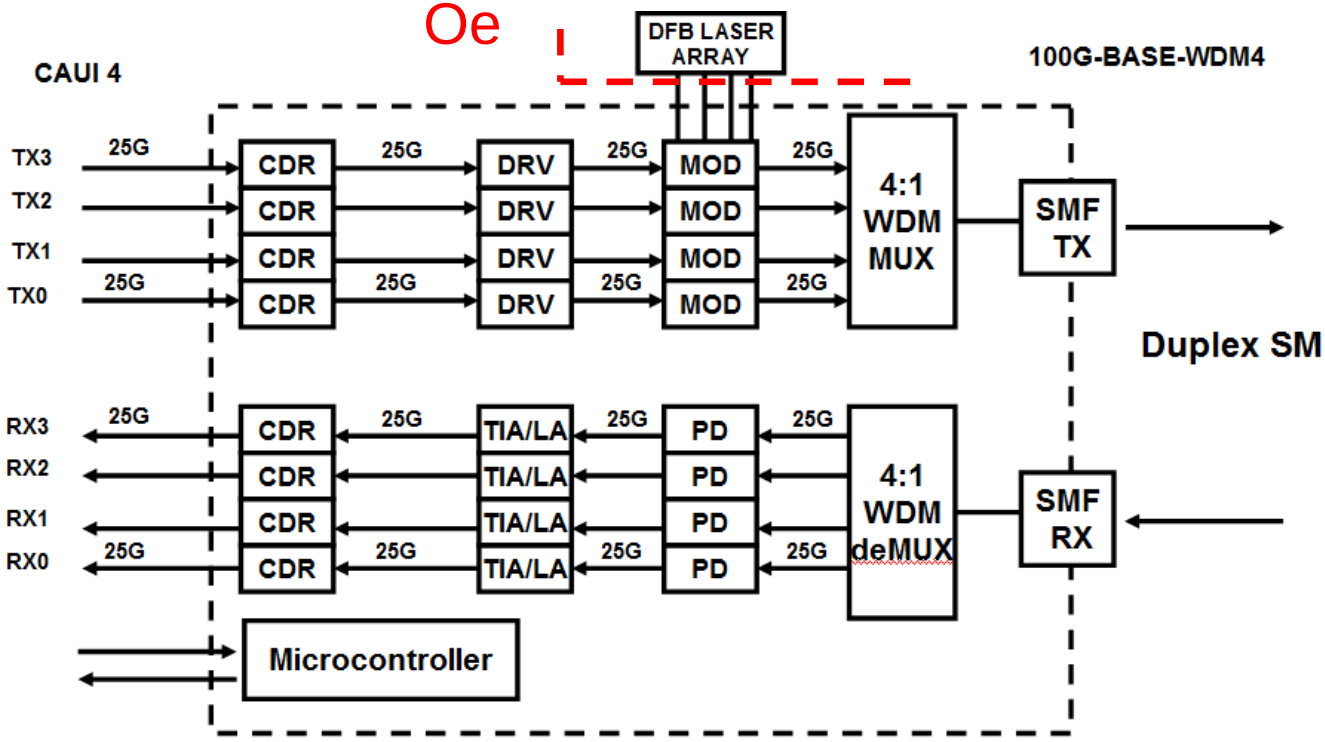
- TF November 2012 Plenary Meeting Question:
  - Is uncooled CWDM DFB laser array at elevated temperatures feasible?

- Impact of elevated case temperatures on 100G-BASE-WDM4 optical budget is discussed

Proposed 100G-BASE-WDM4 Link Budget

Reference:100GBASE-WDM4 illustrative link power budget (vlasov_01a_1112_optx)

- Channel insertion loss is defined as 3.5dB for a 2km link
- It is defined for case temperature 0°C – 70°C in the BOL as stated in NEBS GR-63



100G-Base-WDM4 block diagram from vlasov_01a_1112_optx

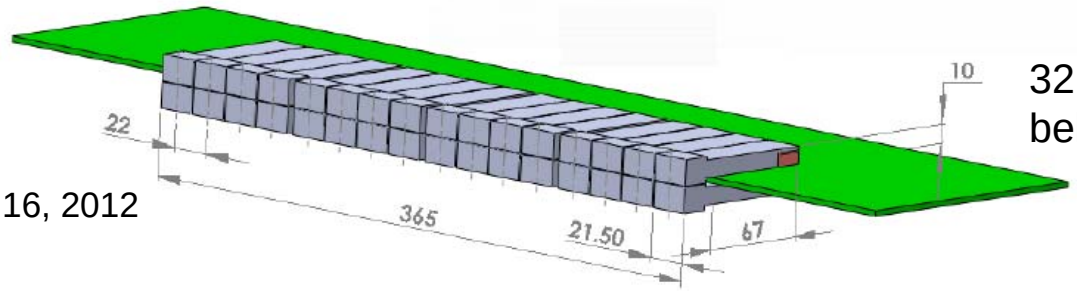
- Link budget implies laser average output power of 13dBm (20mW) at Oe

Question:

Is uncooled CWDM DFB laser array at elevated temperatures feasible?

- Temperatures higher than 70°C can be expected at the card edge with dense ports
- Laser temperature can significantly exceed that

Example:

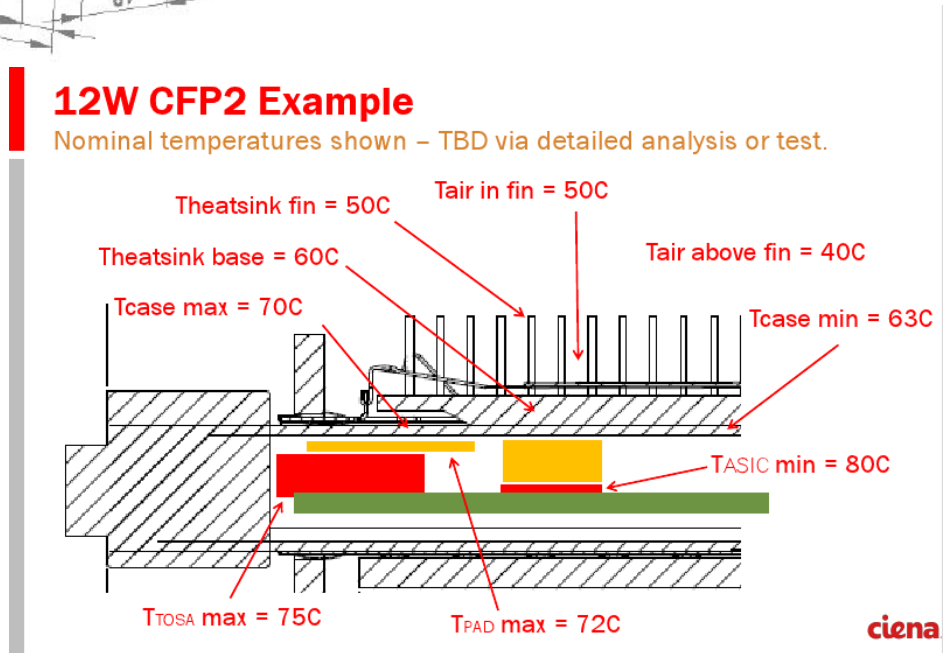


32 CFP4 or 36 QSFP28 belly-to-belly

www.cfp-msa.org, March 16, 2012

Solution: Design better package/vent

- Decrease module power <3W
- Direct air flow via baffles or ducting
- Reduce thermal resistance
- Increase heatsink area
- Add heatpipes



Scott Kipp and Terry Graham, "PLUGGABLE MODULE HEATSINK REQUIREMENTS", Google Thermal Modeling Group, August 15th, 2012

Conclusion: Temperature difference of 5-10°C is feasible

Answer :

Existing 4ch CWDM DFB array can support 100G-BASE-WDM4 power budget for 2km link at elevated temperatures

- CyOptics 4 channel DFB arrays
  - Based on CyOptics high volume manufacturing platform (millions shipped)
  - CWDM channel grid 1270, 1290, 1310 and 1330nm
  - Array not optimized for CW operations (originally designed for direct modulation)
  - λ/4 shifted DFBs and spot size converters decrease slope efficiency
  - Additional performance difference due to use of λ/4 shifted DFBs and spot size converters in DFB array

- Performance in comparison with discrete single-channel DFB

Slope Efficiency	Discrete	Array	Unit
25C	0.44	0.35	W/A
75C	0.31	0.21	W/A
85C	0.29	0.19	W/A

  - At 75C slope efficiency of array degraded vs discrete laser diode
  - The array design and slope efficiency can be optimized for CW operation

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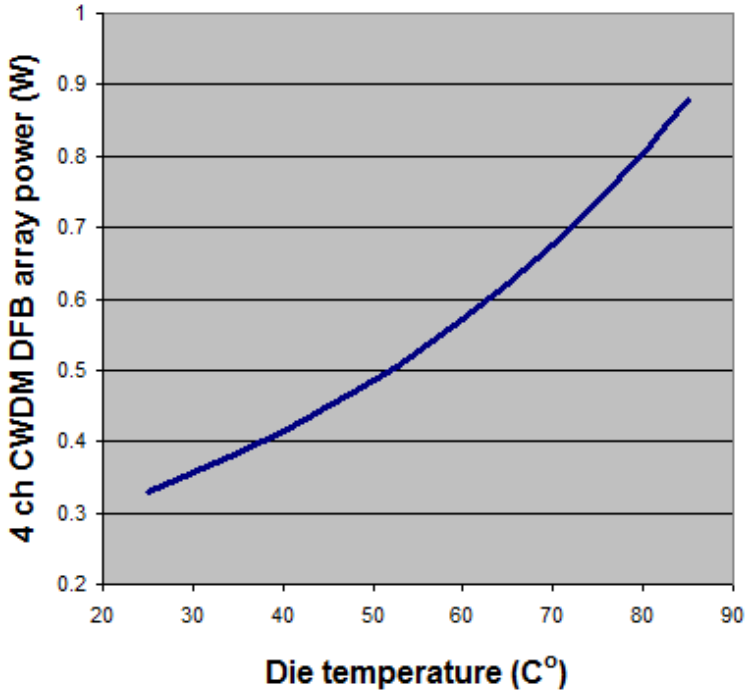
Impact on total module power

DFB CWDM Array bias currents needed to achieve 20mW at 75C

Discrete DFB laser	83mA
4ch CWDM DFB Array	119mA

Assumptions:

- Un-cooled operation – DFB die temperature raises to 85C
- DFB current need to be adjusted to maintain constant optical power of 20mW
- 2km link power budget will be maintained



Conclusion: Total laser dissipated power is increased by 3x
However it is still below 1W for all 4 channels

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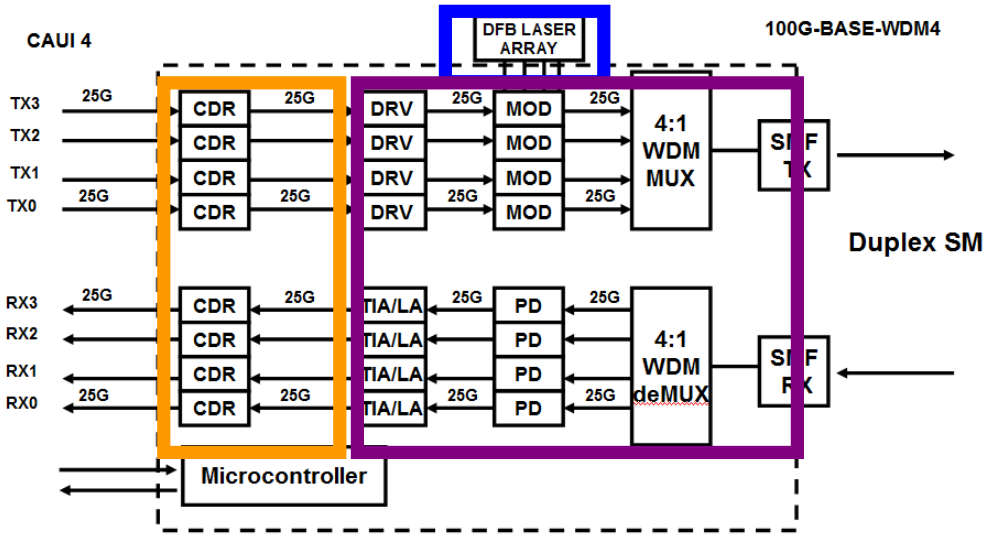
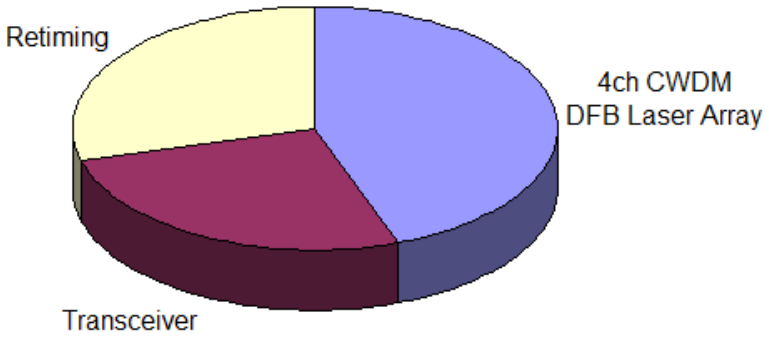
Estimates of a total module power





Total power <2W
(worst case, laser at 85ºC)

100G-Base-WDM4 block diagram from vlasov_01a_1112_optx

Lowest power classes for both CFP4 and QSFP28 are feasible

Conclusion:

Total module power <2W will help to decrease case temperature even for dense ports

Conclusion

- Existing CWDM DFB arrays can support WDM4 specs at elevated temperatures
- Power efficiency of WDM4 solution would allow to increase port densities at the card edge
- Further development of efficient cooling solutions beyond IEEE standards activities is needed
  - MSA package specs (cooling area, thermal resistance, etc.)
  - OIF card edge specs
  - Cooling ducts/buffles and/or heatpipes