

# Demonstration of the 12.8T 8×DR8 High-Density Liquid-Cooled 64-Channel Pluggable XPO LRO Module and XPO Emulation Platform

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# Topics for Today

## **XPO Form-Factor Review**

Overview of mechanical and electrical design

## **XPO Emulation Box Review**

Overview of emulation platform

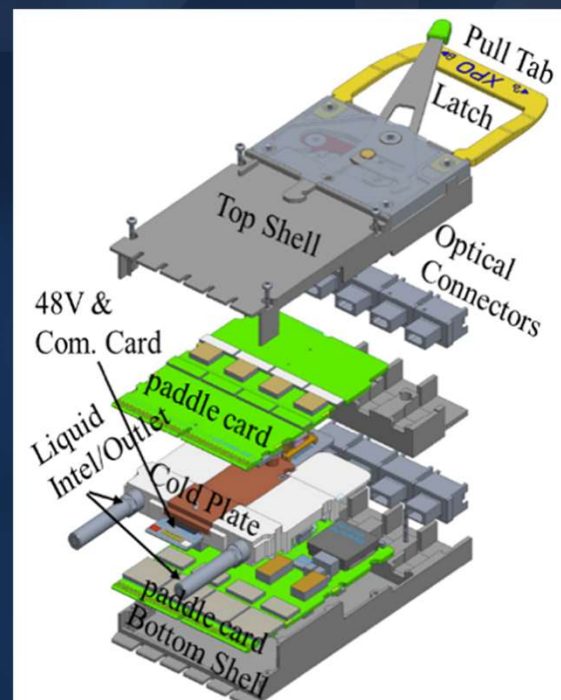
## **Demonstration of Liquid-Cooled 64-Channel Pluggable XPO LRO**

Review of various performance metrics demonstrating XPO LRO capability

# XPO Form-Factor Review

## Key Aspect of the XPO Module:

- 2 Identical High Speed Paddle Cards, each card supporting 32 channels of 200G/lane
- Integrated Cold Plate cooling both paddle cards
- 8 MPO16 Optical Connectors
- Liquid Inlet/Outlet Quick Disconnects
- Separate low speed Card and 48V input card
- Ejector Latch

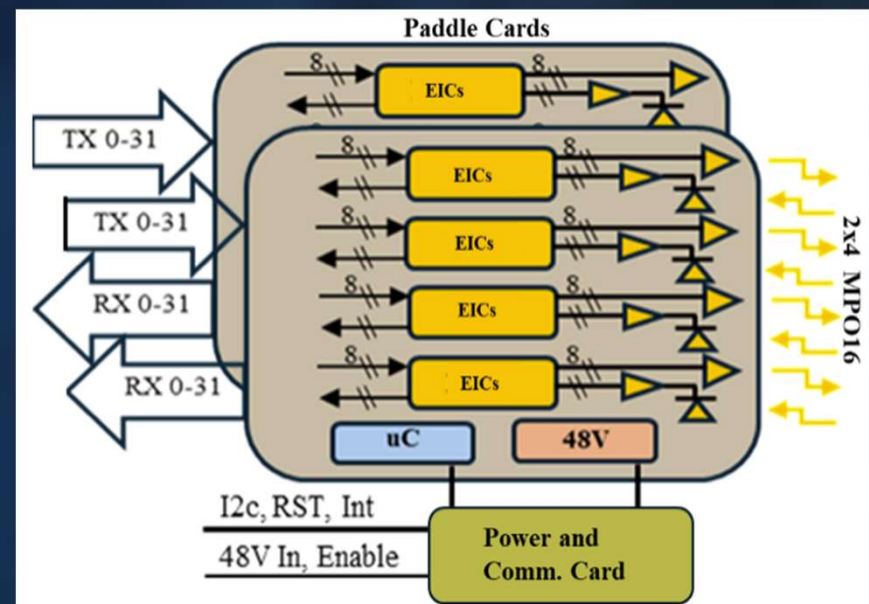


# Electrical Design of the 12.8T LRO Module

The LRO module consists of two paddle cards.

Each paddle card features the following components.

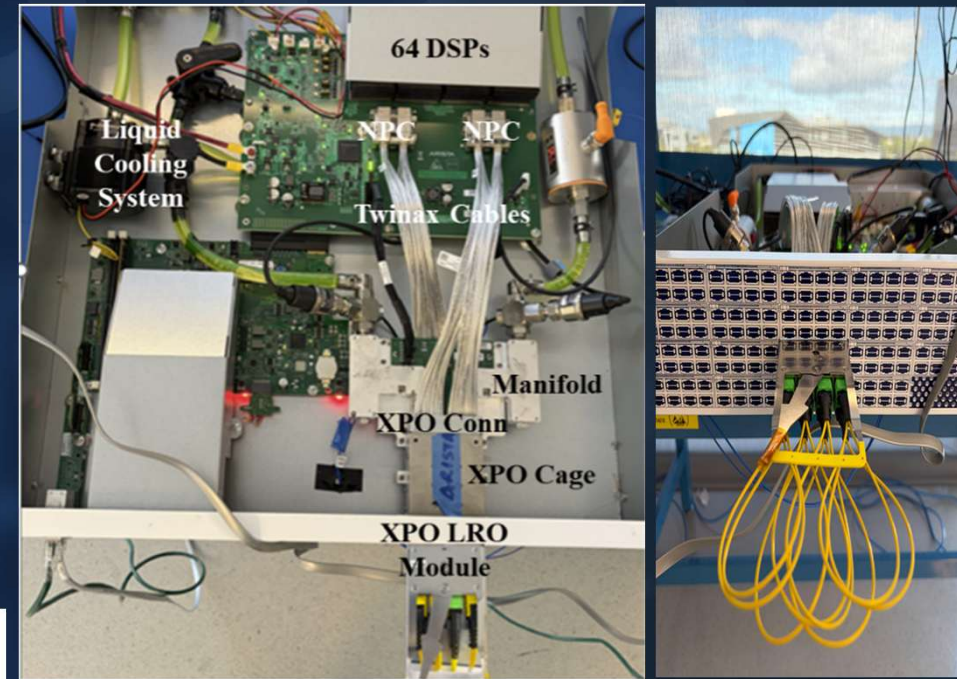
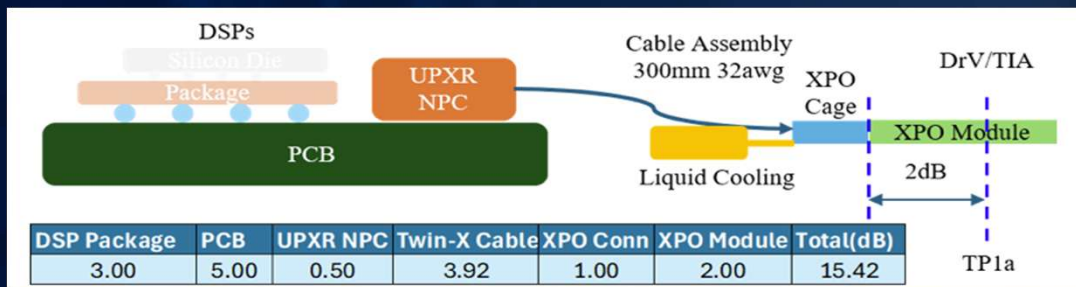
- 4 1.6T transmit-only 3 nm DSPs with Integrated linear driver
- 4 PICs (8x212Gbps)
- 16 100mW continuous-wave lasers
- 8 4x212 Gbps TIAs with Integrated 2.5D photodiodes
- 1 microcontroller 32 channel control and monitor
- 1 48V to lower voltage rails conversion Circuit



# XPO Emulation Platform

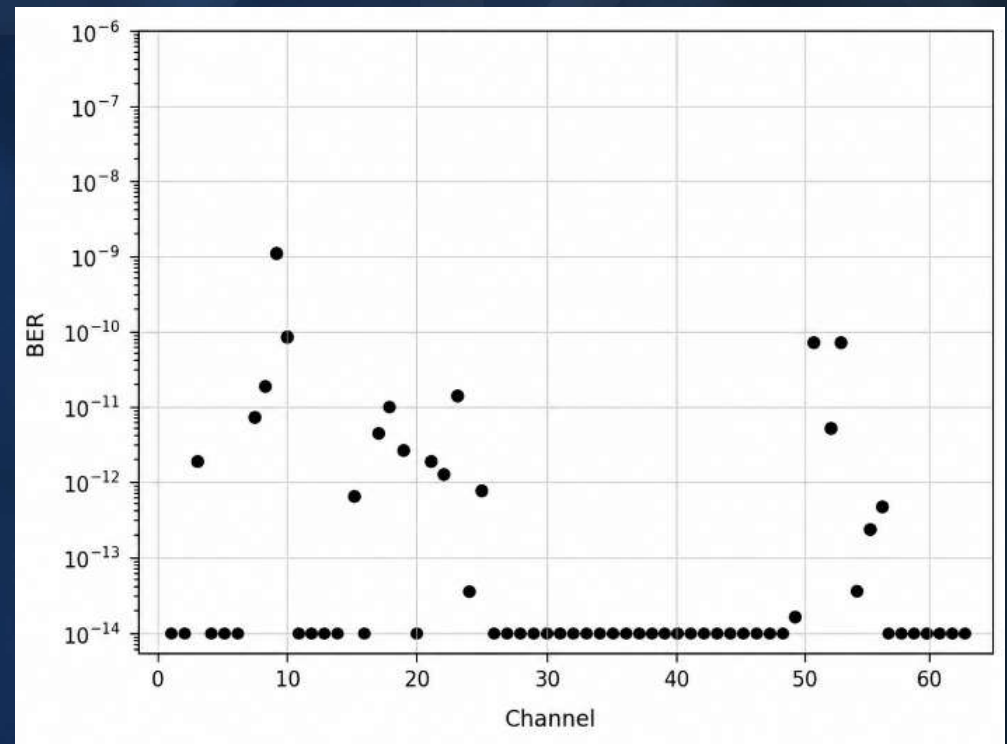
The Arista-designed emulation box, equipped with 212 Gb/s SerDes, was developed to exercise all 64 channels of the XPO LRO module. The emulation platform featured the following characteristics

- 4 Agera3 DSPs - 16 lanes 212 Gbps each
- NPC Copper Flyover Cables
- 300 mm long 32 AWG Twinax
- Integrated Liquid Cooling
- 15 dB bump-to-bump insertion loss



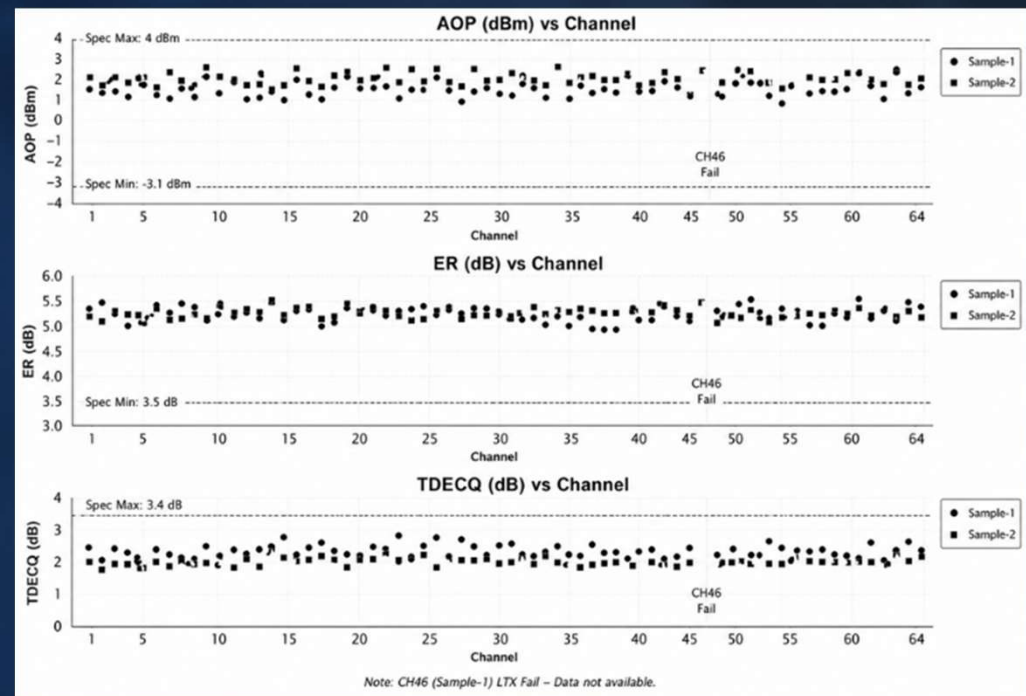
# XPO Emulation Box Verification

- Test setup: Passive electrical loopback XPO module
- 64 TX channels looped back to corresponding RX channels through PCB copper traces
- Two-way insertion loss:  $\sim 30$  dB at 53 GHz Nyquist frequency
- Measured BER: Better than  $1 \times 10^{-10}$  for most channels with one outlier channel



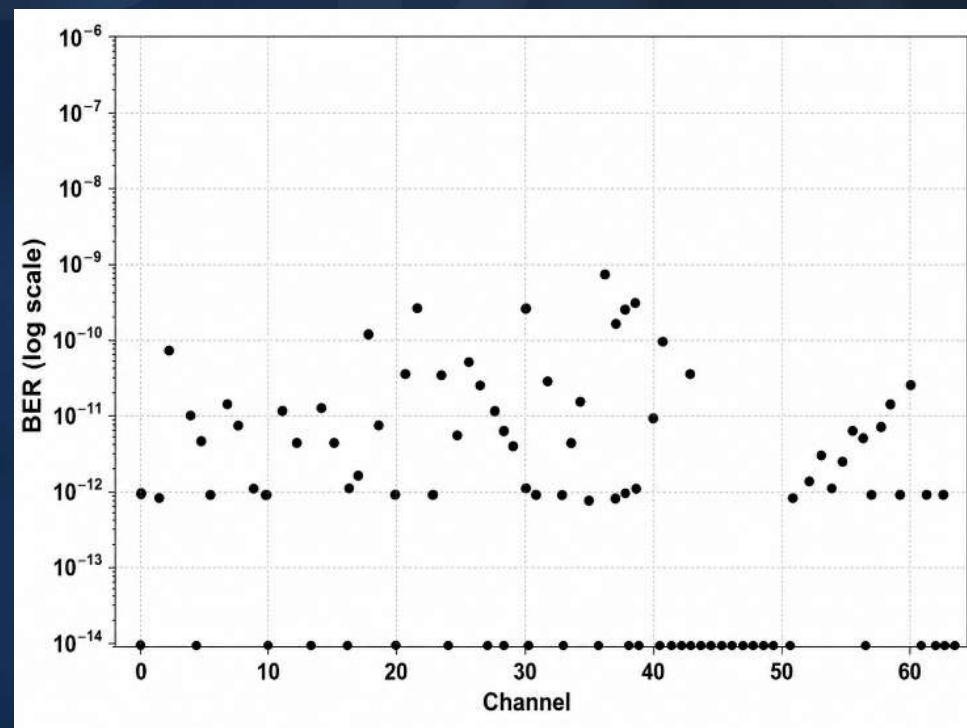
# 12.8T XPO LRO Module Results - TX Performance

- Test setup: 12.8T LRO XPO module tested using the XPO emulation box
- TX measurements: AOP, ER, and TDECQ
- Test equipment: Keysight DCA-N1093A with 1 dB attenuation
- Equalization: 15-tap FFE at 106.25 GBd (3 pre-taps, IEEE 802.3dj Draft 2.0)
- Measured AOP: 2.36 dBm
- Measured ER: 5.19 dB
- Measured TDECQ: 2.26 dB
- Result: All 64 channels were well within the required specification limits



# 12.8T XPO LRO Module Results - RX Performance

- Test configuration: Optical loopback using integrated DSP error detectors
- Measured BER: Better than  $1 \times 10^{-9}$  across all channels
- Channel insertion loss: 15 dB
- Result: Excellent linear receiver performance across all channels
- Overall performance: TX and RX results meet the 212 Gb/s IEEE P802.3dj/df optical



# 12.8T XPO LRO Module Results - Power Consumption

- Total module power: ~130 W
- Energy efficiency: ~10 pJ/bit
- Power per 1.6T port: ~16.5 W, comparable to a 1.6T OSFP LRO module
- Power architecture: 48 V  $\rightarrow$  12 V  $\rightarrow$  5 V, 3.3 V, and lower-voltage rails
- Power-conversion efficiency: ~92%
- Lower-voltage rails supply the DSPs and associated components

# Summary

- Demonstrated a 12.8T, 64-channel, liquid-cooled XPO LRO pluggable optical module and a 64-channel XPO emulation platform
- Emulation platform validated all electrical TX/RX channels with ~30 dB bidirectional insertion loss, achieving BER  $< 1 \times 10^{-10}$  for most channels
- XPO LRO module achieved BER  $< 1 \times 10^{-9}$  over a 15 dB die-to-die channel at 212 Gb/s PAM4
- TX and RX performance met IEEE P802.3dj/df specifications
- Total module power of ~130 W, corresponding to ~10 pJ/bit and ~16.5 W per 1.6T port
- Demonstrates XPO as a scalable, high-density, energy-efficient, and serviceable pluggable optical architecture for next-generation hyperscale AI infrastructure

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Thank You