400 G/Lane Optics Module Connectors

Lightning Talks



OCP GLOBAL SUMMIT | 2026

400G XPO Optics

Sam Kocsis

Director of Standards and Technology
Amphenol

Overview

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- **Beyond 200G Pluggable Optics**
- **Introducing XPO**
- **The 448G Frontier**
- **Re-Introducing XPO**

Beyond 200G Pluggable Optics

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Primary implementation bottlenecks beyond 224G:

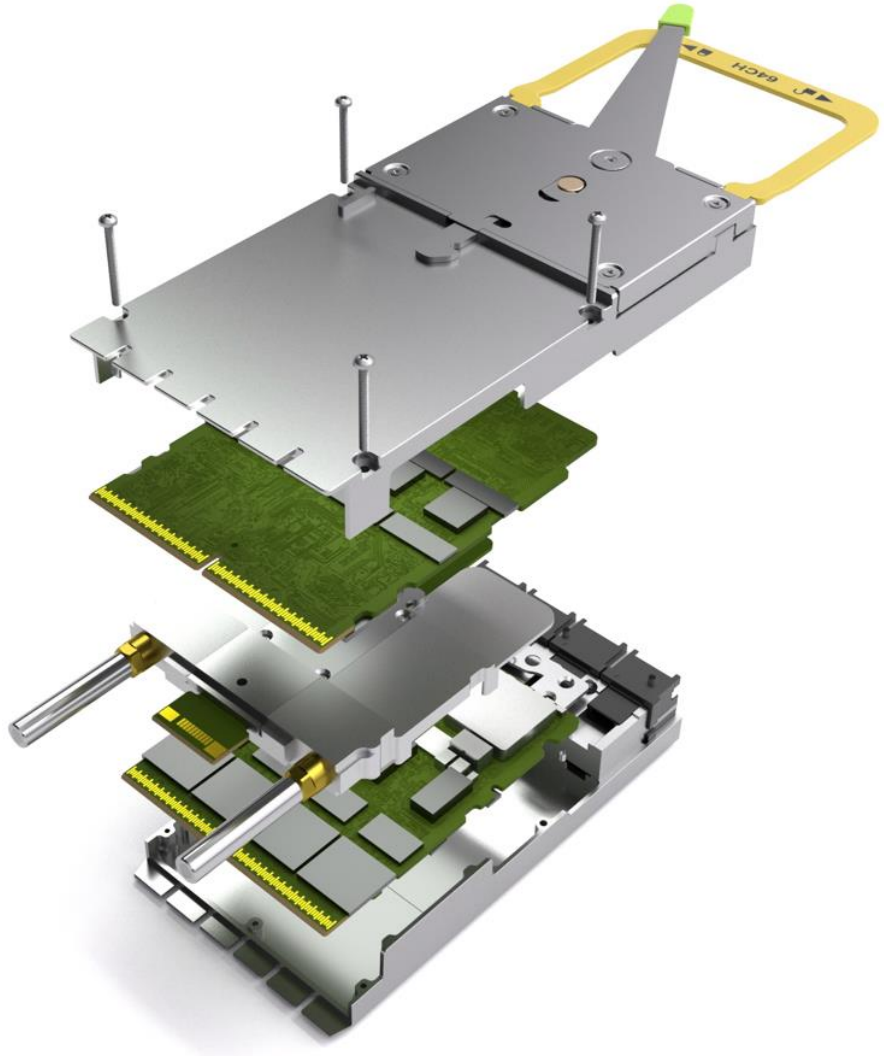
1. **ASIC Package, BGA Breakout performance**

2. **Pluggable IO performance**

Introducing XPO

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- 64 high-speed lanes
- Electrically hot-pluggable
- Single 48V power supply
- Integrated liquid cooling
- MPO-16 compatible interfaces
- Less than 90W (Linear Module)



XPO Advancing Architectures

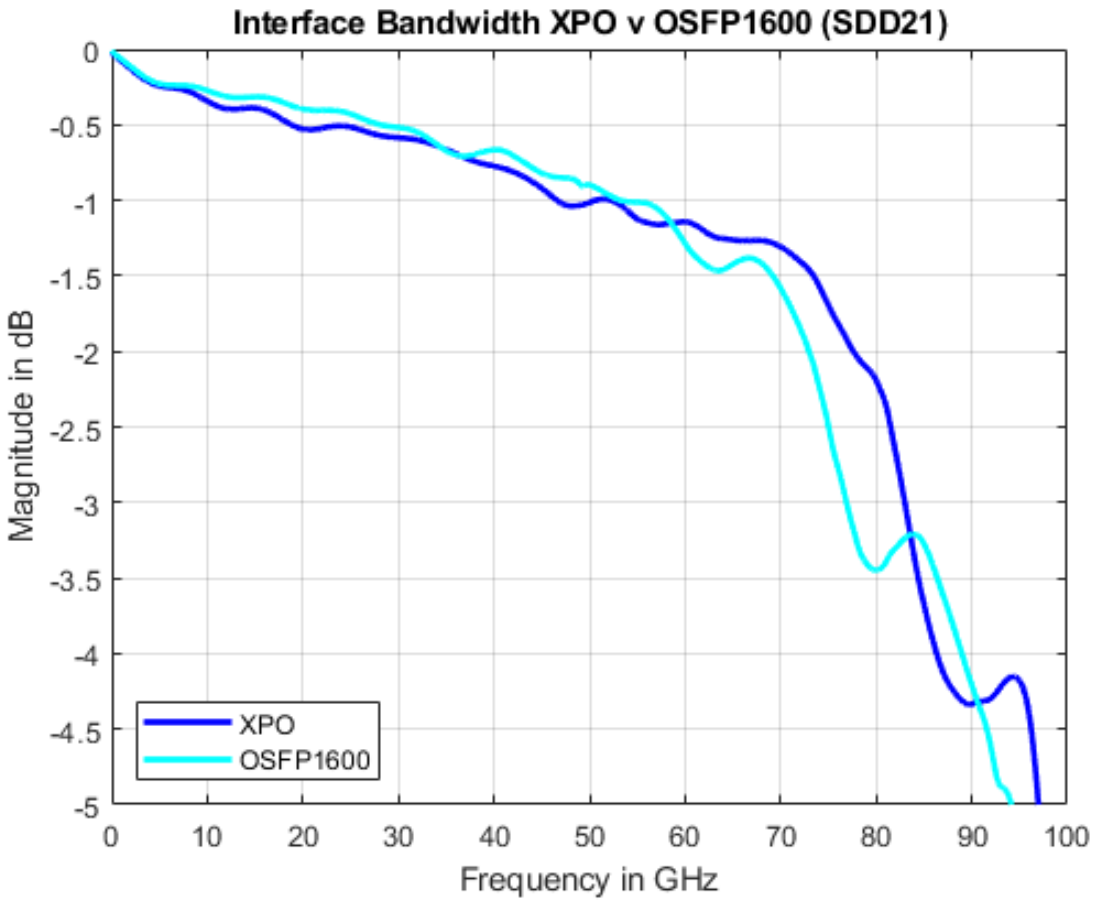
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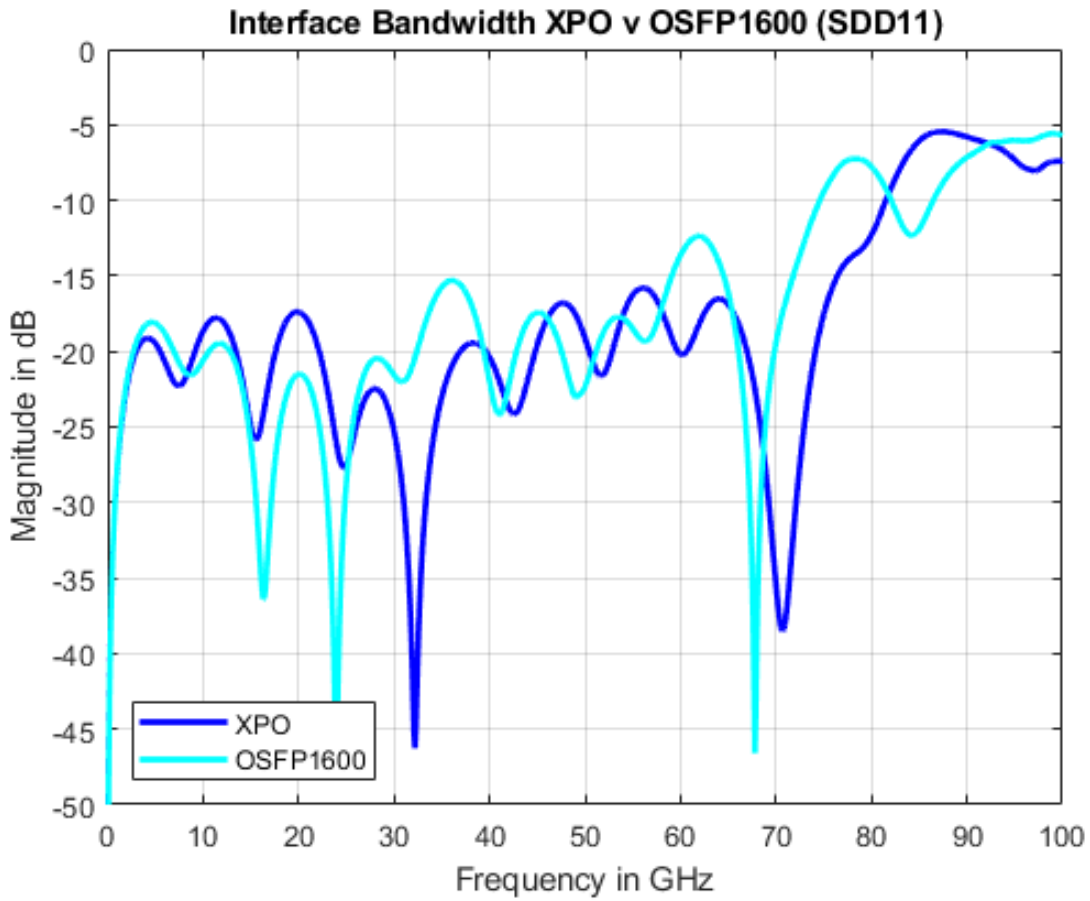


Advantages of CPO	Goals of XPO
Best channel	Better C2M channel
Reach (Optical)	Supports *all* optical technologies
Density	Matched faceplate density

XPO Performance

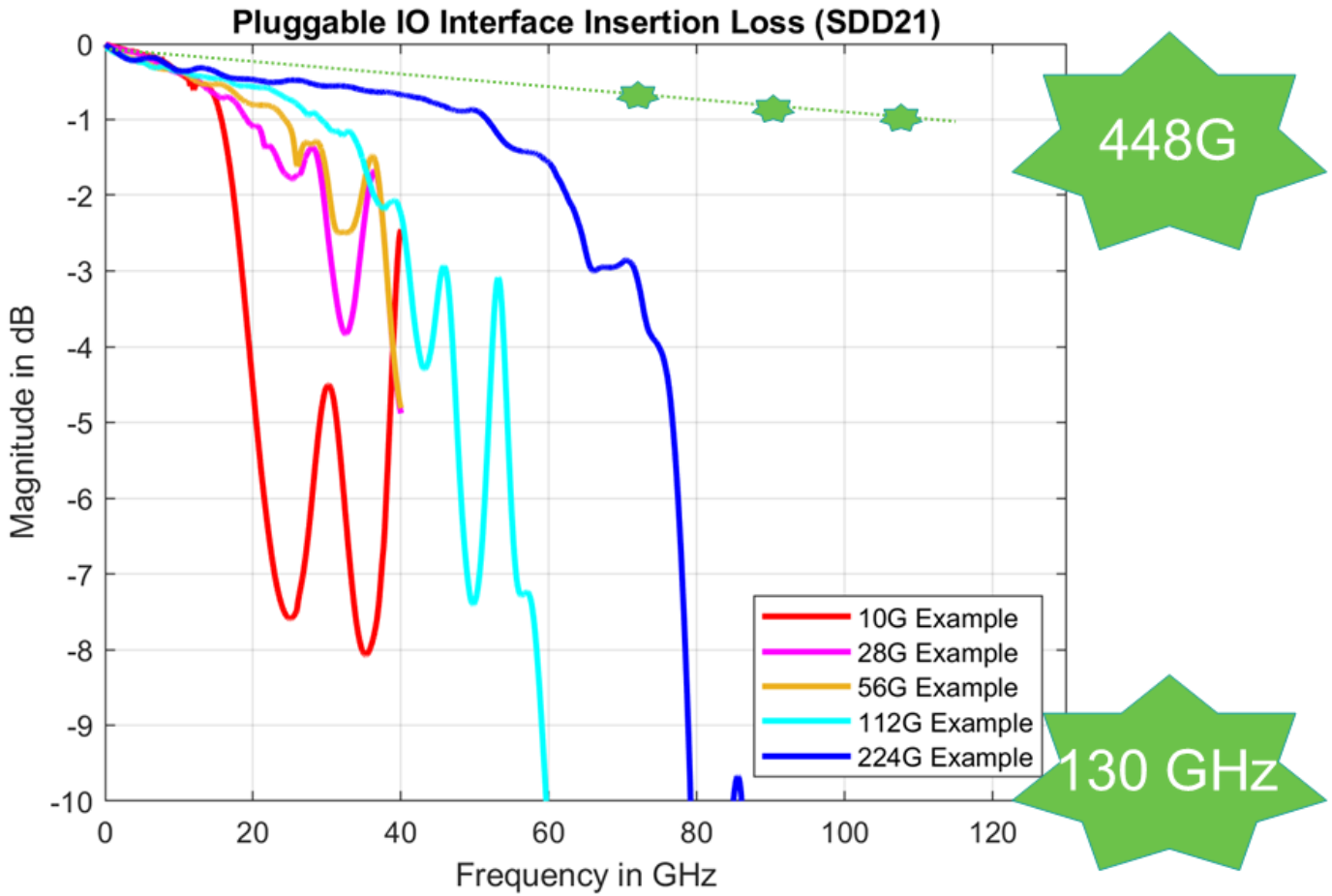
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The 448G Frontier

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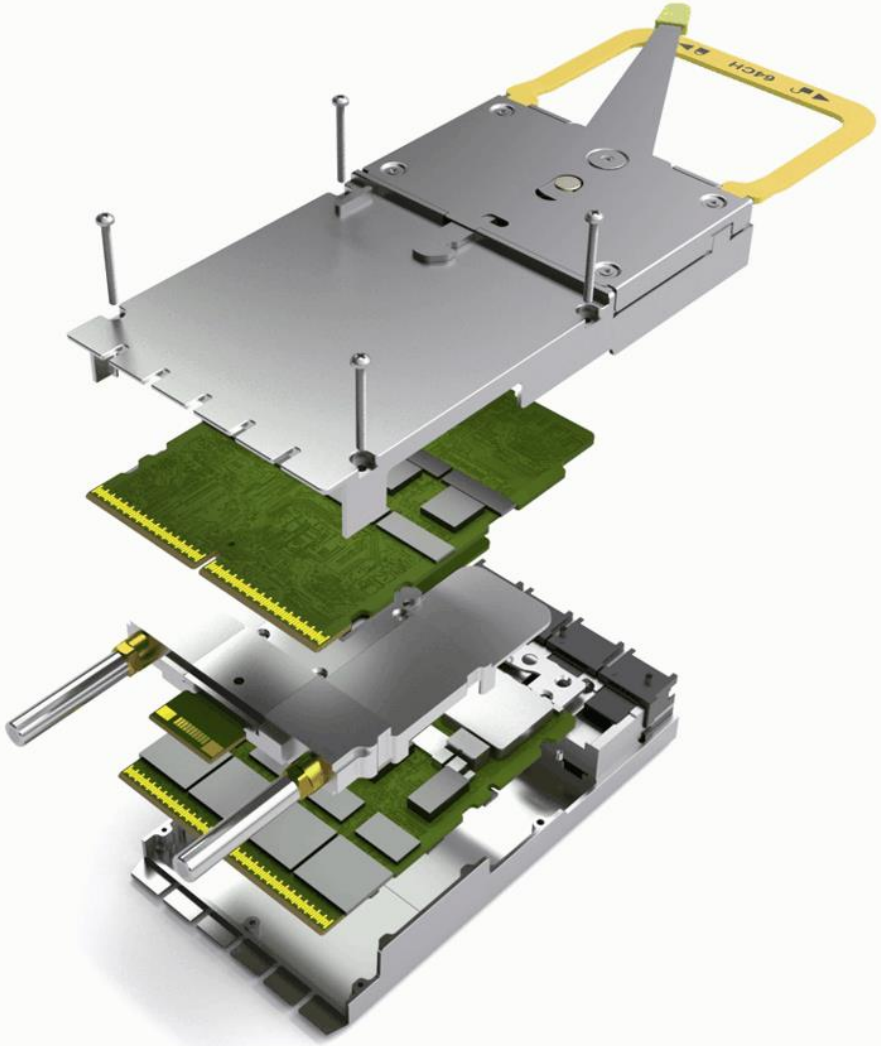
IO Bandwidth drives Modulation

Like XPO,
Innovation expected at 448G!

Re-Introducing XPO

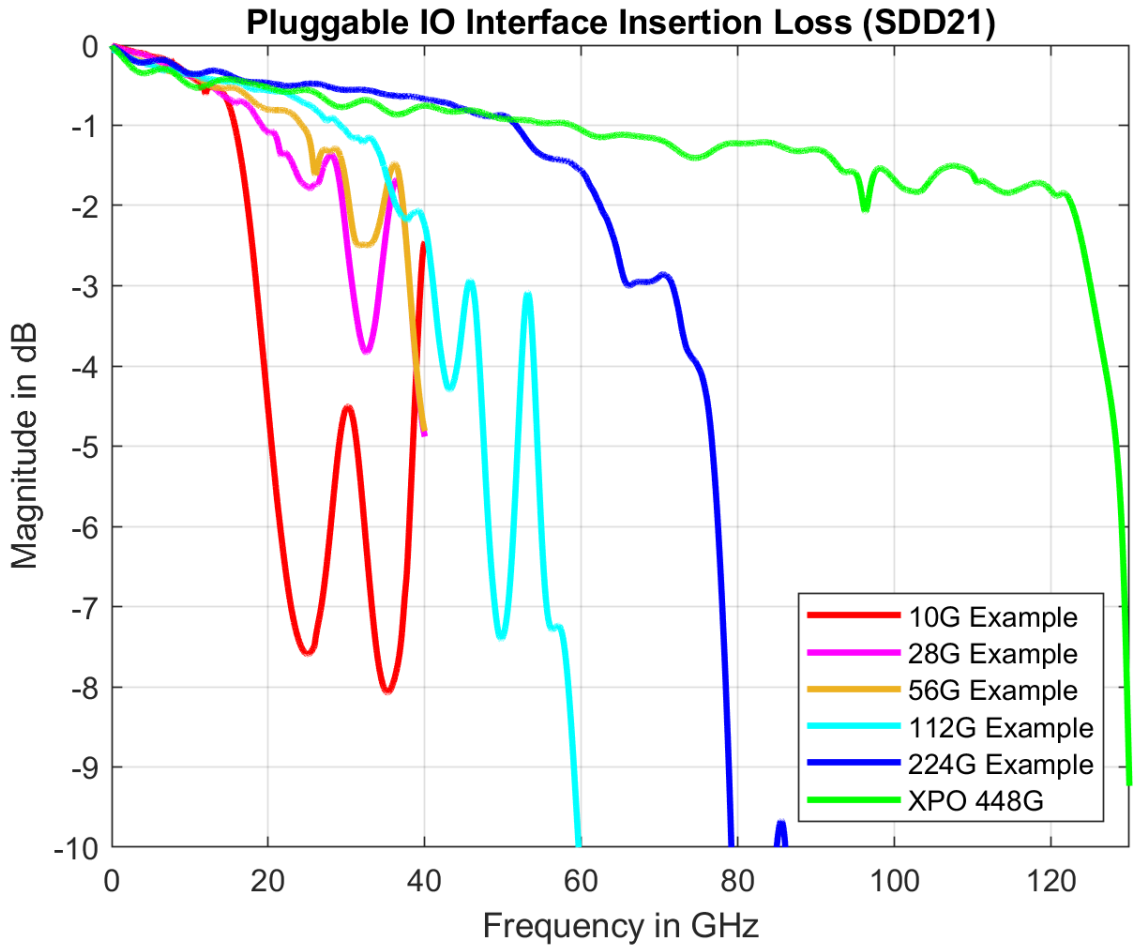
Amphenol

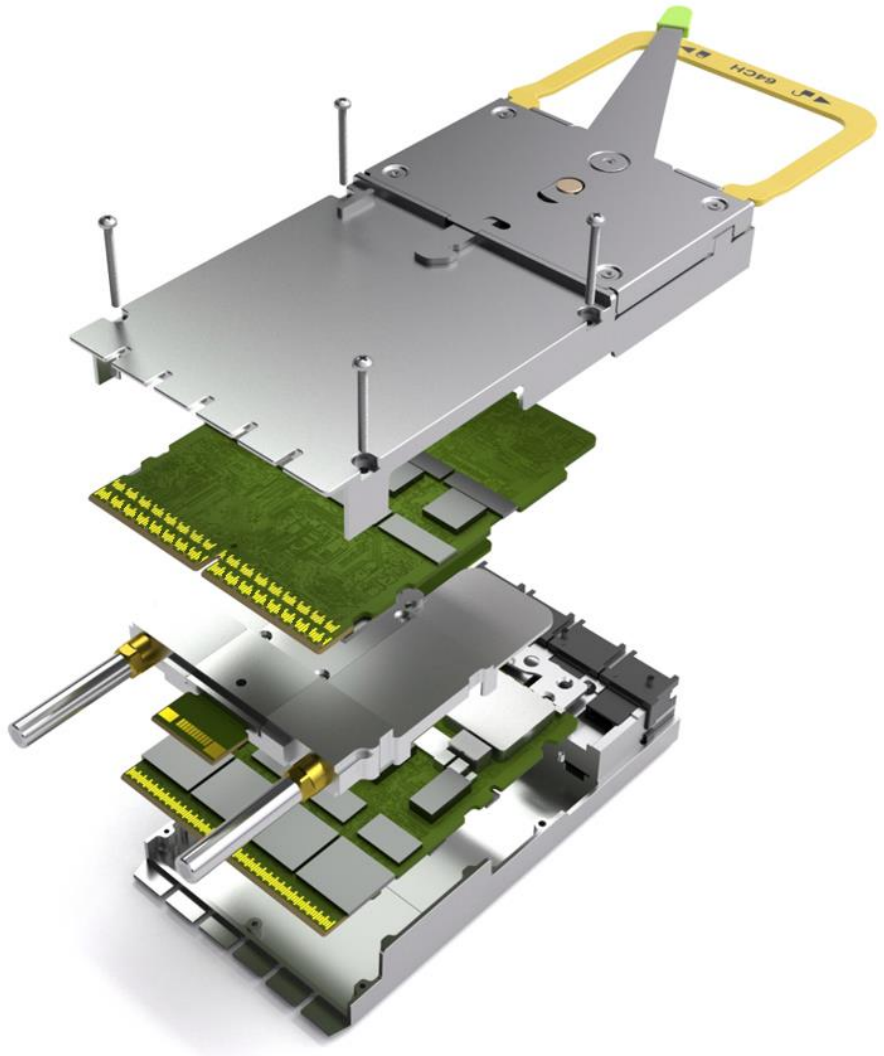
- Reuse mechanical/thermal infrastructure
- Preserve card edge interface
- Tighten tolerance loops
- Further reduce the pad pitch
- Offset high-speed lanes to limit crosstalk
- XPO @448G?



The 448G Frontier and XPO

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Call to Action

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- 448G IO is going to be challenging
  - One solution may not fit all
- 448G solutions needed for PAM-6 …and PAM-4
- Where to find additional information (URL links)
  - IEEE 802.3dv | https://www.ieee802.org/3/dv/
  - OIF | https://www.oiforum.com/
  - XPO MSA | https://xpomsa.com/
  - Amphenol | https://www.amphenol-cs.com/

XPO (eXtra Dense Pluggable Optics): Fast-forward to 448 Gbps

Terry Little

Sr. Development Engineering Manager

Foxconn Interconnect Technology

XPO (eXtra-dense Pluggable Optics) Introduction

Today, we are proud to introduce our XPO (eXtra-dense Pluggable Optics) platform—a fully integrated, high-density "pluggable" connectivity architecture.

We will discuss a scalable path forward from today's 224 Gbps solutions, to the next-generation 448 Gbps AI and high-performance computing systems.

I would like to acknowledge the leadership and vision of Andy Bechtolsheim, Co-founder and Chief Architect of Arista Networks, and the contributions of the XPO MSA member companies in advancing the next generation of high-density optical interconnect technology.

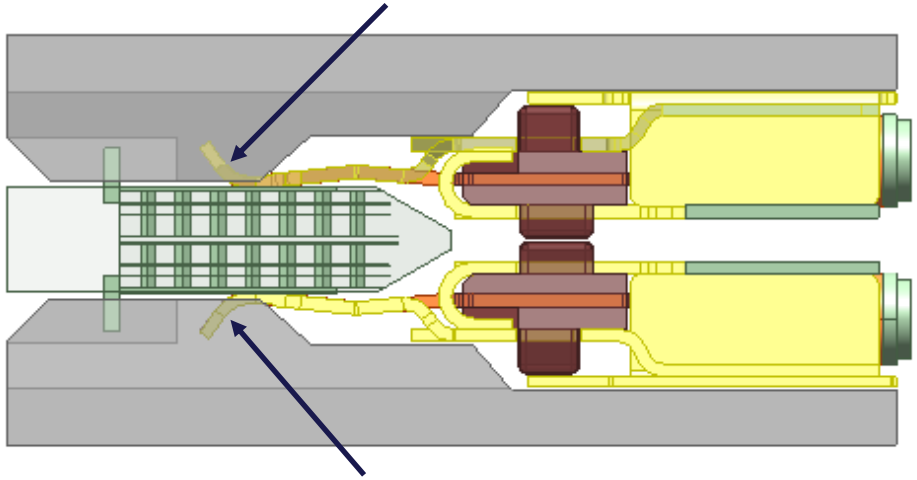
Key highlights include:

- High-density "Card-edge" connector for next-generation AI infrastructure, **thus keeping the same existing XPO connector form factor.**
- Builds upon the proven 224 Gbps architecture to provide a scalable path to 448 Gbs.

Fast-forward to 448 Gbps XPO

XPO “Fast-forward” to 448 Gbps

Traditional 224G “Cantilever Beam” Contact Geometry



- Traditional “Cantilever Beam Contact Geometry produces un-desirable IL “roll-off” at high frequency.

<u>The New 448G XPO system connector Objectives:</u>

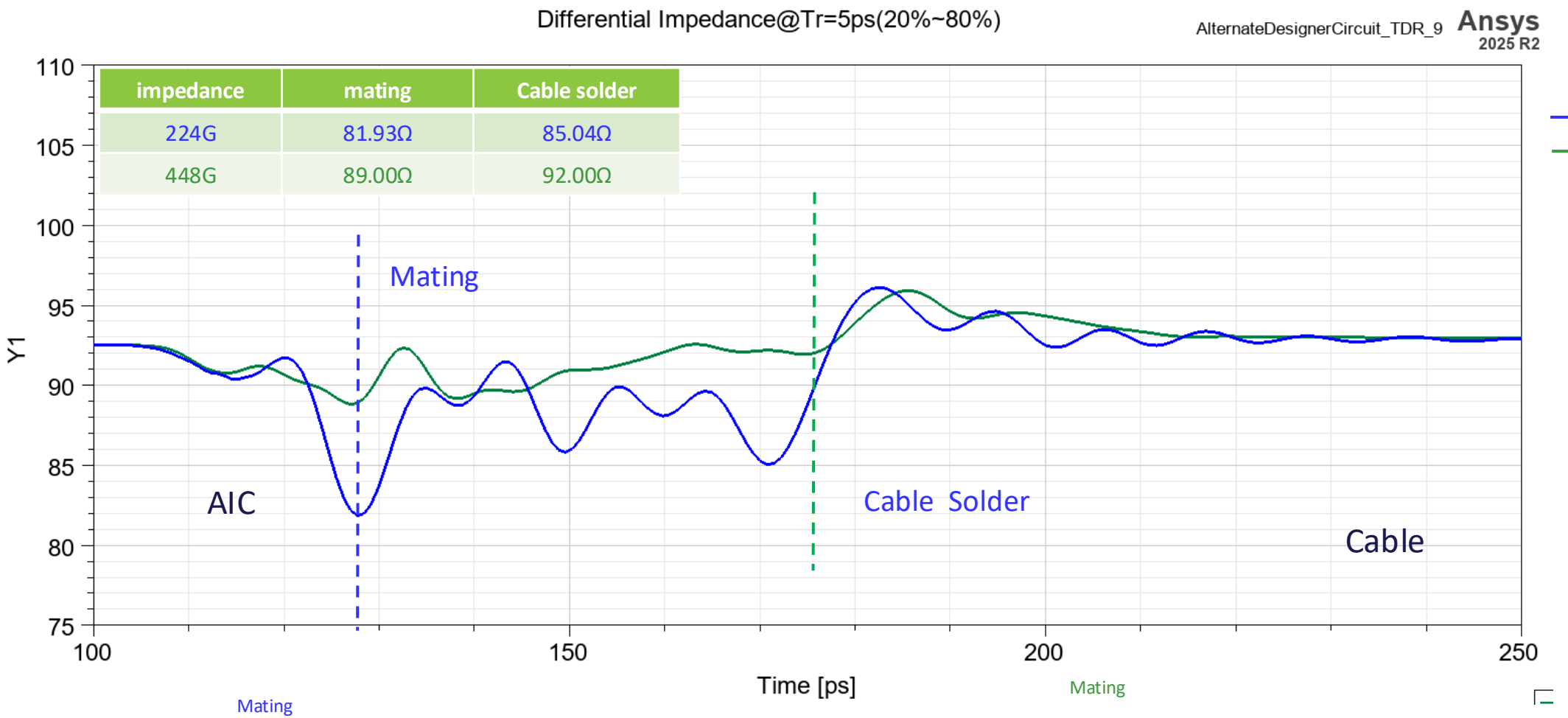
<u>The mechanical objective</u> is to maintain the same XPO “Card-Edge” Form Factor. (0.56mm pitch)

<u>The electrical objective</u> is to minimize undesirable stub effects at high frequencies.

High-speed interfaces are sensitive to:
- Stub length
- Impedance discontinuities
- Reflection-induced insertion loss

XPO Card-edge 448G Simulation Results--Differential Impedance

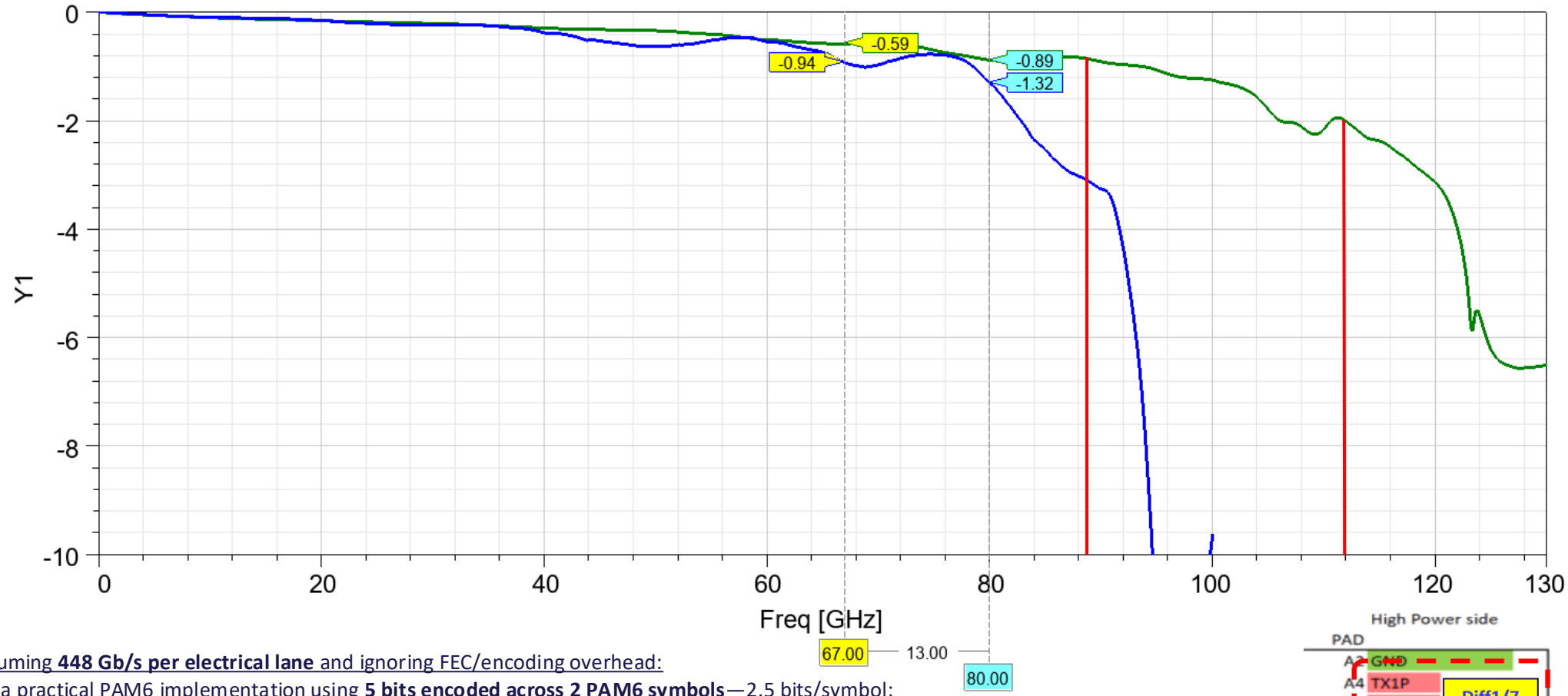
impedance	mating	Cable solder
224G	81.93Ω	85.04Ω
448G	89.00Ω	92.00Ω



Mating

Mating

XPO Card-edge 448G Simulation Results--Differential Insertion Loss



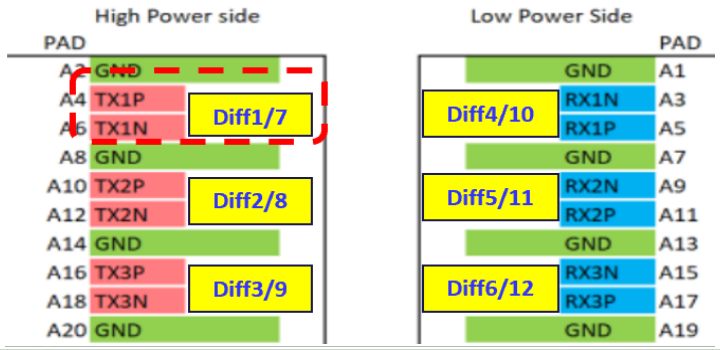
<u>Assuming **448 Gb/s per electrical lane** and ignoring FEC/encoding overhead:</u>

For a practical PAM6 implementation using **5 bits encoded across 2 PAM6 symbols**—2.5 bits/symbol:

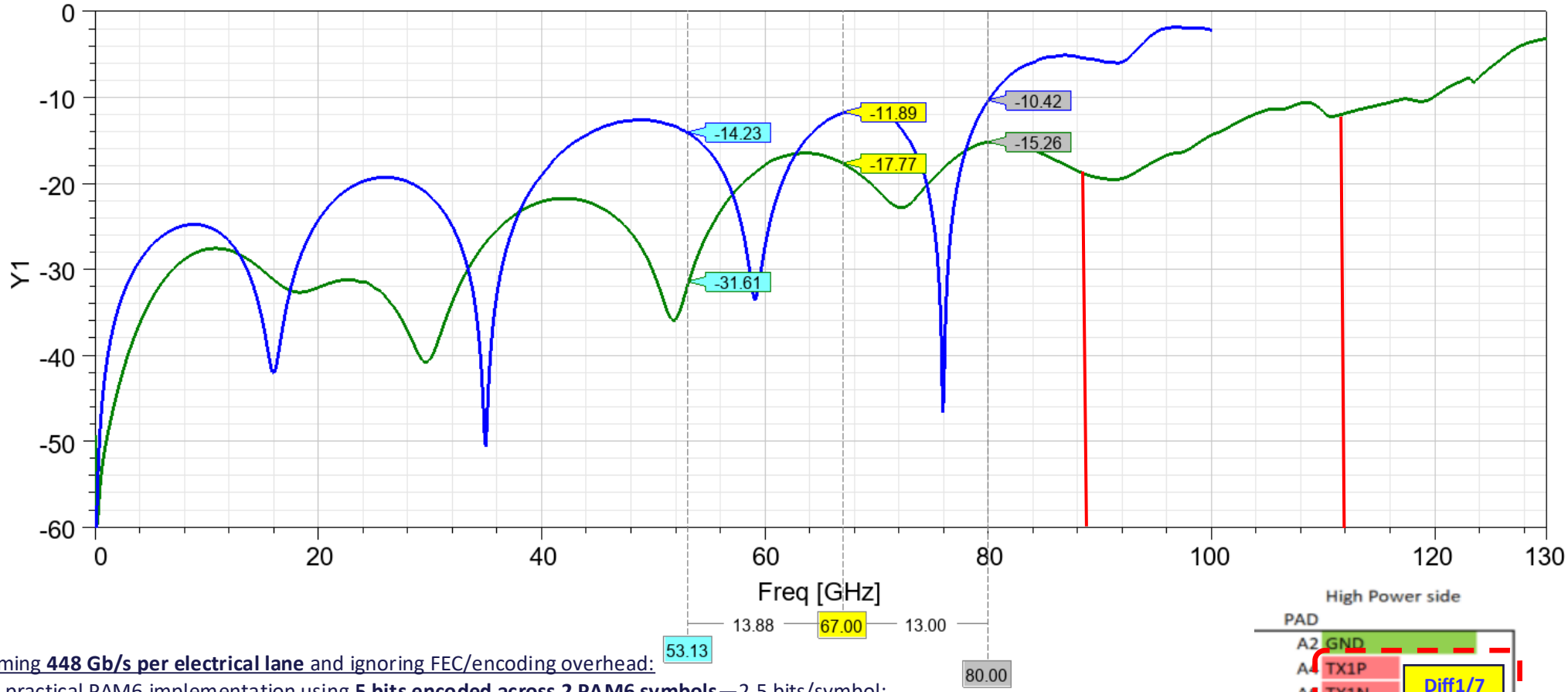
- Symbol rate: 448 ÷ 2.5 = **179.2 GBd**
- Nyquist frequency: 179.2 ÷ 2 = **89.6 GHz**

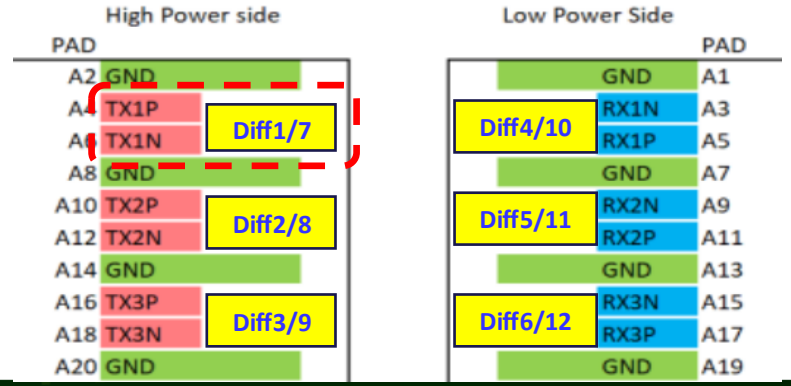
So, the anticipated targets are approximately:

- **448G PAM4: 112 GHz**
- **448G PAM6: 87–90 GHz**
- Actual baud rate and Nyquist frequency will be slightly higher when line-coding or FEC overhead is included.



XPO Card-edge 448G Simulation Results--Differential Return Loss





Assuming **448 Gb/s per electrical lane** and ignoring FEC/encoding overhead:

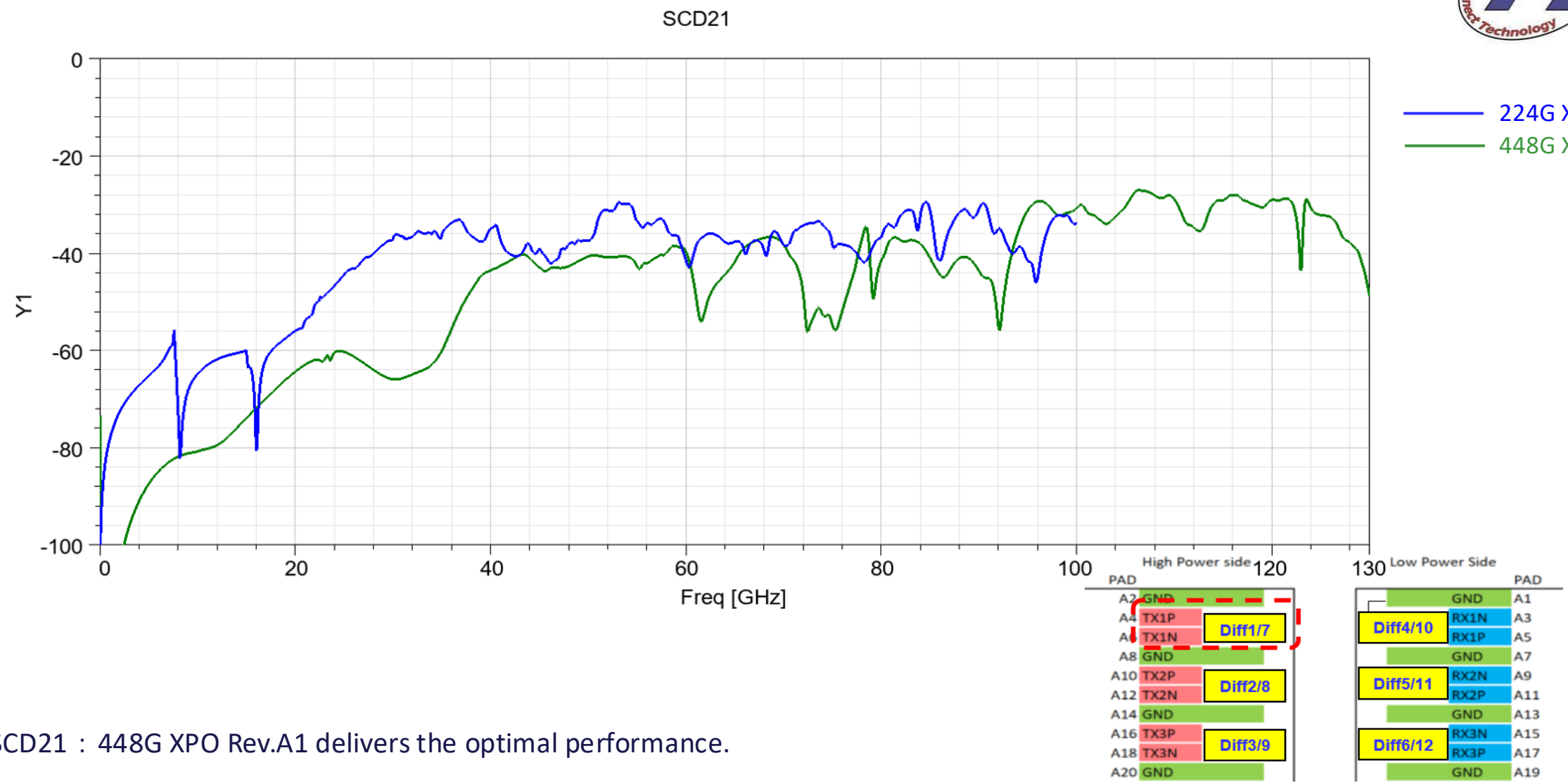
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XPO Card-edge 448G Simulation Results—SCD21



- SCD21 ： 448G XPO Rev.A1 delivers the optimal performance.

Call to Action

448G XPO Path-forward is critical

448G solutions are needed to support both PAM-6 and PAM-4 modulations

Additional information:

XPO MSA | https://xpomsa.com/
IEEE 802.3dv | https://www.ieee802.org/3/dv/
FIT | https://www.fit-foxconn.com/

Luxshare-Tech 448G CPC, Backplane and IO

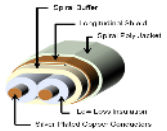
Robbie Xu *Head of US Sales and Marketing, Luxshare-Tech*

448G Passive Channel Building Blocks

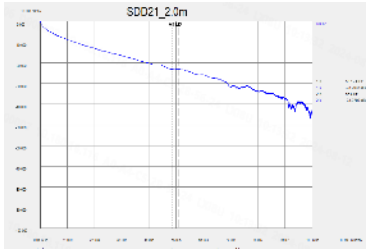
LUXSHARETECH

OPTAMAX 448G Twinax (Ready)

- 92ohm， Bandwidth >100GHz， Drainless & Drian optional
- Insertion loss & Bending Performance： Leading the industry



Frequency (GHz)	31 AWG Loss (dB / m)
26.56	6.6
56	10.0
110	19.0

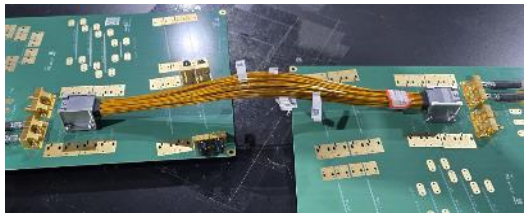


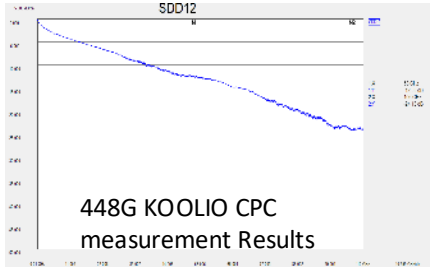
31AWG 2m measurement data

KOOLIO CPC: Bandwidth support of 448G PAM4 (Ready)

- Pushing the boundaries of ongoing innovation

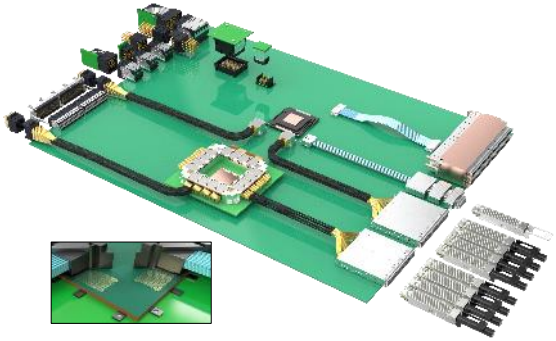
- Full ecosystem continuity: Supports pluggable IO and high-speed backplane architectures
- 0 stub, 360-degree shielding, industry highest density
- mSAP/substrate capable, bandwidth 100GHz+





448G KOOLIO CPC measurement Results

End to End interconnect

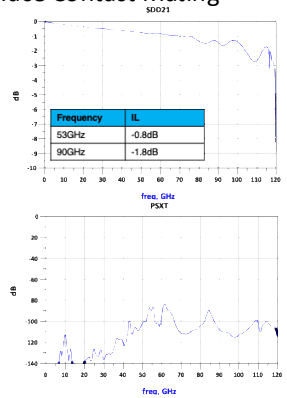


NEXUS 448G Cable Backplane (Sample)

Unique mating interface, robust mechanical design

- 92ohm, Bandwidth >100GHz， cable to cable interconnect
- Coaxial-like structure, fully shielding and Surface Contact Mating





448G NEXUS Cable Backplane Simulation Result

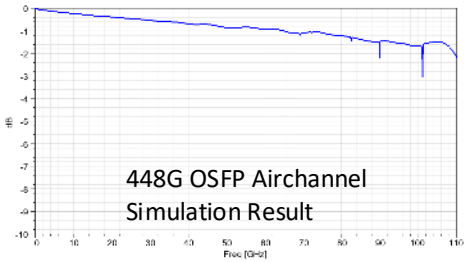
OSFP 448G Airchannel (Sample)

OSFP-like size interface, pluggable module

- Leverage Backplane technology, bandwidth>100GHz
- Support Both Passive and Active module

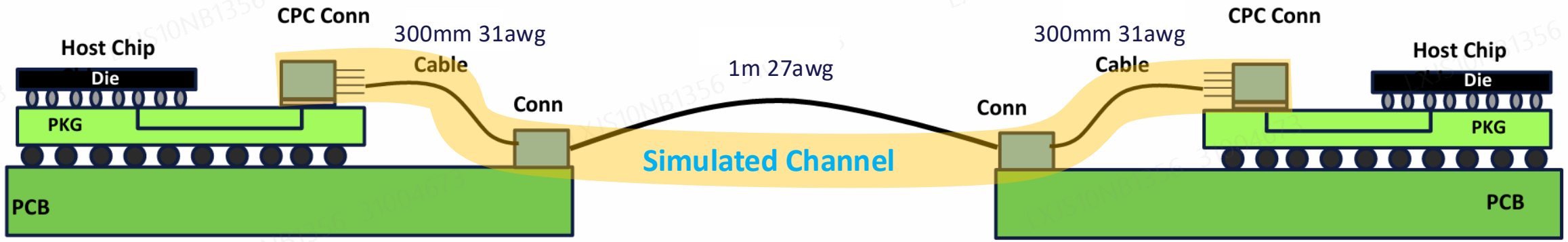


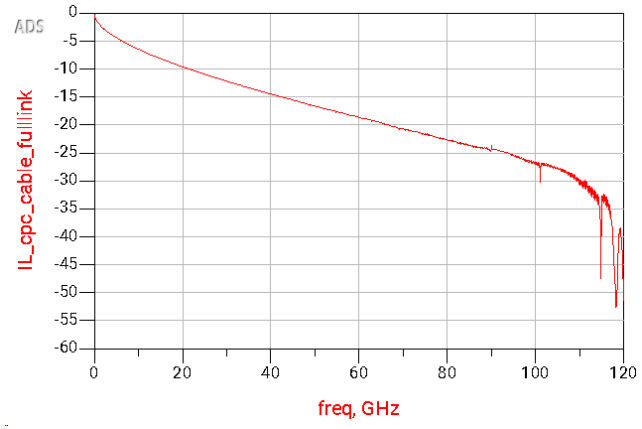
SDD21

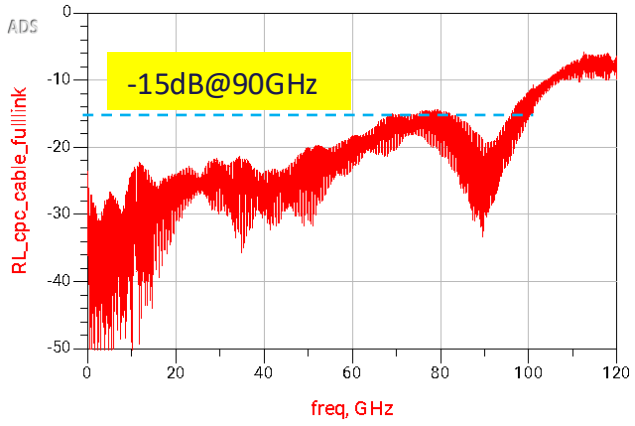


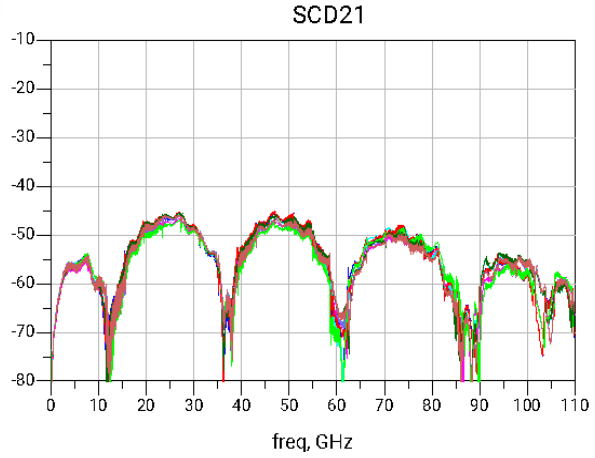
448G OSFP Airchannel Simulation Result

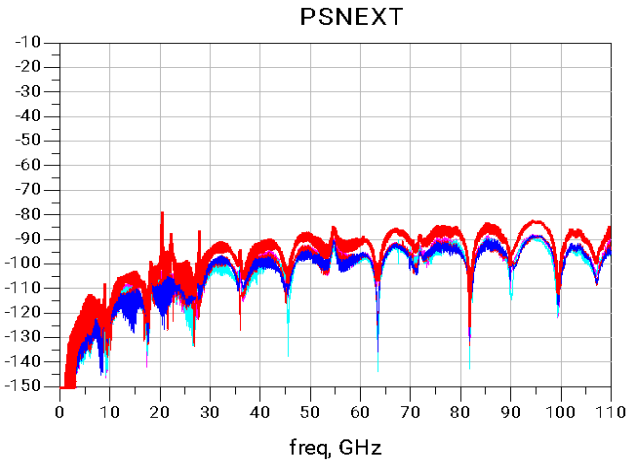
448G Channel Simulation











The CPC to IO to CPC loss is ~28dB at 106GHz

– For a total of 1.6m of twin-ax (2 x 300mm 31awg CPC to IO cable + 1m 27awg IO to IO cable), excluding substrate losses

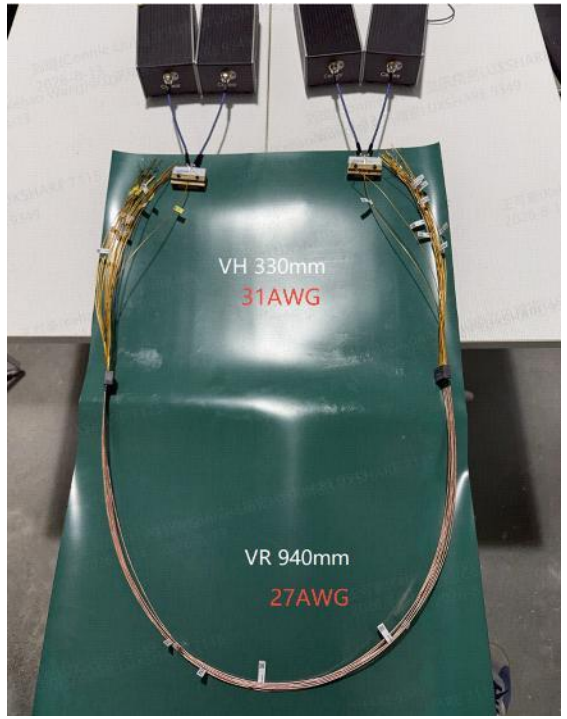
Return loss is under -15dB at 98GHz

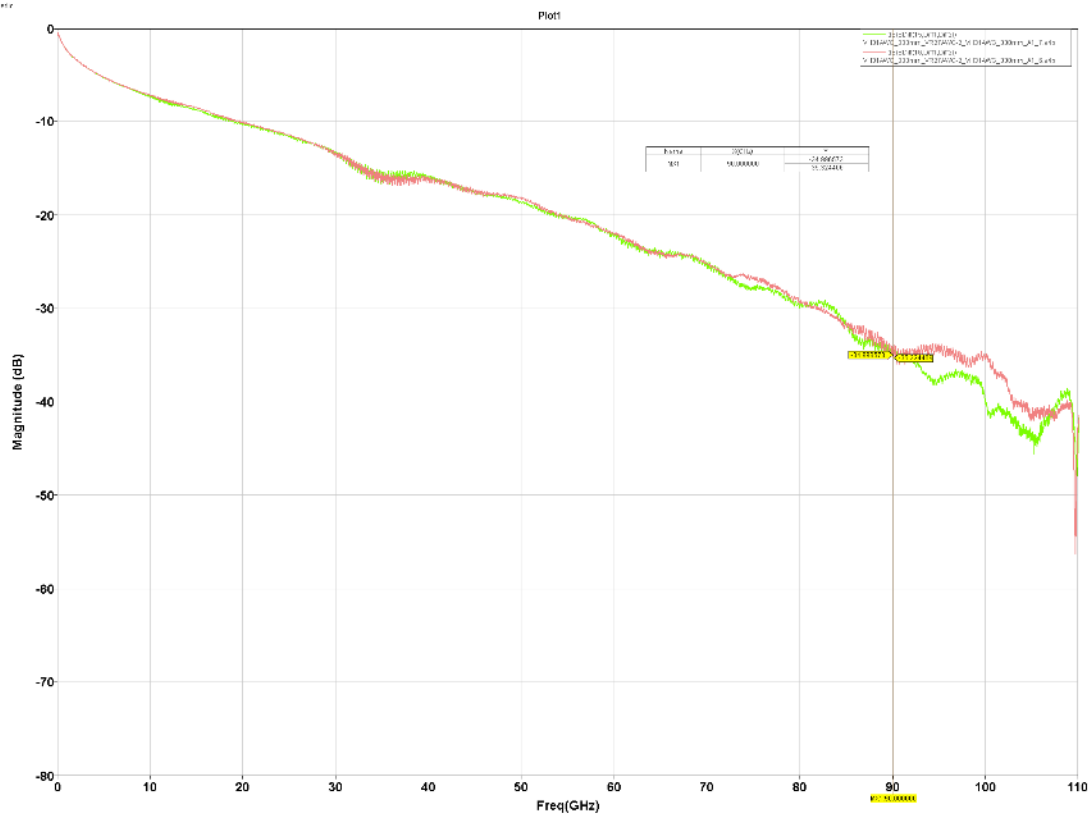
Crosstalk is generally kept below the 60dB level

448G CPC to Backplane to CPC Measurement

LUXSHARETECH

- Clean response out to 90GHz
- No resonance until just at 110GHz
- Cleared manufacturing process issues



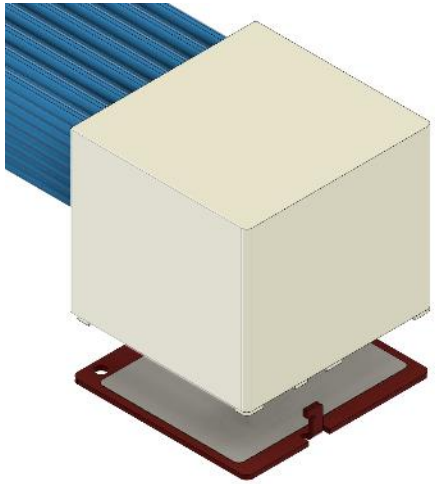


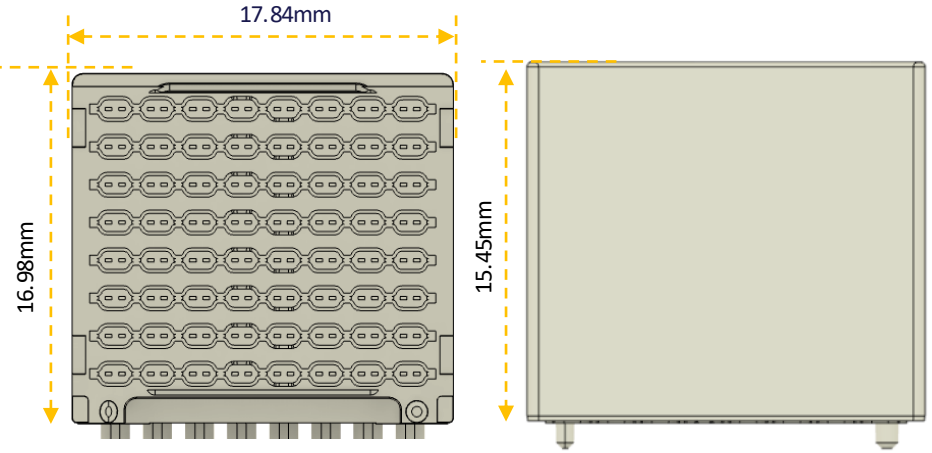
Twinax Test Fixture	**330mm 31awg** Twinax	Mated VH-VR Conn	**940mm 27awg** Twinax	Mated VR-VH Conn	**330mm 31awg** Twinax	Twinax Test Fixture

448G CPC Form Factor and Configurations

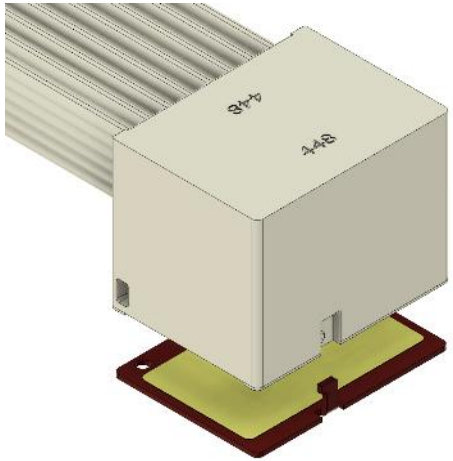
LUXSHARE TECH

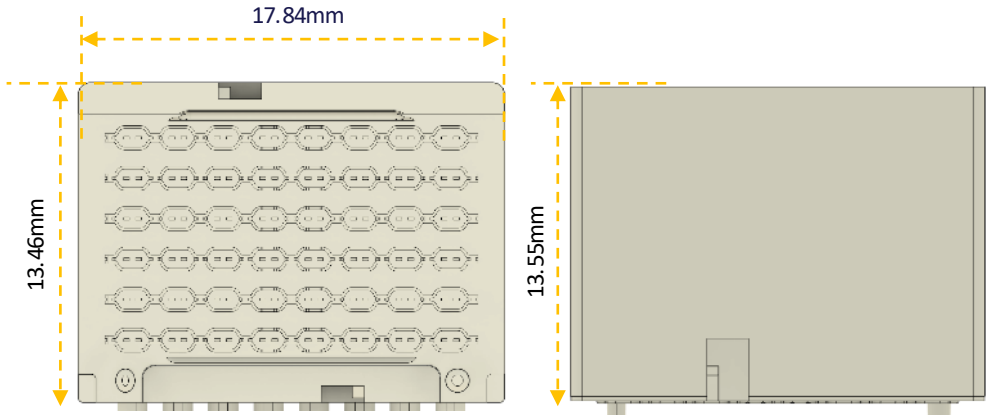
8p8c Configuration



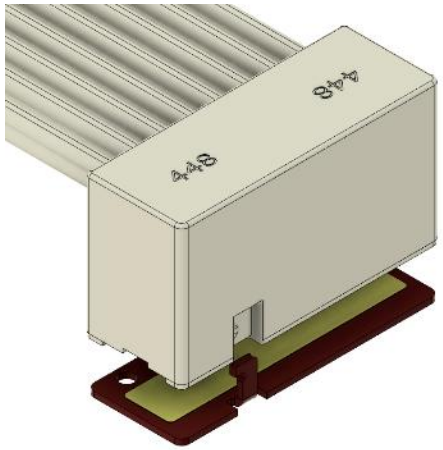


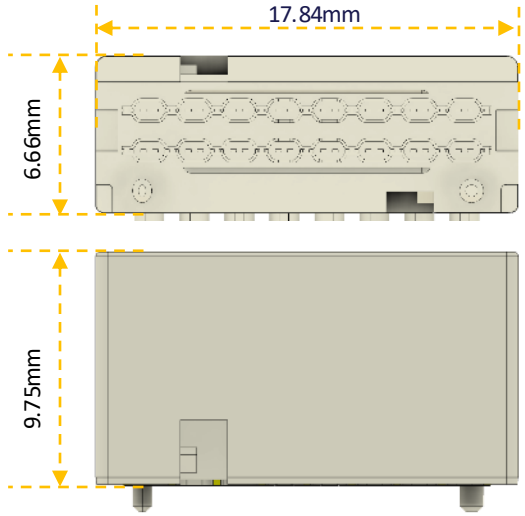
8p6c Configuration





8p2c Configuration

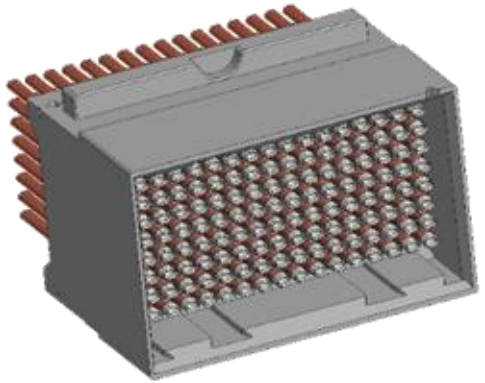




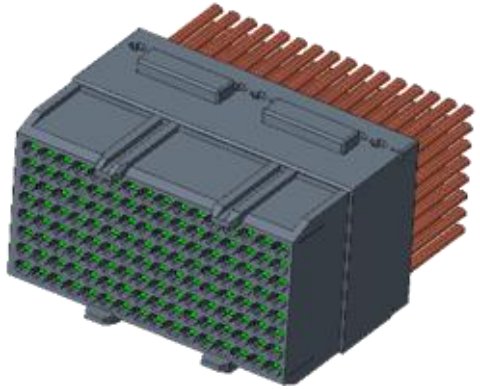
448G Backplane Enables 448G Cable Cartridge

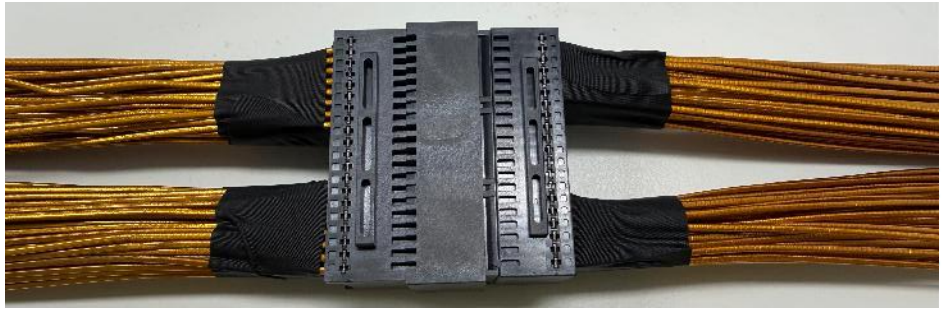
LUXSHARETECH

Vertical Header (Cartridge)

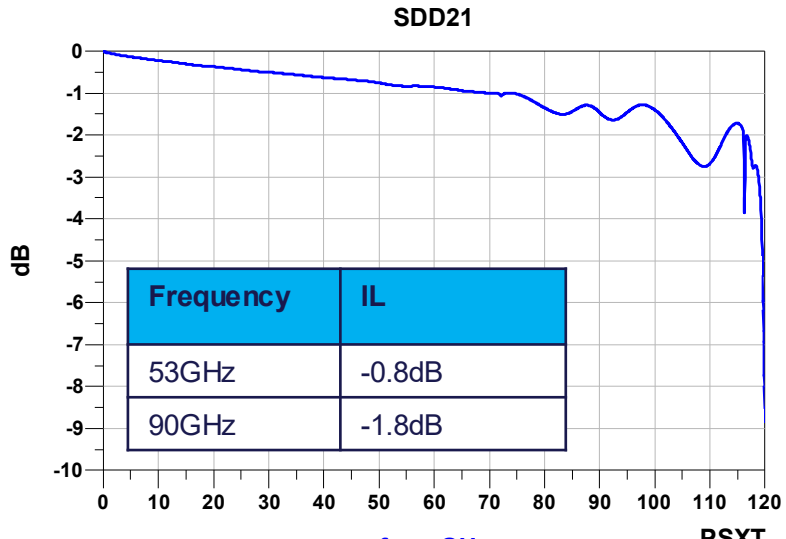


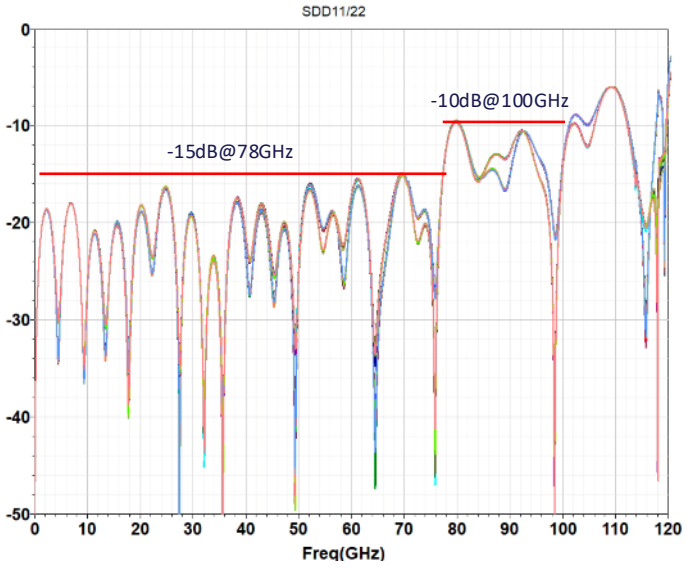
Vertical Receptacle (to CPC)

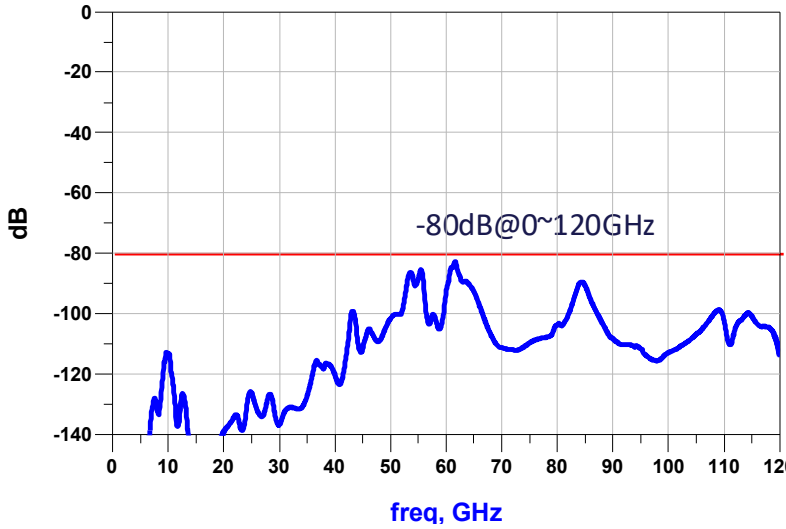




NEXUS 448G 27AWG~31AWG Cabled VH-VR solution



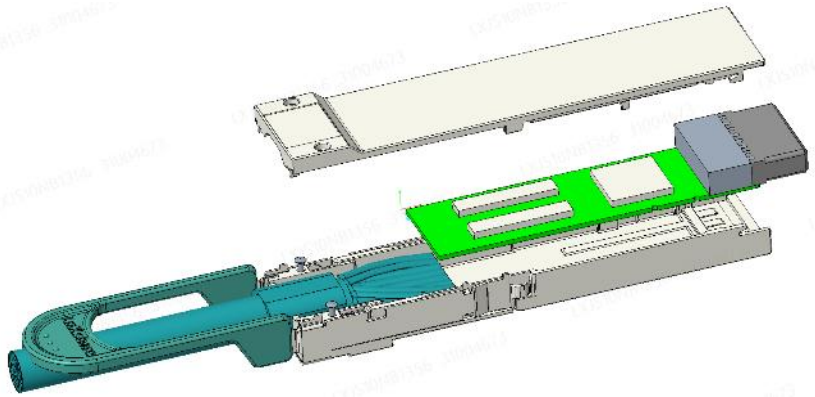




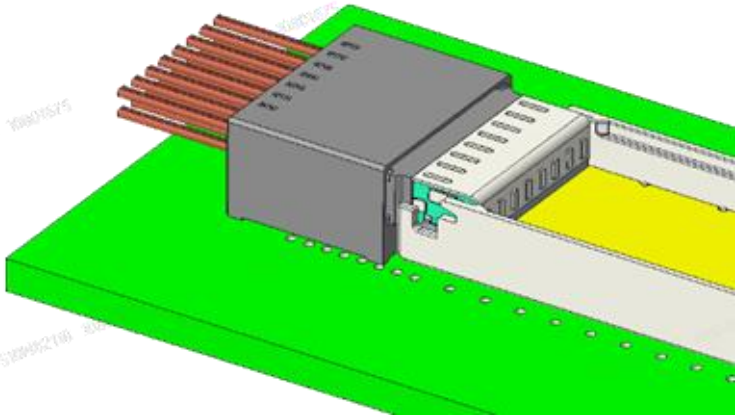
448G HSIO OSFP with Innovative BP Interface

LUXSHARETECH

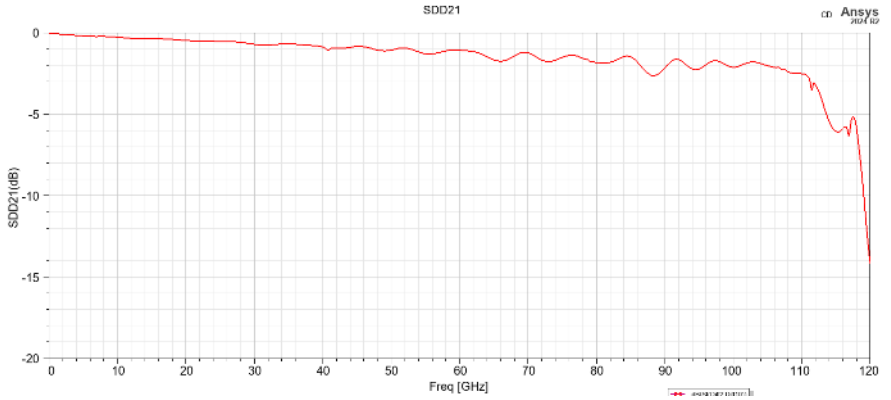
Pluggable Module



Mated Plug-Receptacle



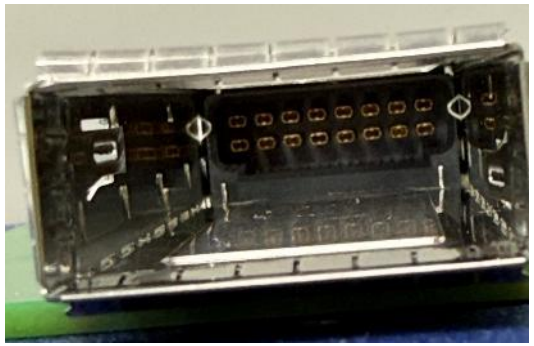
SI frequency beyond 110GHz



Pluggable Module Sample



Receptacle Sample



Summary and Call to Action

- Improvements to the Luxshare CPC-448G design and manufacturing process have made significant SI performance
  - Clean response up to the observable 110GHz bandwidth
- First sample of BP and HSIO Connection (31awg-27awg)
  - Results are promising showing channel nearly capable of 110GHz
  - Also working on cable-to-PCB right-angle connector variant
- What are your thoughts/preferences on
  - 92ohm vs 85ohm
    - So far, we have both 92ohm and 85ohm move in parallel
    - Industry and Eco-system needs to define the mainstream impedance when 448G system design kicks off
  - 448G PAM-6 vs 448G PAM-4
- Link to Luxshare-Tech Technologies and Contact
  - https://en.luxshare-tech.com
  - robbie.xu@luxshare-ict.com

OCP SPECIAL FOCUS:
PHOTONICS



400G/Lane Optics Module Connectors

Matthew Ho

Principal System Architect, TE Connectivity



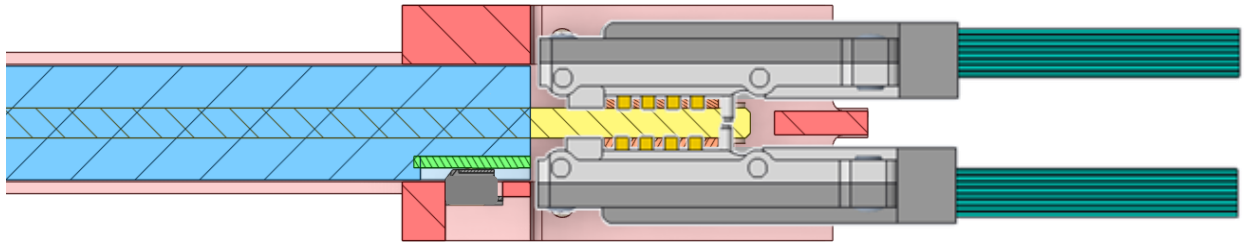
Motivation

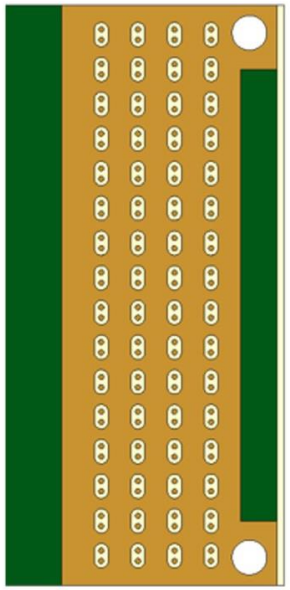
- Existing OSFP lacks a clear path to 448G
- Challenges of 448G IO
  - Suitable electrical interface at 448G PAM4
  - Scalable form factor
  - Supports cabled host

AdrenaLINE MegaLane – Mating Interface

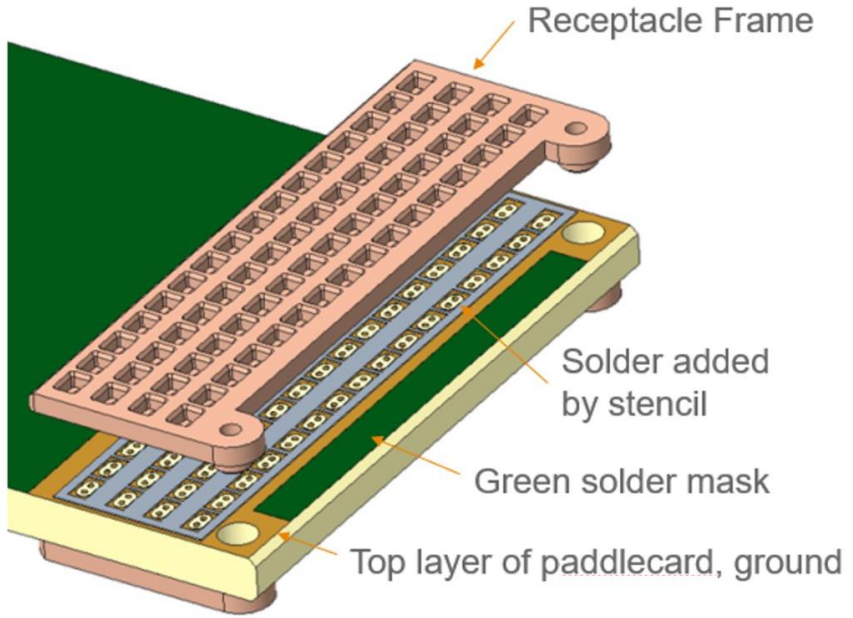
- Novel stubless interface
- Cabled host twinax lands at footprint
- Fully shielded pairs at the module

Mated Interface





Paddlecard

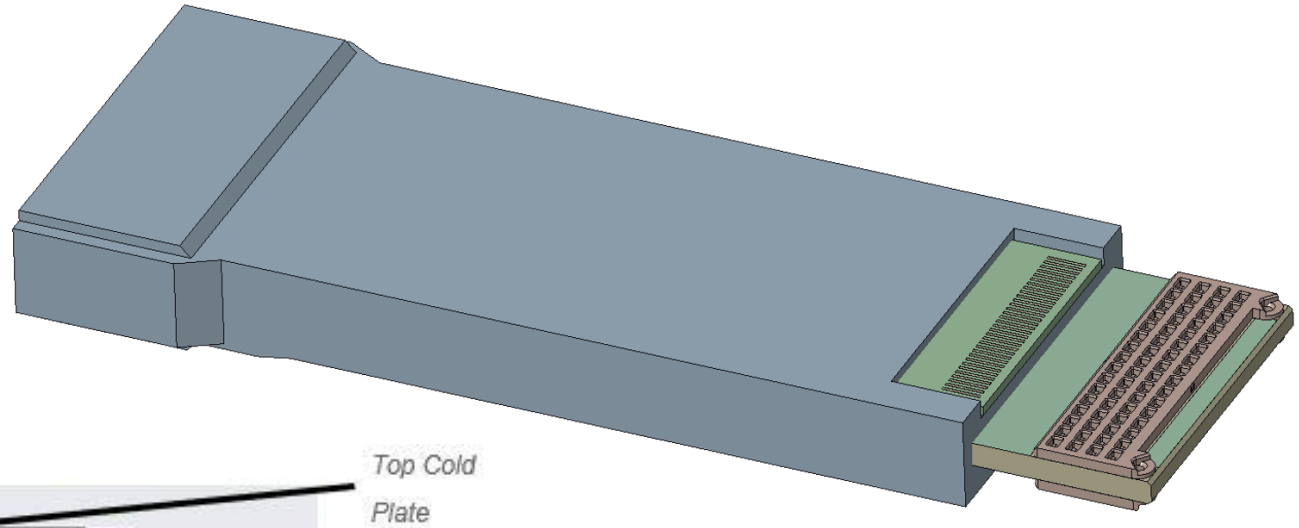


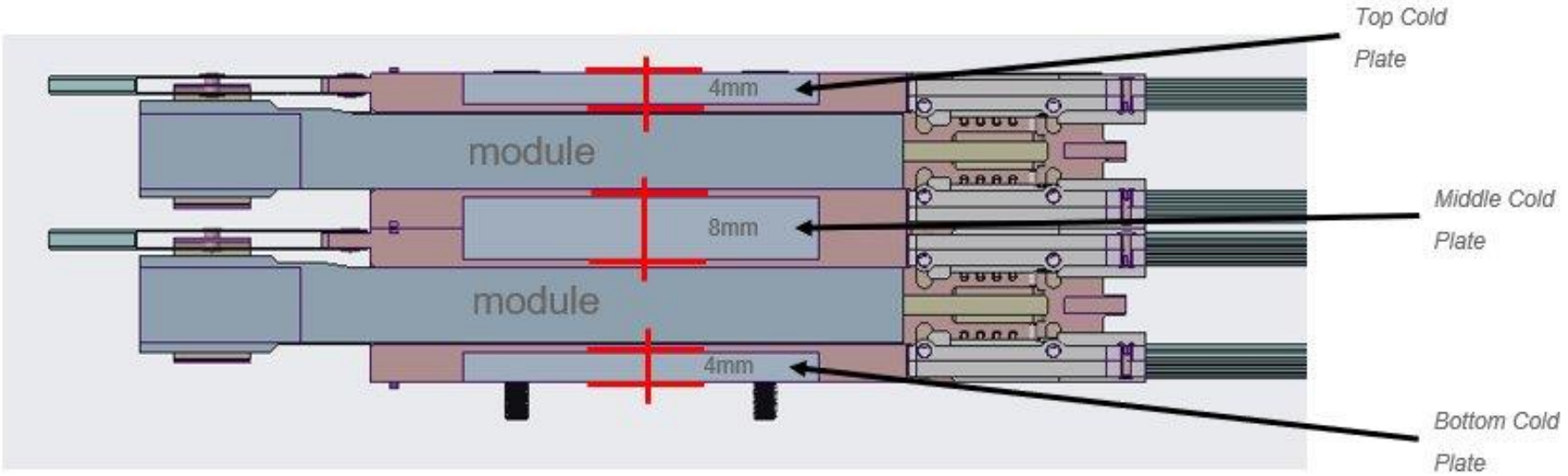
Assemble Receptacle Frames to Paddlecard Top and Bottom

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AdrenaLINE MegaLane – Module Application

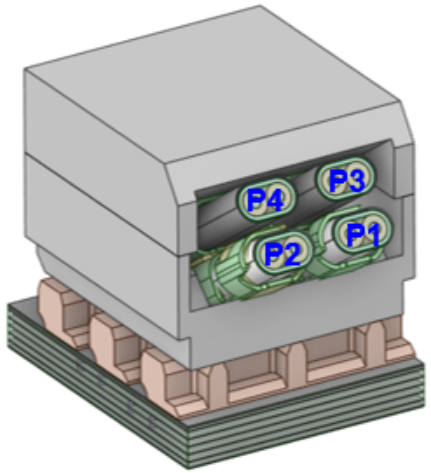
- Scalable interface (x8/x16/x32/x64)
- Power isolated from high speeds
- Dual sided cold plates

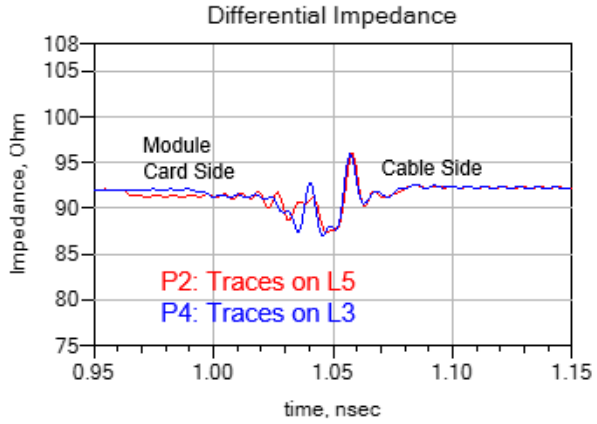


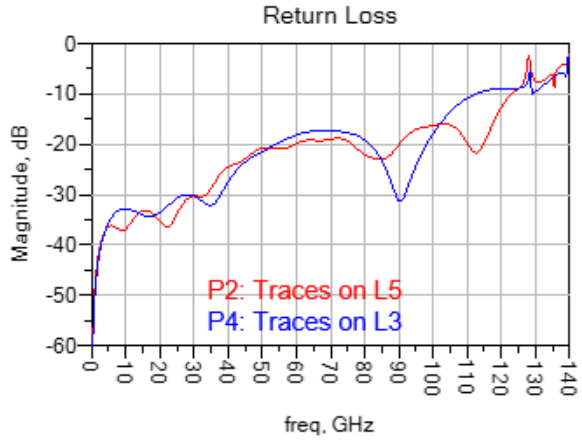


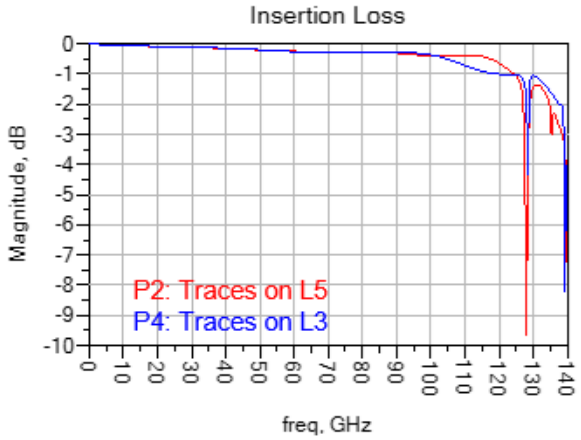
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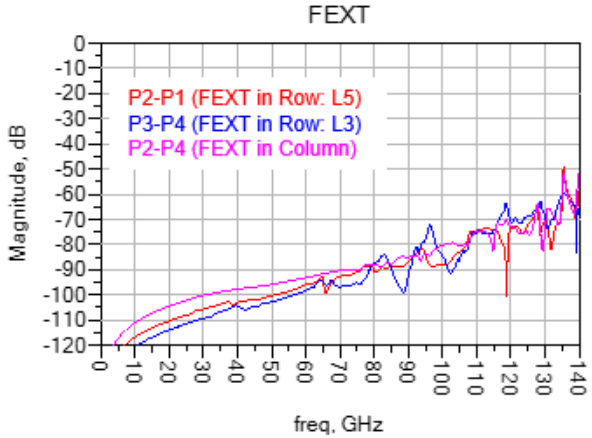
AdrenaLINE MegaLane - SI Performance

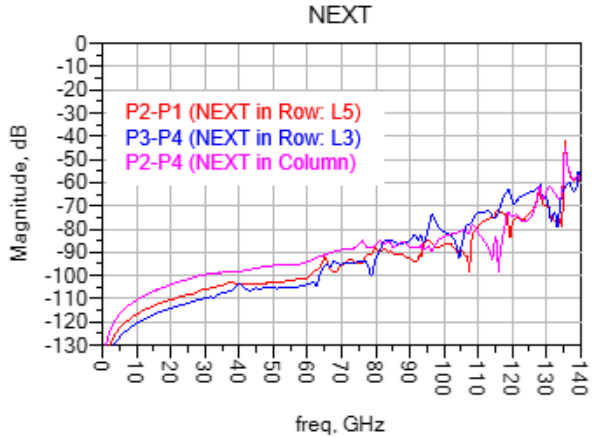












The results include 0.5mm trace, module card pads, connector and 2mm cable

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Call to Action

- Tell us your form factor preference (x8/x16/x32/x64)
- North Star: 448G PAM4 Performance
  - TE's MegaLane shows credible path with sim and measured data
- Read about USFP adopting TE MegaLane
  - https://nvidianews.nvidia.com/news/nvidia-and-cisco-introduce-new-pluggable-optics-form-factor-to-scale-ai-factories
- Get to know MegaLane more in depth
  - TE Contact: matthew.ho2@te.com

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Thank You!

